

Financial Incentives for Teachers in STEM fields: A National Data Set

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Abstract

In this paper, I describe the process to obtain a national data set of state-sponsored financial incentives utilized to recruit and retain teachers in STEM fields. The resulting products are two data sets in Stata format: [STEM_Programs_State_Level.dta](#) and [STEM_Programs_Program_Level.dta](#) which are available to researchers¹. Between 1983 and 2016, 41 states implemented 87 unique financial programs aimed at increasing the supply of teachers, especially in shortage subject and geographic areas. The most common program type is scholarship-loan, followed by loan forgiveness. Most programs focus on increasing supply of teachers in Mathematics and Science. Finally, a visual representation (maps) of the variation across states of programs characteristics is also presented.

I Motivation

A Teacher Shortages in the US

There is a longstanding view that there is a serious shortage of mathematics and science teachers in the US K-12 public education system (Guthrie & Zusman, 1982; Darling-Hammond & Skyes, 2003; Murphy, DeArmond, & Guin, 2003; Chin, Young, & Floyd, 2004; Moin, Dorfield, & Schunn, 2005; NCCTQ, 2007; Podolsky and Kini, 2016). The teacher shortage problem has two dimensions. The first is **geographical** in which hard-to-staff schools are usually located in high-poverty neighborhoods; these hard-to-staff schools and districts often have difficulties attracting and retaining qualified and fully licensed teachers (Chin, Young, & Floyd, 2004; Podlsky and Kini, 2016; Ingersoll & Perda, 2010; Darling-Hammond & Skyes, 2003). Shortages also exist in **subject areas** such as mathematics and science (Chin, Young, & Floyd, 2004; Podlsky and Kini, 2016; NCCTQ, 2007). Individuals with knowledge and experience in these areas can earn significantly higher starting salaries in private job sectors.

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¹Note to my dissertation committee: Please do not share the data files yet until this paper is published. The main reason I placed the links here is for you to see the final products of this paper. I am not comfortable sharing the data files to the public yet. Thanks.

A deeper look into the problem reveals that, the shortage problem does not emerge because the supply does not match demand. The real problem lies in the **unequal distribution** of high quality teachers with surpluses in some areas and shortages in others (Darling-Hammond & Skyes, 2003). Ingersoll & Perda (2010) point out that teacher shortages result from an uneven production of new teachers across locales.

Darling-Hammond & Skyes (2003) state that there are longstanding shortages in particular fields which result from more attractive earnings opportunities outside teaching. For example, when compared with what could have been their salary outside teaching, mathematics and science teachers suffer larger wage disparities than those teaching English and social studies. The opportunity cost for college graduates trained in mathematics and science is higher if they want to teach. Moin et al. (2005) point out that, nationally, between 1993 and 1999, 39 percent of school districts reported having math and science teacher vacancies.

Moreover, teacher pay is not only relatively low but, during the 1990's has even declined relative to other professions. Even after adjusting for the shorter work year in teaching, teachers earn 15 to 30 percent less than college graduates who enter other occupations (Darling-Hammond & Skyes, 2003). In a similar venue, Podlsky & Kini, (2016) point out that even after adjusting for a shorter work year, beginning teachers, nationally earn about 20% less than individuals with college degrees who enter other occupations; the gap widens to 30% by mid career.

Another reason behind the teacher shortages is the pre-retirement teacher attrition/turnover (Ingersoll & Perda, 2010). According to Darling-Hammond & Skyes (2003), since 1990 the annual outflow of teachers has surpassed the influx by increasingly large margins. As many as 20 percent of new teachers may leave teaching after 3 years and around 30 percent after five years. In addition, teacher turnover is 50 percent higher in high-poverty schools than in more affluent ones.

In sum, the evidence suggests that, the shortage problem is due to, (1) an uneven distribution of teachers; while some regions have shortages other regions have surpluses; (2) the shortage in fields like math and science is driven by wage differentials that favor occupations outside teaching, therefore, increasing the opportunity costs for individuals who have math and science knowledge and are willing to teach (Darling-Hammond & Skyes, 2003; Ingersoll and Perda, 2010). Also, (3) the wage differentials between teaching and non-teaching occupations is another driver of teacher shortages, and finally, (4), the high levels of attrition characteristic of the teaching profession,

especially within the first five years, contributes to the teacher shortages problem.

Indeed, more research is needed to better understand the sorting mechanisms of teachers within schools. If teachers are allocated into schools according to the price choice theory, then it should suffice for school districts to increase the wages high enough for teachers to fill up the positions. If teachers are sorted into schools by other mechanisms not related with pecuniary compensation then other solutions must be sought. Apparently, the responses by state governments to teacher shortages imply that the price choice theory is the prevailing sorting mechanism of teachers into schools. If this is the case, the shortages are artificially generated by the school districts when they do not increase wages high enough.

B States' Response to Teacher Shortages

In response to teacher shortages, in recent decades, states have implemented a wide range of initiatives aimed to recruit new teachers - especially in mathematics and science (Arfin, 1986; Ingersoll & Perda, 2010; Darling-Hammond & Hudson, 1990). These programs include emergency certification, out of field assignments to fill vacancies, alternative certification programs, scholarships, bonuses and student loan forgiveness, among others (Moin et al., 2005).

Typically, the financial incentives are in the form of scholarship/loans, forgivable loans and tuition reimbursement for new teachers (Chin, Young, & Floyd, 2004; Podolsky & Kini, 2016), and signing bonuses for current teachers (Clotfelter, Glennie, Ladd, & Vigdor, 2007; 2008). The program recipients must commit to teaching in hard-to-staff schools and/or to teach in subjects areas such as mathematics and science (Chin, Young, & Floyd, 2004; Podolsky & Kini, 2016).

This study focuses on financial incentives implemented by states aimed to increase teachers' labor supply, especially in mathematics and science and critical shortage areas. Some states might address the teacher shortage problem by using non-financial incentives such as out of field certification programs. In these cases, this data do not capture that activity. Instead, the data and analyses presented here only involve financial incentives.

C Research Questions and Contribution

Given the intense efforts made by state governments to recruit highly qualified teachers across all locales and subjects, the research questions guiding this study are the following:

1. Starting in 1980, which states have implemented financial incentive programs aimed to recruit and retain teachers in STEM fields?
2. What is the purpose of each program?
3. What is the size of each program in terms of the number of recipients?
4. What is the size of each program in terms of expenditures?
5. What is the average duration of the programs?
6. What are the different types of programs (e.g., loans, scholarship, etc)?
7. What are the focus of the programs (e.g., math and science, shortage areas, etc)?
8. When normalized to account for state education systems' size (number of teachers and students), what is the distribution of STEM program characteristics across states?
9. Is there a geographic pattern across the US states in terms of the above variables?

This study intends to contribute to the literature of teachers' labor supply decisions by creating a data set that includes all state-sponsored financial incentive programs aimed to recruit and retain teachers, especially in mathematics and science, and/or critical shortage areas. A goal of this study is the creation of a national data set that allows researchers, by merging this data with other data sources, to answer the following research questions:

- What is the impact of financial incentives for teachers on student education outcomes such as academic achievement, high school graduation, college access and success, etc.?
- What is the impact of financial incentives for teachers on teacher labor supply decisions?
- What is the impact of financial incentives for teachers on the distribution of teaching credentials across districts?
- Do financial incentives for teachers play a role in shaping equality of opportunity to high quality teachers?
- Do financial incentives for teachers impact the stock of teachers at the state and district levels?

The above questions, are only a small set out of all possible questions that researchers might answer with these data. One of the main contributions of this study is to put forward this data set, and encourage researchers to use it in their research endeavors.

This paper is organized as follows. In section (II), I review the literature of financial incentives and teachers' labor supply. In section (III), I describe the existing data sources of financial incentives for teachers and present the process I followed to construct a new data set of financial aid programs

aimed at increasing the supply of teachers in math and science and/or critical shortage geographic areas. In this section, I also define the variables included in the data set. In section (IV), I present the main results of the paper such as the program characteristics at the program level, and, variation of program characteristics across states. In this section, I also include a visual representation of the distribution of program characteristics in a US map. Conclusions are presented in section (V).

II Related Literature - Financial Incentives and Teachers' Labor Supply

Even when many states have implemented financial incentive programs aimed at increasing the supply of teachers, especially in under-privileged geographic areas and/or in content areas such as mathematics and science, there is little evidence of the impact of these initiatives (Berry & Hirsch, 2005).

To my knowledge, there are only three studies that assess the impact of financial incentives aimed at recruiting teachers to understaffed schools. Steele, Murnane and Willett (2010) exploited a natural experiment in California to evaluate the impact of the Governor's Teacher Fellowship (GTF) on the probability to teach in low-performing schools. The GTF was created in 2000 and subsequently eliminated in 2002, provided \$20,000 to newly licensed teachers who work for four years at schools in the bottom half of the state's Academic Performance Index (API). The purpose of the study was to estimate the impact of GTF on the decisions of new teachers to begin their careers in low performing schools.

The sample included individuals who were enrolled in a teacher licensure program during the academic years 1998-1999, 1999-2000, 2000-2001, 2001-2002 and 2002-2003, and who were also APLE² recipients. Only students enrolled in post-baccalaureate teacher licensure programs during the 2000-2001 and 2001-2002 academic years were eligible to apply. The outcome was a binary variable that indicates whether or not individuals began working in low-performing schools within two years after the licensure program's first enrollment. The treatment variable was equal to 1 if individuals received the GTF, and 0 otherwise.

Since the acquisition of GTF is endogenous, they used eligibility to receive GTF as instrument for receiving GTF. Eligibility was equal to 1 if individuals were enrolled during the academic years

²APLE stands for Assumption Program of Loans for Education.

2000-2001 and 2001-2002; the active years of the program. The results indicate that receiving the GTF increased the probability of starting working in a low-performing school by 28 percentage points.

Clotfelter, Glennie, Ladd and Vigdor (2008) examined the impact of the Math, Science and Special Education (MSSE) Teacher Recruitment Program in North Carolina. Between 2001 and 2004, the state of North Carolina offered a \$1,800 annual salary bonus to certified math, science, and special education teachers who worked at low-performing and high-poverty middle schools and high schools. By using a triple difference-in-differences analyses within a discrete time hazard model, the authors estimated the impact of the bonus program on the hazard rates of teachers.

The triple difference exploited three types of eligibility: schools, subjects and time. The hazard rate was defined as the probability of ending a teaching spell during year $t + 1$ conditional on having taught in year t . The results indicate that the bonus program reduced turnover rates by about 17%.

Finally, Feng and Sass (2015) analyzed the impact of the Florida Critical Teacher Shortage Program (FCTSP) on teacher attrition. One arm of the FCTSP provided loan forgiveness to certified teachers who worked in designated shortage areas. The other arm provided tuition reimbursement³ to teachers who pursued certification.

In 2011, the maximum amount of tuition reimbursement was \$2,808, and the maximum amount forgiven, for up to four years, was \$2,500 per year for undergraduates and \$5,000 per year for graduate students. Similarly to Clotfelter et al (2008), Feng and Sass also estimated a difference-in-differences model within a discrete hazard approach. The hazard rate represents the probability that a teaching spell ends at period $t + 1$ conditional on being active in period t . They also used subject and time eligibility to perform the difference-in-differences approach. The results indicate that the loan forgiveness arm of the program reduced the probability of leaving teaching by 8.6% for science high school teachers, and, by 11% for middle and high school math teachers.

In sum, the evidence presented suggests that there is a positive effect of the above mentioned programs on recruitment and retention of teachers in shortage areas. Teachers respond to financial incentives. Nevertheless, more research is still needed to understand whether or not the financial incentives aimed at increasing teachers' labor supply are effective in providing equality of access to

³Tuition reimbursement was applied directly to tuition costs of the certification.

high quality teachers to all students, regardless of their socioeconomic background.

III Construction of a National Data Set

A Existing data on financial incentives for teachers

To my knowledge, there are only two institutions that collect information about state-sponsored financial incentives aimed to recruit and retain teachers: The [Education Commission of the States \(ECS\)](#) and the [National Association of State Student Grant and Aid Programs \(NASSGAP\)](#). In both cases, the information is collected and analyzed at the state level.

According to Aragon (2016) from ECS, most states have implemented financial incentives to improve teacher recruitment and retention. She divides the financial incentives in three types: **salary requirements** (e.g., minimum salary and salary schedules), **diversified pay**, i.e., differential payment aimed to attract teachers to work in hard-to-staff schools and/or shortage subject areas, and, **pay-for-performance**, to recognize excellence in teaching. Based on these categories, 7 states have implemented a minimum salary requirement, 17 states have programs based on salary schedules⁴, 23 states have implemented diversified pay, and 16 states have pay-for-performance programs.

Zinth (2008), also from ECS, conducted a 50-state analysis of state recruitment efforts of high school teachers in STEM fields. She concluded that 37 states provide loan-forgiveness, scholarship or tuition reimbursement to individuals seeking certification who agree to teach in shortage subject areas such as Math and Science. Also, she found that 12 states offer supplemental pay for teachers in STEM fields.

The information from ECS, although rich in content it was last [updated](#) in 2008. In addition, the report is presented as a snapshot in time and not as a time series and therefore, it is difficult to analyze the dynamics of creation or elimination of the programs. In any case, as I will mention later in this paper, I utilized the ECS report as the seminal list of all the financial incentives aimed at recruiting STEM teachers in high school.

The National Association of State Student Grant and Aid Programs (NASSGAP) conducts an annual survey about state-sponsored financial aid programs. Unlike ECS, NASSGAP collects the

⁴Differential pay according to credentials and experience

information in a year-by-year basis. Among other elements, it collects program name, expenditures, recipients, and type. The reports span from 1977 to 2015. Unlike, ECS, the information from NASSGAP does not include program description, eligibility requirements, participant commitments, and, law statutes.

Even though this paper utilizes information from ECS and NASSGAP, many financial aid programs that I eventually found using the process described later in the paper, were not included in either ECS or NASSGAP data sets.

B A New Data Set of Financial Incentives for Teachers

For this study, I define STEM Teacher Recruitment Programs or just STEM programs as any financial aid utilized to recruit teachers, with emphasis on, but not limited to, mathematics and science and/or critical shortage geographic areas. First, I identified the websites that contained information about state-sponsored financial aid programs aimed at recruiting math and science teachers as well as teachers to work in critical shortage geographic areas.

Even though there might be additional websites with this information, in the observation period from May 2016 to September 2016, this is the smallest set that includes all the programs: Education Commission of the States www.ecs.org, www.iteachamerica.org, www.mathteaching.org, www.teachtomorrow.org, www.teachingdegree.org, www.collegegrant.net, www.credible.com, www.collegescholarship.org and www.collegeinvestor.com.

The outcome of the first step is a list of all the state-sponsored financial aid programs aimed at recruiting math and/or science teachers as well as teachers to work in critical shortage geographic areas; in other words, a list of all STEM programs. This list included only three variables: state, program name and program description.

Next, for each program, I searched for the following information: the first year of implementation, last year the program was active or observed on the internet, the per-year budget allocated⁵, and, the per-year number of recipients. For some programs, I also collected contact information, eligibility requirements, and responsibilities. In this search process I relied on www.google.com, www.yahoo.com, and www.bing.com.

This process led me to informational websites like the ones described above, websites of higher

⁵The budget allocated includes overhead costs. Therefore, the recipients did not necessarily receive all the money

education state institutions (e.g., Alabama Commission On Higher Education <http://www.ache.alabama.gov/>, California Student Aid Commission <http://www.csac.ca.gov/>), state legal statutes (e.g., Louisiana <http://law.justia.com/codes/louisiana/2011/rs/title17/rs17-427-2>, Missouri <http://law.justia.com/codes/missouri/2015/title-xi/chapter-173>), state departments of education (e.g., Mississippi [http://www.mde.k12.ms.us/OTC/SLF\\$,Oklahoma\\$http://www.okhighered.org/state-system/overview/part3.shtml](http://www.mde.k12.ms.us/OTC/SLF$,Oklahoma$http://www.okhighered.org/state-system/overview/part3.shtml)), and state assistance authorities (e.g., North Carolina http://www.ncseaa.edu/pdf/FTNC_Current_Announcement.pdf). Finally, I complemented the information with reports from the National Association of State Student Grant and Aid Programs ([NASSGAP](#)).

Even when the search was conducted exclusively using the Internet, which appear in the mid 1990's, most historical records and documents have been digitalized and made available to the public. Thus, if a STEM program was implemented during the early 1980's or 1990's the probability to find it on the Internet is still very high.

Finally, the program-level data set includes the following variables: state, program name, program description, the first year of implementation, the last year observed, the average per-year expenditures, and the average per-year number of recipients. It is noteworthy that, for the programs with more than one year of information on expenditures and recipients, after adjusting for inflation⁶, I calculated the average across all available years. The program level data set can be found in this [link](#). All the programs found were implemented as early as 1983; therefore, the time frame I use in this paper covers all the years between 1983 and 2016.

C Examples of STEM Programs

There is a sizable variation across all programs regarding program types, assigned budgets, the number of participants and eligibility requirements. For example, in 2001 Alabama implemented the Mathematics and Science Scholarship-Loan Program for Alabama Teachers (MSSPAT) which is awarded to Alabama residents attending an Alabama university and seeking a teaching degree in math or science. Recipients must commit to teaching for five years in a critical shortage school.

In 2007, Arizona launched the Mathematics, Science, and Special Education Teacher Student Loan Program to defray in-state tuition, instructional materials and mandatory fees for students pursuing a teaching degree. Loans may be taken out for five years, and are forgiven on a one year

⁶In 2011 real USD

of loan basis for one year of service in a public school teaching mathematics or science.

California implemented the Assumption Program of Loans for Education (APLE), which is a competitive teacher incentive program that encourages outstanding students to become teachers in subject areas where teacher shortages have been identified. Examples of these fields are 7th to 12th grade mathematics and life/physical sciences. In order to be eligible for loan reimbursement, the prospective teacher must agree to teach in a public school for four years.

Finally, Colorado, in 2001 started the Colorado Loan Incentive for Teachers (LIFT) which is a program that offers up to \$2,000 in loan forgiveness per year, for up to four years for teachers who began teaching math, science, special education, or linguistically diverse education on or after June 11, 2001.

Without being comprehensive, the programs above give the reader a notion of the types of programs included in this study. Indeed, over the last three decades many states have implemented financial incentives aimed at increasing the supply of teachers. The complete list of all the programs can be downloaded [here](#).

D Definition of Variables - Program Level Data

Since the program-level data includes the start and end years of each program as well as recipients and expenditures, for each program, I constructed the following vectors. The vector `expenditures` is a 1X34 row vector that includes the elements `expenditures_1983`, `expenditures_1984`, ..., `expenditures_2016`, which are equal to the average expenditure per program for the years between the start year and end year; 0 otherwise. Similarly, the vector `recipients`, is also a 1X34 row vector that includes the variables `recipients_1983`, `recipients_1984`, ..., `recipients_2016`; these elements are equal to the average number of recipients for the years the program was active and 0 otherwise. Since the data includes all the states regardless of whether or not they implemented STEM programs, I created a variable named `stem_program` which is equal to one if the state implemented at least one STEM program between 1983 and 2016 and 0 otherwise.

Based on the variable `program description`, I coded the variable `program type` which includes the following categories: 1) `loan forgiveness` is a financial aid program in which the recipient already has debt and the hiring institution will pay some or all the loan to the lender according to the program rules. Under this program type individuals are expected to teach in public schools,

especially in shortage areas. 2) **scholarship**; this program type induces individuals into teaching by paying tuition costs to obtain teaching degrees. There is no obligation for the recipient to teach. 3) **scholarship loan**, this is the most commonly utilized program in which states finance college tuition and fees with the expectation that recipients will teach in public schools for a number of years after college graduation. If the recipient does not teach as agreed, the scholarship is converted into a loan which the recipient must pay. 4) **tuition reimbursement**, is a program type in which individuals are reimbursed part of all their college or graduate tuition costs with the expectation that the recipient will teach in a subject or geographic shortage area. Finally, 5) **salary bonus** is utilized to induce current teachers into shortage subject or geographic areas. Each program was assigned to only one category.

Again, based on the variable **program description**, I coded four dummy variables that provide information about the program **focus**. Unlike program type, one program could have more than one focus. The **program focus** variables are: **math & science**, **critical shortage area**, **low performing schools** and, **minorities**. These variables are equal to one if, in the program description these themes (e.g., math and science, low performing schools, etc) are mentioned; 0 otherwise.

In sum, the program-level data set includes the following variables: **state**, **program name**, **program description**, **start year**, **end year**, **duration**⁷, **average per-year recipients**, **average per-year expenditures** and the vectors **recipients** and **expenditures**.

E Definition of Variables - State Level Data

Based on the program-level data, I created the state-level data by collapsing the variables at the state level. In this process, the variables **program name** and **program description** are no longer relevant. The variable **program type** was converted to dummy variables. The variable **star year** is the earliest year in which states implemented their first STEM program; **end year** is the latest year in which states have at least one active STEM program. The variable **duration** is the difference between **end year** and **start year**.

All the variables **recipients_1983**, ..., **recipients_2016**, **expenditures_1983**, ..., **expenditures_2016**, **average per-year recipients**, **average per-year expenditures**, **loan forgiveness**, **scholarship**,

⁷Duration = end year - start year.

scholarship-loan, tuition reimbursement, salary bonus, math and science, critical shortage area, low performing schools, and minorities were collapsed from program level to state level by adding rows within each state.

Consequently, for example, the state-level variable `recipients_2000` represents the sum across all programs within each state of the average per-year number of recipients in 2000. Similarly, the variable `math and science` represents the number of different STEM programs focused on math and science each state has ever implemented.

To account for the size of the states' education systems, I combined the state-level data of STEM programs with information from the National Center for Education Statistics (NCES) - Common Core of Data (CCD). For each state-year between 1983 to 2016, I collected the following quantities: number of students K-12, number of high school students, number of teachers and number of secondary school teachers.

By combining the state-level STEM programs data with data from the CCD, I calculated the following variables per state-year: recipients per 1,000 teachers, recipients per 1,000 secondary school teachers, recipients per 1,000 students, recipients per 1,000 high school students, expenditures per teacher, expenditures per secondary school teacher, expenditures per student and expenditures per high school student. This is the [link](#) to the state-level data.

IV STEM Programs Characteristics

A STEM Program Characteristics - Variation Across Programs

In this section, I describe the characteristics of the STEM programs both at the program and state levels. Between 1983 and 2016, 41 states implemented at least one STEM program; in total 87 unique programs were found. As table (1) indicates, the most common program type is scholarship-loan (64%). This implies that most participants obtain financial aid to pay their college education, especially to become teachers. Once graduated, they are required to teach in a public school, most likely math and science and/or in a shortage geographic area. This incentive intends to increase the supply of new teachers by inducing individuals who are currently enrolled in college or who will start college, to become math and science teachers in public schools.

The second most common STEM program type is loan forgiveness (20%). This program type serves mainly current teachers who want to pay their student debt by teaching in a hard-to-staff school and/or teaching math and science.

Table 1: Distribution of Program Types. N=87

Program Type	N	%
Loan Forgiveness	17	20
Scholarship	7	8
Scholarship/Loan	56	64
Tuition Reimbursement	1	1
Salary Bonus	6	7
Total	87	100

Source: STEM Programs - Program Level.dta.

There are seven STEM programs that are scholarships, six salary bonuses and only one tuition reimbursement. Regarding program focus, table (2) includes the proportion of programs, that focus on math and science, critical shortage areas, low performing schools and minorities.

For instance, 47% of the programs focus on math and science; in other words, they are intended to induce individuals to teach mathematics and science. Also, 41% of the programs focus on critical shortage geographic areas. In fact, some programs focus on both. The third focus, minorities, as its name indicates, induces individuals from minority groups into teaching. Finally, only 4.6% of the programs focus on low performing schools. Notably, the California Assumption Program of Loans for Education, APLE, focuses on low performing schools as well as on math and science.

Table 2: Proportion of Programs with Specific Focus. N=87

Program Focus	Mean	Sd
Math and Science	0.47	0.50
Critical Shortage Areas	0.41	.50
Low Performing Schools	0.046	0.21
Minorities	0.10	0.31

Source: STEM Programs - Program Level.dta.

In table (3), I present combined information of program type and program focus. Of the 17 loan forgiveness programs, 65% focus on math and science and 47% focus on critical shortage areas. In addition, of the 56 scholarship-loan programs, 41% emphasize math and science; 39% aim to increase teachers' supply in critical shortage areas; 9% focus on minorities and 3.6% focus on low performing schools. The two most popular program types - scholarship-loan and loan forgiveness - address shortages in math and science as well as shortages in critical geographic areas.

Table 3: Program Type vs Program Focus. N=87

Program Type	Math and Science	Critical Shortage Areas	Low Performing	Minorities	N
Loan Forgiveness	.65	.47	0	0	17
Scholarship	.29	.14	0	.57	7
Scholarship/Loan	.41	.39	.036	.089	56
Tuition Reimbursement	0	1	0	0	1
Salary Bonus	.83	.67	.33	0	6
Total	.47	.41	.046	.10	87

Source: STEM Programs - Program Level.dta.

In order to gauge the size of the programs in terms of the number of recipients, table (4) includes

the distribution of program grantees across the 87 programs. As shown, 54% of the programs serve, on average, 250 or less individuals per year. The percentages above the first bracket is too scattered to note any pattern. Noticeably, there are three programs with 2,000 grantees or more and eight with no information about how many individuals they serve.

Table 4: Average annual recipients. N=87

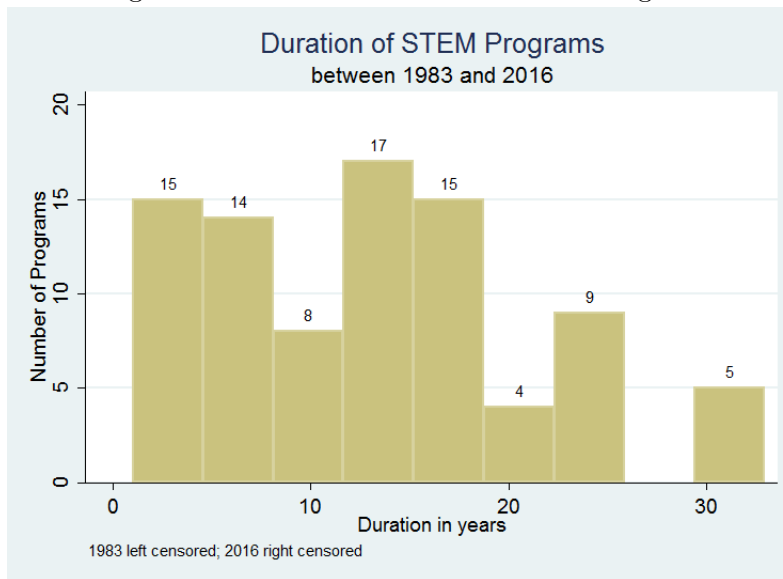
Average Annual Recipients	N	%
[0, 250]	47	54.02
(250,500]	14	16.09
(500,750]	2	2.30
(750,1000]	5	5.75
(1000,1250]	2	2.30
(1500,1750]	4	4.60
(1750,2000]	2	2.30
(2000,+]	3	3.45
missing	8	9.20
Total	87	100

Source: STEM Programs - Program Level.dta.

Moreover, between 1983 and 2016, some programs were implemented and eliminated. For instance, as figure (1) indicates, 15 programs were observed for a period of less than five years, 29 lasted less than 10 years; 8 were observed to last exactly 10 years; 22 programs lasted between 10 and 20 years, and, 18 programs lasted 20 years or more. In fact, 5 programs were observed throughout the entire observation period.

Importantly, 1983 and 2016 are the censoring years, which means that, even when some programs might have started before 1983, they are coded as starting in 1983. Similarly, there might be programs that are active after 2016; nevertheless, for those programs 2016 is the last year they were observed in the data.

Figure 1: Duration in Years of STEM Programs



Regarding when the programs were first and last observed, table (5) includes the distribution of start and end years for all the programs. There are 3 programs that started in 1983 or before. Also, in 1991, 11 programs started, and combining 2001, 2002 and 2003, 25 programs were born. These patterns require further explanation because starting in 2001, many states were interested in increasing teachers' labor supply. A potential reason might be the passing of the No Child Left Behind (NCLB) Law in 2001 which entered into effect in 2002. After this period, some states started STEM programs but not with the 2001-2003 intensity. Regarding the end year of the programs, 2014 seems to be the year in which many states decided to drop the support for these programs as 32 programs disappeared. In addition, 25 programs were last observed in 2016, which implies that they might still be active.

An alternate measure of the programs' size is annual expenditures. Table (6) shows the distribution of annual expenditures across the 87 programs. All the monetary measures were inflation adjusted to represent 2011 real dollars. As table (6) indicates, almost half of the programs spent 0.5 Million or less per year. There is a large variation across the programs regarding the budget allocated.

Table 5: Distribution of Start and End years. N=87

Year	Start	End	Year	Start	End
1983	3		2001	9	
1984	3		2002	9	
1985	1		2003	7	
1986	1		2004	2	2
1988	1		2005	3	1
1989		1	2006	3	
1990		1	2007	3	1
1991	11		2008	2	2
1992	1		2009	4	2
1993	1	1	2010		6
1994	2		2011	1	2
1995	2		2012	1	5
1996	1		2013	4	2
1997	1	1	2014	1	32
1998	3		2015		3
1999	3		2016		25
2000	4		Total	87	87

Source: STEM Programs - Program Level.dta.

Table 6: Distribution of Annual Expenditures (2011 USD). N=87

Annual Expenditures (2011USD)	N	%
[0, \$0.5M]	41	47
(\$0.5M, \$1M]	9	10
(\$1M, \$1.5M]	8	9
(\$1.5M, \$2M]	4	5
(\$2M, \$2.5M]	4	5
(\$2.5M, \$3M]	5	6
(\$3M, \$3.5M]	2	2
(\$3.5M, \$4M]	1	1
(\$4M, \$4.5M]	2	2
(\$4.5M, 5M]	1	1
(\$5M, \$5.5M]	2	2
(\$5.5M, +]	8	9
Total	87	100

Source: STEM Programs - Program Level.dta.

B STEM Program Characteristics - Variation Across States

The above mentioned tables and graphs refer to individual programs and do not account for the size of the different education systems. For instance, having 250 grantees per year is a large number for Wyoming but a very small for New York or California. In the following paragraphs, I discuss STEM program characteristics normalized to account for state by year number of teachers and students. By doing so, I compare STEM program characteristics across states.

Table (7) includes summary statistics of all the variables collapsed at the state level. For instance, **duration** was calculated as the difference between the latest year each state had an active STEM program minus the earliest year the same state had an active STEM program. Recall that some states have more than one STEM program and the start and end years of these programs within each state need not to coincide. Of the 34 observed years, the "life expectancy" of the programs is about 13 years. In this case, both the mean and the median coincide.

Some states have been working during a long time in recruiting teachers through STEM programs. For instance, California, Delaware, Oklahoma and South Carolina all have at least one active STEM program for at least 30 years. Other states (and DC) don't have any STEM programs for the same time period: Alaska, DC, Michigan, Minnesota, Nevada, New Hampshire, New Jersey, Oregon, Rhode Island and Vermont.

The average number of **recipients** is about 892; however, the median is 136. This implies that there are some states that invest in their STEM programs very heavily. For example, New York's programs serve about 12,000 individuals per year, North Carolina's programs impact about 5,400 individuals, and California's program impacts about 4,800 individuals each year. The programs of Idaho, Wyoming and Hawaii impact less than 30 individuals per year.

The mean **expenditures** is about 4 Million and again, the median is about 0.5 Million. This implies that there are large states that invest heavily. The four states with the highest investments are New York, North Carolina, Iowa and California. It is important to consider that the budgets assigned might or might not include overhead costs, thus, not all the money is assigned to program participants.

The variables **recipients per 1,000 teachers**, **expenditures per teacher**, **recipients per 1,000 secondary teachers**, **expenditures per secondary teachers**, **recipients per 1,000**

students, expenditures per student, recipients per 1,000 high school students, and, expenditures per high school student were calculated as follows. First, the state-level variables, recipients_1983 ,..., recipients_2016, expenditures_1983 ,..., expenditures_2016 were divided by the corresponding (by year) measure of teachers_1983 ,..., teachers_2016, students_1983 ,..., students_2016, secondary_ teachers_1983 ,..., secondary_ teachers_2016, and high_school_ students_1983 ,..., high_school_ students_2016.

Next, for each state, I calculated the average (mean of elements in the row) of all non-missing values of the recipients per 1,000 teachers, expenditures per teacher, recipients per 1,000 secondary teachers), expenditures per secondary teachers, recipients per 1,000 students), expenditures per student, recipients per 1,000 high school students), and, expenditures per high school student. Table (7) includes the summary statistics using across-state variation. The resulting statistics account now for the education system size across states.

For instance, for every 1,000 teachers around 6 individuals participate in STEM programs, and, for each teacher, the expenditures in STEM programs is about \$30 USD. For every 1,000 secondary teachers, about 16 individuals participate in STEM programs. Also, for each secondary teacher, expenditures in STEM programs are about \$83, and for every 1,000 students, 0.37 individuals are STEM programs grantees. Additionally, for each student, states spend about \$2 in STEM programs and for each 1,000 high school students, about 1.27 individuals participate in STEM programs. Finally, for each high school student, states invest about \$7 in STEM programs.

Table 7: State Level Program Characteristics. N=87

	mean	sd	min	max	p10	p25	p50	p75	p90
Duration (years)	13	10	0	33	0	2	13	22	24
Annual recipients	892	2,025	0	12,229	0	23	136	807	2,686
Annual expenditures	\$4,098,705	\$8,056,020	\$0	\$45,100,000	\$0	\$144,050	\$538,598	\$4,623,649	\$9,365,375
Recipients / (1,000 teachers)	5.63	9.86	0.00	54.80	0.00	0.06	1.92	6.40	14.24
Expenditures / teacher	\$29.46	\$45.88	\$0.00	\$191.82	\$0.00	\$0.46	\$9.31	\$37.48	\$69.00
Recipients / (1,000 secondary teachers)	16.16	28.58	0.00	150.31	0.00	0.18	3.91	16.47	37.57
Expenditures / secondary teacher	\$83.18	\$131.86	\$0.00	\$523.63	\$0.00	\$1.50	\$23.19	\$130.69	\$232.66
Recipients / (1,000 students)	0.37	0.64	0.00	3.43	0.00	0.00	0.14	0.41	0.94
Expenditures / student	\$1.94	\$3.01	\$0.00	\$12.49	\$0.00	\$0.03	\$0.65	\$2.81	\$4.94
Recipients / (1,000 high school students)	1.27	2.30	0.00	12.91	0.00	0.01	0.48	1.44	3.40
Expenditure / high school student	\$6.66	\$10.49	\$0.00	\$45.37	\$0.00	\$0.12	\$2.18	\$9.31	\$17.45
Loan Forgiveness	0.33	0.48	0.00	1.00	0.00	0.00	0.00	1.00	1.00
Scholarship	0.14	0.35	0.00	1.00	0.00	0.00	0.00	0.00	1.00
Scholarship / Loan	1.10	1.20	0.00	5.00	0.00	0.00	1.00	2.00	2.00
Tuition Reimbursement	0.02	0.14	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Salary Bonus	0.12	0.38	0.00	2.00	0.00	0.00	0.00	0.00	0.00
Math and Science	0.80	0.85	0.00	3.00	0.00	0.00	1.00	1.00	2.00
Critical Shortage Area	0.71	0.97	0.00	4.00	0.00	0.00	0.00	1.00	2.00
Low Performing Schools	0.08	0.34	0.00	2.00	0.00	0.00	0.00	0.00	0.00
Minorities	0.18	0.39	0.00	1.00	0.00	0.00	0.00	0.00	1.00

Source: STEM Programs - State Level.dta.

Furthermore, the variables `loan forgiveness`, `scholarship`, `scholarship-loan`, `tuition reimbursement`, and `salary bonus` were calculated as follows. When the data was at the program level, these variables were dummy variables. When the data was transformed to state-level, these dummies were collapsed by adding the values of these dummies within each state. If, for instance, a state has two programs in the `loan forgiveness` category, then its state-level value on the variable `loan forgiveness` is equal to 2.

As table (7) indicates, the average number of loan forgiveness programs is about 0.33. The corresponding statistics for `scholarship`, `scholarship-loan`, `tuition reimbursement`, and `salary bonus` are, respectively 0.14, 1.1, 0.02 and 0.12. Across all the states, the conclusion is the same, the most popular program type is `scholarship-loan`, followed by `loan forgiveness`.

The variables `math and science`, `critical shortage areas`, `low performing schools` and `minorities` were calculated similarly to the program type variables. When collapsing from program-level to state-level each variable was calculated as the sum of the dummy variables within each state. Across all states, the number of programs focused on math and science is about 0.8 and focusing on critical shortage areas is about 0.71.

Table (8) presents state-level information regarding STEM program characteristics. As mentioned, `start` refers to the earliest year in which each state implemented at least one STEM program. Some states have implemented STEM programs since the beginning of the observation period. For example, California (1983), Connecticut (1983), Delaware (1984), Pennsylvania (1984), Oklahoma (1985), South Carolina (1984) and Washington (1983). The states with the largest program size in terms of program recipients are: New York, North Carolina, California, Georgia and Florida. Regarding average annual expenditures the states with the largest investments are New York, North Carolina, Iowa, California, Mississippi, Georgia, Illinois, South Carolina and Utah.

Table 8: Across States Distribution of STEM Programs Characteristics

State	Start	End	Duration	Recipients ⁸	Expenditures ⁹
Alabama	2001	2016	15	176	\$846,652
Alaska			0	0	\$0
Arizona	2011	2014	3	36	\$193,677
Arkansas	1994	2014	18	827	\$3,104,066

⁸Average annual recipients

⁹Average annual expenditures

California	1983	2016	33	4,788	\$16,591,672
Colorado	2001	2008	7	248	\$443,040
Connecticut	1983	2014	12	383	\$3,059,283
Delaware	1984	2016	32	34	\$395,875
DC			0	0	\$0
Florida	1991	2014	19	3,109	\$4,580,539
Georgia	1995	2011	16	3,551	\$9,365,375
Hawaii	2002	2004	2	23	\$119,000
Idaho	1992	1993	1	28	\$84,864
Illinois	1986	2016	30	1,207	\$8,652,812
Indiana	1991	2014	23	214	\$317,478
Iowa	2001	2016	13	639	\$16,884,974
Kansas	2005	2007	2	36	\$191,500
Kentucky	1991	2014	23	1,550	\$4,623,649
Louisiana	2003	2005	2	33	\$244,000
Maine	1998	2014	16	340	\$1,099,799
Maryland	1991	2014	19	433	\$2,027,210
Massachusetts	1999	2016	17	807	\$6,403,656
Michigan			0	0	\$0
Minnesota			0	0	\$0
Mississippi	1991	2016	23	2,686	\$9,713,505
Missouri	2003	2015	11	300	\$538,598
Montana	2007	2016	9	120	\$364,000
Nebraska	2000	2012	12	0	\$3,429,000
Nevada			0	0	\$0
New Hampshire			0	0	\$0
New Jersey			0	0	\$0
New Mexico	1994	2016	22	40	\$144,050
New York	2000	2016	16	12,229	\$45,119,421
North Carolina	2001	2014	12	5,428	\$29,482,719
North Dakota	2001	2014	13	285	\$298,125
Ohio	2009	2016	7	0	\$6,825,000
Oklahoma	1985	2016	31	136	\$494,325
Oregon			0	0	\$0
Pennsylvania	1984	2008	24	2,168	\$6,576,526
Rhode Island			0	0	\$0
South Carolina	1984	2016	32	1,405	\$8,651,061
South Dakota	2003	2016	13	117	\$1,859,350
Tennessee	1991	2014	23	293	\$1,290,925
Texas	2001	2016	15	820	\$3,899,257
Utah	1996	2016	18	465	\$8,426,077
Vermont			0	0	\$0
Virginia	2002	2014	12	277	\$928,490
Washington	1983	2014	23	87	\$386,308
West Virginia	1991	2014	23	64	\$269,828
Wisconsin	1998	2014	16	91	\$244,258
Wyoming	1997	2015	18	24	\$864,000

All monetary measures are presented in inflation adjusted in 2011 USD. The average annual recipients and expenditures were calculated as the average of non-zero quantities across row after transforming from Program Level to State Level data. Source: `STEM Programs - State Level.dta`.

Table (9) includes the number of programs by type that each state has implemented. As previously mentioned, the most popular type is scholarship-loan. For instance, North Carolina and Mississippi have implemented 5 scholarship-loan programs; Illinois, South Carolina and Missouri implemented 3 scholarship-loan programs. Other program types appear 2 times or less in each state.

Table 9: Across States Distribution of STEM Program Type

State	Loan givenness	For- Scholarship	Scholarship Loan	Tuition Reimburse- ment	Salary bonus
Alabama	0	0	2	0	0
Alaska	0	0	0	0	0
Arizona	0	0	1	0	0
Arkansas	1	1	1	0	0
California	0	0	1	0	0
Colorado	1	0	0	0	0
Connecticut	0	1	1	0	0
Delaware	0	0	2	0	0
DC	0	0	0	0	0
Florida	0	0	2	1	0
Georgia	0	0	2	0	0
Hawaii	0	0	1	0	0
Idaho	0	0	1	0	0
Illinois	1	0	3	0	0
Indiana	0	1	0	0	0
Iowa	1	0	1	0	1
Kansas	0	0	1	0	0
Kentucky	0	1	1	0	0
Louisiana	0	0	0	0	1
Maine	0	1	0	0	0
Maryland	1	0	2	0	0
Massachusetts	0	0	2	0	0
Michigan	0	0	0	0	0
Minnesota	0	0	0	0	0
Mississippi	1	1	5	0	0
Missouri	0	0	3	0	0
Montana	1	0	0	0	0
Nebraska	0	0	1	0	0
Nevada	0	0	0	0	0
New Hampshire	0	0	0	0	0

New Jersey	0	0	0	0	0
New Mexico	1	0	1	0	0
New York	0	0	2	0	0
North Carolina	0	0	5	0	2
North Dakota	1	0	0	0	0
Ohio	1	0	0	0	1
Oklahoma	1	0	1	0	0
Oregon	0	0	0	0	0
Pennsylvania	1	0	1	0	0
Rhode Island	0	0	0	0	0
South Carolina	1	0	3	0	0
South Dakota	0	0	2	0	0
Tennessee	1	0	2	0	0
Texas	1	0	1	0	0
Utah	0	0	2	0	1
Vermont	0	0	0	0	0
Virginia	0	0	1	0	0
Washington	1	0	1	0	0
West Virginia	0	1	0	0	0
Wisconsin	1	0	0	0	0
Wyoming	0	0	1	0	0

Each cell represents the number of programs each state has from each program type. Source: **STEM Programs - State Level .dta**.

Regarding program focus, table (10) presents the distribution of programs by state. North Carolina and Mississippi have both three programs focused on increasing teacher labor supply in math and science, and, New York, Utah, Maryland, Delaware, Arkansas, Connecticut, Washington and Ohio have all two programs focused on math and science teachers. Mississippi is the state with the largest number of programs focused on critical shortage areas (4), followed by South Carolina (3), and, North Carolina, Arkansas, Illinois, South Dakota, Alabama, Iowa, Georgia, Florida and New Mexico have all two programs focused on critical shortage areas.

Table 10: Across States Distribution of STEM Program Focus

State	Math & Science	Critical Shortage Area	Low Performing Schools	Minorities
Alabama	1	2	0	0
Alaska	0	0	0	0
Arizona	1	0	0	0
Arkansas	2	2	0	1
California	1	0	1	0
Colorado	1	0	0	0
Connecticut	2	1	0	1

Delaware	2	0	0	0
DC	0	0	0	0
Florida	0	2	0	1
Georgia	0	2	0	0
Hawaii	1	0	0	0
Idaho	0	0	0	0
Illinois	1	2	0	1
Indiana	0	0	0	1
Iowa	1	2	0	0
Kansas	1	1	0	0
Kentucky	1	0	0	1
Louisiana	1	1	0	0
Maine	0	0	0	0
Maryland	2	0	0	0
Massachusetts	1	0	0	0
Michigan	0	0	0	0
Minnesota	0	0	0	0
Mississippi	3	4	0	0
Missouri	0	0	1	1
Montana	1	1	0	0
Nebraska	0	1	0	0
Nevada	0	0	0	0
New Hampshire	0	0	0	0
New Jersey	0	0	0	0
New Mexico	0	2	0	0
New York	2	1	0	0
North Carolina	3	2	2	1
North Dakota	1	1	0	0
Ohio	2	1	0	0
Oklahoma	1	1	0	0
Oregon	0	0	0	0
Pennsylvania	1	1	0	0
Rhode Island	0	0	0	0
South Carolina	1	3	0	0
South Dakota	1	2	0	0
Tennessee	0	0	0	1
Texas	1	1	0	0
Utah	2	0	0	0
Vermont	0	0	0	0
Virginia	1	0	0	0
Washington	2	0	0	0
West Virginia	0	0	0	0
Wisconsin	0	0	0	0
Wyoming	0	0	0	0

Each cell represents the number of programs each state has from each program focus. Source: **STEM Programs - State Level.dta**.

When STEM program characteristics are normalized to account for the size of the states' ed-

education systems the results are presented in table (11). Mississippi, South Carolina, New York, California and Kentucky are the states with the largest ratio of STEM program recipients per 1,000 teachers. In addition, the states with the highest ratio of STEM program expenditures per teacher are Mississippi, Iowa, South Carolina, Utah and New York. The states with the largest ratio of STEM program recipients per 1,000 students are Mississippi, New York, South Carolina, North Dakota and Kentucky. Finally, the states with the largest ratio of STEM program expenditures per student are Iowa, Mississippi, South Carolina, New York and Wyoming.

Table 11: Across States Distribution of STEM Program Normalized Characteristics

State	Recip. /		Exp /		Recip. /		Exp /		Recip. /		Exp /	
	1000	teach- ers	teacher	1000	sec teachers	1000	stu- dents	student	1000	hs stu- dents	hs stu- dents	hs students
Alabama	1.18		\$5.82	3.21		\$15.95	0.08	\$0.39	0.27		\$1.34	
Alaska	0.00		\$0.00	0.00		\$0.00	0.00	\$0.00	0.00		\$0.00	
Arizona	0.09		\$0.46	0.29		\$1.56	0.00	\$0.02	0.01		\$0.07	
Arkansas	5.80		\$23.69	13.74		\$55.68	0.41	\$1.68	1.44		\$5.84	
California	19.26		\$66.76	67.14		\$232.66	0.86	\$2.96	2.97		\$10.30	
Colorado	1.27		\$2.26	2.65		\$4.74	0.08	\$0.13	0.26		\$0.46	
Connecticut	2.79		\$21.58	6.87		\$50.41	0.21	\$1.60	0.70		\$5.44	
Delaware	2.17		\$36.51	4.33		\$72.94	0.14	\$2.37	0.48		\$8.03	
DC	0.00		\$0.00	0.00		\$0.00	0.00	\$0.00	0.00		\$0.00	
Florida	11.35		\$14.50	29.99		\$38.27	0.66	\$0.86	2.35		\$3.01	
Georgia	14.24		\$37.48	35.00		\$92.13	0.94	\$2.47	3.40		\$8.95	
Hawaii	0.18		\$0.95	0.39		\$2.01	0.01	\$0.06	0.04		\$0.20	
Idaho	0.14		\$0.42	0.30		\$0.90	0.01	\$0.02	0.02		\$0.07	
Illinois	6.40		\$48.31	22.80		\$172.22	0.40	\$3.00	1.38		\$10.43	
Indiana	2.57		\$3.81	5.85		\$8.66	0.15	\$0.22	0.51		\$0.75	
Iowa	4.46		\$173.78	13.13		\$498.67	0.32	\$12.49	1.05		\$40.67	
Kansas	0.09		\$0.49	0.18		\$0.98	0.01	\$0.04	0.02		\$0.12	
Kentucky	17.73		\$58.70	70.09		\$228.25	1.10	\$3.63	3.87		\$12.78	
Louisiana	0.06		\$0.45	0.20		\$1.50	0.00	\$0.03	0.02		\$0.12	
Maine	10.50		\$34.01	33.25		\$107.69	0.87	\$2.81	2.80		\$9.07	
Maryland	3.14		\$15.59	7.52		\$37.08	0.21	\$1.02	0.69		\$3.42	
Massachusetts	6.00		\$47.65	16.47		\$130.69	0.44	\$3.51	1.49		\$11.83	
Michigan	0.00		\$0.00	0.00		\$0.00	0.00	\$0.00	0.00		\$0.00	
Minnesota	0.00		\$0.00	0.00		\$0.00	0.00	\$0.00	0.00		\$0.00	
Mississippi	54.80		\$191.82	150.31		\$523.63	3.43	\$12.05	12.91		\$45.37	
Missouri	1.06		\$2.06	2.19		\$4.26	0.08	\$0.15	0.25		\$0.50	
Montana	3.41		\$10.35	10.90		\$33.07	0.25	\$0.75	0.82		\$2.48	
Nebraska	0.00		\$60.70	0.00		\$162.22	0.00	\$4.51	0.00		\$14.58	
Nevada	0.00		\$0.00	0.00		\$0.00	0.00	\$0.00	0.00		\$0.00	

New Hampshire	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00
New Jersey	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00
New Mexico	1.00	\$3.81	3.59	\$13.79	0.06	\$0.25	0.22	\$0.84
New York	28.70	\$105.66	75.15	\$276.67	2.18	\$8.04	7.33	\$27.00
North Carolina	10.61	\$68.07	30.32	\$193.25	0.71	\$4.60	2.49	\$16.00
North Dakota	14.18	\$14.82	37.57	\$39.29	1.18	\$1.23	3.69	\$3.86
Ohio	0.00	\$10.61	0.00	\$23.19	0.00	\$0.66	0.00	\$2.18
Oklahoma	2.80	\$7.24	6.52	\$16.76	0.18	\$0.47	0.65	\$1.70
Oregon	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00
Pennsylvania	6.69	\$20.35	15.40	\$46.84	0.40	\$1.23	1.38	\$4.21
Rhode Island	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00
South Carolina	28.84	\$158.24	90.23	\$496.88	1.83	\$10.09	6.42	\$35.44
South Dakota	3.77	\$36.80	13.89	\$137.02	0.28	\$2.70	0.94	\$9.31
Tennessee	2.42	\$11.21	8.69	\$40.26	0.15	\$0.71	0.54	\$2.51
Texas	0.99	\$4.71	2.51	\$11.94	0.07	\$0.32	0.24	\$1.14
Utah	10.88	\$112.80	26.87	\$279.18	0.48	\$4.94	1.66	\$17.53
Vermont	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00	0.00	\$0.00
Virginia	1.26	\$4.22	2.34	\$7.82	0.09	\$0.29	0.28	\$0.95
Washington	1.21	\$5.37	2.95	\$13.14	0.06	\$0.27	0.20	\$0.90
West Virginia	2.21	\$9.31	5.69	\$23.93	0.16	\$0.65	0.52	\$2.21
Wisconsin	0.77	\$2.06	1.97	\$5.29	0.05	\$0.14	0.16	\$0.44
Wyoming	1.92	\$69.00	3.91	\$140.78	0.15	\$5.39	0.48	\$17.45

All monetary measures are presented in inflation adjusted in 2011 USD. All measures were calculated as the average of non-zero quantities across row after transforming from Program Level to State Level data. Source: **STEM Programs - State Level.dta**.

C STEM Program Characteristics - Variation Across States: Maps

The following analyses rely on maps generated using state-level information. Figure (2) shows across-state variation in duration, recipients and expenditures. For duration, the pattern is clear; the states with the largest duration of STEM programs are Illinois, Indiana, Kentucky, Tennessee, Mississippi, South Carolina, West Virginia, Pennsylvania, Oklahoma, California and Washington. Interestingly, most states are near each other. Regarding annual recipients, the states with the greatest number of STEM program recipients are located in the South (Texas) and South East as well as California. Finally, in terms of expenditures, the states with the highest investments in STEM programs are located in the East and South East.

Figure (3) shows the between-state variation in program type. For instance, states with loan forgiveness STEM programs are located in the North (Oregon, Montana, North Dakota), the South (New Mexico, Texas, Oklahoma, Arkansas, Colorado, Tennessee and Mississippi), as well as in the Midwest (Wisconsin, Illinois, Iowa, Ohio), and one state in the East (Pennsylvania). The states that concentrate most of the scholarship-loan STEM programs are Illinois, Missouri, Mississippi, North Carolina and South Carolina. This finding is important since most of the STEM programs are scholarship-loans. Tuition reimbursement programs are located in Florida and scholarships are located in Indiana, Kentucky, West Virginia, Arkansas, Mississippi and Maine.

Figure (4) shows the variation across states in terms of program focus. Notably, most states have at least one program focused on math and science. Some states have more than one program devoted to attract math and science teachers (Washington, Utah, Arkansas, Mississippi, Ohio, North Carolina and New York). Conversely, the states that invest in STEM programs focused on critical shortage areas are concentrated mainly in the South-East and in the Mid-West. STEM Programs with focus on low performing schools are scarce, and are located in California, Missouri and North Carolina. Finally, states with STEM Programs aimed to attract minorities into teaching are located in the Mid-West.

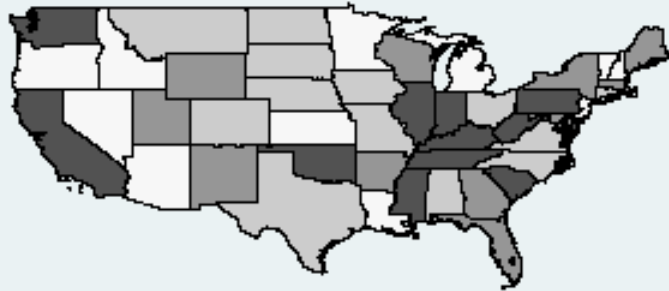
In terms of the normalized number of recipients, figure (5) shows the between-state variation in four measures: recipients per 1,000 teachers, recipients per 1,000 secondary teachers, recipients per 1,000 students and recipients per 1,000 high school students. In the four cases, the states with the highest number of recipients per unit of either teachers or students are located in the East and

South-East, although there are also states in the West like California and Utah.

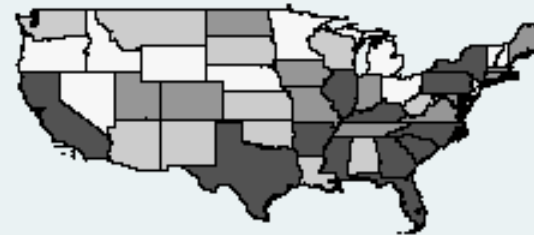
Finally, regarding the normalized version of expenditures, figure (6) shows the between state variation in expenditures per teacher, expenditures per secondary teacher, expenditures per student and expenditures per high school student. In the four cases, the states that invest the heaviest are located across all the mid-range of the US (California, Utah, Wyoming, Nevada, Iowa, Illinois, Kentucky, Missouri, North Carolina and South Carolina and New York).

Figure 2: Across-State variation on: Duration, Recipients and Expenditures

Duration: years of active STEM programs
Between 1983 and 2016



Average recipients
Between 1983 and 2016



Average expenditures
Between 1983 and 2016

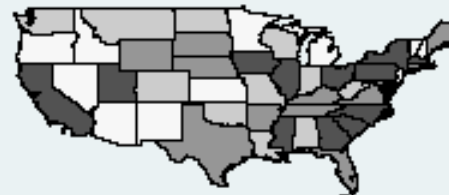


Figure 3: Across-State variation on: Program Type

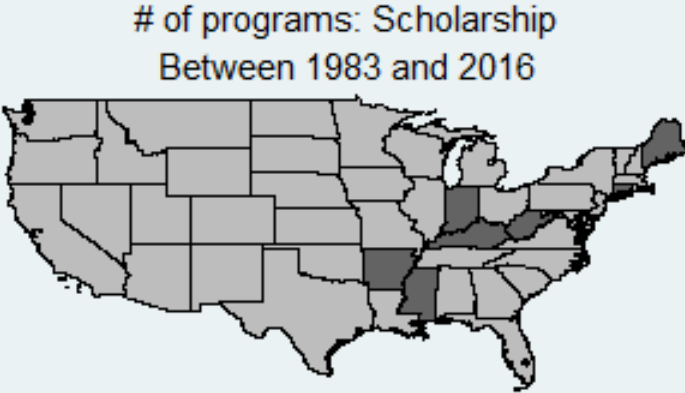
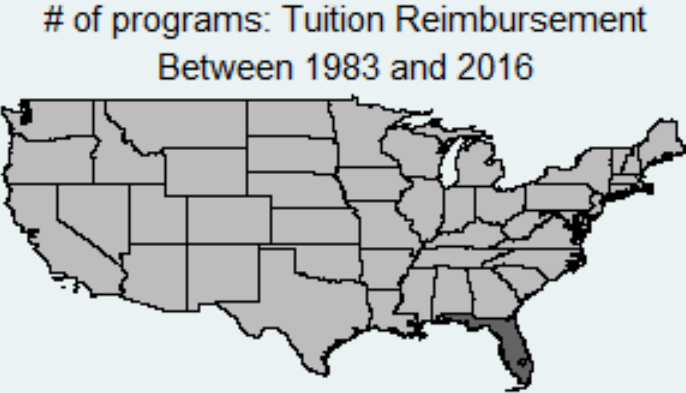
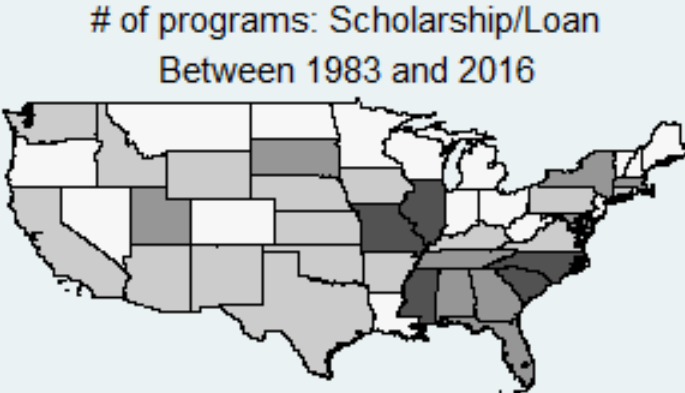
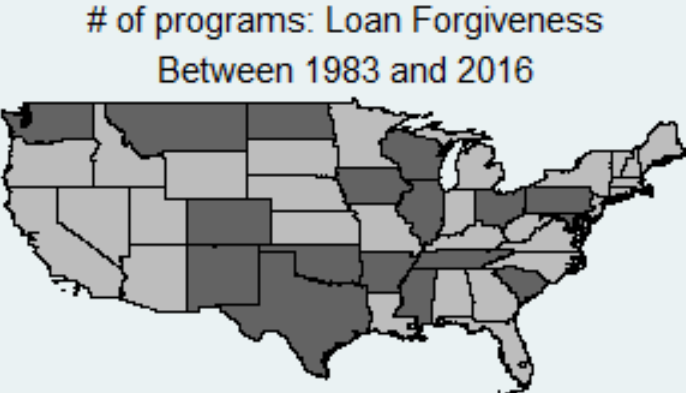
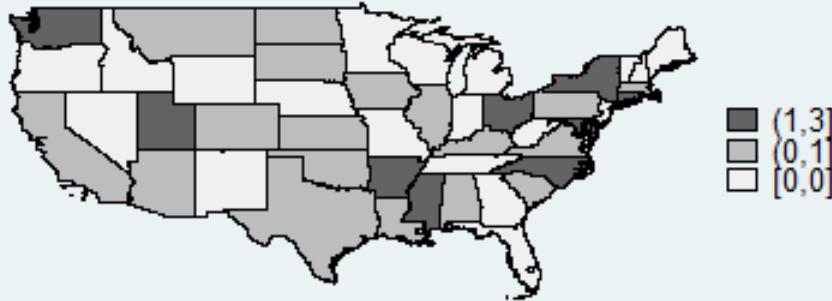
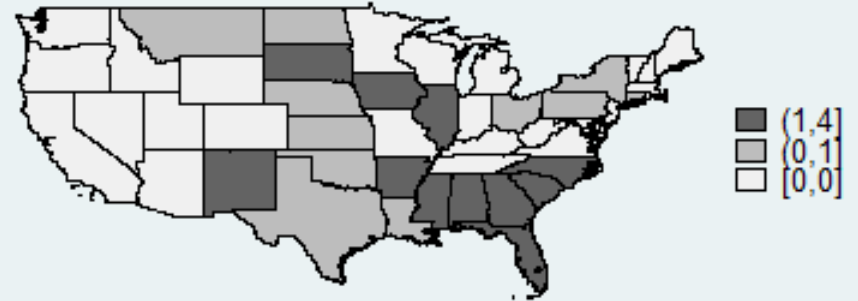


Figure 4: Across-State variation on: Program Focus

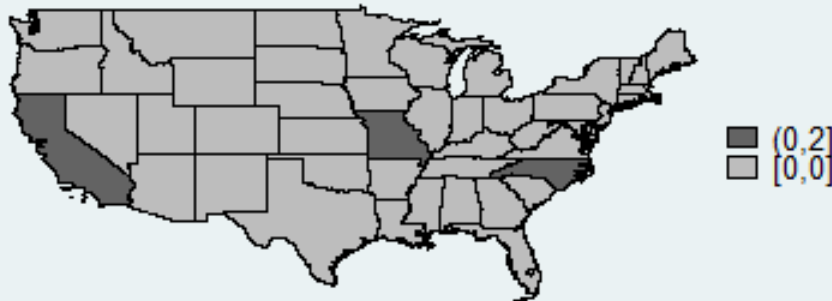
of programs: Math and Science
Between 1983 and 2016



of programs: Shortage Areas
Between 1983 and 2016



of programs: Low Performing Schools
Between 1983 and 2016



of programs: Minorities
Between 1983 and 2016

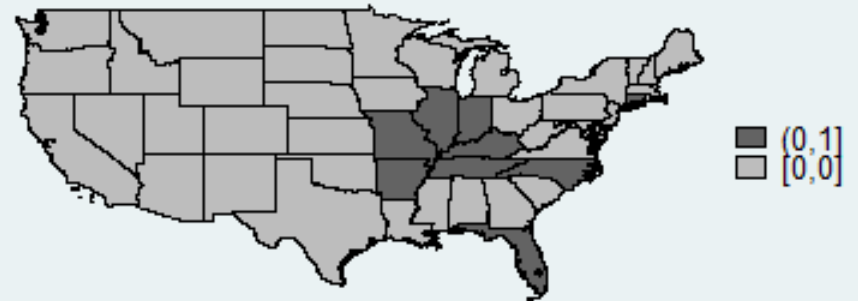


Figure 5: Across-State variation on: Recipients

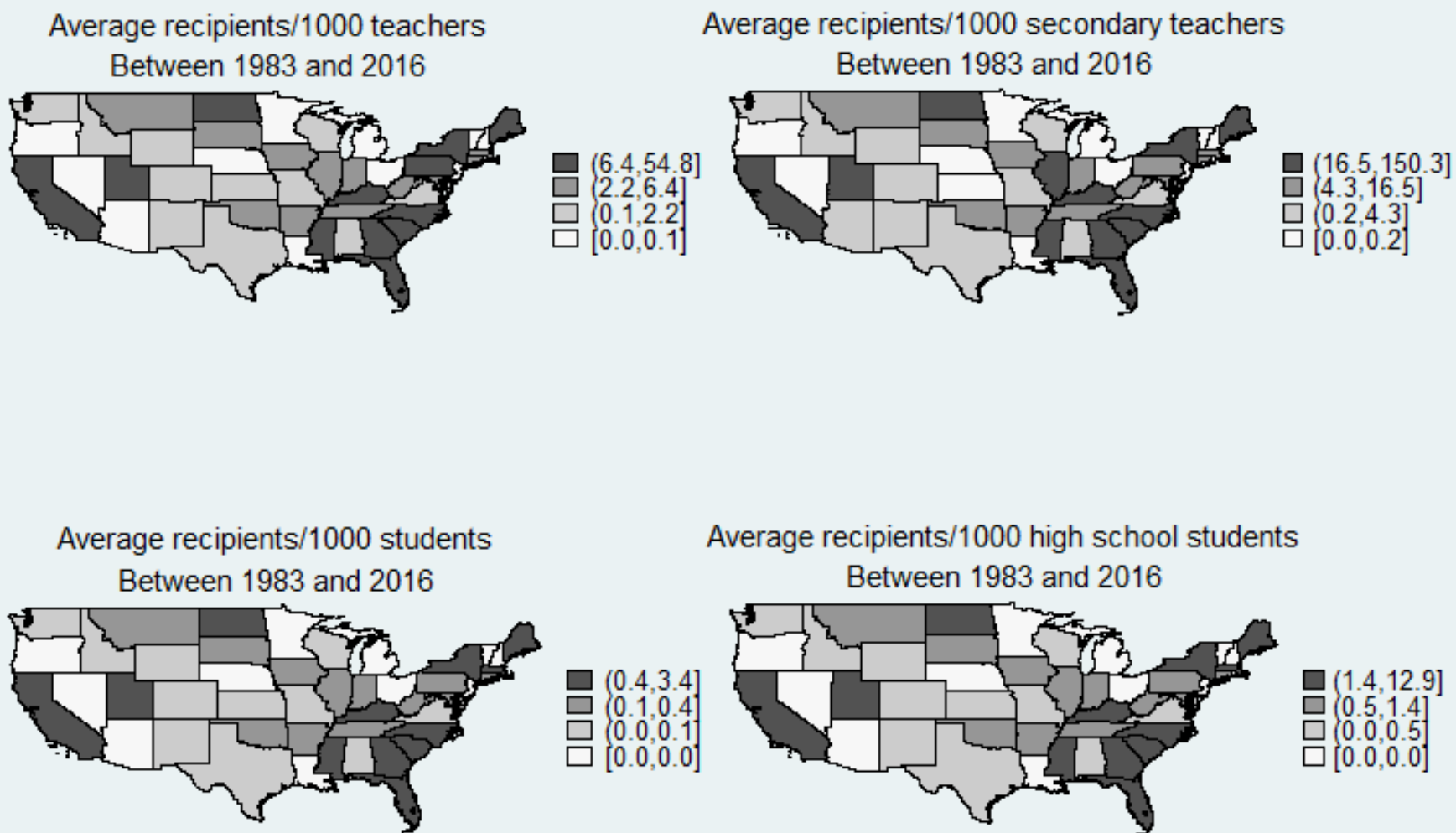
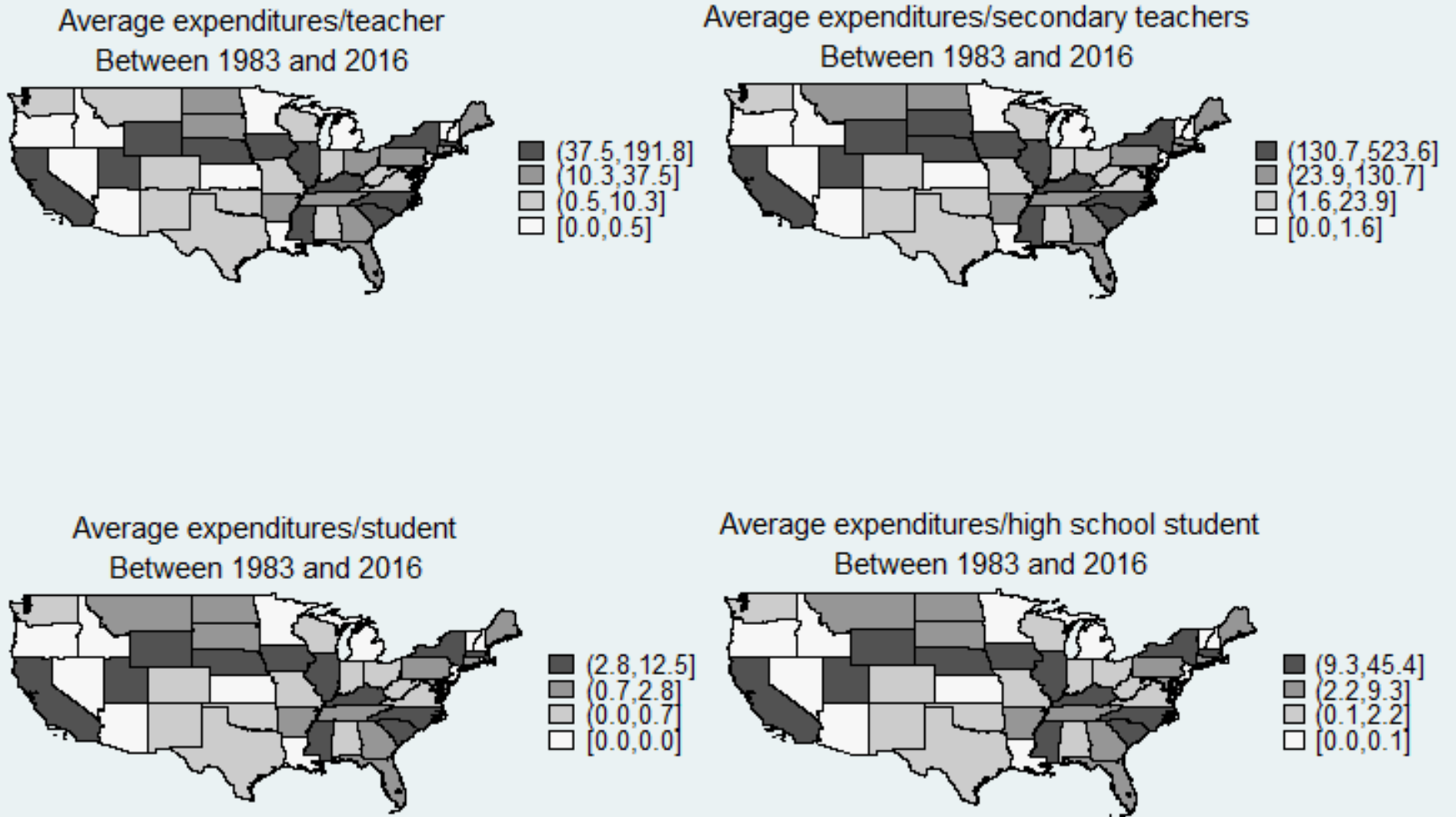


Figure 6: Across-State variation on: Expenditures



V Conclusions

This study serves two purposes. First, to inform the reader the process of gathering the data and coding the variables of financial incentives aimed to recruit and retain teachers in STEM fields and/or critical shortage areas. In doing so, I encourage researchers to utilize and improve the data that is available to the public. A contribution derived from this purpose is the promotion of research that involves financial incentives of the nature described in this study. A suggested set of research questions is offered in section (I).

Second, this study provides a comprehensive (national) view of all the financial incentive programs aimed to recruit and retain teachers in STEM fields. The most popular type of program is scholarship-loan and the two main focus are math and science and critical shortage areas. There is a sharp variation on states' approaches to solve teacher shortages in math and science and/or critical shortage areas. On the one hand, some states invest heavily and for a long period of time on these programs whereas other states haven't even started.

Geographically, there are some interesting patterns to discuss. The states with the highest expenditures per unit of education system (e.g., students, teachers) are located across the center of the US and are adjacent in most cases. In contrast, the states with the largest ratios of recipients per unit of education system are mostly located in the East Coast and California. Finally, whereas loan forgiveness programs are located in the South and North, the Scholarship-Loan programs prevail in the South-East.

Indeed, more research is needed to assess the role of financial incentive programs for teachers on a number of education outcomes. Large sums of money are invested in a yearly basis and programs are born and disappear often. Nevertheless, the decisions to implement or eliminate programs could be done more systematically if these programs were evaluated appropriately in terms of the marginal costs and marginal benefits to individuals and society.

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