Do Education Investments Maximize Aggregate Earnings and Employment?

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Abstract

The purpose of this paper is to measure the impact of state-level investments in public education on aggregate state labor markets, specifically earnings and employment. Through a careful interpretation of the results and application of my theoretical model, I determine whether these educational investments are maximizing earnings and employment, presumably through spillovers. This paper finds that educational spending is underprovided in terms of maximizing earnings and employment.
1 Introduction

In the past, K-12 educational spending was largely funded by local governments.\textsuperscript{1} However, in the 1970’s, contributions for education from state governments started to meet and some years even surpass contributions of local governments for educational spending. In fact, in 2013, state governments funded 46\% while local governments funded 45\% of total educational spending.\textsuperscript{2} In addition to this centralization of educational spending, President Reagan’s administration released \textit{A Nation at Risk: The Imperative for Educational Reform}.\textsuperscript{3} This report influenced state governments to embrace more responsibility for education and the outcomes of this education. States having more control over policies affecting education offer motivation to examine educational investments and their effects at the state level.

In 2008, the Department of Education released a document titled: \textit{A Nation Accountable: Twenty-five Years After A Nation at Risk}. The authors note that \textit{A Nation at Risk} prompted several educational reforms including dramatic increases in total and per-pupil educational spending for all levels of government. In 1983, educational spending in the U.S. totaled $141 billion.\textsuperscript{4} In 2005, that value nearly quadrupled to $576 billion for total educational spending, after adjusting for inflation. Not only did total spending increase, but per-pupil spending also rose from $5,691 to $9,266 during this time span.\textsuperscript{5} Because these large increases in educational spending have not shown great improvements in student performance, a closer analysis at how effective and efficient this funding as well as other investments in education are, could be helpful for future education policies.

As educational funding budgets and reform continue to cause controversial debates within the U.S., determining the presence and impact of educational spillovers as well as the maximizing potential of education, in terms of future earnings and employment, is an important task. Identifying the relationships between future earnings and employment and the percent of a state’s labor force with a college degree, high school diploma, and

\begin{footnotesize}
\begin{enumerate}
\itemFederal Education Budget(2014)
\itemCensus Bureau, Public Elementary-Secondary Education Finance Report, 2013 Data.
\itemReleased by the National Commission on Excellence in Education
\itemSnyder et al. (2006). In constant 2013 dollars.
\itemSnyder et al. (2007). In constant 2013 dollars.
\end{enumerate}
\end{footnotesize}
the labor force’s cognitive skills could be useful when making future policy decisions. In addition, although the amount of funds the government allocates to education does not necessarily measure the quality of that education or determine student performance, knowing the relationship between the amount of funds allocated to education and the resulting labor market outcomes could be useful as well.

The benefits related to an increase in education stem from three different channels. The primary benefit of education is the increased productivity of the individual receiving the education. Through the increased productivity resulting from increased education, the individual receives a higher salary. The second benefit of education is known as spillovers to society. When one worker’s education level increases, and in turn their level of productivity, other workers can benefit from this increased education level (Gruber 2011). As one worker becomes more productive due to increased education, other workers around them tend to increase their productivity as well. In addition, the firm where the worker is employed will also benefit due to the increased productivity through increased output and revenues. When examining firm benefits from education at the state level, it’s important to note that the firm may also benefit due to worker migration into the state. Society can also benefit from increased education due to fiscal externalities such as changes in tax revenue and program costs.

Past research including Berger and Fisher (2013), Fisher and French (2009), and Bauer et al. (2006) measure the private returns to education and have shown that more education leads to higher median wages. In addition, Moretti (2004) provides evidence to support the claim that more educated individuals increase the wages of even less-educated individuals. These higher wages then result in higher tax revenues, some of which may be returned back to education by means of funding.

There is an extensive literature beginning with Oates (1969) and Brueckner (1979, 1982, 1983) that identifies the balanced-budget relationship between property values and local educational spending. They argue that estimating this relationship provides evidence about whether educational spending is at an efficient level. While there is an

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6Hanushek (1981)
extensive literature examining the relationship between educational attainment for individuals and their labor market outcomes, there is much less evidence on how educational spending within a state affects future aggregate employment and earnings within that state, presumably a motivation for state-support of both K – 12 and higher education. Examination at the aggregate state level allows for the inclusion of educational externalities affecting overall productivity (Moretti (2004)) and offers evidence about whether states appear to be providing education at levels consistent with maximizing future employment and earnings. To determine the relationship between education and labor market outcomes, I follow Harden and Hoyt (2003) examination of how balanced-budget changes in the tax structure affect labor markets.

In contrast to previous studies that use the level of educational attainment to measure the impacts of educational resources on individuals, I examine the impacts of a variety of educational investments, monetary and non-monetary, on state-level earnings and employment. It is important to investigate the returns to schooling at a broader, overall state level because the social returns to education are more than just the sum of the individual returns; because there are external returns playing a part as well (Moretti 2004). In addition to examining the effects of different educational investments, the theoretical model I develop allows me to determine whether or not states are providing the level of education that maximizes earnings and employment. Determining the maximizing potential of education can provide important policy implications as well as provide insights as to what factors impact future earnings and employment. For example, if educational funding is provided at an insufficient level, human capital is being underinvested and as a result, economic growth and improvements in social welfare would be slower than they otherwise could be (McMahon 1997).

To aid my investigation, the theoretical model developed employs a government budget constraint to relate education and taxes to earnings and employment in the state. The framework of this model allows for individual and firm mobility and a balanced-budget analysis of the impact of education on earnings and employment.

I empirically implement this model using a 36-year panel spanning from 1976-2011
using state-level data. I include variables for the proportion of a state’s labor force with a college degree, high school diploma, and lagged educational spending among others to investigate the impact of education on earnings and employment. My empirical approach follows a first differenced dynamic panel data model and the results of this estimation provide a clearer view of the impact of education provided within a state on that state’s economic performance.

Preliminary results suggest that the U.S. government is overproviding education in terms of maximizing earnings and underproviding in terms of maximizing employment. Because linear and quadratic terms of educational are included in both empirical models, a test is run to determine if the derivative of the two terms is different from zero. Upon applying this test at the mean, it is determined that the marginal changes are different from zero for the earnings and employment regressions for most specifications. This testing helps to reaffirm the conclusions made from this investigation. Further testing at the 25th, 50th, and 75th percentiles offers more insight to the maximizing potential of education.

Due to the high degree of interstate mobility of U.S. residents, a measure is needed to account for those in the workforce of a state who did not receive their education there. Using state of birth as a proxy for where a person received their K-12 education, I implement a birthplace weighted matrix which allows the education investments to be more accurately measured. However, the estimates for earnings and employment that I find may in fact be under- or overestimating the actual benefits of this state’s level of educational support. Extensions to this paper include additional estimations in order to fully account for state-to-state migration and to measure the size of any education spillovers that may exist between states.

It is important to determine whether the relationship found between education and economic outcomes is a causal one that can support future policy decisions. In order for policymakers to support any policies designed to change the level of educational investment, there must exist confidence in the fact that changing education will have a positive impact on the economy. Reverse causality is a potential issue when discussing
education investment and positive returns to earnings. As people become richer, they buy more goods, so as incomes increase, people may be willing to invest more on their children’s education. In order to avoid incorrectly identifying the relationship between education and economic outcomes, I use a ten-year lag when using the education spending variable. Using this long of a lag allows me to avoid reverse causality issues because the income earned from this investment in education occurs ten years later. In addition, regression specification tests also help to prove the direction of causality. As the regression output tables show, results for income and employment are insensitive to the addition of other relevant variables and therefore avoid omitted variable bias.

The remainder of this paper is organized as follows. Section II provides a literature review and discusses the most relevant papers supporting my investigation. Section III presents the model and its theoretical background. Section IV includes a description of the data and empirical methodology, while Section V discusses my results. Finally, Section VI addresses caveats, discusses contributions, offers extensions for future work, and concludes the paper.

2 Literature Review

There exists a vast literature providing motivation for my study. In particular, I focus on three areas of research to guide both my theoretical and empirical modeling: returns to education, spillovers from education, and the efficiency and optimization of educational provision.

2.1 Evidence for the Returns to Education Expenditure

The early literature focuses on the returns to education expenditures and provides the underlying theme for the research below. Morgan and Sirageldin (1968) provide some of the initial evidence of positive returns to spending on education, while Curs et al. (2011) provide the most recent empirical work of positive returns to education spending.

Studies using educational expenditures as a proxy for school quality have continually
emerged in the education literature. Morgan and Sirageldin (1968) provide evidence on the relationship between state-level primary and secondary educational funding and future earnings of those living in the state in which they received education. They find a positive relationship between primary and secondary expenditures per pupil and a person’s earnings such that $1.00 more per year per pupil spent on education in a state increases hourly earnings by $0.24 for those who went to school in that state. Ribich and Murphy (1975) support Morgan and Sirageldin (1968) by confirming that additional spending on education does increase lifetime income, although the income gains (when properly discounted) resulting from increased educational spending are 35% less than the amount of extra funds invested in education. Ribich and Murphy also suggest that education expenditures influence how many years of schooling an individual receives, which in turn may determine an individual’s future earnings.

Johnson and Stafford (1973) find high returns to educational expenditures per pupil, but find that these follow a pattern of diminishing marginal returns. Rizzuto and Wachtel (1980) find smaller impacts on earnings from educational expenditures per pupil compared to previous authors, but also conclude that while expenditures per pupil exert a positive and significant effect on earnings, the impact is diminishing. Rizzuto and Wachtel also suggest that using expenditures per pupil as a proxy for school quality may not be the best option due to simultaneity and causality issues. However, papers following Rizzuto and Wachtel address these issues and continue to use education spending as a proxy for school quality.

More recently, Curs et al. (2011) investigate funding for higher education and how the level of privatization in the education system affects U.S. state economic growth. Using state-level data from 1970-2005, the authors employ Arellano-Bond estimation techniques in order to avoid the potential endogeneity bias of education expenditure. To account for the fact that education is an investment over many years, in their model, the authors use five year averages of past education expenditures to measure the effect of this spending on per-capita income growth. They find that states with large market shares of students in public higher education have a positive relationship between funding and per-capita
income growth. In contrast, states with large shares of private higher education have a negative relationship between funding and economic growth. Although their work is mainly focused on higher education, the authors also find positive returns to K-12 education expenditures on per-capita income growth.

Although the relationship found between education spending and earnings is interesting, Hanushek et al. (1996) find that using aggregated education data, for instance data at the state level, can cause the impact of education expenditure to be biased upward due to omitted variable bias. Betts (1996) also shows that of all the current research finding significant and positive effects of educational spending, 43% come from state-level data and 29% from data aggregated to the district level. In contrast, some papers suggest that the use of aggregated data is beneficial for estimating purposes because of a potential reduction in measurement error and the ability to capture spillover effects.

2.2 Evidence for the Returns to Education using Aggregate Data

While there is an extensive literature examining the relationship between educational attainment for individuals and their private labor market outcomes, there is much less evidence on how educational spending within a state affects aggregate economic factors. The estimates for private returns to education may in fact be underestimating the full returns to education if education exhibits characteristics of a public good or generates positive externalities. To support the contribution of my study, a review of the literature concentrated on aggregate returns to education and educational externalities is needed.

Studies concentrated on estimating aggregate returns to education and educational externalities prove to be useful for my research. The existing literature offers insight on empirically estimating the aggregate returns to public services, such as education, due to externalities and spillovers. Sianesi and Van Reenen (2003) among others supply estimates for educational returns on per-capita income and employment by using educational attainment as their measure of education.

Sianesi and Van Reenen (2003) review the literature in which returns to educational
attainment are measured based on macro-economic performance, such as changes in GDP. The authors summarize the studies as a whole and suggest that human capital does increase productivity and that education does more than just signal an individual’s level of ability to the employer. The authors also suggest that the efficiency with which educational funds are allocated matters tremendously to economic growth. According to this literature summary, previous micro and macro studies attempting to find a relationship between educational inputs and economic performance have failed to find any such relationship. One of these studies, Hanushek and Kim (1999), find that educational inputs such as teachers and expenditures, do not significantly affect educational quality. In summary, Sianesi and Van Reenen (2003) state that up to the time of their writing, no relationship has been found between educational inputs and quality, suggesting that no policy prescriptions come from this part of the macro literature.

2.3 Evidence for the Returns to Education using Micro-Data

In contrast to the empirical literature on returns to education using aggregate data, Becker (1964) and Mincer (1974) introduce theoretical models and Ashenfelter and Rouse (1998) and Arias and McMahon (2001) among many others provide estimates of educational returns to individuals. Although these studies estimate educational returns to individuals using micro-data, they offer insight for the aggregate return models used in this paper.

Psacharopoulous (2006) provides a brief summary of this literature on the value of investment in education. Psacharopoulous finds that educational expenditures prioritized to lower levels of education, which focus on the acquisition of general skills and knowledge, are the most advantageous to social welfare. Because of this finding, the attention of this paper will be focused on K-12 educational expenditures. Schultz (1961a, 1961b) introduced the concept of investment in human capital to explain why national income was growing faster than the traditional factors of production, while Becker (1964), Mincer (1974), Hansen (1963), and Conlisk (1971) modeled this concept of investment in human

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8Preschool, Primary, and Secondary have higher rates of return than Higher Education
capital and the measurement of its value.

Estimating the returns to education at the individual level by modeling schooling as an instrument of human capital formation is a strategy many studies follow. In fact, estimating the returns to education through human capital formation has been ongoing since the 1950’s. Goode (1959) defines human capital as knowledge, skills, attitudes, aptitudes, and other acquired traits contributing to production. For the entirety of this paper, when discussing human capital, this is the definition to which I will be referring. Frazis (2002) emphasizes that economists consider the human capital theory to be one of the dominant explanations behind the returns to education in the labor market. Ashenfelter and Rouse (1998) and Arias and McMahon (2001) are two studies that offer estimates for the educational returns to the individual. Ashenfelter and Rouse (1998) use identical twins to measure returns to schooling for the individual and find an average return of 9%, while Arias and McMahon (2001) find slightly higher average dynamic rates of return for college educated males and females of 13.3% in real terms.

2.4 Evidence for Spillovers from Education

To further support the potential presence of educational externalities in my research, a review of the spillover literature is necessary. Moretti (2004) investigates the social returns to higher education at the city level and finds that as the supply of college graduates increases in a city, wages for high school dropouts, high school graduates, and college graduates increase. This finding indicates that there may be some sort of spillover of benefits occurring between more educated people and others around them. In agreement to Moretti (2004), Lucas (1988) and Marshall (1890) argue that positive externalities from education may be generated across workers through the sharing of knowledge and skills. In addition, Romer (1986, 1992) also acknowledge that externalities from education may exist when outputs from that education become public goods that spill over into the economy.

9Psacharopoulous(1994)
2.5 Evidence on Efficiency and Optimization in Educational Provision

The literature that examines the efficiency of public service provision offers techniques that I adapt to form my educational spending models and interpretations. Examples of these studies include Brueckner (1979, 1982, 1983) and Barrow and Rouse (2004), which help to motivate my investigation of whether educational spending at the state level maximizes future earnings and employment. For example, Brueckner (1979, 1982, 1983) provide a rich theoretical background for the maximization investigation and interpretations used in this paper. Brueckner (1979) develops a theoretical model and an estimating equation involving a government budget constraint that together allow for the inspection of whether a public good is provided efficiently. Brueckner uses property value determination along with a public good and property taxation of northeastern New Jersey communities for this study. Brueckner’s theory argues that efficient levels of public goods are those that maximize property values. Through this investigation, Brueckner concludes that the communities in the study overprovide public goods and that a reduction in the provision of these public goods would lead to an increase in the communities’ property values. Brueckner’s approach rests upon the strong assumption that all of the communities were “identically efficient or inefficient in providing the public good.” Brueckner argues that this assumption is justified by the fact that if communities were found to provide public goods inefficiently, all of the communities would be likely to provide the good inefficiently in the same direction, that is, either all communities would be overproviding the good or all communities underproviding the good, due to parallels in governmental structure and political processes.

Brueckner (1982) follows the same research agenda of examining the efficiency of public goods by using property value maximization for communities in Massachusetts. In this paper, aggregate property values in a community resemble an inverted U-shaped function of its public good output, which is maximized at the point in which the output level reaches Pareto-efficiency. Because of the inverted U-shaped function and by applying the same assumption as in the 1979 paper that communities exhibit a common efficiency
bias, Brueckner is again able to make efficiency interpretations simply based upon the sign of the coefficient associated with the public good. If the coefficient on the public good is positive, Brueckner interprets the public good as being underprovided, and if the coefficient is negative, then the public good is overprovided. Incorporating similar logic, if the aggregate property values in a community are unresponsive to marginal changes in the public goods provided, that is, if the coefficient is nearly zero, then this value indicates that the public good is being provided efficiently. When investigating the efficiency of community educational expenditures and non-education municipal expenditures in Massachusetts, Brueckner finds neither of the associated coefficients to be significantly different from zero. Under the assumption that a common efficiency bias exists, Brueckner suggests that these results indicate the communities are neither systematically over- nor underproviding public goods.

In contrast to Brueckner (1979, 1982, 1983) Barrow and Rouse (2004) examine school expenditure efficiency by investigating whether state aid for education maximizes property values. They find that the school districts do not overspend on education and the state funding is valued by residents.

Harden and Hoyt (2003) studies the impact of state taxes on employment and investigates whether the mix of taxes chosen by state governments maximize employment. Using a balanced-budget framework and adapting the work of Helms (1985) and Carroll and Wasylenko (1994) the authors find a significant negative impact of the corporate income tax on employment and suggest that these taxes are set too high. The authors conclude that states are not selecting the mix of taxes to maximize employment. This balanced-budget framework is useful when building my theoretical model.

2.6 Most Recent Evidence

Finally, recent work by Hanushek et al. (2015) provides strong procedural support for this analysis. The authors investigate how school quality is related to state growth by using newly formed measures of human capital that focus on cognitive skills rather than years of schooling. Due to the high mobility of U.S. residents, they incorporate migration
rates into their human capital measures which allow the authors to more accurately measure the effects of educational achievement on incomes. Then, by analyzing a range of feasible educational quality reforms, they discover very large state-level economic returns. Following the authors’ procedure, I implement a similar birthplace matrix in order to more accurately measure state education spending and student achievement.

In addition, Hanushek et al. (2015) describes how policies of one state could have major implications for other states due to outmigration. If only one state chooses to reform education, benefits to this state may be very low if the educated workers then move to another state and take their higher quality education with them. However, if all states reform in similar ways, then any educated worker who leaves the state in which they were educated, would potentially be replaced by another equally educated worker migrating from another state. In the authors’ scenario in which only one state’s education improves up to the best state, the outcomes of such reform are much lower than when all states improve up to the best state, 2.6 times GDP versus 4 times GDP, respectively. Also, these economic outcomes vary dramatically by state depending on that particular state’s rate of outmigration. In essence, the states with high rates of outmigration would suffer the most and could subsequently lose the desire to invest (time, money, and energy. Or not in the financing way) more in education if they are not receiving much benefit. Because of this, it is much more beneficial for all states to reform education policies instead of just a few. This could motivate federal policy in the future.

These studies add essential insight into the model setup, estimations, and interpretations used in this paper. By merging the ideas of the literature that focus on the individual returns to education, the aggregate returns to educational attainment, expenditures, externalities, and the models of efficiency, I explore an area of research that has not been extensively studied. While there is a vast literature examining the relationship between educational attainment for individuals and their labor market outcomes, there is much less evidence on how educational spending within a state affects future aggregate employment and earnings within that state, presumably due to the existence of educational spending spillovers.
My research differs from previous studies in various ways. First, my data spans from 1976 to 2011, which is a much longer timeframe and is more recent than other studies. Second, my data is aggregated to the state level for different reasons. Spillovers from investments in education exist and by using state-level data, I’m able to account for school district spillovers as a whole. In addition, I’m able to more specifically investigate the existence and size of these potential spillovers and externalities from spending on education in future extensions to this work. My research also differs from past studies in that not only am I examining the impact of education spending on earnings and employment, but I am also using a balanced-budget framework which allows me to determine whether the amount spent on education is at a level that maximizes future earnings and employment. As Hanushek et al. (2015) points out, much of the previous education literature does not provide a practical way of calculating the benefits from education and in fact can distort both calculations of cost and benefits. Through my investigation, I offer a more viable way to calculate these economic benefits by incorporating birthplace rates as well as present value discounting methods.

3 Structure and Model

To study the implications of education, analyzing its effect on earnings and employment through a theoretical model is necessary. To determine the relationship between education and labor market outcomes, I follow Harden and Hoyt (2003) examination of how balanced-budget changes in the tax structure affect labor markets. From this theoretical model, a hypothesis is derived for relating education and taxes with earnings and employment, while allowing for individual and firm mobility. The related theoretical model represents the government’s problem as it plans to maximize future social welfare, or total income, of its constituents as it chooses the level of education and taxes. Consider a simple two-period model in which education in a state is chosen to maximize the net incomes of the current generation (t-1) and the discounted income of their children. Let there be two states, 1 and 2. Then assume that the wages of the future generation (t)
depend on the education they receive and the education received by co-workers in the
other state. Children in period t-1 may be employed in state 1 or 2 as adults. Then, the
problem in state 1 at time t is:

$$\text{Max} \ E_{t-1} - T_{t-1} + \beta (w_{t1}(E_{t-1}^{-1}, \gamma_{11} E_{t-2}^{-1}) \theta_{t1} L_{t-1}^1 - T_{t1}^1)$$

subject to

$$L_{t-1}^1 T_{t-1} = L_1 E_{t-1}^{-1},$$

where

$$E_i^{t-1}$$ is the level of education expenditures per pupil in state i in year t-1, $$L_1^t$$ is
the number of workers in state 1 at time t, $$T_i^t$$ are taxes in state i at time t, $$w_{ij}^t$$ is the
wage of workers educated in state i working in state j at time t, and $$\theta_{ij}^t$$ is the fraction of
workers born in state i working in state j at time t.

And where

$$\gamma_{ji}^t = \frac{\theta_{ij}^t L_{ji}^t}{\theta_{ij}^t L_i^t}, i \neq j$$

(3)

gives the ratio of workers born in state j to workers born in state i working in state i.

The first order condition is then:

$$- \frac{L_1^t}{L_{t-1}^1} + \beta (\frac{\partial w_{11}^t}{\partial E_{t-1}} \theta_{11}^t + \frac{\partial w_{12}^t}{\partial E_{t-1}} \theta_{12}^t) = 0$$

(4)

And upon expanding the above equation to include those who were educated in state 2,
the socially optimal investment in education satisfies the condition:

$$- \frac{L_1^t}{L_{t-1}^1} + \beta (\frac{\partial w_{11}^t}{\partial E_{t-1}} \theta_{11}^t + \frac{\partial w_{12}^t}{\partial E_{t-1}} \theta_{12}^t + \frac{\partial w_{21}^t}{\partial E_{t-1}} \gamma_{12}^t + \frac{\partial w_{22}^t}{\partial E_{t-1}} \gamma_{12}^t) = 0$$

(5)

where it is obvious that the residents in state 1 ignore any impact that education of their
children have on the wages earned by those working in either state 1 or 2 who, as children,
received their education in state 2. This can be seen through the fact that terms two and three of the above equation are independent of terms four and five.

Finally, estimation of the impact of education in a state on labor earnings, measured by $\beta$ in the model above, is given by:

$$\frac{\partial w^t_{11}}{\partial E^{t-1}_{11}} + \frac{\partial w^t_{21}}{\partial E^{t-1}_{12}} \gamma_{12}$$

(6)

where only earnings of those working in the state matter. Now, the equation for the relationship between wages, employment, birthplace, and education has been derived. Below, I illustrate the meaning of equation (6) as it relates to equation (5) and explain how I will use this theoretical model in conjunction with my empirical model to estimate the returns to education in a state.

Using this framework, I employ related empirical tests to determine whether education is maximizing future earnings and employment. Following Brueckner (1982), if the effect from education on earnings and employment is positive, the government could be underproviding education. This is derived from thinking about the nature of education and its exponential shape, or inverted U-shape, as illustrated in Figure 1 below. When a positive coefficient is estimated, we can think of the government’s level of education as being on the rising side, or in the positively sloped area of the exponential function, as in point A. Being in this area would indicate that the level of education is below the maximizing level of education because this coefficient represents the partial derivative, or slope, of this relationship. Using the same logic, if the effect is a negative value, the government could be overproviding education, as in point B. Lastly, if the coefficient is approximately zero, the government may be choosing an efficient level of education that maximizes earnings and employment, as in point C. At this point of maximization, the slopes of the two wage functions are opposite in sign, but equal in magnitude, as shown by Figure 1 below. The summation of these two slopes equal zero, as formulated by the theoretical modeling of equation (5).
4 Empirical Methodology

As discussed earlier, rather than simply focus on quantifying the impact of education on wages, as developed in the preceding section, I determine if, in fact, the level of education chosen in a state is set to maximize aggregate earnings. To test this hypothesis, a dynamic panel data model is formulated as:

\[ Y_{it} = \theta Y_{it} + \alpha E_{it-10} + \eta E_{it-10}^2 + \beta X_{it} + \gamma_i + \mu_t + \psi_{it} \]  

(7)

where \( Y_{it} \) is per capita earnings, \( Y_{it-1} \) is per capita earnings lagged one year, \( E_{it-10} \) is a variety of educational investments lagged ten years, \( E_{it-10}^2 \) is the square of this educational investment lagged ten years, \( X_{it} \) is a vector containing other state-level variables such as labor force demographics and the percentage of state residence who live in urban areas, \( \gamma_i \) are state fixed effects, and \( \mu_t \) are year fixed effects. Examples of the variety of educational investments used in the model above include the percent of the labor force who have college degrees, the percent of the labor force who have high school diplomas, cognitive measures of student achievement, and the level of educational spending. In order to correctly measure the labor force, when using high school diplomas and educational spending, these variables will be lagged ten years.

When estimating this baseline model, all variables are first differenced and earnings
are transformed into logs as I instrument using Arellano Bond techniques as done by Curs et al. (2011). By following this procedure, I avoid inconsistent estimates due to estimating a model with both a lagged dependent variable and fixed effects. I also control for endogeneity issues and potential reverse causality issues between earnings and the percent of the labor force with a high school diploma and educational spending by estimating my empirical model in this way.

\[
\Delta \ln(Y_{it}) = \theta \Delta \ln(Y_{it}) + \alpha \Delta E_{it-10} + \eta \Delta E_{it-10}^2 + \beta \Delta X_{it} + \Delta \mu_t + \Delta \nu_{it} \tag{8}
\]

The use of the ten year lag for the educational spending variable was selected based on both theory and through a careful inspection of the Bayesian information criterion (BIC) for multiple lag options. Theory suggests that because investments, such as those in education, can take many years to impact economic factors and because current educational spending might only affect those who are currently in school, values of educational spending should be lagged a significant number of years in this model. In the Curs et al. (2011) income growth regression, the average of the previous five years of higher education expenditure is used to account for this investment over many years. In addition, when examining multiple year lags, the ten year lag on educational spending minimized the value of the BIC. Schwarz (1978) introduced the BIC to be used with descriptive models in comparison to the Akaike information criterion (AIC) which is used for predictive models. For this earnings regression, the difference in values of the BIC with the ten year lag versus other year lags shows strong evidence to use the ten year lag for the educational spending variable.

Also for my model, in order to be able to interpret education in terms of maximizing earnings and employment, a squared term of the education variable is needed to model the quadratic shape of education. In addition, in order to reduce endogeneity issues, current educational expenditures are excluded from this model. Furthermore, issues of unobserved heterogeneity and autocorrelation can be mitigated by using the dynamic panel data model in first differences. Following my theoretical setup, the education

\footnote{Krueger and Lindahl (1998) find a quadratic form for schooling fits better}
measures used here capture both the benefits and the costs of education.

The baseline empirical model of Equation (7) is then modified in order to capture the education effects on the state employment level as:

$$ M_{it} = \theta M_{it} + \alpha E_{it-10} + \eta E_{it-10}^2 + \beta X_{it} + \gamma_i + \mu_t + \nu_{it} $$ \hspace{1cm} (9)

where $M_{it}$ is the level of total employment, $M_{it-1}$ is the level of total employment lagged one year, and all other variables are defined as above in Equation (8). When empirically solving this model, all variables are first differenced as shown by Equation (10) below. Again, for the choice of the value of the lagged educational spending variables, theory and comparison of the BIC values for multiple lag options showed the ten year lag to minimize the BIC.

$$ \Delta \ln(M_{it}) = \theta \Delta \ln(M_{it}) + \alpha \Delta E_{it-10} + \eta \Delta E_{it-10}^2 + \beta \Delta X_{it} + \Delta \mu_t + \Delta \nu_{it} $$ \hspace{1cm} (10)

5 Data

To examine the effects of education on these aggregate factors, I employ a 36-year panel spanning from 1976-2011 of state-level data for the 50 U.S. states plus Washington D.C. From the U.S. Bureau of Economic Analysis (BEA), I obtain my two primary variables of interest, earnings by place of work\textsuperscript{11} and the annual employment level, as well as total annual state population. From the U.S. Bureau of Labor Statistics (BLS), I collect the state unemployment rate and labor force demographics. K-12 education data are obtained from the National Center for Education Statistics (NCES) and include total expenditures per pupil by each state government and total enrollment levels which are recorded at an annual frequency for academic years. I collect total higher educational funding and enrollment levels from the Annual Digest of Education Statistics for public

\textsuperscript{11}Earnings are the sum of wages and salaries, supplements to wages and salaries, and proprietors’ income.
institutions. I then calculate higher educational funding per pupil by dividing total public college funding by the enrollment level. I also calculate the college enrollment rate by dividing the enrollment level by the state population. All data are expressed in 2014 dollars. Summary statistics of data values are shown in Table 1 of the Appendix.

Due to the high mobility of U.S residents between states, migration rates must be accounted for when measuring education. For example, the workforce in the state of Kentucky is not only made up of individuals educated there, but also those educated in any other state who then migrated to Kentucky. For this reason, I use place of birth as a proxy to most accurately measure where a state resident received their education. Similar to the Hanushek et al. (2015) weighted average migration matrix, I use a weighted average birthplace matrix in order to measure the appropriate amount of education invested in each state’s current workforce. Using data from the 1960 Census obtained from IPUMS, this state-by-state migration matrix contains birthplace numbers for 1% of the 1960 population for each state. This matrix is then divided by the population of each state from this sample in order to have a birthplace rate. Last, this birthplace rate matrix is multiplied by a vector of education for all years to create the most accurate measure of education for each state.

Figure 2 below illustrates the linear relationship between earnings per capita and educational spending for 1976, 2011, and then for all years put together. In all three graphs, the positive relationship between educational spending and earnings per capita is apparent.

Figure 3 below illustrates the relationship between lagged educational spending and the log of earnings for all years. Due to being large outliers, the District of Columbia and Alaska are left out of these graphs.

To give some perspective of the differences in K-12 educational spending and earnings per capita across states, Figure 4 and Figure 5 below map earnings and spending patterns across states. Earnings per capita for years 1976 and 2011 are shown below in Figure 4.

---

12 Total higher education funding includes funding from Federal, State, and Local governments.
13 Higher education spending values for 2001 and 2002 were imputed due to missing data using data from years 2000 and 2003.
14 Parallels Card and Krueger (1992)
Figure 2: Linear Relationship Illustration

1976  
2011  
All Years

Figure 3: Earnings and Lagged Education Expenditures

1 Year Lag  
5 Year Lag  
10 Year Lag

Although many states’ earnings level change, some states are consistently at the higher end while other states are consistently at the lower end of the earnings spectrum.

Educational spending in years 1976, 1996, 2006, and 2011 are shown in Figure 5 below. The maps show areas with consistently high educational spending in states such as Wyoming and in multiple Northeastern states. The maps also show areas of consistently low educational spending in states such as Utah, Idaho, Mississippi, and Tennessee.

To offer a more detailed investigation of educational spending effects, I break down

Figure 4: Earnings Per Capita

Earnings Per Capita 1976  
Earnings Per Capita 2011
educational spending into three main categories: instruction, non-instruction, and support services spending. Unfortunately, data for these narrowed categories exists only for a short time span, starting in 1997 and continuing until 2011. Empirical estimations for these narrowed categories of educational spending are forthcoming.

6 Results

Table 2 in the appendix presents the results from my estimations for earnings modeled by (8). Educational expenditures lagged ten years are positive and statistically significant for most specifications, while the square of educational expenditures lagged ten years is negative and statistically significant across all specifications. To correctly interpret the coefficients, a few adjustments need to be made. I first run a test on the derivative of the linear and quadratic educational spending terms at the mean to determine if the marginal change is different from zero:

\[
\frac{dY}{dE} = \alpha_E + 2E \cdot \eta_E^2 = 0
\]  

The preliminary results of this test indicate that the marginal change is statistically different from zero and is positive when tested at the mean, while it varies when tested at
the 25th, 50th, and 75th percentiles. To calculate the present value of benefits for each specification, the total differential at the mean was then multiplied by mean earnings. To determine the benefits of this education spending in terms of lifetime earnings, this value was then discounted for 40 years. Proper discounting was done using a 3% discount rate, as is standard.\footnote{Hanushek et al. (2015)}

This final value gives the appropriately discounted present value of the benefits from education spending. In order to determine if education spending is maximizing earnings, this benefit value then needs to be compared to the cost of education. Applying a $1.00 increase per pupil per year for grades K-12 assumes that the total amount spent on education is $12 per pupil. Then, due to using a ten-year lag on the education variables, this $12 needs to be properly discounted for those 10 years. Again using a 3% discount rate, the $12 becomes $16.13. Thus, for the level of education spending to be considered “efficient” or maximizing earnings, the benefit from this education spending in terms of increased earnings needs to equal $16.13. In the table below, all discounted values for the benefits from education are less than the cost of $16.13. This indicates that education spending is not maximizing earnings and is in fact being overspent.

From Table 2, we also observe that earnings per capita lagged one year are positive and statistically significant for all specifications. Intuitively this makes sense; a person’s earnings positively affect their earnings in the next year. The coefficient for the unemployment rate is negative and statistically significant, which again makes intuitive sense. The coefficients for K-12 enrollment are negative and highly significant for most specifications, whereas the college enrollment coefficients are positive and statistically significant for all specifications.

Table 3 in the appendix shows the preliminary results for employment modeled by (10). The results show that the growth of the employment level lagged one year is positive and statistically significant. This intuitively makes sense as a person’s employment level could positively affect their employment level in the next year. Results also indicate that the educational expenditure variable lagged ten years is positive and statistically

\footnote{Hanushek et al. (2015)}
significant for most specifications. In addition, the square of the educational expenditure variable lagged ten years is negative and statistically significant for specifications (1) – (3), although all values are rather small. These results indicate that employment is increasing at a decreasing rate based on educational expenditures. Educational spending is therefore being underprovided in terms of maximizing employment. Again, to confirm these results a similar test of whether the marginal change is different from zero indicates that the results are statistically different from zero, as can be seen by the values towards the bottom of the table.

Also from Table 3, we observe that the unemployment rate is negative and statistically significant. The negative value associated with the unemployment rate makes intuitive sense because as the unemployment rate increases, fewer people are employed, which translates into a lower employment level. Again, K-12 enrollment, college enrollment, and college expenditure per pupil vary in sign and statistical significance depending on model specifications.

Results from regressions implementing the other types of education investments are forthcoming.

7 Caveats, Contributions, and Extensions

There are two main caveats that warrant mention at this point. First, different changes in state-level policies such as educational quality and achievement requirements could have various effects on state-level education. These policy changes will be accounted for and addressed in the empirical estimations in the future. In addition, following the work of Hanushek et al. (1996), an investigation at disaggregated levels of schooling data, for instance at the district level, would likely result in more reliable estimates of the true impact of education on future earnings and employment. Estimation using micro-data is forthcoming.

This paper adds to the literature because of its differing viewpoint for analysis on education. Whereas previous literature focus on human capital formation as the mecha-
nism through which education affects the individual, I turn my attention away from just the human capital or quality of education aspect and focus on a variety of educational investment types. My theoretical predictions allow me to empirically test whether or not education set by the government is maximizing earnings and employment. The preliminary results of this paper indicate that the U.S. government is overproviding education in terms of maximizing earnings and underproviding in terms of maximizing employment. Results like these are not only important to the literature but they are also important for those who are setting policies in regards to education. If in fact the results found in this study prove reliable, future policy setters will have a tradeoff to consider, whether to maximize earnings or maximize employment. It is important to note that a true evaluation of the financial investments in education requires a “comprehensive assessment of all of the returns to schooling – market, nonmarket, and external/public goods effects” (Wolfe and Haveman (2002)). This statement motivates future work for measuring the size of education spillovers as extensions to this paper.
8 References


Moretti, Enrico. 2004. Estimating the social return to higher education: evidence


### Table 1: Summary Statistics

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<th>Mean</th>
<th>Std. Dev.</th>
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### Table 2: Earnings Regression

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|                           |          |          |          |          |          |          |
| Total Differential Education (at mean) | 0.829*** | 0.302*** | 0.142*  | 0.152*** | -0.072  | -0.107  |
| Total Differential Education (25th)   | 1.133*** | 0.531*** | 0.294** | 0.169*** | 0.247   | 0.199   |
| Total Differential Education (75th)   | 0.616*** | 0.143**  | 0.036   | -0.119*** | 2.139   | 1.988   |
| Observations                 | 1.683    | 1.632    | 1.632   | 1.632   | 850     | 80      |
| Year Fixed Effects          | Yes      | Yes      | Yes     | Yes     | Yes     | Yes     |
| Labor Force Demographics    | No       | No       | No      | No      | No      | Yes     |

Education Expenditures (linear & quadratic), College Expenditures, Taxes per capita, and the interaction term are reported in thousands of dollars. Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1