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Essays on public education finance

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CERTIFICATE OF APPROVAL

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ABSTRACT

This dissertation consists of three chapters. The first chapter addresses the role of housing market dynamics in explaining the choice of public education finance systems at the state level. The second chapter assesses the effects of increased levels of state involvement in public education finance on total amount of resources for public schools by taking into account the differences in state aid formulae. The third chapter examines the relationship between spending per pupil in public schools and demographic characteristics of the population.

In the first chapter, I analyze the welfare effects of different public education finance systems. Specifically, I show that the public education finance system that decreases intrastate spending inequality by setting a minimum spending per pupil, *Foundation*, would be chosen over the system that sets a guaranteed tax base for every district, *Power-Equalizing*, if they were subject to a majority voting. The main mechanism behind this is that higher property tax rates under a Power-Equalizing system compared to a Foundation system lead to lower housing wealth for the majority in the former. The model suggests that a relatively lower mean income, and a lower income inequality in a state results in a Foundation system being chosen by a majority. In addition, the model suggests that the states that choose a Foundation system over a Power-Equalizing system should observe higher house prices. Finally, I provide suggestive evidence supporting these theoretical results.

In the second chapter, I quantitatively address the effects of increased lev-

els of state involvement in public education finance in the U.S.. By using district level data on K-12 public education finance, income and demographic composition in 2008, I conclude that state governments redistribute from wealthier districts to poorer districts. Local authorities, however, respond to the centralization of public education finance systems by decreasing their contributions. Thus, every dollar increase in state aid increases total expenditures by less than one dollar. Using the categorization of Jackson et al. (2014), I argue that the effect of state funds on total expenditures is different for different state aid formula types. In states with Equalization and Local Effort Equalization plans, a dollar increase in state aid increases total expenditures by as little as 31 cents. In states with minimum foundation plans, in contrast, a dollar increase in state aid increases total expenditures by as much as 70 to 81 cents. These results seem to be robust to type of the public education finance reform of the state.

In the third chapter, I explore the underlying demographic factors that lead into a stronger preference for public education. Previous studies suggest that lower share of elderly, higher share of school age children, and higher share of college graduates in the population result in a higher level of spending per pupil in public schools. However, the existing literature does not take into account the differences in state aid formulae. This is important given that these formulae differ and they have direct effects on levels and dispersion of spending in the districts. My analysis suggests that the type of state aid formula affects the relationship between demographic characteristics and spending per pupil in public schools. Specifically, the effects of these three variables on public education expenditures are bigger in the states with Minimum Foundation plans compared to Equalization and Local Equalization plans. This is a direct result of the latter two state aid formulae being more centralized compared to Minimum Equalization plans. While they control for spending inequality at a higher degree, public education finance system in the state becomes more centralized which leads into a weaker relationship between each of these demographic variables and spending levels in the districts. These results are also seem to be robust to the type of the public education finance reform of the state.

PUBLIC ABSTRACT

This dissertation is an extensive analysis of the public education finance system in the U.S.. The first chapter presents a theoretical model that helps us to compare two of the most commonly used state-level public education finance systems. By taking into account of the differences in housing market conditions between two systems, it concludes that the states that experience lower income growth and income inequality growth are more likely to choose a finance systems that sets a minimum spending per pupil in the state over the second system. And these states are expected to experience higher property values if such a switch occurs.

The second chapter is a quantitative analysis of the effect of increased control of state governments in public education finance. By using data from 2008 on income, housing wealth, demographics, and finance of school districts, it concludes that higher state involvement in public education finance has a negative effect on total expenditure per pupil. In addition, this effect is different for different public education finance systems. Specifically, the state-aid formulae that controls for the inequality by setting a minimum level has the smallest negative effect on total expenditure among all the other systems.

The third chapter explores the relationship between demographics and higher spending in public schools. By using the same data set with the previous chapter, it concludes that the effects of demographics on total expenditures are of different magnitudes for different public education finance systems.

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PUBLIC EDUCATION FUNDING: FOUNDATION SYSTEM VS. POWER-EQUALIZING SYSTEM WITH PROPERTY TAXES

1.1 Introduction

Public education is considered to be one of the most important public policy areas in the U.S.. According to recent estimates from the National Association of State Budget Officers State Expenditure Report, educational expenditures constitute the largest budgetary category at the state level. For Fiscal Year 2013, around 20 percent of all state spending was devoted to elementary and secondary (K-12) education.

U.S. Public education was founded on the principles of local financing and control. There were over $110,000$ school districts in the country in the early 1900s, and funding was mostly supported by local property tax revenues. During the 1930s, a wave of school finance reform centralized the funding process. Since then, many states modified aid formulas to account for differences in property tax bases in the state in order to equalize per pupil spending across districts. These reforms are often mandated by court decisions. In this process of reforms, however, different states adopted different systems in equalizing spending per pupil across districts. Most states mandate a minimum level of spending per pupil by district which is called the Foundation amount. If districts cannot create enough revenue to meet this Foundation amount, the state remedies the difference using state aid. This guarantees that every child in the public education system receives a minimum level of education regardless of family income or the wealth level of the district. Following Fernandez and Rogerson (2003), I refer to these as *Foundation* systems. Other states offer a guaranteed tax base to districts. This guaranteed tax-base ensures that two districts with the same property tax rates raise the same tax revenue regardless of differences in property values. State aid matches any difference between the actual property values in the district and the guaranteed tax-base. I refer to these as *Power-Equalizing* systems.

Fernandez and Rogerson (2003) argue that a Power-Equalizing system would be chosen over a Foundation system if they were subject to majority voting. This is due to higher redistribution of funds in the former. The Foundation system is currently the most-used however. Indeed, Pennsylvania, New York, Colorado, and Massachusetts have switched from a Power-Equalizing system to a Foundation system since 1990.

In this paper, I extend Fernandez and Rogerson (2003) by introducing a housing market to the model. Housing market decisions are crucial to public education finance with an average of 35 percent of expenditures being funded through property tax revenues. The importance of property tax revenues for public education funding is bigger at the district level. Nearly 80 percent of district funding for public education is supported by these revenues. The remaining 20 percent comes from many other sources including sales tax revenues. Accounting for changes in housing market decisions is important when we compare finance systems. From one system to another, property tax rates are different which distorts housing demand and property tax revenues differently. In fact, the model predicts that most districts, including the median voter, have higher property tax rates when subject to a Power-Equalizing compared to a Foundation system. As a result, a majority of districts face a higher gross price and a lower net of tax price for housing which results in lower housing wealth in a Power-Equalizing system. Even though the majority of districts benefit from more redistribution under a Power-Equalizing system, it is possible that this lower housing wealth makes a Foundation system more appealing for the majority. As such, a Foundation system might be preferred to a Power-Equalizing system when we introduce the housing market to the analysis.

Then, this model offers an explanation for the recent public education finance system switches towards Foundation. The explanation provided is as follows. The states that switched from a Power-Equalizing system to a Foundation system are such that the housing market effect is stronger than the redistribution effect. This is possible if a state has a relatively lower per capita income, or lower income inequality. In order to test this hypothesis, I analyze the recent switches into a Foundation system. By comparing the growth rates of per capita income, and gini coefficient for these switcher states with different reference groups, I provide evidence that the states that switched are characteristically different from the states that did not switch as the model predicts. In addition, the model offers some predictions on the house prices of switcher states. As a result of the housing market effect, these states should observe an increase in house prices after the switch. By comparing the house price data from 1990, 2000, and 2010 I show that the model can qualitatively capture the changes in house prices for a majority of districts that switched towards Foundation.

Although there are many other systems that states use to decrease inequality in per pupil spending, the Foundation and Power-Equalizing systems are the most commonly used. According to the categorization of state aid formulas in Jackson et al. (2014), twelve states use a pure Foundation system and seven states use a pure Power-Equalizing system. In addition, there are 30 states that employ both of these systems and one state that uses a different system to decrease intrastate spending inequality. These two systems constitute the core of public education funding.

Many researchers have examined state level public education funding policies and their economic effects. Among the theoretical papers, Fernandez and Rogerson (1998) compare the effects of a locally financed system and state-financed system on income distribution, intergenerational income mobility, and welfare. They compare two extreme public education finance systems; local finance system which has no mechanism to control for intrastate spending inequality and state finance system which fully equalizes spending across districts. While they compare those two systems, they include the effects coming from a housing market. In conclusion, systems decreasing spending inequality the most lead to higher average income, and higher education spending as a fraction of income. Steady-state welfare is higher under a more equal public education finance system. On the other hand, their welfare measure is somehow problematic. The welfare of an household under a finance system is the expected utility for a hypothetical individual whose income is a random draw from that period's income distribution. This measure would overlook the fact that it is possible for a majority of the households to be worse off under a certain finance system compared to the alternative while on average the welfare of the state is higher. This paper analyzes the welfare change of each household separately. In addition, following Fernandez and Rogerson (2003), it analyzes more commonly used and less extreme public education finance systems. Fernandez and Rogerson (2003), however, do not take the effects of different finance systems on housing markets into account. As described above, the latter is crucial to rationalize recent switches from Power-Equalizing to Foundation systems. In a similar spirit, Epple and Ferreyra (2008) examine general equilibrium effects of school funding reform of 1994 in Michigan. This reform has two components: property tax reduction and centralization of school funding at the state level, with increases for low-revenue districts and revenue caps for high-revenue districts. In their model, the main effect of the reform is the capitalization of lower property taxes and revenue changes with an increase in school quality in low-wealth districts. With a change in income distribution that favored low-income households between 1990 and 2000, their model predicts that observed housing appreciation can be decomposed into the capitalization of lower taxes and revenue changes, and an appreciation pattern related to changes in the income variance. They also present empirical evidence to support these predictions for the Detroit metropolitan area. Also, Ferreyra (2009) applies the model in Epple and Ferreyra (2008) to study the effects of school finance reform on the Detroit metropolitan area. She estimates a general equilibrium model of multiple jurisdictions with 1990 data from Detroit. She then validates the model by comparing model's predictions with 2000 data. According to counterfactual simulations using the estimates, she concludes that feasible revenue-based reforms that ensure spending equity or adequacy have little impact on school quality or household demographics in Detroit. In addition to the evidence presented in this paper, these empirical findings are consistent with the predictions of the current model in the sense that a Foundation system may socially be beneficial over a Power-Equalizing system after accounting for the effects coming from the housing market and property tax revenues. While these results are consistent with this paper, Epple and Ferreyra (2008) do not model the political economy behind the Michigan reform but rather describe its effects. This paper analyzes welfare gains and provides conditions under which a system would be more likely to be chosen by majority voting.

There are a few empirical papers that compare the effects of different public education systems. Evans et al. (1996) argue that court-ordered finance reforms over the last 40 years decreased spending inequality within states significantly. This decrease was a result of the increases in public education spending in poor districts being higher than the decreases in the rich districts. Thus, the recent changes in public education finance systems lead to a "leveling up" while decreasing the inequality of spending in public schools. Conversely, Hoxby (2001) argues that Power-Equalizing systems cause more "leveling down" compared to Foundation systems. Including the effects of changes in the housing market and property tax revenues, she concludes that Power-Equalizing decreases total resources devoted to public education. Card and Payne (2002) analyze the effects of school finance reform on student achievement. They show that reforms leading to lesser intrastate public school spending inequality narrow differences in SAT score outcomes across family backgrounds. In addition to the evidence presented in this paper, these empirical findings are consistent with the predictions of the current model. In other words, this paper can rationalize these findings. In the sense that a Foundation system may socially be beneficial over a Power-Equalizing system after accounting for the effects coming from the housing market and property tax revenues. In contrast, a Power-Equalizing system yields higher benefits for the majority without the housing market effects.

The rest of this paper is organized as follows. Section 1.2 presents the theoretical model and results. Section 1.3 provides empirical evidence to support the predictions of the model. Section 1.4 concludes.

1.2 Model

In this section, I first introduce the basics of the model. Then, I solve the model for the Foundation and Power-Equalizing systems separately. Following that, I compare the solutions to both systems and present the main results of the model by first analyzing first the redistribution effect and then the housing market effect. In the last subsection, I provide comparative statics to guide the empirical analysis in Section 1.3.

1.2.1 The Basics

This economy consists of a finite number, N, of households. Each household is endowed with one child, and has preferences over private consumption goods c, housing services h, and the the education of the child q.

$$u(c,h) + v(q).$$

The function u and v are assumed to be strictly concave, increasing, and twice continuously differentiable. The function u is separable, increasing in both arguments and defines homothetic preferences over c and h. Specifically, I employ the following utility function:

$$u(c,h) + v(q) = \frac{a_c c^{\alpha} + (1 - a_c)h^{\alpha}}{\alpha} + A\frac{q^{\gamma}}{\gamma},$$

with $A > 0$, $\alpha < 1$, $\gamma < 1$, $0 < a_c < 1$.

Districts in a state are assumed to differ only in initial income endowments, y^j, having a cumulative distribution described by $F(y)$ with mean, μ, to be greater than median, $y_M < \mu$. This is a plausible yet an important assumption for the theoretical results presented in this paper. There are multiple i indexed districts, and the distribution of households into districts is exogenous and constant with the same number of households in each district. In this paper, I focus on the perfect income sorting of individuals into districts as in Fernandez and Rogerson (2003). Thus, every individual in a given district i has the same income, y_i, and each district has a representative household. So districts can be sorted by income as $y_1 < y_2 < y_3 < ... < y_N$. In addition, these districts are characterized by a proportional tax on housing expenditures, t_i, a net of tax housing price, p_i, and a quality of education, q_i, which the representative household takes as given. Tax revenues are used exclusively to fund local public education. All residents of a given district receive the same quality of education and education cannot be privately supplemented. How education is funded will depend on the state financing system. The next two subsections contain a detailed explanation for each system.

Each district has its own housing market, with the supply of housing in district i given by $H_i(p_i)$. $H_i(p_i)$ is assumed to be increasing, continuous, and equal to zero when the net of tax price, p_i, is zero. I use the following functional form of $H_i(p_i) = ap_i^b$ with $a > 0$, $0 \leq b \leq 1$ for all districts. That is, when $b = 0$ the housing supply is perfectly inelastic and as b increases the elasticity increases as well. The gross-of-tax housing price in i is given by $\pi_i = (1 + t_i)p_i$. Houses in each district are owned by the households in that district.

The interaction among districts in a state can be described as a three-stage game. In the first stage, households learn their district of residence, the income distribution across districts, and the state education finance system. Given these, districts choose state-wide policy variables through majority voting. The set of these state policy variables depends on the education finance system described below. In the second stage, districts choose property tax rates given the variables from the previous stage. In the last stage, households make housing and consumption choices and children receive education. Households know prices, tax rates, education spending and state's public education finance system at this stage. For any given state income distribution, and state finance system, we can solve the three-stage game by backward induction. Next, we solve the model separately for each finance system.

Later I ask which finance system would be chosen by majority voting which can be viewed as Stage 0 of this game.

1.2.2 Foundation System

In this system, districts are required to tax income at some minimum level, τ_f, in order to match state-mandated minimum per pupil spending. They are free to choose local property tax rates in order to increase per pupil education spending. So, we have per pupil spending in district i:

$$q_i = \tau_f \mu + t_i p_i h_i, \text{with } t_i \in [0, 1]$$

In Step 3, district i is characterized by a foundation income tax rate, τ_f, gross-of-tax housing price, π, and the quality of education, q. Given π, q and τ_f, a household with income y and housing wealth H solves the following problem:

$$\max_{h,c} u(c, h) + v(q)$$

$$\text{s.t. } c + \pi h = (1 - \tau_f)y + pH.$$

With separable and homothetic preferences, the solution to this problem is of the form:

$$c^* = \psi h^*, \psi = \frac{(\frac{1-a_c}{a_c})^{\frac{1}{\alpha-1}}}{\pi^{\frac{1}{\alpha-1}}}, h^* = \frac{(1 - \tau_f)y + ap^{b+1}}{\psi + \pi}, \tag{1.1}$$

and $\pi = (1+t)p$.[1] It is sufficient to have $\alpha < 1$ in order to have a unique price, p, that clears the housing market. To see that, recall the housing market clearing condition, $H(p) = h^*(p)$. Using the solution above, we get:

$$H(p) = ap^b = \frac{(1-\tau_f)y + ap^{b+1}}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p} = h^*(p). \tag{1.2}$$

Note that housing demand h^* is not necessarily decreasing in the house price, p, because of the additional wealth effect. But if parameters are such that h^* is increasing in p, it is always less steep than housing supply with $h^* \to \infty$ as $p \to 0$. Hence, there is a unique price that clears the market.[2]

In Step 2, given τ_f and the solution to the above problem, districts maximize indirect utility by choosing a property tax rate, t_i:

$$\max_{0 \le t \le 1} u(c^*, h^*) + v(q)$$

$$\text{s.t. } q = \tau_f \mu + tph^*,$$

$$c^*, h^* \text{given by (1.1).}$$

The first-order condition for this problem is given by

$$\underbrace{\frac{\partial u}{\partial c}\frac{\partial c}{\partial t} + \frac{\partial u}{\partial h}\frac{\partial h}{\partial t}}_{-MC_F} + \underbrace{\frac{\partial v}{\partial q}\frac{\partial q}{\partial t}}_{MB_F} = 0 \tag{1.3}$$

and together with the budget constraint of the district allow us to solve for the optimal property tax rate, t^*.

[1] See the appendix for a detailed solution.

[2] See the appendix for the details.

Note that $-\left(\frac{\partial u}{\partial c}\frac{\partial c}{\partial t}+\frac{\partial u}{\partial h}\frac{\partial h}{\partial t}\right)$ is the marginal utility cost (MC_F) of increasing the property tax rate while $\frac{\partial v}{\partial q}\frac{\partial q}{\partial t}$ is the marginal utility benefit (MB_F) of increasing the property tax rate. $\frac{\partial v}{\partial q}\frac{\partial q}{\partial t}$ is positive as v is increasing in q and q is increasing in t from the district's budget constraint.[3] But for a solution to exist we need $\frac{\partial u}{\partial c}\frac{\partial c}{\partial t}+\frac{\partial u}{\partial h}\frac{\partial h}{\partial t}$ to be negative. This is only possible if and only if $a_c\psi^{\alpha}\alpha\pi < (1-a_c)(\psi+(1-\alpha)\pi)$.[4] However since $u(c,h)$ and $v(q)$ are both concave we can show that for low values of t, $MC_F < MB_F$; for high values of t, $MC_F > MB_F$. Hence, there exists a unique solution to (1.3). The second-order condition for this problem is given by:

$$\frac{\partial MB_F}{\partial t}-\frac{\partial MC_F}{\partial t}<0 \tag{1.4}$$

and I refer to this condition in the proof of *Proposition 2.* Finally, it is straightforward to see that the richer districts have a higher property tax rate, $\frac{\partial t}{\partial y}>0$. This is used in the proof of *Proposition 1.*

In Step 1, districts decide on the Foundation amount which will be funded through a state income tax. Given the solutions to the previous steps:

$$\max_{0<\leq\tau_f\leq 1} u(c^*,h^*)+v(\tau_f\mu+t^*p^*h^*)$$

$$\text{s.t. } c^*,h^*\text{given by (1.1) and } t^*\text{given by (1.3).}$$

The solution to this problem is as as follows. For $y>\mu$, districts would prefer no redistribution, with $\tau_f=0$. This is because they are the ones supporting the

[3]See the appendix for the derivation.

[4]See the appendix for the derivation.

system. Any positive level of redistribution would be a net loss. On the other hand, districts having $y < \mu$, would prefer positive redistribution. Because they are poor, they benefit from redistribution. As this tendency increases with income, $\frac{\partial \tau_f}{\partial y} > 0$, richer districts would prefer to increase spending, so their preferred foundation tax rate would increase up to the mean income. Overall, preferences for the foundation tax rate, τ_f, are single-peaked. Thus, the Median Voter Theorem applies for the solution of τ_f. Since those districts with income exceeding y_μ would vote with the lower part of the income distribution, the median voter for τ_f, V, has a lower income, y_V, than the median income, y_M, which is also lower than the mean income, μ, by assumption.

1.2.3 Power-Equalizing System

In a Power-Equalizing system, there is no minimum level of per pupil spending. Instead, a guaranteed tax base, z_R, enables poor districts to raise the same revenue as the rich districts when applying the same property tax rate, $\tilde{t}$. The difference between actual and guaranteed tax base is met by state aid to the districts. Revenues generated under this system are independent of the district tax base and given by $\tilde{q} = \tilde{t} z_R$.

The difference between aggregate expenditures on education and the amount raised by each district is assumed to be funded by a state-wide tax τ_R on income.

$$\tau_R \sum_i y_i = \sum_i \tilde{t}_i (z_R - \tilde{p}_i \tilde{h}_i),$$

with $\tau_R \geq 0$.

We can characterize the equilibrium by applying the same solution method used for the Foundation system. In Step 3, given $\tilde{\pi}$, $\tilde{q}$, z_R and τ_R a representative household with income y and a housing wealth $\tilde{H}$ solves the following problem:

$$\max_{\tilde{h},\tilde{c}} u(\tilde{c},\tilde{h}) + v(\tilde{q})$$

$$\text{s.t. } \tilde{c} + \tilde{\pi}\tilde{h} = (1-\tau_R)y + \tilde{p}\tilde{H}.$$

Again, as a result of homothetic preferences, we have

$$\tilde{c}^* = \tilde{\psi}\tilde{h}^*, \tilde{\psi} = \frac{\left(\frac{1-a_c}{a_c}\right)^{\frac{1}{\alpha-1}}}{\tilde{\pi}^{\frac{1}{\alpha-1}}}, \tilde{h}^* = \frac{(1-\tau_R)y + a\tilde{p}^{b+1}}{\tilde{\psi}+\tilde{\pi}} \tag{1.5}$$

As in the Foundation system, we solve for $\tilde{p}_i$ using the housing market clearing condition. It is decreasing in the property tax rate, $\frac{\partial\tilde{p}}{\partial\tilde{t}} < 0$ as in the Foundation system.[5] Also, if $\tau_f = \tau_R$ and $(\pi, q) = (\tilde{\pi}, \tilde{q})$ then $(c^*, h^*) = (\tilde{c}^*, \tilde{h}^*)$. Hence the results we have for Step 3 from the Foundation system apply here.

In Step 2, districts maximize their indirect utility by choosing a property tax rate given a guaranteed tax base, z_R, and the solution to the above problem.

$$\max_{0\le\tilde{t}\le1} u(\tilde{c}^*,\tilde{h}^*) + v(\tilde{q})$$

$$\text{s.t. } \tilde{q} = \tilde{t}z_R,$$

$$\tilde{c}^*, \tilde{h}^* \text{given by (1.5).}$$

The first-order condition for this problem is given by:

[5] See the appendix for the derivation.

$$\underbrace{\frac{\partial u}{\partial \tilde{c}}\frac{\partial \tilde{c}}{\partial \tilde{t}} + \frac{\partial u}{\partial \tilde{h}}\frac{\partial \tilde{h}}{\partial \tilde{t}}}_{-MC_{PE}} + \underbrace{\frac{\partial v}{\partial \tilde{q}}z_R}_{MB_{PE}} = 0, \tag{1.6}$$

and allows us to solve for the optimal property tax rate, $\tilde{t}^*$.

Similar to the Foundation system, $-\left(\frac{\partial u}{\partial \tilde{c}}\frac{\partial \tilde{c}}{\partial \tilde{t}} + \frac{\partial u}{\partial \tilde{h}}\frac{\partial \tilde{h}}{\partial \tilde{t}}\right)$ is the marginal utility cost (MC_{PE}) and $\frac{\partial v}{\partial \tilde{q}}z_R$ is the marginal utility benefit (MB_{PE}) of increasing the property tax rate. For the existence of the solution, we need $\frac{\partial u}{\partial \tilde{c}}\frac{\partial \tilde{c}}{\partial \tilde{t}} + \frac{\partial u}{\partial \tilde{h}}\frac{\partial \tilde{h}}{\partial \tilde{t}}$ to be negative. Similar to the Foundation we need to impose a condition on parameters.[6] Following the solution in Foundation, we can argue that $u(c,h)$ and $v(q)$ are both concave we can show that for low values of t, $MC_{PE} < MB_{PE}$; for high values of t, $MC_{PE} > MB_{PE}$. Hence, there exists a unique solution to (1.6). The second-order condition for this problem is given by:

$$\frac{\partial MB_{PE}}{\partial t} - \frac{\partial MC_{PE}}{\partial t} < 0, \tag{1.7}$$

which is used in the proof of *Proposition 2*.[7]

In Step 1, given the solutions to the previous steps, districts choose a guaranteed tax base and the corresponding income tax rate. In order to determine the median voter district, we solve the following maximization problem for each district with income y and housing wealth $\tilde{H}$:

$$\max_{z_R, \tau_R} u(\tilde{c}^*, \tilde{h}^*) + v(\tilde{t}^* z_R)$$

[6]Derivation fort this very similar to the one in Foundation.

[7]See the appendix for the derivation.

$$\text{s.t. } z_R = \frac{\sum_i \tilde{t}_i \tilde{p}_i \tilde{h}_i + \tau_R \sum_i y_i}{\sum_i \tilde{t}_i},$$

$$\tilde{c}^*, \tilde{h}^* \text{given by (1.5).}$$

For a solution to this problem to exist, preferences must have the single crossing property in (τ_R, z_R). As our policy space is one dimensional under a Foundation system, we don't need such a property. Single-peaked preferences in the policy variable is the only condition we need for the Median Voter Theorem to apply. Under a Power-Equalizing system, we have a two-dimensional policy space. Therefore, we must meet two conditions to guarantee that the single crossing property holds, as is in Fernandez and Rogerson (2003) and Epple and Ferreyra (2008).[8] First, any two indifference curves of any two individuals may cross only once. Second, an indifference curve through any (τ_R, z_R) point must be increasing in income. In what follows I assume that parameters are such that the single-crossing property holds.[9] Given this, the Median Voter Theorem applies and the district with the median income is the decisive district. That is, hence, the preferred guaranteed tax base is monotonically increasing in income, we have $y_{V_{PE}} = y_M$. Furthermore, the median voter for this problem has an indirect utility that decreases in the income tax which he therefore sets to the lowest possible level, $\tau_R^*(V_{PE}) = 0$. Finally, we solve for z_R in the state by solving this maximization problem for $V_{PE} = M$.

[8]The necessary condition for single-crossing is the same with Fernandez and Rogerson (2003).

[9]For a reasonable number of set of parameters, I have checked that the model has those properties.

1.2.4 Foundation vs. Power-Equalizing

In this section, I argue that it is possible for a Foundation system to be chosen over Power Equalizing system by majority voting in Step 0 of the game. The reason behind this is that there are two competing effects. First, there are more districts benefitting from state redistribution under a Power-Equalizing system than under a Foundation system. This redistribution effect favoring the Power-Equalizing system over the Foundation system under majority voting is the main mechanism in Fernandez and Rogerson (2003). However, their model abstracts from housing markets and applies taxes on income rather than property as I do here. Adding the effects of such a switch between markets on housing markets, introduces a second effect. At an interior solution, for some districts with housing wealth below the guaranteed tax base, property tax rates under a Power-Equalizing system are higher compared to the Foundation system. This is because the cost of increasing education expenditures under a Power-Equalizing system is lower compared to that under a Foundation system for a majority of districts. For district i, the optimal property tax rate under a Foundation system, t_i^*, is potentially different than the optimal property tax rate under a Power-Equalizing system, $\tilde{t}_i^*$. This is mainly a result of the chosen guaranteed tax base, z_R, being different than the actual property tax base of the district. If the district is poor, the tax base of the district is lower than z_R, then MB is higher under a Power-Equalizing system than a Foundation system for every property tax rate. I refer to this result in the proof of *Proposition 2* in the next subsection when I compare the two systems. These districts would find it optimal to increase education expenditures, which necessitates increasing property tax rates. Higher property tax rates result in a lower net of tax price of housing and hence lower housing wealth in the district. This favors the Foundation system over the Power-Equalizing system under majority voting. Next, I analyze the redistribution effect and housing market effect in detail.

1.2.4.1 Redistribution Effect

The next proposition says that the guaranteed tax base, z_R, is greater than the property tax base of the district with the mean income, $\tilde{p}_\mu \tilde{H}_\mu$. This implies that the mean income district, μ, will benefit from redistribution, because his property tax base is lower than the guaranteed tax base in the state. Conversely, μ does not benefit from redistribution under a Foundation system. Because I assume that the median of the income distribution is less than the mean of the income distribution, $y_M < \mu$, the majority tends to prefer a Power-Equalizing system over a Foundation system as a result of purely the redistribution effect.

Proposition 1: For any non-negative income tax rate, the guaranteed tax base chosen by the median voter district in the state, z_R, is greater than the property tax base of the mean income district, $\tilde{p}_\mu \tilde{H}_\mu$.

Proof: By definition, $\tau_R \sum_i y_i = \sum_i \tilde{t}_i(z_R - \tilde{p}_i \tilde{H}_i)$. First, richer districts set a higher property tax rate, $\tilde{t}_i < \tilde{t}_{i+1}$. Second, we have $\frac{\partial \tilde{p}}{\partial y} > 0$ so richer districts have higher property wealth through higher housing demand compared to poorer districts, i.e. $\tilde{p}_{\tilde{t}_i} \tilde{H}_{\tilde{t}_i} < \tilde{p}_{\tilde{t}_{i+1}} \tilde{H}_{\tilde{t}_{i+1}}$. Thus we get $\tau_R \sum_i y_i < \sum_i \tilde{t}_{z_R}(z_R - \tilde{p}_i \tilde{H}_i)$. This implies that

$Nz_R \geq \sum_i^N \tilde{p}_i \tilde{H}_i$. Suppose that $z_R \leq \tilde{p}_\mu \tilde{H}_\mu$. So $\tilde{p}_\mu \tilde{H}_\mu \geq \frac{\sum_i^N \tilde{p}_i \tilde{H}_i}{N}$. This contradicts $\tilde{p}_i \tilde{H}_i$ being a strictly convex function of income. Thus, $\tilde{p}_\mu \tilde{H}_\mu < z_R$.$\blacksquare$

In order to see the redistribution effect more clearly, we can compare the per unit cost of increasing education spending for both systems.

$Cost_F(y_i) = \frac{\tau_f y_i + t_i p_i H_i}{\tau_f \mu + t_i p_i H_i}$ and $Cost_{PE}(y_i) = \frac{\tilde{t}_i \tilde{p}_i \tilde{H}_i}{\tilde{t}_i z_R}$

Both are increasing in income; the closer income gets to the point of redistribution, the less the district benefits from it. As $\tilde{p}_\mu \tilde{H}_\mu < z_R$ by Proposition 1, the cost for μ is less than one in the Power-Equalizing system and equals one in the Foundation system. For the median income district, y_M, additionally:

$Cost_{PE}(y_M) < \frac{\tilde{p}_{y_M} \tilde{H}_{y_M}}{\tilde{p}_\mu \tilde{H}_\mu}$ and $\frac{y_M}{\mu} < Cost_F(y_M)$

Furthermore, we have $\frac{\tilde{p}_{y_M} \tilde{H}_{y_M}}{y_M} < \frac{\tilde{p}_\mu \tilde{H}_\mu}{\mu}$ as $\tilde{p}\tilde{H}$ is a convex function. Thus, we have $Cost_{PE}(y_M) < Cost_F(y_M)$. This implies that y_M is better off under Power-Equalizing than under Foundation as a result of purely the redistribution effect. This is the only effect in Fernandez and Rogerson (2003). Hence, they conclude that a Power-Equalizing system will always be chosen over a Foundation system under majority voting.

1.2.4.2 Housing Market Effect

When a housing market is in place, there will be potential differences in property tax rates across systems. The next proposition tells us that, in the Power-Equalizing system, districts which benefit from the redistribution of funds, $\tilde{p}_i \tilde{H}_i < z_R$, choose higher property tax rates than they do in the Foundation system. This is a result of these districts having a lower cost of increasing education spending in the Power-Equalizing system than in the Foundation system as shown above. With a lower cost of increasing education spending, they choose to have higher education spending, and this is only possible with higher property tax rates under a Power-Equalizing system. Higher property tax rates result in higher gross price and lower net-of-tax price for housing. This shifts housing demand down and decreases supply. Hence, housing wealth and housing consumption of the districts is lower under a Power-Equalizing system than a Foundation system. So, the housing market effect favors a Foundation system over a Power-Equalizing system. While more districts benefit from the redistribution under a Power-Equalizing system than under a Foundation system, the majority tend to prefer a Foundation system over a Power-Equalizing system as a result of purely the housing market effect. This effect does not exist in Fernandez and Rogerson (2003) so a Power-Equalizing system is always preferred over a Foundation system by the majority. That can only happen in this paper if the housing market effect disappears which requires households do not enjoy housing consumption, i.e. set $a_c = 1$.

Proposition 2: At an interior solution, for every district with a property tax base lower than the guaranteed tax base in the state, $\tilde{p}_i \tilde{H}_i < z_R$, if $\tau_R = \tau_f$, property tax rates under the Power-Equalizing system are greater than property tax rates under the Foundation system, i.e. $t_i^* < \tilde{t}_i^*$.

Proof: Since $\tau_R = \tau_f$, Stage 3 is identical in both systems if $(\pi, q) = (\tilde{\pi}, \tilde{q})$. Now, we recall the first-order conditions in each system for the optimal property tax rate:

$$\textbf{F: } \overbrace{-(\frac{\partial u}{\partial c}\frac{\partial c}{\partial t} + \frac{\partial u}{\partial h}\frac{\partial h}{\partial t})}^{MC_F} = \overbrace{\frac{\partial v}{\partial q}\frac{\partial q}{\partial t}}^{MB_F}$$

$$\textbf{PE:} \underbrace{-(\frac{\partial u}{\partial \tilde{c}}\frac{\partial \tilde{c}}{\partial \tilde{t}} + \frac{\partial u}{\partial \tilde{h}}\frac{\partial \tilde{h}}{\partial \tilde{t}})}_{MC_{PE}} = \underbrace{\frac{\partial v}{\partial \tilde{q}} z_R}_{MB_{PE}}$$

There are four properties used in this proof:

1. For every property tax rate, t, marginal cost is the same under both systems, $MC_F(t) = MC_{PE}(t)$.

2. For every property tax rate, t, marginal benefit under the Power-Equalizing system is higher than it is under the Foundation system as $\frac{\partial q}{\partial t} < z_R$ for the districts with $\tilde{p}_i \tilde{H}_i < z_R$, $MB_F(t) < MB_{PE}(t)$.

3. Both sides of both of the first-order conditions are decreasing in property tax rates, $\frac{\partial MC_F(t)}{\partial t}, \frac{\partial MB_F(t)}{\partial t}, \frac{\partial MC_{PE}(t)}{\partial t}, \frac{\partial MB_{PE}(t)}{\partial t} < 0$

4. The second-order condition for each system implies that the MB is steeper than MC, i.e. $\frac{\partial MB}{\partial t} < \frac{\partial MC}{\partial t}$.

The first and the second properties imply that for any district with $\tilde{p}\tilde{H} < z_R$, property tax rates under two systems are different, $t^* \neq \tilde{t}^*$. Suppose $t^* > \tilde{t}^*$, then the second and the third property imply that MC has to be steeper than MB which would contradict the fourth property. Thus, it has to be the case that $t^* < \tilde{t}^*$.■

Proposition 2 is for $\tau_R = \tau_f$. The previous subsection argues that the income tax rate in the Power-Equalizing system is zero, $\tau_R = 0$. Because the optimal property tax is higher with a lower income tax, $\frac{\partial \tilde{t}}{\partial \tau_R} < 0$, we still have $t^* < \tilde{t}^*$.

1.2.5 Comparative Statics

The model argues that when we compare a Power-Equalizing system with a Foundation system, there are two effects we must consider: the redistribution effect and the housing market effect. If the redistribution effect dominates the housing market effect for a majority of districts, the state would opt for the Power-Equalizing system if they were put to a vote. On the other hand, if the housing market effect dominates the redistribution effect for a majority of districts, the state would opt for the Foundation system instead. In what follows, I analyze the effects of changes in the income distribution and housing supply elasticity on the size of both the redistribution effect and the housing market effect. In the next section, I examine the switches between public education finance systems in the recent years and see if those switches can be rationalized with the results produced by this model.

1.2.5.1 Income Distribution

Using two examples, I derive comparative statics to see under what conditions the redistribution effect is weakened and the housing market effect is strengthened in order to rationalize observed switchers from a Power-Equalizing system to a Foundation system. I find that, first, the redistribution effect is smaller if the districts have similar income levels. In other words, if the variance of the income distribution is smaller, then the redistribution effect is smaller. Second, the housing market effect is bigger if per capita income in the state, μ, is lower.

First, the size of the redistribution effect is the difference between the cost of increasing education spending by a dollar under two systems, $Cost_F(y_i) - Cost_{PE}(y_i)$, as defined in Section 2.4.1. Second, the size of the housing market effect is the difference between property tax rates under the two systems, $\tilde{t}^* - t^*$. Consider the case in which we have a log-utility function and a linear housing supply function: $\alpha = 0$, $\gamma = 0$, $a = 1$, $b = 1$, $a_c = 0.5$. Then, for a mean preserving spread of the income distribution, the redistribution effect is bigger because $Cost_{PE}(y_i)$ decreases faster than $Cost_F(y_i)$. The reason for this is that the wealth difference between the median voter and rich districts is higher so the median voter sets the level of redistribution under the Power-Equalizing system, z_R, higher. Also, with the above parameter values we get

$$\tilde{t}^* - t^* = 2A^2 - A\tfrac{\tau_f \mu}{(1-\tau_f)y} + \tfrac{\tau_f \mu}{(1-\tau_f)y}.$$

The housing market effect is therefore decreasing in μ. In other words, a lower μ leads to a bigger housing market effect. I also analyzed for parameter values in Fernandez and Rogerson (2003) and a concave house supply function as in Fernandez and Rogerson (1998): $\alpha = -1$, $\gamma = -1$, $a = 1$, $b = 0.5$, $a_c = 0.5$. Same intuition follows.

1.2.5.2 House Supply Elasticity

Using two extreme cases for house supply elasticity, perfectly inelastic house supply and perfectly elastic house supply, I argue that both the redistribution effect and the housing market effect exist under both cases. However, the size of these effects are different for different elasticities while their directions are unchanged. In addition, the change in the size of these effects with respect to the differences in elasticities are not monotone.

First, recall that the redistribution effect is the difference in the per unit cost of increasing education spending between two systems, $Cost_{PE}(y_M) < Cost_F(y_M)$. As long as we have $\tilde{p}_\mu \tilde{H}_\mu < z_R$, this inequality holds. And Proposition 1 shows us that $y_M < \mu$ guarantees the existence of the redistribution effect which does not depend on the elasticity. However, the size of the elasticity will in fact affect the difference in the per unit cost of increasing education spending between two systems. For example, if we have a perfectly inelastic housing market supply, the differences in property tax rates between two systems will be completely absorbed by the net-of-tax house prices. As a result, this will affect $z_R - \tilde{p}_\mu \tilde{H}_\mu$ and $Cost_F(y_M) - Cost_{PE}(y_M)$ which is the size of the redistribution effect. The size of this effect would have been different if we had a perfectly elastic housing market supply as the net-of-tax house prices remain unchanged with respect to the changes in property tax rates but we still would have had a redistribution effect. Second, under the Power-Equalizing system property tax rates are higher compared to the property tax rates under the Foundation system as it is argued by Proposition 2. When the housing market is perfectly inelastic, this difference will be reflected on the net-of-tax house prices with no change in the house supply. The net-of-tax house prices will be lower under the Power-Equalizing system compared to the Foundation system. As the households own these houses, their housing wealth will be lower also. This will make the households worse-off under the Power-Equalizing system compared to the

Foundation system. On the other hand, when the housing market is perfectly elastic, the difference between property tax rates under two systems will be reflected on the house supply with no change in the net-of-tax house prices. As the property tax rates are higher under the Power-Equalizing system, the gross price of housing will be higher so this will decrease the housing demand which will decrease the housing supply in the equilibrium. Similarly, as they own these houses, their housing wealth will be lower which will make the households worse-off under the Power-Equalizing system compared to the Foundation system. Thus, under both perfectly inelastic and perfectly elastic housing market the housing market effect exist. And the size of this effect is potentially different under these market structures.

1.3 Suggestive Evidence

Comparative statics above suggest at least two possible reasons for a state to be more likely to prefer a Foundation system over a Power-Equalizing system in the model: a lower per capita income, μ, and a lower income inequality, $var(y)$. In addition, the model also has implications for the switcher states on house prices. It is argued that the Power-Equalizing system has higher property tax rates and lower house prices compared to the Foundation system. Thus, the states that switched from former to the latter, should observe an increase in the house prices. In this section, I will try to see how well these implications match with the data.

1.3.1 Income Distribution

Even though this model has no implications on the transition from one system to another, its theoretical results could be tested empirically by analyzing the switches between systems in the recent years. In the light of the comparative statics, states with a lower per capita income, and a lower income inequality would be good candidates to have a Foundation system or even switch into a Foundation system if they have a Power-Equalizing system currently. For those switcher states, μ and $var(y)$ are identified by per capita income and gini coefficient respectively.[10]

There are at least two possible ways to compare the variables of interest across states. First way would be to report the levels of these variables and sort the states into systems with respect to their relative levels using the model. Then, we could verify whether the results actually match. For example, the model predicts that the states with a Foundation system should have at least one of the following two: a low level of per capita income, or a low gini coefficient. Moreover, those states with a Power-Equalizing system should have at least one of: a high level of per capita income, or a high gini coefficient. Second way, which I use in this paper, is to report the growth rates of those two variables for each state and determine if the reported growth rates are significantly different for those states that have switched into a different finance system recently. One advantage of using growth rates is that the states differ in many other characteristics, such as geographical or industrial factors, that are not captured by the current model. By comparing the growth rate

[10]Different inequality measures does not seem to have large impacts on the results.

of each variable, we can difference out these characteristics across states.

The experiment in this section operates as follows. I compare the growth rate of the variables of interest for switchers with respect to the reference group. We focus our attention on two types of switchers: states that switched from a Power-Equalizing system to a Foundation system, and states that switched in the opposite direction. Reference groups differ depending on the finance system in place prior to the switch. Table 1 and Table 2 are defined by the following:

S: Switcher. Either from Power-Equalizing to Foundation or in the opposite direction.

RG: Reference group. Either Power-Equalizing or Foundation, depending on the original type.[11]

I report the yearly percentage change in each variable and compare it with the average change in the reference group.

- $INC_t^S = \%\Delta\text{Per Capita Income}_t^S - \%\Delta\text{Per Capita Income}_t^{RG}$
- $INE_t^S = \%\Delta\text{Gini Coefficient}_t^S - \%\Delta\text{Gini Coefficient}_t^{RG}$

Data on per capita income and gini coefficient by states come from the U.S. Dept. of Commerce Bureau of Economic Analysis. Also, data on public education finance systems by state are from Jackson et al. (2014). All of the variables are

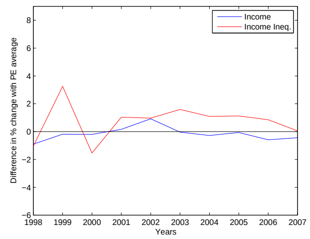
[11] I use two other types of reference groups and report these results in the Appendix. The choice of reference group doesn't affect the results qualitatively.

reported for a period of ten years prior to the switching year for each state. Table 1 reports the above three variables for states switching: from Power-Equalizing to Foundation. These states are Pennsylvania (2008), New York (2006), Colorado (1994), and Massachusetts (1993) between 1990 and 2011. The reference group includes the states that stayed as Power-Equalizing system in the sample years: Delaware, Kansas, New Jersey, North Carolina, Rhode Island, Washington, Wisconsin, and Oregon after 1992. In addition, I report Court-ordered reforms and Legislative reforms separately in Table 1. However, the results seem not to differ qualitatively for our purposes.

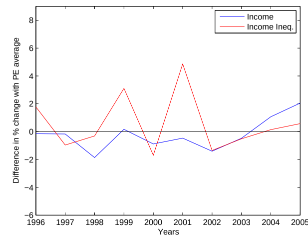
Table 1.1: From Power-Equalizing to Foundation with respect to Power-Equalizing average

STATE	VARIABLE	MODEL	AVG
Court-ordered Reform States			
NY (2006)	INC	(-)	-0.21
	INE	(-)	+0.56
MA (1993)	INC	(-)	+0.41
	INE	(-)	-0.27
Legislative Reform States			
PA (2008)	INC	(-)	-0.16
	INE	(-)	+0.74
CO (1994)	INC	(-)	-0.85
	INE	(-)	-0.82

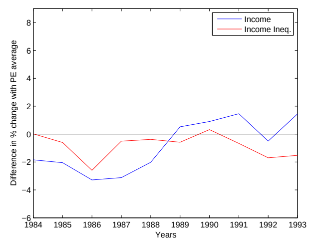
For the four switcher states of Table 1, the model suggests that their growth rates of per capita income and gini coefficient should be lower than the average of the reference group. The third column reports these signs. The last column is the average ten years prior to the switch for each state. As the model would suggest, it appears that these four states are different than the reference group. In New York prior to the switch in 2006 for instance, the growth rate of per capita income was 0.21 percent lower than was the average for Power-Equalizing states each year on average between 1996 and 2005. The model suggests that at least one of the variables should be different from the reference group for a switch to occur. Since the model does not offer an interpretation for the magnitudes of growth rates for a variable or across variables, I focus on the sign of the growth rate. I check that switcher states will match at least one of the two signs. As it happens, all four switcher states have at least one variable with the expected sign. Plotting the values illustrates the difference between these states and the reference group in more detail.



(a) PA (2008)



(b) NY (2006)



(c) CO (1994)

(d) MA (1993)

Figure 1.1: States Switched from Power-Equalizing to Foundation

I plot the variables of interest for each switcher state. The growth rate of per capita income and gini coefficient is lower for switchers compared to the reference group on average. These observations are in line with the predictions of the model.

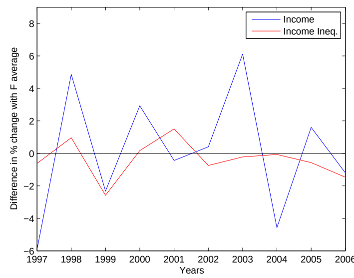
Now, I examine the switchers in the opposite direction. The model suggests that these are the states with a higher redistribution effect (higher growth rate for gini coefficient) or a lower housing market effect (higher growth rate of per capita income). Table 2 reports these variables for the switchers in the opposite direction to Table 1. Our switchers are now the states who switched from a Foundation system to a Power-Equalizing system between 1990 and 2011: North Dakota (2007), Ohio

(2002), Maryland (2002), Alaska (1999), New Mexico (1998), Nebraska (1997), Utah (1997), Wyoming (1995), Alabama (1994), Arkansas (1994), and Indiana (1994). The group of states that stayed as a Foundation system serve as our reference group: California, Idaho, Iowa, Kentucky, Minnesota, Mississippi, Nevada, South Carolina, South Dakota, Tennessee, West Virginia. Similar to Table 1, I report the switchers in two groups: Court-ordered reform states and Legislative reform states. And Table 2 demonstrates us that there is no qualitative difference between these two groups in the variables of interest.

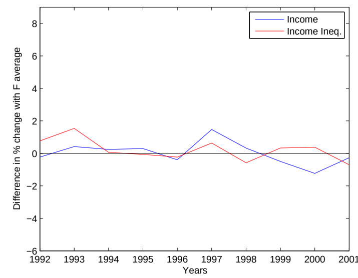
In Table 2 Ohio is a suitable example: prior to the switch in 2002, the growth rate of gini coefficient was 0.21 percent higher than was the average for Foundation states for each year on average between 1992-2001. If we look at each state in Table 2, we notice that there is at least one variable that grows in the direction suggested by the model. For most of the switchers, almost both of the variables grow in the direction suggested by the model. From the plots below, we see that for this type of switchers, the growth rate of per capita income and gini coefficient is consistently higher than that of the reference group as predicted by the model. This trend in growth rates is the polar opposite of the first type of switchers. Overall, the implications of the model appear to be verifiable by the documented switches in either direction.

Table 1.2: From Foundation to Power-Equalizing with respect to Foundation average

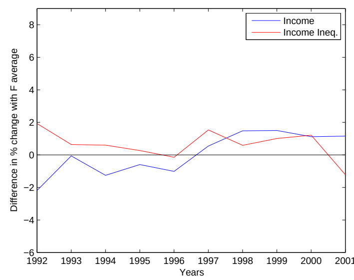
STATE	VARIABLE	MODEL	AVG
Court-ordered Reform States			
OH (2002)	INC	(+)	+0.01
	INE	(+)	+0.21
AK (1999)	INC	(+)	-1.13
	INE	(+)	+1.82
NM (1998)	INC	(+)	-0.32
	INE	(+)	+0.22
WY (1995)	INC	(+)	-0.63
	INE	(+)	+0.83
AL (1994)	INC	(+)	+0.61
	INE	(+)	+0.83
AR (1994)	INC	(+)	+0.30
	INE	(+)	+0.26
Legislative Reform States			
ND (2007)	INC	(+)	+0.15
	INE	(+)	-0.36
MD (2002)	INC	(+)	+0.01
	INE	(+)	+0.64
NE (1997)	INC	(+)	+0.14
	INE	(+)	-0.01
UT (1997)	INC	(+)	+0.29
	INE	(+)	+0.84
IN (1994)	INC	(+)	+0.44
	INE	(+)	+0.78



(a) ND (2007)



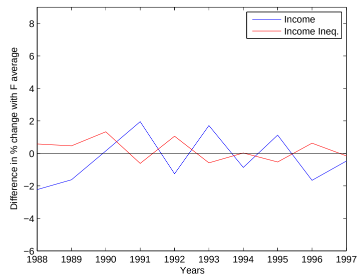
(b) OH (2002)



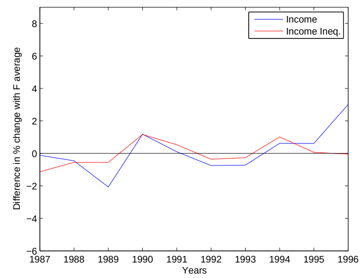
(c) MD (2002)

(d) AK (1999)

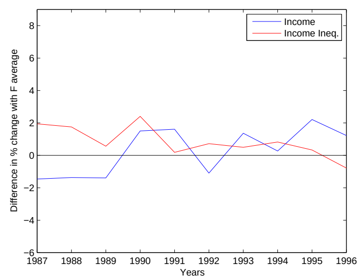
Figure 1.2: States Switched from Foundation to Power-Equalizing



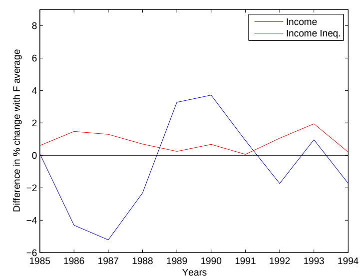
(a) NM (1998)



(b) NE (1997)



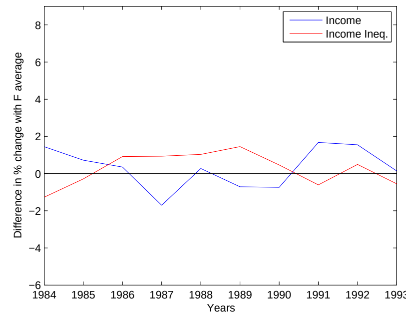
(c) UT (1997)



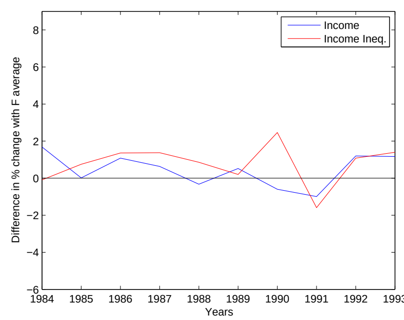
(d) WY (1995)

Figure 1.3: States Switched from Foundation to Power-Equalizing

(a) AL (1994)



(b) AR (1994)



(c) IN (1994)

Figure 1.4: States Switched from Foundation to Power-Equalizing

1.3.2 House Prices

We can also test the validity of the model by comparing the changes in house prices for different states. In the light of the experiment from above, the model suggests that the states that switched from Power-Equalizing to Foundation will experience an increase in house prices while the switchers in the other direction will experience a decrease compared to their reference groups. If there were no data limitations, I would have measured the yearly change in house prices for the switcher states and compare that with the non-switcher states similar to the exercise above.

However, house price data does not exist for every year for the years between 1990 and 2011. Instead, CENSUS provides the median house value by district for 1990, 2000, and 2010. After keeping the districts that exists in all these three years, I use their population as the weight to construct the median house value in the state, P, for 1990, 2000, and 2010. Then, I measure the change in the median house value in the state between these ten year periods. It is also important to mention that if the switch is in 1990s then I compare the growth rates between 1990 and 2000 to the growth rate of the average of the reference group between the same years. If not, then compare the growth rates between 2000 and 2010 to the growth rate of the average of the reference group. The reference groups are the same with above. Lastly, while comparing house prices across states, it would be useful to account for the differences in housing market elasticities across these states. As it is discussed in the previous section, the size of the housing market elasticity affects both the size of the redistribution effect and the housing effect. For that matter, I construct a housing supply elasticity measure for states, HSE. First, Saiz (2010) reports housing supply elasticities for Metropolitan Statistical Areas (MSAs) with population over $500,000$. One with problem with working with MSAs is that some of them are contained in multiple states. I identified those MSAs with the state that has most of the MSA's population. And also in some states there are multiple MSAs. For those states, I computed the weighted average of the elasticities by using the population of the MSA as its relative weight. The population data comes from CENSUS 2000. There is no reported housing supply elasticity data for Alaska, North

Dakota and Wyoming in Saiz (2010).

Table 3 is for the states that switched from Power-Equalizing to Foundation. The model claims that these states should observe an increase in house prices compared to the reference group. Table 3 reports a higher growth in house prices compared the reference group for all the switcher states except Colorado. In addition, the switcher states have similar housing supply elasticity values that are less elastic than the average of the reference group, HSE_{PE}. To sum up, the model captures the qualitative change for three out of four states.

Table 1.3: From Power-Equalizing to Foundation with respect to Power-Equalizing average

STATE	VARIABLE	MODEL	AVG	HSE	HSE_{PE}
Court-ordered Reform States					
NY (2006)	P	(+)	+1.7	+1.58	+2.06
MA (1993)	P	(+)	+3.6	+1.52	+2.06
Legislative Reform States					
PA (2008)	P	(+)	+1.9	+1.58	+2.06
CO (1994)	P	(+)	-1.9	+1.60	+2.06

Next, Table 4 reports the changes in house prices for the states that switched from Foundation to Power-Equalizing. The model suggests the exact opposite for these states: we expect to observe a decline in their house prices after they switched from a Foundation system to a Power-Equalizing system. Table 4 also reports housing supply elasticity measure for each state,HSE, and the average house supply elasticity for the reference group, HSE_F. Table 4 reports both negative and positive values while the model suggests that all the reported values should be negative. This might be a bit of a problem. However, the model still captures the qualitative change for almost half of the switcher states. In addition, there might be other factors that effects the decision of switching from one system to another. So in that case, we might observe the projected changes in house prices as there was no housing market effect in place in the first place. Moreover, house prices are hard to measure so it might be normal not to get clear-cut results from this exercise. Furthermore, it seems that there is no trend in the house supply elasticities of the states that reports higher growth in house prices compared to the reference group. At this point, house price data offers inconclusive results for the validation of the model.

Table 1.4: From Power-Equalizing to Foundation with respect to Power-Equalizing average

STATE	VARIABLE	MODEL	AVG	HSE	HSE_F
Court-ordered Reform States					
OH (2002)	P	(-)	-4.0	+2.48	+1.90
AK (1999)	P	(-)	-1.4	-	+1.90
NM (1998)	P	(-)	+0.4	+2.11	+1.90
WY (1995)	P	(-)	+1.2	-	+1.90
AL (1994)	P	(-)	+0.2	+2.09	+1.90
AR (1994)	P	(-)	-1.6	+2.79	+1.90
Legislative Reform States					
ND (2007)	P	(-)	+10.4	-	+1.90
MD (2002)	P	(-)	+6.4	+1.23	+1.90
NE (1997)	P	(-)	-1.2	+3.47	+1.90
UT (1997)	P	(-)	+5.0	+0.75	+1.90
IN (1994)	P	(-)	+2.3	+3.70	+1.90

1.4 Conclusion

An important result in the public education finance literature is that the Power-Equalizing system is socially preferred over the Foundation system, as established by Fernandez and Rogerson (2003). Yet more states have been using a Foundation system in recent years. Indeed, some states such as Pennsylvania (2008), New York (2006), Colorado (1994) and Massachusetts (1993) switched from using a Power-Equalizing system to using a Foundation system. In this paper, I build a model that helps us understand these switches. This model builds on Fernandez and Rogerson (2003) by introducing a housing market. In a model with no housing market, a majority of individuals prefers Power-Equalizing over Foundation, because redistribution is always higher in the former than in the latter. With the introduction of the housing market however, another effect appears. For most districts, property tax rates are higher in a Power-Equalizing system as a result of lower costs of increasing educational spending for the majority of districts compared to those in a Foundation system. Higher property tax rates result in lower property values and lower housing wealth in the district. This decrease in housing wealth and increase in gross price of housing makes the Power-Equalizing system less attractive for the median voter.

As a result, we have two different effects in a model with a housing market. The redistribution effect works in favor of a Power-Equalizing system while the housing market effect works against it. For the housing market effect dominate the redistribution effect, model requires the following conditions: a lower mean income in the state, μ, or a lower variance of income distribution, $var(y)$. I test these implications of the model by examining data on income distribution of states from 1980 to 2011. By using per capita income in the state for μ and gini coefficient in the state for $var(y)$, I provide suggestive evidence on the implications of the model.

I report that the yearly growth rates of these two variables for those states that have changed their public education finance system in the recent years are significantly different than those of their reference group. For the states that switched from Power-Equalizing to Foundation, I use pure Power-Equalizing states as the reference group; for those that switched in the opposite direction, I use pure Foundation states as the reference group. The reported tables indicate that the states switching from Power-Equalizing to Foundation experienced at least one of the following: a lower growth rate in per capita income, or a lower growth rate in gini coefficient each year. This evidence demonstrates that the model can rationalize the switches in this direction. Additionally, the states that switched in the opposite direction experienced growth rate differences with the reference group in an opposite manner. This confirms the ability of the model to explain switches in the opposite direction as well. In addition, the model offers projections on the house prices. It is suggested that the states that switched into a Foundation system should observe an increase in house prices while the states that switched into a Power-Equalizing system should observe a decrease in house prices. These changes in house prices are due to the housing market effect. In order to test the implication of the model on house prices, I measure the change in house prices for switcher states after the switch with respect to the same reference groups. This exercise offers mixed results. Some of the states do not experience the suggested changes in house prices after the switch. On the positive note, the model captures almost half of the states qualitatively.

CHAPTER 2
STATE INVOLVEMENT IN PUBLIC EDUCATION FINANCE: CROWDING-OUT EFFECT

2.1 Introduction

A rapidly growing literature that strongly connects economic growth with human capital accumulation has emerged in the second half of the Twentieth century. Over 85 percent of K-12 students are currently enrolled in public schools. As such, government policies on public education finance have been a topic of discussion in recent years.

In the U.S., public education finance is mostly regulated by state governments. Although an average of 40 percent of funds come from local sources on average, local governments have little authority over public education finance in many states. State governments have been responsible for setting rules on public education finance so the systems financing public education vary widely across states. It is the state governments who potentially control the distribution of per pupil spending across school districts. Through the 1960's and before, local governments provided the majority of funds for public primary and secondary education in the United States. This high level of state authority on public education is the result of a process started in the 1970's.

Because property taxes were traditionally the primary source of local tax revenue, the resources devoted to education were a function of the property tax base in a district to a large extent. Thus, high levels of inequality in property tax bases across districts led to high levels of inequality in per pupil expenditures in public schools within a state. Beginning with the landmark *Serrano v. Priest* case in California, many states have moved - voluntarily or under court order - towards more redistributive intergovernmental state education grants. Over the four decades since *Serrano*, 43 states have been challenged on the constitutionality of their public school finance systems. This demand for equal opportunity in public schools has increased the involvement of state governments in public education finance system over the years. State funding of K-12 peaked in 2001, when states contributed almost 7 percent more than local governments to the $530 billion of total K-12 expenditures. Currently, the state share in per pupil spending ranges from 31 percent to 86 percent across states, according to the National Center for Education Statistics (NCES).

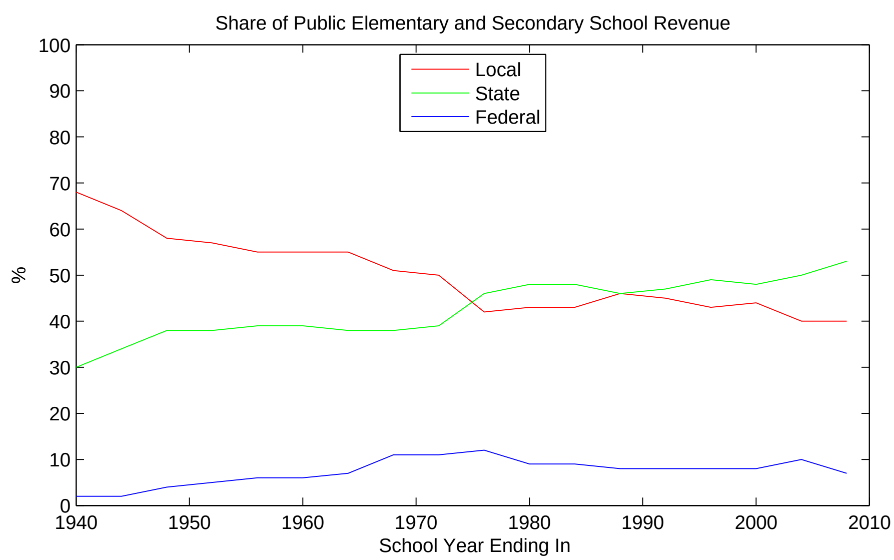


Figure 2.1: Share of Public Elementary and Secondary School Revenue

This paper analyzes the effect of increased state involvement in public education funding on spending levels. Although changes in public education finance systems shift the relative amounts of state aid received by richer and poorer districts, they do not necessarily lead to corresponding changes in per pupil expenditures. School districts can reduce local taxes in response to an increase in state aid. As a result, the total expenditure per pupil in a district might not increase as a result of state aid. Indeed, it can decrease under some circumstances. To analyze these effects, I gather a 2008 U.S. district level data set on public education finance and income, which the next section explains in detail. Using this data set, I try to answer the following questions. How do state and local governments interact to provide education? Do states redistribute across districts? If so, do state contributions crowd out local contributions? And finally, do different type of state aid formulas have different crowding out rates?

In order to answer these questions, I regress total expenditure per pupil in the district on state contribution with a set of interaction terms for different state finance systems after controlling for income and demographic characteristics of the district. The main focus of this research will be on the coefficient of state contribution. If this coefficient is bigger than one, then there is no crowding-out caused by the increased state involvement in public education finance. If it is smaller than one, then there is positive crowding-out. State aid formula categorization is from Jackson et al. (2014).

Overall, states redistribute to districts that are poor, non-white, young and less educated. There is positive crowding-out as a result of increased state involvement in public education. State aid formulas resulting in lower intrastate per pupil expenditure inequality, such as equalization plans and local effort equalizations create the highest crowding out rates. State aid formulas with minimum foundation plans decrease intrastate per pupil expenditure inequality to a lesser degree. Crowding-out rates under minimum foundation plans are smaller compared to those under equalization and local effort equalization plans. In addition, some states dictate spending limits on local districts in their state aid formulas. This appears to decrease crowding-out rates by placing a ceiling on local contributions in wealthier districts. That is, some portion of spending reductions occurs thanks to an altered regulatory framework. This lessens the effects of crowding-out per se. In order to see if these results are robust, I run this model on only court-ordered reforms. And also, I include a measure for the religiosity of the district to see if the results are affected. Both of these experiments confirm the success of the model. Lastly, I confirm that the model doesn't seem to have an endogeneity problem by using an instrumental variable approach.

The public education finance literature provided opposing views on the effects of state involvement on local tax revenues and levels of per pupil total expenditures in public schools. The first group of papers argue that increased state involvement affects total expenditure per pupil level positively. Manwaring and Sheffrin (1997) examine the role of litigation and educational finance reforms on real education expenditure per average daily attendance between 1970 and 1990. They conclude that litigation ultimately had a negative effect in eight states and a positive effect in fourteen others; the positive effects were much more significant. Murray et al. (1998) was the first paper to use district level data examining sources from 1971 to 1996 to investigate the effects of court decisions on intrastate spending inequality and average per pupil expenditures. They find that court-ordered finance reforms reduce within state inequality in spending by 19 to 34 percent. Spending increases in the poorest districts, remaining unchanged in the richest districts. This constitutes an overall leveling up effect. Baicker and Gordon (2006) is another paper arguing that school finance reforms from 1980 to 2000 increased both the level and the progressivity of state spending on education, eventually leading to higher total expenditure per pupil. States accomplished this increase in spending, however, by reducing their aid to localities for other programs. This first group of papers, which claim higher state involvement in public education funding leads to higher levels of spending per pupil spending, don't account for changes in property values. In this paper, I show that higher state involvement has negative effects on per pupil spending after controlling for property values in the school district.

A second group of papers claims that higher levels of state involvement can lead to lower levels of total expenditure per pupil. Downes and Shah (1994) use state level data between 1970 and 1990. They conclude that the effects of court-ordered reforms are not uniform across states, and could be negative. The overall effect of finance reforms on expenditures in a given state depends on such determinants of spending as income, property values, enrollment, and racial and ethnic composition. Fernandez and Rogerson (1998) report that California saw its funding of public education fall between ten and fifteen percent relative to the rest of the U.S. after giving more control over the public education finance system to the state. This paper argues theoretically that a simple political economy model of public finance can account for the bulk of this drop. The authors also conclude that equalization occurred across districts due to leveling down. Guryan (2001) analyzes the effect of educational expenditures on student achievement in the context of a Massachusetts equalization law. He uses district level data before and after the Massachusetts Education Reform Act of 1993 (MERA), which imposed more extensive state controls in public education finance. According to Guryan, each dollar spent on public education by the state government increases total expenditure per pupil by 50 to 75 cents. Thus, the centralization of public education finance decrease total expenditures per pupil in Massachusetts. Hoxby (2001) finds that redistribution in public education finance is based on property values, which are endogenous to schools productivity, taste for education, and the school finance system itself. The paper additionally characterizes different equalization schemes showing why some "level down" and others "level up". These differences depend on how the various plans affect property values and tax price of local marginal local spending. This is one of the first papers arguing that the effects of school finance reforms on total expenditure per pupil depend on the type of reform. It uses district level U.S. Census data from 1970, 1980, and 1990 on per pupil spending, property values, household income, demographic characteristics including race, age, and educational attainment. Hoxby ultimately finds that minimum foundation schemes do not reduce property values unlike equalization schemes which causes leveling down. Card and Payne (2002) study the effect of school finance reforms on the distribution of school spending across districts of varying wealth. It uses district level data from the 1977 and 1992 Census For Governments, concluding that school finance reforms decreases intrastate within state inequality in total expenditure per pupil, however, a dollar increase in state aid increases district education spending by only 50-65 cents. Those state aid systems emphasizing equalization more heavily caused leveling down. Finally, Jackson et al. (2014) analyze the effects of reforms between 1967 and 2010 on the level and distribution of school district spending, as well as their effects on subsequent educational and economic outcomes. Similar to Hoxby (2001), this paper also differentiates between different types of reforms. It argues that while all reforms reduced spending inequality, there were important differences by reform type. Adequacy-based court-ordered reforms increased overall school spending, but equity-based court-ordered reforms reduced the variance of spending with little effect on the overall levels. Reforms entailing high tax prices such as equalization schemes reduced long-run spending for all districts. This paper produces similar results to this second group of papers claiming that higher state involvement decreases total expenditure in public schools and the size of this decrease is different for different state aid formulas. The main contribution of this paper to this group of papers, however, is to quantitatively measure the crowding out rates of each type of state aid formula categorized by Jackson et al. (2014).

The rest of this paper is organized as follows. Section 2.2 gives detailed information about the data set that is used in this paper. Section 2.3 introduces the empirical model and discusses its results. Section 2.4 concludes.

2.2 Data

I gather a 2008 U.S. district level data set on public education finance and income. 2008 is the most recent year for which district level public education finance and income data are available simultaneously. These data come from two sources. The public education finance data are taken from NCES, Common Core of Data, and income data are taken from the 2009 American Community Survey. Merging these two data sets caused some problems, as district names were reported differently across sources. Data points that could not be reconciled between the sources were taken out of the data set. This is unsurprising, the data set includes $10,140$ school districts from 47 states. States like Montana, New Hampshire and Vermont are not included, because their district level public education finance data were reported separately for primary schools and elementary schools. Comparison with data from the other 47 states is therefore impossible. Also Washington, D.C is not included in the data set, as it has only one school district. Still, the data set covers over 90 percent of public education students for 2008.

Table 2.1 is summary statistics from this 2008 U.S. district level data set. Total expenditure per pupil varies greatly across school districts. Average spending in the top ten percent of districts more than triples the corresponding average in the bottom ten percent.

Table 2.1: Income and Demographics of School Districts in 2008

Variable	Mean	Min.	Max.	N
Total Expenditure (per pupil)	11,732	4,441	136,263	10,140
State Aid (per pupil)	6,108	250	52,708	10,140
Median Income (per household)	49,271	10,802	209,104	10,140
Median House Value (per household)	155,719	12,700	1,000,000	10,140
Non-white Ratio (total population)	0.14	0.002	0.99	10,140
Median Age (total population)	39.73	16.6	65.8	10,140
College and above (25-64)	0.28	0.01	0.86	10,140

In some cases, the state contribution to wealthy districts can be as low as \$250 per pupil. In the same state, more than 80 percent of spending in poor districts could be met by state aid. Additionally, there are sizeable differences in incomes of school districts. The wealthiest district exceeds the poorest by a factor twenty in median household income. This unequal distribution of wealth also appears when measured by median house value per household. On average, the median house value is $\$155,719$. The lowest such value is $\$12,700$. Because this variable is capped from above, the highest we observe in the data is $\$1,000,000$.

For demographic variables, the non-white ratio averages fourteen percent. Some school districts have almost all white residents and in others all the residents are non-white. Here, "non-white" includes people who are African-American, Hispanic, Asian, European. The median age is 39.73. The majority of residents have school-age children in some districts. The median age for those districts is 16.6, the households therefore favor higher public education spending. In contrast, other districts have a median age of 65.5. In these districts, the majority of residents would oppose higher public education spending as they would reasonable expect their tax revenues to be spent on more relevant areas. Lastly, I have data on the educational attainment of individuals living in these districts. On average, 28 percent of individuals hold at least a college degree. In some districts, educational attainment is high, while in others it is extremely low. Again, there is a sharp disparity in educational attainment among 2008 school districts. We can also analyze this data set graphically. First, we assign weights to every school district according to the number of pupils. Then, we sort these districts according to mean income, grouping them by deciles so that each decile has an equal number of students. At the end of the day, there are 10 pseudo-districts identified by mean income, total spending per pupil, and local and state contributions per pupil. This is demonstrated in Figure 2.2. The first thing we notice is that richer districts have higher total expenditures per pupil. Their local contributions are higher, and they receive less state aid compared to poorer districts.

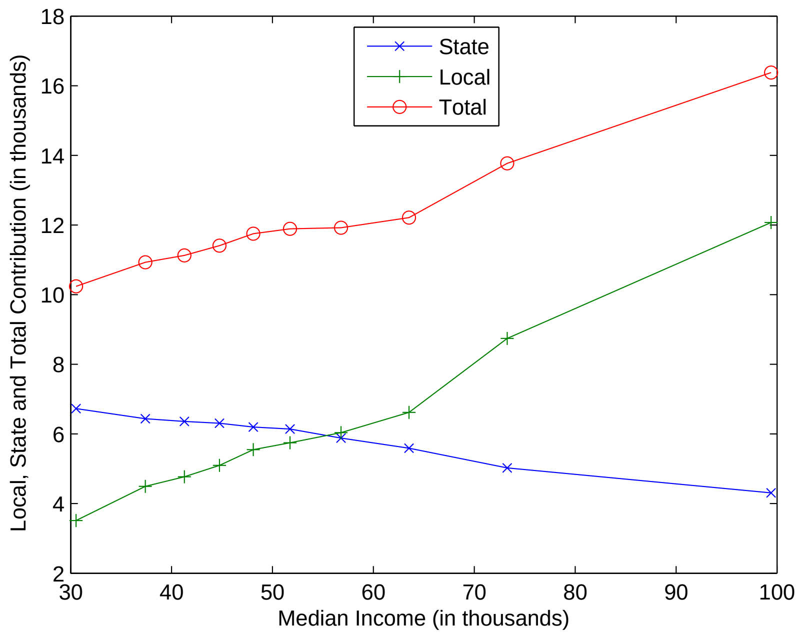


Figure 2.2: School Districts by Median Income

Moreover, Figure 2.3 sorts and groups school districts with respect to state contribution. School districts receiving higher state aid have lower local contributions. A majority of states has minimum expenditure requirements for local districts. For higher levels of state contribution, then, these requirements become binding. In addition, decreases in local contributions as a response to increases in state contributions are large initially, so total expenditure per pupil decreases even state contributions increase. As state requirements start to bind, local contributions can no longer decrease. This results in total expenditures rising with increased state contributions. Figure 2.3 clearly demonstrates increasing state involvement in public education crowds out local contributions. There is thus a cost of decreasing intrastate public education expenditure inequality in terms of a decrease in per pupil expenditure.

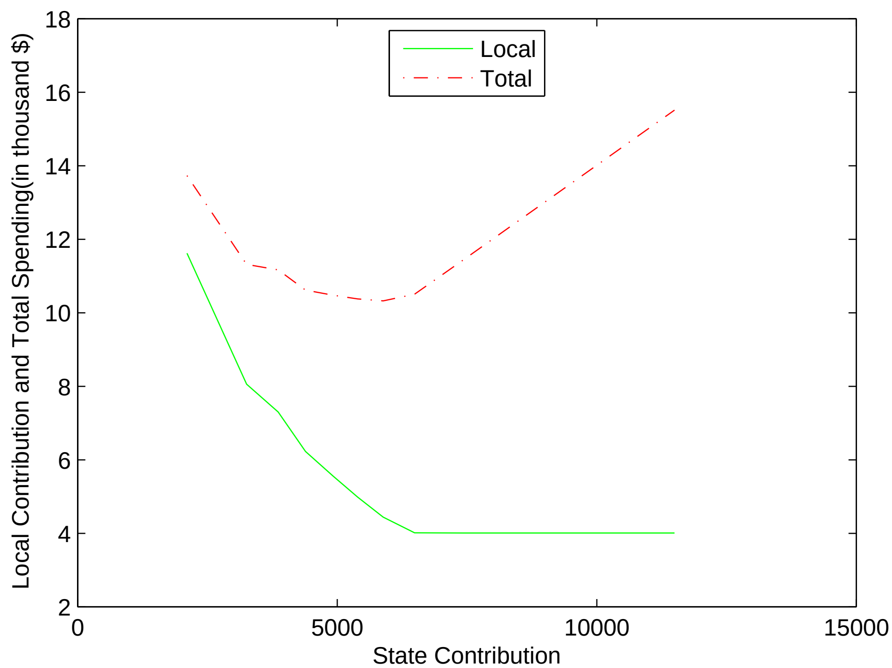


Figure 2.3: School Districts by State Contribution

2.2.1 State aid formulas

The diversity in state public education finance systems makes it a challenge to model state aid formulas. Jackson et al. (2014), however, carefully described common features in state aid formulas across the U.S., characterizing the aid formula for each state as a combination of these features. This is summarized in Table 2 below. The first feature is a Minimum Foundation Plan (MFP) which currently is used by 39 states. This defines state aid as the difference between some per pupil foundation level and district per pupil tax revenue. Districts can invest additional funds if they wish. With this feature, therefore, states try to maintain a minimum level of per pupil spending in every district. A second feature is an Equalization Plan (EP) which is used in 36 states. Here, states guarantee the same tax revenue to all districts with identical tax rates. This aims to eliminate differences in tax base. State aid is defined under the difference between the actual and the guaranteed tax base of each district.

Aside from MFP and EP, states use a number of secondary features. One is Local Effort Equalization Plan (LE). This feature dictates that aid is greater for the districts with greater property tax rates. Thus, LE aims to decrease intrastate spending inequality by giving bigger incentives to low-wealth districts to increase spending per pupil. There are seventeen states currently employing this feature. Second is Spending Limit (SL). Here, state impose a limit on educational spending by district. The goal of this policy is to decrease inequality by reducing spending in the wealthier districts. In addition, there is Flat Grant (FG), which is used in nine states. Districts receive an equal per pupil amount of aid in those states. The last feature is Full State (FS), which exists in four states. States under FS set a uniform expenditure per pupil for all the districts. Intrastate per pupil expenditure inequality is almost zero in those states. These states are dropped from the sample as they won't be providing any information for our purposes. Note that data were from three states (Montana, New Hampshire, and Vermont) due to a lack of uniform reporting. As a result, there are 44 states and seventeen different combinations of state aid formulas that are used currently. This model, therefore, will have sixteen dummy variables (IA being the reference group with MFP+SL) in order to quantify the differences among these systems in terms of spending levels and crowding-out rates.

Table 2.2: Distribution of States into Formula Types

State Aid Formula Feature	State
Minimum Foundation Plan (MFP)	AL, AK, AR, AZ, CA, CO, CT, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MN, MS, MT, MO, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, WY, WV
Equalization Plan (EP)	AL, AK, AR, AZ, CO, CT, DE, FL, GA, IL, IN, KS, LA, MD, ME, MI, MT, MO, NC, ND, NE, NH, NJ, NM, NY, OH, OK, OR, PA, RI, TX, UT, VA, WA, WI, WY
Local Effort Equalization (LE)	AZ, FL, GA, KS, KY, MD, ME, MO, MS, ND, PA, SC, TX, VA, WA, WI, WV
Flat Grant (FG)	CA, DE, IL, IN, KY, MD, MO, MI, NC
Spending Limit (SL)	AR, AZ, CA, HI, IA, ID, KS, MI, MT, NE, NH, OR, TX, VT, WA, WY
Full State Funding (FS)	HI, ID, VT, WA

2.3 Model and Results

In this section, I build a reduced form model to analyze the relationship between increases in state aid and total expenditures per pupil by district for a sample of states with different state aid formulas. To accomplish this, I control for income, property wealth, and demographic characteristics among districts.

$$TotalExp_{sd} = \alpha + \beta_1 X_{sd} + \beta_2 StateAid_{sd} + \sum_i^N \delta_i D_i + \sum_i^N \gamma_i D_i StateAid_{sd} + \epsilon_{sd}$$

s: state index

d: district index

X: set of control variables

D_i : dummy for each state aid formula group

When we quantify above coefficients, the relationship between Total Expenditure per pupil, TotalExp, and State Aid per pupil, StateAid, will be as in the following example. A dollar increase in state aid in Iowa increases total expenditure by \$$\beta_2$, as I place Iowa in the state aid reference group defined by MFP and SL. Alternatively, a dollar increase in state aid in Massachusetts increases total expenditure by \$$\beta_2 + \gamma_1$, because Massachusetts belongs to state aid formula group with only MFP. Below are the results[1] for the regression analysis.

[1] p-value$\leq 0.05 = *$, p-value$\leq 0.01 = **$, p-value$\leq 0.001 = ***$

Table 2.3: Regression Results

Variable	Total Exp. (1)	Total Exp. (2)	Total Exp. (3)
Median Income ($)	0.008*	-0.047*	0.008*
Median HV ($)	0.009***	0.023	0.009***
Non-white Ratio (%)	1078.177*	910.475	1078.174*
Median Age (years)	143.853***	150.171	143.853***
College and above (%)	4512.957***	5196.694*	4512.950***
State Aid ($)	.814***	.616*	.814***
RI (%)	-	-	.213
MFP+SL ($)	-	-	-
MFP ($)	-.115*	.982*	-.115*
MFP+EP ($)	-.022*	.127*	-.022*
MFP+LE ($)	-.262*	-.177	-.262*
MFP+EP+SL ($)	-.064	.082	-.064
MFP+EP+LE ($)	-.409	11.414	-.409
MFP+EP+FG ($)	-.247	-	-.247
MFP+EP+LE+SL ($)	-.035*	-.189	-.035*
MFP+FG+SL ($)	-.051	.319	-.051
MFP+FG+LE ($)	-.358***	-.142*	-.358***
MFP+FG+LE+EP ($)	-.246*	-	-.246*
EP ($)	-.410***	-.335**	-.410***
EP+FG ($)	-.192**	-.341**	-.192**
EP+LE ($)	-.504***	-.466*	-.504***
EP+FG+SL ($)	-.347**	-.321	-.347**
Adjusted-R^2	0.96	0.81	0.96
# of Observations	9800	6352	9800

The second column of the Table 2.3 reports the regression results for the full sample while the third column reports the regression coefficients for the the restricted sample. In the restricted sample, I only included states that their last public education finance reform was court-ordered according to Jackson et al. (2014). I worked with the restricted sample in order to see if court-ordered reforms and legislative reforms are any different from each other. On the fourth column, I reported the regression coefficients on the full sample with an added variable that measures the religiosity of the district in order to see if it is relevant for the question at hand. In what follows, I explain the meaning of the reported numbers on Table 2.3 and explore relationship between total expenditure per pupil and the centralization of the public education funding system in the states.

2.3.1 The Main Model on the Full Sample

These results will be my main findings and they are reported on the second column of Table 2.3. In the next subsections I will give a detailed explanation why that is the case. I first consider the coefficients of the control variables. All control variables have statistically significant coefficients. Income and property wealth increase total expenditure per pupil. Having higher median income by $1000 results in an additional $8 total expenditure per pupil; having $1000 in median property value is matched with $9 of total expenditure per pupil. Furthermore, higher percentage of non-white residents and college graduates in a district result in greater total expenditures per pupil. Lastly, districts with a greater median age have greater total expenditures per pupil.

The remaining reported coefficients are for the effects of different state aid formulas by district. First, state aid formulas with an MFP have lower crowding out rates. In contrast, state aid formulas with an EP and a LE have higher crowding out rates. The reason why a state government would opt to use any such equalization plans is that they result in lower expenditure inequality across districts in comparison with foundation plans. In other words, states with more centralized public education finance systems have higher crowding out rates. Across the specific formula groups, the MFP+SL reference group have the lowest crowding-out rate with an 81 cent increase in total expenditures for each dollar increase in state aid. The highest crowding out rate is for the EP+LE group. Under this scheme, a dollar increase in state aid increases total expenditure by only 31 cents. When adding SL to an MFP scheme the crowding-out increases by 12 cents. This implies that spending limits in expenditure levels of districts lead to lower crowding-out rates. These results are sensible because spending limits will bind wealthier districts preferring high educational spending levels, and crowding-out occurs mostly in wealthier districts. When spending limits are in place, therefore, redistribution as a result of state aid formulas will not decrease local contributions from wealthier districts, as these districts are already spending less than the desired amount. Moreover, crowding-out rates do not change much from MFP+EP to MFP+EP+FG or from EP to EP+FG . This implies that fixed grants do not cause severe crowding-out effects. FG plans, however, do not decrease intrastate expenditure inequality. By comparing other state aid formula groups, I conclude that minimum foundation plans, equalization plans, and local effort equalizations create positive crowding-out rates; minimum foundation plan crowding-out rates are the smallest.

2.3.2 The Main Model on the Restricted Sample

The third column of the Table 2.3 reports the regression results for the restricted sample. I run the regression with the same set of variables on the sample in which I exclude the states that their last public education finance reform was legislative. First thing to note here is that, we lose one third of the sample. And the explanatory power of the model is less with restricted sample, lower Adjusted-R^2. In addition, with less states in the sample we have less type of state aid formulae which will decrease our understanding of the public education funding system. Furthermore, the existing variables became less statistically significant and in some cases became not statistically significant. Specifically, some important control variables are not significant anymore. So this will also weaken the power of each explanatory variable and also the model itself. In conclusion, working with the restricted sample decreased the explanatory power of the model while it did not affect the relationship of each variable with the dependent variable. We still observe crowding-out in public education funding: a dollar increase in state-aid the districts increases total expenditure per pupil less than a dollar. And this crowding-out rate is different for some different state-aid formulae.

2.3.3 Religiosity Index

The last column of the Table 2.3 reports the regression results for the main model with a newly introduced variable. One might suspect that how religious a school district is might have an effect total expenditure per pupil in the district. In order to see if there is any correlation, I included a variable in the regression called Religiosity Index, RI. There is no data on religiosity at the district level however the Association of Statisticians of American Religious Bodies (ASARB) collects data on the county level. Their latest report is for 2010. In their study, they report total number of adherents for almost all the religious groups and total population in the county. So we can calculate what percent of the households in the county is 'religious'. They have a total of 3143 counties in their sample. In order to come up with measure of religiosity for the school districts, I assigned the RI of the county that the school district has the most population resides. So one problem with this is that there are several school districts with the same value for RI. Given our limitations on the data availability, this was the best solution. The mean of RI is 0.51 with a minimum value of 0.03 and a maximum value of 1. According to the regression equation, one percent increase in RI increases total expenditure per pupil by \$0.21. However this coefficient is not statistically significant. In addition, it seemed to correlated with median income and mean house value in the district. So at this point, I have no reason to include RI in the main model. This could be as a result of not having the accurate level data. So, if we had district level data on religiosity then this issue might be revisited.

2.4 Conclusion

According to recent estimates from the National Association of State Budget Officers State Expenditure Report, educational expenditures constitute the largest single category in state budgets. For Fiscal Year 2008, about 21 percent of all state spending was devoted to elementary and secondary education. On average, 53 percent of per pupil expenditure in public elementary and secondary schools are funded by state aid. In some states, this figure is as high as 86 percent. Before the 1970, state contributions to public education were around 27 percent on average. Since then, state governments have taken an active role in decreasing within per pupil expenditure inequality in public schools as a result of court decisions in favor of the centralization of public education finance. In this paper, I analyze the effects of these changes on levels of per pupil expenditure in school districts. To do so, I create a data set of public education finance and income with the demographic characteristics of school districts for 2008.

Firstly, I observe that there is a redistribution of funds from richer districts to poorer districts within each state. Secondly, redistribution crowds out local contributions. A dollar increase in state aid increases total expenditure by less than a dollar. As different states have different state aid formulas, crowding-out rates may differ. To investigate that, I use the categorization explained in Jackson et al. (2014). After controlling for key distinct characteristics, including income, property value, racial composition, age profile, and educational attainment, I conclude that state aid formulas with minimum foundation plans have lower crowding-out rates.

Those with equalization plans and local effort equalizations have higher crowding-out rates. Thus, the more state aid formulas encourage equalization the greater the crowding-out rate is. In addition, spending limits decrease crowding-out rates by limiting total expenditure per pupil in the wealthier districts. That is, when state involvement increases under such schemes, wealthy districts will not decrease their local contribution, as they are already below their preferred spending levels. Lastly, fixed grants do not greatly affect crowding-out rates, because as they are uniform across districts. I confirm the robustness of these results by running this regression for different type of public education finance reforms, and including a measure on the religiosity of the district.

CHAPTER 3
DEMOGRAPHICS AND PUBLIC SCHOOL EXPENDITURES

3.1 Introduction

There is a big heterogeneity in demographic characteristics of school districts across the U.S.. According to the American Community Survey data from 2012, the average of the median age of the top decile districts is almost two times of that of the bottom decile districts. Moreover, the ratio of fraction of the population older than 65 years of age to fraction of the population between ages 5 and 17 ranges from 0.2 to 3 across school districts. In addition, the percentage of individuals with a college degree or above can be as high as 86 percent in some districts while in others it can be as low as one percent. This big discrepancy in demographics reproduces itself when we compare districts in their racial composition. Some school districts in the U.S. have 95 percent or higher white[1] individuals in their community whereas for some other school districts this number is five percent or below. Given the level of heterogeneity in these characteristics, it is not surprising to see that we also observe differences in income and property wealth across school districts. Median household income in the richest school district is more than fifteen times of the poorest district while the ratio of median house value in the richest district to the median house value in the poorest district is higher than 40. Overall, we can conclude that school districts across the U.S. are greatly different from each other in many demographic

[1]It excludes African-American, Hispanic and Asian individuals.

dimensions.

It is documented that there are vast differences in per pupil expenditures in public schools across school districts in the U.S.. In 2012, the average of per pupil expenditures of the top decile districts is 3.3 times of the average of per pupil expenditures of the bottom decile districts. This big spending inequality in public schools exists both within and across states. In the previous chapters, I argue that the choice of public education finance system at the state level has direct effects on both total resources devoted to public education and spending inequality in public schools in the state. However, even among the states with the same state aid formula, we observe differences in spending per pupil of school districts. Thus, there must be some other factors that comes into effect in determining different spending levels in public schools.

This paper answers the following question: *What kind of demographic characteristics result in a stronger preference for public education (i.e. increase in spending)?* This is an important question to the policy makers as there has been a continuing debate on how to allocate resources among districts with different characteristics in a state without affecting total resources devoted to public education in that state. By being able to analyze what factors result in a stronger preference for public education, we can have a better understanding for that matter. In order to answer the question at hand, I regress total expenditure per pupil in the district on percentage of the population older than 65 years of age, percentage of the population between the ages 5 and 17, and percentage of the population with at least a college degree in the school district with a set of interaction terms for different state finance systems after controlling for median income, median house value, median age, and percentage of the population that identified as non-white in the district. I also include fixed effects for different state finance systems. For this analysis, I use the data set from the previous chapter with some additional variables. I will provide more details about these additional variables in the next section.

The model presented in this paper suggests that a higher share of elderly, or a lower share of school age children, or a lower share of at least college degree holders is matched with a lower per pupil expenditure in the public schools among the school districts with the same state aid formula, median income, median house value, median age, and share of white individuals. These results might not seem interesting as we can find many studies with similar findings. However, with statistically significant interaction terms between the explanatory variables and state aid formulas, we can conclude that demographic heterogeneity among school districts affect total expenditure per pupil differently under different state aid formulas. Namely, the coefficients of the explanatory variables are greater in magnitudes for the states with Minimum Foundation plans compared to the states with Equalization or Local Effort Equalization plans. This result is the main contribution of this study. The intuition behind this is as follows. As we learned from the previous chapter, the public education finance system in the states with a Minimum Foundation plan is less centralized compared to the public education finance system in the other states. This is true because Equalization or Local Effort Equalization plans decreases spending inequality in a state at a greater rate compared to Minimum Foundation plan therefore they are more centralized. In addition, these results are robust to type of public education finance reform of the state. In the next section, I will discuss these results in detail.

There has been a decent number of studies that analyzed the connection between demographic characteristics and public education spending levels. Firstly, Downes and Shah (1994) states that spending per pupil is lower in states with larger fractions of the population over 65 years of age or with smaller fractions of the white population. These findings are similar to the ones that are presented in this paper. It is also noted in that paper that there is a negative relation between spending and the fraction of the population that is school age. This surprising result could be a factor of using state level data instead of district level data or not accounting for differences in public education finance systems across states. Secondly, Murray et al. (1998) argues that the relation between per pupil expenditure in public schools and age distribution in the population is statistically insignificant. Even though, this paper uses a district level panel data set, it omits the differences among state public education finance systems. As it is argued so far, this is really important in the analysis of spending in public schools.

The rest of this chapter is organized as follows. Section 3.2 discusses the data set in detail. Section 3.3 presents the empirical model and discusses its results. Section 3.4 concludes.

Table 3.1: Income and Demographics of School Districts in 2008

Variable	Mean	Min.	Max.	N
Total Expenditure (per pupil)	11,732	4,441	136,263	10,140
Median Income (per household)	49,271	10,802	209,104	10,140
Median House Value (per household)	155,719	12,700	1,000,000	10,140
White Ratio (total population)	0.86	0.001	0.99	10,140
Median Age (total population)	39.73	16.6	65.8	10,140
Share of 65+ (total population)	13.66	4.1	32.7	10,140
Share of 5-17 (total population)	18.01	11.08	21.53	10,140
College and above (25-64)	0.28	0.01	0.86	10,140

3.2 Data

The data set used in this chapter is based on the data set from the previous chapter. It is a 2008 U.S. district level data set on public education finance, income, and demographics. Most of the variables including total expenditure per pupil, median household income, median house value, fraction of white population, median age, fraction of college degree or above, and state aid formula type are the same. I introduce variables such as fraction of elderly, and fraction of school age children in the school district. Data on per pupil expenditure in public schools come from National Center for Education Statistics while the rest comes from the American Community Survey. For further details on the source and the nature of these variables, you can read the related section from the previous chapter. Lastly, I use the classification of state aid formulas from Jackson et al. (2014).

Table 3.1 is summary statistics from this 2008 U.S. district level data set. Overall, we observe a high level of heterogeneity across districts in many dimensions. For the new introduced variables; the share of elderly in the population ranges from two percent to 54 percent with a mean around thirteen percent and the share of school aged children ranges from seven percent to 49 percent with a mean around twenty percent. These two variables are important for our analysis because they give us the weight of two opposing parties in the school district for the matter of public education funding. For example, in a school district with a higher share of elderly, we expect to have a weaker preference for public education as a smaller portion of the population would directly benefit from it. The same story goes for a school district with a lower share of school aged children. In a school district with a lower share of school aged children, representative household's objective is not expected to be to increase per pupil expenditure in public schools. Thus, any change in one of these variables would result in a change in the level of spending. In addition, share of college or above individuals in the district plays a pivotal role in determining the level spending in public schools. As it is observed from the table above, school districts differ greatly in the fraction of individuals with college degree or above. In some districts it is as low as one percent and in other districts almost everyone has at least a college degree, 86 percent. In the districts with higher fraction of college or above individuals, it is argued that per pupil expenditure would be higher as these individuals would tend to have a stronger preference towards education. For a more detailed quantitative analysis, we need to estimate coefficients for these variables.

3.3 Model and Results

In this section, I present a reduced form model to explore the relationship between changes in demographic characteristics such as share of elderly, share of school aged children, and share of college degree or above individuals in the population and total expenditures per pupil in the districts district for a sample of states with different state aid formulas. To accomplish this, I control for income, property wealth, median age, and share of white individuals among school districts in the U.S..

$$TotalExp_{sd} = \alpha + \beta_1 X_{sd} + \beta_2 S65_{sd} + \beta_3 S517_{sd} + \beta_4 SC_{sd} + \sum_{i}^{N} \delta_i D_i + \sum_{i}^{N} \gamma_i^1 D_i S65_{sd} + \sum_{i}^{N} \gamma_i^2 D_i S517_{sd} + \sum_{i}^{N} \gamma_i^3 D_i SC_{sd} + \epsilon_{sd}$$

s: state index

d: district index

X: set of control variables

D_i : dummy for each state aid formula group

According to the above reduced form equation, the relationship between total expenditure per pupil, *TotalExp*, and any of the three variables of interest, share of elderly, *S65*, share of school aged children, *S517*, and share of college degree or above individuals, *SC*, will be as in the following example. A marginal increase in the share of elderly in Iowa increases total expenditure by $\$\beta_2$, as I place Iowa in the state aid reference group defined by MFP and SL. Or, a marginal increase in the share of elderly in Massachusetts increases total expenditure by $\$\beta_2 + \gamma_1$, because Massachusetts belongs to state aid formula group with only MFP. We can replace share of elderly and $\$\beta_2$ with share of school aged children and $\$\beta_3$ or share of college degree or above individuals and $\$\beta_4$ and apply the same logic. In short, our interpretation on the coefficients is very similar to the one we had in the previous chapter. Below are the results for the regression analysis.

Let's first discuss the coefficients of the control variables. All control variables have statistically significant coefficients at least at five percent significance level. The relation between income and spending in public schools is positive so is the relation between property wealth and spending in public schools. This is intuitive as it is documented that wealthier districts allocates more funds towards education. According to the numerical analysis, having higher median income by \$1000 results in an additional \$5 total expenditure per pupil; having \$1000 in median property value is matched with \$9 of total expenditure per pupil. Moreover, higher percentage of white residents in a district results in smaller total expenditures per pupil. Every percent increase in percentage of non-white residents is matched with a \$665 decrease in total expenditure per pupil in public schools. Lastly, districts with a greater median age have greater total expenditures per pupil: districts with a year higher median age has \$104 higher total expenditure per pupil in public schools.

Table 3.2: Regression Results

Variable	Total Exp.
Median Income ($)	0.005**
Median HV ($)	0.009**
Non-white Ratio (%)	665.724*
Median Age (years)	103.685*
65+ Ratio (%)	-1452.742***
5-17 Ratio (%)	1913.383**
College and above (%)	1381.328*
MFP+SL ($)	-
MFP ($)	199.365*, -200.838**, -277.156*
MFP+EP ($)	499.219**, -499.655*, -428.597***
MFP+LE ($)	534.762***, -576.919**, -589.654**
MFP+EP+SL ($)	601.015, -504.247, -364.162*
MFP+EP+LE ($)	652.774*, -703.498, -681.958
MFP+EP+FG ($)	550.603*, -504.177**, -473.668***
MFP+EP+LE+SL ($)	701.32*, -753.846**, -664.292**
MFP+FG+SL ($)	101.947***, -204.450, -184.761*
MFP+FG+LE ($)	398.130**, -398.063**, -674.726*
MFP+FG+LE+EP ($)	501.861, -503.707, -826.473
EP ($)	899.816***, -999.543**, -532.722**
EP+FG ($)	862.095*, -924.978*, -676.327***
EP+LE ($)	804.542**, -820.197**, -637.767*
EP+FG+SL ($)	768.070*, -885.506**, -718.123**
Adjusted-R^2	0.98
# of Observations	9800

p-value$\leq 0.05 = *$, p-value$\leq 0.01 = **$, p-value$\leq 0.001 = ***$

The remaining reported coefficients are somewhat harder to interpret. First of all, the next three coefficients are for the effects of share of elderly, share of school aged children, and share of college degree or above individuals in the population on total expenditure per pupil for the reference group which are the school districts in Iowa that has a Minimum Foundation plan with a spending limit. All of these three coefficients are statistically significant at five percent significance level. The model suggests that school districts with one percent higher share of elderly, share of school age children, and share of college degree or above is observed to have \$1453 less, \$1913 more, and \$1381 more total expenditure per pupil respectively. The remainder of the coefficients are for the interaction terms for the other type of state aid formula groups on the relation between total expenditure per pupil and each one of the three variable of interests. Starting from the ninth row, each row reports three coefficients that are the interaction terms for share of elderly, share of school age children, and share of college degree or above in order. So when we analyze the interaction between each of these variable interests and total expenditure per pupil, we need to add these coefficients to the values of the reference group. For instance, for the group of states with a EP, a percent increase in share of elderly is matched with a \$552 decrease in total expenditure per pupil. This is found by $1453 - 899 = 552$. For every state aid formula group, we can find the coefficient of share of elderly, share of school aged children, and share of college degree or above by adding the reported interaction terms to the values of Minimum Foundation plan with a Spending Limit aid formula. First thing to note about the interaction terms is that they all have the opposite signs of the original values. And also they are all smaller in the magnitudes compared to the reference group coefficients so they don't change the sign of the relation to the total expenditure per pupil. Thus, the model suggests that in the states with Equalization plans school districts with one percent higher share of elderly, share of school age children, and share of college degree or above is observed to have \$552 less, \$914 more, and \$848 more total expenditure per pupil respectively. The numbers are very similar the these in the states with Local Equalization plans. It is important to note here is that most of the interaction terms are statistically significant at the five percent level. These results yield that different state aid formulas lead into different magnitudes of the coefficients for the effects of share of elderly, share of school aged children, and share of college degree or above on total expenditure per pupil in the district. Specifically, the effect of these variables are stronger in the states with Minimum Foundation plans compared to Equalization and Local Equalization plans. This is a direct result of the latter state aid formulas being more centralized compared to Minimum Equalization plans. While they control for spending inequality at a higher degree, public education finance system in the state becomes more centralized which leads into a weaker relation between demographic variables and spending levels for the districts.

3.3.1 Type of the Public Education Finance Reform

In this section, I test the model to see if the results are affected by the type of the public education finance reform in the state. For that, I restrict the sample to the states with court-ordered reforms. First, with less states in the sample, the results apply to less states and less type of state-aid formulae. And also, the model's explanatory power is lower in the restricted sample. Moreover, some of the variables are no longer statistically significant. Overall, the estimation results are not that different from the one in the full sample. Thus, the estimation results are not affected by the type of the public education finance reform.

Table 3.3: Regression Results

Variable	Total Exp.
Median Income ($)	0.005*
Median HV ($)	0.009*
Non-white Ratio (%)	675.949*
Median Age (years)	108.663**
65+ Ratio (%)	-1060.379**
5-17 Ratio (%)	1717.206
College and above (%)	774.736*
MFP+SL ($)	-
MFP ($)	-197.583*, -191.241, 348.713
MFP+EP ($)	103.748*, -300.391, 184.888*
MFP+LE ($)	139.203**, 379.751**, 3.114*
MFP+EP+SL ($)	208.046, 310.629, 347.499*
MFP+EP+LE ($)	115.036*, 467.219, 277.003*
MFP+EP+FG ($)	-
MFP+EP+LE+SL ($)	304.683, -552.050, -29.640
MFP+FG+SL ($)	-300.887**, 6.974, 490.701*
MFP+FG+LE ($)	-327.110*, 28.852, 116.093*
MFP+FG+LE+EP ($) -	
EP ($)	503.8478, -798.642**, 69.534*
EP+FG ($)	461.847*, -718.684*, -17.817
EP+LE ($)	406.697**, -616.731**, -1.515*
EP+FG+SL ($)	534.111, -463.882, -103.621
Adjusted-R^2	0.81
# of Observations	6352

p-value$\leq 0.05 = *$, p-value$\leq 0.01 = **$, p-value$\leq 0.001 = ***$

3.3.2 Religiosity Index

In this section, I test to see how the results changes when we account the differences in the religiosity of the school districts. For a district base measure of religiosity I use Religiosity Index, RI, from the previous chapter. The estimation results suggest that an increase in RI increases total expenditure per pupil. However, this is not statistically significant. In addition, the rest of the estimation results didn't change drastically. Thus, there is no need to include this variable in the model.

Table 3.4: Regression Results

Variable	Total Exp.
Median Income ($)	0.005**
Median HV ($)	0.009**
Non-white Ratio (%)	665.652*
Median Age (years)	103.680*
65+ Ratio (%)	-1453.012***
5-17 Ratio (%)	1913.79**
College and above (%)	1384.432*
RI (%)	-11.327*
MFP+SL ($)	-
MFP ($)	199.681*, -201.331**, -278.687*
MFP+EP ($)	499.501**, -500.143*, -429.855***
MFP+LE ($)	535.082***, -577.417**, -596.393**
MFP+EP+SL ($)	601.280, -504.717, 369.267*
MFP+EP+LE ($)	653.105*, -704.075, -682.797
MFP+EP+FG ($)	550.614*, -504.302**, -478.266***
MFP+EP+LE+SL ($)	701.432*, -754.062**, -666.881**
MFP+FG+SL ($)	102.855***, -205.628, -186.573*
MFP+FG+LE ($)	397.987**, -397.923**, -676.163*
MFP+FG+LE+EP ($)	502.173, -504.295, -828.546
EP ($)	905.251***, -100.138**, -529.993**
EP+FG ($)	862.497*, -925.623*, -679.818***
EP+LE ($)	804.810**, -820.609**, -641.272*
EP+FG+SL ($)	768.395*, -886.045**, -721.287**
Adjusted-R^2	0.98
# of Observations	9800

p-value$\leq 0.05 = *$, p-value$\leq 0.01 = **$, p-value$\leq 0.001 = ***$

3.4 Conclusion

The U.S. has over $10,000$ school districts that are different from each other in many demographical characteristics. Some school districts are younger on average and others are older on average. A majority of individuals are African-American in some school districts while this is not the case in others. We can find school districts that more than 70 percent of its population have at least a college degree. This number can go as low as five percent in some other districts. These different demographic characteristics might affect the allocation of funds for public services in the communities. There is also a big variation in spending per pupil in public schools across school districts. This inequality in spending exists if we analyze districts in the same states, across states or in the same type of public education finance system. So in this paper, I tried to answer the following question: *What kind of demographic characteristics result in a stronger preference for public education (i.e. increase in spending)?* By using a district level data from 2008 on income, demographics, and public education finance, I conclude that a higher share of elderly, or a lower share of school age children, or a lower share of at least college degree holders is matched with a lower per pupil expenditure in the public schools among the school districts with the same state aid formula, median income, median house value, median age, and share of white individuals. More interestingly, I conclude that the effect of demographic heterogeneity among school districts on total expenditure per pupil differs under different state aid formulas. That is, in the less centralized public education finance systems the coefficients of the demographic variables are greater in magnitudes compared to more centralized finance systems. Minimum Foundation plan is less centralized compared to Equalization or Local Effort Equalization plans as it controls for spending inequality as a lesser degree.

APPENDIX A
APPENDIX FOR CHAPTER 1

A.1 Household Problem: choosing c^* and h^* (F and PE)

The analysis in this section applies to both education finance systems. Here we solve it for the Foundation system. Just replace τ_f with τ_R for Power-equalizing.

$$\max_{h,c} u(c,h) + v(q)$$

$$\text{s.t. } c + \pi h = (1-\tau_f)y + pH.$$

At this stage, q is taken as given and separable. Therefore, using the budget constraint, this problem is equivalent to solving the following:

$$\max_h \frac{a_c((1-\tau_f)y + pH - \pi h)^\alpha + (1-a_c)h^\alpha}{\alpha}$$

Taking the first-order condition for h gives

$$\pi a_c((1-\tau_f)y + pH - \pi h^*)^{\alpha-1} = (1-a_c)(h^*)^{\alpha-1},$$

or,

$$\pi a_c(h^*)^{1-\alpha} = (1-a_c)((1-\tau_f)y + pH - \pi h^*)^{1-\alpha},$$

or,

$$\left(\pi \frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} h^* = ((1-\tau_f)y + pH - \pi h^*.$$

Using $H(p) = ap^b$ we have:

$$h^* = \frac{(1-\tau_f)y + ap^{b+1}}{\left(\pi\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + \pi}.$$

Define $\psi = \left(\pi\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}}$ to get

$$h^* = \frac{(1-\tau_f)y + ap^{b+1}}{\psi + \pi}.$$

Note that, π and ψ are increasing functions of p. The effect of p on the denominator of the expression for h^* is the usual price effect on demand: an increase in p generates an income effect and a substitution effects both decreasing demand. In this model, however, there is also the additional wealth effect: an increase in p increases the value of the housing stock the household owns.

To find c^*, insert h^* to the budget constraint to get:

$$\begin{aligned}
c^* &= \left[(1-\tau_f)y + ap^{b+1}\right]\left(1 - \frac{\pi}{\psi+\pi}\right) \\
&= \left[(1-\tau_f)y + ap^{b+1}\right]\left(\frac{\psi}{\psi+\pi}\right) \\
&= \frac{\psi\left((1-\tau_f)y + ap^{b+1}\right)}{\psi+\pi} = \psi h^*
\end{aligned}$$

A.2 Housing Market Clearing (F and PE)

To see that there is a unique price that clears the market, divide both sides of the housing market clearing condition (1.2) by $H(p) = ap^b$ to get

$$1 = \frac{(1-\tau_f)y}{ap^b\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right]} + \frac{p}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p}.$$

Clearly, as long as $\alpha < 1$, the first term is decreasing in p. Dividing numerator and denominator of the second term by p, we get the same result for this term.

$$1 = \frac{(1-\tau_f)y}{ap^b\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right]} + \frac{1}{\left((1+t)\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} p^{\frac{\alpha}{1-\alpha}} + (1+t)}.$$

Looking at the equation above, the left-hand side is constant at 1 and the right-hand side is infinite as $p \to 0$ and always decreasing in p as long as $\alpha < 1$. Hence, there is a unique price, p^*, that clears the housing market. Thus, either the housing demand is decreasing or it is overall increasing but less steep than housing supply.

A.3 Housing Market Clearing: new housing supply function (F and PE)

For the remaining derivations, we introduce a new functional form for the house supply function. Basically, it is a modified version of the functional form we have in the paper which shares the same characteristics. The analysis in this section applies to both education finance systems. Suppose the housing supply function is given by $H(p) = a\left(\frac{p}{\overline{p}}\right)^b$. Then housing supply is:

1. perfectly elastic if $b \to \infty$ and $p = \overline{p}$ for all H;

2. perfectly inelastic if $b = 0$ and $H = a$ for all p.

To see that there is a unique price that clears the housing market, recall the housing market clearing condition, $H(p) = h^*(p)$. Using the solution for h^* with

$\pi = (1+t)p$, we get:

$$H(p) = a\left(\frac{p}{\overline{p}}\right)^b = \frac{(1-\tau_f)y + ap\left(\frac{p}{\overline{p}}\right)^b}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p} = h^*(p).$$

Note that demand for housing, h^* is not necessarily decreasing in the house price, p as a result of the additional wealth effect. But if parameters are such that h^* is increasing in p, it is always less steep than housing supply with $h^* \to \infty$ as $p \to 0$. Hence, there is a unique price that clears the market. To see this, divide both sides of the housing market clearing condition by $H(p) = a\left(\frac{p}{\overline{p}}\right)^b$ to get

$$1 = \frac{(1-\tau_f)y}{a\left(\frac{p}{\overline{p}}\right)^b\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right]} + \frac{p}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p}.$$

Clearly, as long as $\alpha < 1$, the first term is decreasing in p. Dividing numerator and denominator of the second term by p, we get the same result for this term.

$$1 = \frac{(1-\tau_f)y}{a\left(\frac{p}{\overline{p}}\right)^b\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right]} + \frac{1}{\left((1+t)\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} p^{\frac{\alpha}{1-\alpha}} + (1+t)}.$$

Looking at the equation above, the left-hand side is constant at 1 and the right-hand side is infinite as $p \to 0$ and always decreasing in p as long as $\alpha < 1$ (i.e., we need some curvature in utility). Hence, there is a unique price, p^* that clears the housing market.

Thus, either the housing demand is decreasing or it is overall increasing but less steep than housing supply.

A.4 The Effect of Property Tax on House Prices

A.4.1 Net of tax price: Derive $\frac{\partial p}{\partial t} < 0$

The housing market clearing equation can be rewritten as:

$$\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right] - \frac{(1-\tau_f)y}{a\left(\frac{p}{\overline{p}}\right)^b} - p = 0$$

or,

$$\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + tp - \frac{(1-\tau_f)y}{a\left(\frac{p}{\overline{p}}\right)^b} = 0$$

Totally differentiating, we get:

$$\frac{1}{1-\alpha}\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{\alpha}{1-\alpha}}\left[p\frac{a_c}{1-a_c} + (1+t)\frac{a_c}{1-a_c}\frac{dp}{dt}\right] + p + t\frac{dp}{dt} + \frac{ab\overline{p}^{-b}p^{b-1}(1-\tau_f)y}{a^2\left(\frac{p}{\overline{p}}\right)^{2b}}\frac{dp}{dt} = 0$$

Simplifying:

$$\frac{1}{1-\alpha}\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{\alpha}{1-\alpha}}\frac{a_c}{1-a_c}\left[p + (1+t)\frac{dp}{dt}\right] + p + t\frac{dp}{dt} + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}\frac{dp}{dt} = 0$$

Collecting terms:

$$\left[\frac{p^{\frac{\alpha}{1-\alpha}}}{1-\alpha}\left((1+t)\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + t + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}\right]\frac{dp}{dt} = -\frac{1}{1-\alpha}(1+t)^{\frac{\alpha}{1-\alpha}}\left(p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} - p$$

Rearranging:

$$\frac{dp}{dt} = -\frac{\frac{1}{1-\alpha}(1+t)^{\frac{\alpha}{1-\alpha}}\left(p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + p}{\frac{p^{\frac{\alpha}{1-\alpha}}}{1-\alpha}\left((1+t)\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + t + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}} < 0$$

Simpler version:

$$\frac{dp}{dt} = -\frac{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{1+t} + p}{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{p} + t + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}} < 0 \tag{A.1}$$

1. perfectly elastic if $b \to \infty$ and $p = \overline{p}$ for all H:

$$\lim_{b\to\infty} \frac{dp}{dt} = -\lim_{b\to\infty} \frac{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{1+t} + \overline{p}}{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{\overline{p}} + t + \frac{b(1-\tau_f)y}{a\overline{p}}} = 0$$

2. Suppose $b = 0$ and $H = a$ for all p (perfectly inelastic housing supply):

$$\begin{aligned}
\frac{dp}{dt}_{|b=0} &= -\frac{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{1+t} + p}{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{p} + t} = -\frac{p}{1+t}\frac{\left(\frac{\psi}{1-\alpha}\right) + p(1+t)}{\left(\frac{\psi}{1-\alpha}\right) + tp} = -\frac{p}{1+t}\frac{\left(\frac{\psi}{1-\alpha}\right) + p(1+t)}{\left(\frac{\psi}{1-\alpha}\right) + tp} \\
&= -\frac{p}{1+t}\left(1 + \frac{p}{\left(\frac{\psi}{1-\alpha}\right) + tp}\right) < -\frac{p}{1+t} < 0
\end{aligned}$$

Note, without a wealth effect, we would have: $\frac{dp}{dt}_{|b=0} = -\frac{p}{1+t}$ so that π remains unchanged (supply inelastic, same quantity demanded only if gross of tax price the same). With the wealth effect p needs to decrease by more than taxes increase so that demand absorbs supply given the negative wealth effect.

A.4.2 Gross-of-tax price: Derive $\frac{\partial \pi}{\partial t} \lesseqgtr 0$

Recall $\pi = (1+t)p$.

$$\begin{aligned}
\frac{\partial \pi}{\partial t} &= p + (1+t)\frac{dp}{dt} = p - \frac{\left(\frac{\psi}{1-\alpha}\right) + \pi}{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{p} + t + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}} \\
&= \frac{\left(\frac{\psi}{1-\alpha}\right) + pt + \frac{b\overline{p}^b(1-\tau_f)y}{ap^b} - \left(\frac{\psi}{1-\alpha}\right) - \pi}{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{p} + t + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}} \\
&= \frac{\frac{b\overline{p}^b(1-\tau_f)y}{ap^b} - p}{\left(\frac{1}{1-\alpha}\right)\frac{\psi}{p} + t + \frac{b\overline{p}^b(1-\tau_f)y}{ap^{b+1}}} \\
&= p\frac{b\overline{p}^b(1-\tau_f)y - ap^{b+1}}{\left(\frac{1}{1-\alpha}\right)\psi ap^b + tap^{b+1} + b\overline{p}^b(1-\tau_f)y}
\end{aligned}$$

1. perfectly elastic if $b \to \infty$ and $p = \overline{p}$ for all H:

$$\lim_{b\to\infty} \frac{d\pi}{dt} = \overline{p} + (1+t) \lim_{b\to\infty} \frac{dp}{dt} = \overline{p} > 0$$

2. Suppose $b = 0$ and $H = a$ for all p (perfectly inelastic housing supply):

$$\begin{aligned} \frac{d\pi}{dt}_{|b=0} &= p + (1+t)\frac{dp}{dt}_{|b=0} = p - p\left(1 + \frac{p}{\left(\frac{\psi}{1-\alpha}\right) + tp}\right) \\ &= -\frac{p^2}{\left(\frac{\psi}{1-\alpha}\right) + tp} < 0 \end{aligned}$$

So, since $\frac{\partial \pi}{\partial t}$ continuous in b, there exists $\widehat{b}$ such that $\frac{\partial \pi}{\partial t}_{|b=\widehat{b}} = 0$. For $b > \widehat{b}$, $\frac{\partial \pi}{\partial t} > 0$ and for $b < \widehat{b}$, $\frac{\partial \pi}{\partial t} < 0$.

A.5 Partial derivatives used in Step 2

A.5.1 Derive $\frac{\partial \psi}{\partial t} > 0$

Holding p fixed, we get:

$$\frac{\partial \psi}{\partial t} = \left(\frac{1}{1-\alpha}\right)\frac{\psi}{1+t}$$

A.5.2 Derive $\frac{\partial h}{\partial t} < 0$

Recall $h^* = \frac{(1-\tau_f)y + ap^{b+1}}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p}$. When the median voter chooses t, he takes p as given but takes the direct effect of t on h into account.

Therefore,

$$\frac{\partial h}{\partial t} = -\frac{\left[(1-\tau_f)y + ap^{b+1}\right]\left(\frac{1}{1-\alpha}(1+t)^{\frac{\alpha}{1-\alpha}}\left(p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + p\right)}{\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right]^2} < 0$$

Simplified:

$$
\begin{aligned}
\frac{\partial h}{\partial t} &= -\frac{h^*}{1-\alpha}\left(\frac{1}{1+t} - \frac{\alpha p}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p}\right) \\
&= -\frac{h^*}{1-\alpha}\left(\frac{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1-\alpha)p(1+t)}{(1+t)\left[\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p\right]}\right) \\
&= -\frac{h^*}{(1-\alpha)(1+t)}\left(\frac{\psi + (1-\alpha)\pi}{\psi+\pi}\right) < 0
\end{aligned}
$$

In the case where $\alpha = 0$, this boils down to:

$$
\frac{\partial h}{\partial t} = -\frac{h^*}{1+t} < 0
$$

A.5.3 Derive $\frac{\partial c}{\partial t} > 0$

Recall $c^* = \psi h^* = \left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} \frac{(1-\tau_f)y + ap^{b+1}}{\left((1+t)p\frac{a_c}{1-a_c}\right)^{\frac{1}{1-\alpha}} + (1+t)p}$. When the median voter chooses t, he takes p as given but takes the direct effect of t on c into account.

Therefore,

$$
\begin{aligned}
\frac{\partial c}{\partial t} &= \frac{\partial \psi}{\partial t}h^* + \frac{\partial h}{\partial t}\psi \\
&= \frac{\psi}{(1-\alpha)(1+t)}h^* - \frac{h^*}{(1-\alpha)(1+t)}\left(\frac{\psi+(1-\alpha)\pi}{\psi+\pi}\right)\psi \\
&= \frac{\psi h^*}{(1-\alpha)(1+t)}\left(1 - \left(\frac{\psi+(1-\alpha)\pi}{\psi+\pi}\right)\right) \\
&= \frac{\psi h^*}{(1-\alpha)(1+t)}\left(\frac{\alpha\pi}{\psi+\pi}\right)
\end{aligned}
$$

So, $\frac{\partial c}{\partial t} > 0$ if $\alpha > 0$ (substitutes) and $\frac{\partial c}{\partial t} < 0$ if $\alpha < 0$ (complements).

In the case where $\alpha = 0$, this boils down to:

$$\frac{\partial c}{\partial t} = 0$$

A.5.4 Derive $\frac{\partial q}{\partial t} > 0$

For foundation:

$$\begin{aligned}
\frac{\partial q}{\partial t} &= ph + pt\frac{\partial h}{\partial t} && \text{(A.2)}\\
&= ph - pt\frac{h^*}{(1-\alpha)(1+t)}\left(\frac{\psi+(1-\alpha)\pi}{\psi+\pi}\right) && \text{(A.3)}\\
&= ph\left(1-\frac{t}{(1-\alpha)(1+t)}\left(\frac{\psi+(1-\alpha)\pi}{\psi+\pi}\right)\right) && \text{(A.4)}\\
&= ph\left(\frac{(1-\alpha)(1+t)(\psi+\pi)-t(\psi+(1-\alpha)\pi)}{(1-\alpha)(1+t)(\psi+\pi)}\right) && \text{(A.5)}\\
&= ph\left(\frac{(1-\alpha)(\psi+\pi)+t(1-\alpha)(\psi+\pi)-t(\psi+(1-\alpha)\pi)}{(1-\alpha)(1+t)(\psi+\pi)}\right) && \text{(A.6)}\\
&= ph\left(\frac{(1-\alpha)(\psi+\pi)-t\alpha\psi}{(1-\alpha)(1+t)(\psi+\pi)}\right) && \text{(A.7)}
\end{aligned}$$

For $\frac{\partial q}{\partial t} > 0$, we need $(1-\alpha)(\psi+\pi) > t\alpha\psi$.

For $\alpha = 0$, this boils down to:

$$\frac{\partial q}{\partial t} = \frac{ph}{1+t} > 0$$

For PE:

$$\frac{\partial q}{\partial t} = z_R > 0$$

A.6 Optimality conditions for Step 2

A.6.1 Foundation

A.6.1.1 FOC in Step 2

The median voter in step 2 takes p as given but takes the effect on c and h into account when choosing t:

$$\underbrace{\frac{\partial u}{\partial c}\frac{\partial c}{\partial t}+\frac{\partial u}{\partial h}\frac{\partial h}{\partial t}}_{-MC_F}+\underbrace{\frac{\partial v}{\partial q}\frac{\partial q}{\partial t}}_{MB_F}=0$$

Using the comparative statics above

$$\underbrace{a_c(\psi h^*)^{\alpha-1}\frac{\psi h^*}{(1-\alpha)(1+t)}\left(\frac{\alpha\pi}{\psi+\pi}\right)-(1-a_c)h^{*\alpha-1}\frac{h^*}{(1-\alpha)(1+t)}\left(\frac{\psi+(1-\alpha)\pi}{\psi+\pi}\right)}_{-MC_F}$$
$$+\underbrace{Aq^{\gamma-1}ph\left(\frac{(1-\alpha)(\psi+\pi)-t\alpha\psi}{(1-\alpha)(1+t)(\psi+\pi)}\right)}_{MB_F}=0$$

$$\underbrace{h^{*\alpha}\left[\frac{a_c\psi^\alpha\alpha\pi-(1-a_c)(\psi+(1-\alpha)\pi)}{(1-\alpha)(1+t)(\psi+\pi)}\right]}_{-MC_F}+\underbrace{Aq^{\gamma-1}ph\left(\frac{(1-\alpha)(\psi+\pi)-t\alpha\psi}{(1-\alpha)(1+t)(\psi+\pi)}\right)}_{MB_F}=0$$

Clearly, $MB_F>0$ under the same condition as $dq/dt>0$. For $MC_F>0$ (i.e. $-MC_F<0$), we need parameters to be such that

$$a_c\psi^\alpha\alpha\pi<(1-a_c)(\psi+(1-\alpha)\pi).$$

For example, with logarithmic utility, $\alpha=0$ and the condition holds. So, if c and h are not too substitutable, the problem is well-defined.

Solving for q:

$$q^{1-\gamma}\left[\frac{a_c\psi^\alpha\alpha\pi-(1-a_c)(\psi+(1-\alpha)\pi)}{(1-\alpha)(1+t)(\psi+\pi)}\right]+h^{*1-\alpha}Ap\left(\frac{(1-\alpha)(\psi+\pi)-t\alpha\psi}{(1-\alpha)(1+t)(\psi+\pi)}\right)=0$$

$$q^{1-\gamma}\left[a_c\psi^{\alpha}\alpha\pi - (1-a_c)(\psi + (1-\alpha)\pi)\right] + Ap((1-\alpha)(\psi+\pi) - t\alpha\psi)h^{*1-\alpha} = 0$$

$$q^{1-\gamma} = \frac{Ap((1-\alpha)(\psi+\pi) - t\alpha\psi)}{(1-a_c)(\psi + (1-\alpha)\pi) - a_c\psi^{\alpha}\alpha\pi}h^{*1-\alpha}$$

$$q^{*} = \left[\frac{Ap((1-\alpha)(\psi+\pi) - t\alpha\psi)}{(1-a_c)(\psi + (1-\alpha)\pi) - a_c\psi^{\alpha}\alpha\pi}\right]^{\frac{1}{1-\gamma}} h^{*\frac{1-\alpha}{1-\gamma}}$$

$$q^{*} = \left[\frac{Ap((1-\alpha)(\psi+\pi) - t\alpha\psi)}{(1-a_c)(\psi + (1-\alpha)\pi) - a_c\psi^{\alpha}\alpha\pi}\right]^{\frac{1}{1-\gamma}} \left(\frac{(1-\tau_f)y + ap^{b+1}}{\psi+\pi}\right)^{\frac{1-\alpha}{1-\gamma}}$$

With the condition on parameters above, we get an interior solution, $q^* > 0$.

Suppose $\gamma = \alpha$, then q^* is also a constant fraction of income:

$$q^{*} = \left[\frac{Ap((1-\alpha)(\psi+\pi) - t\alpha\psi)}{(\psi+\pi)^{1-\gamma}\left((1-a_c)(\psi + (1-\alpha)\pi) - a_c\psi^{\alpha}\alpha\pi\right)}\right]^{\frac{1}{1-\gamma}} \left((1-\tau_f)y + ap^{b+1}\right)$$

If, in addition $\alpha = \gamma = 0$ (log utility), then $\psi = \frac{\pi a_c}{1-a_c}$and $\pi + \psi = \frac{\pi}{1-a_c}$. Hence,

$$q^{*} = \left[\frac{A}{1+t}\right]\left((1-\tau_f)y + ap^{b+1}\right)$$

A.7 Suggestive Evidence: Other Reference Groups

Second experiment: I group the states with respect to their percentage of school aged children in total population in 2010, dividing them into three groups as High, Medium and Low. So, the group they are in according to this categorization is their reference group and numbers are reported in Table A.1 and Table A.2:

High: AK, AR, AZ, CA, CO, GA, ID, IL, IN, KS, MS, NE, NM, NV, OK, TX, UT.

Medium: AL, CT, IA, KY, LA, MD, MI, MN, MO, NC, NJ, OH, SD, TN, WA, WI, WY.

Low: DC, DE, FL, HI, MA, ME, MT, ND, NH, NY, OR, PA, RI, SC, VA, VT, WV.

Third experiment: I group the states with respect to population density in 2010 and divide them into three groups as High, Medium and Low. So, the group they are in according to this categorization is their reference group and numbers are reported in Table A.3 and Table A.4:

High: DC, NJ, RI, MA, CT, MD, DE, NY, FL, PA, OH, CA, IL, HI, VA, NC, IN.

Medium: MI, GA, SC, TN, NH, KY, LA, WI, WA, TX, AL, MO, WV, VT, MN, MS, AZ.

Low: AR, IA, OK, CO, ME, OR, KS, UT, NV, NE, ID, NM, SD, ND, MT, WY, AK.

Table A.1: From Power-Equalizing to Foundation, Reference 2

STATE	VARIABLE	MODEL	AVG
Court-ordered Reform States			
NY (2006)	INC	(-)	-0.26
	INE	(-)	-0.01
MA (1993)	INC	(-)	+0.57
	INE	(-)	+0.43
Legislative Reform States			
PA (2008)	INC	(-)	-0.29
	INE	(-)	-0.06
CO (1994)	INC	(-)	-0.16
	INE	(-)	-0.03

Table A.2: From Foundation to Power-Equalizing, Reference 2

STATE	VARIABLE	MODEL	AVG
Court-ordered Reform States			
OH (2002)	INC	(+)	-0.03
	INE	(+)	-0.15
AK (1999)	INC	(+)	-1.17
	INE	(+)	+1.46
NM (1998)	INC	(+)	-0.20
	INE	(+)	-0.20
WY (1995)	INC	(+)	-0.68
	INE	(+)	+0.13
AL (1994)	INC	(+)	+0.48
	INE	(+)	+0.15
AR (1994)	INC	(+)	+0.76
	INE	(+)	-0.46
Legislative Reform States			
ND (2007)	INC	(+)	-0.26
	INE	(+)	-0.03
MD (2002)	INC	(+)	-0.24
	INE	(+)	+0.27
NE (1997)	INC	(+)	+0.42
	INE	(+)	-0.43
UT (1997)	INC	(+)	+0.56
	INE	(+)	+0.42
IN (1994)	INC	(+)	+0.90
	INE	(+)	+0.07

Table A.3: From Power-Equalizing to Foundation, Reference 3

STATE	VARIABLE	MODEL	AVG
Court-ordered Reform States			
NY (2006)	INC	(-)	-0.17
	INE	(-)	+0.20
MA (1993)	INC	(-)	+0.40
	INE	(-)	+0.20
Legislative Reform States			
PA (2008)	INC	(-)	-0.14
	INE	(-)	+0.23
CO (1994)	INC	(-)	+0.15
	INE	(-)	+0.42

Table A.4: From Foundation to Power-Equalizing, Reference 3

STATE	VARIABLE	MODEL	AVG
Court-ordered Reform States			
OH (2002)	INC	(+)	-0.06
	INE	(+)	-0.40
AK (1999)	INC	(+)	-1.09
	INE	(+)	+1.57
NM (1998)	INC	(+)	+0.02
	INE	(+)	+0.01
WY (1995)	INC	(+)	+0.01
	INE	(+)	+0.57
AL (1994)	INC	(+)	+0.49
	INE	(+)	+0.08
AR (1994)	INC	(+)	+1.07
	INE	(+)	+0.01
Legislative Reform States			
ND (2007)	INC	(+)	+0.02
	INE	(+)	+0.09
MD (2002)	INC	(+)	-0.01
	INE	(+)	+0.02
NE (1997)	INC	(+)	+0.55
	INE	(+)	-0.19
UT (1997)	INC	(+)	+0.69
	INE	(+)	+0.66
IN (1994)	INC	(+)	+0.20
	INE	(+)	-0.25

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