ESSAYS IN PUBLIC ECONOMICS

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ABSTRACT

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This dissertation consists of two chapters on topics in public economics. In the first chapter, I study the conflict over the provision of multiple public goods in U.S. cities. I use a rich data set of municipal spending and Census micro-data to provide evidence that different demographic groups do indeed have conflicting preferences over the composition of public goods and services provided at the local level. To account for endogeneity due to sorting I use a simulated instrumental variable approach where I simulate the demographic distribution in each city that would have occurred if each city's demographic composition had evolved in the same way as in the national level. I then propose a model that can accommodate multiple groups with conflicting preferences over each public good provided and different income distributions within groups and I estimate it using GMM. Using the estimated model, I use the projected evolution of each demographic group to generate predictions on the supply of different public goods in each city. I find that, if the current demographic trends continue, by 2030 there will an average decrease in the provision of public

education in U.S. cities of 2%, an average increase in basic public goods and redistributive spending of 20%, with substantial variability across cities. In the second chapter, I propose a new model of how the level and composition of public services are determined in a city. The model allows for an arbitrary number of groups with different preferences over public goods and within group income heterogeneity. I embed the political economy model of public good provision in the city into a location choice model between the central city and the suburbs in order to study the interactions between mobility and the political conflict over the composition of the budget. Through a numerical exercise I show that mobility and demographic conflict interact in a surprising way, generating a non-monotonic effect between increasing demographic heterogeneity and the size of the public sector. When heterogeneity is low, increasing it reduces the size of the public sector, but it also alters the demographic composition of the city as richer individuals of the minority group leave for the suburbs and the richer individuals from the majority move from the suburbs to the city. This leads to a more homogeneous city and to an inflection in the support for public spending. Eventually, increases in taste heterogeneity lead to increases in public spending per capita, and to a starker segregation between city and suburbs.

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Chapter 1

Introduction

When individuals have different ideas over how to spend public money they are reluctant to contribute with their tax dollars to the public budget. Cities are home to a very diverse constituency—demographically, economically and in terms of values and opinions—yet they rely on the city's government to provide many essential public goods and services—like public school funding, police and fire protection, public transportation, sanitation and public welfare among many others. The public economics literature has produced a considerable amount of evidence supporting this hypothesis. Not much attention—though—has been payed to how this political conflict can be explained by having preferences over different public goods. This dissertation provides methods to model the conflict in the provision of multiple public goods. It consists of two chapters. The first one is an empirical examination of how demographic conflict over the provision of different public goods and services in U.S. cities. The second chapter develops a theoretical model of how conflict over the provision of public goods and city-suburb mobility play out.

In chapter 2, I look at the conflict in the provision of multiple public goods in large U.S. cities. Using a rich dataset on local spending by large cities and suburban municipalities merged with Census micro data, I develop an instrumental variables strategy using simulated instruments to determine the sources of conflict in the provision of public goods. I focus on the provision of three public good aggregates that encompass the vast majority of public goods provided by cities: public education, basic public goods (police, fire, transportation, etc.) and redistributive public goods (public welfare, public hospitals, etc.). I also build and structurally estimate a model of the determination and distribution of local public goods in large cities that takes into account heterogeneity of preferences across demographic groups. I estimate the model with GMM and use the estimated model to generate predictions. I find that there is a political conflict between households with children, young households without children and older empty nesters in the provision of public education, basic public goods and redistribution. I also find that if the current demographic trends continue there will be, by 2030, an average decrease in the provision of public education in U.S. cities of 18%, an average increase in basic public goods of 3% and average redistribution will remain the same, with substantial variability across cities.

In chapter 3, I propose a new model of how the level and composition of public services are determined in a city. The model allows for an arbitrary number of groups with different preferences over public goods and within group income heterogeneity. I embed the political economy model of public good provision in the city into a location choice model between the central city and the suburbs in order to study the interactions between mobility and the political conflict over the composition of the budget. Solving the model numerically, I show that mobility and demographic conflict interact in a surprising way, generating a non-monotonic effect between increasing demographic heterogeneity and the size of the public sector. When heterogeneity is low, increasing it reduces the size of the public sector, but it also alters the demographic composition of the city as richer individuals of the minority group leave for the suburbs and the richer individuals from the majority move from the suburbs to the city. This leads to a more homogeneous city and to an inflexion in the support for public spending. Eventually, increases in taste heterogeneity lead to increases in public spending per capita, and to a starker segregation between city and suburbs.

Chapter 2

An Empirical Analysis of the Conflict in the Provision of Public Goods in U.S. Cities

2.1 Motivation

Not everyone values the services a city provides in equal measure, nor are all residents equally willing to contribute to the public funds. By and large, the value households assign to different public goods depends on their income and their demographics. Young couples with children may value the availability of good schools, the poor may want good public transportation and welfare programs like subsidized housing, the elderly more police protection and nursing homes, and so on. The scarcity of resources and the logic of the democratic process will pit one group against another in the competition for shares of the public budget. Almost everybody will have to settle for a public good level and composition different from their preferred one.

Cities are home to a very diverse constituency, both in therms of their ethnicity, skill, age and income. Eeckhout, Pinheiro, and Schmidheiny [2014] show that urban income distributions are characterized by fat tails. Furthermore, the demographic structure of American cities has been changing rapidly over the last years, as young families with children move to the suburbs and an increasing share of empty nesters from the baby boom generation move into the central cities. Understanding how the provision of local public services is affected by the demographic structure and institutional characteristics of cities is important for a number of reasons. First, an increasing share of the world population lives in cities. In the US, the 25 largest central cities are home to 12% of the total population, when we look at the 25 larges metropolitan areas, the share is 42%. Second, more diverse communities may be less willing to contribute to the provision of essential public services to its residents. The evidence on this fact is mixed, and little is known on the mechanisms that link demographic heterogeneity and the provision of public goods. Third, in many parts of the world, and in the US in particular, local governments carry much of the responsibility in the provision of public goods. For example, in 2008 one-eight of total US GDP was spent by local governments, which corresponds to one-fourth of total government spending, and employed over 14 million people (Glaeser [2012]).

A useful model of the political economy of central cities should incorporate the following two features, which are present in all large American cities. First, cities provide a wide range of public goods and services (education, police and fire protection, health services, housing assistance, waste management, roads, parks,etc.) which are mostly funded at the local level. Second, large cities are home to a very diverse constituency - poor and rich, elderly and young, families and empty nester's- all of which benefit from different public goods in different ways.

Incorporating this features into a tractable empirical model is challenging for several reasons. For example, allowing local governments to provide multiple goods, and having different types of voters means that we can not use the median voter result to map voter's preferences into public policies. The simplicity and tractability of the median voter model has made it the workhorse model in the study of the political economy of local jurisdictions (Epple, Romano, and Sieg [2012]). [1]

In this chapter, I look at the conflict in the provision of public goods in large American cities. Previous studies have shown that a larger share of elderly voters has a depressing effect on public education spending per capita (Poterba [1997], Tosun, Williamson, and Yakovlev [2009] and Figlio and Fletcher [2012]). Previous studies have typically focused on the provision of single good. In contrast, I look at the

[1]The fact that the median voter model is ill-suited for the econometric analysis of large city budgeting has also been noted by Inman [1978].

effect of the demographic structure of a city on the levels and distribution of multiple public goods. Studying the provision of multiple public goods—instead of focusing on a single one—is important since the political conflict between demographic groups is really about different preferences over baskets of public goods. Doing so allows me to unravel the real political friction points between different groups.

Using micro samples from the Census and Census of Governments data, I provide evidence of the conflict between demographic groups. To deal with the potential bias resulting from sorting between different municipalities (Tiebout bias), I use a simulated instruments approach that uses the nation wide patterns of growth of each demographic group to predict the demographic shares in each city and year, using as the base level the population levels observed in 1970, which are taken to be exogenous of the sorting forces during the rest of the sample. A similar strategy has been used by Boustan, Ferreira, Winkler, and Zolt [2013] in their study of the effect of income inequality on the provision of public education in school districts.

I also propose an empirical model of how the level and composition of public services are determined in a city inhabited by people from different demographic groups - hence with different preferences over how to split the public budget - and with different incomes. Public policy is then decided through a democratic process that aggregates all these preferences. I model this process by assuming that two candidates are competing for the mayoral office by proposing feasible combinations of public goods and taxes. To guarantee that a political equilibrium exists, I borrow from the probabilistic voting theory by assuming that candidates have incomplete information about voters' preferences and maximize the expected number of votes (Lindbeck and Weibull [1987], Dixit and Londregan [1996, 1998]). I estimate the model with a multi-equation nonlinear GMM approach using moments derived from the first order conditions of the model.

I find that households with children value public education the most, but have a very low valuation of basic public goods and redistribution spending. Young households without children also have a great value for public education, but this is dominated by their preference for basic public goods. Older households without children value public education the least, and have a strong preference for basic public goods and redistributive spending.

Using the past decade's growth rates of each group I project the population levels of each group to the year 2030. Using the estimated model to compute the distribution of public goods in each city, I find that in most cities demand for public education will decrease substantially whereas demand for basic and redistributive public goods will increase, although there are large discrepancies across cities. This can have potentially large welfare effects across different demographic groups, with the worst hit being poor households with children who are stuck in cities where the political equilibrium is shifting away from public education.

The structure of the chapter is the following. 2.2 offers a literature review on the political economy of public good provision. Sections 2.3 and 2.4 explain the data used in the estimation and the stylized facts that come out of it. In section 2.5 I develop the model and describe its equilibrium. In section 2.6 I discuss how to estimate the model. In section 2.8 I use the estimated model to predict the evolution of the demand for the different public goods.

2.2 Literature Review

This chapter contributes to several strands of the literature—both empirical and theoretical. It fills an important gap in the literature studying the provision of local public goods by developing an empirical model that allows for the provision of multiple public goods to heterogeneous constituencies, thus providing an alternative to the median voter model in the study of local public finance. In the next section I review the different literatures that have studied public good provision by local governments. For each one, I highlight the common ground with this chapter as well as the differences.

The study of the political economy of public good provision by local governments has a long history in economics. Economists have made a number of assumptions about the mechanisms transforming the preferences of the electorate to the policies enacted. In most cases this takes the form of a model of voting by the residents of the local jurisdiction. Residents can vote directly on the policy to be enacted—e.g. how much to spend on public education—or indirectly through representatives. Perhaps the most commonly employed political model in studying local governments is the simple median voter model. In this model it is normally assumed that voters disagree on the policy based on their income. It has long been established—first by Black [1948] and later by Downs [1957]—that when voters decide over a single policy, single-peaked preferences are sufficient to guarantee that a decisive voter exists, also known as Condorcet equilibrium. With the additional assumptions that voters vote sincerely and that the enacted policy will be one that cannot be defeated under majority rule by any other policy, the median voter model predicts that the enacted policy will be the most preferred by the voter with median income. Bergstrom and Goodman [1973] provide the first successful attempt to turn the median voter model into a logically consistent demand equation suitable for empirical analysis. Using their approach, Inman [1978] tests the empirical validity of the median voter model by looking at public school spending decisions in a sample of fifty-eight Long Island school districts. He finds that his sample of Long Island schools do indeed behave as if the median voter is deciding their level of spending. Inspired by this result, a large number of public economists set out to apply the median voter model to a number of public good provision problems. The support for the median voter hypothesis coming out of these studies is mixed, as reported in Romer and Rosenthal [1979]. While the data shows a relation between the income of the median voter and the level of public expenditures it is unclear whether that level of spending is the preferred level of the median voter or some multiple of it. This is sometimes called "the multiple fallacy". An additional shortcoming of this literature is that it ignores the effect of migration across communities, as pointed out by Goldstein and Pauly [1981].

The fact that voters will choose where to live partly based on the different levels of public goods offered by different jurisdictions adds further constraints to the public policies that can be implemented by local governments. Failing to take mobility into account can lead to biases due to sample selection, also known as "Tiebout bias". Inter-jurisdictional equilibrium models take into account that households are mobile and choose among a set of communities based on their public goods, tax rates and housing market conditions. Voters with similar tastes will tend to live together, leading to communities being ranked by the income of its residents. This literature has its origins in the seminal paper by Tiebout [1956]. Bergstrom, Rubinfeld, and Shapiro [1982] and Goldstein and Pauly [1981] use a control function approach to correct for the Tiebout bias, avoiding the need to specify a full equilibrium model. More recently, there has been an effort to work out a theory of public good provision that integrates mobility, housing markets and majority voting in a general equilibrium framework. The theory for this models is developed in Epple and Romer [1991]. Epple and Sieg [1999] provide the first empirical application of an inter-jurisdictional equilibrium model; using data from the 1980 Census for 92 municipalities of the Boston Metropolitan Area they estimate a general equilibrium model where the demographic distribution of each municipality, spending on public schools and housing markets are endogenously determined. The key empirical test is whether the model can match the observed income distributions in the sampled municipalities. They find that the model does indeed match several moments of the observed income distributions along with housing prices and school expenditure levels. The methodology developed by Epple and Sieg [1999] has been applied to many different contexts, from evaluations of public policies like the Clean Air Act (Sieg, Smith, Banzhaf, and Walsh [2004]) to measuring the inefficiencies of fiscal decentralization (Calabrese, Epple, and Romano [2011]). This chapter borrows much of the economic structure developed by this literature, but it does not attempt to model the sorting of households across communities. This literature has dealt almost exclusively with small, relatively homogeneous communities. This chapter focuses on large cities with heterogeneous households along multiple dimensions. While it is reasonable to assume that households in small communities care mainly about the provision of a single good, namely public schools, this is not true for households living in large cities. Finally, I allow households to have distinct preferences for each public good so that the political conflict is about the composition of the bundle of public goods, not only about the level of provision.

This chapter is also related to the literature studying the relationship between ethnic conflict and measures of urban development like population growth and public good provision. Several empirical papers using data from U.S. cities have found that population growth is lower in cities with a larger fraction of nonwhite residents (Glaeser, Scheinkman, and Shleifer [1995], Glaeser and Cutler [1995], Poterba [1997], Luttmer [2001] and Goldin and Katz [1998]). A possible explanation is provided by Alesina, Baqir, and Easterly [1999], which looks at the question of whether higher ethnic fragmentation leads to lower public spending in public goods. They find a strong and robust negative correlation between the level of ethnic fragmentation and the provision of public goods in US cities and counties. In their model, voters differ in their taste for quality, and must decide the quality and quantity of a single public good. In more diverse communities, the chosen quality of the public good is farther away from the preference of the median voter, which leads her to prefer a lower level of public good provision. The main prediction of their model is that higher fractionalization leads to lower provision of publics goods. They test this prediction looking at county, city and metropolitan area data in the US and find that this is actually the case. In my regression analysis I also find that ethnic fragmentation is negatively associated with the provision of public education and basic public goods, but has a positive correlation with redistribution. Even though this chapter does not focus on ethnic conflict, the methodology that I develop could easily be applied to these problems, providing a structural extension of their work. Doing so would also relax some of the assumptions in Alesina et al. [1999], such as the restriction to a single public good, and no income differences within demographic groups.

In a related paper, Alesina, Baqir, and Easterly [2000] explore how local politicians can use local public employment as a tool to redistribute resources to interest groups. They find that public employment is significantly higher in cities with higher ethnic and income inequality. To motivate their findings they use a model of government as in Coate and Morris [1995]. Rugh and Trounstine [2011] use historical data from the turn of the twentieth century to the Second World War to show how different ethnic compositions affected public spending in US cities. They finds that South and Eastern Europeans depressed public spending, whereas black, Latino and Asian populations affected it positively. They argue that these differences stem from the differences in voting rights among people from different ethnicities, so that in the end it is heterogeneity at the voting booth that depresses public spending. Rugh and Trounstine [2011] study the effects of ethnic diversity on the outcomes of municipal bond elections. They find that more diverse cities hold fewer bond elections. But they also find that the probability that a bond will be approved on election day and the average size of the bonds is higher in more diverse cities. They interpret this as evidence of strategic behavior by local politicians.

Ethnic fragmentation is not the only source of political conflict affecting the provision of public goods in cities. Boustan et al. [2013] look at the question of whether the observed increase in income inequality over the past decades had a causal effect on the provision of public school spending in a large set of small U.S. municipalities. To account for possible sources of reverse causality—richer voters moving to districts with higher levels of public school spending—they use a simulated instruments strategy. In particular, they look at the observed Gini coefficients of each of their municipalities in 1970—prior to the start of their sample—and project them using the observed aggregate growth at the national level. This simulated Gini coefficients are correlated with the observed ones, but are unlikely to be correlated with local changes in revenues or expenditures. They find that increasing income inequality causes public spending to go up, and it increases the shares of the budget devoted to police, fire protection and road maintenance. This chapter uses a similar technique to generate instruments for the demographic composition of each city. In my model, income inequality affects outcomes in two ways. First, by potentially changing the average income, with higher expenditure levels if average income increases. Second, by changing the relative average incomes of each demographic group. Local politician's will weight each group's preferences according to how sensitive each group is to a marginal increase in taxation. With proportional taxes, higher income groups will bear a larger burden and will be less likely to favor policies away from their preferences. The equilibrium outcome, thus, gives more weight to richer groups.

Poterba [1997] looks at the intergenerational conflict in the provision of public education. He first establishes that—theoretically—the correlation between the share of older residents and support for public education could go either way. On one hand, older residents may not have any direct use of public schools anymore, but on the other hand public education has some positive externalities, both in terms of crime and property values. From a median-voter perspective, whether changes in the demographic structure will lead to changes in public spending depends on whether the identity of the median voter is altered. In my model, changes from demographic structure will translate into changes in the political equilibrium in a more direct way, since the political equilibrium balances the preferences from the different demographic groups in the city through an electoral competition game.

More recent evidence of intergenerational conflict in providing public goods also point to there being an opposition to increasing expenditures by older voters. Harris, Evans, and Schwab [2001] use data from school districts and control for endogeneity in the demographic shares by using the past share of households from a previous generation that stayed in the district. So, for example, they instrument the share of those older than 65 by the share of those aged 55 to 65 in the previous decade, subtracting those who left the district during that time. Farnham and Sevak [2006] show that households have a tendency to sort according to empty nest status, and that that tendency decreases when fiscal equalization laws are passed. Fletcher and Kenny [2008] find opposition by older households when estimating public school demand equations. Brunner and Ross [2010] use evidence from referendums in California and show that the elderly oppose increases in spending on public schools. Reback [2015] looks at whether tax-price reductions offered to the elderly—which reduce the burden of increased public good provision—decrease their opposition to public school spending, and finds that that is indeed the case.

Epple et al. [2012] take a different approach; they develop an overlapping generations model embedded within a multi-jurisdictional sorting model, as in Epple and Sieg [1999]. Their question is whether stratification by age, along with stratification by income, can explain some of the observed inequalities in school spending across communities. They calibrate the model using data from municipalities in the Boston Metropolitan Area. They find that in equilibrium, households that move when children move out tend to be richer than average. This creates a positive fiscal externality to the communities they move to that can overcome the negative effects from their low political preference for school spending.

Craig, Kohlhase, Austin, and Botello [2014] look at why big cities spend a significant fraction of their budget on income redistribution. They conclude that big cities are able to raise taxes for income redistribution because they exploit significant rents. To do that, they test whether big cities respond to innovations in suburban expenditures. Under the hypothesis that big cities are not rent seeking and are maximizing the welfare of their citizens, we should expect that they do not respond to such innovations.

As mentioned earlier, the most common political model to study the supply of public goods is the median voter model. This model is useful as long as the heterogeneity of voters is unidimensional—like income inequality. If the preferences of voters being such that their preferred levels of public good provision are single-peaked, then existence of a political equilibrium is guaranteed. When new forms of voter heterogeneity are introduced, or when the policy space is multidimensional, we can no longer meaningfully rank the preferences of voters along their sources of heterogeneity. As a result, a political equilibrium with majority voting does not exist anymore.

The applied political economy literature has taken several different paths to deal with this "course of dimensionality". One approach is to add some structure into the voting process by forcing the votes to be unidimensional by having voters compare different options one dimension at a time—voting on school spending first, police spending second, and so on. This comes in two flavors. Voting can be sequential—Stackelberg voting—or it can be simultaneous (Shepsle [1979b]). An example of Stackelberg voting is given by Nechyba [1997]. In his model voters vote on the federally provided public good first, and on the locally provided good second. Additional examples are given by Alesina et al. [1999] and Alesina, Baqir, and Hoxby [2004] where households vote on the quality of the public good first, and on the quantity provided second. A drawback of Stackelberg voting is that the order in which the different votes are scheduled will matter for the final outcome. This may not be desirable in some applications, like when voting over multiple public goods provided by the same level of government.

An interesting approach is taken by Caplin and Nalebuff [1991]. They propose a set of restrictions on the density of voters—a new aggregation technique—that guarantee that the *mean* voter is decisive under a 64% majority rule. Their aggregation technique comes from an application of the mathematical aggregation theorem proposed by Prekopa and Borell. I am not aware of any applications of their method to the problem of local public good provision.

The fundamental issue with the non-existence of equilibrium with multidimensional models is that the payoff functions of the candidates are not smooth. Small deviations in their electoral proposals can create large swings in voter's behavior. The probabilistic voting literature addresses this issue by adding enough heterogeneity into the voter's preferences so as to smooth the candidate's payoff functions. The basic assumption is probabilistic voting models is that voters care about their consumption and, in addition, about other outcome that are not related to consumption—normally this is the identity of the candidate. It is assumed, in addition, that candidates have imperfect information about voters preferences—they can only observe the part of utility that depends on consumption and treat the other component as a random variable. Consequently, they cannot perfectly predict their share of the electorate when making electoral promises, and will therefore maximize their *expected* share of votes. Under some mild concavity assumptions this is enough to guarantee the existence of an equilibrium, even with a multidimensional policy space.

The existence of pure strategy equilibriums in probabilistic voting models has been established by Hinich, Ledyard, and Ordeshook [1972], Denzau and Kats [1977], Coughlin and Nitzan [1981] and Wittman [1983]. The applications of the model were popularized by Lindbeck and Weibull [1987] in their study of redistribution between different socio-economic groups. This model has also been used in the study of the political economy of special interest groups in Dixit and Londregan [1996], Dixit and Londregan [1998]. The model in Dixit and Londregan [1996] provides the motivation for the model developed in this chapter.

2.3 Data

I compiled a data set of the provision of public goods and services and demographic characteristics for a sample of 116 US cities, which correspond to the largest cities in the country. Table 2.1 shows the descriptive statistics for the aggregated variables of the principal cities. Next, I describe in detail the sources of each of these datasets.

I use both aggregated and individual level data from the Census. I obtain individual demographic data from the 5 percent micro-samples Integrated Public Use Micro Samples (IPUMS-USA) for the years 1980, 1990, 2000 and 2010 Ruggles, Fitch, Hall, and Sobek [2000]. These data provide detailed individual and household information like age, income, race, number of kids, commuting time, etc.

An important limitation of these data is that, in order to preserve anonymity, the place of residence is not reported for those individuals living in municipalities with less than 100,000 inhabitants. Another limitation is that for some individuals information on their urban status (city vs. suburb) is missing, again due to anonymity reasons. I drop individuals with missing urban status from the sample [2]. The aggregated Census data comes from the full population Census tables for the years 1980, 1990, 2000, and 2010. I construct the demographic groups for the analysis of this chapter from the IPUMS data set since the aggregated data does not contain enough demographic detail.

From this data I construct the following demographic groups: households younger than 65 without children (group 1), households younger tan 65 with children (group 2), and households older than 65 (group 3).

I collected data on revenues, spending and public employment for municipal governments from the Census of Governments. The data for the central cities comes from the Fiscally Standardized Cities data set, produced by Lincoln Institute of Land Policy (LILP). These data solve a major problem in the study of local public services across cities coming from the fact that different layers of government have different responsibilities in their provision, and how these responsibilities are shared

[2]The IPUMS tables have been used in several studies comparing observations from the central city and the suburbs. See for example Boustan and Shertzer [2010] , Glaeser and Kahn [2010].

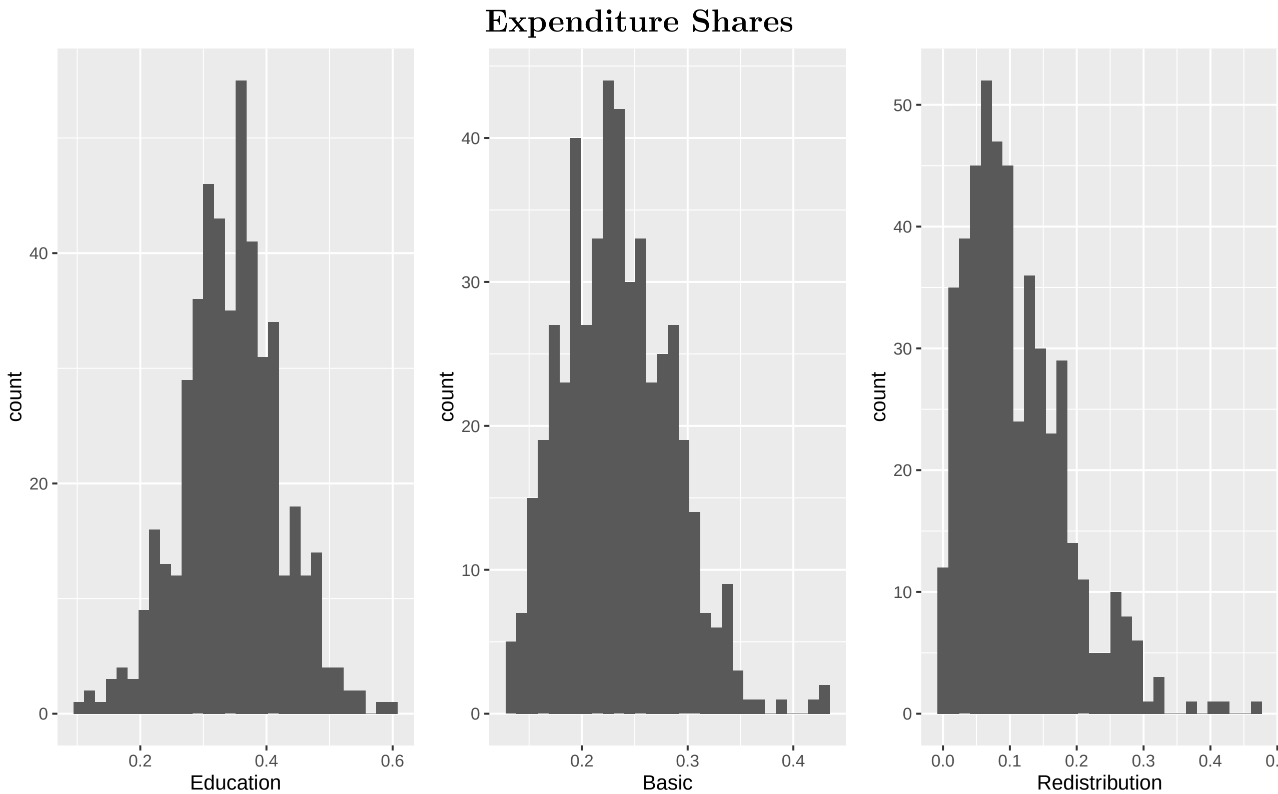

Figure 2.1: Expenditure shares on education, basic spending and redistribution for the period 1980-2010.

changes from region to region. The researchers at the LILP have consolidated revenue and expenditure data from the Census of Governments for a selection of 116 large American cities for the period 1977 to 2010. The data from city governments has been combined with a share from the overlying counties, school districts, and special districts [3].

As an example of this problem, suppose we were to compare total public good

[3]See of Land Policy [2014] for a detailed description of the methodology.

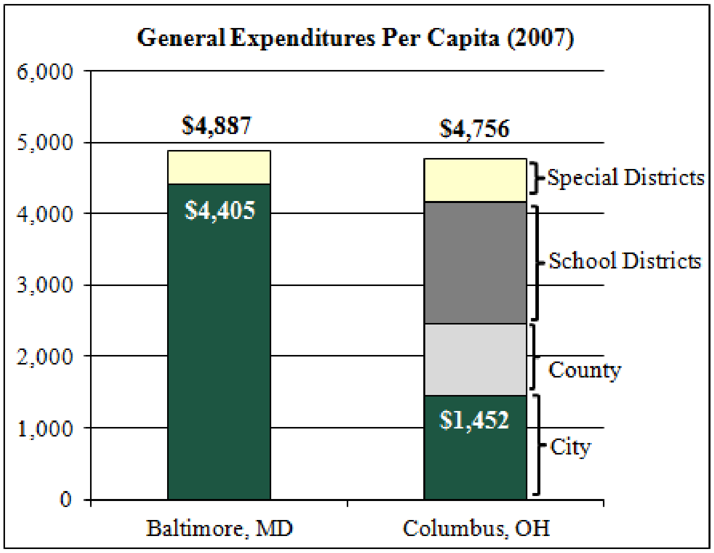

Figure 2.2: The dangers of comparing municipal expenditures. Example using general expenditures per capita. Comparison between Baltimore, MD and Columbus, OH.

Source: Lincoln Institute of Land Policy.

provision in the cities of Baltimore, MD and Columbus, OH. This is illustrated in Figure 2.2. If we were to look only at the expenditure of the city government, we would conclude that Baltimore provides roughly three times more public goods than Columbus. But once we take into account the provision by other government layers that falls within the boundaries if each city we see that citizens from both cities enjoy approximately the same level of public goods.

I merged the fiscal data for central cities and suburbs with the corresponding tables from the decennial Census of Governments [4]. Fiscal data are available for all

[4]Doing this is quite involved since the coding of Census Places changes from year to year and

years ending in five or seven, whereas demographic data are collected in all years ending in zero. To merge the two I interpolate each variable from the Decennial Census using a municipality specific linear trend to obtain estimates for all years in the Census of Governments.

For the analysis in this chapter I aggregate the expenditure data into four categories: Education, Basic, Redistribution, and Other. The Education category is composed of current spending on elementary and secondary education. The Basic category includes expenditures on public safety (police and fire protection, correction facilities, inspection and regulation), transportation, government administration, and parks and recreation. Redistribution contains spending on social services and income maintenance, which includes spending on hospitals and health, and housing assistance. Finally, Other is the residual spending from all current expenditures, which is composed of interest payments on debt, expenditure on utilities, liquor stores and employee and retirement trust. The shares of expenditures in these categories vary widely across cities, as can be seen in the distributions in Figure 2.1.

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there does not seem to be any publicly available crosswalk to facilitate the task. Failure to find the corresponding tables in the Census of Governments happens because (i) not all governments are surveyed by the Census on every round, and (ii) changes in codes. There is no solution for the first problem.

Table 2.1: Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Population	484	525.901	952.585	93.024	8,214.426
Black Share	484	0.249	0.187	0.006	0.845
Other Share	484	0.078	0.074	0.003	0.323
Ethnic	484	0.408	0.135	0.064	0.691
Gini	484	0.470	0.043	0.335	0.572
Income Med	484	35.684	7.398	22.222	67.405
Renters Share	484	0.447	0.086	0.193	0.714
Education Exp Pc	484	1.103	0.352	0.453	2.972
Basic Exp	484	0.750	0.226	0.270	2.100
Redistribution Exp	484	0.395	0.370	0.002	2.849
Education Share	484	0.344	0.078	0.109	0.606
Basic Share	484	0.234	0.051	0.128	0.425
Redistribution Share	484	0.109	0.076	0.001	0.469
Total IG Revenue	484	0.611	0.648	0.028	3.249
Area	482	385.815	508.261	41.372	4,415.143
Number Suburbs	478	61.121	75.303	0	322

Note: 116 principal cities for the period 1980-2010. Population in thousands, all monetary variables in $1000s and 2000 dollars.

2.4 Stylized Facts

In this section I look at the evidence on the relationship between the demographic structure of cities and their level and composition of public good provision. First I regress the budget shares of education, basic spending and redistribution on the demographic shares of households with children and empty nesters (groups 2 and 3) controlling for other demographic observables and city characteristics. I use state and year fixed effects to account for unobservable state-specific characteristics that affect the process through which cities come up with their budgets, and temporal effects on the shares of different public goods that may reflect nation wide trends.

For each public good, the regression equation is given by

$$g^k_{c,t} = \gamma_{s^2} s^2_{c,t} + \gamma_{s^3} s^3_{c,t} + X_{c,t}\beta + \eta_s + \eta_t + \upsilon_{c,t} \tag{2.4.1}$$

where $g^k_{c,t}$ denotes the share of spending on public good category k in city c and year t. The share of each group is given by $s^i_{c,t}$, $X_{c,t}$ contains other demographic covariates and city characteristics, and η_s and η_t denote state and year fixed effects.

Estimating equation 2.4.1 using a fixed effects regression may not be sufficient on its own to establish a causal relationship between the demographic composition of a city and the shares of spending. It is possible that households within a MSA sort between the city and the suburbs partly due to the different public goods that are offered (Goldstein and Pauly [1981]). For example, households with children might choose to live in the suburbs if they consider the level of public education spending in the city to be too low. One might be concerned, then, that the demographic composition of MSAs reflects the provision of public goods and services of its constituent municipalities and not the other way around. It could be that some MSAs might have some advantage in providing some kinds of public goods and that individuals of different groups sort among MSAs according to those advantages.

To mitigate concerns about this form of reverse causality, I construct an instrumental variable that is correlated with changes in an citys demographic composition but is not otherwise associated with changes in local public spending. In particular, I predict the demographic composition of a city at time t based on the city's initial distribution and the national changes in the demographic composition. I then use that predicted distribution as an instrument for the actual demographic distribution. I start with the initial distribution observed in 1970 and project the changes in each group's size using the national growth rates observed in the IPUMS micro-data. The initial share of each group in each city acts as a weight indicating how the national growth of that group affected that particular city. For example, the share of empty nesters grew faster than the share of households with children during the observed period. The instrument will then predict greater changes in cities with a larger proportion of empty nesters in 1970.

The main source of identifying variation from these instruments comes from the different group shares in 1970 across MSAs. Therefore, the validity of these instruments hinges on the 1970's demographic composition and unobservables correlated with it not having predictive power on the current shares of spending. Threats to the validity of the instruments might come from mechanisms involving the demographic shares if 1970 being correlated to some fundamentals that affect the shares of spending today, but it is hard to come with a plausible example. Boustan et al. [2013] use a similar instrumental variables approach in their study of the effects of income inequality on school district's public finances where they simulate the current income distribution in each area based on the observed distribution in 1970 and using the national evolution of incomes.

Formally, for each city c and year t I compute the instrument for the share of the demographic group i as

$$\hat{s}_{itc} = \frac{\hat{\mu}_{tic}}{\sum_i \hat{\mu}_{tic}}$$

where $\hat{\mu}_{tic} = (1 + r_{ti}^{USA})\mu_{1970,ic}$ represents the aggregate national population of group i in year t, r_{ti}^{USA} is the growth rate of group i in the U.S. as a whole, and $\mu_{1970,ic}$ is the population level of group i in city c in 1970. The validity of these instruments relies on the population levels in 1970 being unrelated to the expenditure shares in

First Stage Correlations

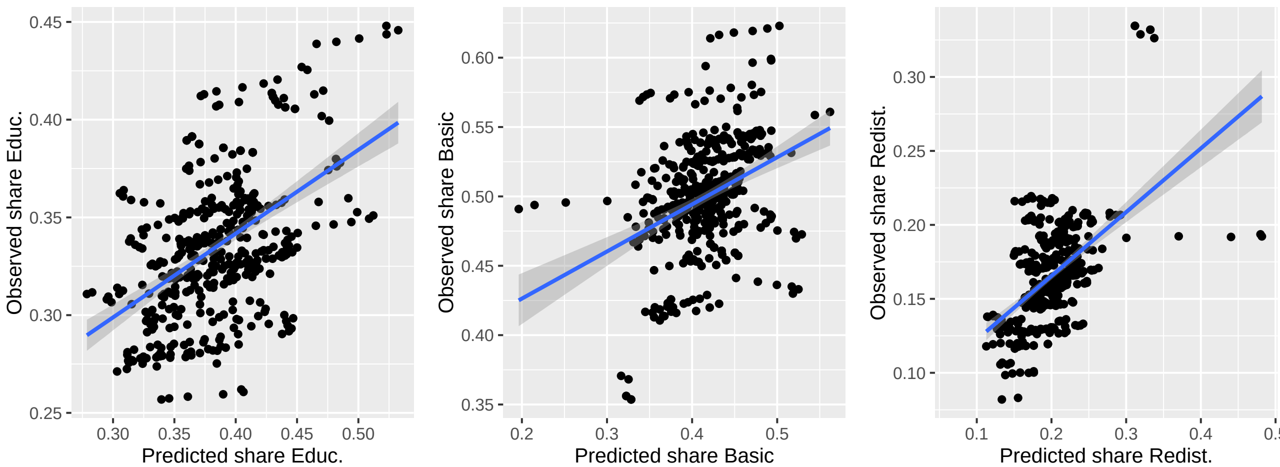

Figure 2.3: First stage correlations.

These scatter plots show the correlation between the predicted city demographic shares using the instruments and the observed city shares.

the future.

The results from the regression in equation (2.4.1) are shown in Table 2.2. The first three columns contain the regression results, including state and year fixed effects, for the expenditure shares in education, basic spending and redistribution. The last three columns contain the results for the same specification using instrumental variables.

Figure 2.3 shows the relationship between the synthetic and the actual city shares. There is a strong and positive relationship between predicted shares and actual shares for all three demographic groups, suggesting that much of the change in shares that occurred during the period 1970 to 2010 was driven by national trends rather than by intra MSA sorting. The F-statistic between the actual and predicted shares for group 2 is 25.38, and for group 3 is 37.27, well above the rule of thumb threshold value of 10.

The degree of ethnic fractionalization, the main variable in Alesina et al. [1999], is positively associated with budgets favoring education and basic spending, but negatively so with spending on redistribution. The share of Hispanic residents has the same pattern of effects, whereas the share of black residents has no significant effect on any expenditure share. Finally, income inequality, as measured by the Gini coefficient, decreases the shares devoted to education and basic spending, but increases the share of redistribution. Another interesting result is that the number of surrounding suburban municipalities is negatively correlated with the share of pending in redistribution but does not seem to have an effect on the other spending categories. Since a higher number of suburbs increases possibilities for richer households to live outside the fiscal limits of the city, this is evidence that income redistribution becomes increasingly harder to implement when households can easily sort themselves based on income.

To look for nonlinearities in the relationship between demographic shares and budget shares run a set of nonparametric regressions (shown in Appendix A.1).

As suggested by the nonparametric results, there are clear limits on what can be learned about the interactions between the demographic composition of cities and their budget shares. In the next section I develop a model of public good provision in cities that accounts for the democratic process through which budgets are decided. In the model, groups are differentiated by their preferences over public goods and by their income distribution. The proposed political process is a simplification of the complicated process through which actual cities decide their budgets, involving strategic interactions between city councils and mayor's offices, but captures the relevant fact that self-interested political agents are deciding the supply of public goods with electoral goals in mind.

Table 2.2: Regression Results

	Educ. (1)	Basic (2)	Redist. (3)	Educ. (4)	Basic (5)	Redist. (6)
Share group 2	0.409***	−0.143**	0.014	0.555**	−0.681***	0.764**
	(0.079)	(0.058)	(0.100)	(0.239)	(0.197)	(0.327)
Share group 3	−0.186**	0.044	0.049	−0.212**	0.200	−0.231
	(0.085)	(0.062)	(0.107)	(0.102)	(0.98)	(0.297)
Ethnic	−0.160***	−0.077***	0.213***	−0.155***	−0.097***	0.244***
	(0.035)	(0.025)	(0.044)	(0.037)	(0.030)	(0.050)
Share black	0.071**	0.016	−0.118***	0.051	0.094**	−0.231***
	(0.030)	(0.022)	(0.037)	(0.046)	(0.038)	(0.064)
Share other	0.316***	−0.183***	0.004	0.226	0.162	−0.495**
	(0.077)	(0.056)	(0.097)	(0.173)	(0.143)	(0.237)
Gini	−0.278**	−0.209**	0.433***	−0.249	−0.344***	0.650***
	(0.118)	(0.087)	(0.149)	(0.157)	(0.130)	(0.216)
Log median income	−0.072***	0.003	0.069**	−0.093**	0.085**	−0.048
	(0.024)	(0.018)	(0.031)	(0.043)	(0.036)	(0.060)
Log population	−0.027*	0.018*	0.013	−0.038*	0.055***	−0.037
	(0.015)	(0.011)	(0.019)	(0.022)	(0.018)	(0.031)
Nb. renters	−0.248***	0.123***	−0.006	−0.210**	−0.011	0.178
	(0.058)	(0.042)	(0.072)	(0.081)	(0.067)	(0.112)
Log college	0.018	−0.005	−0.028	0.029	−0.041**	0.021
	(0.015)	(0.011)	(0.018)	(0.022)	(0.018)	(0.030)
Tot. IG revenue	0.006	−0.018***	0.033***	0.005	−0.018***	0.032***
	(0.006)	(0.005)	(0.008)	(0.006)	(0.005)	(0.009)
Log nb. suburbs	−0.010***	−0.004**	0.008**	−0.010***	−0.007***	0.013***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)
Fixed effects?	Y/R	Y/R	Y/R	Y/R	Y/R	Y/R
IV?	No	No	No	Yes	Yes	Yes
N	478	478	478	478	478	478
R^2	0.541	0.419	0.248			
Adjusted R^2	0.521	0.393	0.215			
Residual Std. Error	0.054	0.039	0.067	0.054	0.045	0.074

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Note: In all of these regressions we are using year and state fixed effects. The first three columns contain the results of the uninstrumented regressions. The last three columns contain the results using the simulated instruments for demographic shares. The shares of group 1 have been omitted because of perfect multicollinearity with the other group shares. Standard errors are clustered at the Census region level.

2.5 Model

In this section I develop a political economy model of the provision of multiple public goods in diverse communities. The provision of public goods in the city is the outcome of the competition between two candidates for mayor's office [5]. A key concern in models of multiple public goods provision is that the median voter is no longer decisive. To address this issue, I assume that candidates have incomplete information about voter's preferences—as is common in models of probabilistic voting—and that they decide their policy platforms in order to maximize their chances to win the election [6].

[5]This is assumed only for simplicity and tractability. The politics of large cities are very complex, and public goods are not always offered by the same layer of government in all places. The major players in determining this provision are the mayor, city council and, sometimes, the county and state government.

The form of government of most American cities falls into one of two categories: (i) a strong mayor, in which the mayor is responsible for most policy decisions; or (ii) a weak mayor, in which the city council is responsible for deciding policy and a city manager, or controller, is hired to execute those policies. For large American cities, which are the main concern of this chapter, the most common form of government is a strong-mayor, which makes the assumption made in the model more plausible.

[6]This is done in order to guarantee that a political equilibrium exists. Nonetheless, assuming that candidates are unable to perfectly predict the outcome of the election is quite realistic.

The city is populated by I demographic groups with populations $\mu_1, \ldots, \mu_I$. The income distribution of group i is given by F_i (with pdf f_i). The city's government provides K public goods, indexed by k. There are two candidates in the city running for mayor's office, an incumbent I and a challenger C. They compete by making credible promises about the level of public goods and the tax rate, $(\boldsymbol{g}, \tau)$. Let the policy proposal of a candidate x be denoted by $(\boldsymbol{g}^x, \tau^x)$. The voter's preferences over policy proposals are given by

$$v_i^x(y) = u_i(\boldsymbol{g}^x, \tau^x; y) + \epsilon^x \quad \text{for } x = \{I, C\} \tag{2.5.1}$$

where $u_i(\boldsymbol{g}, \tau; y)$ is the part of utility that depends on the policy enacted, and ϵ^x is a raw preference for candidate x that does not depend on policy. The deterministic part of utility is given by

$$u_i(\boldsymbol{g}, \tau; y) = (1 - \tau^x)\, y + \sum_k \theta_i^k \ln g_k^x \tag{2.5.2}$$

where g_k denotes per capita consumption of public good k, and ϵ^x is the raw preference for candidate x. Normalizing $\epsilon^C = 0$ we can interpret ϵ^I as the individual bias for candidate I.

To save on notation, let the deterministic utility of a household with income y

under the policies of candidate x be denoted by $u_i^x(y) = u_i(\boldsymbol{g}^x, \tau^x; y)$. The probability that a voter with these preferences will vote for the incumbent mayor I is

$$\Pr(\text{vote for } I \mid y) = \Pr\left(\epsilon_i^C - \epsilon_i^I < u_i^I(y) - u_i^C(y) \mid y\right) \tag{2.5.3}$$

$$= \Phi_i\left(u_i^I(y) - u_i^C(y)\right) \tag{2.5.4}$$

where Φ_i denotes the distribution of $\epsilon_i^C - \epsilon_i^I$.

Assumption 1. *The function $\Phi : \mathbb{R}_+ \to [0,1]$ has the following properties:*

1. $\Phi(x) + \Phi(\frac{1}{x}) = 1$,
2. *Φ is continuous and increasing in x, and*
3. *Φ is concave.*

Aggregating the individual probability of voting for I for all income levels and for all group sizes we get the expected number of votes for candidate I

$$V^I = \sum_i \mu_i \int \Phi_i\left(u_i^I(y) - u_i^C(y)\right) dF_i(y) \tag{2.5.5}$$

It is common in models of probabilistic voting to assume that candidates maximize the total number of votes. In that case, the policy proposal of candidate I

given the policy proposal of candidate C is the solution to the following maximization problem

$$\max_{\boldsymbol{g},\tau} \sum_i \mu_i \int \Phi_i \left(u_i^I(y) - u_i^C(y) \right) dF_i(y) \tag{2.5.6}$$

$$\text{subject to} \quad C(\boldsymbol{g})P^C = \tau Y + T \tag{2.5.7}$$

where $C(\boldsymbol{g})$ is the per capita dollar cost of providing $\boldsymbol{g}$, P^C is the total population of the city, and T are state and federal transfers. For simplicity we assume that $C(\boldsymbol{g}) = \sum_k c_k g_k$, that is, the cost function is linear, and that there are no interactions in the cost of providing different public goods. The parameters c_k measure the dollar cost of providing one unit of k per person.

Definition 2.5.1. *A Nash equilibrium is a policy proposal for the both candidates such that, given the opponent's policy, each candidate can not increase her vote share by deviating.*

Proposition 2. *A Nash equilibrium of the model exists.*

Proof. Since Φ_i is concave, it follows that V^x is concave. If we show that $1 - V^x$ is also concave, since the political game is zero-sum, we can apply Kakutani's fixed-point theorem to conclude that a Nash Equilibrium exits. Without loss of generality, normalize the population to 1. Then, note that

$$V^x = \sum_i \mu_i \int 1 - \Phi_i\left(v_i^{-x}(y) - v_i^x(y)\right) dF(y) \tag{2.5.8}$$

$$= 1 - \sum_i \mu_i \int \Phi_i\left(v_i^{-x}(y) - v_i^x(y)\right) dF(y) \tag{2.5.9}$$

So that

$$1 - V^x = \sum_i \mu_i \int \Phi_i\left(v_i^{-x}(y) - v_i^x(y)\right) dF(y). \tag{2.5.10}$$

Therefore, $1 - V^x$ is a concave function in the policy of $-x$. We conclude that a Nash Equilibrium of this game exists.

□

If the objective function of the candidates is sufficiently concave, then there will exist a unique equilibrium in pure strategies in which both candidates offer the same policy proposal.

The first order conditions are given by

$$\sum_i \mu_i \int \phi_i \left\{ v_i^I(y) - v_i^C(y) \right\} \frac{\partial v_i}{\partial g_k} dF_i(y) = \lambda c_k P^C \tag{2.5.11}$$

$$\sum_i \mu_i \int \phi_i \left\{ v_i^I(y) - v_i^C(y) \right\} \frac{\partial v_i}{\partial \tau} dF_i(y) = -\lambda Y \tag{2.5.12}$$

Equation (2.5.11) equates the votes that the candidate would get from a marginal increase in the provision of g_k to the loss of votes due to the increase in taxes necessary to finance it.

Under sufficient concavity of the objective function, there will exist a unique equilibrium in pure strategies in which both candidates converge to the same policy, so that in equilibrium $v_i^I(y) = v_i^C(y)$. Using the utility function given in equation 2.5.2, we can then rewrite the two first order conditions as

$$\sum_i \mu_i \phi_i(0) \theta_i^k \frac{1}{g_k} = \lambda c_k P^C \tag{2.5.13}$$

$$\sum_i \mu_i \phi_i(0) \int y dF_i(y) = \lambda Y \tag{2.5.14}$$

Combining both first order conditions we get that the equilibrium levels of provision of public goods are given by

$$g_k = \frac{\bar{Y}}{c_k} \left(\frac{\sum_i \tilde{s}_i \phi_i \theta_k^i}{\sum_i \tilde{s}_i \phi_i \hat{y}_i} \right) \quad \text{for } k = 1, \ldots, K \tag{2.5.15}$$

where $\phi_i := \Phi_i'(0)$, $\tilde{s}_i = \frac{\mu_i}{P^C}$ is the fraction of the city's population belonging to group i and $\hat{y}_i := \int y f_i(y) dy$ is the average income of group i in the city.

The solution for the provision of each public good, equation 2.5.15, is as if the government collects all the output generated by the households in the city and divides it across public goods according to a weighted average of the preferences of all demographic groups. The numerator of the term in parenthesis in equation 2.5.15 measures how households in the city value that particular good, θ_K^i, weighted by that group's share of the elecotrate and by the parameter ϕ_i, that measures the denisty of swing voters and therefore the number of votes that are susceptible to be gained by marginally satisfying that group.

We now can write total spending on good k as

$$TS_k = c_k g_k P^C = \frac{\sum_i \phi_i \tilde{s}_i \theta_i^k}{\sum_i \phi_i \tilde{s}_i s_i^y} \quad \text{for } k = 1, \ldots, K \tag{2.5.16}$$

where s_i^y is the share of total income belonging to group i. That is,

$$s_i^y = \frac{\int y f_i(y) dy}{\sum_i \mu_i \int f_i(y) dy} = \frac{\hat{y}_i}{\sum_i \mu_u \hat{y}_i} \tag{2.5.17}$$

Total spending in the city is the amount of resources spent providing all public goods and services

$$TS = \sum_k TS_k = P^C \sum_k c_k g_k = \sum_k \frac{\sum_i \phi_i \tilde{s}_i \theta_i^k}{\sum_i \phi_i \tilde{s}_i s_i^y} \tag{2.5.18}$$

Combining equations (2.5.16) and (2.5.18) we get an expression for the share of spending on public good k

$$s_k^g = \frac{c_k g_k P^C}{TS} = \frac{\sum_i \phi_i \tilde{s}_i \theta_i^k}{\sum_k \sum_i \phi_i \tilde{s}_i \theta_i^k} \tag{2.5.19}$$

The intuition for equation 2.5.19 is similar to that for the optimal provision of each public good (equation 2.5.15). Those groups that represent a large share of the electorate (a high $\tilde{s}_i$)) or have a high proportion of swing voters (a high ϕ_i) will have a higher influence in determining the distribution of public goods.

Proposition 3. *A marginal increase in the urban share of group i will increase the share of spending on good k if*

$$\frac{\theta_i^k}{\sum_k \theta_i^k} > \frac{\sum_i \phi_i s_i \theta_i^k}{\sum_k \sum_i \phi_i s_i \theta_i^k} \tag{2.5.20}$$

and decrease it otherwise.

Proof. Taking the partial derivative of (2.5.19) with respect to $\tilde{s}_i$ we have

$$\frac{\partial s_k^g}{\partial \tilde{s}_i} = \frac{\theta_i^k \left(\sum_i \phi_i s_i \sum_k \theta_i^k\right) - \left(\sum_i \phi_i s_i \theta_i^k\right) \sum_k \theta_i^k}{\left(\sum_i \phi_i s_i \sum_k \theta_i^k\right)^2} \tag{2.5.21}$$

setting this expression to be greater than zero and rearranging terms we get the desired result. □

That is, in this model, an increase in the share of the electorate belonging to group i will lead to an increase in the share of public expenditures devoted to good k if the the willingness to pay for good k relative to the willingness to pay for one additional unit of all public goods for members of group i is greater than that for the average (weighted by ϕ_i) of the rest of the electorate.

2.6 Estimation

The system of equations described in equation 2.5.15 describes the equilibrium distribution for each city and year. To estimate the model I assume that marginal costs are imperfectly observed as is common in the industrial organization literature (Berry, Levinsohn, and Pakes [1995]). Then, I estimate the parameters of the model using a multi-equation nonlinear GMM approach. Below I describe the details of the estimation.

Taking logarithms on both sides of equation 2.5.15 we get

$$\ln(g_k) = \ln\left(\sum_i \phi_i \theta_k^i \mu_i\right) - \ln\left(\bar{Y} \sum_i \phi_i \mu_i \bar{y}_i\right) - \ln(c_k) \quad \text{for } k \text{ in } 1, \ldots, \text{K}. \quad (2.6.1)$$

I assume that marginal costs are imperfectly observed by the econometrician and can be modeled as

$$\ln(c_k) = x_k'\gamma + \nu_k \qquad \text{for } k \text{ in } 1, \ldots, \text{K} \tag{2.6.2}$$

where x_k is a vector of variables affecting the marginal costs. Furthermore, I allow for some preference heterogeneity by allowing the θ_i^k parameters to depend on some city characteristics $\theta_{ic}^k = \bar{\theta}_i^k + \boldsymbol{\theta}_i^k \boldsymbol{z^c}$, where $\boldsymbol{z^c}$ is a vector of city characteristics, like census region. Combining equations 2.6.1 and 2.6.2 give the estimating equations.

The taste parameters are identified by exogenous variation in the demographic shares created by the instruments discussed in section 2.4, which in turn rely on the demographic shares in 1970 being uncorrelated with the unobservable marginal cost components in the sample periods. The ϕ parameters are only identified up to scale, so for the purpose of estimation I make the normalization $\phi_1 = 1$.

Following Hansen [1982], I estimate the model by nonlinear GMM using moments from the provision of the three public goods for each city and year. Moments are given by the condition $E(\boldsymbol{v}_{ct}\boldsymbol{z}_{ct}) = 0$, where $\boldsymbol{v}_{ct} = (v_{1ct}, \ldots, v_{Kct})$ are the error terms given by equation 2.6.1, and $\boldsymbol{z}_{ct}$ is the vector of instruments for city c and year t. The GMM estimator is given by

$$\arg\min_{\boldsymbol{\beta}} \left[\sum_{t=1}^{T} \sum_{c=1}^{N} \frac{1}{NT} z_{ct} \boldsymbol{m}_{ct}(\cdot|\boldsymbol{\beta}) \right]' \boldsymbol{W} \left[\sum_{t=1}^{T} \sum_{c=1}^{N} \frac{1}{NT} z_{ct} \boldsymbol{m}_{ct}(\cdot|\boldsymbol{\beta}) \right] \tag{2.6.3}$$

where $\boldsymbol{\beta}$ denotes the vector of model parameters, $\boldsymbol{W}$ is a weighting matrix and $\boldsymbol{m}_{ct}(\cdot|\boldsymbol{\beta}) = [m^1_{ct}(\cdot|\boldsymbol{\beta}), \ldots, m^K_{ct}(\cdot|\boldsymbol{\beta})]'$ is a vector of moments for each public good k in city c and year t and

$$m^k_{ct} = -\ln\left(\sum_i \phi_i \theta^i_k \mu_i\right) + \ln\left(\bar{Y}\sum_i \phi_i \mu_i \bar{y}_i\right) + x'_k\gamma \tag{2.6.4}$$

2.7 Empirical Results

The parameter estimates of the preference parameters are shown in table 2.3. The relative magnitudes of the preference parameters are consistent with the reduced form results shown in table 2.2. Young households with children (group 1) have a strong preference for basic public goods, contrast to households with children, who have a preference for education spending. The elderly have a preference for redistributive spending followed by basic spending; they do not care much about education spending.

The model does a reasonable good job at fitting the levels of spending on the three public goods in most cities, but it cannot explain the very low and high levels of provision observed in some of the cities, especially for education spending.

Table 2.3: Estimation Results

	estimates	SE
θ_{11}	1.861	0.512
θ_{12}	5.909	0.798
θ_{13}	-4.115	1.461
θ_{21}	2.658	0.204
θ_{22}	1.312	0.189
θ_{23}	0.753	0.190
θ_{31}	0.794	1.313
θ_{32}	4.949	1.864
θ_{33}	5.637	2.587
ϕ_2	8.352	1.173
ϕ_3	0.603	0.289

Note: The first column shows the estimated preference parameters. θ_{ik} denotes the preference parameter of group i over public good k. The second column shows the standard errors.

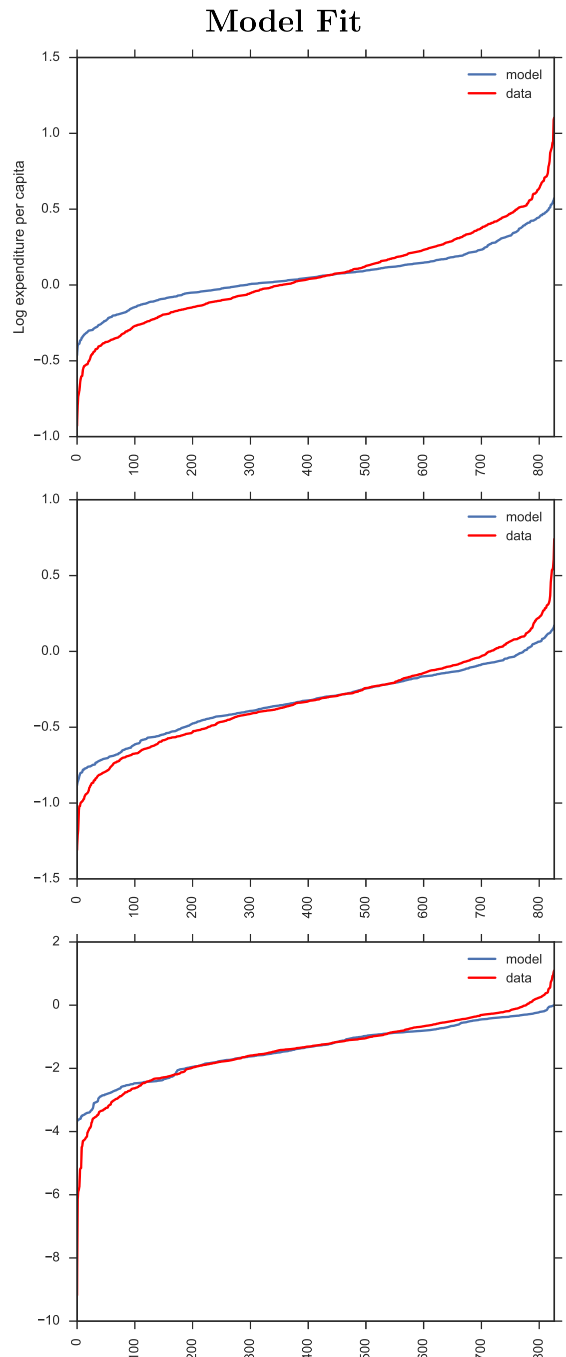

Figure 2.4: Predicted versus observed levels of log per-capita spending for all cities in the sample ranked from lowest to highest.

2.8 Policy Analysis

In this section I look at how the projected demographic changes in each city are likely to translate in changes in the level and composition of the public goods and services they provide. To do that, I estimate the growth rate of each group for each city during the period from 2000 to 2010 and use it to predict population levels in the year 2030. Using the estimated model I predict the levels of provision of each public good in that year. On average, cities are loosing households with children and gaining young households without children and empty nesters, although there is a lot of variability from city to city. On average, spending in education is going to increase slightly bu 2%, with an interquantila range ov variation of 16%. In contrast, basic public goods and redistribution expenditures are projected to increase on average in most cities by approximately 20% each.

Figure 2.6 shows the projected changes education spending per capita for all the cities in the sample. Cities for which education spending is projected to increase are characterized by a growing population of young households without children, who still value education considerably. The total effect on the distribution of public goods cannot be attributed to the population change in a single group, but instead depends on the aggregate changes of all groups. For example, consider the case of Hartford and Philadelphia. Both are expected to loose a similar share of households with children, yet Hartford will see a 38% increase in their elderly population while Philadelphia's share will only increase by 4%. Instead, Philadelphia gains 16% of young families without children to Hartford's 2%. The result is that Hartford's provision of public education is expected increase by a meager 5% whereas Philadelphia's increases by 14%.

Table 2.4 offers a comparison of five large cites: Chicago, Los Angeles, New York and San Francisco. The table shows the projected demographic changes in each of these cities along with the changes in the level and composition of public goods. In all of these cities—with the exception of San Francisco—there is a clear trend of loosing young families and gaining elderly residents. Consequently, the model predicts significant lower expenditures in education in these cities. Chicago stands out for its relatively large projected increase in childless families, which might explain the 23% expected increase in basic expenditures.

Table 2.4: Projected Public Good Provision

City	Chicago, IL	Los Angeles, CA	New York, NY	San Francisco, CA
Growth rate group 1	0.08	0.06	0.09	0.04
Growth rate group 2	-0.27	-0.07	-0.09	0.02
Growth rate group 3	0.04	0.23	0.15	0.10
Change in education (1000s)	-0.06	-0.06	-0.09	-0.01
Change in basic (1000s)	0.31	0.13	0.17	0.03
Change in redistribution (1000s)	0.01	0.39	0.14	0.12
Growth rate in education	-0.06	-0.05	-0.06	-0.01
Growth rate in basic	0.30	0.15	0.21	0.02
Growth rate in redistribution	0.06	0.50	0.19	0.12

Table 2.5: Projected demographic changes and demand for public services.

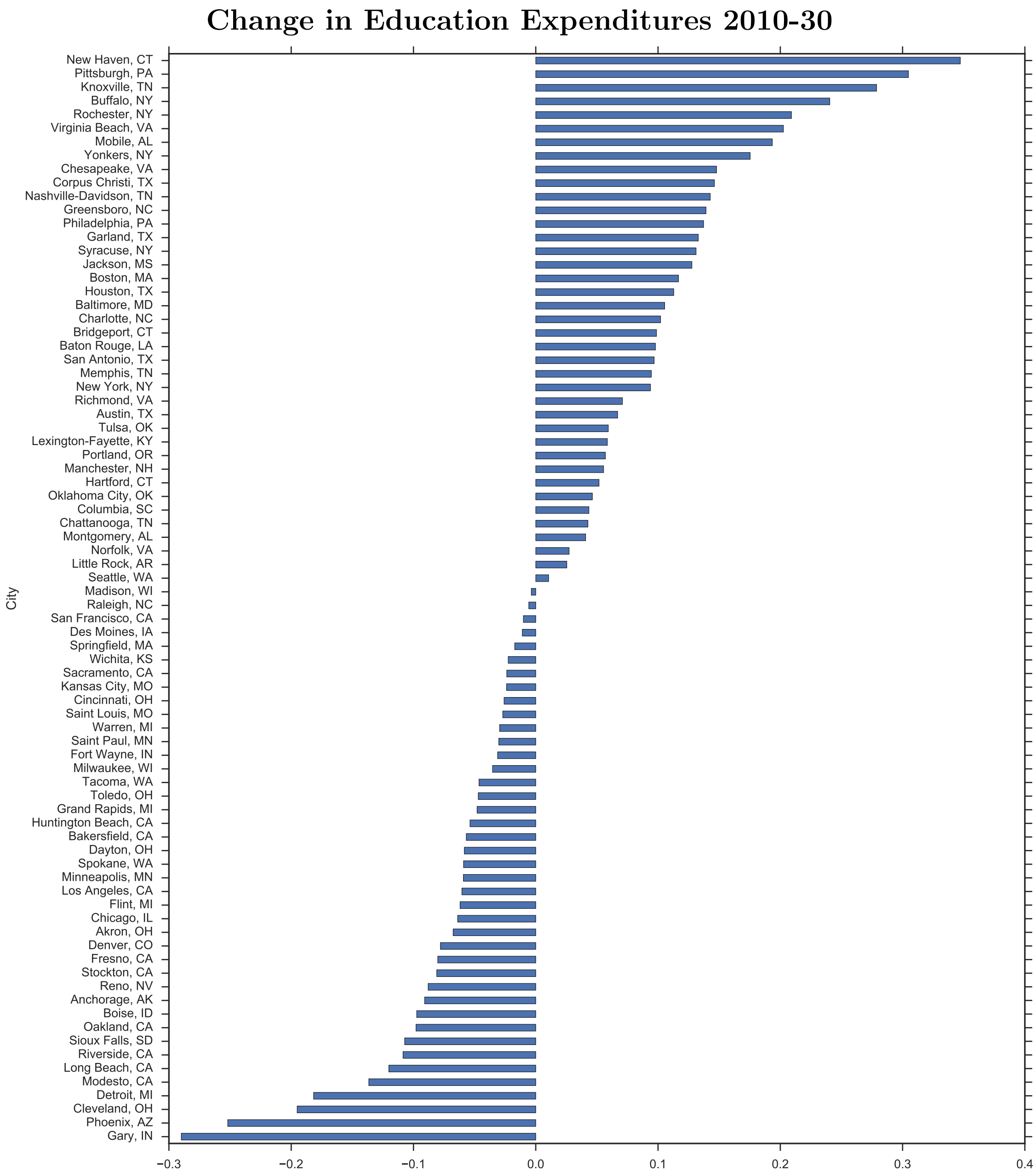

Figure 2.5: Projected changes in education expenditures for the period 2010-30.

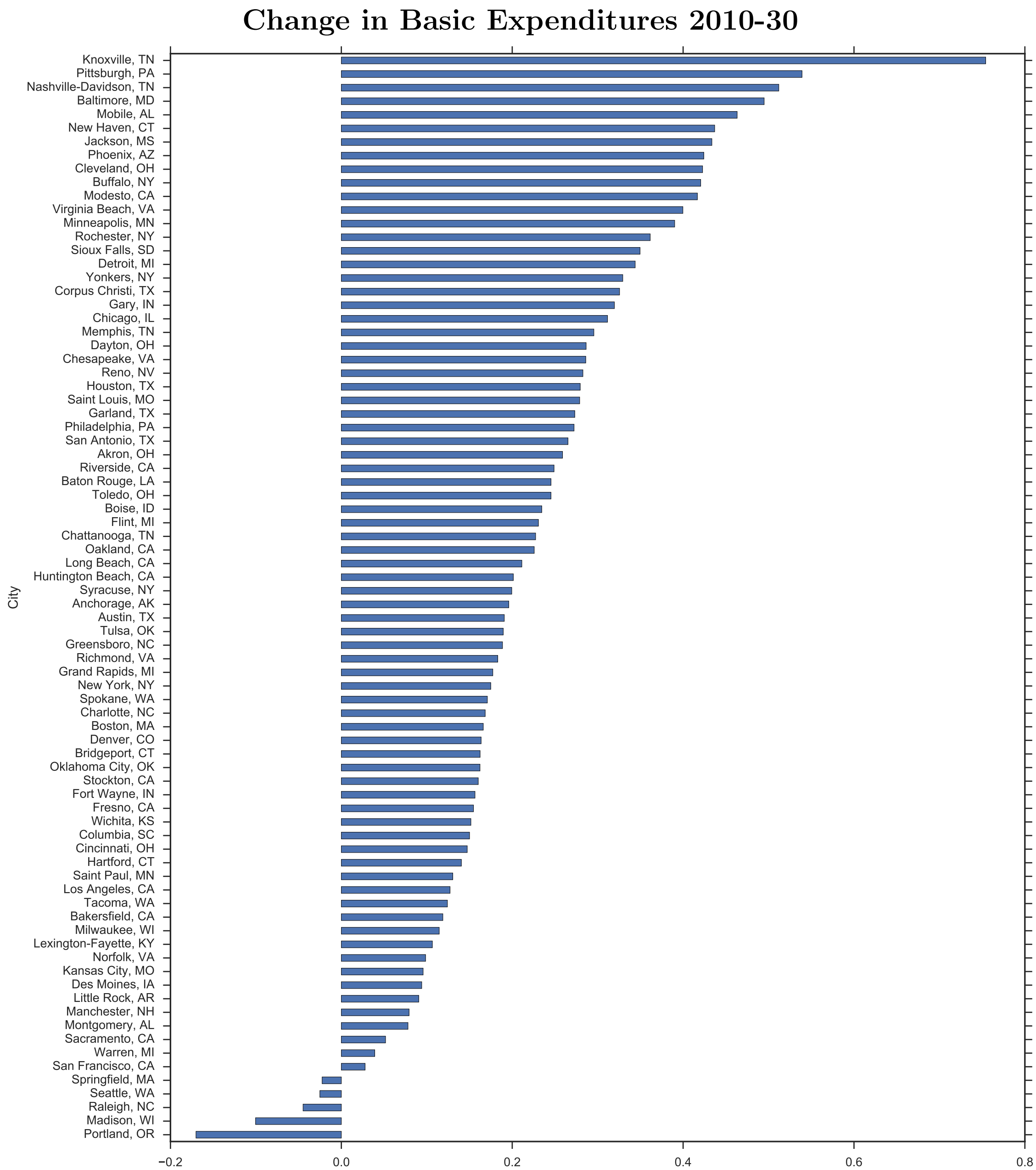

Figure 2.6: Projected changes in basic expenditures for the period 2010-30.

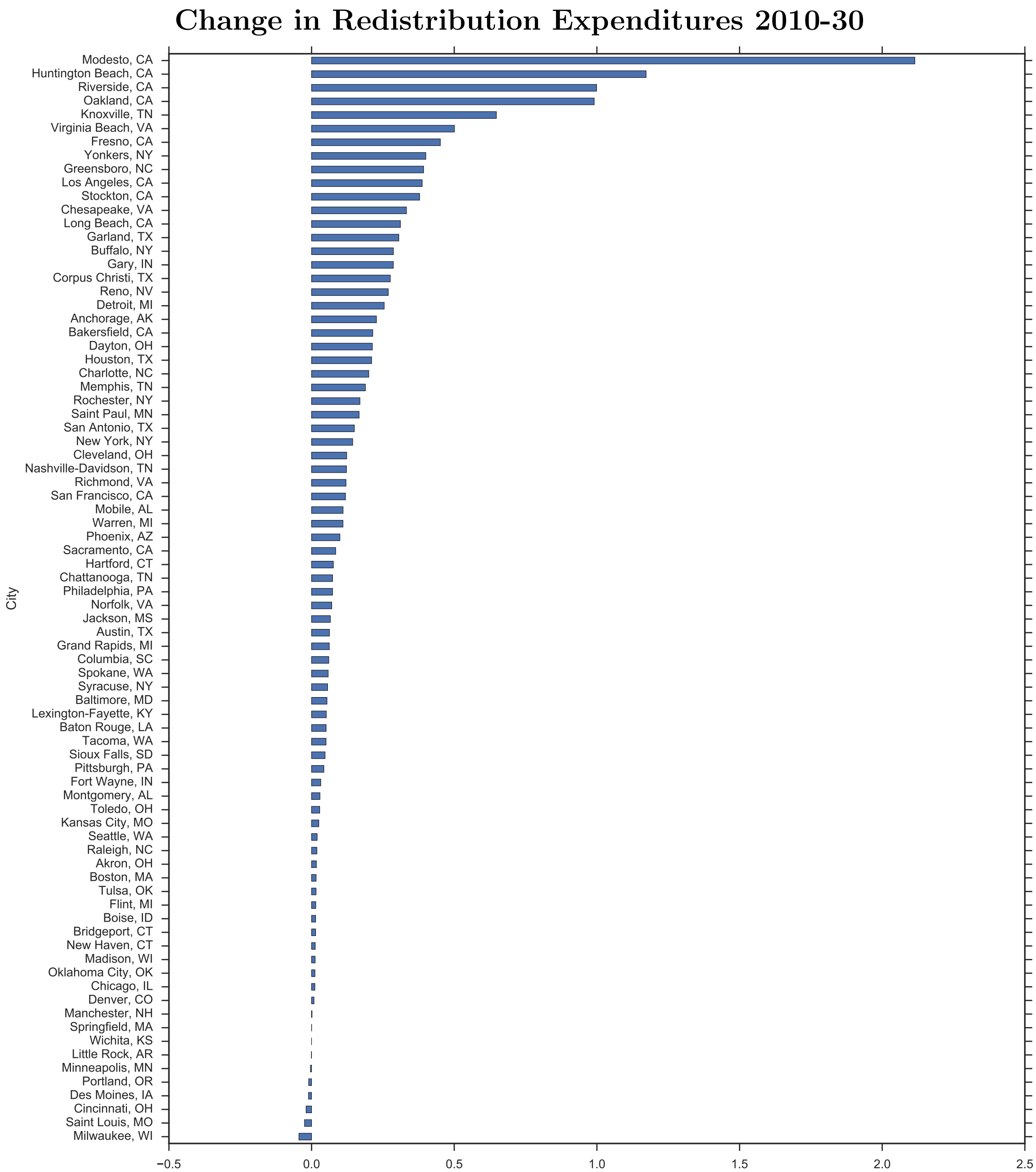

Figure 2.7: Projected changes in redistributive expenditures for the period 2010-30.

Chapter 3

Demographic Composition and Public Goods Provision in Cities

3.1 Motivation

More than half of the world population lives in cities, and more than eight out of ten Americans live in metropolitan areas, which are all centered around a city. We rely on local governments to provide a wide variety of goods and services that have a direct impact on our well being, and in the United States roughly one eighth of the national GDP is spent by local governments. A large body of research has explored the political economy of local public good provision, but not much attention has been paid to the particular problems that arise in large cities—city governments provide a large mix of public goods and have diverse constituencies that differ in more than their income [7].

Almost everybody will have to settle for a public good level and composition different from their preferred one. But unlike a country, where it is fair to assume that citizens are unlikely to move in response to changes in fiscal policy, urban residents are highly mobile. Resident's of a city can easily move away from it jurisdiction if they are unhappy with the bundle of public goods and services provided. This poses significant constraints into the provision problem. This means that the demographic composition of a city government's constituency will reflect the kind of public goods it offers since people will choose to live in the city that offers the bundle of public goods they like the most.

This two-way feedback calls for a joint analysis of public goods determination and the demographic composition of cities. This is the purpose of this chapter. I propose a new model of how the level and composition of public services are determined in a city. The model allows for an arbitrary number of groups with different preferences over public goods and within group income heterogeneity. I embed the political economy model of public good provision in the city into a location choice model between the central city and the suburbs in order to study the interactions between mobility and the political conflict over the composition of the budget.

[7] Glaeser [2012]

I develop a model of the provision of multiple public goods that allows households to belong to different groups that differ in their preferences over the size and composition of the services provided by the city. The model is, at this point, agnostic about what interpretation should be given to these groups. The most natural interpretation is that each group corresponds to different demographics—like age group, ethnicity, religion, family structure, etc. Preferences over the size of the budget and how it should be split will depend on the income of the voter and her group. At the end of the day, public policy is decided through a democratic precess that aggregates all these preferences. But of course, nobody is forced to live int the city. If households are not happy with the current services provided, or with the price of housing, and can get a higher utility elsewhere they will move out. By doing so they will change the demographic composition and the income distribution of the electorate and, hence, the bundle of services that is decided. I assume that the local government finances its expenditures only with a property tax. Even though local governments use a number of revenue instruments, local taxes are the most commonly used.

I solve the model numerically and conduct a series of comparative statics experiments. First, I look at the effect of changing the demographic composition of the city when there is no outside option—no mobility is allowed. I then allow households to belong to different groups that are differentiated in their preferences for different public goods, and endogenize the demographic composition of the city by allowing them to choose between living in the city or in the suburbs. I consider the case of two demographic groups and two public goods living in a metropolitan area with one central city. There is a majority and a minority group with the majority representing 80% of the population in the metropolitan area. To understand how preference heterogeneity affects the demographic composition of the city and the distribution of public goods offered I gradually increase the degree of dispersion in preferences starting from the case of complete agreement—all groups value the two goods the same way—to the case in which they have completely opposed preferences. This leads to a surprising result: preference dispersion has a U-shape effect on total public expenditures in the city. At first, when the two demographic groups start to diverge in their preferences, the equilibrium mix of public goods moves away from the ideal mix of each group. This leads to a lower support for public spending as households want to substitute public goods for private consumption. At the same time, the demographic composition of the city begins to change as well as some of the richer households in the majority move to the suburbs. Eventually, as preferences continue to diverge, the city becomes more homogeneous with rich households from the majority moving into the city and households in the minority leaving to the suburbs. This increased homogeneity changes the political balance in the city and the mix of public goods offered. Eventually, this mix gets closer and closer to the ideal of the majority group and households vote to substitute private consumption for public goods, thus leading to an increase in the size of total expenditures.

The structure of the chapter is a s follows. Section 3.3 develops the model and derives some comparative statics. In section 3.4 I explore some of the properties of the model through some numerical exercises.

This chapter is related to several strands of literature. It borrows most of its economic environment from models of inter jurisdictional sorting, as the ones that followed from Epple and Romer [1991]. The main idea behind these papers is that households are mobile and choose in which community to live based on the available combination of housing prices, taxes, amenities, and public goods. Housing prices result from local housing markets that must clear in all communities. The level of public good in each community is chosen by majority rule and reflects the tastes and endowments of the residents of the community. In most of these models, households differ only in their income endowments, which are exogenous. Equilibrium in these models is characterized by income stratification across communities. When households only differ in their income levels, this stratification is stark; meaning that there is no overlap in the incomes of any pair of communities.

Inter-jurisdictional sorting models, or Tiebout models, as they are also known, have been used in a wide array of applications. Epple and Romer [1991] use their model to study how local governments might engage in redistributive policies when households are mobile. They use a calibrated version of their model to argue that significant levels of redistribution can be achieved even at the local level. **?** use a Tiebout model to understand what are the incentives at play behind zoning ordinances and what are their welfare effects. Kerry Smith, Sieg, Spencer Banzhaf, and Walsh [2004] estimate a Tiebout model to measure the welfare effects of environmental improvements.

This chapter has in common with this literature the fact that each community's public good offer depends on the demographic characteristics of the electorate through a social choice mechanism. Generally these papers can only deal with very restrictive forms of heterogeneity across households and assume some preference restrictions that lead to a median voter result. My model differs with the inter jurisdictional sorting models in that I only have one community—the central city—and an outside option—the suburbs—that serves the purpose of endogeneizing the city's population.

The spatial structure used in this chapter is similar to the one used in the urban models of the quality of life started by Rosen [1979] and Roback [1982]. The purpose of these models is to explain the observed differences in wages, rents and amenities across cities. To do so, they comprise equilibrium conditions for households and firms: identical households must derive the same level of utility no matter where they live, and firms must get the same profits in all locations. Were this not to be the case, households and firms would relocate, moving to the places that offer them higher payoffs. In doing so, they would drive housing prices up and push down wages until utilities are equalized. These models make predictions on city's wages and housing prices as functions of city's characteristics, such as amenities and land endowments.

More recently, Diamond [2013] uses a similar framework to estimate a structural model of cities. She extends the standard model of a system of cities to allow workers to have heterogeneous preferences for locations. She uses her estimated model to asses the extent to which differences in amenities were responsible for differentially driving skilled and non-skilled workers to different cities. For the estimation of her model she uses a discrete choice approach similar to the one proposed by Berry et al. [1995]. Preference parameters are identified by local demand shocks that depend on the industry mix of each city (the mix between skilled and non-skilled labor) and their interaction with housing supply elasticities. The idea behind her identification strategy is that cities' wages and rents will respond differently to demand shocks depending on their housing elasticity. Workers migration decisions will then respond to these changes in wages, rents and endogenous amenities pinning down their preference parameters.

The model in this chapter is also related the literature on ethnic conflict. For example, the paper by Alesina et al. [1999] can be seen as an application of my model. They propose a simple model that relates ethnic fractionalization to the provision of public goods. The main prediction of the model is that higher fractionalization leads to lower provision of publics goods. They test this prediction looking at county, city, and metropolitan area data in the US and find that this is actually the case.

This chapter uses the idea of *structure induced equilibrium* developed by Shepsle [1979b] to obtain a political equilibrium with a multi-dimensional policy space and extends it to allow for multiple groups with distinct preferences. The basic idea is that voting takes place in each dimension separately and simultaneously, taking as given the provision of all the other public goods. The outcome in each dimension is determined by a majority rule. This gives a *reaction function* for each policy. The equilibrium concept employed is that each of these reaction functions must be an optimal response. In other words, the political equilibrium is the fixed point of the optimal response mapping. When households belong to different groups with different preferences there will not be a decisive voter. Instead, the political equilibrium in each dimension will be characterized by two opposing coalitions of voters from the different demographic groups present (though not all groups need to be part of each coalition) such that the coalition favoring higher provision has the same size as the coalition favoring less provision.

In the first model I propose, with only income heterogeneity, enough restrictions are placed on the preferences of voters to obtain a median voter result without the need to use a structure induced equilibrium. The theoretical underpinning of this approach was developed by Grandmont [1978]. The key idea in this model is that all the heterogeneity in preferences can be collapsed into a single dimension, like income. To my knowledge, this is the first application of Grandmont [1978] in the context of local public good provision.

3.2 Model with a Single Type

There is a continuum of households differentiated by their level of income y. Income is distributed according to the distribution function $F(y)$ with density $f(y)$. There exists a single, featureless city, in the economy. Households that live in the city get utility from the consumption of housing services h, and a private composite good b. In addition, households also value consumption of public goods that are offered by the metropolitan government and financed by taxes levied on its residents. I will focus on property taxes since this is the preferred instrument to finance local government services in the US. Tax rates and the level of provision of public goods are decided simultaneously by majority voting among the urban population.

Households that choose not to live in the city get a reservation utility level. I provide more details about the notion of spatial equilibrium I use below. I start by characterizing the equilibrium in the closed city, when people can not move out of the city.

3.2.1 Preferences

I assume utility from public goods consumption are multiplicatively separable from utility from housing services and the private good, and are given by the utility function

$$U(g, h, b) = J(g) \{v(h, b) + C\}$$

where $J(g)$ is increasing and concave, $v(h, b)$ is homogeneous of degree δ in h and b, and concave in both arguments, and C is a constant. This constant can be rationalized by having a function $v(h, b)$ of the Stone-Gary form that requires households to consume some subsistence levels of housing and private good. As argued in Calabrese, Cassidy, Epple, Alesina, and Cullen [2002], the homogeneity assumption is widely used in the optimal taxation literature, in dynamic simulation models, and in a variety of other applications in economics.

Households decisions must satisfy the following budget constraint

$$y = (1 + t)\, p^h h + b$$

where p^h is the suppliers price of housing. Lets denote the gross price of housing by $p := (1 + t)\, p^h$, where t is the tax rate on housing services.

I assume the following timing of events:

1. Household decide whether to live in the city and, if so, they decide how much housing services to consume. The housing market clears.

2. Urban households vote on the level of public goods and the tax rate.

3. Consumption of the private composite good takes place.

This timing assumption implies that at the time of voting the urban population is fixed.

These timing assumptions are common in the literature studying public good provision with mobility, as in Fernandez and Rogerson [1996].

3.2.2 Housing Demand and Supply

When deciding how much housing and private good to consume, households solve the following maximization problem

$$\max_{h,b} U(g,h,b) = J(g)\{v(h,b)+C\}$$

$$s.t. \quad y = (1+t)\,p^h h + b$$

Next, I use some well known properties of systems of demand with homothetic preferences to get to an expression of the indirect utility function. Taking first order conditions we have that

$$\begin{aligned} J(g)\,v_h(h,b) &= \lambda p \\ J(g)\,v_b(h,b) &= \lambda \end{aligned}$$

From which we can obtain an expression for the marginal rate of substitution between housing and private good consumption

$$MRS_{hb}(h,b) := \frac{v_h(h,b)}{v_b(h,b)} = p$$

where we define $p := (1+t)\,p^h$ as the gross of tax housing price. Using the fact that $v_h(h,b)$ and $v_b(h,b)$ are both homogeneous we find that MRS_{hb} depends only on the ratio of housing to private good consumed

$$MRS_{hb}(h/b) = \frac{\left(\frac{1}{b}\right)^{\delta-1} v_h(h,b)}{\left(\frac{1}{b}\right)^{\delta-1} v_b(h,b)} = \frac{v_h(h/b,1)}{v_b(h/b,1)} = p$$

Since nothing in the above equation depends on y, we have that all households will consume housing and private good in the same proportion regardless of their income. In other words, $h/b = \phi(p)$ for all households, where $\phi(p)$ is a positive decreasing function of the tax rate. Plugging in the budget constraint we can write

$$\frac{h}{y - ph} = \phi(t) \Leftrightarrow h(p, y) = \left(\frac{\phi(p)}{1 + \phi(p)p}\right) y = \xi(p)\, y$$

where $\xi(p) := \left(\frac{\phi(p)}{1+\phi(p)p}\right)$. Thus, demand is linear in income y.

The aggregate housing demand in the community is

$$H^d(p) := \int_N h(p, y) f(y)\, dy = \xi(p) \int_N y f(y)\, dy = \xi(p)\, E_N y$$

where $E_N y$ is the average income in the city.

The indirect utility function is defined as

$$V(g, p, y) := U(g, h^*(p, y), y - ph^*(p, y)),$$

so in our case we get

$$\begin{aligned} V(g, p, y) &= J(g)\{v(h^*(p, y), y - ph^*(p, y)) + C\} \\ &= J(g)\{v(\xi(p)y, y - p\xi(p)y) + C\} \\ &= J(g)\left\{v(\xi(p), 1 - p\xi(p))\, y^\delta + C\right\} \\ &= J(g)C + y^\delta \{J(g)\, v(\xi(p), 1 - p\xi(p))\} \end{aligned}$$

Housing is supplied in each community by competitive developers according to the following supply function

$$H^s\left(p^h\right) = Lh^s\left(p^h\right)$$

where $h^s\left(p^h\right)$ is the housing supplied per unit of land in the community. The price of housing, p^h, is found at the intersection of housing supply and the aggregate housing demand

$$Lh^s\left(p^h\right) = \int_N h\left(p, y\right) f\left(y\right) dy$$

3.2.3 City Government

The city government's budget constraint is given by

$$c\left(g, N\right) = tp^h \int_N h\left(p, y\right) f\left(y\right) dy = tp^h H\left(p\right)$$

where $c\left(g, M\right)$ is the monetary cost of providing the bundle of public goods g in a city with a population of M. In the comparative static exercises I do, I consider a linear cost function in the amount of public goods provided that doesn't depend on the size of the population. This is easy to relax. Given that this model includes several public goods there are many interesting questions one could ask about the technology to provide these goods.

3.2.4 Political Equilibrium

Urban residents must vote on the size of the public budget, as given by the tax rate that they decide, and on the composition of government expenditures, as given by the vector of local public goods $g = (g_1, g_2, \ldots, g_K)$. This is a multi-dimensional voting problem which, in general, does not have an equilibrium. In this case, though, the assumptions made on households preferences are enough to guarantee that a majority voting equilibrium exists and is given by the desired public bundle of the median income household.

In particular, the indirect utility function that I derived above falls into the class of *intermediate form* preferences described by Grandmont [1978]. This is also known in the public choice literature as an "order restriction" assumption.

Voters understand the relationship between policy bundles and the gross-of-tax cost of housing as given by the city's budget constraint. It is convenient to rewrite this constraint by using in the definition of the gross-of-tax price of housing to substitute out the tax rate. Doing so we get

$$p = p^h + \frac{c\left(g, N\right)}{H^s\left(p^h\right)}.$$

Each voter's preferred policy bundle is then given by the following maximization problem

$$\max_g V(g,p,y) = J(g)\,C + y^{\delta}\left\{J(g)\,v(\xi(p), 1 - p\xi(p))\right\}$$
$$s.t. \qquad p = p^h + \frac{c(g,N)}{H^s(p^h)}$$

For simplicity, I assume obtain their housing services from absentee landlord, who are not present in the city (exogenous to the model) and who do not vote. This assumption is very common in the literature

If we plug the community's budget constrain we get an expression of the indirect utility function that looks like this

$$W(g,y) := J(g) + y^{\delta} H(g)$$

This preferences are a special case of what is known as "intermediate preferences" which are preferences that can be written as

$$W(q,\alpha) = J(q) + K(\alpha)\,H(q;)$$

where q can be a multidimensional object, and $\alpha \in \mathbb{R}$ is the only source of heterogeneity among voters. Furthermore, $K(\alpha)$ needs to be a monotonic function of any degree, and J and H common to all voters. (Persson and Tabellini [2002])

The next proposition shows that the preferred policy of the median voter is the majority voting equilibrium when preferences are of the intermediate form.

Proposition 4. *A Condorcet winner exists and it coincides with the bliss point of the voter with median income y^m.*

Proof. The proof is based on a separation argument similar to the one used to show the median theorem with single-crossing preferences (Gans and Smart [1996]).

For any bundle of public goods $g \neq g^m$ it must be the case that

$$W(g^m, y^m) = J(g^m) + y^m H(g^m) \geq J(g) + y^m H(g) = W(g, y^m).$$

Rearranging terms we have

$$y^m \lesseqqgtr \frac{J(g) - J(g^m)}{H(g^m) - H(g)} \text{ if } H(g) - H(g^m) \lesseqqgtr 0.$$

If $H(g) - H(g^m) > 0$, then for all $y > y^m$

$$y > y^m \geq \frac{J(g) - J(g^m)}{H(g^m) - H(g)}$$

so that

$$W(g^m, y) = J(g^m) + yH(g^m) > J(g) + yH(g).$$

A similar argument can be made for the case in which $H(g) - H(g^m) < 0$. This means that the preferred policy of the median voter always gets the support of at least half the electorate. □

Next I provide an alternative proof of this result with a nicer geometric interpretation.

Proof. Take any pair of public goods bundles g and g', and define the set of voters that prefer g over g' as

$$\begin{aligned} H &:= \{y : W(g', y) \leq W(g, y)\} \\ &= \{y : J(g') + yH(g') \leq J(g) + yH(g)\} \\ &= \{y : y(H(g') - H(g)) \leq J(g) - J(g')\} \end{aligned}$$

and the set of those who prefer g' over g as

$$H' := \{y : y(H(g') - H(g)) \geq J(g) - J(g')\}$$

If H and H' are convex, then it must be the case that the median voter is decisive. Take $y_0, y_1 \in H$. Then,

$$\begin{aligned} J(g') + (\theta y_0 + (1-\theta) y_1) H(g') &\leq J(g) + (\theta y_0 + (1-\theta) y_1) H(g) \\ \Leftrightarrow (\theta y_0 + (1-\theta) y_1)(H(g') - H(g)) &\leq J(g) - J(g') \end{aligned}$$

which is true since y_0 and y_1 are in H. Hence H is a convex set. A similar argument can be used to show that H' is also convex. □

The assumption of intermediate preferences is related to the assumption of single-crossing preferences, i.e. the requirement that

$$\frac{\partial^2 V}{\partial y \partial g_i} > 0 \quad \text{for all}\, i = 1, \ldots, n$$

although it is less general. As single-crossing, it works because it reduces the heterogeneity in preferences created by having a multidimensional policy space to a single dimension of individual heterogeneity (income, in our case). Then, a standard separation argument can be used. This separation is emphasized in the second proof, in which the Condorcet winner is essentially a bundle of publics goods that divides the electorate in equal parts. No voter is particularly happy with it, but no majority of voters can be found that would support an alternative policy.

Next I discuss how the equilibrium is characterized in the closed city, when the population in the city is fixed, and then I incorporate the conditions that guarantee a spatial equilibrium when households choose whether to live in the city or not.

3.2.5 Equilibrium in the Closed City

An equilibrium in the closed city, i.e. when individuals cannot choose to live outside the city, is a tuple $(\boldsymbol{g}^*, p_h^*, t^*)$ such that

1. The housing market clears:

$$H^s\left(p_h^*\right) = \mu \int_{\underline{y}}^{\bar{y}} h\left(p^*, y\right) f\left(y\right) dy,$$

2. Given p_h^* , there is a majority voting equilibrium, i.e. $(\boldsymbol{g}^*, t^*)$ is the preferred

policy of the median voter,

$$\begin{aligned} \boldsymbol{g}^*, p^* &= \arg\max_{\boldsymbol{g},p} V\left(\boldsymbol{g}, p, y^{med}\right) \\ & s.t. \quad p = p_h^* + \frac{c\left(\boldsymbol{g}, M\right)}{H^s\left(p_h^*\right)} \end{aligned}$$

3. The city runs a balanced budget:

$$c\left(\boldsymbol{g}^*, M\right) = t^* p_h^* H^s\left(p_h^*\right)$$

3.2.6 Equilibrium in the Open City

When households can choose whether to live in the city or not, the size of the urban population and the urban income distribution will depend on the bundles of consumption that are available in the city, including the public goods that are provided by the city's government.

Before I explain the notion of spatial equilibrium used in the model, it is necessary to introduce some new notation. Let $f^{msa}(y)$ be the income distribution in the metropolitan area—the central city and its suburbs—and $f(y)$ be the income distribution in the city. Furthermore, let $\Pr(city \mid y)$ be the probability that an individual with income y will choose to live in the city. The relationship between the urban and the economy-wide income distributions is given by

$$f(y) = \frac{\Pr(city \mid y) f^{msa}(y)}{\int_{\underline{y}}^{\bar{y}} \Pr(city \mid y) f^{msa}(y)\, dy}.$$

$\Pr(city \mid y)$ will depend on the equilibrium objects that characterize the equilibrium in the closed city, and on the particular notion of spatial equilibrium being used. I will assume that households that choose not to live in the city receive a reservation utility $\bar{u}(y)$ that may depend on their income. The value of living in the city for an individual with income y is given by the indirect utility

$$V^*(y) := V(\boldsymbol{g}^*, p_h^*, y).$$

Furthermore, in order to describe the urban population as a probability I assume that households get a random, choice specific value that is identically distributed and does not depend on income.

The probability of living in the city for an individual with income y is then given by

$$\begin{aligned}\Pr(city \mid y) &= \Pr(\bar{u}(y) + \epsilon^o \leq V^*(y) + \epsilon^c \mid y) \\ &= \Pr(\epsilon^o - \epsilon^c \leq V^*(y) - \bar{u}(y) \mid y).\end{aligned}$$

Under the additional assumption that the shocks are distributed as Type-I extreme value, as is usual in discrete choice models, we have a closed form expression for the above probability:

$$s(y) := \Pr(city \mid y) = \frac{\exp\{V^*(y)\}}{\exp\{V^*(y)\} + \exp\{\bar{u}(y)\}}$$

where $s(y)$ is the notation I will use to refer to the urban share of individuals with income y.

Putting it all together, we can define an equilibrium in the open city is a tuple of prices, taxes and public goods $(p_h^*, \boldsymbol{g}^*)$ such that

1. The housing market clears:

$$H^s(p_h^*) = \mu \int h(p^*, y) f(y)\, dy$$

2. There is a political equilibrium in the city:

$$\begin{aligned} \boldsymbol{g}^*, p^* &= \arg\max_{\boldsymbol{g},p} V\left(\boldsymbol{g}, p, y^{med}\right) \\ s.t. \qquad & p = p^h + \frac{c(g, N)}{H^s(p^h)} \end{aligned}$$

3. The city government runs a balanced budget:

$$c(\boldsymbol{g}^*, M) = t^* p_h^* H^s(p_h^*)$$

4. The urban shares for each group and income are given by

$$s(y) = \frac{\exp\{V(\boldsymbol{g}^*, p^*, y)\}}{\exp\{V(\boldsymbol{g}^*, p^*, y)\} + \exp\{\bar{u}(y)\}}$$

which implies that the urban income distributions are given by

$$f(y) = \frac{s(y) f^{msa}(y)}{\int s(y) f^{msa}(y)\, dy} = \frac{s(y) f^{msa}(y)}{s},$$

the median voter in the city is is given by

$$\int_{\underline{y}}^{y^{med}} f(y)\, dy = \frac{1}{2},$$

and the size of the city is

$$M = N \int_{\underline{y}}^{\bar{y}} s(y)\, f^{msa}(y)\, dy.$$

3.3 Model with Several Types

Keeping the same environment as above, I now allow households to belong to different groups who differ amongst themselves in their preferences for public goods. Let there be I groups indexed by i. Each group has mass μ_i, and is allowed to have a different income distribution $F_i(y)$ with density $f_i(y)$, and support $\left[\underline{y_i}, \bar{y}_i\right]$.

Preferences are still given by a utility function of the form

$$U(g, h, b) = J_i(g) \{v(h, b) + C\}$$

where the difference with respect to the previous section is that $J_i(g)$ can be different in each group. Note that the notion of political equilibrium that I use in this section does not rely on the median voter being decisive, as I will explain later. This means that there is no reason to restrain ourselves to a utility function that leads to intermediate form indirect utility. This opens the possibility to study the political conflict over other issues apart from public goods, like for instance with what tax instruments should the city finance its budget, or the amount of redistribution at the local (or national) level. These extensions are left for future research.

I show in the next section that a majority equilibrium still exists when voters from all groups vote on each dimension separately.

Housing market clearing is now given by

$$Lh\left(p^h\right) = \sum_{i=1}^{G} \mu_i \int h_i\left(p, y\right) dF_i\left(y\right)$$

where $h_i\left(p, y\right)$ is the housing demand of and individual of group i with income y.

3.3.1 Political equilibrium

I now turn to discuss how one can characterize the voting equilibrium in this environment. With more than one group we cannot appeal to the median voter result we derived in the previous section. Instead I will use a result by De Donder [2013] to show that we can still find a Condorcet winner when all the groups vote simultaneously on a single issue, provided that the preferences of each group satisfy the single-crossing condition. I then impose that election outcomes in all dimensions be consistent with each other, in a way similar to the requirement of mutual best response of a Nash Equilibrium. This is known in the voting literature as a structure induced equilibrium, a concept that was first introduced by Shepsle [1979a].

Assumption 5. *For each group i, the indirect utility function satisfies the single-crossing condition*

$$\frac{\partial^2 V_i(\boldsymbol{g}, p_h, y)}{\partial y \partial g_k} > 0 \quad \textit{for all} \quad k = 1, \ldots, K.$$

Assumption 5 requires that the marginal rate of substitution between different public goods be increasing in income. This condition is equivalent to an ordering restriction on the preferences represented by the utility function. In particular it demands that the preference relation between any pair of alternatives g and g' not be weakened by increasing y.

Consider the voting problem on a given dimension when quantities for all other public goods are held constant. Lets denote by $B_i^k(y, g_{-k})$ the preferred level of public good g_k for a voter with income y when the level of all other public goods is g_{-k}. In other words,

$$\begin{aligned} B_i^k(y, g_{-k}) : &= \arg\max_{g_k} V_i(g_k, g_{-k}, p, y) \\ s.t. \quad & p = p^h + \frac{c(g, N)}{H^s(p^h)} \end{aligned}$$

It can be shown that $B_i^k(y, g_{-k})$is a continuous and increasing function (the fact that it is increasing follows from Theorem 1 in Milgrom and Shannon [1994]. The range of $B_i^k(y, g_{-k})$ is given by $\left[\underline{g_i}^k, \bar{g}_i^k\right]$ where $\underline{g_i^k} := B_i^k\left(\underline{y_i}, g_{-k}\right)$, and $\bar{g}_i^k := B_i^k(\bar{y}_i, g_{-k})$.

For each public good, we want to characterize the number of voters that would oppose an increase in its provision. Suppose that for a given level of public good k, say $\tilde{g}_k$, we can find a type $\tilde{y}_i$ in all groups such that she most prefers that level of public good, i.e. $\tilde{g}_k = B_i^k(\tilde{y}_i, g_{-k})$ for all i. Then, a separation argument can be used, as in Gans and Smart [1996], to show that in each group, all individuals with income higher than $\tilde{y}_i$ will prefer higher levels of public good k than $\tilde{g}_k$, and the opposite for all those individuals poorer that $\tilde{y}_i$. If we find a level $\hat{g}_k$ such that half of the electorate wants less and half wants more, then we will have found a Condorcet winner for that dimension.

In looking for a Condorcet winner we need to be able to back up the type of the individuals that most prefer a given level of public good. For this purpose it is useful to define the following function:

$$y_i^*(g, g_{-k}) := \begin{cases} \tilde{y}_i \geq \underline{y_i} & \text{if} \quad g = \underline{g_i^k} = 0, \\ \underline{y_i} & \text{if} \quad 0 < g \leq \underline{g_i^k}, \\ \left(B_i^k\right)^{-1}(g, g_{-k}) & \text{if} \quad \underline{g_i^k} < g < \bar{g}_i^k, \\ \bar{y}_i & \text{if} \quad \bar{g}_i^k < g, \end{cases}$$

where $\tilde{y}_i := \sup\left\{y : B_i^k(y, g_{-k}) = 0\right\}$ is the richest individual that prefers a level of zero for public good k. For g inside the range of $B_i^k(y, g_{-k})$, $y_i^*(g, g_{-k})$ is the income of the household in group i that prefers a level g of the k^{th} public good the most. For values of g that fall outside the range of $B_i^k(y, g_{-k})$, $y_i^*(g, g_{-k})$ is set to equal the bounds of the income support.

Consider the example in Figure 3.1. There we have the bliss point functions over a public good g for two groups. All individuals from group 1 richer than $y_1^*(6)$ will vote for $g = 6$ when paired against any $g < 6$, and so will all voters from group 2 richer than $y_2^*(6)$. If it turns out that those individuals richer than $y_1^*(6)$ and $y_2^*(6)$ in their respective groups add up to half of the electorate, then $g = 6$ will have a majority of votes against any $g < 6$ from the richer individuals. Similarly, any $g > 6$ will be defeated by the coalition of voters below $y_1^*(6)$ and $y_2^*(6)$ in their respective groups.

The assumption that $B_i^k(y, g_{-k})$ is monotonically increasing is not restrictive and is easily relaxed. The only important thing is that it must be continuous.

The following proposition shows that a majority-voting equilibrium exists when voting on each dimension separately[8].

[8] As a final note, I want to point out that the method to find a Condorcet winner described in this section is not much different than the one described in Epple, Romer, and Sieg [2001]. In their paper households are characterized by an income y and a value α that describes the intensity of her preferences towards the unique public good provided by a local government. The two dimensions of heterogeneity are assumed to be jointly distributed with a pdf $f(y, \alpha)$. Then, they prove that a bundle (g^*, p^*) is a majority-rule equilibrium in a given community j if we can find $\tilde{y}^j(\alpha)$such that:

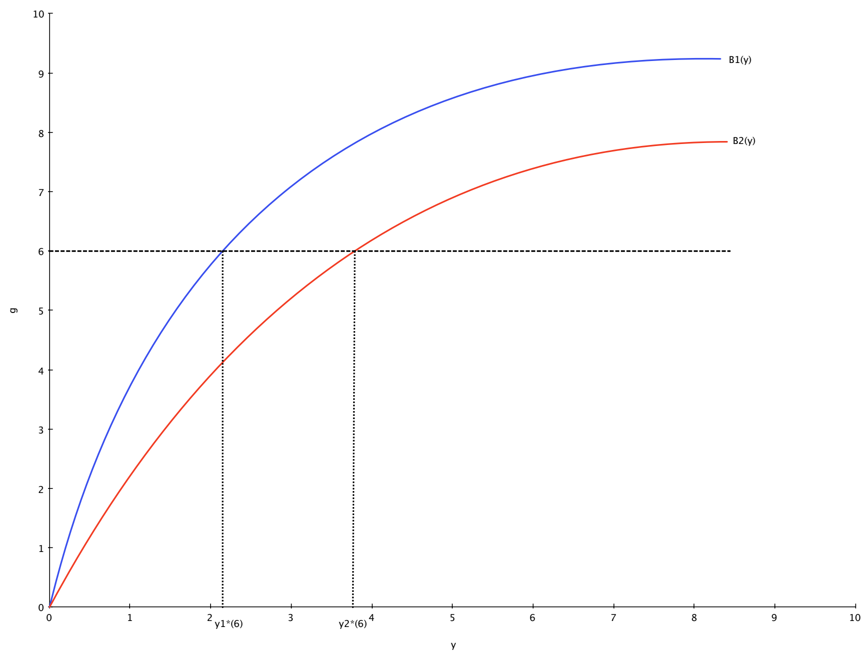

Figure 3.1: Bliss point functions for two groups.

Proposition 6. *The Condorcet winner when all groups vote on g_k holding g_{-k} constant exists and is given by g_k^* such that*

$$\sum_{i=1}^{I} \mu_i F_i \left(y_i^* \left(g_k^*, g_{-k} \right) \right) = \frac{1}{2} \left(\sum_{i=1}^{I} \mu_i \right)$$

---

1. (g^*, p^*) satisfies the community's government budget constraint (GBC),

2. $\mathrm{V}\big(p^*, g^*, \tilde{y}^j(\alpha), \alpha\big) \geq V\left(p, g, \tilde{y}^j(\alpha), \alpha\right)$ for all (p, g) that satisfy the GBC and for all $\alpha \in \left[\alpha_j, \alpha^j\right]$,

3. $\int_{\alpha_j}^{\alpha^j} \int_{y^{j-1}(\alpha)}^{\tilde{y}^j(\alpha)} f(y, \alpha)\, dy d\alpha = \frac{1}{2} \int_{\alpha_j}^{\alpha^j} \int_{y^{j-1}(\alpha)}^{y^j(\alpha)} f(y, \alpha)\, dy d\alpha.$

If we consider α being a discrete variable and, consequently, write a sum in place of the outer integral, we would get a similar expression as the one in this chapter. In that case, $\tilde{y}^j(\alpha)$ would be analogous to my $y_i^*(g^*)$ function.

The next step is to characterize the political equilibrium when individuals vote on all dimensions. Let $C^k(g_{-k})$ be the Condorcet winner when vote on the k^{th} dimension. A structure induced equilibrium is then defined as a tuple $(p^*, g_1^*, \ldots, g_K^*)$ such that for a given p_h

$$g_k^* \in C^k\left(g_{-k}^*\right) \quad \text{for all} \quad k = 1, \ldots, K,$$

and the city's budget constraint is satisfied

$$p^* = p_h + \frac{c(\boldsymbol{g}^*, M)}{H^s(p_h)}.$$

Example of voting equilibrium

To see how this might look like consider Figure 3.2. In this example group 1 is the majority, representing 70% of the electorate. As you can see in the left panel, basically the entire population of group 2 would like a level of g_1 lower that 10. Yet they are forced to swallow a slightly higher level of that public good since most of group 1 wants a level higher than $g_1 = 10$. The right panel shows the structure induced equilibrium. The blue line represents the Condorcet winners for g_1 for a given value of g_2. The red line is its counterpart for g_2.

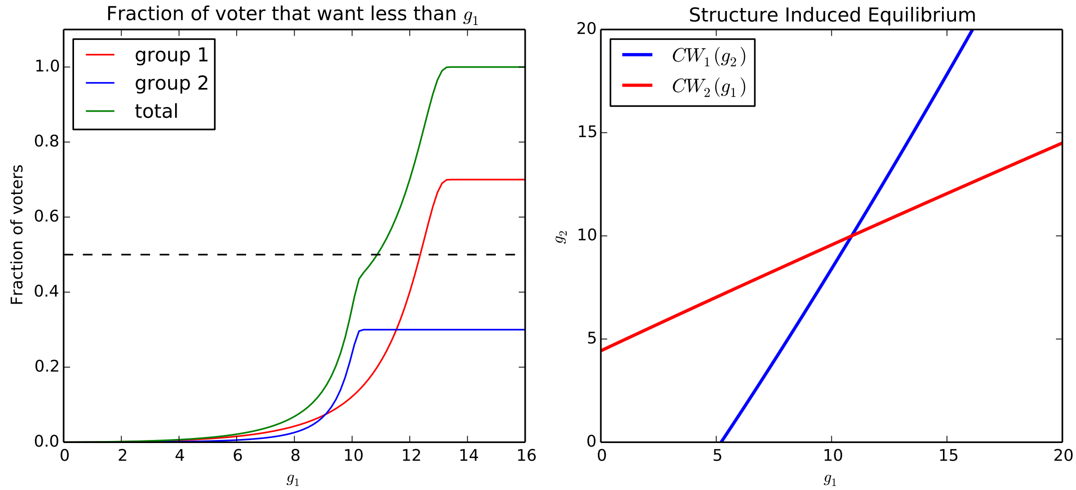

Figure 3.2: Voting Equilibrium.

Note: The left panel shows what happens when voting over g_1 *holding* $g_2 = 9.99$ *fixed. The doted line represents a majority (population is 1). The Condorcet winner for that dimension is found at the intersection of the green line with the doted line.*

The second panel shows the "reaction functions" for the two public goods. The intersection is the structure induced equilibrium.

Parameters: size of group 1 is 0.7*, size of group 2 is* 0.2*, net-of-tax price is* $p_h = 2.95$*,* $\alpha_1 = 0.54$*,* $\alpha_2 = 0.46$*,* $\gamma_1 = \gamma_2 = 0.37$*, both groups have the same income distribution over* $[1, 50]$*,* $c_0 = 0$*,* $c_1 = c_2 = 0.5$*,* $L = 0.8$ *,* $\epsilon = 0.5$*. Note that this parameters are in the context of the functional assumptions I make in 3.4.*

3.3.2 Equilibrium in the Closed City

In a closed city, all demographic variables are fixed and do not depend on what happens inside the city.

An equilibrium in the closed city is a tuple $(p_h^*, \boldsymbol{g}^*, t^*)$ such that

1. Given the income distributions and urban populations of each group $\{F_i(y), \mu_i\}_{i=1}^{I}$, the housing market clears

$$Lh(p_h^*) = \sum_{i=1}^{G} \mu_i \int h_i(p^*, y) f_i(y) \, dy.$$

2. Given $\{F_i(y), \mu_i\}_{i=1}^{I}$ and the net-of-tax price of housing p_h^* public good levels are determined by a political equilibrium such that

$$\sum_{i=1}^{I} \mu_i F_i\left(y_i^*\left(g_k^*, g_{-k}^*\right)\right) = \frac{1}{2}\left(\sum_{i=1}^{I} \mu_i\right) \quad \text{for all} \quad k = 1, \ldots, K.$$

3. The city's government runs a balanced budget

$$c(g^*, M) = t^* p_h^* H^s(p_h^*).$$

3.3.3 The Open City

I now allow people in the economy to decide whether they want to live in the city or not. This will allow people to vote with their feet and leave the city if they are unhappy with the chosen policies. The main complication is that now each group's urban income distribution will depend on prices and the chosen policies. As was the case in the previous section, it is necessary to introduce some new notation.

Notation and basic demographic accounting

- N : Population in the economy

- N_i: Size of the population of group i in the economy

- M: Population in the city

- μ_i: urban population size of group i

- $\mu_i(y)$: size of type i and income y urban population

- $F_i^{msa}(y), f_i^{msa}(y)$: Income distribution and density in the economy of group i

- $F_i(y), f_i(y)$: Income distribution and density in the city of group i

The income distribution for the urban population of group i can be characterized a

$$f_i(y) = \frac{\Pr(city_i \mid y) f_i^{msa}(y)}{\int_{\underline{y_i}}^{\bar{y}_i} \Pr(city_i \mid y) f_i^{msa}(y)\, dy} = \frac{s_i(y) f_i^{msa}(y)}{s_i}$$

where $\Pr(city_i \mid y)$ is the probability that an individual from group i with income y chooses to live in the city, $s_i(y)$ is the share of the population of group i and income y that lives in the city, and $s_i = \int_{\underline{y_i}}^{\bar{y}_i} \Pr(city \mid y) f_i^{msa}(y)\, dy$ is the aggregate urban share of group i.

The size of the urban population of group i is given by

$$\begin{aligned} \mu_i &= \int_{\underline{y_i}}^{\bar{y}_i} \mu_i(y)\, dy \\ &= N_i \int_{\underline{y_i}}^{\bar{y}_i} \Pr(city \mid y) f_i^{msa}(y)\, dy \\ &= s_i N_i \end{aligned}$$

The size of the city, M, is the sum of the urban populations of all groups

$$M = \sum_{i=1}^{I} \mu_i = \sum_{i=1}^{I} \int_{\underline{y_i}}^{\bar{y_i}} \Pr\left(city_i \mid y\right) f_i^{msa}\left(y\right) dy = \sum_{i=1}^{I} s_i N_i$$

3.3.4 Spatial equilibrium

To characterize the equilibrium population and demographic composition of the city we need to introduce a notion of spatial equilibrium that gives us an expression for $\Pr\left(city \mid y\right)$.

The notion of spatial equilibrium that I use in this model is very simple. Households that choose not to live in the city get a reservation utility $\bar{u}_i(y) + \epsilon_i$, where $\bar{u}_i(y)$ is known and can be a function of the type of household and its income, and ϵ_i is a random variable representing fluctuations in reservation utility unrelated to the household related variables.

There is a single, featureless city. By featureless I mean that the city is just the possibility of consuming a bundle of goods, with no notion of space. One can think of adding neighborhoods to the city, or a central business district to which households must commute to get their income. Endowing the model with such features would permit to study segregation patterns within the city.

In equilibrium, all households of the same type, (i, y_i, ϵ_i), must get their reservation utility whether they choose to live in the city or not. If some households were receiving more than their reservation utility by living in the city, more households of that tupe would choose to live in the city driving up housing prices and hence reducing the utility from living in the city.

Then, the probability that an individual of group i with income y will choose to live in the city is given by $\Pr\left(V_i^*\left(y\right) > \bar{u}_i\left(y\right) + \epsilon_i \mid y\right)$,

Hence, we can write the share of the urban population of type i and income y as

$$s_i\left(y\right) := \Pr\left(V_i^*\left(y\right) > \bar{u}_i\left(y\right) + \epsilon_i \mid y\right) = \Pr\left(\epsilon_i < V_i^*\left(y\right) - \bar{u}_i\left(y\right) \mid y\right)$$

Integrating over all income levels within the group we get the aggregate share of urban population for type i (The percentage of type i individuals that choose to live in the city)

$$\begin{aligned} s_i &= \int_{\underline{y_i}}^{\bar{y_i}} s_i\left(y\right) f_i^{msa}\left(y\right) dy \\ &= \int_{\underline{y_i}}^{\bar{y_i}} \Pr\left(\epsilon_i < V_i^*\left(y\right) - \bar{u}_i\left(y\right) \mid y\right) f_i^{msa}\left(y\right) dy \end{aligned}$$

Finally, multiplying each share by the total population of each type we get the aggregate urban populations of each type

$$\mu_i = s_i N_i = N_i \int_{\underline{y_i}}^{\bar{y_i}} \Pr\left(\epsilon_i < V_i^*\left(y\right) - \bar{u}_i\left(y\right) \mid y\right) f_i^{msa}\left(y\right) dy$$

This expression does not correspond to a closed form solution for μ_i since $V_i^*\left(y\right)$ depends on the type composition of the urban population $\{\mu_i\}_{i=1}^{I}$. The equilibrium proportions of each type are implicitly given by the following system of I equations

$$\mu_i = \int_{\underline{y_i}}^{\bar{y_i}} \Pr\left(\epsilon_i < V_i^*\left(y \mid \{\mu_i\}_{i=1}^I\right) - \bar{u}_i(y) \mid y\right) f_i^{msa}(y)\, dy \quad \text{for} \quad i = 1, \ldots, I$$

where I write $V_i^*\left(y \mid \{\mu_i\}_{i=1}^I\right)$ to emphasize that individual utility from living in the city depends on the type composition of the population.

3.3.5 Type-I Extreme Value Assumption

Alternatively, we can think of the utility of both living in the city or outside to include a random shifter. Under the assumption that these shifters come from a Type-I Extreme Value distribution, we can write the probability that a household of type i with income y will choose to live in the city as

$$\begin{aligned} s_i(y) = \Pr\left(\bar{u}_i(y) + \epsilon_i^o < V_i^*(y) + \epsilon_i^c \mid y\right) &= \Pr\left(\epsilon_i^o - \epsilon_i^c < V_i^*(y) - \bar{u}_i(y) \mid y\right) \\ &= \frac{\exp\{V_i^*(y)\}}{\exp\{V_i^*(y)\} + \exp\{\bar{u}_i(y)\}} \end{aligned}$$

Then, the urban share of group i is given by

$$\begin{aligned} s_i &= \int_{\underline{y_i}}^{\bar{y_i}} s_i(y) f_i^{msa}(y)\, dy \\ &= \int_{\underline{y_i}}^{\bar{y_i}} \left(\frac{\exp\{V_i^*(y)\}}{\exp\{V_i^*(y)\} + \exp\{\bar{u}_i(y)\}}\right) f_i^{msa}(y)\, dy \end{aligned}$$

The total urban population of group i is implicitly given by the system of equations

$$\mu_i = s_i N_i = N_i \int_{\underline{y_i}}^{\bar{y}_i} \left(\frac{\exp\left\{ V_i^* \left(y \mid \{\mu_i\}_{i=1}^I \right) \right\}}{\exp\left\{ V_i^* (y) \mid \{\mu_i\}_{i=1}^I \right\} + \exp\left\{ \bar{u}_i (y) \right\}} \right) f_i^{msa} (y) \, dy \quad \text{for} \quad i = 1, \ldots, I$$

3.3.6 Voting in The Open City

When we model the voting process in the open city we need to make a stand on the level of sophistication of voters. That is, we need to make an assumption on how they anticipate the changes in prices and demographics that different policies will imply. One option is that they consider the demographic composition of the city as fixed, unresponsive to different policies, and that they only take into account changes in the level of gross prices through the government budget constraint. This is known in the literature as the “myopic voters” assumption. Alternatively, one can make the more realistic assumption that voters actually do internalize the demographic changes that different policies will bring forth. This is known in the literature as the “utility taking” assumption. The timing assumption made in this model implies that the population in the city is fixed at the time of voting, which simplifies somewhat the analysis.

To clarify ideas, let’s look at how the political equilibrium is determined in the two cases. With myopic voters, both the urban population of each group and their income distribution is held fixed when the vote is held on each public good. That is,

$(p_h^*, \boldsymbol{g}^*)$ are determined as the solution to

$$\sum_{i=1}^{I} \mu_i F_i\left(y_i^*\left(g_k^*, g_{-k}^*\right)\right) = \frac{1}{2}\left(\sum_{i=1}^{I} \mu_i\right) \quad \text{for all} \quad k = 1, \ldots, K$$

given p_h, and $\{\mu_i, F_i\}_{i=1}^{I}$.

Instead, under utility taking, $(p_h^*, \boldsymbol{g}^*)$ are determined as the solution to

$$\sum_{i=1}^{I} \mu_i\left(p_h^*, \boldsymbol{g}^*\right) F_i\left(y_i^*\left(g_k^*, g_{-k}^*\right); p_h^*, \boldsymbol{g}^*\right) = \frac{1}{2}\left(\sum_{i=1}^{I} \mu_i\left(p_h^*, \boldsymbol{g}^*\right)\right) \quad \text{for all} \quad k = 1, \ldots, K$$

where all demographic objects are responsive to the different policies being considered.

3.3.7 Equilibrium in the Open City

Putting it all together, we can define an equilibrium in the open city as a tuple of prices, taxes and public goods $(p_h^*, t^*, \boldsymbol{g}^*)$, and a set of urban shares for each group $\{s_i(y)\}_{i=1}^{I}$ such that

1. The housing market clears:

$$H^s\left(p_h^*\right) = \sum_{i=1}^{I} \mu_i \int_{\underline{y_i}}^{\bar{y}_i} h\left(p^*, y\right) f_i(y)\, dy$$

2. There is a political equilibrium in the city:

$$\sum_{i=1}^{I} \mu_i F_i\left(y_i^*\left(g_k^*, g_{-k}^*\right)\right) = \frac{1}{2}\left(\sum_{i=1}^{I} \mu_i\right) \quad \text{for all} \quad k = 1, \ldots, K$$

3. The city government runs a balanced budget:

$$c\left(\boldsymbol{g}^{*}, M\right)=t^{*} p_{h}^{*} H^{s}\left(p_{h}^{*}\right)$$

4. The urban shares for each group and income are given by

$$s_{i}(y)=\frac{\exp \left\{V_{i}\left(\boldsymbol{g}^{*}, p^{*}, y\right)\right\}}{\exp \left\{V_{i}\left(\boldsymbol{g}^{*}, p^{*}, y\right)\right\}+\exp \left\{\bar{u}_{i}(y)\right\}} \quad \text{for} \quad i=1, \ldots, I$$

which implies that the urban income distributions are given by

$$f_{i}(y)=\frac{s_{i}(y) f_{i}^{msa}(y)}{\int_{\underline{y_{i}}}^{\bar{y}_{i}} s_{i}(y) f_{i}^{msa}(y) d y}=\frac{s_{i}(y) f_{i}^{msa}(y)}{s_{i}} \quad \text{for} \quad i=1, \ldots, I$$

and the sizes of each group's urban population are given by

$$\mu_{i}=s_{i} N_{i} \quad \text{for} \quad i=1, \ldots, I$$

3.4 Numerical Simulation

To get a better sense of the forces at work in the model and of the interaction between preference heterogeneity and the demographic composition of the city, I assume functional forms for preferences and technology and solve the model numerically[9].

[9] I only present results for the version of the model with several types. I also solved the model for a single type, which it turns out is very useful to feed starting values to the full model since it is solved almost instantly, and they give very similar results when heterogeneity between groups is very low.

I then perform some comparative statics exercises. Next I describe the common environment that I use in these applications.

I assume that there are only two public goods being offered by the city's government and that there are only two groups in the economy. Individual preferences are given by[10]

$$U_i\left(g_1, g_2, h, b\right) = \left(g_1^{\alpha_i} g_2^{1-\alpha_i}\right)^{\xi_i} \left(h^{\gamma} b^{1-\gamma} + C\right).$$

Note that the groups are different in the parameter α_i—the weights that they give to each public good. Solving the consumer's problem of optimal consumption of housing and private good yields the demand functions

$$h_i\left(y, p\right) = \frac{\gamma}{p} y \quad \text{and} \quad b_i\left(y, p\right) = \left(1 - \gamma\right) y$$

Plugging these demands into the utility function we get the indirect utility function

$$V_i\left(g_1, g_2, p, y\right) = \left(g_1^{\alpha_i} g_2^{1-\alpha_i}\right)^{\xi_i} \left(\gamma^{\gamma} \left(1 - \gamma\right)^{1-\gamma} p^{-\gamma} y + C\right)$$

We need $C < 0$ for these preferences to satisfy single-crossing. To see this, lets use the fact that a sufficient condition for single-crossing is that the Spence-Mirrlees condition that marginal rates of substitution (MRS) be increasing in income

[10]Note that I am assuming that public goods are complementary. This does not need to be the case; for instance, one could assume that the public good composite is of the CES form: $\left(\sum_k \theta_k g_k^{\rho}\right)^{1/\rho}$ for some $0 < \rho < 1$.

is satisfied.[11] An increasing MRS between (g_k, p) means that richer individuals are willing to pay more in housing services in order to consume a given level of public goods. The MRS is given by

$$-\frac{\partial V_i/\partial g_k}{\partial V_i/\partial p} = \frac{\xi_i \alpha_i \left(\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma} p^{-\gamma} y + C\right)}{\gamma^{\gamma+1}\left(1-\gamma\right)^{1-\gamma} p^{-\gamma-1} g_1 g_2^{1-\alpha_i} y}.$$

Taking its derivative with respect to income we see that

$$-\frac{\xi_i \alpha_i C}{\gamma^{\gamma+1}\left(1-\gamma\right)^{1-\gamma} p^{-\gamma-1} g_1 g_2^{1-\alpha_i} y^2} > 0 \quad \text{if and only if} \quad C < 0.$$

I assume that the reservation utility from living in the suburbs is linear and increasing in income. A justification for this is that it is much easier for richer households to live outside the city (or move to another city) than it is for poorer ones. It is given by

$$\bar{u}_i\left(y\right) = \beta_0 + \beta_1 y.$$

Income for both groups is distributed according to a beta distribution, $f_i^{msa} \sim Beta[a_i, b_i]$, scaled to span an interval $\left[\underline{y_i}, \bar{y}_i\right]$. I use a beta distribution because it is bounded—which simplified solving the model—and because it is flexible and can approximate most commonly used distributions.

[11] For more details see Gans and Smart [1996]. Note that voters must decide g_1, g_2 *and* p (or, equivalently,t) but that thanks to the budget constraint we can substitute out p. The relevant single-crossing condition for the theorem in 3.3 to apply is between g_k and p, depending on which dimension k is being decided.

I assume a linear cost function for the two public goods that does not depend on the population in the city. None of these assumptions is crucial, and they are easily relaxed. Hence, the cost of producing g_1 and g_2 is given by

$$c(g_1, g_2) = c_0 + c_1 g_1 + c_2 g_2.$$

Housing supply according to a constant elasticity supply function

$$H^s(p_h) = L p_h^{\epsilon}$$

where L is the land endowment in the city, and ϵ is the price elasticity.

Before working out the case with the open city I present a comparative static in the closed city to see how the voting mechanism works.

3.4.1 Comparative Static 1: Changes in Group Shares

For this exercise I consider the population in the city as fixed and I look at how the equilibrium bundles of public goods changes as we change the relative population sizes of the two groups.

I consider a city with the following parameters:

γ	C	ξ	β_0	β_1	α_1	α_2	c_0	c_1	c_2
0.37	-0.3	0.3	-10	1	0.6	0.4	0	0.5	0.5

Table 3.1: Parameter values for simulation 1.

Figure 3.3 shows the bliss public good bundles over the (g_1, g_2) space for both groups. That is, it plots

$$\begin{aligned} g_1^i(y), g_2^i(y) &= \arg\max_{g_1, g_2} V_i(g_1, g_2, p, y) \\ s.t. \qquad & p = p_h + \frac{c(g_1, g_2)}{H^s(p_h)} \end{aligned}$$

for all $y \in \left[\underline{y_i}, \bar{y}_i\right]$. Solving this maximization problem for the two groups it is possible to see that the desired composition of the two public goods is given by

$$\frac{g_1^*}{g_2^*} = \frac{1-\alpha_i}{\alpha_i}\frac{c_2}{c_1}$$

which is independent of income. So both groups differ in the desired ratio of public goods, and richer individuals always want to consume more of both public goods.

For this exercise I assume that group 2 is on average richer than group 1. This can be seen in Figure 3.4 where I plot the same bliss points of Figure 3.3 but now on the (y, g_k) space, and the income distributions of the two groups.

Now, if they were voting on the provision of a single public good, we would expect that as we move the proportion of group 2 individuals from 0 to 1, the provision would monotonically increase since they are on average richer and, hence, have a higher demand for public goods. But when we consider the problem of choosing two public goods we see that this monotonicity need not apply to all goods. For instance,

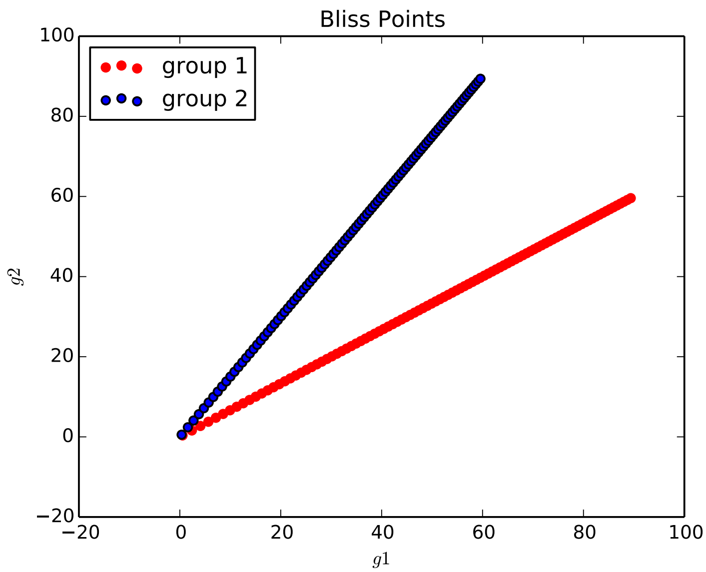

Figure 3.3: Bliss points in the (g_1, g_2) space.

Note: each point represents the bliss point of a household from demographic group g and income y. Points farther away to the NE represent the bliss points of richer households.

in this example, group two, if left alone, would choose higher levels of both public goods than group 1 left alone since they are richer on average. Yet as we move the share of group 2 from zero to one we see that the provision of good 1 decreases first as the proportions of the two goods adjust gradually towards the preferences of group 2. But it increases later, reflecting the higher demand for both public goods of group 2 relative to group 1.

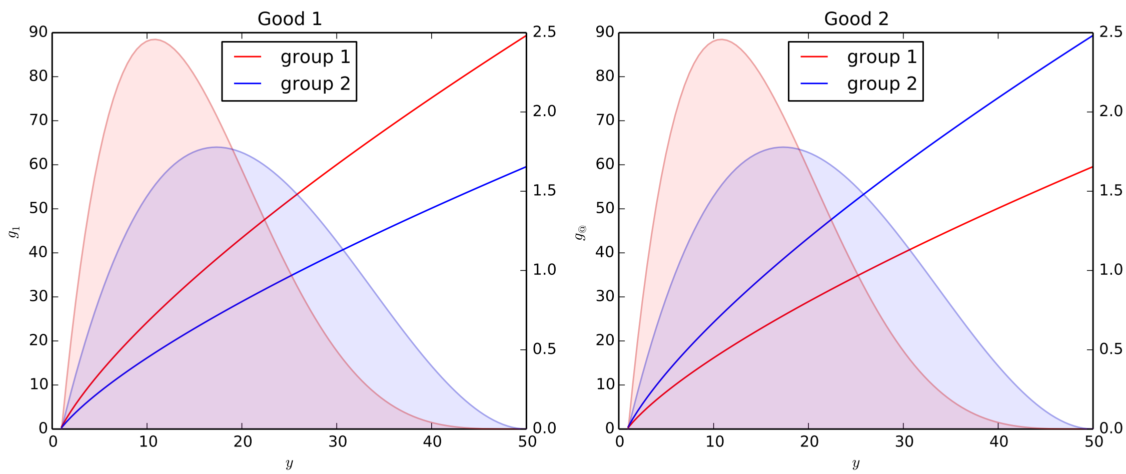

Figure 3.4: Cross-section of bliss points for the two public good dimensions.

Note: The shaded plots are the income distributions of the two groups.

3.4.2 Comparative Static 2: Increase in Taste Heterogeneity in the Open City

This exercise is motivated by Alesina et al. [1999]. Their model predicts that an increase in preference heterogeneity always leads to a decrease in public good provision and, consequently, in the size of the public sector. The reason is that as the population becomes more and more heterogeneous in their desired bundle of public goods, they would rather have lower taxes and spend the money in private consumption than see it being spent on stuff they do not like.

Table 3.2 shows the parameters I used for this exercise. There is a clear majority in the economy, group 1, who accounts for 80% of the total population. To simplify I assume both groups have the same income distribution. To begin with, I assume both groups have the same preferences over public goods, valuing both goods the same, i,e, $\alpha_i = 0.5$ for $i = 1, 2$. Then, I gradually create a split between α_1 and α_2, symmetrically increasing the former and decreasing the latter.

Not surprisingly, when both groups value both public goods the same, the city's government provides them in equal measure. The urban population of group 1 is larger, but fairly representing their larger share in the economy. Furthermore, both groups have the same income distribution in the city as they do in the economy.

As both group's preferences split apart, the majority, i.e. group 1, starts to get its way in the division of public funds. This can be seen in the actual provision of public goods moving towards a higher supply good 1 versus good 2. The tax rate drops as the minority would like to see public spending reduced. An important point here is that given the parameters I picked, preferences *within* each group are very concentrated. By this I mean that voters in each group tend to favor, by and large, the same policies, and hence tend to vote in block.

So far this is in line with the mechanism described in Alesina et al. [1999] result. But as preferences move even further apart, the demographic composition of the city changes, which—by construction—can't happen in Alesina et al. [1999]. More people

γ	C	ξ	β_0	β_1	c_0	c_1	c_2
0.37	-0.3	0.3	-10	1	0	0.5	0.5

Table 3.2: Parameter values for simulation 2.

from group 1 move in, and some people of group 2 move out. As the city becomes more homogeneous—the majority takes over—the tax rate begins to increase since households' valuation of the public bundle increases.

Interestingly, even though the two groups have the same income distribution at the national level, their urban income distributions gradually split apart as we increase taste heterogeneity, as can be seen from Figure 3.6. This is due to rich individuals from the minority leaving the city and taking the outside option—with the poorer ones stuck in the central city—and rich individuals from the majority settling in the city as the services it provides become more liking to their taste. This result is driven by the that richer individuals get a better outside option than poorer ones.

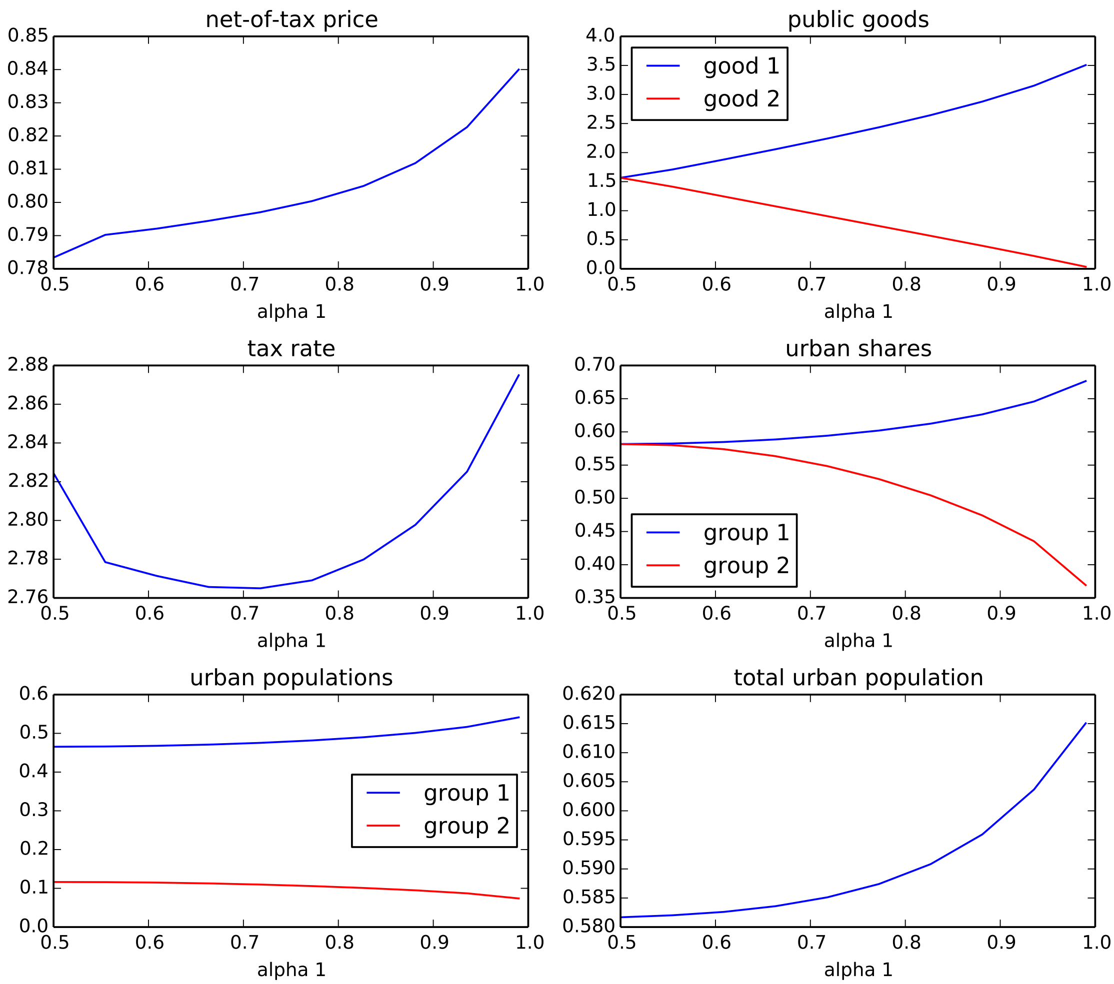

Figure 3.5: Effects of an increase in taste heterogeneity.

Note: Metropolitan area population proportions for each demographic group are $N_1 = 0.8 and$ $N_2 = 0.2$

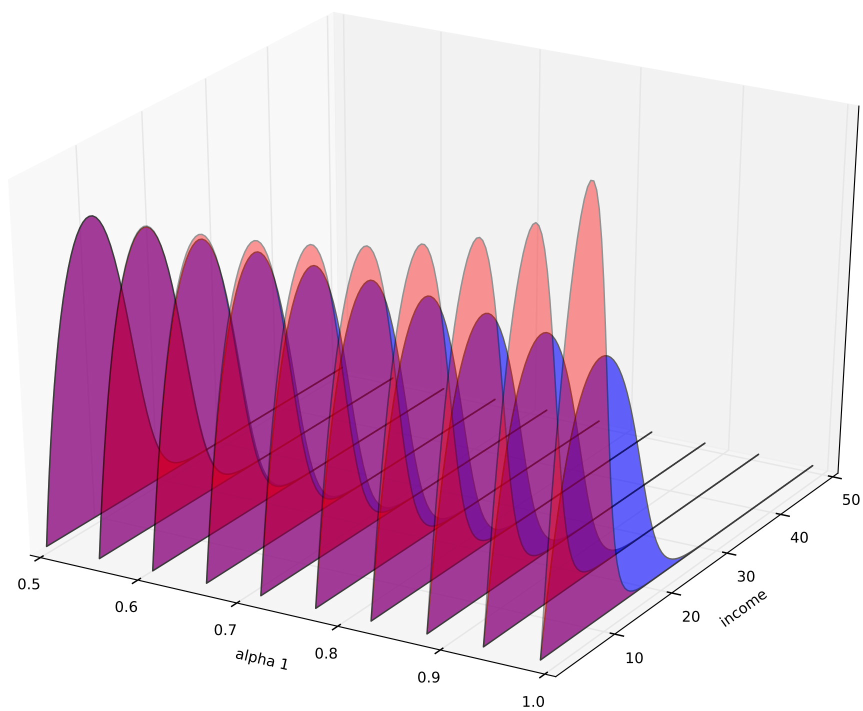

Figure 3.6: Evolution of the urban income distributions of the two demographic groups.

Note: as preferences diverge income inequality across groups grows due to rich individuals from the minority leaving the city and rich individuals from the majority moving into the city. This happens even though income distributions for the two groups are identical in the metropolitan area.

Chapter 4

Conclusions

In chapter 2 I have developed an econometric model of the provision of multiple public goods when voters are heterogeneous in income and belong to different groups characterized by different preferences over public goods. I use this model to study the intergenerational conflict in the provision of public goods in large U.S. cities, where I focus on the provision of three public good categories: public education, basic public goods and redistribution. Using Census data and Census of Governments data I show, using a simulated instrumental variables approach, that households with children, young households without children and older empty nesters do indeed have conflicting preferences over public good provision. I then estimate a model of the provision of multiple public goods in order to predict the effect on public good provision of predicted changes in the demographic structure of cities. I find that provision of public education is likely to fall due to an increase in the shares of young households without children and older empty nesters, and the effects can vary substantially from city to city.

In this chapter I have not made an attempt to model the location decision of households within metropolitan areas. Future work will explicitly model the decisions of households to locate in the central city of an MSA or in one of their suburbs. The methods developed in this chapter can also be fruitfully applied to study the ethnic conflict over the provision of public goods in developing countries.

In chapter 3 I introduce a model of the provision of public goods that can accommodate an arbitrary number of public goods and demographic groups with different preferences over public bundles, and with heterogeneous incomes within groups. The key assumptions that guarantee an equilibrium are that voting takes place on each dimension separately (structure induced equilibrium), and that the preferences of each group satisfy the single crossing condition. Furthermore I embed the political economy model into a stylized model of location choice between a central city and its suburbs in order to study the interaction between mobility and demographic heterogeneity in the central city. Through a numerical exercise I show that mobility and demographic conflict interact in a surprising way, generating a non-monotonic effect between increasing demographic heterogeneity and the size of the public sector. When heterogeneity is low, increasing it reduces the size of the public sector, but it also alters the demographic composition of the city as richer individuals of the minority group leave for the suburbs and the richer individuals from the majority move from the suburbs to the city. This leads to a more homogeneous city and to an inflexion in the support for public spending. Eventually, increases in taste heterogeneity lead to increases in public spending per capita, and to a starker segregation between city and suburbs.

Appendices

Appendix A

Chapter 1

Group Share and Expenditure Correlations

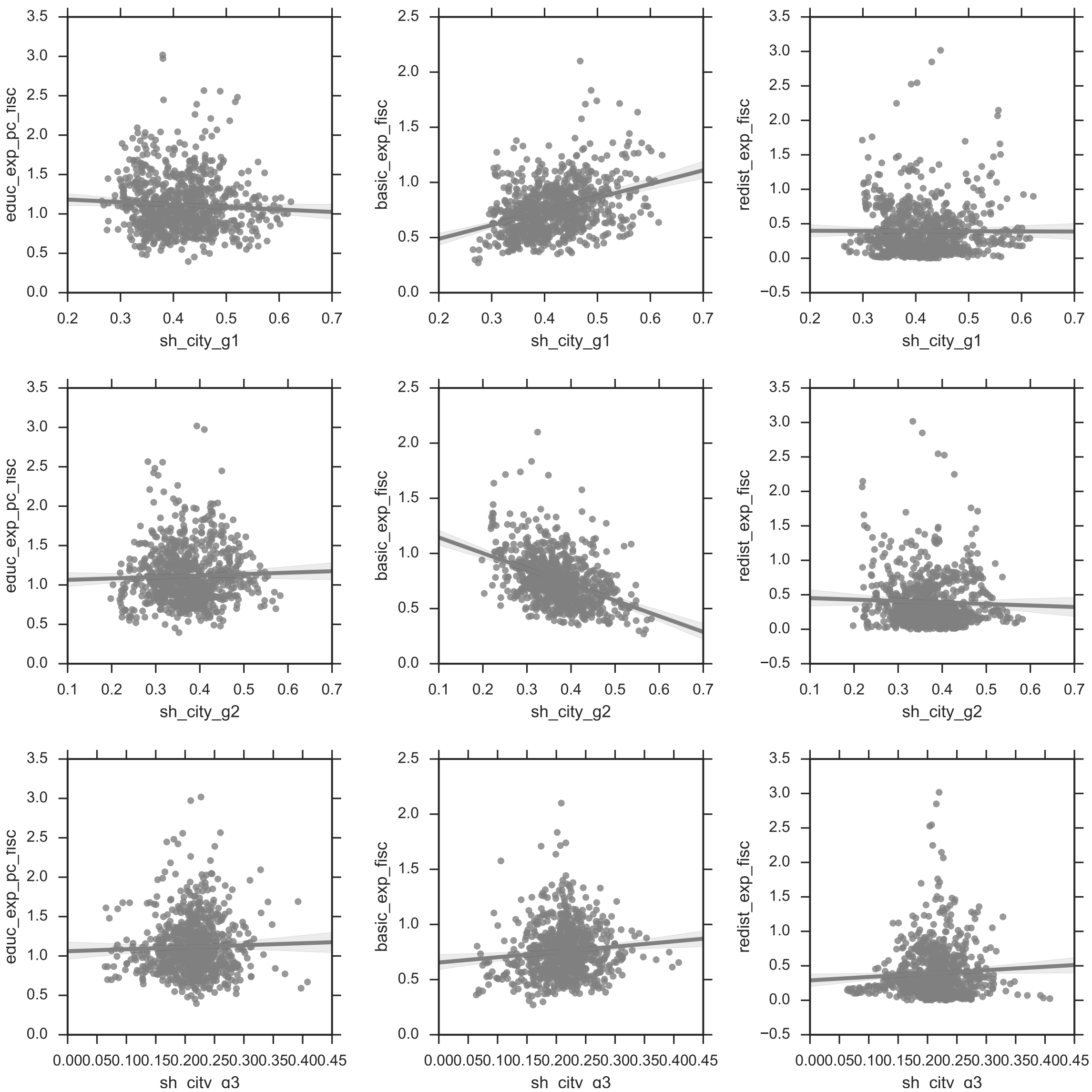

Figure A.1: Group share and expenditure correlations.

Note: these scatterplots show the correlations between the share of each group and expenditures per capita in education, basic and redistribution.

A.1 Nonparametric Analysis of Budget Shares

The linear regression design used in the previous section may not capture the full extent through which group demographic shares may impact the composition of the budget. Since the budget is decided through a democratic process, it is unlikely that different interest groups, as reflected by group shares, are going to have a linear effect on budget shares since the actual political power of each group is going to depend on the existing group composition.

To allow for nonlinear effects between group shares and the shares of expenditures I run a fully nonparametric regression of the form

$$g_{c,t}^{k} = f\left(s_{c,t}^{2}, s_{c,t}^{3}\right) + v_{c,t}$$

where f is an arbitrary function of the group shares which is estimated using a Gaussian kernel.

Figure A.2 shows the estimated functions for each of the three budget shares. In the first panel, representing the budget share for education, we can see a clear conflict between groups 2 and 3. At any point in the domain, increasing the share of group 3 decreases the share of spending in education, and the opposite is true for the share for group 2. The relationship is less clear for basic spending, depicted the second panel. Here, increasing the share of group 3 decreases the share of basic spending when the share of group 2 is also high, but has basically no effect when the share of group 2 is around its mean value of 0.38. In the case of redistribution, there is a clear U-shaped relationship between is share and the share of group 2, which explains why no effect whatsoever is picked up by our regression design.

Nonparametric Regression of Expenditure Shares

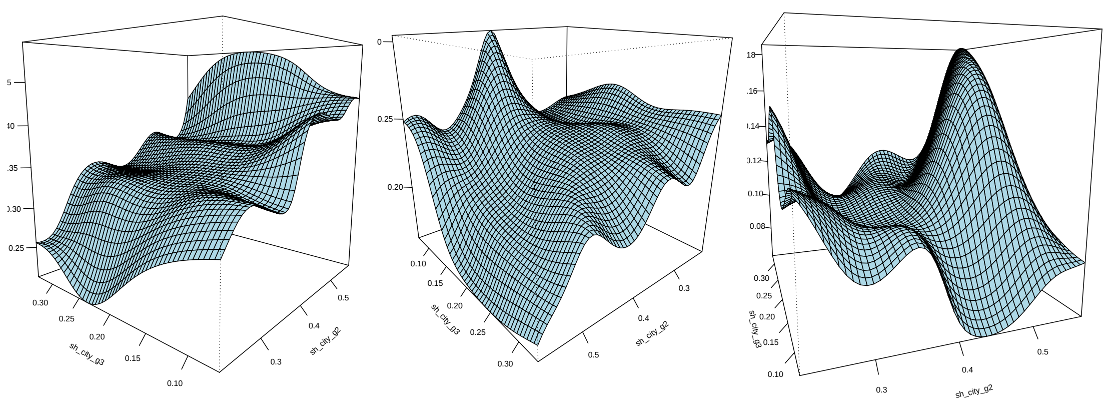

Figure A.2: Nonparametric regressions of education, basic, and redistribution spending on the city demographic shares of group 2 and group 3.

Note: in all three cases I have used a Gaussian kernel, and the bandwidths have been adjusted to avoid excessive roughness.

A.2 Regression Tables

Table A.1: Simulated Regression Results: Education Expenditure

	(1)	(2)	(3)	(4)	(5)
sh_city_g2	0.286***	0.544***	0.255***	0.091	0.409***
	(0.074)	(0.080)	(0.078)	(0.094)	(0.079)
sh_city_g3	−0.177*	−0.133	−0.213**	−0.316***	−0.186**
	(0.091)	(0.084)	(0.084)	(0.104)	(0.085)
ethnic	−0.125***	−0.152***	−0.209***	0.123*	−0.160***
	(0.038)	(0.036)	(0.038)	(0.070)	(0.035)
r_black_nh_sh	0.093***	0.070**	−0.004	0.415***	0.071**
	(0.032)	(0.031)	(0.034)	(0.090)	(0.030)
r_other_nh_sh	0.413***	0.156**	0.438***	0.049	0.316***
	(0.074)	(0.078)	(0.097)	(0.170)	(0.077)
gini	−0.091	−0.349***	−0.297**	−0.0003	−0.278**
	(0.114)	(0.114)	(0.123)	(0.153)	(0.118)
log(incmed_hh_nh)	−0.105***	−0.122***	−0.128***	−0.097**	−0.072***
	(0.027)	(0.025)	(0.029)	(0.047)	(0.024)
log(Population)	−0.054***	−0.042***	−0.016	0.079***	−0.027*
	(0.015)	(0.015)	(0.016)	(0.023)	(0.015)
renters_sh_nh	−0.458***	−0.223***	−0.445***	−0.509***	−0.248***
	(0.053)	(0.056)	(0.068)	(0.144)	(0.058)
log(educ_col_nh)	0.036**	0.033**	0.013	−0.025	0.018
	(0.015)	(0.015)	(0.016)	(0.027)	(0.015)
Total_IG_Revenue	0.035***	0.018***	0.025***	0.035***	0.006
	(0.006)	(0.006)	(0.008)	(0.009)	(0.006)
log(ALAND)	0.003				
	(0.006)				
lnb_subs	−0.008***	−0.008***	−0.0002	0.001	−0.010***
	(0.003)	(0.003)	(0.004)	(0.010)	(0.003)
Constant	1.863***				
	(0.341)				
Fixed effects?	No	Year	Year and State	City	Year and Region
N	478	478	478	478	478
R^2	0.418	0.480	0.681	0.843	0.541
Adjusted R^2	0.401	0.461	0.641	0.796	0.521
Residual Std. Error	0.060 (df = 464)	0.057 (df = 460)	0.047 (df = 424)	0.035 (df = 366)	0.054 (df = 457)

Notes:

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.2: Simulated Regression Results: Basic Expenditure

	(1)	(2)	(3)	(4)	(5)
sh_city_g2	-0.206^{***}	-0.213^{***}	-0.172^{***}	-0.090	-0.143^{**}
	(0.051)	(0.057)	(0.056)	(0.078)	(0.058)
sh_city_g3	-0.045	-0.085	-0.091	0.039	0.044
	(0.062)	(0.061)	(0.060)	(0.086)	(0.062)
ethnic	-0.071^{***}	-0.061^{**}	-0.062^{**}	-0.093	-0.077^{***}
	(0.026)	(0.026)	(0.028)	(0.058)	(0.025)
r_black_nh_sh	0.032	0.037^{*}	0.018	-0.078	0.016
	(0.022)	(0.022)	(0.025)	(0.075)	(0.022)
r_other_nh_sh	-0.175^{***}	-0.145^{**}	-0.045	0.167	-0.183^{***}
	(0.050)	(0.056)	(0.070)	(0.141)	(0.056)
gini	-0.099	-0.046	-0.286^{***}	-0.166	-0.209^{**}
	(0.078)	(0.082)	(0.089)	(0.127)	(0.087)
log(incmed_hh_nh)	0.038^{**}	0.027	-0.034	-0.010	0.003
	(0.018)	(0.018)	(0.021)	(0.039)	(0.018)
log(Population)	0.023^{**}	0.017	-0.006	0.004	0.018^{*}
	(0.010)	(0.011)	(0.012)	(0.019)	(0.011)
renters_sh_nh	0.102^{***}	0.023	0.021	-0.060	0.123^{***}
	(0.036)	(0.040)	(0.049)	(0.119)	(0.042)
log(educ_col_nh)	-0.014	-0.003	0.015	-0.036	-0.005
	(0.011)	(0.010)	(0.011)	(0.022)	(0.011)
Total_IG_Revenue	-0.032^{***}	-0.032^{***}	-0.013^{**}	-0.018^{**}	-0.018^{***}
	(0.004)	(0.004)	(0.006)	(0.008)	(0.005)
log(ALAND)	0.009^{**}				
	(0.004)				
lnb_subs	-0.006^{***}	-0.007^{***}	0.008^{***}	0.010	-0.004^{**}
	(0.002)	(0.002)	(0.003)	(0.008)	(0.002)
Constant	-0.313				
	(0.233)				
Fixed effects?	No	Year	Year and State	City	Year and Region
N	478	478	478	478	478
R^2	0.360	0.365	0.608	0.746	0.419
Adjusted R^2	0.342	0.342	0.560	0.669	0.393
Residual Std. Error	0.041 (df = 464)	0.041 (df = 460)	0.034 (df = 424)	0.029 (df = 366)	0.039 (df = 457)

Notes:

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A.3: Simulated Regression Results: Redistribution Expenditure

	(1)	(2)	(3)	(4)	(5)
sh_city_g2	−0.029	−0.180*	−0.031	−0.057	0.014
	(0.088)	(0.099)	(0.084)	(0.077)	(0.100)
sh_city_g3	−0.014	−0.056	0.240***	0.172**	0.049
	(0.108)	(0.104)	(0.089)	(0.085)	(0.107)
ethnic	0.177***	0.192***	0.205***	0.034	0.213***
	(0.045)	(0.045)	(0.041)	(0.057)	(0.044)
r_black_nh_sh	−0.111***	−0.100***	−0.012	−0.183**	−0.118***
	(0.038)	(0.038)	(0.036)	(0.074)	(0.037)
r_other_nh_sh	−0.050	0.090	−0.297***	−0.272*	0.004
	(0.087)	(0.096)	(0.104)	(0.139)	(0.097)
gini	0.140	0.294**	0.681***	−0.101	0.433***
	(0.135)	(0.141)	(0.131)	(0.125)	(0.149)
log(incmed_hh_nh)	0.093***	0.104***	0.188***	−0.001	0.069**
	(0.032)	(0.031)	(0.031)	(0.038)	(0.031)
log(Population)	0.054***	0.049***	0.060***	−0.045**	0.013
	(0.018)	(0.018)	(0.017)	(0.019)	(0.019)
renters_sh_nh	0.133**	−0.001	0.122*	0.333***	−0.006
	(0.063)	(0.069)	(0.073)	(0.118)	(0.072)
log(educ_col_nh)	−0.061***	−0.061***	−0.067***	0.038*	−0.028
	(0.018)	(0.018)	(0.017)	(0.022)	(0.018)
Total_IG_Revenue	0.003	0.013*	0.001	−0.010	0.033***
	(0.007)	(0.007)	(0.009)	(0.008)	(0.008)
log(ALAND)	−0.002				
	(0.007)				
lnb_subs	0.009***	0.009***	−0.025***	−0.022***	0.008**
	(0.003)	(0.003)	(0.004)	(0.008)	(0.003)
Constant	−1.047***				
	(0.403)				
Fixed effects?	No	Year	Year and State	City	Year and Region
N	478	478	478	478	478
R^2	0.157	0.179	0.622	0.891	0.248
Adjusted R^2	0.133	0.148	0.575	0.858	0.215
Residual Std. Error	0.071 (df = 464)	0.070 (df = 460)	0.050 (df = 424)	0.029 (df = 366)	0.067 (df = 457)

Notes:

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A.4: Simulated IV Results: Education Expenditure

	(1)	(2)	(3)	(4)
ethnic	−0.099	−0.209***	0.021	0.127
	(0.075)	(0.066)	(1.009)	(0.083)
r_black_nh_sh	−0.147	−0.089	−0.781	0.457***
	(0.101)	(0.085)	(3.470)	(0.112)
r_other_nh_sh	−0.463	−0.798**	−3.746	0.148
	(0.334)	(0.366)	(17.828)	(0.214)
gini	0.347	−0.713**	−0.365	−0.048
	(0.303)	(0.281)	(1.707)	(0.193)
log(incmed_hh_nh)	−0.443***	−0.322***	−1.154	−0.050
	(0.129)	(0.091)	(4.450)	(0.092)
log(Population)	−0.290***	−0.245***	−0.899	0.087**
	(0.092)	(0.080)	(3.452)	(0.034)
renters_sh_nh	−0.238*	0.522**	2.025	−0.566***
	(0.136)	(0.254)	(9.657)	(0.159)
log(educ_col_nh)	0.293***	0.247***	0.898	−0.041
	(0.097)	(0.082)	(3.464)	(0.036)
Total_IG_Revenue	0.031***	−0.017	0.050	0.036***
	(0.011)	(0.015)	(0.080)	(0.010)
log(ALAND)	−0.032			
	(0.020)			
lnb_subs	0.003	−0.006	0.040	0.0001
	(0.007)	(0.006)	(0.186)	(0.012)
‘sh_city_g2(fit)‘	2.730***	2.896***	9.521	0.061
	(0.825)	(0.802)	(37.336)	(0.206)
‘sh_city_g3(fit)‘	0.432	1.289**	3.370	0.039
	(0.530)	(0.544)	(10.640)	(0.611)
Constant	5.058***			
	(1.367)			
Fixed effects?	No	Year	Year and State	City
N	448	448	448	448
R^2	-0.919	-0.523	-9.954	0.841
Adjusted R^2	-0.977	-0.584	-11.302	0.794
Residual Std. Error	0.111 (df = 434)	0.099 (df = 430)	0.276 (df = 398)	0.036 (df = 345)

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.5: IV Results: Basic Expenditure

	(1)	(2)	(3)	(4)
ethnic	−0.080**	−0.042	0.130	−0.045
	(0.038)	(0.036)	(0.738)	(0.067)
r_black_nh_sh	0.145***	0.129***	−0.622	−0.085
	(0.051)	(0.046)	(2.539)	(0.090)
r_other_nh_sh	0.225	0.335*	−3.300	0.212
	(0.170)	(0.198)	(13.044)	(0.172)
gini	−0.374**	0.037	0.010	−0.240
	(0.154)	(0.151)	(1.249)	(0.156)
log(incmed_hh_nh)	0.195***	0.133***	−0.851	0.042
	(0.066)	(0.049)	(3.256)	(0.074)
log(Population)	0.112**	0.100**	−0.621	−0.023
	(0.047)	(0.043)	(2.526)	(0.027)
renters_sh_nh	0.041	−0.309**	1.723	0.069
	(0.069)	(0.137)	(7.066)	(0.128)
log(educ_col_nh)	−0.117**	−0.089**	0.631	−0.046
	(0.049)	(0.044)	(2.534)	(0.029)
Total_IG_Revenue	−0.029***	−0.018**	−0.002	−0.019**
	(0.006)	(0.008)	(0.058)	(0.008)
log(ALAND)	0.029***			
	(0.010)			
lnb_subs	−0.010***	−0.009***	0.043	0.008
	(0.003)	(0.003)	(0.136)	(0.009)
‘sh_city_g2(fit)‘	−1.217***	−1.266***	6.530	−0.145
	(0.420)	(0.433)	(27.318)	(0.166)
‘sh_city_g3(fit)‘	−0.117	−0.522*	1.548	0.265
	(0.270)	(0.293)	(7.785)	(0.492)
Constant	−1.873***			
	(0.696)			
Fixed effects?	No	Year	Year and State	City
N	448	448	448	448
R^2	-0.259	-0.123	-13.847	0.739
Adjusted R^2	-0.297	-0.168	-15.675	0.662
Residual Std. Error	0.056 (df = 434)	0.053 (df = 430)	0.202 (df = 398)	0.029 (df = 345)

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.6: Simulated IV Results: Redistribution Expenditure

	(1)	(2)	(3)	(4)
ethnic	0.174***	0.226***	−0.260	0.045
	(0.057)	(0.056)	(2.014)	(0.070)
r_black_nh_sh	−0.061	−0.092	1.632	−0.241**
	(0.077)	(0.072)	(6.926)	(0.094)
r_other_nh_sh	0.155	0.303	8.435	−0.334*
	(0.253)	(0.309)	(35.578)	(0.180)
gini	0.249	0.669***	0.401	−0.032
	(0.230)	(0.237)	(3.407)	(0.163)
log(incmed_hh_nh)	0.179*	0.151*	2.330	−0.037
	(0.098)	(0.077)	(8.881)	(0.078)
log(Population)	0.185***	0.164**	1.800	−0.042
	(0.070)	(0.067)	(6.889)	(0.029)
renters_sh_nh	−0.035	−0.277	−4.766	0.406***
	(0.103)	(0.214)	(19.272)	(0.134)
log(educ_col_nh)	−0.189**	−0.183***	−1.813	0.029
	(0.073)	(0.069)	(6.912)	(0.030)
Total_IG_Revenue	0.006	0.032**	−0.038	−0.014
	(0.009)	(0.013)	(0.159)	(0.009)
log(ALAND)	−0.005			
	(0.015)			
lnb_subs	0.005	0.012**	−0.109	−0.020**
	(0.005)	(0.005)	(0.371)	(0.010)
‘sh_city_g2(fit)‘	−1.104*	−1.189*	−18.679	−0.147
	(0.627)	(0.677)	(74.511)	(0.174)
‘sh_city_g3(fit)‘	−1.032**	−1.290***	−5.849	−0.226
	(0.403)	(0.459)	(21.235)	(0.514)
Constant	−1.552			
	(1.039)			
Fixed effects?	No	Year	Year and State	City
N	448	448	448	448
R^2	-0.205	-0.181	-46.464	0.878
Adjusted R^2	-0.241	-0.228	-52.308	0.841
Residual Std. Error	0.084 (df = 434)	0.084 (df = 430)	0.551 (df = 398)	0.030 (df = 345)

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.7: Using MSA Shares as Instruments: Education Expenditure

	(1)	(2)	(3)	(4)	(5)
ethnic	-0.128^{***}	-0.146^{***}	-0.202^{***}	0.111	-0.155^{***}
	(0.039)	(0.037)	(0.040)	(0.086)	(0.037)
r_black_nh_sh	0.111^{***}	0.033	-0.029	0.384^{***}	0.051
	(0.042)	(0.048)	(0.053)	(0.104)	(0.046)
r_other_nh_sh	0.492^{***}	0.019	0.342^{*}	-0.004	0.226
	(0.117)	(0.163)	(0.190)	(0.223)	(0.173)
gini	-0.114	-0.296^{**}	-0.246	0.055	-0.249
	(0.155)	(0.133)	(0.152)	(0.188)	(0.157)
log(incmed_hh_nh)	-0.076^{*}	-0.154^{***}	-0.157^{***}	-0.139	-0.093^{**}
	(0.043)	(0.042)	(0.056)	(0.095)	(0.043)
log(Population)	-0.028	-0.050^{**}	-0.027	0.094^{***}	-0.038^{*}
	(0.019)	(0.021)	(0.028)	(0.028)	(0.022)
renters_sh_nh	-0.487^{***}	-0.163^{*}	-0.420^{***}	-0.501^{***}	-0.210^{**}
	(0.059)	(0.089)	(0.090)	(0.157)	(0.081)
log(educ_col_nh)	0.008	0.041^{*}	0.024	-0.026	0.029
	(0.020)	(0.021)	(0.028)	(0.044)	(0.022)
Total_IG_Revenue	0.036^{***}	0.017^{***}	0.024^{***}	0.032^{***}	0.005
	(0.006)	(0.006)	(0.008)	(0.010)	(0.006)
log(ALAND)	0.005				
	(0.010)				
lnb_subs	-0.008^{***}	-0.006^{*}	0.002	0.005	-0.010^{***}
	(0.003)	(0.003)	(0.005)	(0.010)	(0.003)
‘sh_city_g2(fit)‘	0.049	0.736^{***}	0.404	0.023	0.555^{**}
	(0.153)	(0.235)	(0.284)	(0.243)	(0.239)
‘sh_city_g3(fit)‘	-0.275	-0.249	-0.296	-0.685^{*}	-0.212
	(0.236)	(0.180)	(0.196)	(0.391)	(0.217)
Constant	1.611^{***}				
	(0.544)				
Fixed effects?	No	Year	Year and State	City	Year and Region
N	478	478	478	478	478
R^2	0.405	0.466	0.675	0.838	0.536
Adjusted R^2	0.388	0.447	0.635	0.788	0.516
Residual Std. Error	0.061 (df = 464)	0.058 (df = 460)	0.047 (df = 424)	0.036 (df = 366)	0.054 (df = 457)

Notes:

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.8: Using MSA Shares as Instruments: Basic Expenditure

	(1)	(2)	(3)	(4)	(5)
ethnic	−0.076***	−0.068**	−0.056*	−0.047	−0.097***
	(0.027)	(0.029)	(0.029)	(0.073)	(0.030)
r_black_nh_sh	0.058**	0.095**	−0.005	−0.142	0.094**
	(0.029)	(0.037)	(0.038)	(0.087)	(0.038)
r_other_nh_sh	−0.081	0.108	−0.132	0.291	0.162
	(0.080)	(0.125)	(0.137)	(0.188)	(0.143)
gini	−0.175	−0.063	−0.237**	−0.247	−0.344***
	(0.107)	(0.102)	(0.110)	(0.158)	(0.130)
log(incmed_hh_nh)	0.073**	0.086***	−0.061	0.055	0.085**
	(0.030)	(0.032)	(0.041)	(0.080)	(0.036)
log(Population)	0.036***	0.049***	−0.015	−0.004	0.055***
	(0.013)	(0.016)	(0.020)	(0.023)	(0.018)
renters_sh_nh	0.099**	−0.117*	0.041	0.004	−0.011
	(0.040)	(0.068)	(0.065)	(0.132)	(0.067)
log(educ_col_nh)	−0.032**	−0.034**	0.024	−0.073**	−0.041**
	(0.014)	(0.016)	(0.020)	(0.037)	(0.018)
Total_IG_Revenue	−0.031***	−0.028***	−0.013**	−0.021***	−0.018***
	(0.004)	(0.005)	(0.006)	(0.008)	(0.005)
log(ALAND)	0.015**				
	(0.007)				
lnb_subs	−0.006***	−0.010***	0.010***	0.011	−0.007***
	(0.002)	(0.003)	(0.003)	(0.008)	(0.003)
‘sh_city_g2(fit)‘	−0.386***	−0.668***	−0.042	−0.363*	−0.681***
	(0.105)	(0.180)	(0.206)	(0.204)	(0.197)
‘sh_city_g3(fit)‘	0.036	−0.085	−0.177	0.196	0.200
	(0.163)	(0.138)	(0.142)	(0.328)	(0.179)
Constant	−0.699*				
	(0.374)				
Fixed effects?	No	Year	Year and State	City	Year and Region
N	478	478	478	478	478
R^2	0.335	0.265	0.598	0.730	0.250
Adjusted R^2	0.316	0.238	0.548	0.648	0.218
Residual Std. Error	0.042 (df = 464)	0.044 (df = 460)	0.034 (df = 424)	0.030 (df = 366)	0.045 (df = 457)

Notes:

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table A.9: Using MSA Shares as Instruments: Redistribution Expenditure

	(1)	(2)	(3)	(4)	(5)
ethnic	0.197***	0.208***	0.186***	0.017	0.250***
	(0.049)	(0.049)	(0.046)	(0.070)	(0.056)
r_black_nh_sh	−0.204***	−0.211***	0.068	−0.130	−0.102
	(0.053)	(0.064)	(0.060)	(0.084)	(0.122)
r_other_nh_sh	−0.380**	−0.359*	−0.019	−0.307*	0.119
	(0.147)	(0.215)	(0.216)	(0.181)	(0.575)
gini	0.440**	0.399**	0.465***	−0.091	0.939***
	(0.196)	(0.175)	(0.174)	(0.152)	(0.349)
log(incmed_hh_nh)	−0.031	−0.001	0.278***	−0.011	0.116
	(0.055)	(0.055)	(0.064)	(0.077)	(0.159)
log(Population)	0.018	0.007	0.079**	−0.050**	0.132
	(0.024)	(0.027)	(0.032)	(0.023)	(0.152)
renters_sh_nh	0.122*	0.221*	0.088	0.293**	−0.333
	(0.074)	(0.117)	(0.102)	(0.127)	(0.448)
log(educ_col_nh)	−0.010	−0.021	−0.087***	0.059*	−0.151
	(0.025)	(0.027)	(0.032)	(0.035)	(0.154)
Total_IG_Revenue	0.002	0.009	0.005	−0.007	0.026**
	(0.008)	(0.008)	(0.009)	(0.008)	(0.011)
log(ALAND)	−0.025*				
	(0.013)				
lnb_subs	0.012***	0.015***	−0.031***	−0.025***	0.009*
	(0.004)	(0.004)	(0.005)	(0.008)	(0.005)
‘sh_city_g2(fit)‘	0.540***	0.535*	−0.383	0.131	−0.942
	(0.193)	(0.309)	(0.323)	(0.197)	(1.479)
‘sh_city_g3(fit)‘	−0.428	−0.253	0.671***	0.309	−1.428
	(0.299)	(0.237)	(0.223)	(0.317)	(1.035)
Constant	0.373				
	(0.687)				
Fixed effects?	No	Year	Year and State	City	Year and Region
N	478	478	478	478	448
R^2	0.014	0.041	0.563	0.889	-0.143
Adjusted R^2	-0.014	0.005	0.509	0.856	-0.196
Residual Std. Error	0.077 (df = 464)	0.076 (df = 460)	0.053 (df = 424)	0.029 (df = 366)	0.083 (df = 427)

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Appendix B

Chapter 2

B.1 Chapter 2: Computation Appendix

Solving the model numerically, I have had difficulties getting third party nonlinear equation solvers to solve this system directly.[12] Instead, what I do is to combine the equations characterizing the equilibrium into a mapping that maps prices to prices so that finding the equilibrium is turned into a fixed point problem. To do so, note that given a net-of-tax price of housing, p_h, we can use the second and third equations, i.e. the equations describing a political equilibrium, to obtain $(p^* (p_h), g_1^* (p_h), g_2^* (p_h))$, where I write p_h in parenthesis to indicate that these values depend on the initial guess of the net-of-tax price of housing.

Given these values, in particular, given $p^* (p_h)$, we can use the housing market

[12] I used the Python programming language for the numerical exercises in this paper.

clearing condition to obtain a new value of p_h.

In short, if we call $\mathcal{H} : p \to p_h$ the mapping given by housing market clearing, and $\mathcal{P} : p_h \to p$ the mapping corresponding to the political equilibrium, we want to find a fixed point of $\mathcal{P} \circ \mathcal{H} : p_h \to p_h$.

Most of the numerical complications come from the need to look for roots of highly nonlinear and badly behaved functions (and systems).

To solve for the open city equilibrium I do the following:

Fix a tolerance level δ. Enter a given iteration j with a guess for the net-of-tax price of housing and bundle of public goods $\left(p_h^{(j)}, \boldsymbol{g}^{(j)}\right)$. Then,

1. Use the conditions for a political equilibrium to find $\boldsymbol{g}^{(j+1)}$. That is, solve

$$\sum_{i=1}^{I} \mu_i \left(p_h^{(j)}, \boldsymbol{g}^{(j)}\right) F_i \left(y_i^* \left(g_k^{(j+1)}; g_{-k}^{(j+1)}\right), p_h^{(j)}, \boldsymbol{g}^{(j)}\right) = \frac{1}{2} \left(\sum_{i=1}^{I} \mu_i \left(p_h^{(j)}, \boldsymbol{g}^{(j)}\right)\right)$$

   for $k = 1, \ldots, K$.

2. Find the implied gross-of-tax price of housing:

$$p^{(j+1)} = p_h^{(j)} + \frac{c\left(\boldsymbol{g}^{(j+1)}\right)}{H^s\left(p_h^{(j)}\right)}.$$

3. Find the new net-of-tax price of housing that clears the housing market. That is, solve for $p_h^{(j+1)}$ in

$$H^s\left(p_h^{(j+1)}\right) = \sum_{i=1}^{I} \mu_i \left(p_h^{(j)}, \boldsymbol{g}^{(j)}\right) \int_{\underline{y_i}}^{\bar{y_i}} h\left(p^{(j+1)}, y\right) f_i\left(y; p_h^{(j)}, \boldsymbol{g}^{(j)}\right) dy.$$

4. If $\left|p_h^{(j+1)} - p_h^{(j)}\right| < \delta$ stop. Otherwise, repeat 1-3 starting with a guess $\left(p_h^{(j+1)}, \boldsymbol{g}^{(j+1)}\right)$.

A couple of observations about this algorithm. First, note that all demographic variables are held constant through each pass of the equilibrium conditions. This is due to the myopic voters assumption. Second, nothing guarantees that this algorithm will converge to a solution. In fact, experimentation shows that under some parameterizations, prices tend to blow up. A way to deal with this is to use "dampening" in each iteration. This is done by setting the new guess of the net-of-tax price as a weighted average of the value that clears the housing market and the previous guess, i.e.

$$p_h^{(j+1)} = w\tilde{p}_h + (1-w)\, p_h^{(j)} \quad \text{for} \quad 0 < w < 1$$

where $\tilde{p}_h$ is the price that clears the market in step 3 of the algorithm. Choosing the right dampening weigh w can also accelerate the convergence of the algorithm considerably.

Solving the system in point 1 is expensive since every evaluation ...Every evaluation of the equations in point 1 above requires one maximization and finding two roots for each of the $k = 1, \ldots, K$ equations and each of the groups $i = 1, \ldots, I$. The maximization is to find the bliss point of each public good g_k given a price p_h, an income y, and a value for the other public goods g_{-k}:

$$\begin{aligned} B_k^i\left(g_k; y, p_h\right) &= \max_g V_i\left(g_k, \boldsymbol{g}_{-k}, p_h, y\right) \\ s.t. \qquad & p = p_h + \frac{c\left(g_k, \boldsymbol{g}_{-k}\right)}{H^s\left(p_h\right)} \end{aligned}$$

Then, when we evaluate $y_i^*\left(g_k; \boldsymbol{g}_{-k}\right)$ we need to find the root of $g_k - B_k^i\left(g_k; y, p_h\right)$.

Given the utility function I assumed in my numerical exercises, the market clearing condition in point 3 is

$$Lp_h^{\epsilon} = \frac{1}{p}\left(\gamma_1 E y_1 + \gamma_2 E y_2\right)$$

where Ey_i is the mean income of the urban population of group i. Hence, to update the net-of-tax price in the last step I use

$$p_h^{(j+1)} = \left(\frac{1}{Lp^{(j+1)}}\left(\gamma_1\left(Ey_1\right)^{(j)} + \gamma_2\left(Ey_2\right)^{(j)}\right)\right)^{\frac{1}{\epsilon}}$$

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