ESSAYS ON PREFERENCES FOR REDISTRIBUTION

Dilara Tosu

University of Girona

DOCTORAL THESIS

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This thesis is dedicated to:
My dear parents "Melahat Orhan Tosu" and "Ilhami Tosu",
thank you for your unconditional love.

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Abstract

This dissertation explores individuals' attitudes towards redistribution. Chapter 1 and Chapter 2 present two dynamic theoretical models that are used to analyze the interrelation between education decisions and preferences for redistribution. Chapter 3 uses an empirical approach to study the relationship between segregation, which is measured by assortative mating, and the demand for redistribution.

In Chapter 1, the individual cost of acquiring higher education depends on the level of education attained by the parents in a setting with no borrowing constraints. This difference in education costs for a given ability leads to unequal opportunities across individuals. Then, the poorer-uneducated individuals demand redistribution whereas the rich-educated oppose it. I provide a full characterization of the equilibrium. If the returns to education are large and inequality of opportunity is low, the equilibrium is characterized by a majority of educated individuals and no redistribution. If the returns to education are low and/or the inequality of opportunities is large, the economy may end up at a corner solution with no education and no redistribution. An equilibrium with a majority of uneducated people and positive redistribution also exists for intermediate values of the parameters. Finally, the equilibrium is not always unique.

In Chapter 2, parents choose the education level for their children, who can have high or low innate earning-ability, in a framework with borrowing constraints. The properties of preferences for redistribution are conventional when the cost of education is low or when the returns to education are salient. In contrast, when the cost of education is high and the returns to education are relatively low then non-conventional results occur. First, the coalition of the educated may demand a positive (although low) level of redistribution. The latter happens when the proportion of educated individuals is higher than the proportion of low ability earners. Second, the uneducated individuals with high earning ability collude with the educated to oppose redistribution policy if the proportion of low ability individuals is larger than the educated.

In Chapter 3, we study the relationship between segregation and preferences for redistribution by using the data from 8 rounds of ESS between the years 2002-2016 and the IPUMS. We use the incidence of assortative mating in terms of education, occupation, and nativity to infer the level of segregation within 111 regions in 10 European countries. We find that increased socioeconomic segregation in most forms of assortative mating leads the affluent to support less redistribution.

KEYWORDS: *preference for redistribution; education decision; assortative mating; segregation*

Resumen

Esta tesis explora las actitudes de los individuos hacia la redistribución. Los capítulos 1 y 2 presentan dos modelos teóricos dinámicos que se utilizan para analizar la interrelación entre las decisiones educativas y las preferencias de redistribución. El Capítulo 3 utiliza un enfoque empírico para estudiar la relación entre la segregación, que se mide mediante el apareamiento selectivo, y la demanda de redistribución.

En el Capítulo 1, el coste individual de adquirir educación superior depende del nivel de educación alcanzado por los padres en un entorno sin restricciones de endeudamiento. Esta diferencia en los costes de educación genera desigualdad de oportunidades entre los individuos. En este contexto, los individuos más pobres y sin educación exigen redistribución, mientras que los ricos con educación se oponen. Proporciono una caracterización completa del equilibrio. Si los retornos a la educación son grandes y la desigualdad de oportunidades es baja, el equilibrio se caracteriza por una mayoría de individuos educados y sin redistribución. Si los retornos a la educación son bajos y / o la desigualdad de oportunidades es grande, la economía puede terminar en una solución de esquina sin educación y sin redistribución. También existe un equilibrio con una mayoría de personas sin educación y una redistribución positiva para los valores intermedios de los parámetros. Finalmente, el equilibrio no siempre es único.

En el Capítulo 2, los padres eligen el nivel de educación para sus hijos, que pueden tener una capacidad de ingresos innata alta o baja, en un modelo con restricciones de endeudamiento. Las propiedades de las preferencias para la redistribución son convencionales cuando el coste de la educación es bajo o cuando los retornos a la educación son elevados. Por el contrario, cuando el coste de la educación es alto y el rendimiento de la educación es relativamente bajo, se producen resultados no convencionales. Primero, la coalición de educados puede exigir un nivel positivo (aunque bajo) de redistribución. Esto último ocurre cuando la proporción de individuos educados es más alta que la proporción de personas con bajos ingresos. En segundo lugar, las personas sin educación con alta capacidad de ingresos se unen a las personas educadas para oponerse a la política de redistribución si la proporción de personas con baja capacidad es mayor que la de los educados.

En el Capítulo 3, estudiamos la relación entre la segregación y las preferencias de redistribución utilizando los datos de 8 rondas de ESS entre los años 2002-2016 y el IPUMS. Utilizamos la incidencia del apareamiento selectivo en términos de educación, ocupación y natividad para inferir el nivel de segregación de 111 regiones en 10 países europeos. Encontramos que una mayor segregación socioeconómica en la mayoría de las formas de apareamiento selectivo lleva a los ricos a apoyar una menor redistribución.

PALABRAS CLAVE: *preferencia por la redistribución; decisión educativa; apareamiento selectivo; segregación*

Resum

Aquesta tesi explora les actituds dels individus envers la redistribució. El capítol 1 i el capítol 2 presenten dos models teòrics dinàmics que s'utilitzen per analitzar la interrelació entre les decisions d'educació i les preferències de redistribució. El capítol 3 utilitza un enfocament empíric per estudiar la relació entre la segregació, que es mesura mitjançant l'aparellament selectiu, i la demanda de redistribució.

Al capítol 1, el cost individual de l'adquisició d'educació superior depèn del nivell educatiu dels pares en un entorn sense restriccions d'endeutament. Aquesta diferència en els costos d'educació genera desigualtat oportunitats entre els individus. Es troba que els individus més pobres sense educació demanen una redistribució mentre que els rics educats s'hi oposen. Proporciono una caracterització completa de l'equilibri. Si el retorn a l'educació és gran i la desigualtat d'oportunitats és baixa, l'equilibri es caracteritza per una majoria d'individus educats i sense redistribució. Si la rendibilitat a l'educació és baixa i / o la desigualtat d'oportunitats és gran, l'economia pot acabar en una solució de cantonada sense educació i sense redistribució. També existeix un equilibri amb la majoria de persones sense educar i una redistribució positiva per als valors intermedis dels paràmetres. Finalment, l'equilibri no sempre és únic.

Al capítol 2, els pares escullen el nivell d'educació dels fills, que poden tenir una capacitat d'ingressos innata alta o baixa, en un model amb limitacions a l'endeutament. Les propietats de les preferències per a la redistribució són convencionals quan el cost de l'educació és baix o quan els rendiments a l'educació són elevats. En canvi, quan el cost de l'educació és elevat i el retorn a l'educació és relativament baix, es produeixen resultats no convencionals. En primer lloc, la coalició dels educats pot exigir un nivell de redistribució positiu (encara que baix). Això succeeix quan la proporció d'individus educats és superior a la proporció de persones amb baixa capacitat d'ingressos. En segon lloc, els individus sense educació amb alta capacitat d'ingressos creen una coalició amb els educats per oposar-se a la política de redistribució si la proporció d'individus de baixa capacitat d'ingressos és més gran que la proporció d'individus amb educació.

Al capítol 3, estudiem la relació entre la segregació i les preferències per a la redistribució mitjançant l'ús de les dades de 8 rondes d'ESS entre els anys 2002-2016 i l'IPUMS. Utilitzem la incidència de l'aparellament selectiu en termes d'educació, ocupació i naixement per inferir el nivell de segregació dins de 111 regions de 10 països europeus. Trobem que l'augment de la segregació socioeconòmica en la majoria de formes d'aparellament selectiu porta als més rics a recolzar una menor redistribució.

PARAULES CLAU: *preferència per a la redistribució; decisió sobre educació; aparellament selectiu; segregació*

Contents

List of Abbreviations

ESS	European Social Survey
EU-LFS	European Union Labor Force Survey
EU-SILC	European Union Statistics on Income and Living Conditions
IMF	International Monetary Fund
IPUMS	Integrated Public Use Microdata Series
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
POUM	Prospect of Upward Mobility
PSID	Panel Study of Income Dynamics

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Introduction

Income inequality has been rising over the past three decades in most countries. The Gini coefficient is at an average of 0.318 in 2013 and 2014 across OECD countries which is the highest value in history since the mid-1980s (OECD, 2016). The top earners benefit most from economic growth, e.g, a striking example is the United States, where 47 % of the total growth in pre-tax income went to the top 1% between 1975 and 2012 (OECD, 2015).

The rise in the earnings gap between rich and poor has an aftermath in terms of lower economic growth and unequal opportunities. It is well established that income inequality has an negative impact on growth (see Alesina and Rodrik, 1994; Persson and Tabellini, 1994). Corak (2013) finds that there is less upward mobility across generations in countries with more income inequality. Zhang and Eriksson (2010) find that inequality of opportunity, defined by differences of parents' earnings, and income inequality is positively correlated by using data from China.

Inequality is a chosen macroeconomic result and some countries will fail to create shared prosperity while others succeed (Stiglitz, 2015). The institutions and policies chosen by societies have a significant role in explaining differences in income inequalities across countries (Piketty & Saez, 2014). Transfers, e.g., unemployment and family cash benefits, are one important way of reducing the variations in income. Redistributive policies play a significant role in lowering income inequality. According to the Dabla-Norris et al. (IMF 2015 report), an increase in the proportion of government redistributive spending relative to the total spending by 7.1 percent is linked to a 0.6 percent decrease in income inequality.

The size of redistribution is determined by the state or by a collective choice. The literature is divided into two separate views. One view favors normative aspects and advocates the government role in redistribution (e.g., Boadway and Keen, 2000; Boadway et al., 2002; Schokkaert et al., 2004; Fleurbaey and Maniquet, 2006; Luttens and Ooghe, 2007). The other view is related to positive aspects and emphasizes individuals' preferences for income distribution. In the political-economy literature, early studies done by Romer (1975), Roberts (1977) and Meltzer and Richard (1981).The tax rate for redistribution is chosen under the majority voting rule. Indeed, in most of the democratic countries, the income tax is determined through a political process. The government collects a personal income tax that shapes social reforms through income redistribution.

The objective of the dissertation is two-fold:

In Chapter 1 and Chapter 2, I present a dynamic theoretical model to explain the interaction between education decisions and the political economy of redistribution. In both chapters, the tax is proportional to the individual's income and imposed on everyone. Transfers are shared equally by all. I analyze the long-term behavior of the proportion of educated individuals by using the Markov chain.

In Chapter 1, I focus on differences in socioeconomic background, assuming away borrowing constraints to invest in education. These differences disappear once all parents are educated. I characterize the equilibrium in terms of the relative size of returns to education and inequality of opportunity, measured as the difference in costs of attaining education by children of educated and uneducated parents.

In Chapter 2, I study the differences in earning ability that are innate to the individual and do not disappear over time. The costs of attaining education are equal for all but, now, not everyone can afford them. I characterize the equilibrium in terms of the relative size of returns to education and the innate differences in productivity between high and low earners. The financial cost of education is also important in this model and generates two scenarios: a low education cost and a high education cost scenario.

When the education cost is low, everyone is educated in the long run, but there will still be some redistribution at equilibrium if the majority of individuals are born with low earning abilities.

When the education cost is high, only the educated can afford the education of their children. Then, the initial proportion of educated individuals in the economy replicates itself in the long run, and the equilibrium depends both on the size of this proportion and the proportion of low earning ability individuals in the economy. If returns to education are very large, the equilibrium implies zero redistribution if the majority of the population is educated from the outset. In contrast, if the majority is uneducated, there is redistribution at equilibrium and this can be large if the proportion of low ability earners in the economy is large. If the return to education is low relative to the innate earning differences, then there are two possible equilibrium outcomes. The coalition of the educated prefer a low level of redistribution and the coalition of the uneducated demand a medium level of redistribution in an environment where the proportion of the educated individuals is larger than the low-ability earners. On the other hand, if the uneducated and high-ability earner and the educated individuals constitutes a coalition to oppose redistribution in an environment where the proportion of the low-ability earners individuals is larger than the educated.

In Chapter 3, we present an empirical analysis of the effect of segregation in society on preferences for redistribution. Segregation is a nonrandom distribution of people and can be measured by for example social positions, demographic characteristics, race, language, religion, neighborhoods or marriages. We measure segregation by assortative mating. Inequality is positively linked with the tendency of people to choose their cohabiting partners from a similar social group. This association may constitute similar cultural values, socioeconomic status, education, ethnicity, or religion. Moreover, assortative mating has risen recently. In the early 1990s, spouses had very similar earnings in 33 percent of the working couples, today it is 40 percent (OECD, 2015).

The last chapter sheds new light on the role of segregation through assortative mating and individuals' attitudes toward redistribution at the regional level. We follow the paper Greenwood et al. (2014) to generate assortative mating indexes in terms of education, occupation, and nativity-status of the partners. We calculate the fraction of couples with the same socioeconomic status for each region as the actual matching then we compute the fraction of both partners have the same status randomly through contingency tables. The ratio of the actual to random matches yields the values for assortative mating. We use data from eight rounds of ESS (European Social Survey) between the years 2002-2016 for redistribution and the IPUMS (Integrated Public Use Microdata Series) for assortative mating indexes of 111 regions 10 European countries. The countries are Austria, Greece, Italy, France, Spain, Switzerland, Portugal, Poland, Ireland, and Slovenia.

We find that the incidence of couples at the same level of education, occupation, and nativity status is negatively associated with individuals' support for redistribution at the regional level. Particularly, the affluent display less support for redistribution in a segregated region. The results are in line with Bjorvatn and Cappelen (2003). They find that high-income individuals are socially detached from other groups in segregated regions due to high-income inequality. Thereby they may not be willing to demand redistribution. This negative association between segregation and redistribution is compatible with our work.

Chapter 1

Education Decisions and Preferences for Redistribution when Parental Education Matters

1.1 Introduction

The government collects individual income taxes which play an important role for social reforms through income redistribution. The income tax provides funding for public goods, programs and services, such as social security, public schools, roads, rail, housing, and cash transfers (e.g., unemployment, pensions, and family cash benefits). The standard economic analysis implies that the redistributive taxation policy involves a cost. It helps to reduce income inequality whereas it generates efficiency distortions in the labor market. In consideration of the efficiency-equity debate, the literature on income distribution can be classified into two strands. The first one is related to a normative perspective where governments determine the rate of redistribution to create an economy with a balance of productivity and equality (e.g., Boadway and Keen, 2000; Boadway et al., 2002; Schokkaert et al., 2004; Fleurbaey and Maniquet, 2006; Luttens and Ooghe, 2007). The second one is associated with a positive perspective where the redistribution policy is determined collectively by voters. The initial contributions to the determination of redistribution through a political process have been studied by Romer (1975), Roberts (1977) and Meltzer and Richard (1981). They use the median voter theorem to analyze the basic connection between income inequality and redistributive taxation policies.

The static model by Meltzer and Richard (1981) assumes that the median voter's only objective is to maximize his after-tax income and finds that the poor support redistributive policy whereas the rich oppose it. The current income is one of the essential determinants of preferences for redistribution. Nevertheless, in a dynamic environment, poor individuals may prefer less redistribution if they expect that they or their children will be rich in the future. Benabou and Ok (2001) develop Prospect of Upward Mobility (POUM) in which the expectation for upward social mobility affects the preferences for redistribution. Alesina and La Ferrara (2005) test the POUM hypothesis by constructing an index of income mobility for the U.S from the Panel Study of Income Dynamics (PSID). They find that when the likelihood of climbing up in the income ladder increases, then the individual's support for redistribution decreases. There is a negative correlation between the expected future income and approval of the redistributive policy. Ravallion and Lokshin (2000) show that currently better-off individuals tend to increase their taste for redistribution if they expect a fall in their welfare for Russia. In general, individuals do not know their actual probability of having upward or downward social mobility in the future. Their previous experiences of mobility may shape their optimistic or pessimistic perceptions for future mobility. Piketty (1995) focuses on the effect of personal history of mobility on the preferences for government's reducing income inequality policies.

In this paper, I contribute to the latter strand related to positive aspects where the policies for distribution of income determined through a political process and education decision is endogenous. I examine how inequality of opportunity affects an individual's decision for redistribution and higher education participation.

I construct a dynamic model in which individuals differ in their learning ability and parent's education. Education comes at a cost that depends on an individual's ability and her parent's education but there is no borrowing constraint.[1] This difference in education costs for a given ability leads to unequal opportunities. Individuals are aware of the impact of tax distortions on higher educational attainment.

The equilibrium is characterized concerning the relative size of returns to education and inequality of opportunity. If the return to education is low and/or the inequality of opportunities is large, the economy can end up at a corner solution in which there is neither redistribution nor higher educated individuals. A low level of inequality of opportunity is a necessary condition for an interior equilibrium where the uneducated favors redistribution whereas the educated opposes it. This conventional result holds simply because individuals are self-interested and they want to maximize

[1] Hare and Ulph (1981) analyze an optimal tax problem in the presence of imperfect capital markets to study its effects on wealth inequality, similarly to the work of Loury (1981).

their income.[2] If the return to education is large, and inequality of opportunity is low, there is an equilibrium with a majority of educated individuals and no redistribution. In contrast, for intermediate values of these parameters, the equilibrium with a majority of uneducated people and positive redistribution also exists. Finally, the equilibrium is not always unique.

This study relates to Del Rey and Racionero (2002), but differs in two crucial aspects. Del Rey and Racionero (2002) focus on the relation between optimal fiscal policies and educational choices whereas I model individual's private economic decisions in absence of a social planner where the most preferred income tax rate is determined through a political process. Moreover, in their model, a lump-sum subsidy is given to only individuals who acquire higher education. In the model presented here, the lump-sum subsidy is targeted to all individuals.

The remaining of the paper is organized as follows. Section 1.2 summarizes the related literature. In Section 1.3, I illustrate the main features of the model. The investment decision in higher education, the dynamics of the model by using the Markov chain, and lastly the individual's political preferences towards redistribution are explained. Section 1.4 contains the equilibrium results. The last section concludes.

1.2 Earlier Studies

A large body of literature investigate the political equilibria for redistribution policies. The seminal model is by Meltzer and Richards (1981), when the median income is less than the mean income, the median voter prefers a positive tax. The chosen tax rate is the ratio of the median to the mean income, a measure for the income inequality. Thus, high inequality implies a high rate of redistributive taxation.

There are some early and recent examples for the political-economic analysis of income distribution and education decisions. Creedy and Francois (1990) show that higher education has a positive impact on the growth of the economy and the earnings of the general growth are shared equally. Under the majority voting rule, the uneducated majority approves the policies to subsidize education due to the indirect gain via growth. Soares (2003) explains that self-interested individuals promote public spendings on education due to returns on capital, because education improves the next generation's skills. Fernandez and Rogerson (1995) analyze the political process

[2] Alesina and Giuliano (2009) and Isaksson and Lindskog (2009) also stress that individuals with higher education tend to be less supportive of redistribution. This negative association between educated individuals and support for redistribution is even stronger in developed economies with equality than in developing and highly unequal countries (Dion and Birchfield, 2010).

for education subsidies. The rich and middle class create a coalition against the poor when they vote. They support education subsidies although they do not want the poor to overcome the credit constraints with subsidies to obtain an education. They also find evidence that children from richer families tend to acquire more tertiary education than the children of the poor. So that the education subsidies are a way of transfers from the poor to the rich. Haupt (2012) argues that the expansion and the decline of public funding for higher education were political forces driven by skilled parents. Initially, the skilled parents support education subsidies because their children will benefit most from education. A higher subsidy promotes more individuals to obtain an education. Accordingly, it boosts the number of skilled individuals. They gain political power. The increase in the number of educated individuals leads the subsidies to be too expensive to afford so that supporters reduce their demand for public spending in education. They approve private contributions for higher education. He concludes that equality of opportunity rises during the expansion phase whereas it decreases during the decline phase.

Another strand of literature is growing on individuals' socioeconomic characteristics as determinants for preferences for redistribution. Some of the determinants are the belief in effort vs luck (Alesina and Angeletos, 2005), racial and ethnic heterogeneity (Alesina and Glaeser, 2004; Lupu and Pontusson, 2011), probability of becoming unemployed (Fernandez-Albertos and Manzano, 2016), individuals' occupation, i.e., being a public sector or a private sector worker Cusack et al. (2006).

Some studies examine the mobility and individual's demand for redistribution. Individuals who have a pessimist perception of intergenerational mobility are more inclined to embrace redistributive policies, and in particular, policies for equality of opportunity (see Alesina, Stantcheva and Teso, 2018). For instance, if Americans believe that there are equal opportunities for everyone then they tend to be more opposed to redistribution. Because they see higher social mobility as a substitute to redistribution as long as there are equal opportunities for all. Conversely, if they think that the inequality of opportunity exists then they may approve the redistributive policies (see Alesina and La Ferrara, 2005). Castillo and Perales (2019) contribute the literature by studying the limited effects of social origins on preferences for redistribution. The preferences of destination class shape the attitudes towards redistribution more than the preferences of origin class. Rainer and Siedler (2008) confirm the validity of the POUM hypothesis by using data from the German Socio-Economic Panel (SOEP). Their results indicate that the likelihood of having occupational upward mobility reduces the support for redistribution and vice versa.

Thus, expectation of occupational upward and downward mobility is an important determinant for attitudes towards redistribution.

1.3 The model

1.3.1 The basic environment of the model

I consider an economy in which individuals are heterogeneous concerning their ability and their family educational background. There are two types of individuals: some with educated parents and some with uneducated parents. Individuals live only for one period. They attend university, work and pay income taxes in the same period. At the end of the period, each adult gives birth to one child and dies. The size of population is 1 and its growth is zero. The timing of events is as follows. First, the level of the income tax rate is determined by the majority voting rule. Second, each individual makes her own decision about investing in education.[3] The ability level of individuals is denoted by a. It is stochastically determined at birth. For simplicity, I assume that a is uniformly distributed between 0 and 1.

Education influences earnings. The income of an educated individual is represented by $w+R$, where the parameter R is the return to education. R is same for all individuals. The income of uneducated individuals is denoted by w. The government levies a proportional income tax on all individuals. Let the tax rate be τ. It takes a value between 0 and 1. The government redistributes the tax revenue as a per capita transfer equally across all individuals. The government budget is always balanced. Let $\pi(\tau)$ stand for the proportion of educated individuals which is affected by the chosen tax. Let $\bar{y}$ denote the average income of individuals in the whole economy,

$$\bar{y} = w(1 - \pi(\tau)) + (w + R)\pi(\tau),$$

and the subsidy is $\tau\bar{y} = \tau(w+\pi(\tau)R)$. Higher education is privately provided and there are no liquidity constraints. Education involves a cost which depends on the education level of parents and the ability level of individuals. Let $\gamma_i C(a)$ represent the cost of education where the subscript i denotes parent's education; $i = 1$ if parents are educated and 0 otherwise.

Assumption 1 *Having tertiary education is more costly for individuals with uneducated parents than individuals with educated parents,* $\gamma_0 > \gamma_1$.

[3] I show that the reverse timing of events leads corner solutions, where the preferred tax rate is either 0 or 1 in Appendix A.1. The following papers have the same order of decisions as this paper has. See Creedy and Francois (1990), Soares (2003) and Haupt (2012) for voting over education subsidies; Traxler (2009a) for tax evasion, Traxler (2009b) for tax avoidance.

I support this assumption with the following references. According to OECD (2017) report, individuals whose at least one parent completed tertiary degree are more likely to acquire higher education than individuals whose parents both have less than tertiary degree completed. Oreopoulos et al. (2006) report that an increase in parental education leads to a decrease in the likelihood of a child repeating a schooling year or a grade. Moreover, Iannelli (2002) shows that parental education has a significant effect on the chances of leaving education early and of graduating from tertiary education. Bukodi and Goldthorpe (2013) suggest decomposing social origins into three components. They find that parents' education affects distinctively and significantly their children's educational attainment, as well as parental class and parental status.

The parameter γ_i indicates the influence of parent's education on the cost of having higher education of an individual. The cost function $C(.)$ is assumed to be a decreasing and convex function of an individual's ability. The opportunity cost of foregone earnings is ignored.

Let $\Delta\gamma$ be the difference of the effect parent's education such that $\Delta\gamma = \gamma_0 - \gamma_1$. If $\gamma_0 = \gamma_1$ then two individuals from two different backgrounds but with the same ability would make the exact same decision concerning education. In this case opportunities are equal. The larger $\Delta\gamma$ the more difficult it is for an individual with less educated parents, relative to an individual with more educated parents, to attain education. Hence, $\Delta\gamma$ is interpreted as a measure of inequality of opportunity. The model is resolved by backward induction. Let's begin with the education decision.

1.3.2 Investment in Education

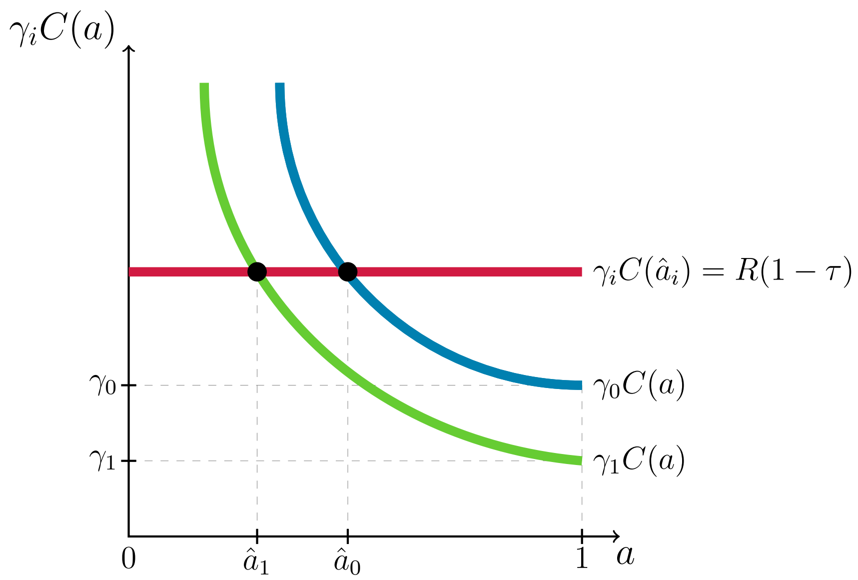
The education decision is explored for a given tax rate. The utility function is assumed to be linear in consumption. It is comprised of the net income, the public transfer, and the cost of education for educated individuals:

$$U_i(a, \tau, \pi) = (w + \hat{e}_i R)(1 - \tau) + \tau(w + \pi(\tau)R) - \hat{e}_i \gamma_i C(a) \tag{1}$$

$$i = \{1, 0\} \ \ and \ \tau \in (0, 1)$$

where $\hat{e}_i$ is an indicator function that takes one of two values: either 1, if an individual chooses to acquire higher education or 0, if not. The first term of the utility is the net labor income, the second term is the received subsidy, and the third term is the education cost for those that study.

Figure 1.1: The Threshold Ability Level



Individuals decide to invest in education by comparing their utility with and without education in the presence of a given tax rate. If the utility function with education is higher than the utility without education, $R(1-\tau) > \gamma_i C(a)$, then they prefer to attain higher education. Let $\hat{a}_i$ stand for threshold ability level such that individuals are indifferent to study or not. The threshold ability is determined by:

$$R(1-\tau) = \gamma_i C(\hat{a}_i) \text{ where } i = \{1, 0\}\,. \tag{2}$$

Remember that $C'(.) < 0, C''(.) > 0$. For tractability, I use the particular cost function $C(a) = \frac{1}{a}$, where $a \,\epsilon\, (0, 1]$. When we substitute the cost function of ability into equation (2), we obtain

$$\hat{a}_i = \frac{\gamma_i}{R(1-\tau)} \tag{3}$$

The education decision is summarized as follows

$$\hat{e}_i = \begin{cases} 0 & \text{if } a < \hat{a}_i, \\ 1 & \text{if } a \geq \hat{a}_i. \end{cases}$$

The individuals whose ability is larger than the threshold ability level will invest in higher education. For the sake of clarity, let us analyze how the educational background of parents and individual's learning ability level affect the decision making for participating in higher education using the following Figure 1.1.

In Figure 1.1, since by assumption $C(0) = \infty$, there will be always some individuals who do not choose to study due to their low-learning ability levels. Assumption 1 and equation (2) yield $\hat{a}_0 > \hat{a}_1$. All individuals with an ability level below $\hat{a}_1$ will decide not to attend university. Individuals with the ability between $\hat{a}_1$ and $\hat{a}_0$ will acquire education as long as their parents are educated. Finally, all individuals with ability level larger than $\hat{a}_0$ will attend university, independently of their family background. Additionally, among those who undertake higher education, individuals with uneducated parents are fewer but smarter than individuals who have educated parents.

The threshold ability level is a function of the tax, the return to education, and the effect of parent's education on having tertiary education, i.e., $\hat{a}_i = f\ (\tau,\ R,\ \gamma_i)$. Let us perform some comparative statics to understand the relationship between $\hat{a}_i$ and τ.

$$\frac{\partial \hat{a}_i}{\partial \tau} = \frac{\gamma_i}{R(1-\tau)^2} > 0, \tag{4}$$

$$\frac{\partial^2 \hat{a}_i}{\partial \tau^2} = \frac{2\gamma_i}{R(1-\tau)^3} > 0, \tag{5}$$

$$\frac{\partial^2 \hat{a}_i}{\partial \tau \partial R} < 0. \tag{6}$$

A marginal increase in the tax rate enhances the threshold ability level for all individuals to attain education. Hence, there are less people with tertiary education. Moreover, the marginal effect of the tax on the thresholds is even larger for higher levels of tax rates and for low levels of R. Redistribution leads to a decrease in the proportion of educated people in society.

1.3.3 Dynamics of the model

I next study how the proportion of educated individuals evolve over time. I use a Markov chain to analyze the dynamics of our model under given taxes. The proportions of educated and uneducated individuals are indicated by the steady-state vector Π. This probability vector represents also the initial state whose entries are non-negative and sum to 1. Let $\pi(\tau)$ and $1 - \pi(\tau)$ be the initial proportion of educated and uneducated people, respectively. The starting distribution of the Markov chain model and the steady state vector Π is:

$$\Pi = (1 - \pi(\tau),\ \pi(\tau)\ \ ).$$

Remember that the ability level is uniformly distributed. Thus, the threshold ability level corresponds to the probability of remaining uneducated. Let $\hat{a}_0(\tau)$ be the probability of remaining uneducated of an individual whose parents are uneducated whereas let $\hat{a}_1(\tau)$ stand for the probability of remaining uneducated of an individual whose parents are educated. The transition matrix is denoted by P and can be defined as below

$$P = \begin{bmatrix} \hat{a}_0(\tau) & 1-\hat{a}_0(\tau) \\ \hat{a}_1(\tau) & 1-\hat{a}_1(\tau) \end{bmatrix}$$

Let's analyze the long-term behavior of the Markov chain. Multiplying the transition matrix by the initial state vector gives us back the initial state vector so that the probabilities remain steady.

$$\Pi P = \Pi.$$

It follows that the long-run distribution of educated individuals is given by

$$\pi^*(\tau) \quad = \frac{1-\hat{a}_0(\tau)}{1-\hat{a}_0(\tau)\ +\hat{a}_1(\tau)} \tag{7}$$

In the long-run, if all individuals with educated parents obtain higher education, then everyone will be educated. Moreover, if none of the individuals with uneducated parents study, then no one will study.[4] The long-run behavior of π^* is:

$$\pi^* = \begin{cases} 1 & \text{if } \hat{a}_1 = 0, \\ 0 & \text{if } \hat{a}_0 = 1. \end{cases} \tag{8}$$

Lemma 1. *The interior equilibria*

The interior equilibria, $\pi^* \epsilon (0,1)$, *occur if*

$$R(1-\tau) > \gamma_0. \tag{9}$$

Proof. Refer to equation (8), when $\hat{a}_0 = 1$ then no one studies. Then there is nothing to redistribute. When we put $\hat{a}_0 = 1$ into equation (2) then $\gamma_0 = R(1-\tau)$. Then we know that if $R(1-\tau) < \gamma_0$, there is a corner equilibrium, $\pi^* = 0$ and $\tau^* = 0$. □

By substituting equation (3) back into equation (7), $\pi(\tau)$ for a given τ is as follows:

$$\pi(\tau) = \frac{R(1-\tau)-\gamma_0}{R(1-\tau)-\Delta\gamma} \tag{10}$$

Let us perform comparative statics analysis to analyze the link between the proportion of the educated and τ.

$$\frac{\partial \pi}{\partial \tau} = \frac{-R\gamma_1}{(R(1-\tau)-\Delta\gamma)^2} < 0 \tag{11}$$

[4] According to equation (2), the return to education goes to infinity when $\hat{a}_1 = 0$ due to the specific cost function assumption and $C(a) = \frac{1}{a}$. As a result of infinite returns, everyone studies, $\pi = 1$. I do not consider this rare case therefore $a\epsilon\,(0,1]$.

$$\frac{\partial^2 \pi}{\partial \tau^2} = \frac{-2R^2\gamma_1}{(R(1-\tau)-\Delta\gamma)^3} < 0 \tag{12}$$

We know that equation (12) is negative by Lemma 1. Thus, the proportion of educated individuals is a decreasing and concave function in τ.

Individuals are aware of the negative effect of higher taxes on the tertiary educational attainment. Higher taxes reduce the incentive to study and the income revenue of the government, and accordingly the received transfer.[5]

1.3.4 Voting on taxes

In this subsection, I analyze voting over the redistributive tax policy. Individuals are rational and they choose the income tax to maximize their utility. I summarize the voting results in Proposition 1.

Proposition 1. ***Equilibrium level of redistribution***

If the uneducated are the majority then they favor redistribution in equilibrium. However, if the educated are the majority then they choose zero tax.

$$\tau^* = \begin{cases} 0 & \text{if } \pi \geq \frac{1}{2}, \\ 1 - \frac{\Delta\gamma + \sqrt{(R-\Delta\gamma)\gamma_1}}{R} & \text{if } \pi < \frac{1}{2} \end{cases}$$

Proof. The income tax rate is determined by the majority voting rule. Individuals vote on the level of the income tax rate to maximize their utility. When an individual anticipates that he undertakes higher education, then the most preferred tax rate of an educated individual is given by the solution to

$$Max_\tau (w+R)(1-\tau) + \tau(w + \pi(\tau)R) - \gamma_i C(a).$$

The first order condition is:

$$R\left(\pi(\tau^*) - 1 + \tau^* \frac{d\pi}{d\tau^*}\right) < 0. \tag{13}$$

From equation (11), we know that $\partial\pi/\partial\tau$ is negative and π is less than 1. Thus the first order condition is negative. The utility goes down as the median voter moves away from the zero tax. The preferences are single-peaked over a single-dimensional policy space. Therefore, when the median voter expects to be an educated individual in the future then the majority will be educated, $\pi \geqslant \frac{1}{2}$, and the most preferred policy is zero redistribution.

[5] In the overlapping generations model of Persson and Tabellini (1994), redistributive taxation also affects investment in human capital.

If an individual thinks that he will not acquire higher education, then he only considers the net transfer that he will gain from the redistribution. Let us proceed with the maximization problem of an uneducated individual which is represented as below

$$Max_\tau w(1-\tau) + \tau(w + \pi(\tau)R).$$

The first order condition is:

$$\pi(\tau^*)R + \tau^* R\frac{d\pi}{d\tau^*} = 0. \tag{14}$$

Let's substitute equation (10) and (11) into the first order condition, which gives us the most preferred tax rate :[6]

$$\tau^* = 1 - \frac{\Delta\gamma + \sqrt{(R-\Delta\gamma)\gamma_1}}{R} \tag{15}$$

The utility function is concave in τ^* so that the tax rate (15) is the local maximum of $U(\tau)$. The preferences are single-peaked in utility function[7].

In the first stage, if the median voter anticipates that he will not obtain higher education, $\pi \leqslant \frac{1}{2}$, then he favors redistribution, $\tau^* > 0$. □

1.4 Equilibrium Results

In this section, I analyze the preferences of the median voter who is the decisive voter, to determine the equilibrium outcome. I investigate how the proportion of educated individuals affects the degree of redistribution. The equilibrium outcomes are in the following Proposition 2.

Proposition 2. ***Equilibrium Results***

i. *The unique equilibrium with an educated majority and zero redistribution occurs iff*

$$R > \gamma_0 + 3\gamma_1.$$

ii. *The unique equilibrium with an uneducated majority and positive redistribution occurs iff*

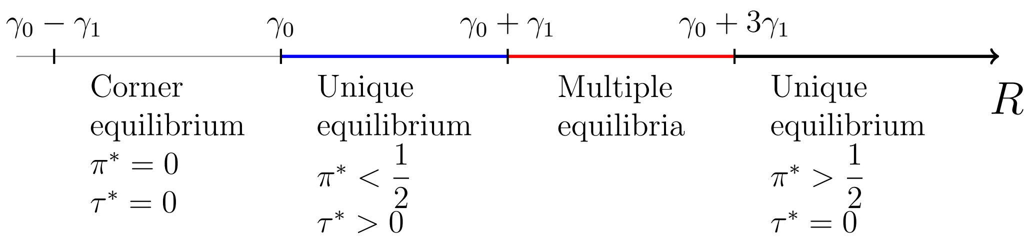
$$\gamma_0 < R < \gamma_0 + \gamma_1.$$

[6] Proof in appendix A.2.
[7] Proof in appendix A.2.

iii. *Multiple equilibria* $\pi^* \geqslant \frac{1}{2}$ *and* $\tau^* = 0$ *or* $\pi^* \leqslant \frac{1}{2}$ *and* $\tau^* > 0$ *occur if*

$$\gamma_1 + \gamma_0 \leqslant R \leqslant 3\gamma_1 + \gamma_0.$$

Figure 1.2: The Range of R



Proof. First, let us consider an economy with an educated majority and no redistribution. By Proposition 1, $\tau^* = 0$ if $\pi \geqslant \frac{1}{2}$. Now let us prove that when the tax is zero, then the majority is educated, $\pi^* \geqslant \frac{1}{2}$. By substituting zero tax into equation (10) we obtain $\pi^* = \frac{R-\gamma_0}{R-\Delta\gamma}$, which is larger than 1/2 iff $R \geqslant \gamma_0 + \gamma_1$. The established result:

$$\tau^* = 0 \text{ } and \text{ } \pi^* \geqslant \frac{1}{2} \text{ } IFF \text{ } R \geqslant \gamma_0 + \gamma_1. \tag{16}$$

Second, let us consider an economy with an uneducated majority and positive redistribution. By Proposition 1, the uneducated median voter maximizes his utility with the positive tax rate (15), i.e., $\tau^* > 0$ if $\pi \leqslant \frac{1}{2}$. We prove that if $\tau^* > 0$, then $\pi^* \leqslant \frac{1}{2}$. By substituting the positive tax rate into equation (10) we obtain $\pi^* = 1 - \frac{\sqrt{\gamma_1}}{\sqrt{R-\Delta\gamma}}$, which is smaller than 1/2 IFF $R \leqslant \gamma_0 + 3\gamma_1$. We obtain the result:

$$\tau^* > 0 \text{ } and \text{ } \pi^* \leqslant \frac{1}{2} \text{ } IFF \text{ } R \leqslant \gamma_0 + 3\gamma_1. \tag{17}$$

Lastly, to avoid corner solution, we substitute zero tax and the positive tax rate (15) into equation (9) to derive the specified conditions for an interior equilibrium in Lemma 1. We obtain

$$\pi^* \epsilon (0, 1) \text{ and } \tau^* \epsilon [0, 1) \text{ if } R > \gamma_0.$$

In Figure 1.2, I illustrate the uniqueness of the equilibrium types and the multiplicity of equilibria by using the equilibrium outcomes (16) and (17). The interior equilibria exist when the return to education is larger than γ_0; otherwise the corner solution occurs. For a low level of R, there is a unique equilibrium where the majority of individuals are uneducated and they have a pro-redistributive behavior. However, for a medium level of R, either the equilibrium of uneducated majority and positive redistribution or the equilibrium with educated majority and zero redistribution may occur. The expectations about being educated or not play a role in here. Finally, when returns to education are sufficiently large, then there is a unique equilibrium in which the majority of people acquire higher education and they prefer zero redistribution.

$\square$

In Figure 1.3, I illustrate each type of equilibrium of Proposition 2. From equations (11) and (12), we know that the proportion of educated individuals in the population is decreasing and concave in τ. At the same time, τ can take two values depending on $\pi \lesseqgtr \frac{1}{2}$. Moreover, it never touches the x-axis, $\pi \neq 0$, by Lemma 1. In Figure 1.3(b), when $\gamma_0 < R \leqslant \gamma_0 + \gamma_1$ there is an unique equilibrium where the green curve and red line cross only once. Then τ is the positive tax rate given by (15), where $\pi \in \left(0, \frac{1}{2}\right)$. In Figure 1.4(c), when $\gamma_1 + \gamma_0 \leqslant R \leqslant 3\gamma_1 + \gamma_0$ multiple equilibria occur where the green curve and red line cross twice. The last figure 1.5(d) depicts an unique equilibrium where the green curve and red line cross only once. When $R > \gamma_0 + 3\gamma_1$, $\pi \in \left(\frac{1}{2}, 1\right)$ then the τ is always zero.

To understand the relationship between the parameters γ_i, R and the variables $\hat{a}_i$, π^*, τ^* at the equilibrium level, I perform comparative statics analysis summarized in Corollary 1.

Corollary 1. *Comparative Static Analysis*

Let the conditions of the unique equilibrium with an uneducated majority and positive redistribution be satisfied; i.e., $\gamma_0 < R < \gamma_0 + \gamma_1$. *Then the following results hold.*

i. *An increase in* γ_0 *reduces* $\hat{a}_1^*$, τ^* *and* π^*, *while it raises* $\hat{a}_0^*$;

$$\frac{\partial \hat{a}_0^*}{\partial \gamma_0} > 0, \ \frac{\partial \tau^*}{\partial \gamma_0} < 0, \ \frac{\partial \hat{a}_1^*}{\partial \gamma_0} < 0, \ \frac{\partial \pi^*}{\partial \gamma_0} < 0.$$

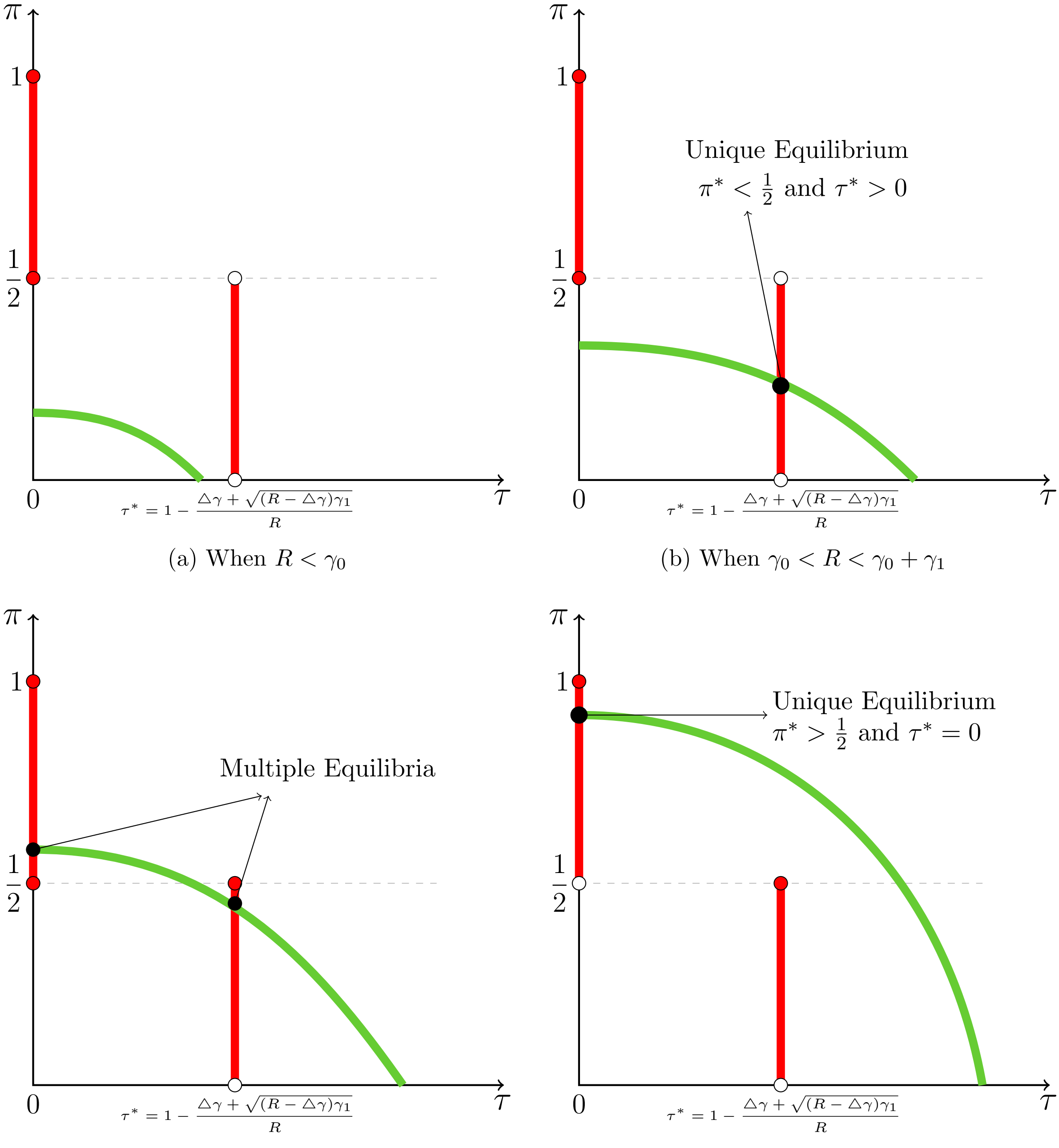
ii. *An increase in* γ_1 *increases* $\hat{a}_i^*$ *and* τ^*, *while it decreases* π^*;

$$\forall i \in \{0,1\}, \ \frac{\partial \hat{a}_i^*}{\partial \gamma_1} > 0, \ \frac{\partial \tau^*}{\partial \gamma_1} > 0, \ \frac{\partial \pi^*}{\partial \gamma_1} < 0.$$

iii. *An increase in* R *reduces* $\hat{a}_i^*$, *while it increases* π^* *and* τ^*;

$$\forall i \in \{0,1\}, \ \frac{\partial \hat{a}_i^*}{\partial R} < 0, \ \frac{\partial \tau^*}{\partial R} > 0, \ \frac{\partial \pi^*}{\partial R} > 0.$$

Figure 1.3: Each Equilibrium Type



(a) When $R < \gamma_0$

(b) When $\gamma_0 < R < \gamma_0 + \gamma_1$

(c) When $\gamma_0 + \gamma_1 \leq R \leq \gamma_0 + 3\gamma_1$

(d) When $R > \gamma_0 + 3\gamma_1$

Let the conditions of the unique equilibrium with an educated majority and no redistribution be satisfied; i.e., $R > \gamma_0 + 3\gamma_1$. Then the following results hold.

iv. *An increase in γ_i increases $\hat{a}_0^*$ and $\hat{a}_1^*$, while it decreases π^*.*

$$\forall i \in \{0, 1\}\,, \ \frac{\partial \hat{a}_0^*}{\partial \gamma_i} > 0, \frac{\partial \hat{a}_1^*}{\partial \gamma_i} > 0, \ \frac{\partial \pi^*}{\partial \gamma_i} < 0.$$

v. *An increase in R decreases $\hat{a}_i^*$, while it increases π^*.*

$$\forall i \in \{0, 1\}\,, \ \frac{\partial \hat{a}_i^*}{\partial R} < 0, \ \frac{\partial \pi^*}{\partial R} > 0.$$

Proof. See Appendix A.3. □

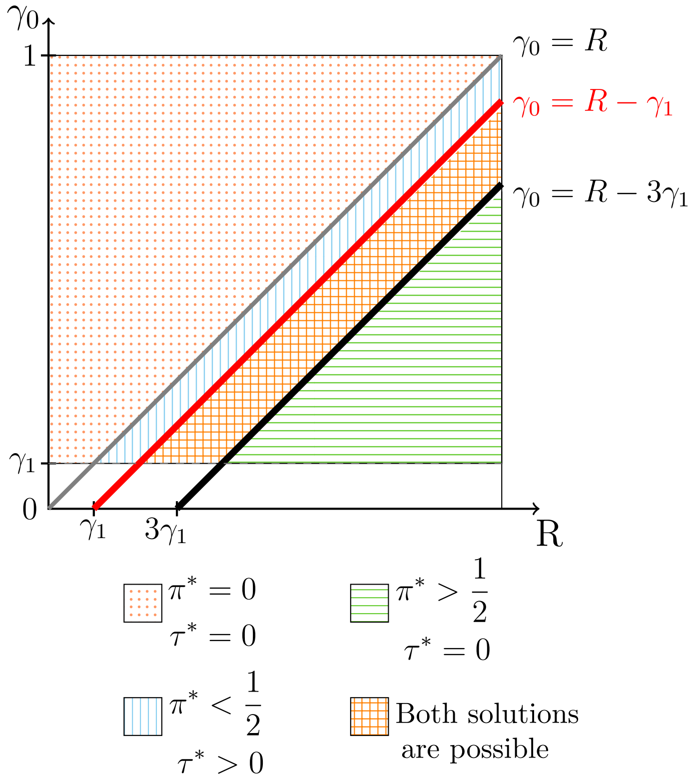
According to the results for the equilibrium of an uneducated majority and positive redistribution based on Corollary 1, a marginal increase in γ_0 (i.e it also implies an increase in inequality of opportunity, $\Delta\gamma$) generates two direct effects. Firstly, it increases $\hat{a}_0^*$, i.e., the threshold ability level for individuals with uneducated parents. Secondly, it decreases the chosen tax level, τ^*, and consequently, the net returns to education boosts. Higher net returns make tertiary education more desirable for all individuals. More people with educated parental background attain higher education. However, fewer individuals with uneducated parents obtain tertiary education because the increase in γ_0 has a more dominant effect on $\hat{a}_0^*$ than τ^* . In sum, there are fewer educated people; π^* decreases.

An increase in the effect of parents' education reduces the chosen tax rate, which entails an increase in net returns to education. The basic intuition behind this result is that the uneducated majority might face a trade-off: a higher chosen tax brings not only higher redistribution rate but also a low educational attainment particularly for individuals with an uneducated parents background. Thus, the uneducated majority may prefer lower redistribution to to keep education desirable.

Lastly, an increase in γ_1 leads to fewer individuals with tertiary education but higher redistribution. It increases directly the cost of education for individuals with educated parents. Furthermore, it raises the chosen tax rate so that there is less net return to education for all individuals. Hence, there are fewer educated people and less upward mobility. Finally, the effect of R is as expected. The threshold ability levels $\hat{a}_i$ decreases with R whereas π and τ raise with R.

Figure 1.4 indicates all possible equilibria. The effect of uneducated parents on the cost of individual's education, γ_0, is placed on the y-axis. Notice that the relevant area is where $\gamma_0 > \gamma_1$ by *Assumption 1.* On the x-axis, there is the return to education,

Figure 1.4: All Equilibrium Types Together



R. The 45^o line is where $R = \gamma_0$. Let us substitute the zero tax or positive tax rate (15) into equation (10) in Lemma 1 to obtain that interior equilibrium occur when $R > \gamma_0$. Thus in the dotted area where $R < \gamma_0$, the corner solution occurs such that $\pi^* = 0$ and $\tau^* = 0$. The green horizontal lined area fulfills the condition for *Proposition 1,* which is $R > \gamma_0 + \gamma_1$. In this area, there is an equilibrium where the educated majority opposes redistribution. The area with blue vertical lines fulfills the condition of *Proposition 1* when $R < \gamma_0 + 3\gamma_1$, the equilibrium where the majority is uneducated and the redistribution is positive. Lastly in the checkered area, there are multiple equilibria when $\gamma_1 + \gamma_0 \leqslant R \leqslant 3\gamma_1 + \gamma_0$.

An increase in γ_1 leads $\Delta\gamma$ to be low but the cost of education is higher for all individuals so that everyone is worse off. For a very high level of γ_0, there is always a corner solution, $\pi^* = 0$ and $\tau^* = 0$, regardless of the level of R. For a medium level of γ_0 and R, there is an uneducated majority which favors redistribution. On the other hand, there is an educated majority which prefers zero redistribution when R is large and γ_0 is low enough . In the checkered area, one of the two equilibrium types may occur depending on the expectations of individuals about other individual's education decision.

To sum up, a relatively low level of inequality of opportunity is necessary but not sufficient for ensuring the educated majority (the green area). A large R is also needed although it does not guarantee to have an educated majority. The interaction of these parameters determine the equilibrium type. Conversely, the combination of low returns to education and high inequality of opportunity yields a corner equilibrium with no education and no redistribution.

1.5 Concluding Remarks

This paper studies the interrelation between endogenous education decisions and preferences for redistribution. I focus on differences in the socioeconomic background where there are no financial constraints to invest in education. The education decision of an individual depends on his learning ability, his parent's educational background, and the chosen redistribution policy. The inequality of opportunity is measured as the difference in the costs of attaining education by children of educated and uneducated parents.

Individuals take into account the disincentive effects of the taxes on the proportion of educated people when they vote on taxes. For instance, the uneducated majority demands less redistribution because they face a trade-off: a higher chosen tax brings not only higher redistribution but also low educational attainment for the individuals with uneducated parents. Individuals know that those people who obtain education will give up on investing in higher education at some point when optimal tax is very high. The redistribution policy is long-lasting. Thus, the uneducated majority expect to be worse off in the future if they expropriate the educated minority today. Therefore, they demand less redistribution.

The model produces two types of equilibria where either an uneducated majority is in favor of redistribution or the educated majority is averse to it. The interaction of inequality of opportunity and the returns to education play a crucial role in the choice of participating in higher education and redistribution level. I provide a full characterization of the equilibrium. For a low return to education and large inequality of opportunity, there will be neither redistribution nor higher educated individuals. In the model, if the return to education is large and inequality of opportunity is low, the equilibrium is with a majority of educated individuals and no redistribution.

However, for intermediate values of these parameters, there is an equilibrium with an uneducated majority and positive redistribution.

Chapter 2

Education Decisions and Preferences for Redistribution when Family Income Matters

2.1 Introduction

In the majority of democratic countries, the size of public transfers is determined through a political process. Since 2010, redistribution through income taxes and transfers has reduced in most of the advanced economies (OECD, 2016). The early seminal contributions in standard political-economy models of redistribution have been done by Romer (1975), Roberts (1977) and Meltzer and Richard (1981). Romer (1975) studies that the linear tax rate is determined through a majority voting where the preferences are single-peaked. Roberts (1977) develops a model where labor supply is endogenous and taxes are distortionary. Under general assumptions, a Condorcet winner exists where it is the tax rate preferred by the voter who has a median income. Meltzer and Richard (1981) extend the standard model by studying income inequality. They find that the effect of increasing inequality is positive on redistribution demand where the linear tax rate determined by the median voter theorem.

This paper focuses on the effect of innate earning ability level (high and low) and education heterogeneity on the demand for redistribution. Individuals subject to financial restrictions to choose the education level for their children. The main assumption is that education is always a profitable investment and educated parents can afford the education of their children (e.g. Acemoglu and Pischke, 2001; Bjorklund and Salvanes, 2010). A proportional tax is imposed on pre-tax income and collected taxes are redistributed equally as a lump-sum transfer payment to all individuals. The income redistribution is determined by a Condorcet winner process to keep the political process as simple as possible. Voters' preferences over tax rates are single-peaked. The Condorcet winner tax policy defeats any other alternative policy in a pairwise vote and gets the majority of votes. Individuals first vote on redistribution and then they decide on the level of education for their children.[1] I investigate the dynamics of the model where two possible equilibria are depending on the cost of education. First, I study the scenario where the cost of education is low, everyone will invest in education in the long-run. Second, I focus on the scenario where the cost of education is high, the children born in an uneducated family remain uneducated. Hence, the initial aggregate level of education persists over time.

The properties of preferences for redistribution are conventional when the cost of education is low or when the returns to education are salient. In contrast, when the cost of education is high and the returns to education are relatively low then non-conventional results occur. First, the coalition of the educated may demand a positive (although low) level of redistribution. The latter happens when the proportion of educated individuals is higher than the proportion of low ability earners. Second, the uneducated individuals with high earning ability form a coalition with the educated to oppose redistribution policy if the proportion of low ability individuals is larger than the educated.

The paper proceeds as follows. Section 2.2 presents the related literature. Section 2.3 shows the basics of the model. Section 2.4 deals with the education decision of individuals for a given tax and subsidy rate. In section 2.5, I introduce the different scenarios of the low and high cost of education and the evolution of the proportion of each type of individuals in the population. Section 2.6 shows the voting equilibria of redistribution that emerge for each high and low cost of education scenario. Section 2.7 concludes. Proofs are in Appendix B.

2.2 Related Literature

In the strand of literature where non-linear tax function has been voted over multidimensional policy space, Cukierman and Meltzer (1991) analyze majority voting over quadratic tax functions in income. Under restrictive assumptions, they prove that the median voter's most preferred tax function is the Condorcet winner and it is progressive. Additionally, De Donder and Hindriks (2004) study a similar model and they show that the most progressive tax function is the Condorcet winner. Marhuenda and

[1]In the model of Dhami and Al-Nowaihi (2010), individuals first vote on a redistributive tax rate then they make their labor supply decision. Borck (2009) analyzes firstly the voting equilibrium. Secondly, individuals make their tax evasion decision.

Ortuno-Ortin (1995) focus on individuals' attitudes towards tax progressivity instead of voting equilibrium outcomes. They use the Downsian framework where two political parties have different income tax proposals and individuals are self-interested. When the median income is less than the mean income, the progressive tax proposal, convex tax function, is preferred over regressive one, concave tax function, by popular demand. In contrast, Hindriks (2001) finds that when low and high-income individuals constitute the majority, they favor more regressive or less progressive tax proposals.

Several papers find that redistribution of income is not from the rich to the poor. Some unconventional results emerge in voting equilibrium. Epple and Romano (1996a) and Epple and Romano (1996b) demonstrate that the rich and poor form a coalition against the middle class. On the other hand, Fernandez and Rogerson (1995) find that the rich and the middle-class vote over the education subsidies against the poor. The poor cannot afford higher education even after the subsidies are distributed. Thus, the transfers are from the poor to the rich and middle class. Borck (2009) studies that when individuals can evade taxes where the voting is pairwise by the simple majority then the poor and the rich form a coalition against the middle class and the redistribution may be from the middle class to rich and poor. Dhami and Al-Nowaihi (2010) prove the existence of a Condorcet winner when voters are concerned about fairness as well as they care for their utility in the standard political economy model. Solano-Garcia (2017) finds that middle class individuals are against income redistribution due to their concerns about fairness in tax compliance. However, the author observes that the poor and the rich may constitute a coalition against the middle to vote in favor of income redistribution in the absence of tax enforcement.

2.3 The model

Consider an overlapping generations model where individuals live for two periods. I focus on the steady-state results, and therefore I refrain from the use of time subscripts. During an individual's childhood, no economic decision is made. Adults take two decisions. First, they vote on the income tax rate, which finances a lump-sum subsidy S to all individuals. Second, they decide whether to invest in the education of their children.

Let n^i stand for an innate earning ability which takes two values: high and low, $i = \{h, l\}$, such that $n^h > n^l > 0$. Ability is determined stochastically at birth and independent of parental ability. The income of an educated individual is $n^i + R$, where R represents the returns to education. The earnings of an uneducated depend only on her innate earning ability, n^i. The returns to education and innate ability are assumed to remain constant over time.

There are four different groups in the society characterized by different innate abilities and education levels. A proportion π^{ij} of individuals belongs to a group of ability i, which can be low or high ($i = \{l, h\}$) and education j, which can be educated or uneducated($j = \{e, u\}$). The total population is

$$\pi^{he} + \pi^{hu} + \pi^{le} + \pi^{lu} = 1.$$

Let π be the proportion of educated individuals in society $\pi = \pi^{he} + \pi^{le}$ and $1 - \pi$ be the proportion of uneducated individuals, i.e., $1 - \pi = \pi^{hu} + \pi^{lu}$. Let θ be the proportion of individuals born with low earning ability, $\theta = \pi^{le} + \pi^{lu}$ and $1 - \theta$ be the proportion of individuals born with high earning ability, $1 - \theta = \pi^{he} + \pi^{hu}$. Then we can define each proportion of individual types as follows: $\pi^{he} = (1 - \theta)\pi$, $\pi^{hu} = (1 - \theta)(1 - \pi)$, $\pi^{le} = \theta\pi$, and $\pi^{lu} = \theta(1 - \pi)$. The mean of the distribution of earnings $\bar{y}$ is given by:[2]

$$\bar{y} = R\pi + n^l + (1 - \theta)\Delta n, \tag{1}$$

where Δn stands for the difference between the earnings of a high and a low ability earner (henceforth, the earning ability differential), i.e., $n^h - n^l$. Let τ be the proportional tax rate to earnings. Then $\tau\bar{y}$ is collected and redistributed equally to each person as a per capita subsidy S.

$$S = (\tau - \tau^2)\bar{y}.$$

This lump sum transfer is financed by the tax revenue as in the standard model of redistribution (Romer, 1975). The cost of collecting taxes is assumed to be convex in this model to avoid corner solutions (as in Perotti, 1993). The subsidy is a decreasing function of tax for $\tau > \frac{1}{2}$. Thus, no individual will vote for τ larger than $\frac{1}{2}$. The optimal tax will lie in $\tau \in \left[0, \frac{1}{2}\right)$.

I solve the model by backward induction. Therefore, let us begin with studying the education decision.

[2] $\bar{y} = R(\pi^{he} + \pi^{le}) + n^h(\pi^{he} + \pi^{hu}) + n^l(\pi^{le} + \pi^{lu})$

2.4 Education decisions with given taxes

In this section, individuals decide whether to finance the education of their children or not. The utility is assumed to be linear in consumption. The lifetime utility of an individual is given by

$$U(\tau, n^i, R) = \overbrace{(n^i + e^j R)(1-\tau) + S}^{\text{Individual's income}} + \underbrace{(n_m + e_n R)(1-\tau) + S - e_n k}_{\text{Children's income}} \tag{2}$$

where e^j is the indicator function taking the value one if the individual is educated, $j = e$, and zero if $j = u$. Investment in children's education involves a cost k. Let e_n take the value one if children are educated, $n = e$, and zero if children are uneducated, $n = u$. Let n_m be the earning ability of children where $m = \{h, l\}$. Individuals compare their utility with and without providing education for their children. Education is assumed to be always a desirable investment such that the net return to education is larger than the cost.

Assumption 1. $R(1-\tau) > k$

In the model, individuals cannot borrow from a capital market to finance the education of their children. Hence, they maximize their utility subject to a liquidity constraint:

$$n^i(1-\tau) + S > k \; for \; i = \{h, l\}. \tag{3}$$

Assumption 1 is a necessary but not sufficient condition to have an investment in education.[3] Some individuals, even if they want to invest in education, cannot afford it because of the credit constraints. Given Assumption 1, it is straightforward to see that educated individuals can pay the cost of education for their children. This result is formalized in Lemma 1.

Lemma 1. *Educated individuals, regardless of their earning ability level, can afford the education of their children.*

[3]Since we assume that $R(1-\tau) > k$, which together with the result $\tau < \frac{1}{2}$ would imply that $R > 2k$ in equilibrium.

2.5 Stationary Equilibrium

In this section, let's analyze the dynamics of the model for a fixed τ. In particular, I examine the evolution of the proportion of each type of individuals by calculating the steady-state probabilities in discrete time. I consider a stochastic process. The proportion of a different group of individuals based on education and ability status, π^{ij}, constitute the states of the system at any given time. The proportion of each type is denoted by the steady-state vector Π. This probability vector represents the initial state or starting distribution of a Markov chain whose entries are non-negative and sum up to 1:

$$\Pi = (\pi^{lu}, \pi^{le}, \pi^{hu}, \pi^{he}).$$

Let p^{ij}_{mn} denote the transition probability from the current state ij to the state mn. Assume p^{ij}_{mn} that is fixed and independent over time. The probability p^{ij}_{mn} consists of four different characteristics of individuals and their children: let i be the individuals' ability, let j stand for their education level, let m be the innate ability of their children and finally let n indicate education level of children. The transition probability matrix of the process P can be written as

$$P = \begin{bmatrix} p^{lu}_{lu} & p^{lu}_{le} & p^{lu}_{hu} & p^{lu}_{he} \\ p^{le}_{lu} & p^{le}_{le} & p^{le}_{hu} & p^{le}_{he} \\ p^{hu}_{lu} & p^{hu}_{le} & p^{hu}_{hu} & p^{hu}_{he} \\ p^{he}_{lu} & p^{he}_{le} & p^{he}_{hu} & p^{he}_{he} \end{bmatrix}$$

The probability p^{ij}_{mn} represents the probability that an individual in state ij will have a child in state mn. For instance, p^{lu}_{he} is the probability of an uneducated individual with low ability to have educated children with high ability. Being born with low or high ability is assumed to be independent of family history. Therefore, to move from one state of ability level to another is random. At the steady-state, the proportions of the population in the various state is given by

$$\Pi P = \Pi$$

Multiplying the transition matrix by the initial state vector gives us back the initial state vector so that the probabilities remain steady.

Let's focus on the probabilities of remaining in any π^{ij} in the long run. There are two scenarios of education decisions, which depend on the level of the cost of education. For a given tax and subsidy, we describe two levels of cost of education and related scenarios as follows:

$$\begin{aligned} &\textit{Low k scenario}: \quad \mathbf{k} < n^h(1-\tau) + S \\ &\textit{High k scenario}: \quad \mathbf{k} > n^h(1-\tau) + S \end{aligned}$$

In the scenario of low k, only the individual of type lu is constrained to invest in the education of their children whereas the individual of type hu can buy the education. However, in the scenario of high k, neither individual of type hu nor lu can afford the education.

2.5.1 The equilibrium at the low k scenario

Let us consider first the scenario where the cost of education is low. Individuals hu can overcome the financial constraint through their high innate ability to pay for the education of their children. However, individuals lu cannot.[4] Therefore, $p^{hu}_{mu} = 0$ and $p^{lu}_{me} = 0$.

Remember that the probability of being born with low ability and being born with high ability are θ and $1-\theta$, respectively. Therefore, $p^{lu}_{lu} = \theta$, $p^{lu}_{hu} = 1-\theta$, $p^{hu}_{le} = \theta$, and $p^{hu}_{he} = 1-\theta$. The transition matrix P in this case is:

$$P = \begin{bmatrix} \theta & 0 & 1-\theta & 0 \\ 0 & \theta & 0 & 1-\theta \\ 0 & \theta & 0 & 1-\theta \\ 0 & \theta & 0 & 1-\theta \end{bmatrix}$$

From $\Pi P = \Pi$ we obtain the stationary equilibrium where

$$\begin{aligned} \pi^{lu} &= \pi^{lu}\theta \\ \pi^{le} &= \theta(1-\pi^{lu}) \\ \pi^{hu} &= (1-\theta)\pi^{lu} \\ \pi^{he} &= (1-\theta)(1-\pi^{lu}) \end{aligned} \tag{4}$$

An individual's financial capability to pay the cost of education for her children determines the distribution of education in the next generation. From the distribution given by (4), the probability of being in state π^{lu} in the long run is $\pi^{lu}\theta$. Note that this can only be true if $\theta = 1$ or $\pi^{lu} = 0$. Since θ is exogenous and generally different from zero, it can only be the case that $\pi^{lu} = 0$. Therefore, the long-run distribution of each type of individuals as follows:

$$\begin{aligned} \pi^{lu} &= 0 \\ \pi^{le} &= \theta \\ \pi^{hu} &= 0 \\ \pi^{he} &= 1-\theta \end{aligned} \tag{5}$$

[4] I analyze the trivial case where all type of individuals can afford the education (i.e. $n^l(1-\bar{\tau})+S >$ **k**) in Appendix B.1.

From the long-run distributions (5), we can conclude that everyone will be educated in equilibrium, i.e., $\pi^* = 1$. The basic intuition behind this is simple. Although the uneducated individuals with low ability, lu, cannot afford the cost of education for their children, their high-ability children will be able to provide education for their future children. In time, no one will remain in the proportion of the individual of type lu.[5] Therefore, everyone will study. Briefly, there is upward mobility due to the low cost of education and all dynasties end up having the financial power to pay the cost of education in the low-cost scenario.

2.5.2 The equilibrium at the high k scenario

Let us now consider the scenario where the cost of education is high and correspondingly neither the uneducated individuals with high ability, hu, nor the uneducated individuals with low ability, lu, can afford education for their children. Therefore, $p_{le}^{lu}0 =$ and $p_{le}^{hu} = 0$.

In this scenario, the sorting of income of each individual is as follow: $n^h + R > n^l + R > k > n^h > n^l$ as a results of a high cost of education and Assumption 1. Then the individual le earns more than the individual hu such as $n^l + R > n^h$ which leads to $\Delta n < R$, i.e., the return to education is larger than earning ability differential.

The matrix of transition probabilities P can be written as:

$$P = \begin{bmatrix} \theta & 0 & 1-\theta & 0 \\ 0 & \theta & 0 & 1-\theta \\ \theta & 0 & 1-\theta & 0 \\ 0 & \theta & 0 & 1-\theta \end{bmatrix}$$

In the long run, the probabilities of being in each type are:

$$\begin{aligned} \pi^{lu} &= \theta(\pi^{lu} + \pi^{hu}) \\ \pi^{le} &= \theta(\pi^{le} + \pi^{he}) \\ \pi^{hu} &= (1-\theta)(\pi^{lu} + \pi^{hu}) \\ \pi^{he} &= (1-\theta)(\pi^{le} + \pi^{he}) \end{aligned} \tag{6}$$

From equations (6), we can see that the distribution of educated and uneducated individuals does not change in the long-run. The proportion of the educated equals the same proportion of the educated period after period. Therefore, let π_0 stand for

[5] In Appendix B.2, I study when children inherit the ability of their parents. In contrast to the results of low-cost scenario, the high-ability children of the individual lu will remain uneducated.

the initial proportion of educated individuals to simplify this replication. Then the long-run distribution in terms of π_0 is:

$$\begin{aligned}\pi^{lu} &= \theta(1-\pi_0)\\ \pi^{le} &= \theta\pi_0\\ \pi^{hu} &= (1-\theta)(1-\pi_0)\\ \pi^{he} &= (1-\theta)\pi_0\end{aligned} \tag{7}$$

In the high cost scenario, $\pi^* = \pi_0$. There is no transition across generations and the long-run distribution replicates the initial distribution. Children of educated individuals will benefit from education. In contrast, children of uneducated individuals will remain uneducated as will all their descendants. [6]

To summarize, the credit constraint only affects uneducated individuals according to Lemma 1. The individual lu is always constrained in both scenarios. Therefore, what distinguishes these two scenarios is whether the individual of type hu can invest in education or not. There are two possible scenarios. If uneducated individuals with high ability can provide education for their children then everyone studies in the long run. On the other hand, if uneducated individuals with high innate ability cannot afford the education of their children then an education trap exists.

We summarize the results in the following Lemma 2.

Lemma 2. ***Stationary equilibrium***

Given Assumption 1 and for a given τ and S,

$$\pi^* = \begin{cases} 1 & if \quad k < n^h(1-\tau)+S \\ \pi_0 & if \quad k > n^h(1-\tau)+S \end{cases}$$

Corollary 1. *Given Assumption 1, in the low k scenario, earning ability differential can be higher or lower than the return to education (i.e., $\Delta n \lesseqgtr R$). In the high k scenario, the return to education is higher than earning ability differential, i.e., $\Delta n < R$.*

2.6 Social Choice for Redistributive Tax

In this section, let us focus on the political setting of income redistribution. Individuals vote over a tax rate with its implied lump-sum subsidies to maximize their utility.

[6]In Appendix B.2, for the high cost of education scenario, the stationary equilibria with inherited ability conclude that the ability and education level of children is just a replication of their parents. There is no transition between generation in terms of both educationṅ and ability at the steady-state.

Let τ^* denote the chosen tax rate. The most preferred tax rates of each individual type are: τ^*_{he}, τ^*_{hu}, τ^*_{le} and τ^*_{lu}. The following Lemma establishes the preferred tax rates.

Lemma 3. ***The preferred tax rates***

- The preferred tax by the individual of type 'he' is always zero, $\tau^*_{he} = 0$.

- The preferred tax by the individuals of type 'le' and 'hu' depends on the value of $\Delta n/R$. *The tax rates are as follows*

$$\tau^*_{le} = \begin{cases} \frac{1}{2}\left(1 - \frac{n^l + R}{\bar{y}}\right) & if \quad \frac{\Delta n}{R} > \frac{1-\pi}{1-\theta} \\ 0 & if \quad \frac{\Delta n}{R} < \frac{1-\pi}{1-\theta} \end{cases}$$

$$\tau^*_{hu} = \begin{cases} \frac{1}{2}\left(1 - \frac{n^h}{\bar{y}}\right) & if \quad \frac{\Delta n}{R} < \frac{\pi}{\theta} \\ 0 & if \quad \frac{\Delta n}{R} > \frac{\pi}{\theta} \end{cases}$$

- The preferred tax by the individual of type 'lu' is always positive and given by

$$\tau^*_{lu} = \frac{1}{2}\left(1 - \frac{n^l}{\bar{y}}\right)$$

Proof. See Appendix B.3. □

It is noteworthy that any preferred tax is lower than $\frac{1}{2}$.

I use Condorcet winner to analyze the social choice for redistribution policy. By Lemma 3, there are four different tax rates and each type of individual has a different order of preference over all these tax policies. If a tax rate is preferred to every other alternative rate in a pairwise election and if it gains a majority of the votes, then this tax policy is the winner. The preferences are single-peaked therefore there are no voting cycles.

Definition 1. *A Condorcet Winner policy beats all other alternative policies in head-to-head election.* τ^* *is a Condorcet winner if, for all* $\tau \neq \tau^*$, $U(\tau^*; n^i, R) \geqslant U(\tau; n^i, R)$ *for at least half of the population.*

Lemma 4 concludes the sorting of the preferred tax rates according to their size where τ^*_{le}, τ^*_{hu} and τ^*_{lu} are low (L), medium (M), and high (H), respectively, under the high cost framework.

Lemma 4. ***Ranking of the preferred tax rates in regard to their size.***

By Lemma 3, when $\frac{\Delta n}{R} \in \left(\frac{1-\pi}{1-\theta}, \frac{\pi}{\theta}\right)$ *then the ranking of tax rates is*

$$\begin{aligned} \tau^*_{lu} &> \tau^*_{le} > \tau^*_{hu} > \tau^*_{he} = 0 \ if \ \ 1 < \frac{\Delta n}{R} < \frac{\pi}{\theta}. \\ \tau^*_{lu} &> \tau^*_{hu} > \tau^*_{le} > \tau^*_{he} \ = 0 \ if \ \ \frac{1-\pi}{1-\theta} < \frac{\Delta n}{R} < 1. \end{aligned}$$

Proof. By Lemma 3, the individual of type lu prefers the largest amount of tax, whereas the individual of the type he prefers the lowest. When we compare the positive values of τ^*_{le} with τ^*_{hu}, we observe that the size of these tax rates depends on whether the individual hu earns more than le or not, i.e., $n^h \gtreqless n^l + R$. Hence, if $\Delta n > R$ then $\tau^*_{le} > \tau^*_{hu}$. In contrast, if $\Delta n < R$ then $\tau^*_{hu} > \tau^*_{le}$ which corresponds to the high cost scenario by Corollary 1.

□

2.6.1 Voting equilibrium with the low cost of education

Given Assumption 1 and the low cost of education scenario (i.e., $\mathbf{k} < n^h(1-\tau^*)+S$), all types of individuals can invest in their children's education except the type lu. As seen in Section 2.5.1, in the long-run, $\pi^* = 1$. Under these circumstances, uneducated individuals do not have any political power in the long-term since everybody studies. Therefore, the preferences of educated individuals matter only. Everyone is educated but individuals differ in their ability. Then, the question is which type of individuals, in terms of ability level, has the majority.

i. Equilibrium with $\tau^* = 0$

If the individuals with high innate ability are the majority then they always prefer zero redistribution (see Lemma 3). $\pi^{he} > \frac{1}{2}$ implies $\theta < \frac{1}{2}$ at the stationary distribution (5). Consequently, $\tau^* = 0$.

ii. Equilibrium with $\tau^* = \tau^*_{le}$

When the individuals with low innate ability are the majority then they will opt for the positive tax rate, τ^*_{le}.[7] In the long-run distribution given by (5), $\pi^{le} > \frac{1}{2}$ implies

[7]Let's substitute $\pi^* = 1$ into the thresholds of the preferences of the individual le shown in Lemma 3. We obtain if $\frac{\Delta n}{R} < 0$ then individual lu prefers zero tax, besides that, if $\frac{\Delta n}{R} > 0$ then he prefers positive tax τ^*_{le}. Note that $R > 0$ and $n^h > n^l$. Then the value of $\frac{\Delta n}{R}$ cannot be negative.

$\theta > \frac{1}{2}$. Thus, $\tau^* = \tau^*_{le}$. I substitute $\pi^* = 1$ in the equation of positive tax rate of τ^*_{le} to set:

$$\tau^*_{le} = \frac{1}{2}\left(\frac{(1-\theta)\Delta n}{R + n^l + (1-\theta)\Delta n}\right)$$

Note that I find $\frac{\partial \tau^*}{\partial R} < 0$, $\frac{\partial \tau^*}{\partial (1-\theta)} > 0$ and $\frac{\partial \tau^*}{\partial \Delta n} > 0$. When the return to education increases, the size of the tax decreases. However, the number of low-ability individuals and the innate ability-gap are positively related with the preferred tax. Higher inequality in terms of ability brings higher redistribution.

The results are summarized in Proposition 1.

Proposition 1. ***Condorcet winner with the low cost of education***

Given Assumption 1 and $\mathbf{k} < n^h(1-\tau^*) + S$*, the equilibrium* $\pi^* = 1$ *occurs where the Condorcet winner is*

$$\tau^* = \begin{cases} 0 & if \quad \theta < \frac{1}{2} \\ \tau^*_{le} = \frac{1}{2}\left(\frac{(1-\theta)\Delta n}{R + n^l + (1-\theta)\Delta n}\right) & if \quad \theta > \frac{1}{2} \end{cases}$$

2.6.2 Voting equilibrium with the high cost of education

Given Assumption 1 and the scenario of high education cost (i.e., $k > n^h(1-\tau^*)+S$), the uneducated individuals are financially constrained to buy education for their children. Additionally, there is no mobility across generations in terms of education where $\pi^* = \pi_0$ (see Subsubsection 2.5.2).

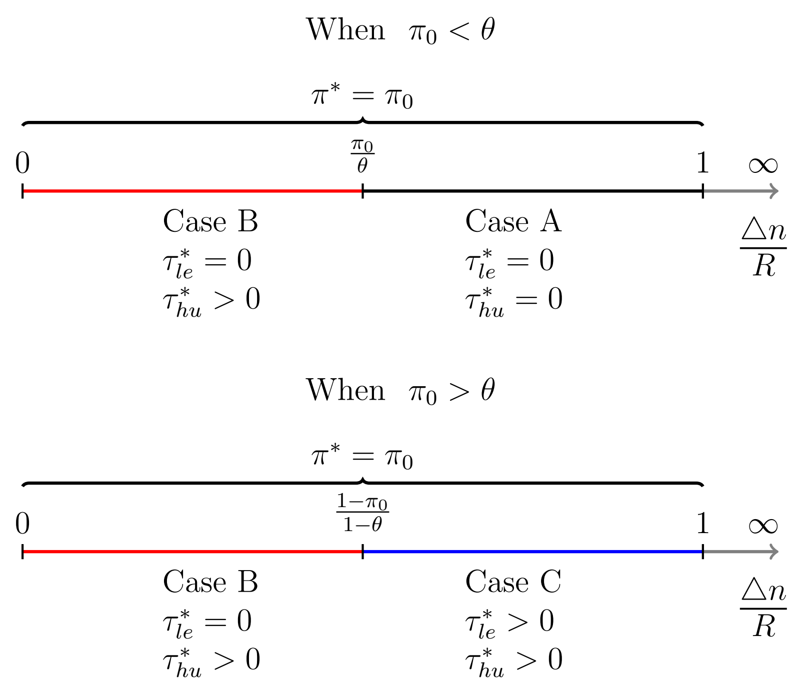
There are four types of individuals in terms of ability and education. Each individual type chooses a different tax rate to maximize her utility. Accordingly, there are potentially four optimal taxes.[8] The preferences of all types of individuals are single-peaked over the single-dimension policy.[9]

[8] Appendix B.3 shows the preferred taxes made by different individual of types in the equilibrium of $\pi^* = \pi_0$ are:

$$\begin{aligned} \tau^*_{lu} &= \frac{1}{2}\left(\frac{R\pi_0 + (1-\theta)\Delta n}{R\pi_0 + n^l + (1-\theta)\Delta n}\right), \\ \tau^*_{le} &= \frac{1}{2}\left(\frac{R(\pi_0 - 1) + (1-\theta)\Delta n}{R\pi_0 + n^l + (1-\theta)\Delta n}\right), \\ \tau^*_{hu} &= \frac{1}{2}\left(\frac{R\pi_0 - \theta\Delta n}{R\pi_0 + n^l + (1-\theta)\Delta n}\right), \\ \tau^*_{he} &= 0. \end{aligned}$$

[9] The order of tax preferences of each individual type is analyzed in Appendix B.5.

Figure 2.1: The Range of $\frac{\triangle n}{R}$



The redistribution policy is determined by a majority voting if a single individual of type ij forms the majority, $\pi^{ij} > \frac{1}{2}$ for one ij, then his preferred tax is the chosen policy for all. In contrast, a joint decision has to be made for redistribution through a Condorcet winner process if $\pi^{ij} < \frac{1}{2}$ for $\forall_{ij}$.

Let us analyze when no individual type is the majority by itself and there are three cases, labeled as A, B, and C. These cases depend on whether le and hu prefer a zero or a positive tax rate.

In Figure 2.1 the conditions for each cases base on Lemma 3 and Corollary 1. When the value of $\frac{\Delta n}{R}$ is close to 1 then the voting behavior of the individuals of type le and hu are more similar. For instance, both of the individual types, le and hu, simultaneously prefer a zero tax in the case of A or they simultaneously prefer a different size of positive tax rate in the case of C. However, if $\frac{\Delta n}{R}$ is close to zero then they act differently.

Let us now find the Condorcet winner in each case.

1. **Case A:** $\tau^*_{le} = 0$ *and* $\tau^*_{hu} = 0$

By Lemma 3 and Corollary 1, the proportion of individuals with low ability is larger than the proportion of the educated, $\pi_0 < \theta$, and individuals of type le and hu

simultaneously prefer zero tax when

$$\frac{\pi_0}{\theta} < \frac{\Delta n}{R}. \tag{8}$$

Only uneducated individuals with low ability vote for a positive tax and the rest of individual types choose zero tax. Since no single group shapes the majority in (A, B, C) cases then the most preferred tax policy which is $\tau^* = 0$ by the coalition of educated individuals and individual type of hu is the winner policy.

Proof. See Appendix B.6, Case A. □

2. **Case B:** $\tau^*_{le} = 0$ *and* $\tau^*_{hu} > 0$

By Lemma 3, the individual of type le prefers zero tax, and the individual of type hu chooses a positive tax when

$$\frac{\Delta n}{R} < Min\left\{\frac{\pi_0}{\theta}, \frac{1-\pi_0}{1-\theta}\right\}. \tag{9}$$

The preferences of individual le are equivalent to those of he individuals. If $\pi_0 > \frac{1}{2}$, the coalition of the educated is the majority and their tax rate wins, i.e., $\tau^* = 0$. However, if the coalition of the uneducated constitutes the majority, i.e. $\pi_0 < \frac{1}{2}$, then the Condorcet winner is τ^*_{hu}.

Proof. See Appendix B.6, Case B. □

3. **Case C:** $\tau^*_{le} > 0$ *and* $\tau^*_{hu} > 0$

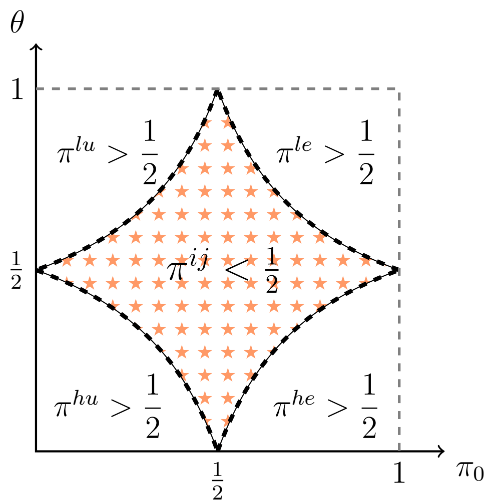
By Lemma 3 and Corollary 1, there are more educated individuals than the low-ability earners, $\pi_0 > \theta$ and individuals le and hu vote for positive tax rates: τ^*_{le} and τ^*_{hu} as their first-best, respectively, when

$$\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R}. \tag{10}$$

All individuals prefer a positive redistribution except individuals of type he. Accordingly, each type of individuals has a different optimal tax rate in this case. There are two possible outcomes: If the coalition of the educated is the majority, i.e $\pi_0 > \frac{1}{2}$, then the Condorcet winner is τ^*_{le} while if the coalition of the uneducated is the majority, i.e $\pi_0 < \frac{1}{2}$, then τ^*_{hu} wins.

Proof. See in Appendix B.6, Case C. □

Figure 2.2: Majority Allocations

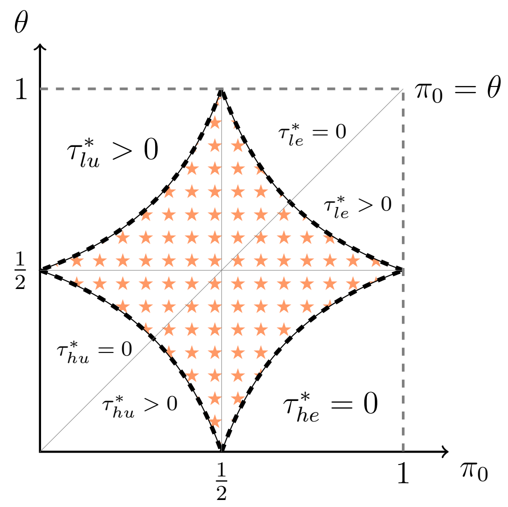


A summary of all types of equilibria is depicted in the following illustrations. Figure 2.2 identifies the areas in each corner where a single group has the majority. In the interior zone, no single group represents the majority. Figure 2.3 refers to the equilibrium tax level by majority in each area. The x-axis represents the initial level of educated individuals, $\pi_0 \,\epsilon\, (0, 1)$, while the y-axis depicts the percentage of low-ability individuals θ. In the area below the 45^o line $\pi_0 > \theta$ and above the 45^o line $\pi_0 < \theta$.

The non-coalition solutions require $\pi^{ij} > \frac{1}{2}$ for one ij where $i = \{h, l\}$ and $j = \{e, u\}$ which occur outside of the diamond square. The outcomes are trivial. Whenever an individual type consists of more than half of the population then her choice is the chosen redistributive policy. The curve from point $(0, \frac{1}{2})$ till point $(\frac{1}{2}, 1)$ corresponds to $\theta(1 - \pi_0) > \frac{1}{2}$ which implies $\pi^{lu} > \frac{1}{2}$. We obtain the other curves and their related equilibrium outcomes in the same fashion.[10] In contrast, in the starred area of the diamond square, none of the individual types constitute the majority by itself. $\pi^{ij} < \frac{1}{2}$ for $\forall_{ij}$. There are four types of voters and jointly agreed decision has to be made through a Condorcet winner process.

[10]The curve from $(\frac{1}{2}, 1)$ till $(1, \frac{1}{2})$ corresponds to $\theta\pi_0 > \frac{1}{2}$ which implies $\pi^{le} > \frac{1}{2}$. In the area above $\pi^{le} > \frac{1}{2}$, educated individuals with low ability compose the majority and the chosen tax is zero tax if $\pi_0 < \theta$ or positive tax τ^*_{le} if $\pi_0 > \theta$. The curve from $(1, \frac{1}{2})$ till $(\frac{1}{2}, 0)$ corresponds to $(1 - \theta)\pi_0 > \frac{1}{2}$ which implies $\pi^{he} > \frac{1}{2}$. In the triangle below the curve, educated individuals with high ability are the majority and they always prefer zero-tax. The curve from $(\frac{1}{2}, 0)$ till $(0, \frac{1}{2})$ belongs $(1-\theta)(1-\pi_0) > \frac{1}{2}$ which implies $\pi^{hu} > \frac{1}{2}$. In the area below the curve, uneducated individuals with high-ability are the majority and the chosen tax is zero tax if $\pi_0 < \theta$ or positive tax τ^*_{hu} if $\pi_0 > \theta$.

Figure 2.3: Equilibria by Majority



In Figure 2.4, I explain case B where $\frac{\Delta n}{R} < Min\left\{\frac{\pi_0}{\theta}, \frac{1-\pi_0}{1-\theta}\right\}$. In this case, $\frac{\Delta n}{R}$ is relatively smaller than in case A and C. Then, earning ability differential is relatively lower whereas returns to education are higher. In case B, educated individuals, independent of their ability level, have the same preferences for redistribution. The interior area with yellow horizontal lines represents that the coalition of the educated is the majority and their most preferred tax policy, which is zero redistribution, is the winner policy. In the interior area with green dots, the coalition of the uneducated constitutes the majority and they support for a medium level of redistribution. Thus, the τ^*_{hu} beats every other alternative policy in a head to head election and τ^*_{hu} is the Condorcet winner.

Figure 2.4: Equilibrium Tax Levels in Case B $\left(\text{low } \frac{\Delta n}{R}\right)$

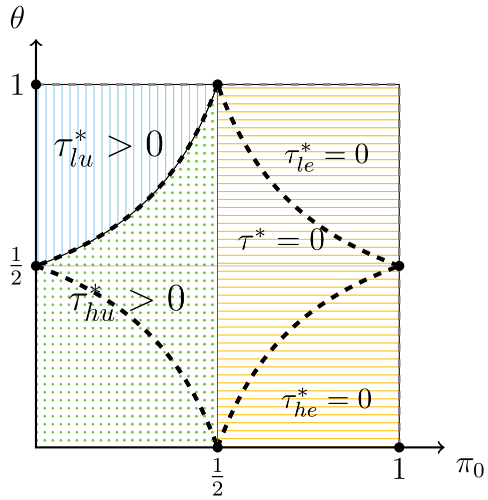


Figure 2.5: Equilibrium Tax Levels in Case A and C $\left(\text{large } \frac{\Delta n}{R}\right)$

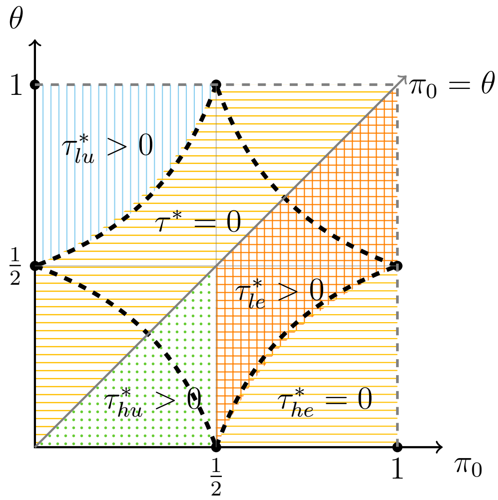


Figure 2.5 shows the solutions of cases A and C where $\frac{\Delta n}{R} > Min\left\{\frac{\pi_0}{\theta}, \frac{1-\pi_0}{1-\theta}\right\}$. In both cases, the value of $\frac{\Delta n}{R}$ is relatively larger than in case B. This means that the returns of education and earning ability differential are relatively more similar than in case B.

The relevant area for case A is an interior area located above the 45^o line where $\pi_0 < \theta$. In case A, all types of individuals oppose to redistribution except the uneducated individuals with the low-ability. Therefore, the zero redistribution policy collectively chosen by the coalition of the educated and individual of type hu.

Case C corresponds to the interior area below the 45^o line where $\pi_0 > \theta$. In this case, each individual type have different first-best tax policy. Therefore, there are four Condorcet candidate policy. In the green dotted area inside of the diamond square, if the coalition of the uneducated constitutes the majority then the Condorcet winner is a medium level of tax τ^*_{hu}. In the orange checkered area in the diamond square, the coalition of the educated is the majority and they favor a low level of tax then the winner policy is τ^*_{le} .

We summarize all possible results as follows.

Proposition 2. ***Condorcet winner in non-coalition solutions with high cost of education***

Given Assumption 1 and $\mathbf{k} > n^h(1-\tau^*) + S$, *the equilibrium* $\pi^* = \pi_0$ *occurs. When* $\pi^{ij} > \frac{1}{2}$ *for one* ij, *the Condorcet winner is*

$$\tau^* = \begin{cases} \tau^*_{lu} & if \quad \theta(1-\pi_0) > \dfrac{1}{2} \\ 0 & if \quad (1-\theta)\pi_0 > \dfrac{1}{2} \end{cases}$$

if $\theta\pi_0 > \frac{1}{2}$, *the Condorcet winner is*

$$\tau^* = \begin{cases} \tau^*_{le} & if \quad \dfrac{\Delta n}{R} > \dfrac{1-\pi_0}{1-\theta} \\ 0 & if \quad \dfrac{\Delta n}{R} < \dfrac{1-\pi_0}{1-\theta} \end{cases}$$

if $(1-\theta)(1-\pi_0) > \frac{1}{2}$, *the Condorcet winner is*

$$\tau^* = \begin{cases} \tau^*_{hu} & if \quad \dfrac{\Delta n}{R} < \dfrac{\pi_0}{\theta} \\ 0 & if \quad \dfrac{\Delta n}{R} > \dfrac{\pi_0}{\theta} \end{cases}$$

Proposition 3. ***Condorcet winner in coalition solutions with the high cost of education***

Given Assumption 1 and $\mathbf{k} > n^h(1-\tau^*) + S$, *the equilibrium* $\pi^* = \pi_0$ *occurs.*

(i) When $\pi^{ij} < \frac{1}{2}$ *for* $\forall_{ij}$, $\pi_0 < \theta$ *and*
if $\pi_0 > \frac{1}{2}$, *the Condorcet winner is* $\tau^* = 0$,
if $\pi_0 < \frac{1}{2}$, *the Condorcet winner is*

$$\tau^* = \begin{cases} 0 & if \quad \dfrac{\Delta n}{R} > \dfrac{\pi_0}{\theta} \\ \tau^*_{hu} & if \quad \dfrac{\Delta n}{R} < \dfrac{\pi_0}{\theta} \end{cases}$$

(ii) When $\pi^{ij} < \frac{1}{2}$ *for* $\forall_{ij}$, $\pi_0 > \theta$ *and*

if $\pi_0 < \frac{1}{2}$, *the Condorcet winner is* $\tau^* = \tau^*_{hu}$,

if $\pi_0 > \frac{1}{2}$, *the Condorcet winner is*

$$\tau^* = \begin{cases} \tau^*_{le} & if \quad \dfrac{\Delta n}{R} > \dfrac{1-\pi_0}{1-\theta} \\ 0 & if \quad \dfrac{\Delta n}{R} < \dfrac{1-\pi_0}{1-\theta} \end{cases}$$

2.7 Concluding Remarks

In this paper, I study the preferences for redistribution where individuals are characterized by innate earning ability, high or low, and the education level. Individuals confront a credit constraint to provide education for their children. The financial level of cost of education generates two possible scenarios in the model: a low education cost and a high education cost scenario.

In the case of the low cost of education, the dynamics of the model conclude that everyone will be educated in the long-run. There will still be some redistribution at equilibrium if the majority of individuals are born with low earning abilities.

In the case of the high cost of education, I mainly focus on the collective choice of redistribution by using Condorcet winner in the presence of no single group of individuals holds the majority by itself. Three outcomes are possible: zero tax, a low tax, and a medium tax rate. I derive the equilibrium conditions for each outcome. The high tax rate has never been jointly agreed on policy.

In this framework, only the children of educated individuals obtain education whereas the children of the uneducated remain uneducated. This leads the initial proportion of educated individuals replicates itself in the long run. The equilibrium depends on both the proportion of educated individuals and the proportion of low earning ability individuals. If the returns to education are salient and when the coalition of the educated holds the majority, the equilibrium implies zero redistribution. On the other hand, if the coalition of the uneducated holds the majority then there is a medium level of redistribution at the equilibrium.

If the return to education is low relative to the earning ability differential then there are two possible equilibrium outcomes. In an economy where the proportion of low-ability earners is larger than the proportion of educated, zero redistribution is the Condorcet winner policy by the coalition of the educated and uneducated individuals with high-ability. In the meanwhile, in an economy where the proportion of educated is larger than the proportion of low ability individuals, the coalition of the educated constitutes the majority then there is an equilibrium with a low level of redistribution. If the coalition if the uneducated forms the majority then the winner tax policy is again medium level.

Chapter 3

Segregation and Preferences for Redistribution[†]

3.1 Introduction

Over the last decades, income inequality level have increased significantly in many industrialized countries while redistribution has remained stable or decreased in most countries (OECD, 2016). This contradicts the seminal Meltzer-Richard (1981) model, which predicts that an increase in income inequality is positively related to a higher demand for income redistribution in the country. In their model, individuals' only concern is to maximize their after-tax income where the redistribution rate is determined by a majority voting rule. The empirical literature finds mixed results about the relationship between pre-tax income inequality and redistribution. As Alesina and Guiliano (2009) state, the lack of empirical consensus suggests that there are other relevant determinants of preferences for redistribution apart from individual income. Several papers have contributed to this literature by extending the analysis along multiple dimensions (see the next section for a literature review). In this paper, we explore the role of segregation in explaining the preferences for redistribution.

There are several studies that link the increase in inequality with an increase in socio-economic segregation. In highly unequal societies, the rich become disconnected from the reality of the poor through the living spaces. Watson (2009) and Reardon and Bischoff (2011) confirm this strong relationship between income inequality and income segregation in metropolitan areas in the US between the years 1970 and 2000. As income inequality rises, the rich and the poor are less likely to live close to each other. Moreover, segregation in itself has been found to increase inequality (Fernandez and Rogerson, 2001; Fernandez, Guner, and Knowles, 2005). If we think that

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segregation may by itself affect the preferences for redistribution, it must be included in the analysis when studying the relationship between inequality and redistribution.

At least two theories explain the negative effect of segregation on the preferences for redistribution. Bjorvatn and Cappelen (2003) argue that segregation may reduce the social attachment of the rich with other groups in society, which reduces the willingness of the rich to make transfers to the poor. Windsteiger (2017) proposes that individuals may demand less redistribution because they perceive less inequality in a segregated society. Both models help explain this negative association between segregation and redistribution. We empirically estimate how preferences for redistribution are affected by segregation in society. If segregation only affects negatively the preferences of the affluent, our results will support the social attachment story of Bjorvatn and Cappelen (2003), while a general negative effect of segregation to all individuals will suggest the mechanism of less perceived inequality (Windsteiger 2017).

We use assortative mating as a measurement for social segregation in a region (see Schwartz 2013 for a review of the literature on assortative mating). Assortative mating might be the result of residential segregation, which reduces the likelihood that individuals from different backgrounds meet, or due to differences in lifestyles and preferences of different social groups (Bouchet-Valat 2018). Both cases imply little interaction between different groups in society, which leads to real segregation. Bruch and Mare (2009) explain how assortative mating in race, educational attainment, social class background, and religion are several of many segregation processes in society. We follow the paper Greenwood et al. (2014) to compute assortative mating by taking into consideration the levels of education, occupation, and nativity-status of the partners. We calculate first the fraction of couples with the same socioeconomic status for each region as the actual matching then we compute the fraction of both partners have the same status randomly through contingency tables. The ratio of the actual to random matches yields the values for assortative mating.

We investigate the relationship between differences in the incidence of assortative mating and individuals' attitudes to redistribution on a sub-national scale. We exploit the data for socio-economic status of spouses from the IPUMS (Integrated Public Use Microdata Series) and combine this data set with individual attitudinal data from the bi-annual 2002-2016 waves of the ESS (European Social Survey) for 111 regions in 10 different European countries. Many papers study different aspects of educational assortative mating (Blossfeld ,2009; Skopek, Schulz and Blossfeld, 2010; Smits, Ultee and Lammers, 1998; Stevens, 1991), as well as assortative mating by occupation

(Hout, 1982). As far as we know we are the first to study the effect of assortative mating on preferences for redistribution.

The rest of the paper is organized as follows. Section 3.2 provides a literature review on inequality and preferences for redistribution. Section 3.3 explains the data and methodology used. Results are presented in Section 3.4. We conclude in Section 3.5.

3.2 Literature Review

A large body of literature in political economics discusses the relationship between income inequality and redistributive preferences. In the seminal Meltzer-Richard (1981) model, there is a positive relationship between income inequality and the demand for income redistribution in a given country. Several authors confirm this positive effect of inequality on preferences for redistribution (see, e.g., Borge and Rattsoe, 2004; Finseraas 2009; Olivera 2015; Karabarbounis 2011; Milanovic, 2000). Olivera (2015) finds that variations in income inequality are positively related to variations in preferences for redistribution over time. Nevertheless, Georgiadis and Manning (2012) identify a negative relationship. They find that the demand for redistribution declines in UK while income inequality increases. In several studies, no significant association was found (e.g., Gouveia and Masia, 1998; Kenworthy and McCall, 2007; Scervini, 2012). Alesina and Glaeser (2004) find that income distribution is not a significant determinant of redistribution.

Several studies provide alternative explanations about the relationship between inequality and preference for redistribution. The POUM hypothesis states that when individuals expect to experience upward mobility in society, they prefer less redistribution (Benabou and Ok, 2001; Alesina, Stantcheva, and Teso, 2018). Instead Corneo and Gruner (2000) add two mechanisms in Meltzer-Richard (1981) model. First, they pose that individuals have preferences for redistribution independent of their income level. Second, they argue that individuals care about the effect of redistribution on their close social circle. They find support for both mechanisms. Some papers highlight the difference between actual inequality and perceived inequality. People tend to underestimate the income inequality or their position in the income distribution (Cruces et al., 2013; Karadja el al. 2014; Norton and Ariely, 2011; Norton et al., 2014).

A couple of papers explicitly consider the relationship between segregation and preferences for redistribution. Bjorvatn and Cappelen (2003) state that residential segregation of rich and poor arises as a consequence of high income inequality. Such divisions within a society may reduce the solidarity between social classes. Hence, the rich are less willing to share their prosperity with the poor. Additionally, Windsteiger (2017) shows that an increase in the actual inequality makes people perceive less inequality due to segregation. This misperception of inequality leads people to support less redistributive policies.

A strand of the political economics literature studies the impact of individual characteristics on preferences for redistribution. Iversen and Soskice (2001) find that individuals who have made risky investments in skills are less mobile than general, portable workers. Therefore, they may face an unemployment period or even suffer from a future income loss. To protect themselves from these risks, they are more prone to support government spending. The authors also add that union members, female individuals, the elderly people have strong incentives to support government spending. In contrast, self-employed individuals, better-informed individuals, individuals who support right-wing parties are more likely to oppose social protection. White people are more prone to be against redistribution than black people (see Alesina and Ferrara, 2005). Individuals who live in rural areas, married individuals tend to support more redistribution (Ravallion and Lokshin, 2000). Cusack et al. (2006) find that publicly employed workers compared to private-sector workers, students and retired individuals are more likely to embrace redistribution. The possibility of becoming unemployed plays a significant role in preferences for redistribution (see Fernandez-Albertos and Manzano, 2016). Rehm (2011) calculates the unemployment risk within the categorized occupation and its relation with preferences for redistribution. If the occupational unemployment risk increases then workers with a high risk of unemployment are more likely to approve government spending. Rehm (2011) also finds that better-off individuals in terms of income and higher educated individuals people are more likely to disfavor the reducing income inequality policies.

Individuals' beliefs in effort and luck affect the preferences for government spending. Alesina and Angeletos (2005) find that if society believes that effort is an important determinant for income then they tend to demand low levels of redistribution whereas if luck, family connections or corruption play role in income then they tend to support redistributive policies. The political ideology is a significant determinant of preferences for redistribution (see Alesina and Giuliano, 2009). Alesina, Stantcheva, and Teso (2018) find that left-wing individuals support redistributive taxation but the ones who are pessimistic about intergenerational mobility support even more redistribution.

Another line of research shows that culture is an important determinant for redistribution preferences. Luttmer and Singhal (2011) show that the government redistribution policy of immigrant in the country of birth is associated with his attitudes towards redistribution in the country of residence. Alesina and Fuchs-Schündeln (2007) find that individuals from former East Germany are more likely to have pro-redistribution attitudes than individuals from West Germans after reunification. Corneo and Grüner (2002) show that individuals from former socialist countries tend to demand stronger preferences for reducing economic inequality than those from Western nations. Fong (2001) indicates that individuals tend to be in favor of redistribution if they believe that the main determinant of poverty is exogenous.

3.3 Data and Methodology

3.3.1 The datasets

We study the preferences for redistribution using data from eight rounds of the ESS which were carried out from 2002 to 2016. The survey includes questions about individuals' attitudes towards redistribution as well as individual characteristics. It is widely used in the welfare state literature.[1] We measure individual support for redistribution depending on the answers to this statement: *"The government should take measures to reduce differences in income levels"*. The respondent's answers vary on a scale from 1 to 5: disagree strongly (1), disagree (2), neither agree nor disagree (3), agree(4), agree strongly (5).

Our second main data source is IPUMS to compute assortative mating at the regional level. Both datasets contain regional-level identifiers at the NUTS level regions to be used for merging. We use the countries where the information on the socio-economic status of the partner is available. We consider married couples and also cohabiting couples. We compute the assortative mating in the regions at the NUTS 2 level for these countries: Austria, Greece, Italy, Spain, and Portugal in the year 2001; for Ireland, Poland and Slovenia in 2002; for France in 2006; and lastly for Switzerland in 2000. The sample size of the regions in the IPUMS data ranges from 1,959 to around 1 milion couples and 61 thousand couples per region.

We follow the paper Greenwood et al. (2014) to calculate the incidence of assortative mating in the region. First, the fraction of couples with the same education level for each region is computed as the actual matching. Secondly, we create a contingency

[1]see Olivera (2015), Senik et al.(2009), Luttmer and Singhal (2011).

table where the diagonal describes that both partners have the same education level based purely on chance. The sum along the diagonal defines the random matching. The ratio of the actual to random matches yields the values for assortative mating by educational status. We proceed with a similar path to the other dimensions, occupational and nativity, of assortative mating. The range is from 1 (the couple has the same educational level randomly) to infinity (maximum level of mating in the region). The incidence of assortative mating at the regional level is used as a proxy for socioeconomic segregation.

Table 3.1: ISCO-08 Major Groups and Skill Levels

	Skill Level
1 Managers	4
2 Professionals	4
3 Technicians and Associate Professionals	3
4 Clerks	2
5 Services and Sales Workers	2
6 Skilled Agricultural and Fishery Workers	2
7 Craft and Related Trades Workers	2
8 Plant and Machine Operators, and Assemblers	2
9 Elementary Occupations	1

Source: Adaptation of Table 1 from International Labor Office (2012)
Available at
`https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_172572.pdf`

To calculate assortative mating by educational status, we classify the education level in four categories: less than the primary level of education completed; the primary level of education completed; the secondary level of education completed; and university level education completed. We also compute assortative mating in terms of occupational and nativity status. Nativity is categorized depending on native or foreign-born conditions. We use the classification of occupations based on skill levels. ISCO-08 describes four levels of aggregation which is listed in Table 3.1. Managers and Professionals (ISCO-08 major groups 1 and 2) are considered to be at the highest skill level 4. Technicians and Associate Professionals (ISCO-08 major group 3) belongs to the medium-high skill level 3. ISCO-08 major groups 4, 5, 6, 7 and 8 include occupations at the same medium -low skill level 2. Elementary occupations (ISCO-08 major group 9) comprises occupations at the lowest skill level 1. We exclude armed forces.

Table 3.2: Correlations between Inequality and Assortative Mating Variables

	(1) Gini Before tax	(2) Gini After tax	(3) Ass. Mating by education	(4) Ass. Mating by occupation	(5) Ass. Mating by nativity
Gini Before Tax	1.0000				
Gini After Tax	0.5910	1.0000			
Ass. Mating by education	0.5149	0.6478	1.0000		
Ass. Mating by occupation	0.2956	0.4202	0.4687	1.0000	
Ass. Mating by nativity	-0.0559	-0.0088	-0.1423	0.0249	1.0000

Table 3.2 shows the correlations of the assortative mating measures among themselves and with two measures of inequality: the Gini coefficient before and after redistribution. Assortative mating by education and occupation are positively correlated, although far from perfect. Moreover, they are both positively correlated with the Gini coefficients. In contrast, the level of assortative mating by nativity is negatively correlated to education assortative mating, while has very low correlation with occupation assortative mating and inequality.

We pool the eight rounds of the ESS data and combine them with our regional measures of assortative mating. Our cross-sectional data of individual attitudes covers 111 regions of 10 European countries: Austria (AT), Italy (IT), Poland (PL), Spain (ES), France (FR), Switzerland (CH), Portugal (PT), Ireland (IE), Slovenia (SI) and Greece (EL). The final sample size is 68,341 observations without missing information. The number of observations per region is 615 on average, ranging between 35 to 3,297 observations.

3.3.2 Econometric specification

We estimate an OLS regression where the dependent variable y_{inct} measures the preferences for redistribution of an individual i living in region n of country c, at survey round t. We estimate this linear regression for each dimension of assortative mating variable.

$$y_{inct} = AM_n\beta + X_{it}\delta + Z_{nt}\gamma + \alpha_c + \mu_t + \epsilon_{inct}.$$

AM_n is the measure of assortative mating of region n. The vector X_{it} contains the individuals' characteristics such as age, age squared, gender, partnership status, nativity, highest level of education, main activity in the last seven days (before the interview), the number of people living in the household, the area where respondent's live (big city, suburbs, small city, village), a subjective evaluation of household income (living comfortably, coping, difficult or very difficult to live on present income), and the political ideology of the respondent (0-left, 10-right). All the individual characteristics are from the ESS. The vector Z_{nt} controls for regional characteristics, which consists of the percentage of the unemployment rate (population aged 15-74 years) and the percentage of tertiary educational attainment level (population aged 25-64) for the year 2001 (source Eurostat); gini measures (France, Switzerland, Ireland, Slovenia and Portugal for 2010; Austria, Greece, Italy, Poland, and Spain for the year 2013) and GDP per capita for the year 2001 (source OECD).[2] We also include the share of the foreign-born population for the year 2015 to estimate the effect of assortative mating by nativity on preferences for redistribution. We include country and year dummies to capture country and year fixed effects which are highly significant for all specifications. The terms α_c and μ_t stand for the country and year fixed effect, respectively. Finally, ϵ_{int} is the error term. We cluster the standard errors at the regional level.

The main variable of interest is the incidence of assortative mating used as a measure of segregation of the society. Segregation through mating is expected to have a negative effect on the preferences for redistribution. There are two main reasons to explain this relationship. First, it could be that more segregation reduces the social involvement of individuals, which decreases the willingness of the rich people to redistribute (Bjorvatn and Cappelen 2003). Second, more segregation might reduce the perceived inequality level of a country. Then, if preferences for redistribution are positively correlated with inequality as in Meltzer and Richard (1981), more segregation reduces the perception of inequality and preferences for redistribution (Windsteiger 2017). All observations are weighted in accordance with the design weights and the population size weights used from the European Social Survey.

3.3.3 Descriptive statistics

Table C.1 (in Appendix C) provides the summary statistics of the dependent variable, individual characteristics, regional, and political ideology control variables. The demand for redistribution is high on average (4 out of 5 points). Most of the sample is native and around 63% have a partner. The average individual is 42 years old and lives in a household with three members. 30% of the sample has tertiary education and around 60% of the population in the sample are employed. Moreover, almost 52% of the people live in a village or a small city and the rest lives in a big city or the suburbs of big cities. The majority of individuals agree that they live comfortably or at least they are coping with their current income. However, 22% of them believe that they have difficulties with their income. An average individual has a centrist political attitude (5 out of 10 points).

[2]Note that we could not find Gini data for Ireland, Portugal, Greece, and Poland at the Nuts2 level but we use the data for these countries at the Nuts 1 level.

Figure 3.1: Assortative Mating by Educational Status

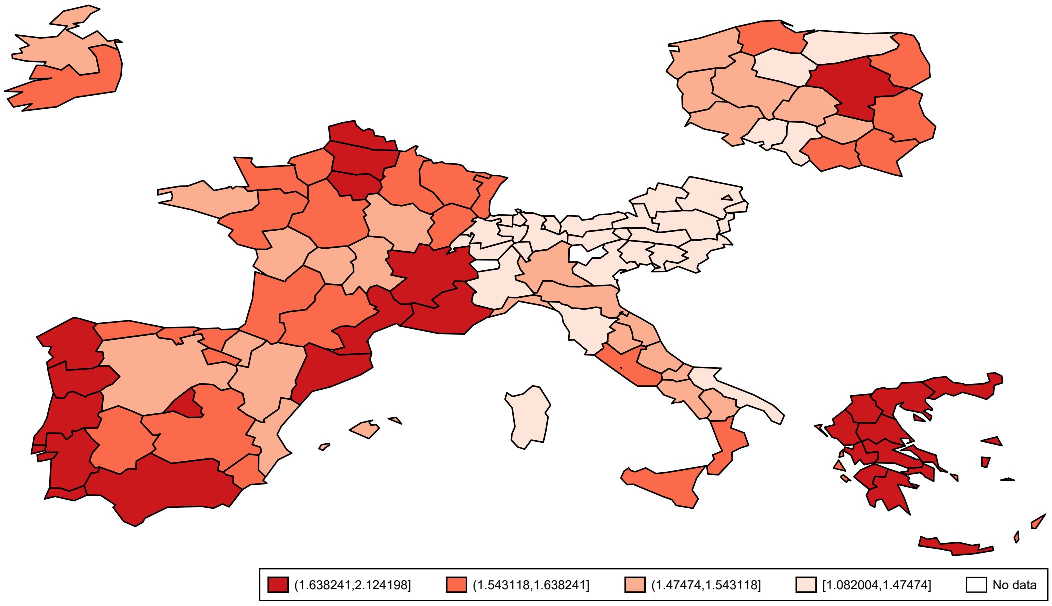
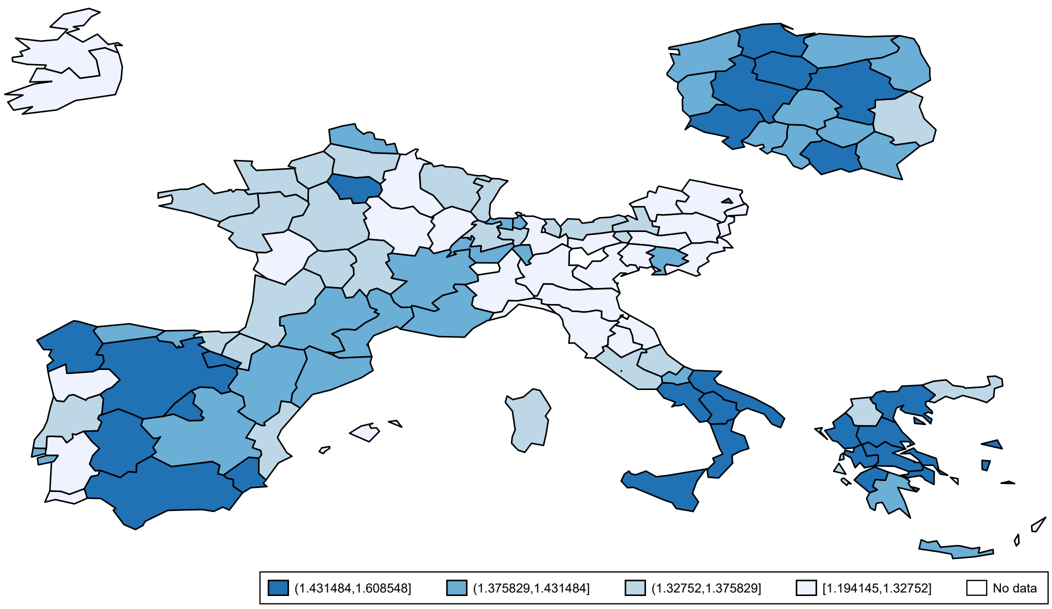
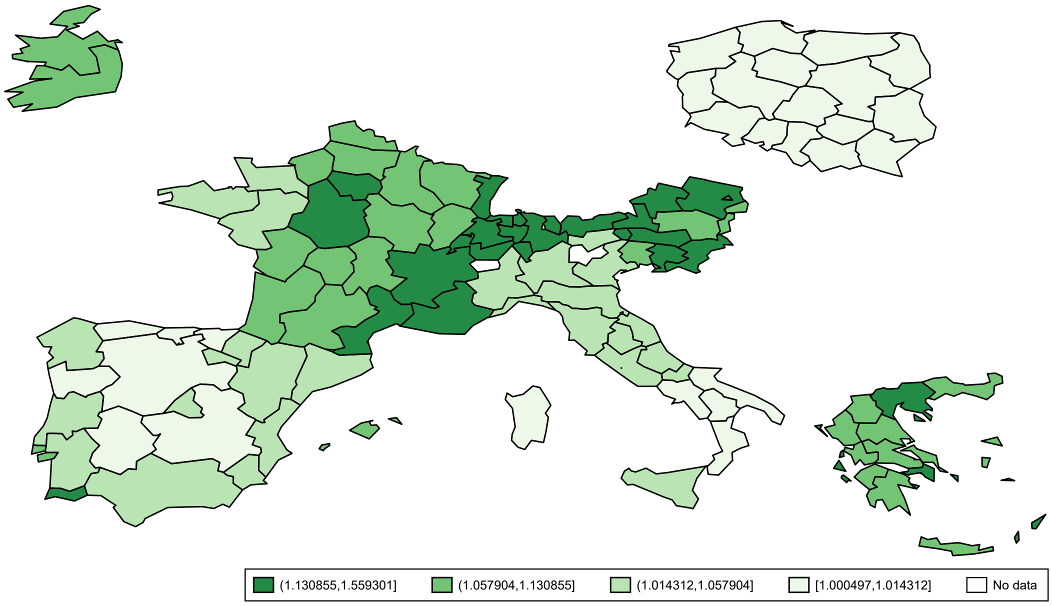


Figure 3.2: Assortative Mating by Occupational Status



There is a considerable amount of differences for individuals' attitudes towards redistributive taxation across countries. The countries that request redistributive tax above average are Greece, Portugal, Slovenia while the countries below the average are Switzerland and Ireland (see Figure C.1). We can also observe that the demand for redistribution has a decreasing trend for France over time. The geographical

Figure 3.3: Assortative Mating by Nativity Status



representations of variations in assortative mating indexes across European regions are plotted in Figures 3.1-3.3. Assortative mating by education ranges from 1.09 to 2.12; assortative mating by occupation ranges between 1.19 and 1.61; and assortative mating by nativity ranges between almost none in Poland to 1.56. There is in general significant heterogeneity of assortative mating within countries. Portugal and Greece have large values for education assortative mating, while Switzerland and Slovenia have low values.

3.4 Results

We analyze the effect of segregation through the incidence of assortative mating on preferences for redistribution. In Table 3.3, we estimate how assortative mating in terms of education affects an individual's support for redistribution. The first column includes the whole sample then we divide the sample into three sub-samples based on income.[3] Column 2 refers to the sample of those that report living comfortably with current income, column 3 refers to those who consider that they are coping on present income, and column 4 refers to those who have difficulties with their present

[3]In the ESS dataset, the rounds 1,2, and 3 have different classification of income deciles than the rounds 4 to 8. It is not possible to combine them. Not to lose observations, we decided to use respondents' subjective evaluation of income instead of income deciles. They are strongly correlated (Correlation in the rounds 1 to 3 is 0.5249 and correlation in the rounds 4 to 8 is 0.5167).

income. Each column includes country and year fixed effects, regional controls, basic-individual characteristics, and political-ideology control variable.

Results reveal that segregation affects negatively preferences for redistribution only for those individuals who live comfortably on present income. Table 3.4 shows similar results when segregation is measured as assortative mating by occupation.

Table 3.3: Assortative Mating by Educational Status and Support for Redistribution

	(1) All sample	(2) Living comfortably on present income	(3) Coping on present income	(4) Difficult and very difficult on present income
Assortative Mating by Educational Status	-0.006 (0.176)	**-0.396**** **(0.195)**	0.047 (0.236)	0.170 (0.162)
N	68341	20220	32622	15499
adj. R^2	0.084	0.113	0.053	0.035
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: OLS estimation. The dependent variable depends on the answers to this survey question: Should the government take measures to reduce differences in income levels? We use eight ESS rounds from 2002 to 2016. The independent variable is assortative mating in terms of education at the regional level (for its computation IPUMS dataset is used). The first column includes the whole sample, column 2 includes the group of individuals who live comfortably on their present income, column 3 includes individuals who cope with their present income and lastly, column 4 includes individuals who have difficulties with their present income. Regional controls contain the percentage of the unemployment rate (population aged 15-74 years) and the percentage of tertiary educational attainment level (population aged 25-64) for the year 2001 from Eurostat; Gini before tax and transfers (France, Switzerland, Ireland, Slovenia and Portugal for 2010; Austria, Greece, Italy, Poland, and Spain for the year 2013) and GDP per capita for the year 2001 (source OECD). Individual controls include nativity status, partnership status, gender, age, age squared, education level, the size of household, activity status before interview-i.e., being unemployed, student, retired..etc, individual's domicile-e.g., living in a big city, suburbs, in a small city or a village, feelings about present income-e.g., living in comfort or coping on present income. Ideology control includes attitudes towards the left or right-wing political position. Standard errors in parentheses. Robust standard errors clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In Table 3.5, we introduce assortative mating by nativity as the main independent variables. Unlike other tables, regional controls include the share of the foreign-born population for the year 2015.[4] The upper and lower panel distinguish the sample based on native and foreign-born condition. In the first estimation, all columns include only native-borns. The more couples with the same nativity-status are in the region, the less support for redistribution given by native-born individuals who live

[4]The data from OECD is available for all countries except Ireland and Slovenia.

Table 3.4: Assortative Mating by Occupational Status and Support for Redistribution

	(1) All sample	(2) Living comfortably on present income	(3) Coping on present income	(4) Difficult and very difficult on present income
Assortative Mating	-0.163	**-0.745*** **	0.088	0.007
by Occupational Status	(0.194)	**(0.242)**	(0.272)	(0.229)
N	68341	20220	32622	15499
adj. R^2	0.084	0.113	0.053	0.035
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: The OLS estimation includes country fixed effects and year fixed effects, regional controls, individual controls and ideology controls (see the notes of table 3.3 for details). The independent variable is assortative mating in terms of occupation at the regional level. Standard errors in parentheses. Robust standard errors clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

comfortably with their income and who have difficiulties with their present income. For foreign-borns the assortative mating variable is not significant in any regression, although coefficient is negative for more affluent individuals. Note that there are few observations.

These results suggest that the effect of segregation on attitudes towards redistribution is negative. In particular, the wealthy ones display less support for redistribution when there is high segregation in any form of assortative mating such as educational, occupational or nativity. It is consistent with the theory where the wealthy may be less willing to prefer redistribution due to their deteriorated social attachment in the presence of high segregation (Bjorvatn and Cappelen, 2003).

To analyze extreme segregation at the top and the bottom of the society, we compute assortative mating by using different classification methods for education and occupation levels. In the upper panel of table C.3 in Appendix C, we compute assortative mating in terms of having less than a primary education degree. Nevertheless, in the lower panel, assortative mating is measured by having a completed tertiary degree.[5] In table C.4 we report the results when using assortative mating at the top and the bottom occupation level. According to skill level classification, the top occupations are the managers and professionals (ISCO-08 codes 1 and 2) whereas the occupations at the bottom are the elementary occupations (ISCO-08 code 9).

[5]In the computation of assortative mating by having less than a primary degree, Austria and Ireland are not included because all individuals completed at least a primary degree education.

Table 3.5: Assortative Mating by Nativity Status and Support for Redistribution

	(1) All sample (native-born)	(2) Living comfortably on present income (native-born)	(3) Coping on present income (native-born)	(4) Difficult on present income (native-born)
Assortative Mating by Nativity Status	**-0.427****	**-0.602****	-0.104	**-0.548***
	(0.208)	**(0.270)**	(0.265)	**(0.292)**
N	46311	13585	22119	10607
adj. R^2	0.093	0.117	0.062	0.033
	(1) All sample (foreign-born)	(2) Living comfortably on present income (foreign-born)	(3) Coping on present income (foreign-born)	(4) Difficult on present income (foreign-born)
Assortative Mating by Nativity Status	0.537	-0.074	0.530	1.373
	(0.416)	(0.528)	(0.514)	(0.972)
N	5442	1566	2262	1614
adj. R^2	0.091	0.121	0.076	0.126
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: The OLS estimation includes country fixed effects and year fixed effects, regional controls, individual controls and ideology controls (see the notes of table 3.3 for details). The independent variable is assortative mating in terms of the nativity at the regional level. The upper and lower panel distinguish the sample between native and foreign-born. In the first estimation, the sample consists of only native-born whereas in the second estimation the sample comprises foreign-born individuals. Standard errors in parentheses. Robust standard errors clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The negative coefficient of assortative mating by having less than a primary education degree and by the top occupations remains highly significant for the wealthy group as before.[6] In contrast to the first regression results in tables C.3 and C.4, none of the coefficients are statistically significant at the 10 percent level where assortative mating computed in terms of a completed tertiary degree and bottom occupations. In conclusion, segregation at the bottom level of education and at the top level of occupation affects negatively individual's support for redistribution. In particular, affluent individuals demand less redistribution in more segregated regions.

The rest of the results are consistent with the existing literature. Table C.5, in Appendix C, presents individual characteristics. Being native-born is positively associated with the demand for redistribution. Highly educated individuals are less likely to demand redistribution. The literature explains this significant and negative coefficient with prospects for upward mobility such that people invest more in education to have upward mobility in the future. We also find that men are more inclined to disapprove of redistribution than women. Compared to employed individuals, retired and unemployed individuals more likely to support shared prosperity, whereas stu-

[6]The geographical representations for assortative mating by having less than a primary degree, by tertiary degree, by top occupations, and by bottom occupations are presented in Figure C.2, C.3, C.4 and C.5, in Appendix C, respectively.

dents are averse to it. Furthermore, individuals who live in a small city or a village tend to vote for more redistribution than individuals living in a big city. Ideologically, left-wing individuals are more likely to be "equalitarians". Accordingly, they are more inclined to embrace the government's role in reducing income inequality than right-wing individuals. Finally, we use the individuals' perception of their income level as a proxy for income. The more individuals consider that their current income is not sufficient for living, the more they tend to support redistribution.

We test the robustness of the results by using alternative variables related to attitudes to social spending. The special modules on welfare attitudes from the rounds of 2008 and 2016 of ESS inquire in which extent the respondents agree or disagree with the following statements: *"Large differences in income acceptable to reward talents and efforts"*, *"For fair society, differences in standard of living should be small"*, and *"Social services cost businesses too much in taxes"*. Our aim to make a combination with these alternative variables of welfare attitudes into a single indicator. Therefore, we use these three alternative variables and our main dependent variable available in all ESS rounds to construct a composite index of attitudes as the first component of a principal component analysis.

We analyze this overall index of welfare attitudes for each assortative mating variable (see Table C.6 in Appendix C) and compared it to the previous results. The negative association between segregation, measured by assortative mating in terms of occupation, having less than a primary degree, having a top occupation, and support for redistribution remains stable and it preserves its significance. Note that, unlike the previous results, individuals who cope with their present income are likely to demand less redistribution where assortative mating is computed in terms of having less than a primary degree.

For the last part of the analysis, we run a placebo test. We use random survey questions from the ESS, i.e., the respondents' opinions about the importance to care for nature and environment, to be humble and modest and to think new ideas and being creative as dependent variables, respectively. We believe that segregation computed by assortative mating variables should not be affected by these dependent variables. If we would have found some significant effect, then the previous results on preferences for redistribution could be spurious. In table C.7 in Appendix C, we run the model with all control variables. No significant results were found.

3.5 Concluding Remarks

This chapter shows that segregation and preferences for redistribution are associated negatively at the regional level, notably, for affluent individuals. We use data from the IPUMS and the ESS in 111 regions of 10 European countries.

The incidence of assortative mating in terms of education, occupation, and nativity is used as a proxy to measure socioeconomic segregation in a region. Increased segregation in most forms of assortative mating leads the affluent to support less redistribution. This happens when assortative mating is measured in terms of education and occupation.

We observe that this negative relationship between segregation, with regards to assortative mating by nativity status, and redistribution affects individuals who have difficulties to earn a living with their present income. We also study socioeconomic segregation of the top and the bottom of the society. When society is more segregated at the lowest level of education and the top level of occupation, the affluent individuals are likely to support less for redistribution. These results are consistent with the paper of Bjorvatn and Cappelen (2003). In a segregated society due to large inequalities in pre-tax income distribution, the affluent may be more detached to the other groups in society and to be less keen on supporting the redistributive policies.

We analyze the individual characteristics as a determinant for redistribution. Native-born, female individuals, retired and unemployed people, individuals live in a rural area, the ones who have a hard time to earn a living, and the left-wing supporters are more likely to embrace redistributive tax policies. In contrast, students, male individuals, and the ones with higher education are more likely oppose to it.

The main limitation of this analysis is the set of countries. The use of other databases, such as the EU-LFS (European Union Labor Force Survey) and the EU-SILC (European Union Statistics on Income and Living Conditions) should allow widening the range of countries in the analysis.

Conclusion

The aim of this dissertation to analyze the political economy of redistribution. Chapter 1 and Chapter 2 formulate two dynamic and theoretical models to capture the interrelation between education decisions and preferences for redistribution. In contrast, Chapter 3 uses an empirical approach to study the effect of segregation on individuals' preferences for redistribution.

Chapter 1 presents a model where individuals are different in socioeconomic terms. These differences disappear once all parents are educated. Higher education implies a return in income, but comes at a cost that depends on the educational status of parents. There are no borrowing constraints to invest in education. The degree of inequality of opportunity, defined by the differences in education level of parents, and returns to education jointly affect the size of redistribution at equilibrium. If the return to education is large, and inequality of opportunity is low, the equilibrium is characterized by a majority of educated individuals and no redistribution. If the return to education is low and/or the inequality of opportunities is large, the economy can end up at a corner solution with no education and no redistribution. An equilibrium with a majority of uneducated people and positive redistribution also exists for intermediate values of the parameters. Finally, the equilibrium is not always unique due to expectations of individuals about other individuals' education decision.

Chapter 2 constructs a model where individuals differ in their innate earning ability that do not disappear over time. There is a financial cost of education which is same for all but not everyone can afford it. Therefore, individuals confront borrowing constraints to choose the education level for their children. There are four different types of individuals characterized by their education level and earning ability level. Each group has a favorite redistribution policy to maximize their utility but the tax rate is chosen collectively through a Condorcet winner. I consider two scenarios where the cost of education is high or low.

When the education cost is low, all individuals will be educated according to the long term implications of the model. The properties of preferences for redistribution are conventional. The worse off-low ability earners demand some redistribution whereas the better off-high ability earners oppose it.

In contrast, when the education cost is high, only the educated can afford the education for their children. Consequently, there is no mobility across generations and the initial proportion of educated repeats itself in the long-run. Under this setting, I present the equilibrium in terms of the relative size of returns to education and the innate differences in productivity between high and low earners as follows:

- If the returns to education are large and the coalition of the educated constitutes the majority then the winner tax policy is zero redistribution. On the other hand, if the coalition of the uneducated shapes the majority then the the medium level of redistribution is the winner policy.

- If returns to education are relatively low and then the non-conventional results occurs. First, the coalition of the educated may demand a positive (although low) level of redistribution where the proportion of educated individuals is higher than the proportion of low ability earners. Second, the uneducated individuals with high earning ability collude with the educated to oppose redistribution policy where the proportion of low ability individuals is larger than the educated.

Chapter 3 presents an empirical analysis where we study the role of segregation on individuals' attitudes to redistribution at the regional level. We generate assortative mating indexes in terms of education, occupation and nativity to infer the level of segregation within 111 regions in 10 European countries, using data from the ESS between the years 2002-2016 and the IPUMS.

We find that segregation affects negatively the preferences for redistribution, particularly for affluent individuals. Furthermore, the affluent demand less redistribution when society is more segregated at the lowest level of education and the top level of occupation. We relate this result with Bjorvatn and Cappelen (2003). In countries with high-income inequality, society is more segregated socioeconomically and the segregated affluent individuals may be less likely to support redistribution.

Appendix A

Appendix to Chapter 1

A.1 The reverse timing

The reverse timing structure is as follows. In the first stage, individuals decide to have higher education or not. In the second stage, individuals vote on the tax rate. I solve the model by backward induction.

i. 2nd Stage: Voting over taxation

Individuals will choose the most preferred income tax rate to maximize their utility when they already made their decision whether to invest in higher education or not. They vote for τ to maximize their utility by considering given education decision, $\hat{e}$. Since the education decision is given, the effect of π on τ is constant. Thus, the maximization problem when the decisive voter is educated:

$$Max_\tau \ (w+R)(1-\tau)+\tau(w+\pi R)-\gamma_i C(a)$$

The first-order condition to this problem

$$\frac{\partial U}{\partial \tau} = R(\pi - 1) < 0$$

When the median voter is educated, $\tau^* = 0$. The maximization problem when the decisive voter is uneducated shown as follows

$$Max_\tau \ w(1-\tau)+\tau(w+\pi R)-\gamma_i C(a)$$

Then, the FOC

$$\frac{\partial U}{\partial \tau} = R\pi > 0$$

Since there is no restriction on maximization problem, individuals prefer the maximum amount, $\tau^* = 1$, which is total expropriation of educated people.

ii. 1st Stage: Investment in Education

Individuals will find the optimal decision whether to study or not. If they anticipate that the chosen tax is zero, then they compare their utility with and without education. We obtain a threshold ability level, $\hat{a}_i$, where individuals are indifferent to study or not.

$$R = \gamma_i C(\hat{a}_i)$$

Individuals whose ability is larger than threshold will invest in higher education. Individuals whose ability is less than threshold ability level will not. If they anticipate that the choosen tax is positive then they compare two type of utilities in the presence of positive optimal tax. Here is the new threshold to get higher education

$$R(1 - \tau^*) = \gamma_i C(\hat{a}_i)$$

Individuals will find the optimal decision whether to study or not.

iii. Equilibrium

At the equilibrium, individuals make a decision for their education level by anticipating that the chosen tax rate is either 1 or 0 in the first stage. If they predict that the most preferred tax rate is one, $\tau^* = 1$, then there will be no incentives to get higher education, thus no one will study, $\pi^* = 0$. If they anticipate that the tax rate is zero, $\tau^* = 0$, then the interior equilibrium occurs with $\pi^* > \frac{1}{2}$ if $\hat{a}_0 + \hat{a}_1 < 1$ which implies $\gamma_0 + \gamma_1 < R$. To summarize, $\pi^* > \frac{1}{2}$ and $\tau^* = 0$ if $\gamma_0 + \gamma_1 < R$.

A.2 Proof of $\tau^* > 0$

Consider the following maximization problem when the median voter is uneducated

$$Max_\tau \; w(1 - \tau) + \tau(w + \pi(\tau)R) - \gamma_i C(a)$$

The first-order condition is:

$$\frac{\partial U}{\partial \tau} = \pi(\tau^*)R + \tau^* R \frac{\partial \pi}{\partial \tau}.$$

$$R\left(\frac{R(1-\tau^*)-\gamma_0}{R(1-\tau^*)-\Delta\gamma}+\tau^*\frac{-R\gamma_1}{[R(1-\tau^*)-\Delta\gamma]^2}\right)=0$$

$$[R(1-\tau)-\gamma_0]\,[R(1-\tau)-\Delta\gamma]=\tau^* R\gamma_1$$

In order to find the most preferred tax rate, lets isolate τ^*

$$\tau^{*2}R^2-\tau^* 2R(R-\Delta\gamma)+[R-\gamma_0]\,[R-\Delta\gamma]=0$$

Lets find the real roots of the quadratic equation, at first, we need to find its discriminant, shown as the following

$$\Delta=[2R(R(1-\tau)-\gamma_0+\gamma_1)]^2-4R^2(R-\gamma_0)R(-\gamma_0+\gamma_1)$$

$$\Delta=4R^2(R-\Delta\gamma)\gamma_1$$

In order to have positive real root/s, the discriminant has to be positive. By Lemma 1, we know that $R>\Delta\gamma$ then $\Delta\geq 0$.

$$\tau_1^*=1-\frac{\Delta\gamma-\sqrt{(R-\Delta\gamma)\gamma_1}}{R}$$

$$\tau_2^*=1-\frac{\Delta\gamma+\sqrt{(R-\Delta\gamma)\gamma_1}}{R}$$

In order to determine which τ^* is local minimum and which one is local maximum, let's calculate the second derivative of utility function with respect to τ as follows

$$\frac{\partial^2 U}{\partial\tau^2}=R\left(2\frac{\partial\pi}{\partial\tau}+\tau^*\frac{\partial^2\pi}{\partial\tau^2}\right).$$

When we substitute τ_1^* into the second derivative of utility function, we obtain

$$\frac{\partial^2 U}{\partial\left(\tau_1^*\right)^2}=R\left(\frac{2R\gamma_1(R-\Delta\gamma)}{(R-\Delta\gamma)\sqrt{(R-\Delta\gamma)\gamma_1}}\right)>0$$

The shape of $U(\tau)$ is convex with τ_1^* then we conclude that the local minimum is at $(\tau_1^*,0)$. When we substitute τ_2^* into the second derivative of utility function, we obtain

$$\frac{\partial^2 U}{\partial\left(\tau_2^*\right)^2}=R\left(\frac{-2R\gamma_1(R-\Delta\gamma)}{(R-\Delta\gamma)\sqrt{(R-\Delta\gamma)\gamma_1}}\right)<0$$

The shape of $U(\tau)$ is concave with τ_2^* then we conclude that the local maximum is at $(\tau_2^*, 0)$. Thus, all preferences are single-peaked and the preferred positive tax rate is:

$$\tau^* = 1 - \frac{\Delta\gamma + \sqrt{(R - \Delta\gamma)\gamma_1}}{R}.$$

A.3 Proof of Theorem 1

Case $\tau^* > 0$:

The purpose of this Appendix is to perform comparative statics to see the relation between the parameters and the variables at the equilibrium with $\tau^* > 0$. Recall that interior equilibrium with positive redistribution occurs IFF $\gamma_0 < R < \gamma_0 + \gamma_1$.

1. **The derivations of all variables with respect to γ_0**

i. Recall that the chosen tax rate is

$$\tau^* = 1 - \frac{\gamma_0 - \gamma_1 + \sqrt{(R - \gamma_0 + \gamma_1)\gamma_1}}{R}$$

We take the derivative of τ^* with respect to γ_0 as follows:

$$\frac{\partial \tau^*}{\partial \gamma_0} = \frac{1}{R}\left(-1 + \frac{\gamma_1}{2\sqrt{(R - \Delta\gamma)\gamma_1}}\right)$$

The numerator of the fraction is always negative because $R > \gamma_0 - \frac{3}{4}\gamma_1$. Then $\frac{\partial \tau^*}{\partial \gamma_0} < 0$.

ii. When we subsitute the positive tax rate into $\hat{a}_i$ then we obtain

$$\hat{a}_i^* = \frac{\gamma_i}{\gamma_0 - \gamma_1 + \sqrt{(R - \gamma_0 + \gamma_1)\gamma_1}}$$

Let us take the derivative of $\hat{a}_0$ with respect to γ_0 as follows:

$$\frac{\partial \hat{a}_0^*}{\partial \gamma_0} = \frac{\gamma_1\left(2(R + \gamma_1) - \left(2\sqrt{(R - \gamma_0 + \gamma_1)\gamma_1} + \gamma_0\right)\right)}{2\sqrt{(R - \gamma_0 + \gamma_1)\gamma_1}\left(\gamma_0 - \gamma_1 + \sqrt{(R - \gamma_0 + \gamma_1)\gamma_1}\right)^2}$$

We check whether the numerator is positive or not.

$$(2R - \gamma_0)^2 + 4R\gamma_1 > 0$$

As we can see above, the numerator is always positive. An increase in the cost of education γ_0 generates an increase in $\hat{a}_0^*$. Then $\frac{\partial \hat{a}_0^*}{\partial \gamma_0} > 0$.

When we take the derivative of $\hat{a}_1^*$ with respect to γ_0 as follows:

$$\frac{\partial \hat{a}_1^*}{\partial \gamma_0} = \frac{\gamma_1}{\left(\gamma_0 - \gamma_1 + \sqrt{(R-\gamma_0+\gamma_1)\gamma_1}\right)^2}\left(-1 + \frac{\gamma_1}{2\sqrt{(R-\gamma_0+\gamma_1)\gamma_1}}\right)$$

We check the sign of the numerator.

$$-2\sqrt{(R-\gamma_0+\gamma_1)\gamma_1} + \gamma_1 \lesseqgtr 0$$

The numerator of the fraction above is negative because $R > \gamma_0 - \frac{3}{4}\gamma_1$. Then $\frac{\partial \hat{a}_1^*}{\partial \gamma_0} < 0$. A marginal increase in the cost of education γ_0 generates a decrease in $\hat{a}_1$.

iii. When we subsitute positive tax rate into π^* then we obtain

$$\pi^* = 1 - \sqrt{\frac{\gamma_1}{R-\gamma_0+\gamma_1}}$$

Lets take the derivative of π^* with respect to γ_0 as follows:

$$\frac{\partial \pi^*}{\partial \gamma_0} = -\frac{\sqrt{\gamma_1}(R-\gamma_0+\gamma_1)^{-\frac{3}{2}}}{2}$$

The cost of education γ_0 decreases in π^* such that $\frac{\partial \pi^*}{\partial \gamma_0} < 0$.

2. **The derivations of all variables with respect to γ_1**

We take the derivative of $\hat{a}_0^*$ with respect to γ_1 as follows:

$$\frac{\partial \hat{a}_0^*}{\partial \gamma_1} = \frac{\gamma_0\left[2\sqrt{\gamma_1}\left(\sqrt{R-\gamma_0+\gamma_1} - \sqrt{\gamma_1}\right) + \gamma_0\right]}{\left(\gamma_0 - \gamma_1 + \sqrt{(R-\gamma_0+\gamma_1)\gamma_1}\right)^2 2\sqrt{(R-\gamma_0+\gamma_1)\gamma_1}}$$

Then $\frac{\partial \hat{a}_0^*}{\partial \gamma_1} > 0$.

We take the derivative of $\hat{a}_1^*$ with respect to γ_1 as follows:

$$\frac{\partial \hat{a}_1^*}{\partial \gamma_1} = \frac{\gamma_0 2\sqrt{(R-\gamma_0+\gamma_1)\gamma_1} + \gamma_1(2R-\gamma_0)}{2\sqrt{(R-\gamma_0+\gamma_1)\gamma_1}\left(\gamma_0 - \gamma_1 + \sqrt{(R-\gamma_0+\gamma_1)\gamma_1}\right)^2}$$

Then $\frac{\partial \hat{a}_1^*}{\partial \gamma_1} > 0$.

We take the derivative of π^* with respect to γ_1 as follows:

$$\frac{\partial \pi^*}{\partial \gamma_1} = -\frac{1}{2}\left[\frac{\gamma_1}{R-\gamma_0+\gamma_1}\right]^{-\frac{1}{2}} \frac{R-\gamma_0}{(R-\gamma_0+\gamma_1)^2}$$

Then $\frac{\partial \pi^*}{\partial \gamma_1} < 0$.

Lets take the derivativative of τ^* with respect to γ_1 as follows:

$$\frac{\partial \tau^*}{\partial \gamma_1} = \frac{1}{R}\left(1 - \frac{(-\gamma_0 + 2\gamma_1)}{2\sqrt{(R - \Delta\gamma)\gamma_1}}\right)$$

Then $\frac{\partial \tau^*}{\partial \gamma_1} > 0$.

3. **Comparative Statics with respect to** R

Lets take the derivative of $\hat{a}_i^*$ with respect to R as follows:

$$\frac{\partial \hat{a}_i^*}{\partial R} = -\frac{\gamma i \gamma_1}{2\sqrt{(R - \Delta\gamma)\gamma_1}\left(\Delta\gamma + \sqrt{(R - \Delta\gamma)\gamma_1}\right)^2}$$

When the return to education increases, the threshold of ability decreases $\frac{\partial \hat{a}_i^*}{\partial R} < 0$.

ii. Lets take the derivative of π^* with respect to R as follows:

$$\frac{\partial \pi^*}{\partial R} = \frac{\sqrt{\gamma_1}(R - \Delta\gamma)^{-\frac{3}{2}}}{2}$$

When the return to education increases the proportion of educated also increases, $\frac{\partial \pi^*}{\partial R} > 0$.

iii. Lets take the derivativative of τ^* with respect to R as follows:

$$\frac{\partial \tau^*}{\partial R} = \frac{2\Delta\gamma\sqrt{\gamma_1}\left(\sqrt{R - \Delta\gamma} - \sqrt{\gamma_1}\right) + \gamma_1 R}{2\sqrt{(R - \Delta\gamma)\gamma_1}R^2}$$

Then $\frac{\partial \tau^*}{\partial R} > 0$.

Case $\tau^* = 0$:

Let us use the parameters γ_i, R and the variables $\hat{a}_i^*$, π^* to perfom comparative statics at the zero tax equilibrium. Remember that interior equilibrium with no redistribution occurs IFF $R > \gamma_0 + 3\gamma_1$.

i. The derivation of π^* with respect to γ_i is negative, $\frac{\partial \pi^*}{\partial \gamma_i} < 0$.

$$\frac{\partial \pi^*}{\partial \gamma_0} = -\frac{\gamma_1}{(R - \gamma_0 + \gamma_1)^2}$$
$$\frac{\partial \pi^*}{\partial \gamma_1} = -\frac{1}{(R - \gamma_0 + \gamma_1)^2}$$

The derivative of π^* with respect to R is positive, $\frac{\partial \pi^*}{\partial R} > 0$.

$$\frac{\partial \pi^*}{\partial R} = \frac{\gamma_1}{(R - \gamma_0 + \gamma_1)^2}$$

ii. The derivative of $\hat{a}_i^*$ with respect to γ_i is positive, $\frac{\partial \hat{a}_i^*}{\partial \gamma_i} > 0$ and with respect to R is negative, $\frac{\partial \hat{a}_i^*}{\partial R} < 0$.

$$
\begin{aligned}
\frac{\partial \hat{a}_i^*}{\partial \gamma_i} &= \frac{1}{R^2} \\
\frac{\partial \hat{a}_i^*}{\partial R} &= -\frac{\gamma_i}{R^2}
\end{aligned}
$$

Appendix B

Appendix to Chapter 2

B.1 Stationary Equilibrium when $n^l > k$

I compute the trivial case where everyone can afford education for their children. Here is the transition matrix:

$$P = \begin{bmatrix} 0 & \theta & 0 & 1-\theta \\ 0 & \theta & 0 & 1-\theta \\ 0 & \theta & 0 & 1-\theta \\ 0 & \theta & 0 & 1-\theta \end{bmatrix}$$

The long-run distribution is $\pi^{lu} = 0$, $\pi^{le} = \theta$, $\pi^{hu} = 0$, $\pi^{he} = 1 - \theta$. Thus, in the long-run, everyone will be educated, $\pi^* = 1$.

B.2 Stationary Equilibrium with Inherited Ability

In this case, children inherits the innate ability from their parents which is just one-generation dependence.

(i) Let's first suppose a situation in low cost scenario where only uneducated individuals with low ability cannot afford education but the rest of the individuals can. Then the transition matrix is:

$$P = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

At the steady state, the distribution of individuals which depends on education and ability is :

$$\begin{aligned}\pi^{lu} &= \pi^{lu}\\ \pi^{le} &= \pi^{le}\\ \pi^{hu} &= 0\\ \pi^{he} &= \pi^{hu}+\pi^{he}\end{aligned}$$

In contrast to the case where ability is not inherited, the children, whose parents are lu, remain uneducated.

(ii) Let's suppose the situation in high cost scenario where only educated individuals can afford the education for next generation whereas uneducated ones cannot. The transition matrix is the identity matrix. At the steady state, the ability and education level of children is just a replication of their parents (i.e. $\pi^{lu} = \pi^{lu}, \pi^{le} = \pi^{le}, \pi^{hu} = \pi^{hu}, \pi^{he} = \pi^{he}$). There is absolutely no transition between generation in terms of education and ability. As shown above, when ability of children depends on their parents, they are caught forever in education and poverty trap.

B.3 The preferred tax rates for each ij

I analyze tax rates chosen by different group of people.

a) The maximization problem of individual of type he can be represented as below

$$Max_{\tau}\ (n^h + R)(1-\tau) + (\tau - \tau^2)\ \bar{y} + (n_m + e_n R)(1-\tau) + S - e_n k$$

The solution to this problem is:

$$-(n^h + R) + \bar{y}(1 - 2\tau^*_{he}) = 0$$

When we write $\bar{y}$ explicitly into the equation shown above, we obtain the chosen tax by individual of type he

$$\tau^*_{he} = \frac{R(\pi - 1) - \theta\Delta n}{2(R\pi + n^h - \theta\Delta n)}$$

Since the numerator will be always negative, $R(\pi - 1) - \theta\Delta n < 0$, the preferred tax of educated and high skilled individuals is always zero, $\tau^*_{he} = 0$.

b) Individual of type hu solves his utility maximization problem. It can be written as:

$$Max_{\tau}\ n^h(1-\tau) + (\tau - \tau^2)\bar{y} + (n_m + e_n R)(1-\tau) + S - e_n k$$

The solution to this problem is:

$$-n^h + (1 - 2\tau^*_{hu})\bar{y} = 0$$

The preferred tax of individuals hu is $\tau^*_{hu} = \frac{\bar{y}-n^h}{2\bar{y}}$. When we substitute $\bar{y}$ into the first-order condition equation, we obtain the chosen tax by individuals of type hu

$$\tau^*_{hu} = \frac{R\pi - \theta\Delta n}{2(R\pi + n^h - \theta\Delta n)}$$

If $\frac{\Delta n}{R} < \frac{\pi}{\theta}$ is satisfied, then the uneducated and high-skilled individual prefers a positive tax. Otherwise, the preferred tax is zero.

c) The utility maximization problem for individuals of type le is:

$$Max_\tau \ (n^l + R)(1 - \tau) + (\tau - \tau^2)\bar{y} + (n_m + e_n R)(1 - \tau) + S - e_n k$$

The solution to this problem is:

$$-(n^l + R) + (1 - 2\tau^*_{le})\bar{y} = 0$$

The tax rate is $\tau^*_{le} = \frac{\bar{y}-(n^l+R)}{2\bar{y}}$. When we substitute $\bar{y}$ into the first-order condition, we obtain

$$\tau^*_{le} = \frac{R(\pi - 1) + (1 - \theta)\Delta n}{2(R\pi + n^l + (1 - \theta)\Delta n)}$$

The educated and low-skilled individual prefers positive tax if $\frac{1-\pi}{1-\theta} < \frac{\Delta n}{R}$ holds. Otherwise individual of type le prefers zero-tax.

d) The utility maximization problem for an uneducated individual with low ability becomes:

$$Max_\tau \ n^l(1 - \tau) + (\tau - \tau^2)\bar{y} + (n_m + e_n R)(1 - \tau) + S - e_n k$$

The first order condition of this problem is:

$$-n^l + (1 - 2\tau^*_{lu})\bar{y} = 0$$

The chosen tax of individual of type lu is determined by $\tau^*_{lu} = \frac{\bar{y}-n^l}{2\bar{y}}$. When we substitute $\bar{y}$ into the first-order condition, we obtain

$$\tau^*_{lu} = \frac{R\pi + (1 - \theta)\Delta n}{2(R\pi + n^l + (1 - \theta)\Delta n)}$$

Since the numerator will be always positive, $R\pi + (1 - \theta)\Delta n > 0$. The uneducated and low skilled individuals always prefer positive tax, $\tau^*_{lu} > 0$.

B.4 The credit constraint with a different chosen tax

In this part, I indicate the credit constraints that individuals confront for each equilibrium type with chosen tax. The credit constraint in equilibrium where everyone is educated is shown below

$$(1-\tau^*)(n^h+\tau^*\bar{y}) > k \ and \ \pi^* = 1$$

Let's substitute τ_{le} into credit constraint of equilibrium with $\pi^* = 1$ and we obtain

$$\left(1+\frac{R+n^l}{R+n^l+(1-\theta)\Delta n}\right)\left(2n^h+(1-\theta)\Delta n\right) > 4k$$

The credit constraint in equilibrium which depends on initial education level is:

$$(1-\tau^*)(n^h+\tau^*\bar{y}) < k \ and \ \pi^* = \pi_0$$

Let's substitute τ_{lu} into the credit constraint of equilibrium with $\pi^* = \pi_0$

$$\left(1+\frac{n^l}{R\pi_0+n^l+(1-\theta)\Delta n}\right)\left(R\pi_0+2n^h+(1-\theta)\Delta n\right) < 4k$$

Let's substitute τ_{le} into the credit constraint of equilibrium with $\pi^* = \pi_0$

$$\left(1+\frac{R\pi_0+n^l}{R\pi_0+n^l+(1-\theta)\Delta n}\right)\left(2n^h+R(\pi_0-1)+(1-\theta)\Delta n)\right) < 4k$$

Let's substitute τ_{hu} into the credit constraint of equilibrium with $\pi^* = \pi_0$

$$\frac{(R\pi_0+2n^h-\theta\Delta n)^2}{(R\pi_0+n^h-\theta\Delta n)} < 4k$$

Let's substitute $\tau_{he} = 0$ into credit constraint of equilibrium with $\pi^* = 1$ and we obtain $n^h > k$ whereas the credit constraint of equilibrium with $\pi^* = \pi_0$ is $n^h < k$.

B.5 The ranking of preferences of each individual ij for redistribution

I analyze the first, second and the third best choice of tax for individual type lu, le, hu, and he. Then I rank the preferences for each individual type.

1. **The tax preferences of the individual type lu are:**

$$U^{lu}(\tau^*_{lu}) \succ U^{lu}(\tau^*_{hu}) \succ U^{lu}(\tau^*_{le}) \succ U^{lu}(0)$$

Proof. Consider that by Lemma 3, if $\frac{\Delta n}{R} \in \left(\frac{1-\pi_0}{1-\theta}, \frac{\pi_0}{\theta}\right)$ then τ^*_{le} and τ^*_{hu} have positive value.

a) Let's study the comparison in which lu prefers τ^*_{hu}over τ^*_{le}.

$$U^{lu}(\tau^*_{hu}) > U^{lu}(\tau^*_{le})$$

When we substitute tax rates τ^*_{hu} and τ^*_{le} into the utility function of lu then we obtain

$$\begin{aligned} (1-\tau^*_{hu})(n^l + \tau^*_{hu}\bar{y}) &> (1-\tau^*_{le})(n^l + \tau^*_{le}\bar{y}) \\ 0 &> (\Delta n - R)(\Delta n + R) \end{aligned}$$

As we can see above $U^{lu}(\tau^*_{hu}) > U^{lu}(\tau^*_{le})$ exists as long as $\frac{\Delta n}{R} < 1$ which is always satisfied in high cost of education scenario.

b) Let's analyze the comparison in which the individual π^{lu} prefers τ^*_{le} over zero tax.

$$U^{lu}(\tau^*_{le}) > U^{lu}(0)$$

When we substitute tax rates τ^*_{le} and zero tax into the utility function of π^{lu} then we obtain

$$\begin{aligned} (1-\tau^*_{le})(n^l + \tau^*_{le}\bar{y}) &> n^l \\ (\bar{y} - n^l - R)(\bar{y} - n^l + R) &> 0 \end{aligned}$$

When we substitute $\bar{y}$ into the equation shown above

$$[R(\pi_0 - 1) + (1-\theta)\Delta n]\,[R(1+\pi_0) + (1-\theta)\Delta n] > 0$$

We can conclude that $U^{lu}(\tau^*_{le}) > U^{lu}(0)$ holds if $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R}$. As a result, when τ^*_{le} is positive then the individual lu always prefers τ^*_{le} over zero tax.

c) Let's analyze the comparison in which the individual lu prefers τ^*_{hu} over zero tax.

$$U^{lu}(\tau^*_{hu}) > U^{lu}(0)$$

When we substitute tax rates τ^*_{hu} and $\tau^* = 0$ into the utility function of lu then we obtain

$$\begin{aligned} (1-\tau^*_{hu})(n^l + \tau^*_{hu}\bar{y}) &> n^l \\ (\bar{y} - n^h)(\bar{y} + n^h - 2n^l) &> 0 \end{aligned}$$

When we substitute $\bar{y}$ into the equation shown above

$$[R\pi_0 - \theta\Delta n]\,[R\pi_0 + (2-\theta)\Delta n] > 0$$

From the inequality shown above, $U^{lu}(\tau^*_{hu}) > U^{lu}(0)$ exists if $\frac{\Delta n}{R} < \frac{\pi_0}{\theta}$ which is always true since we suppose that τ^*_{hu} is positive tax rate. Thus the individual lu always prefers τ^*_{hu} over zero tax. □

2. **The tax preferences of the individual** *he*

The tax preferences of the individual type *he* **are:**

$$U^{he}(0) \succ U^{he}(\tau^*_{le}) \succ U^{he}(\tau^*_{hu}) \succ U^{he}(\tau^*_{lu})$$

Proof. Consider that by Lemma 3, if $\frac{\Delta n}{R} \in \left(\frac{1-\pi_0}{1-\theta}, \frac{\pi_0}{\theta}\right)$ then τ^*_{le} and τ^*_{hu} have positive value.

a) Let's first study $U^{he}(\tau^*_{le}) > U^{he}(\tau^*_{lu})$. When we substitute tax rates τ^*_{le} and τ^*_{lu} into the utility function of *he* then we obtain

$$\begin{aligned}(1-\tau^*_{le})(n^h + R + \tau^*_{le}\bar{y}) &> (1-\tau^*_{lu})(n^h + R + \tau^*_{lu}\bar{y}) \\ 2(n^h - n^l) + R &> 0\end{aligned}$$

The value of $2\Delta n + R$ is always positive. Therefore, the inequality of $U^{he}(\tau^*_{le}) > U^{he}(\tau^*_{lu})$ is always true.

b) Let's study whether $U^{he}(\tau^*_{le}) > U^{he}(\tau^*_{hu})$ holds or not. When we substitute tax rates τ^*_{le} and τ^*_{hu} into the utility function of *he* then we obtain

$$\begin{aligned}(1-\tau^*_{le})(n^h + R + \tau^*_{le}\bar{y}) &> (1-\tau^*_{hu})(n^h + R + \tau^*_{hu}\bar{y}) \\ [R - \Delta n]\,[R + \Delta n] &> 0\end{aligned}$$

According to the inequality shown above, if $\frac{\Delta n}{R} < 1$ then $U^{he}(\tau^*_{le}) > U^{he}(\tau^*_{hu})$ holds. The individual *he* will always prefer τ^*_{le} over τ^*_{hu}.

c) Let's study the comparison of $U^{he}(\tau^*_{hu}) > U^{he}(\tau^*_{lu})$. When we substitute tax rates τ^*_{hu} and τ^*_{lu} into the utility function of *he* then we obtain

$$\begin{aligned}(1-\tau^*_{hu})(n^h + R + \tau^*_{hu}\bar{y}) &> (1-\tau^*_{lu})(n^h + R + \tau^*_{lu}\bar{y}) \\ \Delta n\,[\Delta n + 2R] &> 0\end{aligned}$$

The value of $\Delta n\,[\Delta n + 2R]$ is always positive so that $U^{he}(\tau^*_{hu}) > U^{he}(\tau^*_{lu})$ is always satisfied. □

3. **The tax preferences of the individual le**

We proved that the second and the third best of individual le are: In case B

$$U^{le}(0) \succ U^{le}(\tau_{hu}^*) \succ U^{le}(\tau_{lu}^*)$$

In case C, when $\frac{\Delta n}{R} < \frac{2-\pi_0}{2-\theta}$

$$U^{le}(\tau_{le}^*) \succ U^{le}(0) \succ U^{le}(\tau_{hu}^*) \succ U^{le}(\tau_{lu}^*)$$

In case C, when $\frac{2-\pi_0}{2-\theta} < \frac{\Delta n}{R}$

$$U^{le}(\tau_{le}^*) \succ U^{le}(\tau_{hu}^*) \succ U^{le}(0) \succ U^{le}(\tau_{lu}^*)$$

Proof. ***a)*** Lets analyze first the comparison of $U^{le}(\tau_{hu}^*) > U^{le}(\tau_{lu}^*)$ in which the individual le prefers τ_{hu}^* over τ_{lu}^*. Take into account that τ_{hu}^* is positive tax rate so the condition $\frac{\Delta n}{R} < \frac{\pi_0}{\theta}$ holds by definition of lemma 3.

$$U^{le}(\tau_{hu}^*) > U^{le}(\tau_{lu}^*)$$

When we substitute tax rates τ_{hu}^* and τ_{lu}^* into the utility function of le then we obtain

$$\begin{aligned} (1-\tau_{hu}^*)(n^l + R + \tau_{hu}^*\bar{y}) &> (1-\tau_{lu}^*)(n^l + R + \tau_{lu}^*\bar{y}) \\ 0 &> \Delta n(\Delta n - 2R) \end{aligned}$$

As we can see above $U^{le}(\tau_{hu}^*) > U^{le}(\tau_{lu}^*)$ is true if $\frac{\Delta n}{R} < 2$ which is always true in second scenario. Therefore, $U^{le}(\tau_{hu}^*) > U^{le}(\tau_{lu}^*)$ always holds in all cases of second scenario.

b) Lets study the possibility of the individual le prefers zero-tax over highest tax rate τ_{lu}^*.

$$U^{le}(0) > U^{le}(\tau_{lu}^*)$$

When we substitute tax rates $zero - tax$ and τ_{lu}^* into the utility function of le then we obtain

$$\begin{aligned} n^l + R &> (1-\tau_{lu}^*)(n^l + R + \tau_{lu}^*\bar{y}) \\ 0 &> (\bar{y} - n^l)(\bar{y} - n^l - 2R) \end{aligned}$$

When we substitute $\bar{y}$ into the equation shown above

$$[R\pi_0 + (1-\theta)\Delta n]\,[R(\pi_0 - 2) + (1-\theta)\Delta n] < 0$$

The inequality of $U^{le}(0) > U^{le}(\tau^*_{lu})$ holds if $\frac{\Delta n}{R} < \frac{2-\pi_0}{1-\theta}$. We know that $\frac{2-\pi_0}{1-\theta}$ is larger than one, $1 < \frac{2-\pi_0}{1-\theta}$.And this means that $\frac{\Delta n}{R} < \frac{2-\pi_0}{1-\theta}$ is always true. Consequently, individual le always prefers zero-tax over τ^*_{lu}.

c) Lets study the possibility of the individual le prefers τ^*_{hu}over zero tax. Take into account that τ^*_{hu} is positive tax rate so the condition $\frac{\Delta n}{R} < \frac{\pi_0}{\theta}$ holds by definition of lemma 3.

$$U^{le}(\tau^*_{hu}) > U^{le}(0)$$

When we substitute tax rates τ^*_{hu} and $zero - tax$ into the utility function of le then we obtain

$$\begin{aligned}(1-\tau^*_{hu})(n^l + R + \tau^*_{hu}\bar{y}) &> n^l + R \\ (\bar{y} - n^h)(\bar{y} + n^h - 2(n^l + R)) &> 0\end{aligned}$$

When we substitute $\bar{y}$ into the equation shown above

$$[R\pi_0 - \theta\Delta n]\,[R(\pi_0 - 2) + (2-\theta)\Delta n] > 0$$

In order to $U^{le}(\tau^*_{hu}) > U^{le}(0)$ to be satisfied, we need to identify what are the signs of $R\pi_0 - \theta\Delta n$ and $R(\pi_0 - 2) + (2-\theta)\Delta n$.

- When we suppose that both signs are positive:

$(+,+)$ If $\frac{2-\pi_0}{2-\theta} < \frac{\Delta n}{R} < \frac{\pi_0}{\theta}$ which implies $\pi_0 > \theta$ then $U^{le}(\tau^*_{hu}) > U^{le}(0)$ holds. Lets show where $\frac{2-\pi_0}{2-\theta}$ takes place :

$$\frac{1-\pi_0}{1-\theta} < \frac{2-\pi_0}{2-\theta} < 1 < \frac{\pi_0}{\theta}$$

In case C, we conclude that $U^{le}(\tau^*_{hu}) > U^{le}(0)$ is true if $\frac{2-\pi_0}{2-\theta} < \frac{\Delta n}{R} < 1$.

- When we suppose that both signs are negative:

$(-,-)$ If $\frac{\pi_0}{\theta} < \frac{\Delta n}{R} < \frac{2-\pi_0}{2-\theta}$which implies $\pi_0 < \theta$ then $U^{le}(\tau^*_{hu}) > U^{le}(0)$ holds. Since $\pi_0 < \theta$ then the results can only occur in case B. and the first best of individual le is zero -tax.

Now lets analyze when $U^{le}(0) > U^{le}(\tau^*_{hu})$ holds.

-The individual le prefers zero tax over τ^*_{hu} if $R\pi_0 - \theta\Delta n > 0$ and $R(\pi_0 - 2) + (2-\theta)\Delta n < 0$. When we suppose that both signs are positive and negative, respectively:

$(+,-)$ If $\frac{\Delta n}{R} < Min\left(\frac{\pi_0}{\theta}, \frac{2-\pi_0}{2-\theta}\right)$ then $U^{le}(0) > U^{le}(\tau^*_{hu})$ holds.

In case C, $U^{le}(0) > U^{le}(\tau^*_{hu})$ exists if $\frac{\Delta n}{R} < \frac{2-\pi_0}{2-\theta}$ holds.

- The individual le prefers zero tax over τ^*_{hu} if $R\pi_0 - \theta\Delta n < 0$ and $R(\pi_0 - 2) + (2-\theta)\Delta n > 0$. When we suppose that both signs are negative and positive , respectively:

$$(-,+) \text{ If } \frac{\Delta n}{R} > Max\left(\frac{\pi_0}{\theta}, \frac{2-\pi_0}{2-\theta}\right) \text{ then } U^{le}(0) > U^{le}(\tau^*_{hu}) \text{ is true.}$$

But this condition implies that $\frac{\Delta n}{R} > 1$ which is not relevant with the second scenario. □

4. **The tax preferences of the individual type** hu

In case B where $\frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$

$$U^{hu}(\tau^*_{hu}) \succ U^{hu}(\tau^*_{lu}) \succ U^{hu}(0)$$

In case B where $\frac{\pi_0}{1+\theta} < \frac{\Delta n}{R}$

$$U^{hu}(\tau^*_{hu}) \succ U^{hu}(0) \succ U^{hu}(\tau^*_{lu})$$

In case C where $\frac{\Delta n}{R} < \frac{2-\pi_0}{2-\theta}$

$$U^{le}(\tau^*_{le}) \succ U^{le}(0) \succ U^{le}(\tau^*_{hu}) \succ U^{le}(\tau^*_{lu})$$

In case C where $\frac{2-\pi_0}{2-\theta} < \frac{\Delta n}{R}$

$$U^{le}(\tau^*_{le}) \succ U^{le}(\tau^*_{hu}) \succ U^{le}(0) \succ U^{le}(\tau^*_{lu})$$

Proof. ***a)*** Lets analyze first the comparison of $U^{hu}(\tau^*_{lu}) > U^{hu}(\tau^*_{le})$.We suppose that τ^*_{le} is positive which requires $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R}$. And this means that we are always in case C. When we substitute tax rates τ^*_{lu} and τ^*_{le} into the utility function of hu then we obtain

$$\begin{aligned}(1-\tau^*_{lu})(n^h + \tau^*_{lu}\bar{y}) &> (1-\tau^*_{le})(n^h + \tau^*_{le}\bar{y}) \\ R - 2\Delta n &> 0\end{aligned}$$

According to the inequality shown above, if $\frac{\Delta n}{R} < \frac{1}{2}$ then $U^{hu}(\tau^*_{lu}) > U^{hu}(\tau^*_{le})$ is true. If $\frac{\Delta n}{R} < \frac{1}{2}$ then the individual hu always prefers τ^*_{lu} over τ^*_{le}. On the contrary, $U^{hu}(\tau^*_{le}) > U^{hu}(\tau^*_{lu})$ is true if $\frac{1}{2} < \frac{\Delta n}{R} < 1$. The results for case C:

(i) When $2\pi_0 - 1 < \theta < \pi_0$, lets show where $\frac{1}{2}$ takes place :

$$\frac{1}{2} < \frac{1-\pi_0}{1-\theta} < 1 < \frac{\pi_0}{\theta}$$

Since we suppose that τ_{le}^* is positive then we are always in case C, $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R}$. As we can see from the order, $\frac{1}{2} < \frac{\Delta n}{R}$ is always true so that the preferences of the individual hu is always: $U^{hu}(\tau_{le}^*) > U^{hu}(\tau_{lu}^*)$ when $2\pi_0 - 1 < \theta$.

(ii) When $\theta < 2\pi_0 - 1 < \pi_0$ where $\pi_0 > \frac{1}{2}$,

$$\frac{1-\pi_0}{1-\theta} < \frac{1}{2} < 1 < \frac{\pi_0}{\theta}$$

Herein, between this interval; $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R} < \frac{1}{2}$, the preference for tax rate is : $U^{hu}(\tau_{lu}^*) > U^{hu}(\tau_{le}^*)$ when $2\pi_0 - 1 > \theta$ where $\pi_0 > \frac{1}{2}$. And between the interval of $\frac{1}{2} < \frac{\Delta n}{R} < 1$, the preference for tax rate is: $U^{hu}(\tau_{le}^*) > U^{hu}(\tau_{lu}^*)$ when $2\pi_0 - 1 > \theta$ where $\pi_0 > \frac{1}{2}$.

b) Lets study the comparison of $U^{hu}(\tau_{lu}^*) > U^{hu}(0)$. When we substitute tax rates τ_{lu}^* and $zero - tax$ into the utility function of hu then we obtain

$$\begin{aligned}(1-\tau_{lu}^*)(n^h + \tau_{lu}^*\bar{y}) &> n^h \\ (\bar{y} - n^l)(\bar{y} + n^l - 2n^h) &> 0\end{aligned}$$

When we substitute $\bar{y}$ into the equation shown above

$$[R\pi_0 + (1-\theta)\Delta n]\,[R\pi_0 - (1+\theta)\Delta n] > 0$$

If $\frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$ then $U^{hu}(\tau_{lu}^*) > U^{hu}(0)$ is true. In constrast, $U^{hu}(0) > U^{hu}(\tau_{lu}^*)$ is true for all cases as long as $\frac{\pi_0}{1+\theta} < \frac{\Delta n}{R}$ holds. We distinguish results for case B and C. The results for case B : (i) When $\pi_0 < \theta$, lets show where $\frac{\pi_0}{1+\theta}$ takes place

$$\frac{\pi_0}{1+\theta} < \frac{\pi_0}{\theta} < 1 < \frac{1-\pi_0}{1-\theta}$$

In the area $\frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$ then $U^{hu}(\tau_{lu}^*) > U^{hu}(0)$ is true. In the area $\frac{\pi_0}{1+\theta} < \frac{\Delta n}{R} < \frac{\pi_0}{\theta}$ then $U^{hu}(0) > U^{hu}(\tau_{lu}^*)$ is true.

(ii) When $2\pi_0 - 1 < \theta < \pi_0$,

$$\frac{\pi_0}{1+\theta} < \frac{1-\pi_0}{1-\theta} < 1 < \frac{\pi_0}{\theta}$$

In the area $\frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$ then $U^{hu}(\tau_{lu}^*) > U^{hu}(0)$ is true. In the area $\frac{\pi_0}{1+\theta} < \frac{\Delta n}{R} < \frac{1-\pi_0}{1-\theta}$ then $U^{hu}(0) > U^{hu}(\tau_{lu}^*)$ is true.

(iii) When $\theta < 2\pi_0 - 1 < \pi_0$ where $\pi_0 > \frac{1}{2}$,

$$\frac{1-\pi_0}{1-\theta} < \frac{\pi_0}{1+\theta} < 1 < \frac{\pi_0}{\theta}$$

In this area, the preference is always : $U^{hu}(\tau^*_{lu}) > U^{hu}(0)$ if $2\pi_0 - 1 > \theta$ because case B takes place in the area less than $\frac{1-\pi_0}{1-\theta}$so that it is always $\frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$. The results for case C : (i) When $2\pi_0 - 1 < \theta < \pi_0$

$$\frac{\pi_0}{1+\theta} < \frac{1-\pi_0}{1-\theta} < 1 < \frac{\pi_0}{\theta}$$

In this area, the preference is always : $U^{hu}(0) > U^{hu}(\tau^*_{lu})$ if $2\pi_0 - 1 < \theta$ because case C takes place in the area more than $\frac{1-\pi_0}{1-\theta}$so that it is always $\frac{\pi_0}{1+\theta} < \frac{\Delta n}{R}$.

(ii) When $\theta < 2\pi_0 - 1 < \pi_0$ where $\pi_0 > \frac{1}{2}$

$$\frac{1-\pi_0}{1-\theta} < \frac{\pi_0}{1+\theta} < 1 < \frac{\pi_0}{\theta}$$

In the area $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$ then $U^{hu}(\tau^*_{lu}) > U^{hu}(0)$ is true. In the area $\frac{\pi_0}{1+\theta} < \frac{\Delta n}{R} < 1$ then $U^{hu}(0) > U^{hu}(\tau^*_{lu})$ is true.

***c*)** Lets analyze the comparison of $U^{hu}(\tau^*_{le}) > U^{hu}(0)$.We suppose that τ^*_{le} is positive which requires $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R}$. And this means that we are always in case C. When we substitute tax rates τ^*_{le} and $zero - tax$ into the utility function of π^{hu} then we obtain

$$(\bar{y} - n^l - R)(\bar{y} + n^l + R - 2n^h) > 0$$

When we substitute $\bar{y}$ into the equation shown above

$$[R(\pi_0 - 1) + (1-\theta)\Delta n]\,[R(\pi_0 + 1) - (1+\theta)\Delta n] > 0$$

In order to the inequality to be positive we need to identify what are the signs of $R(\pi_0 - 1) + (1-\theta)\Delta n$ and $R(\pi_0 + 1) - (1+\theta)\Delta n$. If we suppose that both signs are positive:

$(+,+)$ If $\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R} < \frac{1+\pi_0}{1+\theta}$ which implies $\pi_0 > \theta$ then $U^{hu}(\tau^*_{le}) > U^{hu}(0)$ exists. The order of parameters is:

$$\frac{1-\pi_0}{1-\theta} < 1 < \frac{1+\pi_0}{1+\theta} < \frac{\pi_0}{\theta}$$

Since $\frac{1+\pi_0}{1+\theta}$ is more than one, then we can conclude that $U^{hu}(\tau^*_{le}) > U^{hu}(0)$ is always true when τ^*_{le} is positive (i.e. in case C). If we suppose that the signs of both inequalities are negative:

$(-,-)$ If $\frac{1+\pi_0}{1+\theta} < \frac{\Delta n}{R} < \frac{1-\pi_0}{1-\theta}$ which implies that $\pi_0 < \theta$ then $U^{hu}(\tau^*_{le}) > U^{hu}(0)$ holds. And this means tha we are in case B which is not relevant because in case B τ^*_{le} is not positive but always zero. □

B.6 Proof for each case

In the high cost scenario, we know that the returns to education is larger than the return to ability which is $\frac{\Delta n}{R} < 1$ and at the steady state $\pi^* = \pi_0$.And there are four different chosen tax rates. All preferences are single-peaked. And at this point, the information whether educated individuals is larger or smaller than low-skilled individuals,$\pi_0 \lesseqgtr \theta$, in an economy plays a significant role for redistribution policy and single-peaked preferences. Therefore, we will classify the results according to the case A, B and C. The preliminary conditions of each cases are:

$$\begin{array}{ll} \text{Case A:} & \text{When } \pi_0 < \theta \text{ and } \frac{\pi_0}{\theta} < \frac{\Delta n}{R} < 1 \\ \text{Case B:} & \text{When } \pi_0 \lesseqgtr \theta \text{ and } \frac{\Delta n}{R} < Min\left\{\frac{\pi_0}{\theta}, \frac{1-\pi_0}{1-\theta}\right\} \\ \text{Case C:} & \text{When } \pi_0 > \theta \text{ and } \frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R} < 1 \end{array}$$

Now lets study individuals' preferences with different value of tax rates in comparison by taking into account each cases of the high cost of scenario.

B.6.1 Case A

In case A, everyone chooses zero tax rate except the individual of type lu. And the preliminary condition for this case

$$\frac{\pi_0}{\theta} < \frac{\Delta n}{R} < 1$$

As we can see from the condition, there are always more low-skilled individuals than educated individuals: $\pi_0 < \theta$. Herein, only uneducated individuals with low ability vote for positive tax and the rest of individuals choose zero-tax. Therefore, there are two possible equilibria with zero and positive tax. We study whether individual of type lu has the majority or not. Lets analyze each possibility.

(i) Equilibrium with $\tau^* = 0$

Only the individual of type lu chooses positive tax and the rest of the individuals prefer zero tax. Therefore, if the uneducated individuals with low ability is not the majority then the chosen tax is zero. Besides that we have to consider the credit constraint with chosen tax. Lets substitute $\tau^* = 0$ into credit constraint then we obtain $n^h < k$. And from the long-run distribution we know that $\pi^{lu} < \frac{1}{2}$ implies $\theta(1 - \pi_0) < \frac{1}{2}$.We put all conditions together in order to have the equilibrium with zero tax.

$$If\ \theta(1 - \pi_0) < \frac{1}{2}\ then\ \tau^* = 0$$

(ii) Equilibrium with $\tau^* = \tau^*_{lu}$

If the individual of type lu is the majority then the chosen tax is τ^*_{lu}. From long-run distribution we know that π^{lu} implies $\theta(1-\pi_0)$

$$If\ \theta(1-\pi_0) > \frac{1}{2}\ then\ \tau^* = \tau^*_{lu}$$

The tax rate $\tau^*_{lu}$with $\pi = \pi_0$ as shown below

$$\tau^*_{lu} = \frac{R\pi_0 + (1-\theta)\Delta n}{2(R\pi_0 + n^h - \theta\Delta n)}$$

B.6.2 Case B

In this case, we consider an environment in which individuals le and hu prefer simultaneously zero-tax and τ^*_{hu}, respectively. In order case B to exist, the preliminary condition is:

$$\frac{\Delta n}{R} < Min\left\{\frac{\pi_0}{\theta}, \frac{1-\pi_0}{1-\theta}\right\}$$

There are 4 different types of voters: lu, le, hu, he ; and 3 alternative tax rates: τ^*_{lu}, τ^*_{lu} and $\tau^* = 0$. The individuals he and le have the same preferences. Both of them prefer zero-tax as their first-best and tax τ^*_{hu} as their second best. Thus they will always take joint action, as a result, if educated individuals are the majority then zero-tax policy wins. Now, we can present preference rankings of individuals in the following table.

$Voters$	π^{lu}	π^{le} and π^{he}	π^{hu}
$First\ choice$	τ^*_{lu}	0	τ^*_{hu}
$Second\ choice$	τ^*_{hu}	τ^*_{hu}	?
$Third\ choice$	0	τ^*_{lu}	?

In the table shown above, second and third preferences of individual hu were not included due to the fact that they depend on a threshold: if $\frac{\Delta n}{R} > \frac{\pi_0}{1+\theta}$ is satisfied then he prefers zero-tax over τ^*_{lu}, otherwise, his preference is $U^{hu}(\tau^*_{lu}) > U^{hu}(0)$. Utility always goes down as each individual moves away from the most preferred choice so that preferences are single-peaked.

(i) If $\frac{\Delta n}{R} > \frac{\pi_0}{1+\theta}$, preference ranking of individual π^{hu} is: $\tau^*_{hu} \succ 0 \succ \tau^*_{lu}$

In a pairwise vote between alternative tax rates τ^*_{lu} and $\tau^* = 0$, the alternative tax -zero policy wins by a 3–to–1 vote. And lets suppose that there is a vote between τ^*_{lu} and τ^*_{hu}. Then the alternative τ^*_{hu} wins by a 3–to–1 vote. It seems that the alternative τ^*_{lu} is the last choice of individuals. Therefore, we need to suppose that there is a vote between the alternatives tax-zero and τ^*_{hu}. In order the alternative τ^*_{hu} to be a Condorcet winner, the necessary condition is this: $\pi_0 < \frac{1}{2}$. Then the winner is τ^*_{hu}. On the other hand, if $\pi_0 > \frac{1}{2}$ then the winner is $\tau^* = 0$. The assumption of transitivity holds. Let $\succ$ denote the social preference ordering by majority votes. We can classify the results depending on whether educated individuals are the majority or not:

$$If\ \pi_0 > \frac{1}{2}\ then\ 0 \succ \tau^*_{hu} \succ \tau^*_{lu}\ so\ that\ zero - tax\ is\ the\ winner.$$
$$If\ \pi_0 < \frac{1}{2}\ then\ \tau^*_{hu} \succ 0 \succ \tau^*_{lu}\ so\ that\ \tau^*_{hu}\ is\ the\ winner.$$

(ii) If $\frac{\Delta n}{R} < \frac{\pi_0}{1+\theta}$, preference ranking of individual π^{hu} is: $\tau^*_{hu} \succ \tau^*_{lu} \succ 0$

As we can see above, preferences of individuals le and he are same. There are again 4 individuals and 3 alternative tax rate policy. In pairwise vote, let first individuals vote on tax level τ^*_{lu} over tax-zero. If $\pi_0 < \frac{1}{2}$ then τ^*_{lu} wins. On the other hand, if $\pi_0 > \frac{1}{2}$ then $\tau^* = 0$ wins. Then, individuals vote on tax level τ^*_{lu} over τ^*_{hu}. And τ^*_{hu} wins. Lastly, there is a vote between tax-zero and τ^*_{hu}. If $\pi_0 < \frac{1}{2}$ then τ^*_{hu} wins. On the other hand, if $\pi_0 > \frac{1}{2}$ then $\tau^* = 0$ wins. To sum up, when $\pi_0 > \frac{1}{2}$, the alternative tax-zero has beaten both τ^*_{lu} and τ^*_{hu} so the winner is tax zero. On the other hand, when $\pi_0 < \frac{1}{2}$, the alternative τ^*_{hu} is more preferred over tax-zero and τ^*_{lu} so τ^*_{hu} is the overall winner.

$$If\ \pi_0 > \frac{1}{2}\ then\ 0 \succ \tau^*_{hu} \succ \tau^*_{lu}\ so\ that\ zero - tax\ is\ the\ winner.$$
$$If\ \pi_0 < \frac{1}{2}\ then\ \tau^*_{hu} \succ \tau^*_{lu} \succ 0\ so\ that\ \tau^*_{hu}\ is\ the\ winner.$$

B.6.3 Case C

In case C, there are four choices that people are deciding on: τ^*_{lu}, τ^*_{hu}, τ^*_{le} and $zero{-}tax$. And there are four different individuals: lu, le, hu, he . In order to avoid cycling problem, single-peakedness for preferences is needed. In this case, by lemma 3, we know that under the condition shown below

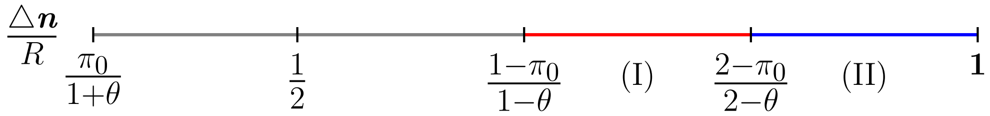
$$\frac{1-\pi_0}{1-\theta} < \frac{\Delta n}{R} < 1$$

individuals le and hu vote for positive tax rates: τ^*_{le} and τ^*_{hu} as their first-best, respectively. From preliminary condition of this case shown above, we can see that educated individuals are superior as number of people than low-skilled individuals: $\pi_0 > \theta$.Only educated individuals with high ability vote for zero tax but the rest of individuals choose different positive tax rates to maximize their utilities. In the next table, we classify the preferences of individuals.

	Type of Voters			
Preference Rankings	π^{lu}	π^{he}	π^{le}	π^{hu}
First choice	τ^*_{lu}	0	τ^*_{le}	τ^*_{hu}
Second choice	τ^*_{hu}	τ^*_{le}	?	?
Third choice	τ^*_{le}	τ^*_{hu}	?	?
Fourth choice	0	τ^*_{lu}	τ^*_{lu}	?

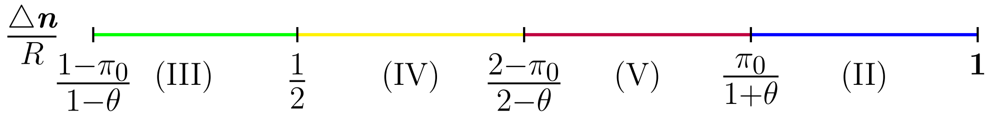
From Appendix X, we know that individual le prefers maximum tax rate τ^*_{lu} as his last choice whereas his second and third best depends on whether $\frac{\Delta n}{R}$ is greater or smaller than $\frac{2-\pi_0}{2-\theta}$. Likewise, appendix X also indicates that the second, third and fourth choice of individual π^{hu} is based on whether $\frac{\Delta n}{R}$ is greater or smaller than $\frac{\pi_0}{1+\theta}$ and $\frac{1}{2}$. If so there are three thresholds which changes the preferences of individual le and hu. We can put $\frac{\pi_0}{1+\theta}$, $\frac{1}{2}$ and $\frac{2-\pi_0}{2-\theta}$ in order three different ways. Note that it is always true that $\frac{2-\pi_0}{2-\theta}$ is greater than $\frac{1-\pi_0}{1-\theta}$ and $\frac{1}{2}$ in case C.

If $\pi_0 > \theta > 2\pi_0 - 1$



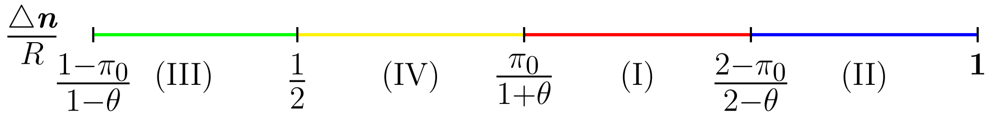
In the first ordering of thresholds, if $\theta > 2\pi_0 - 1$ holds than $\frac{\pi_0}{1+\theta} < \frac{1}{2} < \frac{1-\pi_0}{1-\theta}$ is true as shown above.

If $\pi_0 > \frac{3\pi_0}{2} - 1 > \theta$ which also implies $\pi_0 > \frac{2}{3}$



In the second ordering of thresholds, if $\theta < 2\pi_0 - 1$ holds than $\frac{1-\pi_0}{1-\theta} < \frac{1}{2} < \frac{\pi_0}{1+\theta}$ is true. Moreover, if $\theta < \frac{3\pi_0}{2} - 1$ holds then $\frac{2-\pi_0}{2-\theta} < \frac{\pi_0}{1+\theta}$ is true.

If $\pi_0 > 2\pi_0 - 1 > \theta$ which also implies $\pi_0 > \frac{1}{2}$



There are 5 ways preferences could be ordered. Therefore, we need to analyze separately each different combination of preferences of all individuals.

(I) In the first interval for the thresholds of preferences, the value of $\frac{\Delta n}{R}$ is larger than $\frac{\pi_0}{1+\theta}$ and $\frac{1}{2}$ and less than $\frac{2-\pi_0}{2-\theta}$ which determines preferences of individuals π^{le} and π^{hu}. Then preferences over tax-rates are

$$\begin{aligned} \tau_{le}^* &\succ 0 \succ \tau_{hu}^* \succ \tau_{lu}^* \\ \tau_{hu}^* &\succ \tau_{le}^* \succ 0 \succ \tau_{lu}^* \end{aligned}$$

As we can see from the figure, preferences are single-peaked. In a pairwise vote, τ_{lu}^* is defeated by τ_{le}^*, τ_{hu}^* and $\tau^* = 0$.Thus the maximum level of tax rate policy, τ_{lu}^*, is the least preferred choice. Now, lets suppose there is a vote between τ_{le}^* and zero-tax. Then τ_{le}^* wins by a 3 to 1 vote. And in pairwise vote τ_{le}^* against τ_{hu}^*, if $\pi_0 < \frac{1}{2}$ then τ_{hu}^* wins. On the other hand, if $\pi_0 > \frac{1}{2}$ then τ_{le}^* wins. And finally, in a pairwise vote between τ_{hu}^* and zero-tax, if $\pi_0 < \frac{1}{2}$ then τ_{hu}^* wins whereas if $\pi_0 > \frac{1}{2}$ then zero-tax wins.

The assumption of transitivity holds. Let $\succ$ denote the social preference ordering by majority votes. We can clasify the results depending on whether educated individuals are the majority or not.

$$\begin{aligned} If\ \pi_0 &> \frac{1}{2}\ then\ \tau_{le}^* \succ 0 \succ \tau_{hu}^* \succ \tau_{lu}^*\ so\ that\ \tau_{le}^*\ is\ the\ winner. \\ If\ \pi_0 &< \frac{1}{2}\ then\ \tau_{hu}^* \succ \tau_{le}^* \succ 0 \succ \tau_{lu}^*\ so\ that\ \tau_{hu}^*\ is\ the\ winner. \end{aligned}$$

(II) In the second interval for the thresholds of preferences, the value of $\frac{\Delta n}{R}$ is larger than any type of threshold: $\frac{2-\pi_0}{2-\theta}$,$\frac{\pi_0}{1+\theta}$ or $\frac{1}{2}$. Therefore, preferences over tax-rates are:

$$\begin{aligned} \tau_{le}^* &\succ \tau_{hu}^* \succ 0 \succ \tau_{lu}^* \\ \tau_{hu}^* &\succ \tau_{le}^* \succ 0 \succ \tau_{lu}^* \end{aligned}$$

Preferences are single-peaked. In a pairwise vote, τ_{lu}^* is defeated by τ_{le}^*, τ_{hu}^* and $\tau^* = 0$.Thus once again the alternative τ_{lu}^* is the least preferred choice. Lets suppose we have a vote between τ_{le}^* and zero-tax. Then τ_{le}^* wins. In pairwise vote between alternatives between τ_{hu}^* and zero-tax. Then τ_{hu}^* wins. When there is a vote between τ_{le}^* and τ_{hu}^*. If $\pi_0 < \frac{1}{2}$ then τ_{hu}^* wins. On the other hand, if $\pi_0 > \frac{1}{2}$ then τ_{le}^* wins. The assumption of transitivity holds. And the results are:

$$\begin{aligned} If\ \pi_0 &> \frac{1}{2}\ then\ \tau_{le}^* \succ \tau_{hu}^* \succ 0 \succ \tau_{lu}^*\ so\ that\ \tau_{le}^*\ is\ the\ winner. \\ If\ \pi_0 &< \frac{1}{2}\ then\ \tau_{hu}^* \succ \tau_{le}^* \succ 0 \succ \tau_{lu}^*\ so\ that\ \tau_{hu}^*\ is\ the\ winner. \end{aligned}$$

(III) In the third interval for the thresholds of preferences, the value of $\frac{\Delta n}{R}$ is less than all type of thresholds: $\frac{2-\pi_0}{2-\theta}$,$\frac{\pi_0}{1+\theta}$ or $\frac{1}{2}$. Then preferences over tax-rates are:

$$\tau^*_{le} \succ 0 \succ \tau^*_{hu} \succ \tau^*_{lu}$$

All preferences are single-peaked. The ordering in the third interval requires $\pi_0 > \frac{1}{2}$. Therefore, we only focus on the results where $\pi_0 > \frac{1}{2}$. In a pairwise vote, τ^*_{lu} is defeated by τ^*_{le}, τ^*_{hu} and $\tau^* = 0$.Thus once again the alternative τ^*_{lu} is the least preferred choice. The alternative τ^*_{le} defeats zero-tax and τ^*_{le} wins. In a pairwise vote between τ^*_{hu} and $\tau^*= 0$ and zero-tax wins. And the alternative τ^*_{le} wins a pairwise election to τ^*_{hu}. The assumption of transitivity holds. In this ordering , it is always $\pi_0 > \frac{1}{2}$ thus the social decision is :

$$\tau^*_{le} \succ 0 \succ \tau^*_{hu} \succ \tau^*_{lu} \textit{ and } \tau^*_{le} \textit{ is Condorcet winner.}$$

(IV) In the fourth interval for the thresholds of preferences, the value of $\frac{\Delta n}{R}$ is less than $\frac{\pi_0}{1+\theta}$ and $\frac{2-\pi_0}{2-\theta}$ and larger than $\frac{1}{2}$. Then preferences over tax-rates are in the following graph.

$$\tau^*_{le} \succ 0 \succ \tau^*_{hu} \succ \tau^*_{lu}$$

Here again preferences are single-peaked as we can see from the figure shown above. This ordering requires $\pi_0 > \frac{1}{2}$ so that voting results matter only when educated individuals are the majority. In a pairwise vote τ^*_{le} against τ^*_{hu} and the winner is τ^*_{le}. And between τ^*_{hu} and $\tau^* = 0$ then zero-tax wins. Lastly, when there is a vote between τ^*_{le} and zero-tax. Then τ^*_{le} wins. The assumption of transitivity holds. The overall winner and social decision shown below

$$\tau^*_{le} \succ 0 \succ \tau^*_{hu} \succ \tau^*_{lu} \textit{ so that } \tau^*_{le} \textit{ is the winner.}$$

(V) In the fifth interval for the thresholds of preferences, the value of $\frac{\Delta n}{R}$ is larger than $\frac{2-\pi_0}{2-\theta}$ and $\frac{1}{2}$ and less than $\frac{\pi_0}{1+\theta}$. This ordering only occurs when $\pi_0 > 2\pi_0 - 1 > \frac{3\pi_0}{2} - 1 > \theta$ and this implies that $\pi_0 > \frac{2}{3}$ is always true. Then preferences over tax-rates are in the following graph.

$$\tau^*_{le} \succ \tau^*_{hu} \succ 0 \succ \tau^*_{lu}$$

Preferences are single-peaked as we can see from the figure shown above. In a pairwise vote, τ^*_{lu} is defeated by τ^*_{le}, τ^*_{hu} and $\tau^* = 0$.Thus once again the alternative τ^*_{lu} is the least preferred choice. The alternative τ^*_{le} wins against zero-tax. And τ^*_{hu} beats zero-tax. Finally, when there is a vote between τ^*_{le} and τ^*_{hu} the winner is τ^*_{le}.

The assumption of transitivity holds. In this ordering , it is always $\pi_0 > \frac{2}{3}$ thus the social decision and the Condorcet winner are:

$$\tau^*_{le} \succ \tau^*_{hu} \succ 0 \succ \tau^*_{lu} \textit{ so that } \tau^*_{le} \textit{ is the winner.}$$

Appendix C

Appendix to Chapter 3

Table C.1: Summary Statistics

	mean	sd	min	max
Preferences for Redistribution	3.975	0.989	1	5
Native-born	0.904	0.294	0	1
Living with partner	0.630	0.483	0	1
Male	0.480	0.500	0	1
Age	42.225	13.254	18	65
Agea2/100	19.586	11.214	3	42
Household size	3.043	1.415	1	15
Primary Education	0.296	0.457	0	1
Secondary Education	0.413	0.492	0	1
Tertiary Education	0.291	0.454	0	1
Employed	0.634	0.482	0	1
Student	0.071	0.257	0	1
Unemployed	0.075	0.264	0	1
Retired	0.089	0.285	0	1
Other	0.124	0.330	0	1
Big city	0.203	0.402	0	1
Suburbs of big city	0.271	0.444	0	1
Small city	0.113	0.317	0	1
Village	0.413	0.492	0	1
Living in comfort on present income	0.296	0.456	0	1
Coping on present income	0.477	0.499	0	1
Difficult on present income	0.227	0.419	0	1
Political Ideology	4.889	2.138	0	10
Unemployment Rate	8.878	5.921	1.8	25
Tertiary Educ. Attainment	19.082	8.883	5	44
Gini before taxes	0.487	0.050	0.370	0.576
Gdp per capita	32161.045	13265.155	10512	68328
N	68341			

Table C.2: Descriptive Statistics of Assortative Mating Variables

	mean	sd	min	max
Assortative mating by educational status	1.513	0.260	1.082	2.124
Assortative mating by occupational status	1.385	0.083	1.201	1.609
Assortative mating by nativity status	1.140	0.146	1.000	1.559
Assortative mating by having any degree	1.086	0.155	1.000	1.560
Assortative mating by tertiary degree	1.134	0.083	1.034	1.496
Assortative mating by top occupations	1.188	0.060	1.082	1.302
Assortative mating by bottom occupations	1.129	0.067	1.045	1.404
N	68341			

Table C.3: Assortative Mating by Top and Bottom Educational Degree and Support for Redistribution

	(1) All sample	(2) Living comfortably on present income	(3) Coping on present income	(4) Difficult and very difficult on present income
Assortative Mating by	**-0.566****	**-1.514*****	-0.021	-0.304
Less than Primary Degree	**(0.240)**	**(0.361)**	(0.353)	(0.340)
N	56119	15660	26736	13723
adj. R^2	0.085	0.118	0.054	0.034
Assortative Mating by	-0.644	-0.703	-0.637	-0.946
Tertiary Degree	(0.395)	(0.506)	(0.560)	(0.591)
N	68341	20220	32622	15499
adj. R^2	0.084	0.113	0.054	0.036
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: The OLS estimation includes country fixed effects and year fixed effects, regional controls, individual controls and ideology controls (see the notes of table 3.3 for details). In the upper panel of the table, we compute assortative mating in terms of having a completed educational degree. In the lower panel, assortative mating is measured by having a completed tertiary degree. The value of assortative mating by degree is 1 in Austria and Ireland because all individuals completed at least a primary degree education. Therefore, the sample does not include the countries Austria and Ireland in the first estimation. Standard errors in parentheses. Robust standard errors clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.4: Assortative Mating by Top and Bottom Occupations and Support for Redistribution

	(1) All sample	(2) Living comfortably on present income	(3) Coping on present income	(4) Difficult on present income
Assortative Mating by	**-0.571***	**-0.908****	-0.265	-0.569
Top Occupations	**(0.288)**	**(0.384)**	(0.415)	(0.409)
N	68341	20220	32622	15499
adj. R^2	0.084	0.113	0.054	0.035
Assortative Mating by	0.008	-0.624	0.186	0.306
Bottom Occupations	(0.256)	(0.456)	(0.327)	(0.354)
N	68341	20220	32622	15499
adj. R^2	0.084	0.113	0.054	0.035
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: The OLS estimation includes country fixed effects and year fixed effects, regional controls, individual controls and ideology controls (see the notes of table 3.3 for details). The first regression includes the main independent variable of assortative mating by the top occupations that are managers and professionals (ISCO-08 codes 1 and 2). In the second estimation, the main independent variable is assortative mating by bottom occupations that are elementary occupations (ISCO-08 code 9). Standard errors in parentheses. Robust standard errors clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.5: Individual Characteristics

	Educational	Occupational	Nativity
Assortative Mating	-0.004	-0.158	-0.102
	(0.176)	(0.195)	(0.241)
Native-born	**0.038***	**0.038***	**0.037***
	(0.020)	(0.020)	(0.020)
Living with partner	-0.008	-0.008	-0.008
	(0.017)	(0.017)	(0.017)
Male	**-0.113*****	**-0.113*****	**-0.113*****
	(0.011)	(0.011)	(0.011)
Age	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)
Age2/100	0.001	0.001	0.001
	(0.005)	(0.005)	(0.005)
Secondary Education	-0.005	-0.005	-0.005
	(0.016)	(0.016)	(0.016)
Tertiary Education	**-0.198*****	**-0.198*****	**-0.198*****
	(0.026)	(0.026)	(0.026)
Student	**-0.110*****	**-0.111*****	**-0.110*****
	(0.028)	(0.028)	(0.028)
Unemployed	**0.041****	**0.042****	**0.041****
	(0.019)	(0.019)	(0.019)
Retired	**0.110*****	**0.110*****	**0.110*****
	(0.021)	(0.021)	(0.021)
Other activities	**-0.034****	**-0.034****	**-0.034****
	(0.016)	(0.016)	(0.016)
Household size	0.000	0.000	0.000
	(0.005)	(0.006)	(0.005)
Suburbs of big city	0.043	0.043	0.043
	(0.028)	(0.028)	(0.028)
Small city	**0.084*****	**0.083*****	**0.084*****
	(0.026)	(0.026)	(0.026)
Village	**0.098*****	**0.098*****	**0.098*****
	(0.028)	(0.028)	(0.028)
Coping on present income	**0.209*****	**0.208*****	**0.208*****
	(0.020)	(0.020)	(0.020)
Difficult on present income	**0.341*****	**0.341*****	**0.341*****
	(0.026)	(0.026)	(0.026)
Political Ideology	**-0.064*****	**-0.063*****	**-0.064*****
	(0.007)	(0.007)	(0.007)
Gdp per capita	**-0.000*****	**-0.000*****	**-0.000*****
	(0.000)	(0.000)	(0.000)
Unemployment rate	0.002	0.003	0.002
	(0.005)	(0.005)	(0.004)
Tertiary education attainment	**0.006***	**0.008****	**0.006****
	(0.003)	(0.003)	(0.003)
Gini before tax	-0.556	-0.388	-0.473
	(0.565)	(0.540)	(0.766)
_cons	4.322***	4.420***	4.376***
	(0.273)	(0.302)	(0.239)
N	68341	68341	68341
adj. R^2	0.084	0.084	0.084

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.6: Index of Welfare Attitudes

Dependent variable: **Index of Welfare Attitudes** Independent variable:	All sample	Living comfortably on present income	Coping on present income	Difficult and very difficult on present income
Ass. Mating by Education	-0.403	-0.605	-0.554	-0.194
	(0.322)	(0.519)	(0.335)	(0.534)
Ass. Mating by Less than P. Degree	**-1.197***	**-1.383***	**-1.000***	-1.096
	(0.423)	(0.817)	(0.527)	(0.910)
Ass. Mating by Occupation	**-0.857****	**-1.784*****	-0.533	-0.476
	(0.334)	(0.484)	(0.374)	(0.756)
Ass. Mating by Top Occupation	**-1.279***	**-2.695*****	-0.766	-0.344
	(0.673)	(0.944)	(0.728)	(1.470)
Ass. Mating by Nativity	-0.638	-0.934	0.064	-1.058
	(0.450)	(0.576)	(0.437)	(0.812)
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: The OLS estimations are made separately for each assortative mating variable. The dependent variable is constructed as a composite index of attitudes as the first component of a principal component analysis. For this index, the special modules on welfare attitudes from the rounds of 2008 and 2016 of ESS have been used. The rounds inquire in which extent the respondents agree or disagree with the following statements: *"The government should take measures to reduce differences in income levels"*, *"Large differences in income acceptable to reward talents and efforts"*, *"For fair society, differences in standard of living should be small"*, and *"Social services cost businesses too much in taxes"*. Regressions include country fixed effects and year fixed effects, regional controls, individual controls and ideology controls (see the notes of table 3.3 for details). Standard errors in parentheses. Robust standard errors clustered at the regional level. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.7: Placebo Test

Dependent variable: **Important to care for nature and environment**	All sample	Living comfortably on present income	Coping on present income	Difficult and very difficult on present income
Ass. Mating by Education	0.136	-0.086	0.235	0.108
	(0.152)	(0.213)	(0.196)	(0.225)
Ass. Mating by Occupation	-0.032	-0.043	-0.067	-0.023
	(0.199)	(0.215)	(0.256)	(0.286)
Ass. Mating by Nativity	-0.138	-0.256	-0.011	-0.321
	(0.171)	(0.233)	(0.224)	(0.224)
N	66362	19458	31719	15185
Dependent variable: **Important to be humble and modest, not draw attention**				
Ass. Mating by Education	-0.022	-0.139	-0.065	0.300
	(0.221)	(0.313)	(0.240)	(0.247)
Ass. Mating by Occupation	-0.027	0.201	-0.166	0.056
	(0.307)	(0.457)	(0.346)	(0.343)
Ass. Mating by Nativity	0.057	0.221	0.032	0.060
	(0.242)	(0.334)	(0.250)	(0.285)
N	66296	19431	31686	15179

Continued on next page...

Table C.7: Placebo Test (continued)

Dependent variable: **Important to think new ideas and being creative**	All sample	Living comfortably on present income	Coping on present income	Difficult and very difficult on present income
Ass. Mating by Education	-0.077	-0.411	0.071	-0.028
	(0.182)	(0.264)	(0.226)	(0.274)
Ass. Mating by Occupation	-0.260	-0.499	-0.094	-0.180
	(0.234)	(0.303)	(0.333)	(0.413)
Ass. Mating by Nativity	0.235	0.409	0.006	0.549*
	(0.200)	(0.282)	(0.268)	(0.282)
N	66371	19469	31726	15176
Country and year FE	yes	yes	yes	yes
Regional controls	yes	yes	yes	yes
Individual controls	yes	yes	yes	yes
Ideology controls	yes	yes	yes	yes

Notes: The OLS estimations are made separately for each assortative mating variable. Regressions include country fixed effects and year fixed effects, regional controls, individual controls and ideology controls (see the notes of table 3.3 for details). Standard errors in parentheses. Robust standard errors clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.8: The List of Nuts Regions

	Country	NUTS region	NUTS level	Region's name
AT	Austria	AT11	2	Burgenland
AT	Austria	AT12	2	Niedersterreich
AT	Austria	AT13	2	Wien
AT	Austria	AT21	2	Karnten
AT	Austria	AT22	2	Steiermark
AT	Austria	AT31	2	Obersterreich
AT	Austria	AT32	2	Salzburg
AT	Austria	AT33	2	Tirol
AT	Austria	AT34	2	Vorarlberg
CH	Switzerland	CH01	2	Lake Geneva Region
CH	Switzerland	CH02	2	Espace Mittelland
CH	Switzerland	CH03	2	Northwestern Switzerland
CH	Switzerland	CH04	2	Zürich
CH	Switzerland	CH05	2	Eastern Switzerland
CH	Switzerland	CH06	2	Central Switzerland
CH	Switzerland	CH07	2	Ticino
ES	Spain	ES11	2	Galicia
ES	Spain	ES12	2	Principado de Asturias
ES	Spain	ES13	2	Cantabria
ES	Spain	ES21	2	País Vasco
ES	Spain	ES22	2	Comunidad Foral de Navarra
ES	Spain	ES23	2	La Rioja
ES	Spain	ES24	2	Aragón
ES	Spain	ES30	2	Comunidad de Madrid
ES	Spain	ES41	2	Castilla y León
ES	Spain	ES42	2	Castilla-La Mancha
ES	Spain	ES43	2	Extremadura
ES	Spain	ES51	2	Cataluña
ES	Spain	ES52	2	Comunidad Valenciana
ES	Spain	ES53	2	Illes Balears
ES	Spain	ES61	2	Andalucía
ES	Spain	ES62	2	Región de Murcia
ES	Spain	ES63	2	Ciudad Autónoma de Ceuta
ES	Spain	ES64	2	Ciudad Autónoma de Melilla
ES	Spain	ES70	2	Canarias
FR	France	FR10	2	Île de France
FR	France	FR21	2	Champagne-Ardenne
FR	France	FR22	2	Picardie
FR	France	FR23	2	Haute-Normandie
FR	France	FR24	2	Centre

Table C.7 (continued): The List of Nuts Regions

	Country	NUTS region	NUTS level	Region's name
FR	France	FR25	2	Basse-Normandie
FR	France	FR26	2	Bourgogne
FR	France	FR30	2	Nord-Pas-de-Calais
FR	France	FR41	2	Lorraine
FR	France	FR42	2	Alsace
FR	France	FR43	2	Franche-Comté
FR	France	FR51	2	Pays de la Loire
FR	France	FR52	2	Bretagne
FR	France	FR53	2	Poitou-Charentes
FR	France	FR61	2	Aquitaine
FR	France	FR62	2	Midi-Pyrénées
FR	France	FR63	2	Limousin
FR	France	FR71	2	Rhône-Alpes
FR	France	FR72	2	Auvergne
FR	France	FR81	2	Languedoc-Roussillon
FR	France	FR82	2	Provence-Alpes-Côte d'Azur
EL	Greece	EL11	2	Anatoliki Makedonia, Thraki
EL	Greece	EL12	2	Kentriki Makedonia
EL	Greece	EL13	2	Dytiki Makedonia
EL	Greece	EL14	2	Thessalia
EL	Greece	EL21	2	Ipeiros
EL	Greece	EL22	2	Ionia Nisia
EL	Greece	EL23	2	Dytiki Ellada
EL	Greece	EL24	2	Sterea Ellada
EL	Greece	EL25	2	Peloponnisos
EL	Greece	EL30	2	Attiki
EL	Greece	EL41	2	Voreio Aigaio
EL	Greece	EL42	2	Notio Algaio
EL	Greece	EL43	2	Kriti
IE	Ireland	IE04	2	Border
IE	Ireland	IE05	2	Midland
IE	Ireland	IE06	2	West
IT	Italy	ITC1-ITC2	2	Piemonte-Valle D'aosta
IT	Italy	ITC3	2	Liguria
IT	Italy	ITC4	2	Lombardia
IT	Italy	ITF1	2	Abruzzo
IT	Italy	ITF2	2	Molise
IT	Italy	ITF3	2	Campania
IT	Italy	ITF4	2	Puglia
IT	Italy	ITF5	2	Basilicata

Table C.7 (continued): The List of Nuts Regions

	Country	NUTS region	NUTS level	Region's name
IT	Italy	ITF6	2	Calabria
IT	Italy	ITG1	2	Sicilia
IT	Italy	ITG2	2	Sardegna
IT	Italy	ITH1-ITH2	2	Bozen-Trento
IT	Italy	ITH3	2	Veneto
IT	Italy	ITH4	2	Friuli-Venezia Giulia
IT	Italy	ITH5	2	Emilia-Romagna
IT	Italy	ITI1	2	Toscana
IT	Italy	ITI2	2	Umbria
IT	Italy	ITI3	2	Marche
IT	Italy	ITI4	2	Lazio
PL	Poland	PL11	2	Lodzkie
PL	Poland	PL12	2	Mazowieckie
PL	Poland	PL21	2	Malopolskie
PL	Poland	PL22	2	Slaskie
PL	Poland	PL31	2	Lubelskie
PL	Poland	PL32	2	Podkarpackie
PL	Poland	PL33	2	Swietokryzskie
PL	Poland	PL34	2	Podlaskie
PL	Poland	PL41	2	Wielkopolskie
PL	Poland	PL42	2	Zachodnio pomorskie
PL	Poland	PL43	2	Lubuskie
PL	Poland	PL51	2	Dolnoslaskie
PL	Poland	PL52	2	Opolskie
PL	Poland	PL61	2	Kujawsko-pomorskie
PL	Poland	PL62	2	Warmiasko-mazurskie
PL	Poland	PL63	2	Pomorskie
PT	Portugal	PT11	2	Norte
PT	Portugal	PT15	2	Algarve
PT	Portugal	PT16	2	Centro
PT	Portugal	PT17	2	Lisboa
PT	Portugal	PT18	2	Alentejo
SI	Slovenia	SI01	2	Vzhodna Slovenija
SI	Slovenia	SI02	2	Zahodna Slovenija

Figure C.1: Support for Redistribution over Countries

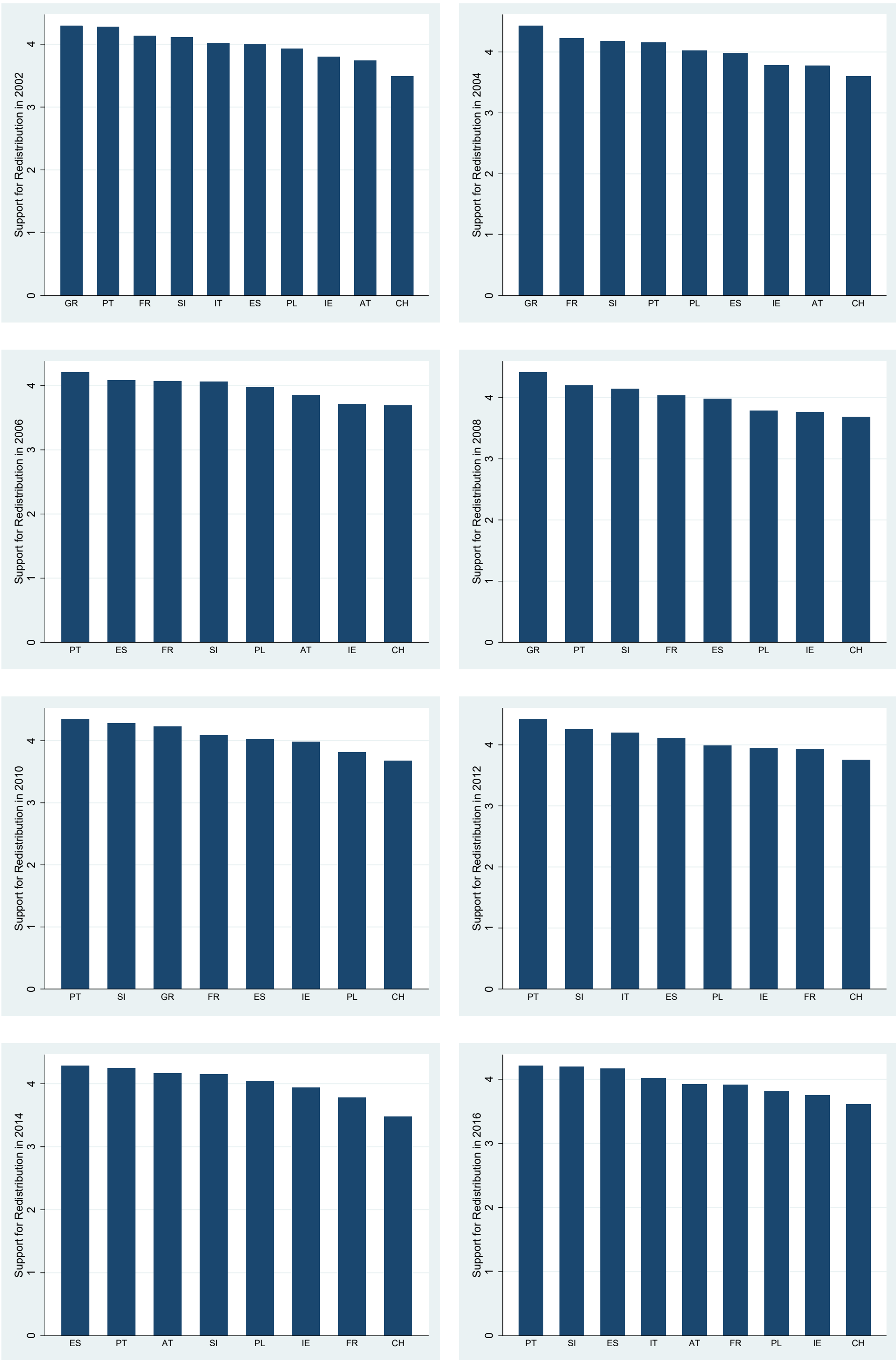


Figure C.2: Assortative Mating by Less than Primary Degree

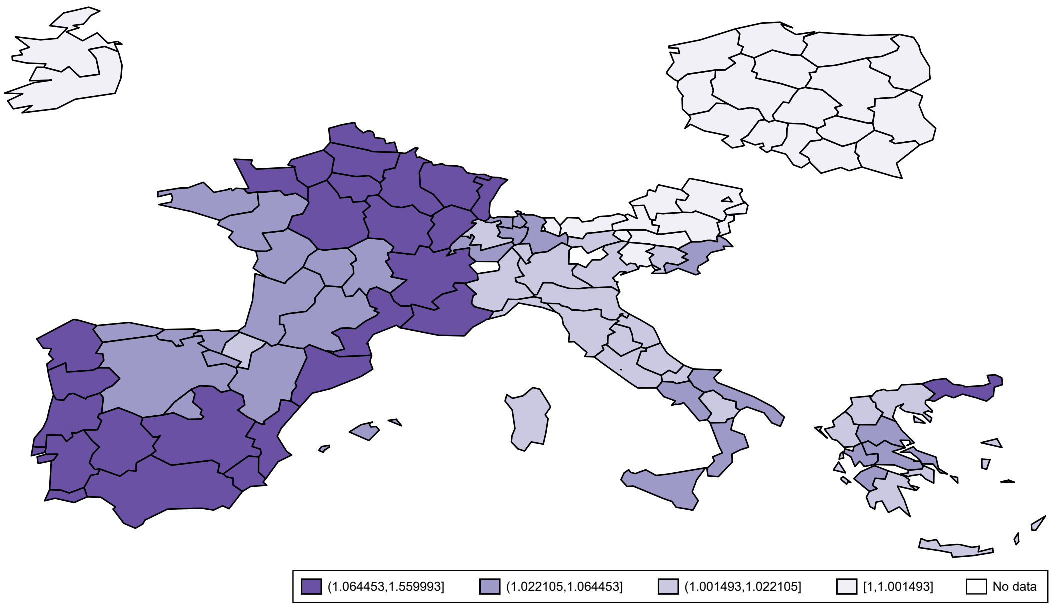


Figure C.3: Assortative Mating by Tertiary Degree

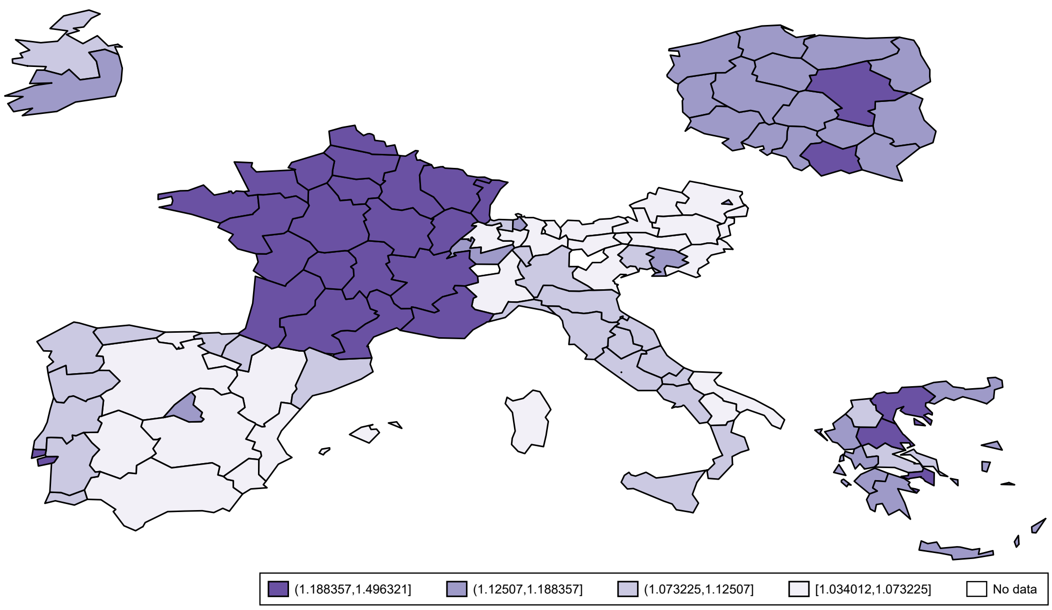


Figure C.4: Assortative Mating by Top Occupations

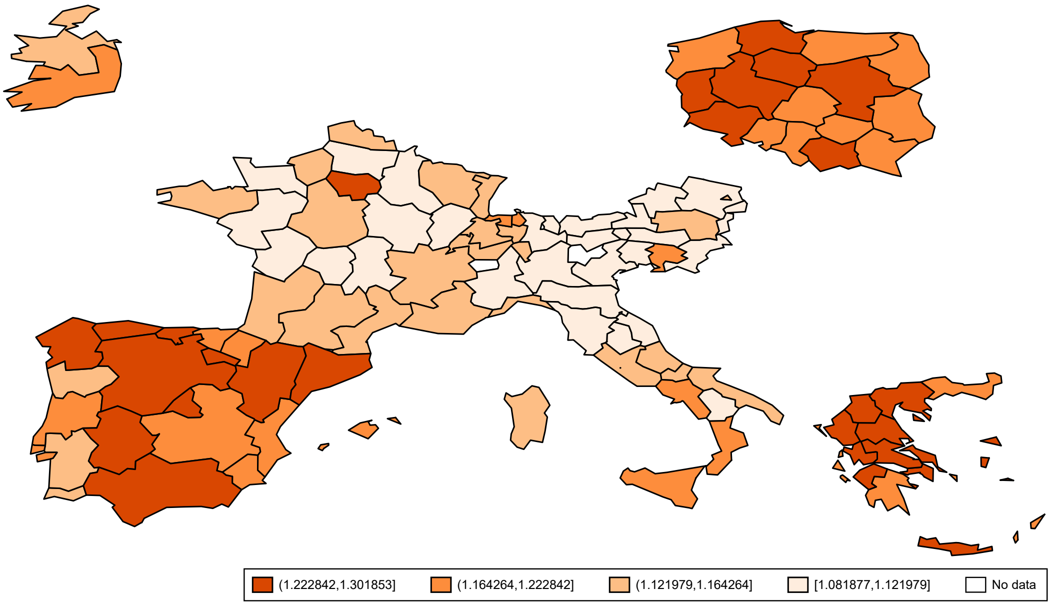
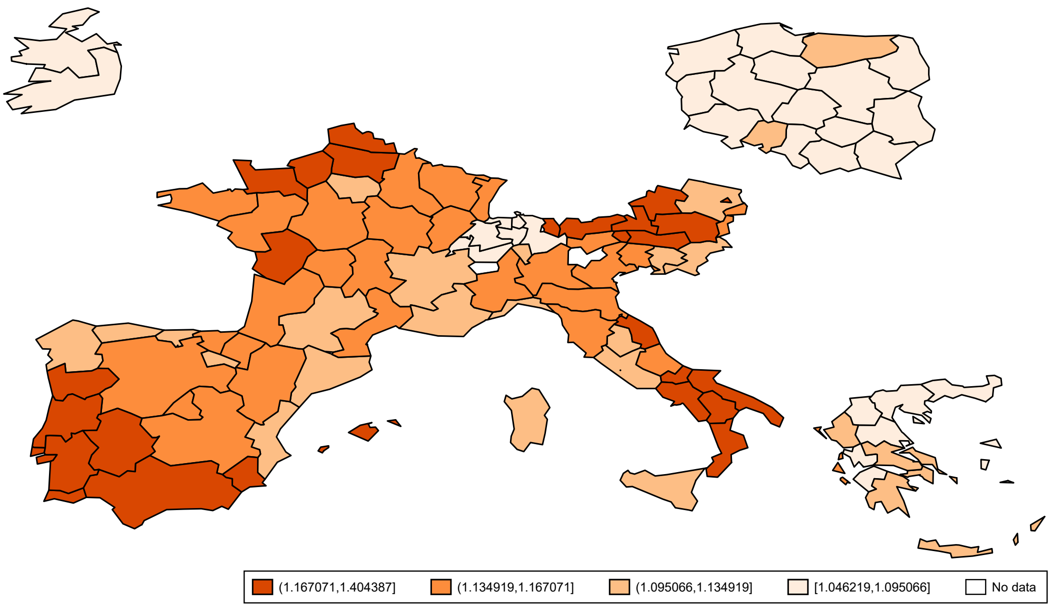


Figure C.5: Assortative Mating by Bottom Occupations



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