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Essays on Public Policy and Human Capital

Autor:

María Lucila Berniell

Director:

Nezih Guner

DEPARTAMENTO DE ECONOMÍA

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Director: **Nezih Guner**

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Resumen

Esta tesis doctoral consta de tres capítulos que tratan diferentes aspectos a través de los cuales la política pública puede afectar las decisiones de las personas acerca de invertir en su capital humano. El primer capítulo analiza los efectos de una llegada masiva de inmigrantes en los patrones de elección de escuela en España. El segundo capítulo se enfoca en entender cómo la familia y la escuela pueden interactuar en la formación de hábitos saludables en el hogar. El tercer capítulo estudia los efectos de la economía informal sobre las decisiones ocupacionales y de inversión en capital humano de las personas.

En el primer capítulo, "*Sorting of Students by Cultural Traits: The Effects of Immigration*", estudio los efectos de la llegada de grandes flujos inmigratorios a países desarrollados en la distribución de rasgos culturales (locales versus foráneos) de los niños en edad escolar, y analizo cómo estos cambios pueden impactar en la segregación escolar público-privada cuando los padres toman en consideración aspectos culturales al momento de elegir escuela para sus hijos. En muchos de estos países tanto la proporción de padres locales que envían sus niños a escuelas privadas como la proporción de padres inmigrantes que mandan sus niños a escuelas públicas aumentaron con el tamaño de la población inmigrante. España es un claro ejemplo de inmigración masiva y subsecuente huida de los padres españoles de las escuelas públicas. Basándome en la literatura previa sobre elección de escuela y sobre transmisión cultural, construyo y calibro un modelo de elección de escuela que puede dar cuenta de la segregación de estudiantes observada en España. El modelo incluye aspectos de equilibrio general en una economía con una única ciudad, muchos barrios, y con generaciones solapadas de individuos heterogéneos en dos dimensiones: ingreso y rasgos culturales. Al momento de elegir escuela, los padres toman en consideración el ingreso esperado para sus hijos en el futuro (el cual dependerá de la calidad educativa que reciban) así como también la identidad cultural que adquieran en las escuelas. Utilizo el modelo para estudiar el impacto de la inmigración sobre la segregación escolar y barrial, y para analizar distintas políticas que pueden afectar la asignación de estudiantes entre escuelas como también los resultados de integración cultural de los inmigrantes. Encuentro que tanto reducir los subsidios a la educación privada como incrementar el valor multi-cultural de la educación pueden contribuir a reducir la segregación de estudiantes entre escuelas públicas y privadas, al mismo tiempo que moderar la segregación barrial y mejorar los patrones de integración cultural y económica de los inmigrantes.

El segundo capítulo, "*Spillovers of Health Education at School on Parents' Physical Activity*" (escrito en colaboración con Dolores de la Mata y Nieves Valdés) explota las reformas educativas sobre Educación para la Salud (ES) a nivel estadual en los Estados Unidos como un cuasi-experimento natural para estudiar el impacto causal de la ES que reciben los niños en la escuela sobre la actividad física que realizan sus padres. Usamos datos del *Panel Study of Income Dynamics* (PSID) para el período 1999-2005 unidos a los datos de las reformas estaduales en la currícula de ES obtenidos de la *National Association of State Boards of Education* (NASBE) *Health Policy Database*, y de los registros del *School Health Policies and Programs Study* (SHPPS) para los años 2000 y 2006. Para identificar los efectos derrame de interés utilizamos diferentes metodologías (DDD, CiC, y DD), en las cuales permitimos la existencia de tratamientos diferenciales. Encontramos un efecto positivo de las reformas de ES en la educación primaria sobre la probabilidad de que los padres hagan actividad física ligera. Implementar cambios sustanciales en la currícula de ES aumenta la probabilidad de que los padres comiencen a hacer actividad física en una magnitud que va entre los 6.3 y los 13.7 puntos porcentuales, mientras que la probabilidad promedio para las madres no parece ser afectada. Analizamos la existencia de varios impactos heterogéneos de las reformas de ES como una forma de esclarecer los mecanismos que motorizan el efecto derrame, y encontramos evidencia consistente con dos hipótesis: la especialización por género en la crianza de los hijos y el hecho de que los niños efectivamente transmiten la información que reciben en la escuela a sus padres.

El último capítulo, "*Investing in Myself?: Informality, Occupational Choice and Investments in Human Capital*", se enfoca en los efectos de la economía informal –muy presente en países en desarrollo– sobre el emprendedurismo y el nivel educativo alcanzado por la población. La evidencia que compara datos entre países señala que estos fenómenos están conectados entre sí: primero, la tasa de emprendedurismo aumenta con el tamaño de la economía informal; segundo, la diferencia en el retorno a la educación superior que reciben emprendedores y trabajadores se hace más grande (favoreciendo más a los emprendedores) cuando el tamaño de la economía informal crece; tercero, en países con altos niveles de informalidad la fracción de individuos con alto nivel educativo que eligen convertirse en emprendedores es mayor que en países con sectores informales pequeños. Para explicar estos hechos estilizados, construyo un modelo con decisiones de inversión en capital humano, elección ocupacional y un sector informal, en el cual el capital humano no solo mejora la eficiencia del trabajo asalariado sino que también mejora las habilidades gerenciales de los emprendedores, y donde la tecnología para producir bienes se caracteriza por la complementariedad entre el capital y la cualificación de los trabajadores. En esta economía hay restricciones crediticias que aparecen como resultado de que las

firmas informales pueden evadir impuestos y esconder el colateral de los intermediadores financieros, y de que hay un costo de hacer cumplir los contratos de crédito. El tamaño que toma el sector informal depende de cuán grandes sean estos costos de asegurar el cumplimiento de contratos, los cuales limitan el uso de capital físico en la economía y también afectan los retornos a la educación de manera diferencial entre ocupaciones. Las predicciones del modelo son capaces de dar cuenta de los tres hechos empíricos que motivan este trabajo y también son capaces de echar luz sobre los mecanismos que operan a medida que aumenta el tamaño de la economía informal. En particular, un mayor nivel de informalidad desincentiva las inversiones en capital humano que hacen los trabajadores, mientras incentiva estas inversiones en el caso de algunos emprendedores, mayormente informales pero habilidosos.

Abstract

This doctoral dissertation consists of three chapters dealing with different dimensions of the impacts of public policy on human capital investments. The first chapter analyzes the effects of massive immigration on the school choice patterns in Spain. The second chapter studies how families and schools can interact in the formation of healthy habits in the household. The third chapter deals with the effects of the informal economy on occupational and educational decisions.

In the first chapter, "*Sorting of Students by Cultural Traits: The Effects of Immigration*", I analyze the effects of large immigration inflows to developed countries in the distribution of cultural traits (native versus immigrant) of school-age children and I study the impacts of these changes on the segregation of students across public and private schools, when cultural considerations play a role in parents' school choices. In many of these countries both the proportion of native parents who chose to send their children to private schools as well as the proportion of immigrant parents who chose public institutions increased with immigration. Spain provides a clear example of large immigration and subsequent native-flight out from public schools. Building on previous literature on school sorting and cultural transmission I construct and calibrate a model of school choice that can account for the observed sorting of students in Spain. The model economy is a single-community, multi-neighborhood general equilibrium model with overlapping generations of individuals who differ along two dimensions, income and cultural traits. Parents care about their children's future income and their acquired cultural identity. I use the model economy to study the impact of immigration on school and neighborhood segregation and to analyze policies that can affect the allocation of students across schools as well as the integration outcomes of immigrants. I find that reducing subsidies to private education as well as increasing its multi-cultural value can reduce the sorting of natives and immigrants across public and private institutions while ameliorating neighborhood segregation and improving cultural and economic integration outcomes of immigrants.

The second chapter, "*Spillovers of Health Education at School on Parents' Physical Activity*" (joint with Dolores de la Mata and Nieves Valdés), exploits state Health Education (HED) reforms in the US as quasi-natural experiments to estimate the causal impact of HED received by children on their parents' physical activity. We use data from the Panel Study of Income Dynamics (PSID) for the period 1999-2005 merged with data on state HED reforms from the National Association of State Boards of Education (NASBE) Health Policy Database, and the 2000 and 2006 School Health Policies and Programs

Study (SHPPS). To identify the spillover effects of HED requirements on parents' behavior we use several methodologies (DDD, CiC, and DD) in which we allow for different types of treatments. We find a positive effect of HED reforms at the elementary school on the probability of parents doing light physical activity. Introducing major changes in HED increases the probability of fathers engaging in physical activity by between 6.3 and 13.7 percentage points, while on average this probability for mothers does not seem to be affected. We analyze several heterogeneous impacts of the HED reforms in order to unveil the mechanisms behind these spillovers. We find evidence consistent with hypotheses such as gender specialization of parents in childcare activities, or information sharing between children and parents.

The last chapter, "*Investing in Myself?: Informality, Occupational Choice and Investments in Human Capital*", focuses on the effect of informality –which is pervasive in many developing countries– on entrepreneurship and educational attainment. Cross country data shows that these phenomena are connected: First, the rate of entrepreneurship increases with the size of the informal economy; second, the difference between the skill premium for entrepreneurs and for workers becomes larger as the size of the informal economy increases; third, in countries with large informal sectors the fraction of high-skilled individuals that choose to be entrepreneurs is larger than in countries with small informal sectors. To explain these facts, I develop a model economy with human capital investment, occupational choice and an informal sector, where the investment in human capital improves the efficiency of labor as well as managerial skills, and the technology to produce goods exhibits capital-skill complementarity. In the model economy, credit constraints and informal firms emerge as a result of the interplay between the ability of informal firms to avoid taxes on one hand and their ability to hide their collateral on the other. In this economy the size of the informal sector is associated with the enforceability of contracts, which by limiting the use of physical capital in the economy it also affects the relative returns to education across occupations. The model predictions are able to account for the three empirical facts, as well as to shed light on the mechanisms at work when the level of informality in the economy increases. In particular, a higher level of informality disincentivizes human capital investments for workers while it incentivizes these investments for the case of some managers, mostly informal but talented.

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Chapter 1

Sorting of Students by Cultural Traits: The Effects of Immigration

1.1 Introduction

Many developed countries have been experiencing large-scale immigration during the last decades. In these countries as these waves of immigration added cultural and economic diversity to the adult population, the composition of school-age children (immigrant versus native) changed as well. In the same period, segregation across private and public schools in the hosting countries has also been increasing: while more native parents have been opting for private schools, a larger share of immigrant parents have been choosing public schools for their children. This "native-flight" is well-documented in many studies which all find similar evidence about the impact of immigration on school segregation.[1]

The current literature on the sorting of students across public and private schools is mostly concerned about income differentials and peer quality as the main driving forces in this segregation process. However, as argued in Nechyba (2006), student sorting across racial, ethnic or cultural dimensions may arise independently of income and/or peer quality sorting. Language, values, and other cultural considerations are important factors in educational decisions and since large-scale immigration involves changes in all these matters it may also crucially affect schooling choices.

[1]For the U.S., see Reardon and Yun (2002), Betts and Fairlie (2001), Fairlie (2006), Fairlie and Resch (2002), Betts and Fairlie (2003), and Ellen, O'Regan, Schwartz, and Stiefel (2007). For Denmark, see Rangvid (2007) and Gerdes (2010). For the U.K., see Burgess, Wilson, and Lupton (2005). For Belgium, see Timmerman, Vanderwaeren, and Crul (2003). For Germany, see Kristen (2008). For Sweden, see Soderstrom and Uusitalo (2010).

In particular, parental concerns about the effectiveness of the transmission of the desired cultural traits at schools may induce them to modify their decisions about the type of schools they prefer for their children.[2] These concerns are likely to arise as a result of increasing immigration. This is specially the case in a society which was relatively homogeneous in its composition of cultural traits, and which happen to become unusually heterogeneous after a large-scale immigration episode. The case of Spain provides a stark example. During the last decade, Spain has experienced a significant inflow of immigrants for the first time in its modern history. This demographic phenomenon rapidly mirrored in schools. Figure 1.1 shows evidence on the native flight in the Comunidad Autónoma de Madrid (CC.AA. de Madrid) from 1998-99 to 2008-09. On the one hand, Figure 1.1 shows that in 1998-99, when the fraction of immigrants in Madrid was only 2.6%, about 59% of natives were attending public schools, while one decade later -when immigrants comprised 17% of total population- roughly 50% of natives chose public institutions. On the other hand, in 1998-99 only 68% of immigrant parents were choosing public schools, while in 2008-09 this number raised to 77%. Moreover, the (negative) correlation of the percentage of natives and immigrants choosing public institutions is very strong.[3] These numbers imply a gap in schooling decisions among natives and immigrants of about 9 percentage points at the beginning of this period that increased to 27 percentage points by 2008/09.

The consequences of sorting of students by their cultural background cover a wide range of important social matters. First, the probability of integration of immigrants to the host culture may be hampered, contributing to the deterioration in social cohesion. Second, this phenomenon may generate unequal income prospects for individuals with different cultural backgrounds, since the quality of education received by natives and immigrants is likely to differ. Finally, the sorting of students can have an impact on the spatial segregation of immigrants across neighborhoods, leading to the formation of ghettos.

In this paper, I study the effect of immigration on native and immigrant parents' decisions about what type of school, public or private, to choose for their children. Some related

[2] Knafo, Assor, Schwartz, and David (2009) highlights the importance of formal schooling in the socialization process of children. Also, Aspachs-Bracons, Clots-Figueras, Costa-Font, and Masella (2008) find that schools are important institutions for identity formation.

[3] In the Spanish school system there are three types of schools: public schools, *escuelas concertadas* (*concerted*), and private schools. Concerted schools are private educational institutions that are publicly subsidized and they account for around 80% to 90% of private schools in Spain. They must provide their services free of charge. However, in practice, parents do spend a considerable amount of money when they choose these schools. The out-of-pocket school expenses in *escuelas concertadas* are about three times larger than in public schools (Arellano and Zamarro, 2007). In what follows I use the term private school to refer to a school which can be either a concerted or a purely private school.

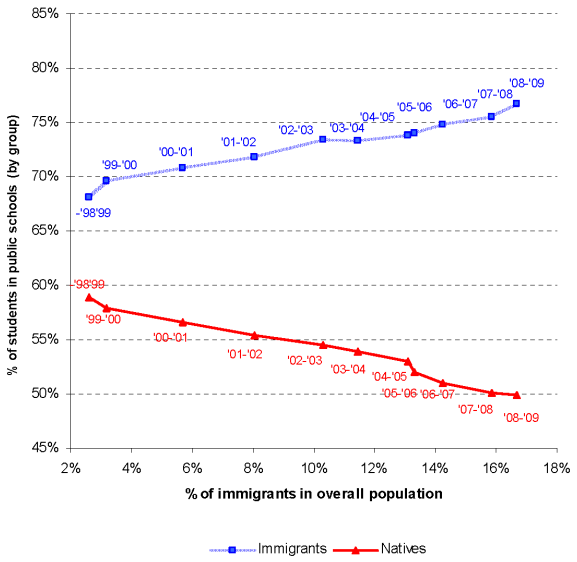


Figure 1.1: Fractions of natives and immigrants choosing public schools. Madrid, 1998-99 to 2008-09.

questions are: What is the impact of these decisions on spatial segregation? What are the effects of student sorting by cultural backgrounds on the integration outcomes of immigrants? What are the consequences of potential integration/segregation patterns on their future income prospects? How can immigration affect the quality of education in public versus private schools?

To be able to answer these questions, I build a model of school choice of natives and immigrants that can account for the segregation observed in the data. The model economy is a single-community multi-neighborhood general equilibrium model populated by two overlapping generations of individuals who differ along two dimensions -income and cultural traits-, and in which parental concerns about children's future income and acquired cultural traits interact. I use the calibrated model to study the effects of a number policies that can affect the allocation of students across schools as well as the integration outcomes of newcomers.

In the model economy, schooling and residential choices entails two key trade-offs. First, choosing public education may be convenient because this option is cheaper than private schools, even though the quality of education in public schools may be lower. Second, choosing to live in a neighborhood with greater quality of housing may be more expensive than living in a lower-quality neighborhood. If there is a link of residential location to school enrollment, schooling and housing decisions are linked in such a way that these

trade-offs need to be solved altogether.[4] Furthermore, if public and private schools also differ in the way they transmit cultural mores and values, e.g. due to the existence of differentiated linguistic or religious educational policies in public and private education, there exists a third dimension needed to be considered in parents' school choice. Parents that care about the cultural traits acquired by their children may be willing to pay more for a type of education which can be more effective in the transmission of their own traits. In this setting, quality of housing, quality of education, and cultural transmission concerns play important roles in determining the sorting of students across schools and neighborhoods by not only income but also by cultural traits.

This paper is related to three strands of literature. First, it relates to the literature on income and peer quality sorting, both in purely public school systems and in systems with private alternatives. Nechyba (2006) surveys this literature and lists three distinct forces affecting school choices, and therefore the sorting of students: (i) heterogeneity in housing markets, (ii) local public funding of schools, and (iii) peer effects. Fernández and Rogerson (1996, 1998), Nechyba (1999), and Epple and Romano (2003), among others, are the key contributions.[5]

Second, this work is related to the empirical literature on sorting of students by ethnic and cultural factors. Betts and Fairlie (2001) show that parental characteristics such as per capita income and educational attainment can only account for 70% of the high school private attendance gap between white natives and minority groups. For the case of Denmark, Rangvid (2007) finds that while Danes choose schools with substantially fewer immigrant peers, immigrants choose schools with on average higher immigrant shares, even when both immigrant and native parents are shown to be concerned about the quality of peer in terms of socioeconomic background of the student body.[6] Card, Mas, and Rothstein (2008) examine the so-called tipping point in the dynamics of neighborhood segregation for the case of the US. They find that one explanation for the importance of neighborhood racial composition in determining this dynamics is that families are concerned about the racial composition of schools. Munk (2006) is an empirical study of schooling choices in the UK and it finds evidence suggesting that socialization and norms

[4] When the enrollment in private schools is not restricted to those residing in the same district/neighborhood as the school, the availability of private schooling alleviates the bundling of these two decisions. However, in Spain there are catchment areas for all primary and secondary public and concerted schools, which implies that the bundling of schooling and residential decisions is still an important feature of the school system.

[5] Recent works estimate this type of models. For instance, see Bayer, Ferreira, and McMillan (2007), and Ferreyra (2007).

[6] Gerdes (2010) finds very similar results for Denmark.

-factors other than quality of education narrowly defined- play an important role in the choice of private or public schools.

Third, the current paper is also linked to the literature on the transmission of preferences, beliefs and norms of behavior (traits), pioneered by Bisin and Verdier (2000, 2001).[7]

There have not been many attempts to put together the traditional school segregating forces with the elements of cultural transmission, and this is the gap that the current paper tries to fill. Important exceptions are Cohen-Zada and Justman (2005), Cohen Zada (2006), and Cohen-Zada and Sander (2008).[8] These papers include empirical results measuring the religious component in the demand for private education in the US. However, these works do not include the analysis of the spatial segregation effects of such feature in the demand for education, neither do they explore the effects of large-scale immigration. In related work, Ferreyra (2007) structurally estimates a model of schooling and residential decisions in which she includes a source of heterogeneity in preferences for religious education, which is independent of the share of individuals sharing each denomination. A closer approach to the current paper is Ioannides and Zanella (2008), which estimates a model in which households search for the best location in the presence of neighborhood effects in the formation of children's human capital and in the process of cultural transmission. They found that households with children, but not those without, are more likely to move out of neighborhoods whose attributes -schools as the most important one- are not favorable to the production of human capital and the transmission of parents' cultural traits, and to move into neighborhoods which instead exhibit desirable such attributes. A related work about how schools may affect the transmission of cultural traits is Aspachs-Bracons, Clots-Figueras, Costa-Font, and Masella (2008), which uses a quasi-experiment approach to study the effects of formal education in shaping identity traits in Catalonia, Spain.

In this paper, the model economy constructed and calibrated for the case of Madrid is able to account for the observed segregation across schools and neighborhoods. This model economy includes cultural concerns about schooling choices as the key sorting force. The framework is also well-suited to produce a number of policy experiments. First,

[7] A complete survey of this literature can be found in Bisin and Verdier (2010).

[8] Gradstein and Justman (2002), Gradstein and Justman (2005) and Kremer and Sarychev (2000) include cultural transmission concerns together with collective action problems in their analysis of the role of public education in shrinking social distance between culturally diverse groups. Albornoz, Berlinski, and Cabrales (2010) is another recent example in this literature. Their model highlights the rich interactions of collective action problems in the provision of public and private education, the effects of segregation and the incentives of parents to contribute in the production of education and the transmission of cultural traits to their children.

I experiment with the level of subsidies to private education and I find that reducing these subsidies mitigates the rise in segregation across schools and neighborhoods that occurs with immigration. Second, I simulate changes in the level of public spending in both types of educational institutions but preserving the shares allocated to public and private ones and I find that neither reducing nor increasing the public funding would have helped to reduce the observed gaps in schooling and neighborhood choices of natives and immigrants. Third, I conduct a policy experiment in which I simulate changes in the orientation of private education to make it more or less majority-oriented (i.e., more or less multi-cultural). For a less multi-cultural private education I find that the sorting of students by cultural traits is aggravated the larger is the scale of immigration. When I simulate a private education which is more multi-cultural, i.e. less majority-oriented, I find that the increasing segregation across schools would be alleviated without worsening off the spatial concentration of immigrants and natives. Accompanying these results on the sorting of immigrants and natives across schools and neighborhood the model also produces some results on educational and integration outcomes. The policy experiments show that making private education less majority-oriented would also improve educational outcomes of immigrants and foster their cultural an economic integration outcomes as well.

The paper is organized as follows. Section 1.2 discusses some key features of immigration and schooling choices in Spain that help to understand the modeling choices detailed in Section 1.3. Section 1.4 presents the calibration strategy and the data used in the numerical exercises. Section 1.5 shows the results for the benchmark economy, while Section 1.6 describes the results of the three policy experiments. Last, Section 1.7 concludes.

1.2 Discussion: Immigration, cultural concerns and schooling choices in Spain

Two thirds of immigrants in Spain reside in only three out of the seventeen existing regions.[9] These regions are Madrid, Catalonia, and Comunitat Valenciana. On the other hand, very low concentrations of immigrants can be observed in regions such as Extremadura, Galicia, Asturias, and Basque Country. The recent evolution of schooling choices in these regions clearly differs from what is shown in Figure 1.1.[10] The opposite is found for Comunitat Valenciana, in Figure 1.2(c). In this region schooling choices of both

[9] If we include Ceuta and Melilla the total number of Spanish regions (Comunidades Autónomas) is nineteen.

[10] See Figures A.1(a) to A.1(d) in Appendix A.

natives and immigrants follow a similar pattern to the one observed in Madrid. However, the case of Catalonia -shown in Figure 1.2(b)- differs remarkably from the other two regions that have recently faced large-scale immigration. In this region, as the share of immigrants in overall population increased, neither natives nor immigrants changed their private versus public schooling choices. However, although Catalonia is in stark contrast with the cases of Madrid and Comunitat Valenciana it does not contradict the argument that parents may be choosing more private education as a result of socialization concerns. Indeed, Catalonia gives a new insight about the driving forces in this type of sorting.

In Spain a high proportion of private education is managed by religious institutions, mainly the Catholic church.[11] Vast evidence supports the idea that individuals sharing Catalan identity are more concerned about the preservation of local cultural traits -specially the Catalan language- than in transmitting religious traits to their children.[12] In this region, the preservation of this cultural trait is carefully taken into account in the curricula of public schools.[13] Therefore, in Catalonia the existing supply of private education may not became more attractive for natives after an episode of large-scale immigration, since public schools are thought to handle well the problem of transmitting local cultural traits through education.[14]

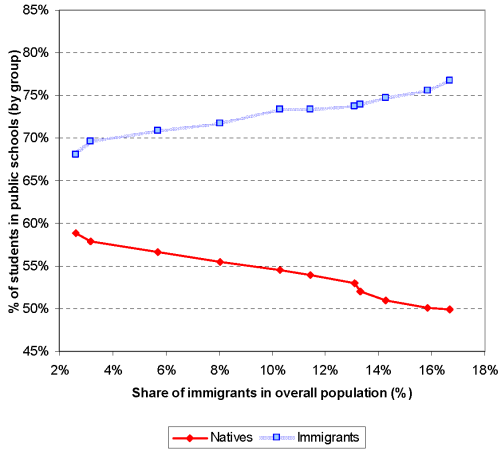
According to Figures 1.2(a), 1.2(c), and 1.2(b) the native-flight from public to private seems to be more pronounced whenever private education offers a type of education that

[11] In Spain, more than two thirds of students choosing private education attend schools managed by the Catholic church (INE, 2005).

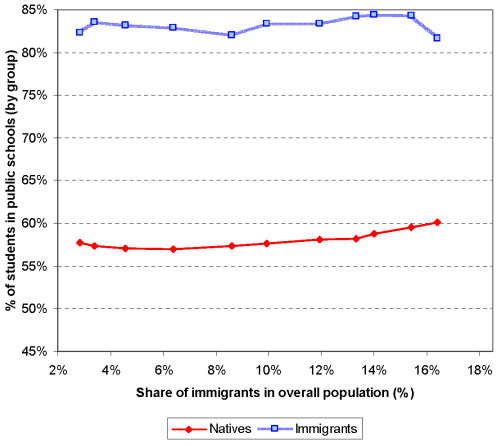
[12] For instance, results from the International Social Survey Programme (ISSP) in its 2003 module about "National Identity" show that 20% of respondents in Madrid said that professing Catholic religion is "very important" to be considered as Spanish. In that survey, only 3.7% of Catalan individuals agree on that statement and this number raises to 14.9% for those from Com. Valenciana. ISSP also reveals that even though Comunitat Valenciana also has an official local language (the *Valenciano*) apart from Spanish -which is the country wide official language- only 3.2% of respondents in that region call that language their primary language of communication. This contrasts with the answers in Catalonia, where 40% of respondents named Catalan as their first language.

[13] In 1983, Catalonia passed a law of compulsory education in Catalan language, which transformed the previous Spanish-only educational system into a bilingual one. By 1989-90, 85% of public schools adhered to use Catalan as the main language for instruction, while this percentage was only about 60% for the case of private schools (van der Goot, 1996).

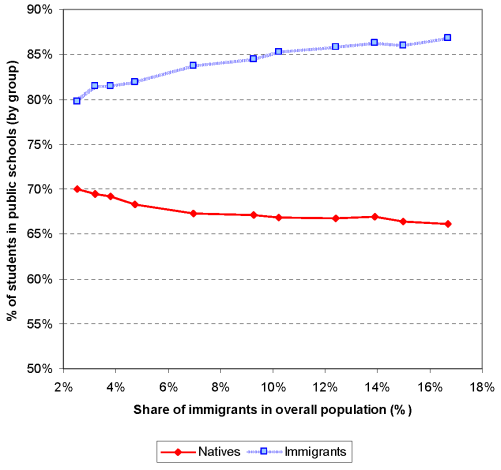
[14] In Aspachs-Bracons, Clots-Figueras, Costa-Font, and Masella (2008) results indicate that there exists a significant effect of a compulsory language policy implemented in education in Catalonia on the identity formation, whereas the non-compulsory language policy implemented in the Basque Country did not have any effect. In Clots-Figueras and Masella (2010) individuals who have experienced greater exposure to teaching in Catalan are more likely to say that they feel more Catalan than Spanish. Additional results show that the effect appears to be present also among individuals whose parents do not have Catalan origins.



(a) Madrid



(b) Catalonia



(c) Com. Valenciana

Figure 1.2: Schooling choices of natives and immigrants in the three regions with more immigrants in Spain (1998/99-2008/09).

is oriented to natives' traits.[15] However, other mechanisms could be at work. Sorting by income, peer effects, and crowding-out hypotheses are usually mentioned as the main drivers in these type of school segregation. However, existing evidence for the case of Spain casts serious doubts about the operation of these alterative segregating forces. I discuss this evidence in Appendix A.

1.3 Environment

The economy is populated by two-period-lived overlapping generations of households of mass one. Each household consists of a parent (old) and a child of school-age (young). Every period a continuum of agents of mass one is born. All decisions are made by old individuals. Households are heterogeneous in two dimensions: income and cultural trait. Individuals may belong to the group of *Natives* (N) or *Immigrants* (I). The share of natives in the overall population is n. There exist R income levels such that $y_1 < y_2 < ... < y_R$. Let ψ_r^j be the fraction of households of group $j \in \{N, I\}$ with income level y_r, where $\sum_r \psi_r^j = 1$. Hence, each parent in this economy is characterized by a pair (y, j) of her income level y and her cultural trait j.

In this economy there is one community formed by several neighborhoods. Each neighborhood coincides with a school district. Neighborhoods are denoted by m, where $m \in \{1, 2, ..M\}$. Each neighborhood is characterized by a different quality of housing, h_m, where $h_1 < h_2... < h_M$. Supply of housing in each neighborhood is fixed and owners of the housing stock live outside the community.[16] Let ρ_m be the measure of houses in each neighborhood, such that $\sum_{m=1}^{M} \rho_m = 1$.

There are three types of goods: private consumption (c), housing quality (h), and quality of education (q). The consumption good is the *numeraire* and the price of housing with quality h_m is p_m. There is a technology to produce quality of education and it only uses spending per student as an input. This technology is available in two types of schools: public and private. There is one school of each type per neighborhood.[17] To be able to attend a given school it is necessary to reside in the neighborhood in which the school is located.

[15] In what follows I use the term majority-oriented education to denote the type of education (public or private) that helps -relatively more than other types- majority parents to socialize their children on majority cultural traits.

[16] All households are renters.

[17] Or alternatively, since schools operate under constant returns of scale, there can be any number of schools of each type operating in each neighborhood.

For public schools, spending per student is the same in all neighborhoods since public schools are community-financed. Let θ_m be the number of students attending the public school in neighborhood m. These students can belong to one of the two cultural groups. Let θ_m^N and θ_m^I be, respectively, the number of native and the number of immigrant students enrolled in the public school in neighborhood m. The level of spending per student, q^{Pub}, is determined by a portion of the revenue raised from a proportional income tax (τ) divided by the number of students attending public schools in all neighborhoods. In this economy private education is publicly subsidized, and only the fraction $(1-\phi)$ of this revenue is allocated to finance public schools. Therefore, quality of education in public schools is

$$q^{Pub} = \frac{(1-\phi)\tau\bar{Y}}{\theta}, \tag{1.1}$$

where

$$\theta = \sum_{j\in\{N,I\}} \sum_{m}^{M} \theta_m^j, \tag{1.2}$$

is the total number of students in public schools in the community, and $\bar{Y}$ is the average income in the community.

Spending per student in private schools consists of two parts: spending by parents, x, and the subsidies received from public funds. Hence, the quality of education for a student attending a private school is

$$q^{Priv} = \frac{\phi\tau\bar{Y}}{\eta} + x, \tag{1.3}$$

where

$$\eta = \sum_{j\in\{N,I\}} \sum_{m}^{M} \eta_m^j, \tag{1.4}$$

is the total number of students in private schools in this community, where η_m^j is the number of students of cultural group j in private schools in neighborhood m.

Parents derive utility from the private consumption good, the quality of housing services, and their child's future income (y^c). In addition, parents derive utility from their child sharing their same cultural trait. Parents receive higher utility, the higher is the probability of their child being successfully socialized to their own cultural trait, s.

Preferences are given by[18]

$$U(c, h, y^c, s) = u_c(c, h) + w(y^c) + g(s). \tag{1.5}$$

The last term in the parents' utility function comes from the fact that parents care about the set of values that they will share with their children in order to enjoy more out of future mutual relationships. This assumption, resulting from a form of *imperfect empathy* (Bisin and Verdier, 2010), can be interpreted as paternalistic altruism, where parents tend to prefer children with their own cultural trait and hence they make decisions in order to attempt to socialize them to this trait. To do so, parents have access to a socialization technology that allows them to affect the cultural traits of their children. This technology combines the *direct socialization* that parents promote at home with the *oblique socialization* effect of schools. The socialization technology is characterized by the production function of the probability that the child is socialized to the natives' culture

$$s_j^N = \lambda \mathbf{1}_{\{j=N\}} + (1 - \lambda)e, \tag{1.6}$$

where λ represents the relative impact of the effort made inside the family, and e represents the effect of the school. With respect to direct socialization, I assume that the influence of the family in the formation of cultural traits is just an environmental effect, since the focus here is on the effect of the school as a socialization device. Under such assumption parents need not to put special effort or expense extra time to teach their children their cultural traits. Therefore, the influence of parents on the formation of children's traits is channeled through the parental weight on the socialization technology, and in Equation 1.6 the indicator function.- $\mathbf{1}_{\{j=N\}}$ takes the value 1 if the parent is native and the value 0 otherwise.

In this economy, oblique socialization -given by e in Equation 1.6- combines the student body's composition together with the cultural orientation of the education provided in each type of school, public or private. This part in the socialization technology captures the process of transmission by which the "na" child is influenced by peers and teachers at schools. To formulate e in such a way that is consistent with the differentiated orientation of public and private schools discussed in Section 1.2, I assume that e is just the exposition to the composition in the student body in public schools, whereas it is a transformation

[18]The functional form chosen for preferences is discussed further in the section on calibration (Section 1.4).

Table 1.1: Probabilities of socialization to Natives's cultural trait.

Type of school that child attends	Native Parent	Immigrant Parent
Public School in neighborhood m	$\lambda + (1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}$	$(1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}$
Private School in neighborhood m	$\lambda + (1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^\omega$	$(1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^\omega$

Table 1.2: Probabilities of socialization to Parent's cultural trait.

Type of school that child attends	Native Parent	Immigrant Parent
Public School in neighborhood m	$\lambda + (1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}$	$1-(1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}$
Private School in neighborhood m	$\lambda + (1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^\omega$	$1-(1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^\omega$

of the share of native students (exposition to native students) for the case of private schools.[19,20] That is,

$$e = \begin{cases} \frac{\theta^N}{\theta^N+\theta^I} & \text{for public schools,} \\ (\frac{\eta^N}{\eta^N+\eta^I})^\omega & \text{for private schools.} \end{cases} \tag{1.7}$$

where $0 \leq \omega$. The lower is ω the more native-oriented or majority-oriented is private education, relative to public education.[21] The promotion of majority-oriented education entails the emphasis of local's history, geography, religion, as well as the use of the majority-language as the only language of instruction. On the other hand, a less majority-oriented education, reflected in a value of ω close to 1, may be pursued via the teaching of certain types of knowledge relating to the cultural characteristics of different peoples, and to the historical, social and economic contexts in which cultural distinctions are rooted (Eurydice, 2004). Tables 1.1 and 1.2 show, respectively, the probabilities of socialization to natives's and to own parent's cultural traits for the case of both children with native and with immigrant parents who attend public or private schools.

[19]This exposition effect is supported by studies in Developmental Psychology, which conclude that the relative proportions of immigrants and host-society members to whom immigrant youth are exposed at school may affect their acceptance of perceived parental values (Knafo, Assor, Schwartz, and David, 2009).

[20]Notice that it is only needed that the ratio of productivities of socialization to natives' traits is not equal to one. An example where the oblique socialization is also not linear can be found in Sáez-Martí and Sjogren (2008).

[21]If parameter ω if smaller than 1, then private education is more majority-oriented than public education.

Each individual's realized income is a draw from a discrete approximation to a lognormal distribution whose mean depends on q. Income received when *old* depends on the quality of education (q) received when *young* as well as on a random idiosyncratic shock. This income process is given by

$$logy' = \mu(q) + \varepsilon \quad \text{with} \quad \varepsilon \sim N(0, \sigma_\varepsilon^2), \tag{1.8}$$

where $\mu(q)$ describes a concave relationship between the quality of education and the mean of future income.[22] Let $P_r(q)$ be the probability that an education investment of q is associated with a future income level y_r, where $P_r(q)$ is the discrete approximation of (1.8).

Hence, in this economy spending on education is closely related to future income. This connection takes place through the assumption that quality of primary and secondary education positively affects future earnings and that quality of education is determined by financial inputs (spending, public or private).[23]

1.3.1 Decisions

All decisions are made by old individuals (parents), who have to decide how much to consume, where to live, and the type of school for their children. I denote the decision about where to live by $b(y, j)$. That is, $b(y, j) = m$ indicates that a parent with type (y, j) chooses to reside in neighborhood m. Possible values for the school choice, $d(y, j)$, are

$$d(y,j) = \begin{cases} 1 & \text{if parent chooses } \textit{public} \text{ school} \\ 0 & \text{if parent chooses } \textit{private} \text{ school.} \end{cases} \tag{1.9}$$

The timing of decisions is such that there are two stages -no elapsed time in between- in which parents first decide where to live, then they decide the optimal level of consumption and the type of school. If parent (y, j) chooses to live in neighborhood m, then she has to pay p_m for housing services.[24] Hence, the disposable income she is left with is

[22] This income process is similar to the one in Fernández and Rogerson (1998). See further details in Section 1.4 on calibration.

[23] There is a large literature discussing the production function of education, see Hanushek (1986), Card and Krueger (1992), Betts (1995), Card and Krueger (1996). Here I will omit the importance of other factors possibly entering as inputs in this production function.

[24] Notice that each household in this economy has to reside somewhere, hence every household spends some fraction of their income on housing services.

$(1-\tau)y - p_m$.[25] Given the residential decision, parents have to decide the type of school for their children and they have an amount of resources $(1-\tau)y - p_m$ to allocate among private consumption and expenditure in schooling. Notice that if public education is chosen the amount of private resources allocated to schooling is equal to zero.

To make their optimal choices parents compare value functions for public and private schooling alternatives in each possible location. Then they decide the best of all possible locations in order to maximize their utility.

Let $V^j(y; p_m, \theta_m^I, \theta_m^N, \theta, \bar{Y})$ denote the indirect utility of an individual of cultural group j, who chooses to send her child to a public school and to live in neighborhood m. This value function depends on the total number of students attending public schools as well as on the composition of the student body in the public school in neighborhood m and the community average income, $\bar{Y}$. The overall number of students in public schools, θ, directly affects the quality of education through the level of spending per student. For a given tax revenue this spending is lower the higher is the number of students in public schools. The share of immigrant or native students in the student body of the public school in neighborhood m, $(\theta_m^j/(\theta_m^j + \theta_m^{-j}))$, affects the probabilities of socialization of the child to each one of the two cultural traits. The average community income affects the spending per student -and thus the quality of education- through the revenue raised by the income tax, which is used to finance public schools' expenditure.

For the case of natives the value function for an individual choosing a public school in neighborhood m is

$$\begin{aligned} V^N(y; p_m, \theta_m^I, \theta_m^N, \theta, \bar{Y}) &= u_c((1-\tau)y - p_m, h_m) + w(y^c(d(y, N) = 1)) \\ &+ g((\lambda + (1-\lambda)\frac{\theta_m^N}{\theta_m^N + \theta_m^I})). \end{aligned} \tag{1.10}$$

For the case of immigrants the value function of choosing a public school in neighborhood m is

$$\begin{aligned} V^I(y; p_m, \theta_m^I, \theta_m^N, \theta, \bar{Y}) &= u_c((1-\tau)y - p_m, h_m) + w(y^c(d(y, I) = 1)) \\ &+ g(1 - (1-\lambda)\frac{\theta_m^N}{\theta_m^N + \theta_m^I}). \end{aligned} \tag{1.11}$$

[25] In this economy choosing private education does not exempt parents from paying the income tax.

The value function of choosing a private school for an individual that chooses to reside in m is denoted by $W^j(y; p_m, \eta_m^I, \eta_m^N, \eta, \bar{Y})$. The indirect utility of a native who sends her child to a private school in neighborhood m is

$$\begin{aligned} W^N(y; p_m, \eta_m^I, \eta_m^N, \eta, \bar{Y}) &= \max_x u_c((1-\tau)y - p_m - x, h_m) + w(y^c(d(y,N)=0)) \\ &+ g[\lambda + (1-\lambda)(\frac{\eta_m^N}{\eta_m^N + \eta_m^I})^\omega]. \end{aligned} \tag{1.12}$$

For immigrant parents, the value function of choosing private schooling is

$$\begin{aligned} W^I(y; p_m, \eta_m^I, \eta_m^N, \eta, \bar{Y}) &= \max_x u_c((1-\tau)y - p_m - x, h_m) + w(y^c(d(y,I)=0)) \\ &+ [1 - (1-\lambda)(\frac{\eta_m^N}{\eta_m^N + \eta_m^I})^\omega]. \end{aligned} \tag{1.13}$$

Let simply denote by $x(y, N)$ and $x(y, I)$ the decision rules for natives and immigrants, respectively.[26] The first order condition for the optimization problems in equations 1.12 and 1.13 is the same for natives and immigrants and it is given by

$$\frac{\partial u_c((1-\tau)y - p_m - x, h_m)}{\partial x} = \frac{\partial w(y^c(d(y,j)=0))}{\partial x}. \tag{1.14}$$

Finally, parent (y, j) chooses $d(y, j)$ and $b(y, j)$ so as to solve her individual decision problem

$$\begin{aligned} \{b(y,j), d(y,j)\} &= \arg\max_{b,d} \{\sum_{m=1}^{M} \mathbf{1}_{\{b=m\}}(dV^j(y; p_m, \theta_m^I, \theta_m^N, \theta, \bar{Y}) \\ &+ (1-d)W^j(y; p_m, \eta_m^I, \eta_m^N, \eta, \bar{Y}))\}. \end{aligned} \tag{1.15}$$

The existence of the socialization technology described above implies that the distribution of students across schools and neighborhoods -obtained as a result of parents' decisions-

[26] Notice that $x(y,N) = x_N^*(y; p_m, \eta_m^I, \eta_m^N, \eta, \bar{Y})$ and $x(y,I) = x_I^*(y; p_m, \eta_m^I, \eta_m^N, \eta, \bar{Y})$, where x_N^* and x_I^* are the solutions for the optimization problems in equations 1.12 and 1.13, respectively.

defines a law of motion for the share of individuals sharing natives' cultural traits. This law of motion for n is given by

$$\begin{aligned} n' &= \sum_{m=1}^{M}[\theta_m^N(\lambda+(1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I})+\eta_m^N(\lambda+(1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^{\omega})] \\ &+ \sum_{m=1}^{M}[\theta_m^I(1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}+\eta_m^I(1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^{\omega}]. \end{aligned} \tag{1.16}$$

In equilibrium housing markets clear and no parents want to change their schooling and residential choices. The steady state equilibrium for this economy is characterized by three stationary distributions: distributions of income for individuals in both cultural groups and a distribution of cultural traits in the overall population.

1.3.2 Equilibrium

Given τ and ϕ, the steady state equilibrium for this economy is a vector of decisions $\{x(y,j),$
$b(y,j), d(y,j)\}_{\forall j,\forall y}$, prices $\{p_m\}_{\forall m}$, a distribution of students across schools $\{\theta_m^N, \theta_m^I, \theta_m, \eta_m^N,$ $\eta_m^I, \eta_m\}_{\forall m}$, a share of individuals with natives' cultural trait n, and fractions $\{\psi^N\}_{\forall r}$ and $\{\psi^I\}_{\forall r}$, such that

1. Each individual (y,j) maximizes her utility -taking $\{p_m\}_{\forall m}$, n, and $\{\theta_m^N, \theta_m^I, \theta_m, \eta_m^N,$ $\eta_m^I, \eta_m\}_{\forall m}$ as given- by choosing $x(y,j)$, $b(y,j)$, and $d(y,j)$ so as to solve the decision problem characterized by Equations (1.10)-(1.15).

2. Housing markets clear

$$\sum_{r=1}^{R}[\mathbf{1}_{\{b(y_r,N)=m\}}\psi_r^N n+\mathbf{1}_{\{b(y_r,I)=m\}}\psi_r^I(1-n)]=\rho_m,\ \forall\ m. \tag{1.17}$$

3. The number of students in each type of school in neighborhood m is consistent with parents' decisions, i.e. the following accounting identities hold

$$\sum_{r=1}^{R} \mathbf{1}_{\{d(y_r,N)=1\}} \psi_r^N n = \theta_m^N, \tag{1.18}$$

$$\sum_{r=1}^{R} \mathbf{1}_{\{d(y_r,I)=1\}} \psi_r^I (1-n) = \theta_m^I, \tag{1.19}$$

and

$$\theta_m^N + \theta_m^I = \theta_m, \ \forall \ m. \tag{1.20}$$

Each parent chooses one neighborhood and one type of school, i.e.

$$\sum_{m=1}^{M} [\eta_m^N + \theta_m^N] = n, \tag{1.21}$$

and

$$\sum_{m=1}^{M} [\eta_m^N + \theta_m^N + \eta_m^I + \theta_m^I] = 1. \tag{1.22}$$

4. The share of individuals with natives' cultural trait, n, is constant, i.e., $n' = n$ in Equation (1.16).

5. Fraction ψ_r^N and ψ_r^I are such that, $\forall\ r$

$$\begin{aligned}
\psi_r^N = & \sum_{m=1}^{M}\sum_{i=1}^{R} \{\psi_i^N [\mathbf{1}_{\{d(y_i,N)=1\}} \mathbf{1}_{\{b(y_i,N)=m\}} [\lambda + (1-\lambda)\frac{\theta_m^N}{\theta_m^N + \theta_m^I}] P_r(\frac{(1-\phi)\tau \bar{Y}}{\theta}) \\
& + \mathbf{1}_{\{d(y_i,N)=0\}} \mathbf{1}_{\{b(y_i,N)=m\}} [\lambda + (1-\lambda)(\frac{\eta_m^N}{\eta_m^N + \eta_m^I})^{\omega}] P_r(\frac{\phi \tau \bar{Y}}{\eta} + x(y_i, N))] \\
& + \psi_i^I [\mathbf{1}_{\{d(y_i,I)=1\}} \mathbf{1}_{\{b(y_i,I)=m\}} (1-\lambda)\frac{\theta_m^N}{\theta_m^N + \theta_m^I} P_r(\frac{(1-\phi)\tau \bar{Y}}{\theta}) \\
& + \mathbf{1}_{\{d(y_i,I)=0\}} \mathbf{1}_{\{b(y_i,I)=m\}} (1-\lambda)(\frac{\eta_m^N}{\eta_m^N + \eta_m^I})^{\omega} P_r(\frac{\phi \tau \bar{Y}}{\eta} + x(y_i, I))]\},
\end{aligned}$$

and

$$
\begin{aligned}
\psi_r^I &= \sum_{m=1}^{M}\sum_{i=1}^{R}\{\psi_i^N[\mathbf{1}_{\{d(y_i,N)=1\}}\mathbf{1}_{\{b(y_i,N)=m\}}[1-[\lambda+(1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}]]P_r(\frac{(1-\phi)\tau\bar{Y}}{\theta}) \\
&+ \mathbf{1}_{\{d(y_i,N)=0\}}\mathbf{1}_{\{b(y_i,N)=m\}}[1-[\lambda+(1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^{\omega}]]P_r(\frac{\phi\tau\bar{Y}}{\eta}+x(y_i,N))] \\
&+ \psi_i^I[\mathbf{1}_{\{d(y_i,I)=1\}}\mathbf{1}_{\{b(y_i,I)=m\}}[1-(1-\lambda)\frac{\theta_m^N}{\theta_m^N+\theta_m^I}]P_r(\frac{(1-\phi)\tau\bar{Y}}{\theta}) \\
&+ \mathbf{1}_{\{d(y_i,I)=0\}}\mathbf{1}_{\{b(y_i,I)=m\}}[1-(1-\lambda)(\frac{\eta_m^N}{\eta_m^N+\eta_m^I})^{\omega}]P_r(\frac{\phi\tau\bar{Y}}{\eta}+x(y_i,I))]\}.
\end{aligned}
$$

That is, the share of natives (immigrants) with income y_r, ψ_r^N (ψ_r^I), is consistent with school and residential decisions of both natives and immigrants.

1.4 Benchmark Economy

I calibrate the benchmark economy to the case of Madrid. In the exercises below I restrict the number of neighborhoods to $M = 2$. I do this by dividing Madrid in two sets of school districts or neighborhoods.[27] The first group of districts represents the low-quality neighborhood (m_1) and the second one represents the high-quality neighborhood (m_2). To select which are the "good" and the "bad" neighborhoods, I ordered all districts according to prices of housing in 1998. The low share of immigrants in 1998 makes the relative price a good measure of the relative quality of housing in the two neighborhoods because plausible effects of immigration on housing prices are still absent.[28] After constructing this ranking of neighborhoods according to housing prices I selected the best districts to be included in the high-quality neighborhood in order to match the total supply of housing in good neighborhoods (m_2) to be around one fourth of total housing stock in 1998.[29,30] Therefore, I set ρ_2 to be roughly one fourth.[31] Finally, I normalized $h_1 = 1$ which gives $h_2 = p_2^{1998}/p_1^{1998} = 1.45$ as the relative quality of housing.

[27] For the calibration of parameters related to neighborhoods I use data for Madrid Metropolitan Area instead of CC.AA. de Madrid due to lack of data at the state level.

[28] See Table A.3 in Appendix A.

[29] Results are robust to the use of other fractions for the relative supply of good to bad housing.

[30] The supply of housing in one particular neighborhood is the percentage of individuals residing in that set of districts.

[31] I use $\rho_2 = 0.236$ in the calibration exercise due to the finite number of neighborhoods (see Table A.3 in Appendix A).

I chose the academic year 2001/02 to calibrate the steady state of the benchmark economy. This year lies in the middle of the decade of mass immigration to Spain. After obtaining the calibrated parameter values, I compute the model results for several other years, ranging from years with very low shares of immigrants -such as 1998/99, when the foreign-born individuals represented only 2.6% of the population- to years with very high shares of immigrants -like 2008/09, when immigrants' share was about 16.7%- in Madrid. Then, I compare these steady states, which only differ in their share of immigrants in overall population, and the aim of this comparison is to see whether an increase in the share of foreign-born population can account for the observed segregation by type of school reported in Figure 1.1.

1.4.1 Functional forms

For the utility function I chose standard forms,

$$u_c(c,h) = \frac{\alpha_c c^\delta + (1-\alpha_c)h^\delta}{\delta}, \tag{1.23}$$

$$w(y^c) = \frac{\alpha_y [E(y^c)]^\gamma}{\gamma}, \tag{1.24}$$

$$g(s) = \alpha_s s, \tag{1.25}$$

where $0 < \alpha_c < 1$, $0 < \alpha_y$, $0 < \alpha_s$, are weights of consumption, income of the child (with expected value $E(y^c)$), and the probability of socialization to parents' traits in parents' utility. Parameters δ, and γ belong to the interval $(0,1)$.

Following Fernández and Rogerson (1998), the concave relationship between the expectation of future income (expected mean income of the child) and the quality of education received when young is given by

$$\mu(q) = y_0 + B\frac{(1+q)^\upsilon}{\upsilon}, \tag{1.26}$$

where B and υ are such that $\mu(q)$ is increasing ($B > 0$) and concave ($\upsilon < 1$).

1.4.2 Parametrization

In this section I describe the parametrization of the benchmark economy which is designed to match aggregate data for Madrid. My strategy is to fix parameters that can be mapped a priori to existing estimates and then set the remaining free parameters so that the steady state match an equal number of moments from the data.

I fix parameters τ, ϕ and λ using a priori information. I calibrate τ in order to match the share of government spending on primary and secondary education (public and private) in the GDP of Madrid in 2002.[32] From 1998 to 2006 public spending on this type of education remained almost constant as a share of GDP (see Figure A.5 in Appendix A), thus I set $\tau = 0.018$. Figure A.5 also shows that subsidies devoted to private education have also remained stable around 20% of total public spending in education. Therefore, I set $\phi = 0.2$.

Parameter λ describes the relative importance attributed to direct socialization in the probability of socialization to natives' cultural traits. As a measure of this weight I take the share of non-sleeping hours that a child of school age spends at home. I construct this number from the annual class hours divided by the total number of non-sleeping hours available in one year, which I assume are 16 hours a day. According to ME (2008) the number of class hours in primary education is about 792 hours a year in Spain.[33] The total number of non-sleeping hours a year is 5840, and dividing this number by 792 produces the value $1 - \lambda = 0.136$, so $\lambda = 0.864$.

I calibrate the remaining parameters y_0, υ, B, σ_ε^2, α_c, α_y, α_s, δ, γ, and ω jointly, in order to match: (i) income per capita; (ii) mean/median ratio of the income distribution; (iii) elasticity of earnings with respect to spending per student, which I denote by ξ_q; (iv) share of spending in private education; (v) share of spending in housing; (vi) relative price of good to bad housing in 2002; (vii) shares of immigrant and native parents choosing public schools; and (viii) shares of immigrants and natives residing in neighborhood m_1.

Data on spending in private education comes from the *Encuesta de Presupuestos Familiares* (EPF).[34] Households spend in private education about 3% of their total expenditures. Data on housing expenditure was obtained from the EPF 2002, and the share

[32] I obtained data on public spending from the Spanish Ministry of Education (ME) and data on regional GDP from the Spanish Institute of Statistics (INE).

[33] According to Eurydice (2009) this number is higher (875) but some other sources indicate that the actual number of class hours is below 700 hours a year.

[34] Data used to compute this moment corresponds to the the year 2007, when the EPF included a supplement on household expenditure in education.

of housing services in total household expenditure -10.6%- includes only the actual and imputed rentals for housing. I also use as a moment in the calibration the relative price of housing in the "good" neighborhood (m_1) relative to the price in the "bad" neighborhood (m_2), which I found to be equal to 1.35 in the data for the year 2002.[35]

One important feature of the model economy is the link between spending on education and future earnings. As in Fernández and Rogerson (1998), my calibration strategy includes matching the elasticity of earnings with respect to spending per student. They use a value of 0.1911 for this elasticity and argue that in the previous literature this elasticity is close to 0.2.[36] Following the same steps as in Fernández and Rogerson (1998) I construct a measure of this elasticity with data for Madrid. To obtain this estimate I use the result in Card and Krueger (1992) that states that a reduction of 10 students in the student-teacher ratio leads to an increase in average future earnings of 4.2%. The average student-teacher ratio for 1990-2006 for CC.AA. de Madrid was about 25.6.[37] The share of teacher salaries in total expenditure on education in Madrid for the period 1995-2005 was about 51%.[38] Then, I first construct the percentage increase in the number of teachers needed to reduce the student ratio in 10 students, and next -assuming that the share of expenditure in teachers salaries in total spending remains constant- I compute the associated change in the cost of such change in the number of teachers. The variation in spending needed is 24.9%, and this number combined with the increase of 4.2% in future earnings yields a value of 0.17 for the elasticity ξ_q. In addition, I use the GDP per capita in Madrid for the year 2002 to match the per person income. From the *Encuesta de Estructura Salarial 2002* (EES 2002) I take the ratio of mean/median wages.[39]

Table 1.3 reports the calibrated values for the parameters in the benchmark economy. Table 1.4 shows model and data moments for the calibration targets, according to which the model produces a good match to the those moments for the calibrated values of the parameters.

[35] Data on prices was obtained in the website of the *Ayuntamiento de Madrid*.

[36] Betts (1996) presents estimations that are around 0.1.

[37] Average number of students per teacher in primary education in Madrid in the period 1990-2008, according to data from ME.

[38] From *Encuesta de financiación y gastos de la ensea privada* INE (1995, 2000, 2005).

[39] I had to make use of labor earnings, instead of a broader measure of income, due to the lack of microdata on the distribution of income in Spain in 2002.

Table 1.3: Parameter values

Parameters		Values
Parameters set a priori		
Weight of direct socialization	λ	0.864
Income tax rate	τ	0.018
Subsidy to private education	ϕ	0.2
Parameters calibrated to data		
Income process	y_0	10.3
	B	9.3
	v	-0.54
	σ_e^2	0.39
Utility function	α_c	0.643
	α_y	7.1
	α_s	1.73
	δ	0.195
	γ	0.275
Shape of the oblique socialization	ω	0.21

Table 1.4: Targets

Moments	Data	Model
Share of spending in private education	0.03	0.03
Share of spending in housing	0.11	0.10
Relative price of "good" to "bad" housing	1.35	1.35
Elasticity of earnings with respect to spending per student	0.17	0.17
Mean income	23.41	23.43
Mean/median income	1.24	1.23
Share of immigrant parents choosing Public schools	0.72	0.72
Share of native parents choosing Public schools	0.55	0.54
Share of immigrants residing in m_1	0.68	0.72
Share of natives residing in m_1	0.77	0.77

1.5 Results

This section presents the main results of changes in the share of immigrants in overall population. Table 1.5 and Figures 1.3 and 1.4 present the main simulation results about the impact of increasing immigration on school and neighborhood segregation. The numbers in bold in Table 1.5 refer to the year used to calibrate the model economy, and the rest are predicted and observed values for school and residential choices of both immigrant and native parents. Also, I discuss the results in Table 1.6 which reports the effects of increasing immigration on some key educational and integration -cultural and economic- outcomes.

School Segregation. The first panel in Table 1.5 and Figure 1.3 report the results on school segregation. In 1998/99, when there was only 2.6% immigrants in total population, the percentage of natives in public schools produced by the model is 57%, while in the data this number is 59%. For the same academic year the model predicts that 67% of immigrants would choose public institutions and in the data this number is 68%. On the other hand, for the academic year 2008/09 -when the share of immigrants in overall population increased to 16.7%- the model predicts that 49% of natives would choose public schools and data shows that this number is 50%. In that year, the simulated benchmark economy gives 80% of immigrants choosing public schools, while the actual number is around 77%. Comparing the same magnitudes for every year in the period 1998/99-2008/09 shows that the predictions of the model follow closely what was actually observed in the data. Therefore, the model economy that includes cultural concerns as a key sorting force is able to account for the increasing sorting of students into public and private education that is observed in the case of Madrid.

The intuition behind this result is the following. When parents choose the type of school for their children they consider both the cost of education and the effect of each type of school on their children's socialization to their own culture. In Madrid, private education is more productive in the formation of native (majority) cultural traits. As a result, when the immigration levels are low, immigrants choose private schools as private education provide better education and both public and private schools are not good for the transmission of immigrant values. On the other hand, as immigration increases, public schools become better options for immigrants (they are cheap, and with many immigrants they are also good for the transmission of minority traits). By a similar logic, private schools become better options for natives.

Table 1.5: School and Neighborhood Sorting in the benchmark economy, 1998/99-2008/09.[§]

Year	Share of immig.	School sorting				Neighborhood sorting			
		Share of natives in public schools		Share of immig. in public schools		Share of natives in m_1 (worse neigh.)		Share of immig. in m_1 (worse neigh.)	
		Data	Model	Data	Model	Data	Model	Data	Model
1998/99	0.026	0.59	0.57	0.68	0.67	0.77	0.77	0.63	0.69
1999/00	0.032	0.58	0.56	0.70	0.67	0.77	0.77	0.65	0.69
2000/01	0.057	0.57	0.55	0.71	0.71	0.77	0.77	0.67	0.70
2001/02	**0.080**	**0.55**	**0.54**	**0.72**	**0.72**	**0.77**	**0.77**	**0.68**	**0.72**
2002/03	0.103	0.54	0.53	0.73	0.72	0.77	0.77	0.69	0.73
2003/04	0.114	0.54	0.53	0.73	0.75	0.77	0.77	0.70	0.75
2004/05	0.131	0.53	0.51	0.74	0.76	0.77	0.77	0.71	0.75
2005/06	0.133	0.52	0.51	0.74	0.76	0.77	0.77	0.72	0.76
2006/07	0.143	0.51	0.51	0.75	0.77	0.77	0.77	0.73	0.77
2007/08	0.159	0.50	0.49	0.76	0.79	0.77	0.76	0.76	0.78
2008/09	0.167	0.50	0.49	0.77	0.80	0.78	0.76	0.76	0.80

[§] Benchmark case in bold.

Neighborhood Segregation. As the share of immigrants increased in Madrid, not only students were being sorted out into public and private institutions, but also neighborhoods where becoming more segregated to a certain extent. This is shown in the second panel in Table 1.5. The results show that as the share of immigrants increased from 2.6% to 16.7% the percentage of immigrants that chose to reside in the "bad" neighborhood grew from 63% to 76%. On the other hand, the share of natives residing in that type of neighborhood remain almost constant along the whole period. Results in Table 1.5 and in Figure 1.4 show that the model is also able to replicate the increase in residential segregation of immigrants in this period of time.

Spatial segregation is closely related to school segregation due to the bundling of decisions that characterizes school systems with district-restricted school enrollment. For instance, choosing private schools inside a "bad" neighborhood is an attractive option for some native parents who desire to send their children to a school in which they will be better exposed to the transmission of majority-traits but who can not afford changing residence to the "good" neighborhood so as to take advantage of the favorable share of natives in public schools there. As a result, in the "bad" neighborhood the share of immigrant students in public schools' classrooms increases. This fact attracts immigrants to the district with low quality of housing, in which not only housing services are cheaper, but also public schools are an attractive option for the formation of minority-traits. Since the model economy include all these separating forces, the simulations done for different levels

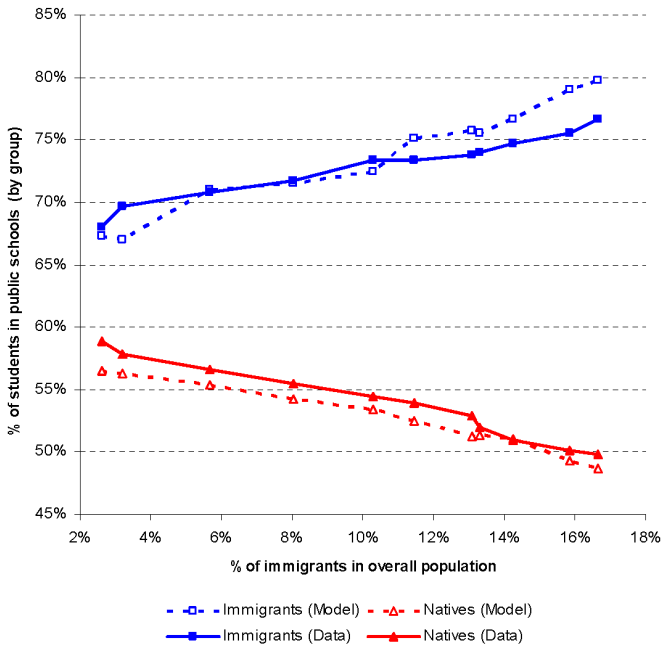


Figure 1.3: School segregation in the data and in the model in Madrid, 1998/99-2008/09.

of the share of immigrants in the overall population are able to replicate the neighborhood sorting observed in the data.

Educational outcomes. Equality of opportunity through education is often advocated as a key goal for public policy. In the case of countries facing large-scale immigration, the increase in the native-immigrant educational gap is a concern that is closely related to segregation across the private and public school systems.[40] Table 1.6 shows some statistics on educational outcomes for the cases of low, moderate, and high levels of immigration. The model predicts that the share of immigrants in public schools raised from 2% in 1998/99 to 24% in 2008/09, which is exactly what is observed in the data for the case of Madrid. Table 1.6 also reports other statistics that are crucial to evaluate the impact of immigration on the school system.[41]

First, simulations show that the quality of education received by natives was only 9% higher in the case of low immigration, while this gap raised to 24% in the scenario with high immigration, corresponding to the academic year 2008/09. This result is mainly driven by the more intensive use of private education by natives with immigration. In

[40] Schnepf (2007) uses PISA, TIMSS and PIRLS databases to show that school segregation is an important determinant of the native-immigrant educational gaps in Continental Europe.

[41] Unfortunately, many of the results produced by the model -such as educational and integration outcomes- cannot directly be compared to existing data for the case of Madrid. Therefore, the evaluation of the suitability of the model to assess the impact of immigration on such dimensions has to rely on indirect evidence or on facts surveyed in previous literature.

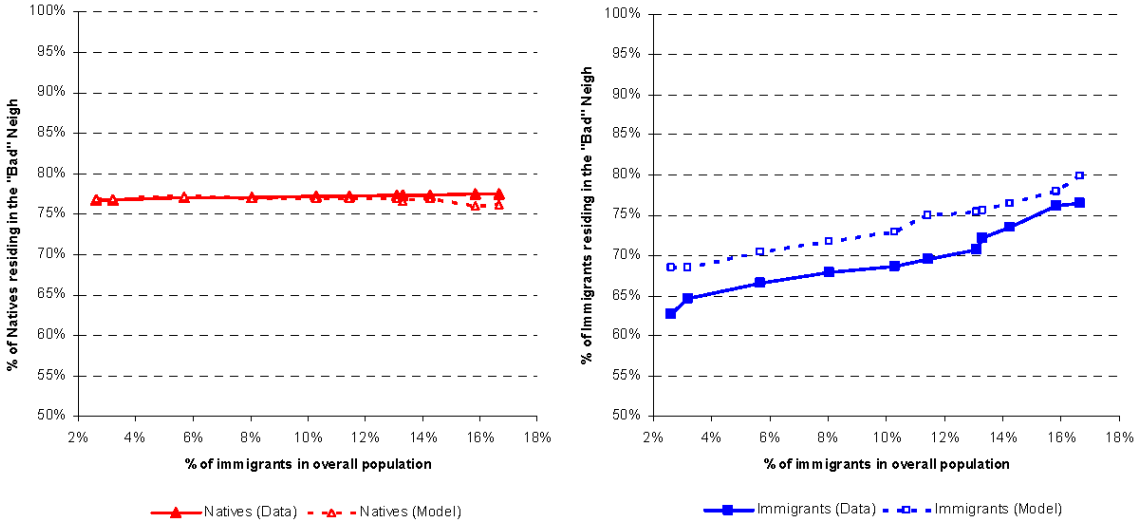


Figure 1.4: Residential decisions of natives and immigrants in Madrid. Data and model results, 1998/99-2008/09.

addition, this result is in line with the evidence in PISA 2000, 2003 and 2006. Data in these surveys for Spain indicates that average scores in Maths, Reading and Science for natives versus immigrants have been increasing with the share of immigrants in the overall population.[42]

Second, the average quality of education in private schools relative to that in public schools decreased as immigrants increased their participation in overall population. For instance, in 1998/99, when there were 2.6% of immigrants in total population, the average quality in private schools was 2.54 times higher than in public ones, and this ratio was reduced to 2.33 in the year with high immigration (2008/09).[43] This implies a reduction of more than 9% in this dimension of educational gaps. In this case, two effects reinforce each other. On the one hand, those natives opting out from public institutions are poorer than those who were choosing private institutions in the case of low immigration, and therefore are buying less education in private institutions. In this regard, the emergence of non-elite private education could be a phenomenon linked to the type of sorting across private and public systems under analysis.[44] On the other hand, the lower number of students in

[42]See Table A.1 in Appendix A.

[43]See Table A.2 in Appendix A. That table shows that in Spain the average score in private is higher than the one in public schools, but the gap has remained almost constant in the three years that the PISA study was conducted. The CDI (*Prueba de Conocimientos y Destrezas Indispensables*) is a standardized exam for all sixth grade students in the region of Madrid which started in the academic year 2004/05. According to the results of the last CDI, the ratio of scores in *concerted* versus public schools was reduced from 1.14 in 2007/08 to 1.07 in the next academic year (El País, 2010), a result in line with the prediction of the model.

[44]See for instance Figlio and Stone (1999) for some empirical evidence on the existence of non-elite private education.

public schools induces an increase in the spending per student in these schools -which is modeled as the key input in the production of education- and this in turn increases the denominator in the ratio of relative quality provided by each type of schools.

Third, the model produces an average quality of education in the "good" neighborhood (m_2) which is higher than the average observed in the "bad" neighborhood (m_1) for all the three academic years reported in Table 1.6. However, as the immigrant population increased its share in total population the gap between the good and the bad neighborhood is reduced. According to results in Table 1.6, with low immigration, the average quality of education in m_2 was about 2.28 times higher than in m_1, while this ratio is 2.10 with high immigration. Here, two key forces are at work. In the first place, those individuals who after the large-scale immigration episode remain in the good neighborhood and who were also choosing private schools there, may now choose to be back in public schools when less immigrants -those choosing to reside in m_1- are enrolled in those schools. Furthermore, those natives residing in m_1 and that have opted-out from public schools and have chosen to send their children to private institutions are helping to increase the average spending in education in m_1 and in this way raising the denominator in the ratio of average quality of education of good to bad neighborhoods.

Integration outcomes. The model economy is well-suited to produce two types of integration outcomes of immigrants. First, there is the probability of cultural integration into the hosting society. This quantity measures how likely is that an individual not sharing native's cultural traits is socialized to them. Recall that in the model economy the probability of acquiring majority's cultural traits is given by a technology that combines both direct and oblique socialization, and predictions of the model in this dimension only capture the changes occurred on the oblique socialization part. In the bottom panel of Table 1.6, the simulation results indicate that the probability of integration of newcomers to the hosting culture is decreasing with the share of immigrants in overall population. This is a result in line both with empirical evidence and with other theoretical approaches to cultural integration (Lazear, 1999).

Second, the model can also produce predictions about what would be the economic penalization for not being integrated to the hosting society. According to results in Table 1.6, the portion of expected income that is lost if not integrated is an increasing mapping of the share of immigrants in overall population. For instance, in the case of low immigration, the expected economic penalization is 2.5% of income, while in the case of high immigration this cost raises to 6.1% of earnings. This result follows from the solution that

Table 1.6: Results on education and integration outcomes, benchmark economy.

Statistics		1998/99 (low immig.) Model	2001/2002 (moderate immig.) Model	2008/09 (high immig.) Model
Educational outcomes	Quality of educ. for natives relative to immigrants'	1.09	1.13	1.24
	Quality of educ. in private relative to public schools	2.54	2.50	2.33
	Quality of educ. in the "good" neigh. relative to the "bad" neigh.	2.28	2.20	2.10
	Share of immigrants in public schools	0.02	0.10	0.24
Integration outcomes	Cultural Integration: Probability of cultural integration	0.134	0.126	0.109
	Economic penalization for not being integrated: Income loss (%) if not assimilated	2.5%	3.6%	6.1%

immigrant parents find for the trade-off of what type of school to choose -which includes the comparison of quality of education that can be acquired in each type of school with the relative productivity in terms of socialization to minority's traits- and which favors the election of public schools the more immigrants are in overall population.

1.6 Policy Experiments

In this section I present the results of three types of policy experiments. These experiments are aimed to assess the different ways in which public policy can affect school and neighborhood segregation as well as education and integration outcomes of immigrants. The three experiments I present include:

1. Changes in the level of subsidies to private education (changing ϕ): this policy only varies the composition of public expenditure in education -but not the overall amount of public financial provisions- giving a higher or lower portion of total tax revenue to public institutions.

2. Changes in the amount of public expenditure in education financed with changes in the tax rate (changing τ): this policy affects public provisions for public and

for private schools, which are split among them in the same proportion as in the benchmark economy.

3. Changes in the orientation of private education (changing ω): this policy makes private education even more majority-oriented (lower ω) or more "multi-cultural" (higher ω).

1.6.1 Changing subsidies to private education

Changing the share of total tax revenue allocated to subsidize private education (changing ϕ) would impact school and neighborhood choices of natives and immigrants. This happens since a higher (lower) ϕ implies more (less) resources for private schools and less (more) for public institutions. The residential decisions are also likely to be affected because school and neighborhood choices are tied up. Table 1.7 and Figures 1.5 and 1.6 present results of experiments in which ϕ is increased to 0.3 and it is reduced to 0.05 from its benchmark value of 0.2.

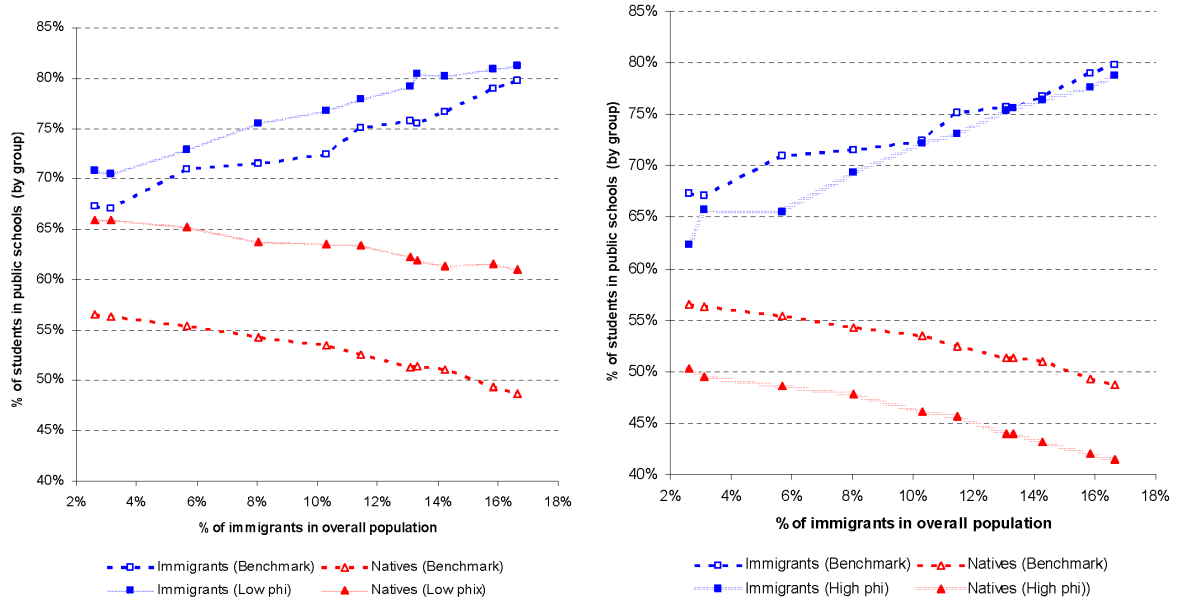
School Segregation. Reducing subsidies to private education implies that parents need to pay more for each unit of quality of education acquired in those schools, which makes public schools relatively more attractive for both immigrant and native parents. Those natives that in the benchmark were choosing private schools because of the advantage in terms of socialization to natives' traits, may now switch to public schools because with a low ϕ buying the desired traits through private schools is too expensive. On the other hand, immigrants that in the benchmark were choosing private schools were doing so only to buy high quality education, since socialization in these schools is not favorable to immigrant traits. Therefore, the reaction to a more expensive private education is likely to be less strong for immigrants than for natives. In this way, the gap in schooling choices, i.e. the difference in the proportion of immigrants and natives choosing public schools, is probably affected when changing ϕ. Numbers in Table 1.7 show that the gap in schooling choices was 10 percentage points in the benchmark with low immigration, raising to 18 and 31 points with moderate and high immigration. When we reduce subsidies to private education these gaps shrink to 4, 12 and 20 percentage points with low, moderate and high immigration, respectively. Therefore, reducing subsidies helps to reduce the widening of the gap that follows immigration. Results for increasing subsidies to private schools produces the opposite impact on such gaps, as shown in Figure 1.5(b).

Neighborhood Segregation. According to results reported in Table 1.7 and Figures 1.6(a) and 1.6(b), when individuals face different levels for the subsidy to private education they rearrange their location decisions. With low subsidies to private schools these institutions become less attractive to natives, who are thus more prone to attend public schools. Those immigrants that were choosing public schools in the good neighborhood find out that with low ϕ there are many more natives in public schools and they react to this less favorable -in terms of the production of their desired cultural traits- composition of classrooms opting to reside in the bad neighborhood and sending their children to public schools there. Figure 1.6(a) show that the effect of lower subsidies to private education is that immigrants are sorted out into the bad neighborhoods from the very beginning of the period, and continue in the same situation towards the end of the period analyzed. That is, neighborhood sorting is not increasing with immigration. The opposite holds true for the case of high subsidies to private schools, as shown in Figure 1.6(b).

Educational outcomes. The effects of changing the level of subsidies to private school on educational outcomes mix several counteracting forces, and the final effects are not easy to discuss a priori. Results on these educational outcomes reported in Table 1.7 indicate that if we reduce subsidies to private education we would also reduce the gap in the mean quality of education received by natives and immigrants. This gap would have dropped to 3% in 1998/99 -compared to the observed 9% in the benchmark economy- and to just 18% -instead of 24% in the benchmark- in the year with highest share of immigrants in overall population. This result is a combination of more natives attending public schools and the lower (higher) endowment of public resources to private (public) education. Contrarily, with high subsidies the native-immigrant gap is increased for the three levels of immigration.

The spatial distribution of quality of education is also affected with the changes in subsidies. With a low level for ϕ, the gap in the quality of education in the good compared to the bad neighborhood is higher in the case of low and intermediate immigration rates than in the corresponding results for the benchmark case. However, with low subsidies and high immigration this gap is reduced, i.e., quality of education is spatially more evenly distributed than in the benchmark. The opposite is valid for the case of high subsidies.

The gap in the quality of education across types of institutions is increased for the three levels of immigration. This is a result explained by the fact that even when public provisions to private schools are lower, those who decide to remain in private schools are those who are sufficiently rich to afford private schools. Since quality of education is a normal

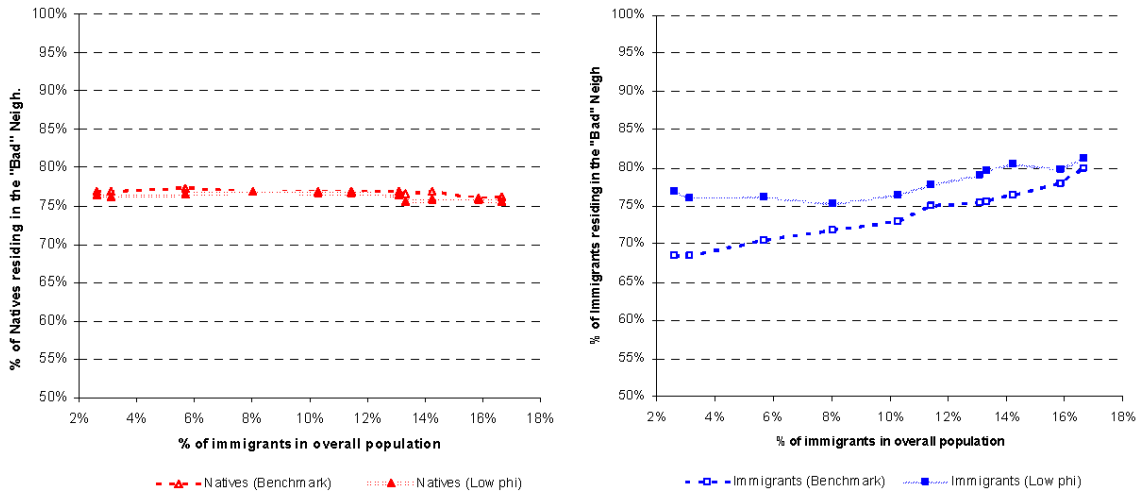


(a) Low ϕ (b) High ϕ

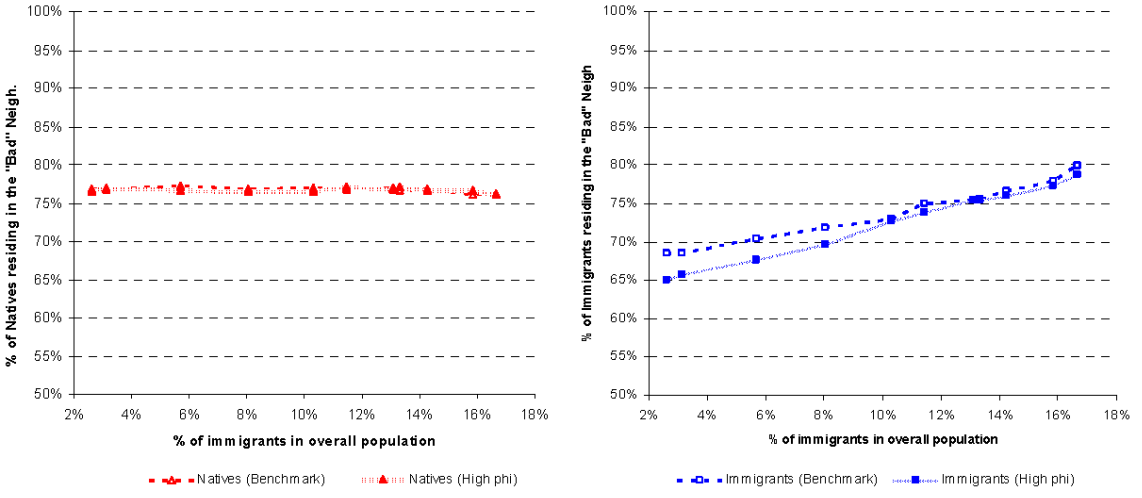
Figure 1.5: School sorting: benchmark economy and simulations with low and high ϕ (subsidy to private education), 1998/99-2008/09.

good, these individuals spend relatively more because they are richer, and this increase the numerator in the ratio of qualities of education.

Integration outcomes. Table 1.7 shows that the probability of cultural integration to the hosting society only shows sizeable changes in the case of high immigration. There, low subsidies implies a higher probability of integration, while higher subsidies reduce this probability. The important result here is that a large school segregation by traits implies a low probability of cultural integration of newcomers, and since reducing subsidies alleviates this segregation it also helps on integrating immigrants to the the local culture. On the other hand, the results about economic integration are fairly large. The key result is that economic integration of immigrants is decreasing with the level of subsidies to private schools.



(a) Low ϕ



(b) High ϕ

Figure 1.6: Neighborhood sorting: benchmark economy and simulations with low and high ϕ (subsidy to private education), 1998/99-2008/09.

Table 1.7: Changing subsidies to private education.

Statistics		1998/99 (low immigration)			2001/02 (moderate immigration)			2008/09 (high immigration)		
		Benchmark	Low subsidy	High subsidy	Benchmark	Low subsidy	High subsidy	Benchmark	Low subsidy	High subsidy
		ϕ=0.20	ϕ=0.05	ϕ=0.30	ϕ=0.20	ϕ=0.05	ϕ=0.30	ϕ=0.20	ϕ=0.05	ϕ=0.30
School Sorting	Share of natives choosing pub. Schools	0.57	0.66	0.50	0.54	0.64	0.48	0.49	0.61	0.41
	Share of immigrants choosing pub. Schools	0.67	0.71	0.62	0.72	0.76	0.69	0.80	0.81	0.79
Neighborhood Sorting	Share of natives in the "bad" neigh.	0.77	0.76	0.76	0.77	0.77	0.77	0.76	0.76	0.76
	Share of natives in the "bad" neigh.	0.69	0.77	0.65	0.72	0.75	0.70	0.80	0.81	0.79
Educational outcomes	Educ. quality for natives relative to immigrants	1.09	1.03	1.11	1.13	1.10	1.15	1.24	1.18	1.27
	Educ. quality in the "good" neigh. relative to the "bad"	2.28	2.48	2.15	2.20	2.40	2.11	2.10	2.04	2.07
	Educ. quality in private relative to public schools	2.54	2.68	2.53	2.50	2.62	2.44	2.33	2.53	2.27
	Share of immigrants in public schools	0.02	0.03	0.02	0.10	0.09	0.10	0.24	0.20	0.27
Integration outcomes	Cultural Integration: Prob. of cultural integration	0.134	0.134	0.134	0.126	0.127	0.127	0.109	0.112	0.107
	Income loss (%) if not integrated	2.5%	1.0%	3.0%	3.6%	2.5%	4.1%	6.1%	3.2%	6.5%

1.6.2 Changing taxes

Changes in the income tax rate lead changes in the amount of total resources allocated to finance both types of education.The simulations below are obtained for the cases of: (i) reducing in 25% the income tax rate (the new income tax rate is as low as 1.35%); (ii) increasing in 25% the income tax rate (the new income tax rate is 2.25%).

School Segregation. With lower public provisions schools affected the most are the public institutions, because their only source financing comes from the tax revenue. Therefore, with a low tax rate both natives and immigrants are expected to flight out from public education. However, when immigration is large enough, immigrants may start opting in public schools again as a way to assure the transmission of their traits to children. Figure 1.7(a) shows that reducing the tax rate actually makes public education a relatively less attractive option for both native and immigrant parents. However, for immigrants, large immigration makes public schools more desirable since they are better prepared to help parents in transmitting their cultural traits than private schools. Therefore, when the share of immigrants in the overall population is very low -only 2.6% of total households- immigrants and natives behave almost alike in their elections of public schools and the gap on these decisions is close to zero. Table 1.8 shows that around half of both groups chooses public schools in 1998/99. However, the gap on these choices raises to about 40 percentage points at the end of the period. Increasing the tax rate leads to a pattern of choices that is the shifted-up version of the one obtained for the benchmark case, as shown in Figure 1.7(b). In this case, the gaps along the whole period under analysis are always similar in magnitude to those obtained in the simulations of the benchmark economy.

Neighborhood Segregation. When the income tax rate is low, immigrants prefer to concentrate less in the bad neighborhood, since the main reason for doing so is to take advantage of the desired oblique socialization at public schools there. However, those schools are less attractive when the public financing is poor because choosing public schools implies a large sacrifice in terms of quality of education just to get the desired low exposition to majority cultural traits (Figure 1.8(a)). In the case of a high income tax rate, the amount of public resources grow more for public than for private schools.[45] Therefore, taking advantage of public education is an attractive option for immigrant parents, who therefore decide to concentrate more densely in the bad neighborhood (Figure 1.8(b)). In

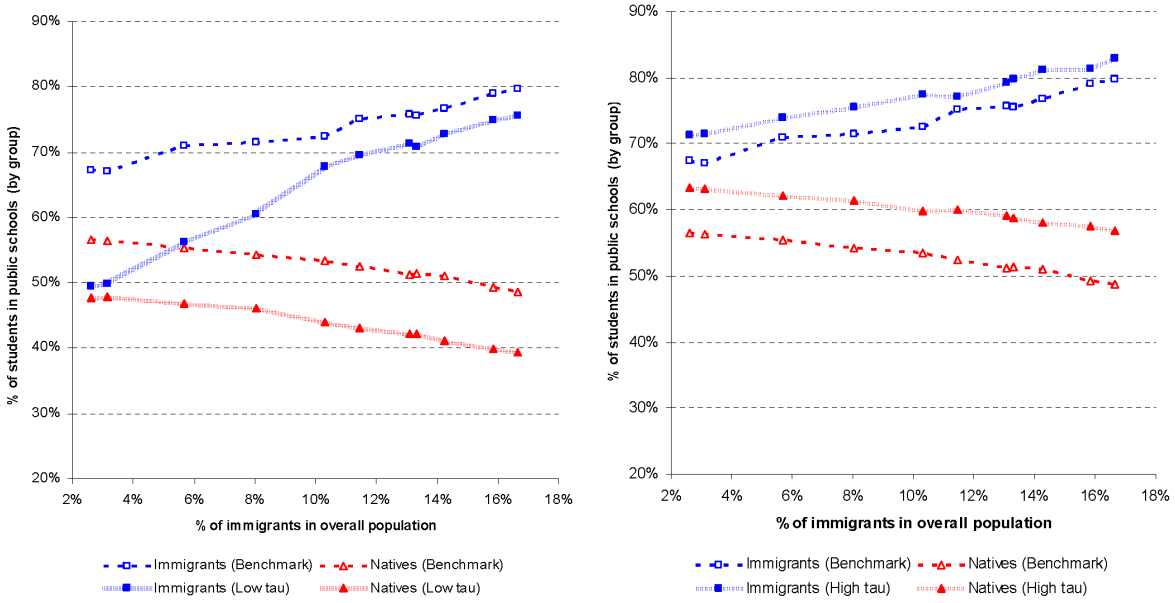
[45]Since the share of tax revenue allocated to finance private schools is just 0.20.

both scenarios, with low and high income tax rates, segregation of immigrants in the bad neighborhoods is increasing with the share of immigrants in overall population.

Educational outcomes. For a low income tax rate, the native-immigrant educational gap is not a monotonic function of the share of immigrants in overall population. First, Table 1.8 shows that in the academic year 1998/99 natives receive a quality of education that is 9% higher than the one received by immigrants in the benchmark case, and for a lower tax rate this gap would be reduced to a 1.4%. However, as immigration increases, the gaps are higher in the case of lower tax rate than in the benchmark economy. This is what is shown in Table 1.8 for the simulations in the years 2001/02 and 2008/09. While the gaps in the benchmark were 13.4% and 24%, with a low tax rate they are equal to 16% and 29%, respectively. When looking at the results with a high tax rate we find that the gap is always lower than in the benchmark, for the three years ranging from low to high shares of immigrants in overall population.

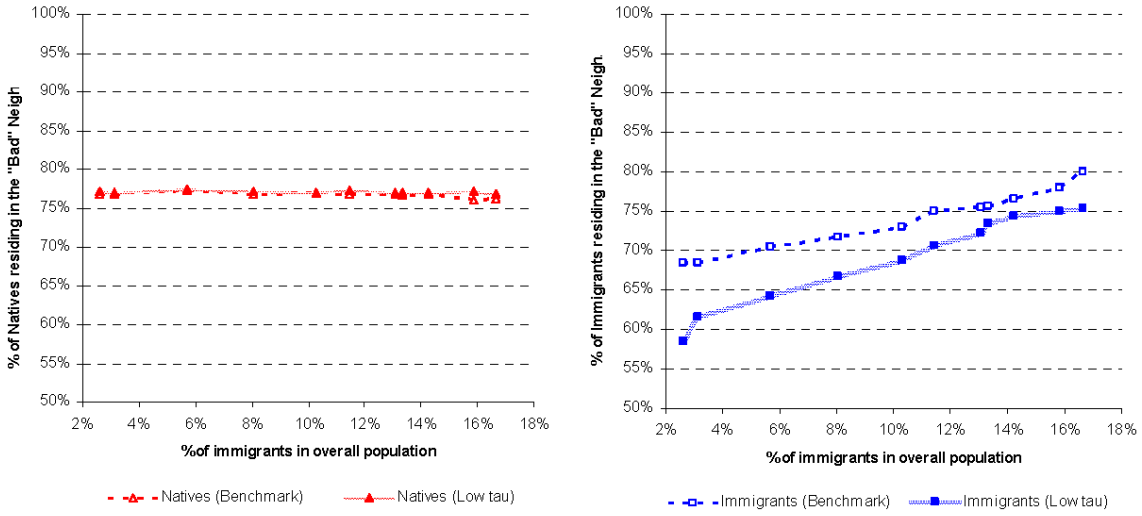
Table 1.8 reports that with a low τ there are not sizeable changes in the ratio of the average quality of education in good to bad neighborhoods. However, as expected, the quality of education imparted at private schools is relatively higher than in the benchmark for all levels of immigration. Also, the opposite holds true for the the experiment with a higher income tax rate.

Integration outcomes. Probabilities of cultural integration are not affected much in comparison to the benchmark. However, with a low income tax rate the economic penalization for not being integrated show a differentiated pattern for the years with low, medium and high immigration shares. First, in the year 1998/99, this income loss is lower than in the benchmark economy, but for the years 2001/02 and 2008/09 the associated income losses are higher that in the benchmark. On the other hand, a higher income tax rate is associated with lower income losses for all the three simulation scenarios reported in Table 1.8.

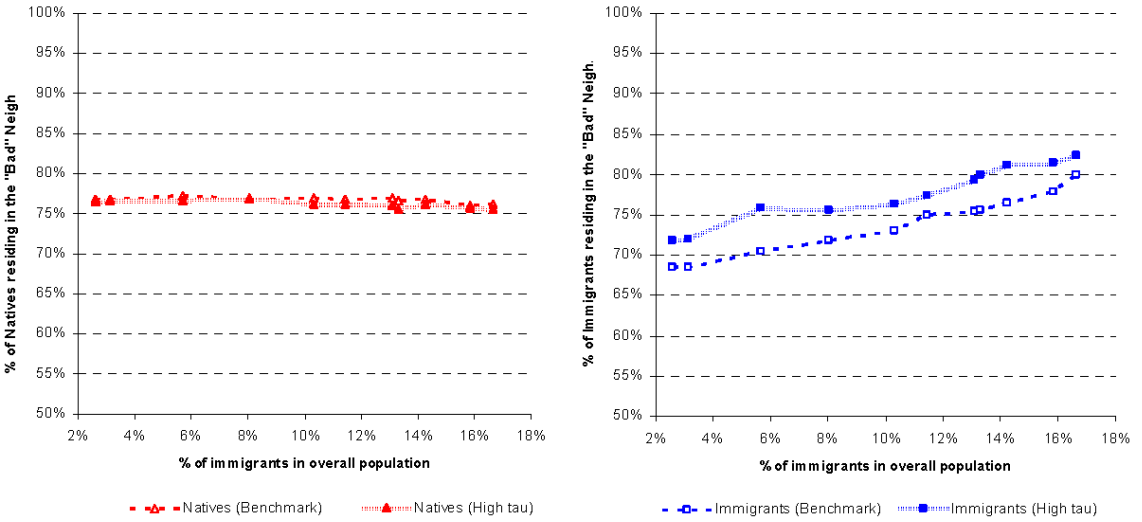


(a) Low τ (b) High τ

Figure 1.7: School sorting, comparing the benchmark economy and the cases with low and high τ (income tax rate), 1998/99-2008/09.



(a) Low τ



(b) High τ

Figure 1.8: Neighborhood sorting, comparing the benchmark economy and the cases with low and high τ (income tax rate), 1998/99-2008/09.

Table 1.8: Changing the income tax rate.

Statistics		1998/99 (low immigration)			2001/02 (moderate immigration)			2008/09 (high immigration)		
		Benchmark	Low tax rate	High tax rate	Benchmark	Low tax rate	High tax rate	Benchmark	Low tax rate	High tax rate
		τ=1.8%	τ=1.35%	τ=2.25%	τ=1.8%	τ=1.35%	τ=2.25%	τ=1.8%	τ=1.35%	τ=2.25%
School Sorting	Share of natives choosing pub. Schools	0.565	0.477	0.633	0.542	0.462	0.614	0.487	0.394	0.569
	Share of immigrants choosing pub. Schools	0.673	0.495	0.714	0.715	0.605	0.755	0.797	0.756	0.830
Neighborhood Sorting	Share of natives in the "bad" neigh.	0.768	0.771	0.765	0.769	0.771	0.770	0.762	0.768	0.757
	Share of natives in the "bad" neigh.	0.685	0.585	0.719	0.718	0.667	0.756	0.800	0.753	0.823
Educational outcomes	Educ. quality for natives relative to immigrants	1.085	1.014	1.061	1.134	1.160	1.100	1.240	1.287	1.188
	Educ. quality in the "good" neigh. relative to the "bad" neigh.	2.285	2.205	2.231	2.201	2.181	2.185	2.105	2.134	1.958
	Educ. quality in private relative to public schools	2.545	2.795	2.392	2.503	2.694	2.316	2.334	2.531	2.262
	Share of immigrants in public schools	0.025	0.012	0.028	0.100	0.082	0.089	0.241	0.270	0.214
Integration outcomes	Cultural Integration: Prob. of cultural integration	0.134	0.135	0.133	0.126	0.129	0.127	0.109	0.108	0.111
	Income loss (%) if not integrated	2.5%	0.5%	1.4%	3.6%	5.2%	2.3%	6.1%	7.5%	4.4%

1.6.3 More or less multi-cultural private education

In this section I present a policy experiment that changes the value of the parameter ω, which is part of the technology for the production of socialization to native traits. With a lower ω children in private schools are more likely to acquire majority traits. In contrast, a higher value of ω is related to a less majority-oriented private education, which can also be thought as a more multi-cultural approach to socialization through private education.[46] A higher ω may involve changes in the teaching-style or in the curricula such that certain types of contents relating to cultural heterogeneity, and to the historical, social and economic contexts of the newcomers are introduced in private schools. In the simulations below I change the value of this parameter, which takes the value $\omega = 0.21$ in the benchmark economy, to evaluate the cases of a more majority-oriented private education with $\omega = 0.05$, and the case of a less majority-oriented -more multi-cultural- private education, with $\omega = 0.40$.

School Segregation. Making the private education system less multi-cultural (lower ω) makes public schools more attractive for immigrants, specially when the share of immigrants in overall population is high. This is due to a sort of increasing returns of socialization to minority traits in public relative to private schools as the share of immigrants in overall population increases. When immigration is low, immigrants are not able to find a type of school that significantly helps them to transmit their traits to their children, since the exposition to immigrant students cannot be high enough due to the few immigrants in the population. In this case, immigrants do not choose public schools that much, since doing so would imply to obtain a lower quality of education compared to that one that can be bought in private institutions. When immigration is high enough, the possibility of a immigrant child is exposed to a greater share of immigrant students in public schools makes these type of schools more attractive. Simulations This pattern of decisions is shown in Figure 1.9(a) and also in Table 1.9. The fact that with lower ω immigrants are choosing less public schools than in the benchmark case is connected to their residential choices. Some immigrants may relocate, changing residence to the neighborhood in which is more likely to find schools with the largest possible presence of immigrants.[47] Figure 1.9(a) also shows that as immigrants increase their share in overall population, the option of public schools is a more attractive one for immigrants. For

[46] This higher value for ω can be also interpreted as a relatively more attractive -in terms of socialization productivity- *public* education for *natives*.

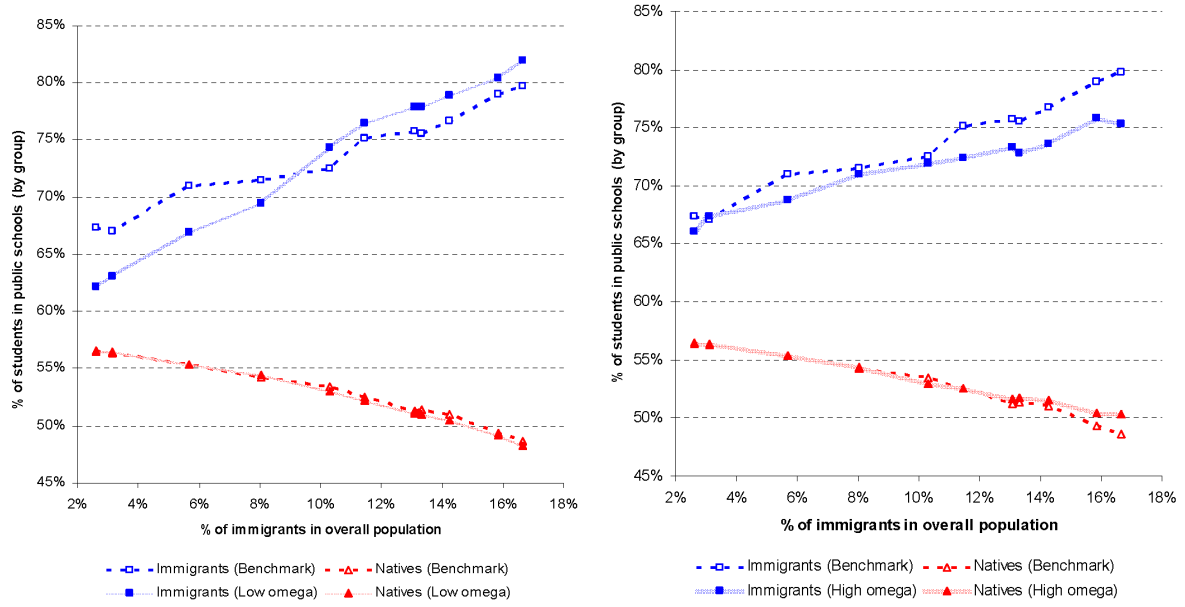
[47] This neighborhood is the bad one, as it will be discussed in the paragraph on neighborhood segregation.

the case of natives, the reaction to having a more majority-oriented private education is almost null in the simulation when compared to the benchmark economy.

The results of the simulations results for the case of a more multi-cultural private education (higher ω) are the opposite, as shown in Figure 1.9(b). There, it can be observed that the school sorting, represented by increasing gaps in natives' and immigrants' decisions as the share of immigrants in overall population increases, is less pronounced. That is, the sorting out of immigrants and natives across types of schools is present from the beginning of the period analyzed and increases with immigration although at a slower pace than in the benchmark case. This result follows from the fact that when private schools are not as good device to assure the transmission of natives' traits as it was in the benchmark, native parents may choose, for instance, to rearrange their residential decisions in order to invest in the socialization probability of their children to majority traits. Notice that figure 1.9(b) resembles what is observed in Figure 1.2(c) for Com. Valenciana, or to a more extreme case -for an even higher value of ω- this experiment would produce the patterns observed for Catalonia, in Figure 1.2(b). Therefore, this type of policy takes the case of Madrid closer to the relative orientation of private-public in these other two regions, as discussed in Section 1.2.

Neighborhood Segregation. In the case of a low value for ω, the presence of a very majority-oriented private education makes that a higher number of immigrants, comparing to the benchmark economy, opt for residing in the low-quality in the beginning of the period. These families concentrate more in the bad neighborhood and choose to reside there because they can take advantage of the more favorable student composition in public schools. This is what Figure 1.10(a) reports for the case of immigrants. In the simulations with a high value of ω, those who are more prone to rearrange residential decisions -comparing with the benchmark case- are the natives. Figure 1.10(b) shows that at the beginning of the period natives tend to reside in the good neighborhood, and the reason for doing this is to take advantage of the classrooms' composition in both public and private schools in this more expensive neighborhood, where relatively less immigrants are residing at the time. However, as the share of immigrants in the population increases the relative gains of switching residence decreases, returning some natives towards the cheaper neighborhood.

Educational outcomes. According to results in Table 1.9, the native-immigrant educational gap is lower with a more majority-oriented private education only when the



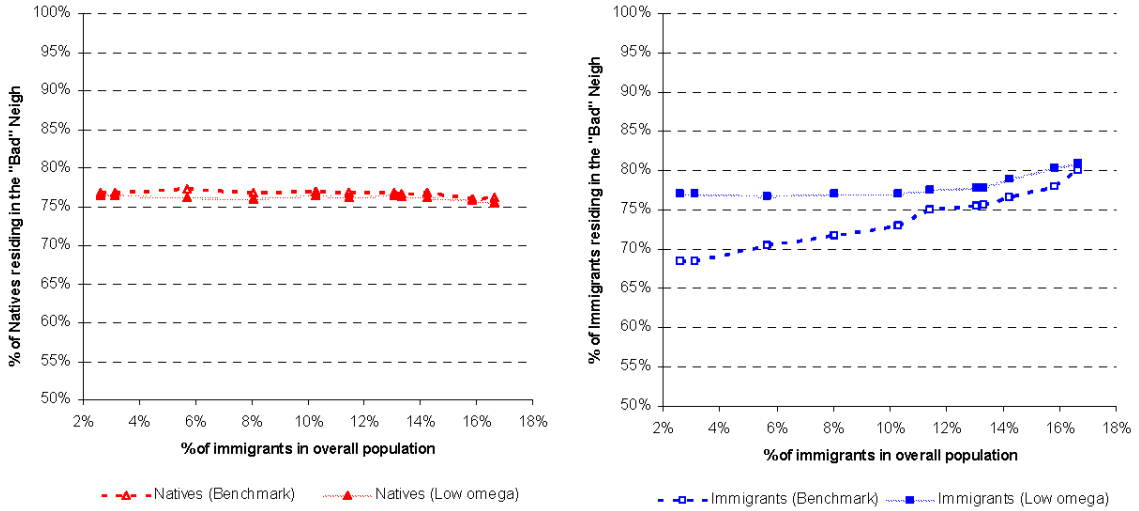
(a) Low ω (more majority-oriented private education)

(b) High ω (less majority-oriented private education)

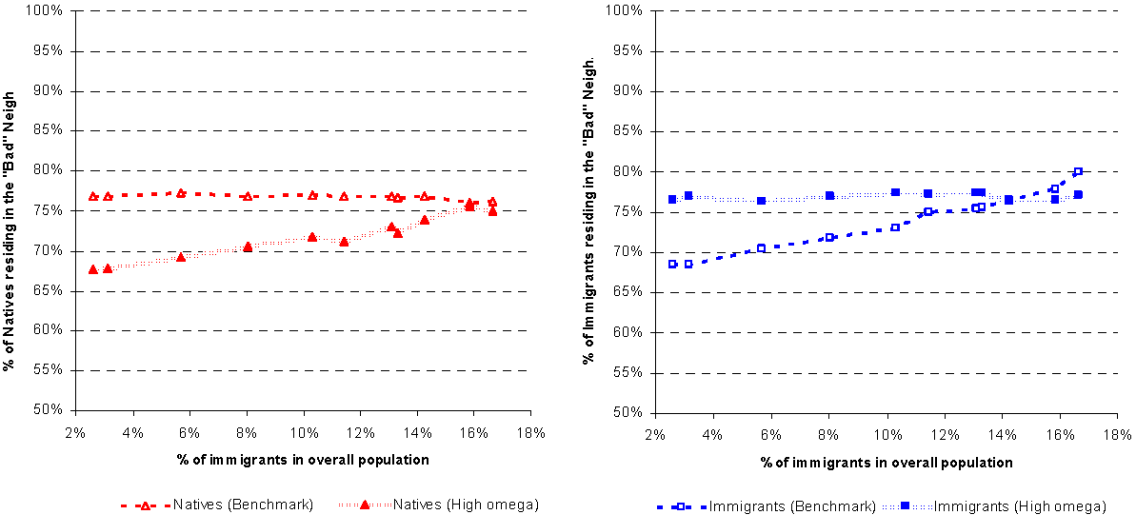
Figure 1.9: School sorting, comparing the benchmark economy and the cases with low and high ω (type of education), 1998/99-2008/09.

share of immigrants in the society is low. With high immigration this gap is higher than in the benchmark. This is driven by the degree of separation across public and private schools explained above. On the other hand, having a more multi-cultural private education helps to reduce the native-immigrant educational gap as immigration increases. The rest of educational outcomes reported on Table 1.9 do not show sizeable effects relative to those shown for the benchmark economy.

Integration outcomes. In the case of high immigration, both indicators of integration improve with a more multi-cultural private education. In this case, the probability of cultural integration increases by a small proportion -from 10.9% to 11.3%- and the income loss if not integrated falls from 6.1% to 4.4% out of the average earnings.



(a) Low ω (more majority-oriented private education)



(b) High ω (less majority-oriented private education)

Figure 1.10: Neighborhood sorting, comparing the benchmark economy and the cases with low and high ω (type of education), 1998/99-2008/09.

Table 1.9: Changing the orientation of private education.

Statistics		1998/99 (low immigration)			2001/02 (moderate immigration)			2008/09 (high immigration)		
		Benchmark	More majority-oriented priv. educ.	Less majority-oriented priv. educ.	Benchmark	More majority-oriented priv. educ.	Less majority-oriented priv. educ.	Benchmark	More majority-oriented priv. educ.	Less majority-oriented priv. educ.
		ω=0.21	ω=0.05	ω=0.40	ω=0.21	ω=0.05	ω=0.40	ω=0.21	ω=0.05	ω=0.40
School Sorting	Share of natives choosing pub. Schools	0.565	0.565	0.564	0.542	0.545	0.544	0.487	0.482	0.504
	Share of immigrants choosing pub. Schools	0.673	0.621	0.661	0.715	0.695	0.710	0.797	0.820	0.753
Neighborhood Sorting	Share of natives in the "bad" neigh.	0.768	0.765	0.677	0.769	0.760	0.705	0.762	0.756	0.750
	Share of natives in the "bad" neigh.	0.685	0.770	0.764	0.718	0.771	0.769	0.800	0.809	0.772
Educational outcomes	Educ. quality for natives relative to immigrants	1.085	1.027	1.085	1.134	1.099	1.120	1.240	1.253	1.181
	Educ. quality in the "good" neighborhood relative to the "bad" neigh.	2.285	2.254	2.256	2.201	2.205	2.221	2.105	2.147	2.002
	Educ. quality in private relative to public schools	2.545	2.575	2.553	2.503	2.510	2.489	2.334	2.354	2.399
	Share of immigrants in public schools	0.025	0.025	0.029	0.100	0.092	0.097	0.241	0.242	0.214
Integration outcomes	Cultural Integration: Prob. of cultural integration	0.134	0.134	0.133	0.126	0.127	0.127	0.109	0.109	0.113
	Income loss (%) if not integrated	2.5%	1.2%	2.3%	3.6%	2.9%	3.7%	6.1%	6.0%	4.4%

1.7 Conclusions

Schools are important institutions for cultural transmission. The importance of these institutions becomes much more clear when the composition of cultural traits in a society is changed as a result of large-scale immigration. Parents, who desire that their children share their cultural traits, may react to the new composition of traits in the population by changing the type of education for their children. Furthermore, when schooling and residential decisions are tied-up because of institutional enrollment restrictions, not only a native-immigrant sorting of students by type of schools may arise but also certain level of neighborhood segregation is likely to be present. In this sense, the existence of cultural concerns related to schooling choices affects both school and neighborhood segregation.

In this paper, the model economy constructed and simulated for the case of Madrid, which includes cultural concerns as a key sorting force, is able to account for the observed segregation across schools and neighborhoods. The model is also well-suited to produce a number of policy experiments. All the simulated policies have been in the political agenda of local authorities, media, and various commentators during last decade. This work contributes to the evaluation of these types of interventions, which is a difficult task to accomplish due to the existence of many non trivial interacting forces, e.g., the general equilibrium effects generated through the housing market. First, I experiment with the level of subsidies to private education and I find that reducing these subsidies mitigates the rise in segregation across schools and neighborhoods as the share of immigrants in overall population increases. On the other hand, increasing subsidies to private education would make both the school sorting and the neighborhood sorting worsen as immigration increases. Second, I simulate changes in the total amount of public spending in both types of educational institutions. I obtain that neither reducing nor increasing this funding would have helped to reduce the observed gaps in schooling choices of immigrants and natives. In addition, this type of policy is also ineffective in ameliorating the rise in neighborhood segregation. Third, I conduct a policy experiment in which I simulate changes of cultural orientation of private education. For a less multi-cultural private education I find that the sorting of students by cultural traits is aggravated the larger is the scale of immigration. Contrarily, a more multi-cultural approach in private education makes segregation across schools less pronounced, without worsening off the spatial concentration of immigrants and natives. This type of policy also improves the integration of immigrants to the hosting society.

Further research could focus on the effects that the labor market penalization for immigrants that are not successfully integrated might have on parents' incentives to socialize their children into traits that differ from those shared by the majority. In this line, an interesting issue is how these incentives affect the formation of networks as informal institutions to overcome the penalization in the labor market. Neighborhood segregation is likely to be affected, and the study of ghetto formation can be enriched by adding these considerations to the analysis. Along similar lines, an interesting avenue for future research is the assessment of the interactions of welfare state provisions -such as unemployment benefits- with the incentives of immigrants to integrate their children into the new society. Adding this dimension would improve our understanding of how public policy can foster integration of the newcomers. All these issues are at the core of the political agenda about the creation of social cohesion and the reduction of conflict.

Chapter 2

Spillovers of Health Education at School on Parents' Physical Activity

2.1 Introduction

Non-communicable diseases such as obesity, cancer, cardiovascular conditions, and diabetes have reached epidemic-like proportions in recent decades. Physical inactivity and sedentary habits are among the most important risk factors for these diseases (WHO, 2003). As a result, prevention increasingly involves changes in lifestyles, such as introducing the practice of regular physical activity in order to reduce risk factors (Kenkel, 2000). This type of preventive measures also implies savings in health care costs, which for the US are estimated to be at least US$ 500 per year lower for physically active versus inactive individuals (WHO, 2003).

Interactions within the family may crucially affect the "production" of healthy lifestyles. As Kenkel (2000) points out, the family is often identified as the unit of production of preventive practices. Previous literature on intra-household health decisions has focused on the interactions between spouses (e.g. Clark and Etile, 2006). As well, the literature on intergenerational transmission of characteristics such as health, education or income, has focused on the effects that parents' decisions can have on children's behaviors and outcomes. However, little research has been done to evaluate the impact of children on parents' decisions, in particular on choices regarding healthy lifestyles.[1]

[1]One exception is Kuziemko (2011), who analyzes the effect of children on parents' investments in education.

Schools can play a fundamental role in providing children with information about healthy lifestyles and health decisions, which may complement what they learn at home. At school, the knowledge about health is transferred to children through the implementation of specific curricular modules, often known as Health Education (HED).[2,3] There is evidence indicating that HED consisting of physical education, nutrition or sexual education could be effective in directly improving the health profiles of children (Cawley, Meyerhoefer, and Newhouse, 2007, Cawley, Frisvold, and Meyerhoefer, 2012, Dupas, 2011, McGeary, 2009). However, it may be the case that parents are as well affected by the education about preventive health care that their children acquire at school.

The first goal of this paper is to assess the existence of spillover effects of Health Education received by children at elementary school on their parents.[4] We exploit the quasi-experiment provided by the changes in the state-level HED requirements in elementary schools implemented between the school years 1999/2000 and 2005/2006 in the US to quantify the effects of these programs on parents' physical activity. Thus, the focus is on a policy that does not imply any transfer of resources to children -the targeted individuals- but instead provides them with new information. A second goal of this paper is to analyze the heterogeneous impacts of this policy as a way to start unveiling the plausible channels through which children receiving HED at schools may affect the probability that their parents engage in physical activity.

To identify the spillover effects of HED policies, we use three methodologies: Triple differences (DDD), Changes-in-Changes (CiC), and Difference-in-Differences (DD). We prefer the DDD estimator over DD and CiC, because we consider that the identifying assumptions behind the DDD estimator are more likely to be fulfilled in our analysis, than those for the DD and the CiC estimators. In the DDD identification strategy we exploit not only the time series and cross-state variation, but also within-state variation. The variation within states makes possible controlling for state-specific time trends that can be correlated with the change in HED policies. We are able to exploit the third difference because within each state there are individuals who were exposed to the treatment and

[2]According to the Centers for Disease Control and Prevention (CDC) "*Health Education is a planned, sequential, and developmentally appropriate instruction about health designed to protect, promote, and enhance health literacy, attitudes, skills, and well-being*" (Kann, Telljohann, and Wooley, 2007).

[3]As stated by WHO (1999), there are several reasons for promoting healthy behaviors through schools. Schools are an efficient way to reach school-age children and their families in an organized way and students spend a great portion of their time in schools, where education and health programs can reach them at influential stages in their lives.

[4]HED in middle and high school levels is not mandatory.

others who were not.[5] The data we use is from the Panel Study of Income Dynamics (PSID) for the period 1999-2005, merged with data on state HED reforms from the State School Healthy Policy Database of the National Association of State Boards of Education (NASBE), and the 2000 and 2006 surveys of the School Health Policies and Programs Study (SHPPS).

Our results show evidence of a positive effect of HED received by children in elementary schools on their fathers' probability of engaging in physical activity. Introducing major reforms in HED in elementary schools makes a father exposed to this policy between 6.3 and 13.7 percentage points more likely to be physically active than a comparable father not affected by the policy. We do not find concluding evidence that the policy under analysis affects the decision of mothers to engage in physical activity.

We explore other heterogeneous impacts of HED reforms along dimensions such as the education and income levels of parents, their type of employment (blue or white collar, etc.) and labor supply (labor force participation, and part versus full time work), and the gender of the children affected by the policy. The impacts are found to be larger among parents with lower levels of education, and we do not find conclusive evidence on other regards analyzed.

We discuss a number of channels that may help to generate the indirect effects of HED programs on parents. The evidence about heterogeneous impacts is consistent with several mechanisms. For instance, a sort of "role modeling" in parenting may be at work, given the differential impact found for fathers and mothers. Parents usually spend more time with their children doing gendered activities, such as physical activity in the case of fathers. Therefore, the promotion of healthy behaviors at school is likely to have an effect on the behavior of fathers rather than that of mothers. A role model component in parenting seems to be more natural in the cases of parents that share their gender with their children (father-son, mother-daughter), but, as noted before, we do not find evidence on this respect. On the other hand, heterogeneous impacts according to the level of education of parents can be thought to be a consequence of an "information sharing" channel. Less educated parents are those who can gain the most by the arrival to the household of the new information about healthy habits. However, the larger impact on parents with lower education can be consistent with other mechanisms as well. For instance, given that the opportunity cost of time is lower for less educated individuals,

[5] We show in Section 2.3.4 that there are remarkable differences in the pre-treatment trends in the outcomes of experimental versus non-experimental states, indicating that the implementation of HED policies is correlated with the behavior of the outcome of interest, which makes the use of a DDD estimator crucial here, while invalidates the DD estimator.

they are precisely those more willing to substitute away hours of work by more time spent in physical activity. Nonetheless, we do not find evidence of this type of substitution effect, neither in the extensive nor in the intensive margin of labor supply (hours worked or labor force participation).

Also, we perform a number of robustness checks that include the use of different identification strategies (CiC and DD), and alternative definitions of the control group. In all cases, we show that results are robust.

This work is related to two strands of literature. First, to the literature on policy evaluation trying to measure the spillover effects of policy interventions on non-targeted individuals, also known as Indirect Treatment Effects (ITE). There is a small number of works in the economic literature assessing the existence of spillovers on non-targeted individuals within the household that present reliable results by using neat identification methodologies. One example is Bhattacharya, Currie, and Haider (2006), who analyze the effects of the School Breakfast Program (SBP) in the US on not only targeted children but also on adult (non-targeted) family members. They find that the SBP improves the quality of diets even for family members who were not directly exposed to the program. The explanation for family spillover effects in this work is that the particular program reduces family budgetary constraints, freeing resources that may be redirected towards other household members. In contrast, we explore family spillovers occurring for non-budgetary reasons.[6,7]

The second strand of literature related to our work consists of recent research evaluating the direct impact of particular aspects of health education at the school level on students' health outcomes and behaviors. Cawley, Meyerhoefer, and Newhouse (2007) find positive effects of physical education requirements on the amount of time high school students engage in physical exercise, although they do not find any impact on Body Mass Index (BMI) or the probability of students being overweight. Cawley, Frisvold, and Meyerhoefer (2012) find that physical education in elementary school lowers BMI z-score and reduces the probability of obesity among 5th graders (in particular, boys). Also, McGeary (2009) assesses the effects of state-level nutrition education program funding on the BMI, the probability of obesity, and the probability of above normal weight. Her results suggest

[6] Harre and Coveney (2000) and Nandha and Krishnamoorthy (2007) analyze two interventions explicitly designed to induce school-age children to affect their families and other community members' health behaviors. Regrettably, neither of these case studies is able to state causality since the interventions were not randomly assigned and affected few individuals.

[7] There are also some works in this literature evaluating external effects at the community level instead of the family level. Some examples are Angelucci and Giorgi (2009), Lalive and Cattaneo (2006), and Miguel and Kremer (2004).

that this funding is associated with reductions in BMI and in the probability of an individual having an above-normal BMI. Moreover, Dupas (2011) finds that sexual education reduced the incidence of teen pregnancy in a randomized controlled trial in Kenya.[8] Even though there is evidence indicating that HED does have direct effects on children, this is not necessarily required to generate indirect effects, given that some of the mechanisms explored in this paper (see Section 2.4.2) can be present in absence of such direct effects on children.

The existence of spillovers of HED on parents' lifestyles indicates that the interaction between children and parents plays a role in the formation of healthy lifestyles within the household, which must be taken into account to properly design policy interventions aimed at increasing the adoption of healthy lifestyles in a given community. Although we are not able to rule out the existence of many mechanisms driving the spillovers, we do provide suggestive evidence about the presence of a number of them and leave the question open for future research that can be conducted in experimental or quasi-experimental setups.

2.2 Health Education Policies in the US

In the 1970s and 80s, research studies showed that healthy kids did better in school and scored higher on achievement tests. As a consequence, some states started to develop and implement HED programs in public schools. In the 1990s, many educators called for the creation of a set of national health education standards that states could use as a template. In 1995, the National Committee for Health Education Standards created national health education standards with K-12 benchmarks covering several content areas of health. In 1998, the Congress urged the Centers for Disease Control and Prevention (CDC) to "expand its support of coordinated health education programs in schools" (Wyatt and Novak, 2000).

As Kahn, Ramsey, Brownson, Heath, Howze, Powell, Stone, Rajab, and Corso (2002) explain, "*HED classes that provide information and skills related to decision making are usually multicomponent, with the curriculum typically addressing physical activity, nutrition, smoking, and cardiovascular disease. HED classes are designed to affect behavior*

[8] Also, Kahn, Ramsey, Brownson, Heath, Howze, Powell, Stone, Rajab, and Corso (2002), Salmon, Booth, Phongsavan, Murphy, and Timperio (2007) and van Sluijs, McMinn, and Griffin (2007) summarize the results of several interventions aimed at evaluating the effectiveness of HED programs in changing children's physical activity, and they all conclude that the interventions reviewed provide inconclusive evidence because of various limitations regarding the validity of the randomization procedures, the short duration of follow-ups, the lack of precision of the physical activity outcome measures, etc.

change through personal and behavioral factors that provide students with the skills they need for rational decision making".

State HED programs are typically characterized by two dimensions. The first is the health education curricula indicating the health related topics schools are *required* to teach. Panel A of Table 2.1 lists the topics included as potential HED requirements. We focus in these five topics because all of them may affect the knowledge about the benefits of being physically active. The second dimension is specific regulations to guarantee and strengthen the effective and coordinated implementation of health education in schools. We broadly refer to these regulations as *enforcements*. Panel B of Table 2.1 describes the three specific state requirements enforcing HED we focus on.[9]

Table 2.1: HED Programs

A) Curricula: Topics covered
1) Alcohol- or Other Drug-Use Prevention
2) Emotional and Mental Health
3) Nutrition and Dietary Behavior
4) Physical Activity and Fitness
5) Tobacco-Use Prevention

B) Enforcements
1) State requires districts or schools to follow national or state health education standards or guidelines
2) State requires students in elementary school to be tested on health topics
3) State requires each school to have a HED coordinator

In the period 1994 and 1999 school health policies at the state level generally remained unchanged, but important changes were detected between 1999 and 2005 (Kann, Brener, and Allensworth (2001) and Kann, Telljohann, and Wooley (2007)). During this period, states either implemented HED programs for the first time or expanded one or both dimensions of pre-existing programs.

[9] The full list of potential topics and enforcements that can be required are shown in Table B.6 in Appendix B.

2.2.1 Databases for HED programs: NASBE and SHPPS

The information we use to define which states have HED programs and the degree of development of such programs -i.e., which topics were required and which enforcements were mandatory at different points in time- comes from two complementary sources: the NASBE State School Health Policy Database and the School Health Policies and Programs Study (SHPPS).

The NASBE Database is a comprehensive set of laws and policies related to health issues at schools of all states in the US. It began in 1998 and is maintained with support from the Division of Adolescent and School Health (DASH) of the CDC. The database contains brief descriptions of laws, legal codes, rules, regulations, administrative orders, mandates, standards, resolutions, and other written means of exercising authority. While authoritative binding policies are the primary focus of the database, it also includes guidance documents and other non-binding materials that provide a detailed picture of a state's school health policies and activities.

The NASBE Database was designed to build upon the SHPPS, conducted by the CDC every 6 years since 1994. SHPPS is a nationwide survey that gathers detailed and comparable information about the characteristics of HED programs at the state level across elementary, middle, and high schools. While SHPPS collects state policy information by means of survey questionnaires that are completed by state education agency personnel, the NASBE Database provides the legal support for the policies reported in SHPPS.

The information of the year in which the reforms were implemented is incomplete in the NASBE Database and non-existent in the SHPPS. However, using the information provided by both sources we can recover the characteristics of the existing HED program in each state in 1999 and 2005. With this information we classified each state as either an *"Experimental State"*, if the state changed the HED program between 1999 and 2005, or as a *"Non-Experimental State"*, if no changes were introduced in the state HED program during the period. Tables B.7 and B.8 in Appendix B give a detailed description of HED programs in all states in 1999 and 2005.

In the NASBE Database and in the SHPPS surveys we found that HED policies across states are highly heterogeneous, not only in terms of whether the state has implemented a HED program, but also regarding the scope and effectiveness in the implementation of such programs. Accordingly, we divided the non-experimental and experimental states into several groups. The non-experimental states are those states that did not change

their HED policies between 1999 and 2005. We classified the non-experimental states into two groups: (1) States without HED programs in 1999 and 2005; (2) States with HED programs implemented by 1999, and without changes in 2005. We name these groups $S1$ and $S2$, respectively.

The experimental states are those that introduced some HED reforms between 1999 and 2005. There are three types of treatments that define three types of experimental states. Group $S3$ are states that, while having some topics in their HED curricula in 1999, did not introduce changes in those topics by 2005, but introduced some reforms in enforcements. Group $S4$ are states that, while having some topics required in 1999, increased the number of topics required by 2005, without introducing changes in enforcements. These two policies involve only minor changes in the already implemented HED programs, so in what follows we refer to these groups of states as "Moderate changes A" and "Moderate changes B", respectively. Finally, we include in the group $S5$ those states that for the first time introduced required topics at state level in their HED programs by 2005. We refer to group $S5$ as "Major changes" group. In S5 there are states like Arkansas and Florida which introduced topics for the first time by 2005, New Mexico and Wyoming which introduced topics as mandatory by 2005 and simultaneously strengthened their HED policies by introducing new enforcements. Also, group S5 includes Texas which by the academic year 2001/2002 implemented a coordinated HED program, and in 2004 the State Board of Education required all public schools in the state to have all HED topics in curriculum.

2.3 Identification Strategy and Data

Our goal is to identify the spillover effects of elementary school HED policies implemented in certain states (the "experimental states") on the behavior of parents of elementary school-age children (the treatment group). Identifying this effect requires, as stated in Gruber (1994), controlling for any systematic shocks to the parents' outcome behavior in the experimental states that are correlated with, but not due to, changes in HED policies. To do so, we use a "differences-in-differences-in-differences" (DDD) approach that allows us to exploit the variation of HED policies across time (time dimension), across states (geographical dimension), and across different groups of individuals residing in the same state (individual dimension). That is, we compare the treatment individuals in experimental states to a set of control individuals in those same states and we measure the change in the treatments' relative outcome, relative to those in states that did not change

HED policies. The identifying assumption requires that there is no contemporaneous shock affecting the relative outcome of the treatment group in the same state-year as the change in the HED policy.

We use a DDD identification strategy instead of the more commonly used "difference-in-differences" (DD) because it does not require the common trend assumption for treatment and control groups. We consider that this assumption will most likely be violated given the characteristics of the policy we are analyzing. In particular, the DD estimator of the spillover effects of HED policies on parents will be biased if the states that increased their HED requirements between 1999 and 2005 were those where health indicators and health habits were deteriorating more rapidly. Section 2.3.4 provides evidence supporting this hypothesis.

The population under analysis includes adults who have children aged 22 years old or younger living with them. Let y_{it} be the outcome of interest for individual i at time t. Our model specification, that allows for different types of treatment, is

$$\begin{aligned} y_{it} = \beta_0 + \beta_1 \tau_t + \beta_2 elem_i + \sum_{k=2}^{5} \beta_{3,k} S_{ki} \\ + \beta_4 (elem_i \times \tau_t) + \sum_{k=2}^{5} \beta_{5,k} (S_{ki} \times \tau_t) + \sum_{k=2}^{5} \beta_{6,k} (elem_i \times S_{ki}) \\ + \sum_{k=3}^{5} \beta_{7,k} (\tau_t \times elem_i \times S_{ki}) + \beta_8 X_{it} + u_{it}, \end{aligned} \tag{2.1}$$

where $i = 1...N$ indexes individuals, and $t = 0, 1$ indexes time (0=before the policy change, 1999; 1=after the policy change, 2005). τ_t is a dummy variable, equal to one in 2005, capturing a nationwide time trend in the outcome; $elem_i$ is a dummy variable that takes the value one if individual i has at least one child of elementary-school-age, reflecting a group fixed effect; and S_{ki} is a dummy variable equal to one if individual i resides in the group of states $k = 2, .., 5$, which allows for group-of-state fixed effect. The experimental states are $k = 3, 4, 5$. X_{it} is a set of observable individual characteristics including age, race, marital status, number of children, children of high-school-age, education level, employment status, full-time/part-time employment, per-capita family labor income, and state dummies. The model allows for differential time trends: (1) between parents of elementary school-age children versus parents of children of other ages, captured by the interaction $(elem_i \times \tau_t)$ and (2) between individuals living in different groups of states,

captured by the interactions $(S_{ki} \times \tau_t)$, for $k = 2, .., 5$. Since parents of elementary school-age children in a given group of states may have a different outcome than parents of children below and above elementary school age living in the same group of states, we include the interactions $(elem_i \times S_{ki})$, for $k = 2, .., 5$. Finally, the triple interaction $(\tau_t \times elem_i \times S_{ki})$ is equal to one only for treated individuals in experimental states $k = 3, 4, 5$, in the post-treatment period. The average treatment effect of HED reforms on the treated in group of states $k = 3, 4, 5$ are given by the β_{7k} parameters, respectively. We call these effects Indirect Average Treatment effects on the Treated, IATT, since we are estimating the indirect effects of HED policies.

2.3.1 Database

We analyze the impact of HED policies on the behavior of adults who have children attending elementary school using data from two sources. We complement the information on HED policies obtained from the NASBE Database and the SHPPS, with the information on individuals obtained from the Panel Study of Income Dynamics (PSID).

The PSID is a nationally representative longitudinal survey of individuals in the US (men, women, and children) and the family units in which they reside. In 1999, the PSID started gathering more detailed information on health status and health behaviors. We concentrate on the indirect effect of HED policies on levels of physical activity, which is reported in this survey.

We base our analysis on the PSID survey years 1999 and 2005, using 1999 as the pre-reform period. We use these two waves as two repeated cross-sections, rather than as a panel. Our final sample consists of 11,026 observations that include parents of children aged 22 years old or younger living with them, who participated in the 1999 and/or 2005 PSID.

Besides the PSID, there are other household and individual surveys containing information about health lifestyles. However, these surveys do not include all the variables we require to conduct our analysis for the years in which we can identify HED policy changes.[10]

[10] In the National Health Interview Survey (NHIS) and the National Health and Nutrition Examination Survey (NHANES) the public-use data files do not include the state identifiers. In the Behavioral Risk Factor Surveillance System (BRFSS) the information on the age of children is incomplete. Finally, there are important limitations in the information about adult's physical activity recorded in the National Longitudinal Survey of Youth 1979 (NLSY79).

In our setting, treated individuals, those exposed to changes in HED policies, are adults who reside in an experimental state, and who have elementary school-age children (6-10). The PSID does not provide information on whether a child is attending elementary school. However, it provides information on the age of children, allowing us to determine if individuals have school-age children.

The control group consists of individuals who were unaffected by changes in state HED requirements; it includes adults who have elementary school-age children (6-10) living in states that did not change HED policies (S1 and S2 groups). Furthermore, to control for possible correlation of state HED policies with unmeasured state trends in health and health behaviors, we use a sample of adults who have children living with them but not of elementary school-age as a within-state comparison group. We group the non-treated individuals in three different control groups. We include in the Treatment-Non-Experimental group (Control 1) individuals with elementary school-age children residing in non-experimental states. The Control-Experimental group (Control 2) includes individuals with children not of elementary school-age residing in experimental states. Finally, in the Control-Non-Experimental group (Control 3) we include individuals with children above and below elementary school age residing in non-experimental states.

The information available in the NASBE database and SHPPS surveys regarding HED in the District of Columbia, Minnesota, and New Hampshire was not conclusive, so we could not classify these states and, consequently do not include them in our sample. Table 2.2 presents the aforementioned state classifications and the sample sizes for the states included in the sample.[11]

Table 2.2: States classification by changes in HED requirements between 1999 and 2005.

Group		Type of policy	Num. of states	Num. of Obs.
Non-Experimental	$S1$	Does not have HED in '99 and '05	5	825
	$S2$	Existing HED in '99 remains unchanged in '05	23	6,602
Experimental	$S3$	Moderate changes A	6	1,095
	$S4$	Moderate changes B	7	1,193
	$S5$	Major changes	5	1,311
Total			46	11,026

Source: NASBE State School Health Policy Database, SHPSS surveys, and PSID database. The number of observations is the number of individuals in each group of states.

[11] The complete list of states in each group, and the number of observations in each state are reported in Table B.9 in Appendix B.

2.3.2 The outcome variable

Our outcome variable is a dummy variable that takes the value one if the individual does light physical activity at least once a week and zero otherwise.[12] Although other measures of intensity of physical activity can be relevant from a medical point of view -like the exact amount of time spent doing physical activity- we restrict our analysis to this other margin -physically active versus physically inactive individuals- since the PSID does not ask about the exact time spent each time individuals do physical activity.[13] Also, it is worth mentioning that the margin physical activity-inactivity is often cited as very important from a health policy perspective, since many of the risk factors associated to chronic diseases are directly linked to physical inactivity or sedentary habits (WHO, 2003).

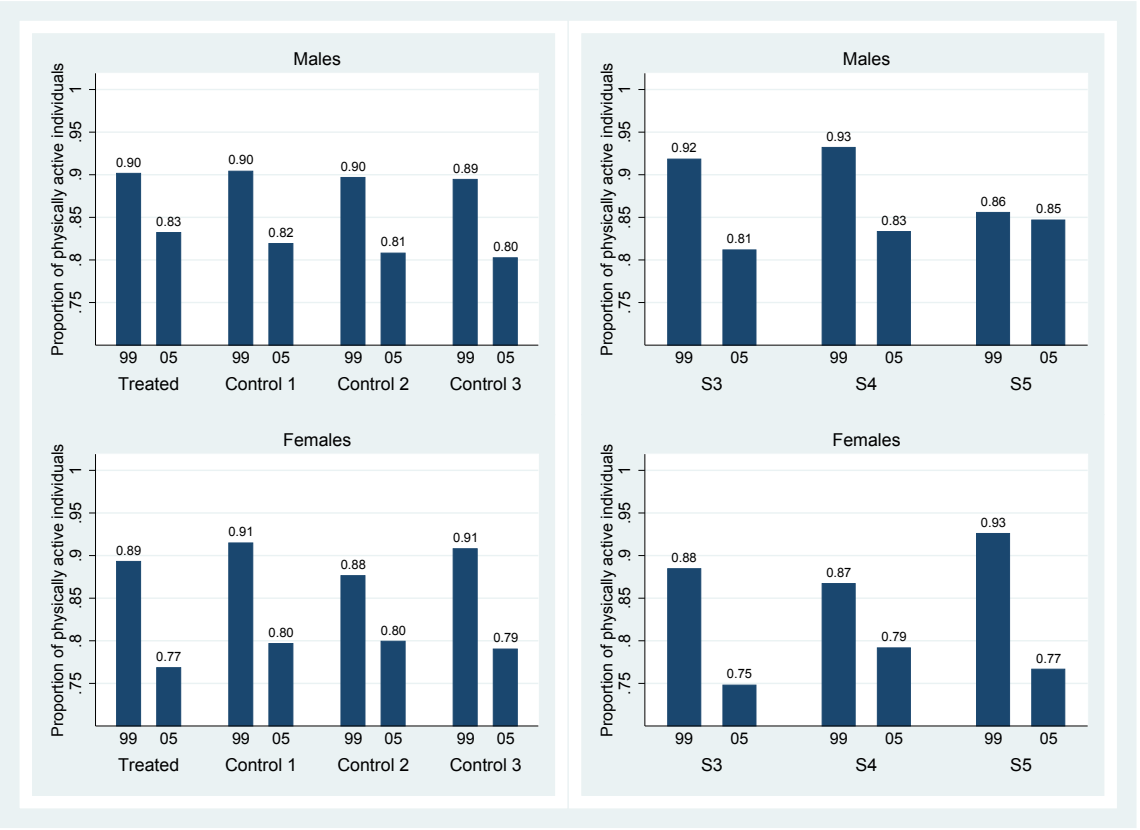
The two graphs in the left panel in Figure 2.1 show the proportion of physically active individuals by gender in 1999 and 2005 for the treated and control groups. We observe a downward trend in all groups for both genders. In particular for the treated groups, the proportion of physically active individuals goes down by 7 percentage points for males, and by 12 percentage points for females. This simple Before-After estimator tells us that HED policies have had a negative impact on the outcome of interest. However, these estimates are obviously biased given that the average of the outcome variable in the three control groups also has a downward trend.

Exploring gender differences, we can see that females in the Treatment-Experimental group (Treated) present a larger drop in the proportion of physically active individuals than that observed for males in the same group. This suggests the need to take gender differences into account when estimating the effect of HED policies.

[12]PSID respondents are asked about their physical activity habits through two questions, the first about how often they do light physical activity (number of times) and the second whether this frequency is daily, weekly, monthly or annual. The exact wording of the questions is reported in Appendix B.

[13]The American College of Sports Medicine and the American Heart Association recommends a minimum of 150 minutes per week of light physical activity to promote and maintain health. This moderate-intensity aerobic activity can be accumulated from bouts lasting 10 or more minutes (Haskell, Lee, Pate, Powell, Blair, Frankli, Macera, Heath, Thomson, and Bauman, 2007). Even though changes around this margin of minutes would be very interesting to be analyzed, with our dataset we could at most compute the number of times per week individuals report doing physical activity and not the total amount of time spent.

Figure 2.1: Proportion of physically active individuals by treated/control groups (left panel), and treated individuals by treatment groups (right panel), and by gender, in 1999 and 2005.



Notes: **Treated:** individuals with elementary school-age children in experimental states. **Control 1:** individuals with elementary school-age children in non-experimental states. **Control 2:** individuals without elementary school-age children in experimental states. **Control 3:** individuals without elementary school-age children in non-experimental states. The type of policies corresponding to the groups of states Sk are as follows. **S3:** Moderate changes A; **S4:** Moderate changes B; **S5:** Major changes. Source: PSID.

As discussed above, the implementation and modification of HED policies between 1999 and 2005 were not homogeneous across states. Therefore, we can expect differences in the temporal evolution of the outcome of interest for treated individuals across the three groups of experimental states. The two graphs in the right panel in Figure 2.1 show the proportion of physically active treated individuals, by gender and by group of experimental states. In the first graph we see that in states belonging to group $S5$, the states that introduced major HED changes, the downward trend in the proportion of physically active males is substantially smaller than the corresponding downward trend in groups $S3$ and $S4$, the groups of states that introduced moderate HED changes. Moreover, the reduction in the proportion of physically active males in the group $S5$ is lower than the fall in all

three control groups. This relatively moderate downward trend for treated males in $S5$ experimental states suggests a positive effect of HED policies on the outcome variable, although it does not seem to be the case for females.

2.3.3 Descriptive statistics

In Table 2.3 we report average values and standard errors of the outcome variable, and other demographic and socioeconomic characteristics for treated and control individuals in 1999 and 2005.

For each group, we find evidence of statistically significant differences in some observable characteristics between 1999 and 2005, although most of these differences vanished when we compute differences in trends between treated and control individuals (reported in column (7)). These differences may produce changes in the observed proportion of physically active individuals between 1999 and 2005 that are not a consequence of changes in HED programs. Hence, to avoid a biased estimation of the effect of interest, in the specification in equation 2.1 we control for observable individual characteristics. Additionally, given the existence of different time trends on the frequency of light physical activity between females and males (Figure 2.1), we interact the whole model in equation 2.1 -except for the vector X_{it}- with a gender dummy.

Table 2.3: Descriptive statistics: All individuals in the sample.

	Treated individuals			Control individuals			Control vs
	1999	2005	Difference	1999	2005	Difference	Treated
	(1)	(2)	(3)	(4)	(5)	(6)	(7)=(6)-(3)
Proportion of physically active	0.90	0.80	-0.10***	0.90	0.80	-0.10***	0.00
parents	(0.30)	(0.40)		(0.30)	(0.40)		
Frequency of light physical	4.32	3.81	-0.52***	4.38	3.76	-0.62***	-0.10
activity (times per week)	(3.07)	(3.25)		(3.09)	(3.23)		
Female	0.56	0.57	0.01	0.56	0.57	0.01	-0.00
	(0.50)	(0.49)		(0.50)	(0.50)		
Age	36.13	36.11	-0.02	37.21	38.82	1.62***	1.63***
	(6.37)	(6.93)		(8.29)	(9.61)		
Years of Education completed	13.01	13.23	0.22*	12.79	13.01	0.22***	-0.00
	(2.36)	(2.24)		(2.75)	(2.52)		
Num. of Children	2.65	2.59	-0.06	2.34	2.30	-0.03	0.02
	(1.36)	(1.26)		(1.25)	(1.21)		
Num. of Children of	1.25	1.29	0.03	0.45	0.33	-0.13***	-0.16***
elementary school-age	(0.50)	(0.52)		(0.72)	(0.61)		
White	0.53	0.51	-0.02	0.56	0.53	-0.03***	-0.01
	(0.50)	(0.50)		(0.50)	(0.50)		
Married	0.77	0.75	-0.02	0.78	0.76	-0.02**	-0.00
	(0.42)	(0.43)		(0.42)	(0.43)		
Unemployed	0.04	0.04	-0.01	0.03	0.04	0.01**	0.02
	(0.21)	(0.19)		(0.17)	(0.20)		
Retired	0.00	0.00	0.00	0.00	0.01	0.00	0.00
	(0.04)	(0.05)		(0.07)	(0.08)		
Disabled	0.02	0.02	0.00	0.02	0.03	0.01***	0.01
	(0.12)	(0.14)		(0.14)	(0.17)		
Full time workers	0.73	0.71	-0.03	0.76	0.73	-0.03***	-0.01
	(0.44)	(0.46)		(0.42)	(0.44)		
Family income	17,109	24,966	7,857	18,778	20,707	1,929***	-5,928
per capita	(20,929)	(192,026)		(22,019)	(29,287)		
Sample size	699	685		4,280	5,362		

Notes: Standard errors reported in parentheses below the corresponding average or proportion. Stars in columns (3) and (6) show statistical significance of differences in mean (continuous variables and variables with more than 12 categories) or proportion (dummy variables) of the referred variable, between years 1999 and 2005. Stars in column (7) show statistical significance of differences in mean. Significance levels: * = 10%; ** = 5%; *** = 1%.

To confirm the existence of a close relationship between individuals' health status, and the practice of physical activity, we looked at correlations between different measures of health status and whether the individual does light physical activity, using the PSID dataset.[14] As expected, we found negative and statistically significant correlations between the probability of having some health conditions, such us having suffered a stroke, and having hypertension, diabetes, and emotional related illnesses. We also found that being physically active is positively correlated with reporting a better self reported health status, and negatively correlated with the body mass index.[15]

2.3.4 Pre-treatment trends in experimental and non experimental states

To explore the possibility that the DD common trends assumption absent the policy is not satisfied, we analyze the pre-treatment trends (1994-1998) of health indicators of adults with children under 18 years old in experimental and non-experimental states using data from the Behavioral Risk Factor Surveillance System (BRFSS).[16] As shown in Table 2.4, the proportion of individuals at risk because of overweight or obesity has increased more rapidly in experimental states than in non-experimental states. As well, between 1994 and 1998 the proportion of individuals with sedentary lifestyles has increased more in experimental than in non-experimental states. Therefore, the different trends in the outcomes of experimental versus non-experimental states indicate that the implementation of HED policies is correlated with the evolution of the outcome of interest, which makes the use of a DDD estimator crucial here.

[14] We are grateful to an anonymous referee for suggesting the inclusion of this empirical evidence to enhance the motivation of the paper.

[15] A complete report of correlations and statistical significance can be found in Table B.2 in Appendix B.

[16] BRFSS is also a nationally representative survey designed to measure behavioral risk factors in the adult population. Note that we made use of this other dataset to evaluate the pre-treatment trends because the PSID does not contain information on health behaviors for this period of time. Additionally, we only consider adults with children under 18 given that is the only information available about age of children living with them, that is, we cannot identify parents with children between 18 and 22 years old as we do in PSID.

Table 2.4: Lack of common trends between experimental and non-experimental states.

Year	Obesity 1 (%)		Obesity 2 (%)		Sedentary lifestyle (%)	
	Non-exper. states	Exper. states	Non-exper. states	Exper. states	Non-exper. states	Exper. states
1994	33,1	32,8	28,3	28,4	59,5	56,9
	(22824)	(13693)	(22824)	(13693)	(22824)	(13693)
1996	35,7	35,6	30,7	31,5	59,0	59,4
	(24612)	(16470)	(24612)	(16470)	(24612)	(16470)
1998	36,9	39,8	32,4	34,9	57,0	59,1
	(29052)	(20767)	(29052)	(20767)	(29052)	(20767)
Var. % ('94-'98)	11,6%	21,3%	14,4%	22,7%	-4,2%	4,0%

Source: BRFSS 1994, 1996, and 1998. Sample sizes in parentheses. *Definitions:* **Obesity 1 (%)**: Percentage of population (with children under 18 years old) at risk for obesity (greater than 120% of weight for height percent median). **Obesity 2 (%)**: Percentage of population (with children under 18 years old) at risk for overweight based on BMI. At risk defined as: >27.8 for males and >27.3 for females. **Sedentary lifestyle (%)**: Percentage of population (with children under 18 years old) at risk for sedentary lifestyle (sedentary or irregular physical activity profile).

2.4 Indirect Treatment Effects

Table B.1 shows the IATT estimates for the three types of treatment, by gender, obtained using a linear probability model (column 1 to 4) and a probit model (columns 5 to 8).[17] Marginal effects for probit models are obtained using the methodology proposed by Blundell, Dias, Meghir, and Reenen (2004).[18] The "DDD" columns present the IATT estimates obtained with the triple difference estimator defined in equation 2.1. The "DD" columns present the IATT estimates obtained with a difference-in-difference identification strategy. In this case, we compare parents of children in elementary school in experimental states before and after of the policy change, and we use as control group parents of children in elementary school in non-experimental states.

[17]Estimates for the probit DDD model are reported in Table B.3 in Appendix B.

[18]The methodology of Blundell, Dias, Meghir, and Reenen (2004) for the case of the DDD estimator is derived in Appendix B. We thank a referee for suggesting this methodology for the identification and computation of marginal effects in non-linear setups.

Table 2.5: IATT by type of treatment and gender.

Group of experimental states	**Linear Probability Model**				**Probit**			
	Male		**Female**		**Male**		**Female**	
	DD	**DDD**	**DD**	**DDD**	**DD**	**DDD**	**DD**	**DDD**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
S3: Moderate changes A	-0.021	-0.012	-0.018	-0.054	-0.035	-0.043	0.010	-0.049
	(0.032)	(0.049)	(0.058)	(0.059)	(0.051)	(0.059)	(0.067)	(0.104)
	[0.521]	[0.802]	[0.751]	[0.365]	[0.490]	[0.460]	[0.876]	[0.638]
S4: Moderate changes B	-0.002	-0.021	0.046	0.000	-0.024	-0.048	0.074	0.012
	(0.047)	(0.073)	(0.045)	(0.089)	(0.060)	(0.088)	(0.073)	(0.118)
	[0.971]	[0.780]	[0.317]	[0.999]	[0.692]	[0.587]	[0.310]	[0.918]
S5: Major changes	0.063	0.085	-0.028	-0.076	0.098	0.137	-0.060	-0.107
	(0.026)	(0.043)	(0.050)	(0.048)	(0.023)	(0.035)	(0.072)	(0.064)
	[0.021]	[0.056]	[0.581]	[0.121]	[0.005]	[0.057]	[0.398]	[0.095]

Notes: Each entry reports marginal effect of the corresponding treatment. Robust standard errors reported in parenthesis are clustered at the state level (analytic standard errors for Linear Probability Models, and bootstrapped standard errors with 1,000 replicas for Probit models). P-values reported in brackets. Sample size for DD estimators: 4,196. Sample size for DDD estimators: 11,026. All regressions include the following covariates: age, age squared, race, gender, marital status, number of children, children of high school-age, years of education and its square, employment status, full-time/part-time employment, log of family income per capita, and state fixed effects.

The DD estimate shows that the change in the HED program in the $S5$ group of states increases the probability of fathers doing physical activity by 6.3 or 9.8 percentage points, depending on the model considered (Columns 1 and 5). Since the DD estimator is likely to be downward biased, this estimate is a lower bound of the real effect under analysis. Using the DDD estimator we find evidence that the effect for fathers affected by this policy is slightly higher, reaching 8.5 or 13.7 percentage points (Columns 2 and 6). The effect on the probability of mothers engaging in light physical activity has opposite sign to that found for fathers, but the effect is statistically significant only in one case (Column 8, with a p-value equal to 0.95). So we conclude that there is no clear evidence of the existence of an indirect effect of HED on mothers. Contrarily to this situation, all four estimates reported for males in the $S5$ group of states are statistically significant, so our conclusion is that the policy has a clear positive effect on fathers.

The estimated effects are not statistically significant for males and females residing in the group of states $S3$ and $S4$. These results suggest that moderate changes in HED programs do not have indirect effects.

Regarding the differences between estimates obtained with the DD estimators and the DDD estimators, we found that these estimates are not statistically different. This is the case for all treatments, gender, and linear and non-linear models.[19]

2.4.1 Heterogeneous effects

We provide evidence on the existence of heterogeneous effects of HED reforms according to several socioeconomic and demographic characteristics of individuals. In all cases described below, we compare at most two additional categories (on top of gender of parents and treatment groups) due to sample size restrictions. For instance, we look at differential impacts on two educational and income levels, or type of employment groups.

First, we analyze differences by educational level. We define a dummy variable that takes the value one if the individual has 12 or more years of education ("high" education level), and zero otherwise ("low" education level). We then estimate the linear probability model (both the DD and the DDD specification) interacting the whole model with this dummy. Results for the DDD specification are reported in Table 2.6.[20] The effect is positive and statistically significant for both low and high educated fathers in the group of states $S5$ (columns 1 and 2). The effect is higher on low educated fathers relative to high educated fathers, and the difference is statistically significant. For mothers in $S5$ we find that the difference in the effects between low and high educated individuals (column 6) is similar as for fathers (column 3) and it is statistically significant as well, but the effect is negative for high educated mothers (columns 5). This result is puzzling and may also be explaining the average null effect found for mothers in Table B.1.

We also looked at heterogeneous effects along other dimensions: income levels (richest quintile of income versus the others), employment status (workers versus non workers, and full time workers versus part time workers), type of employment (blue collar or services versus white collar occupations), gender of the child receiving the HED program (parents with boys in elementary school versus parents with girls in elementary school). In none of these cases we find statistically different effects between groups.[21]

[19] Results are available upon request.
[20] Results for the DD specification are reported in Table B in Appendix B.
[21] Results not reported, but available upon request.

Table 2.6: IATT by type of treatment, gender and education level. Linear Probability Model (DDD).

	DDD Male			**DDD Female**		
	Education Level			Education Level		
	LOW	HIGH	Difference	LOW	HIGH	Difference
	(1)	(2)	(3)	(4)	(5)	(6)
S3: Moderate changes A	-0.119	-0.022	-0.097	-0.148	-0.041	-0.107
	(0.183)	(0.049)	(0.157)	(0.166)	(0.054)	(0.159)
	[0.517]	[0.650]	[0.537]	[0.374]	[0.443]	[0.504]
S4: Moderate changes B	0.051	-0.060	0.112	0.121	-0.012	0.133
	(0.325)	(0.077)	(0.348)	(0.141)	(0.085)	(0.090)
	[0.875]	[0.431]	[0.748]	[0.392]	[0.884]	[0.139]
S5: Major changes	0.309	0.012	0.297	0.173	-0.124	0.297
	(0.127)	(0.042)	(0.116)	(0.055)	(0.052)	(0.065)
	[0.015]	[0.770]	[0.010]	[0.002]	[0.017]	[0.000]

Notes: Each entry in columns 1, 2, 4 and 5 reports marginal effect of the corresponding treatment. Robust standard errors reported in parenthesis are clustered at the state level (analytic standard errors). P-values reported in brackets. Sample size: 11,026. All regressions include the following covariates: age, age squared, race, gender, marital status, number of children, children of high school-age, years of education and its square, employment status, full-time/part-time employment, log of family income per capita, and state fixed effects. All the models are estimated interacting the dummy variable that takes the value 1 if the individual has 12 or more years of education and zero otherwise.

2.4.2 Linking heterogeneous effects and plausible mechanisms at work

We analyze the heterogeneous impacts discussed above as a way to shed some light on the question of what mechanisms can be generating the spillovers of HED on parents. First, the positive impact on fathers and the null average effect on mothers may be informing about a sort of "role modeling" mechanism driving the spillovers. This hypothesis states that parents may do more physical exercise in response to the knowledge children acquire via HED, not because they were not already aware of the benefits of exercising but because they want to complement the instruction received by the child so as to form the desired healthy lifestyle in the child.[22] Since parents usually spend more time with their children doing gendered activities, the impact of HED reforms on physical activity is more likely to appear for fathers rather than for mothers.[23] However, we do not find evidence indicating that, if exists, this "role modeling" is reinforced in same sex parent-child pairs (mother-daughter, father-son).

On the other hand, since lower levels of education are related to less knowledge about health (Kenkel, 1991, Tinsley, 2003), it may be that effects of HED reforms are larger for individuals with lower levels of education, for whom there is more room for improvements in the case of the arrival of "new" information about healthy habits. That is, a sort of "information sharing" between children and their parents may give rise to the heterogeneous effects shown in Table 2.6. However, since the opportunity cost of time is higher for more educated individuals, they may be less willing to substitute away work time by time spent in doing physical activity, and, for this reason (and not due to information sharing), they may be less inclined to increase physical activity as a result of indirect exposure to HED reforms. Nonetheless, as noted before, we do not find evidence of this type of substitution effect, because there is no effect of HED reforms in the extensive or intensive margins of labor supply of parents (neither in the labor force participation nor in hours worked).

[22] According to the President's Council on Physical Fitness and Sports "*...parents can be considered to be the "gatekeepers" of children's physical activity in that they enable or constrain opportunities for their children's physical activity involvement... An important form of influence of parents on children's level of physical activity consists of role modeling practices,..., particularly through shared physical activity experiences...*" (Brustad, 2010).

[23] Figure B.1 in Appendix B shows some evidence on this respect with data from the American Time Use Survey (ATUS). Women spend roughly twice as much time in childcare as do men, a pattern which holds true for all subgroups and for almost all types of childcare, except for "Recreational" childcare. This type of childcare activity includes playing games with children, playing outdoors with children, attending a child's sporting event or dance recital, going to the zoo with children, taking walks with children, etc. In the case of "Recreational" childcare, mothers allocate relatively less of their time with children than do fathers. Thus, this is evidence that fathers are more likely to do stereotypically male activities with their children, among them physical activity.

2.5 Robustness

2.5.1 An alternative identification strategy: Changes in Changes (CiC) estimator

The CIC estimator introduced by Athey and Imbens (2006), generalizes the difference-in-difference estimator under fewer assumptions for consistent estimation. In particular, the CiC estimator is suitable when the policy change analyzed affects a group with different characteristics (observed and/or unobserved) than the group not affected, and the expected benefit of the policy may vary across groups. In the case of HED reforms, it means that the CiC estimator is consistent even if the policy change took place in those states with higher incidence of obesity and lower levels of physical activity among its population. For this reason, the CiC estimator may be an alternative to the DDD estimator presented so far, provided that the assumptions for consistency are fulfilled. The CiC is particularly appealing in our application since the authors developed an extension of the estimator to deal with discrete dependent variables.[24]

In what follows we discuss the assumptions behind the CiC estimator in its simplest version, that is the one without covariates.[25] The crucial assumption for identification with the CiC estimator, called the "Time Invariance Within Groups", states that the distribution of unobservables can vary across groups (treated vs. controls), but not over time within groups. In our case, this assumption means that the distribution of unobservables can differ between individuals residing in experimental and non-experimental states, something highly likely since the experimental states are those with higher proportion of population with weight problems, and higher proportion of physically inactive population. Additionally, the distribution of unobservables in both groups of states (experimental and non-experimental), cannot change over time. This part of the assumption we find difficult to be fulfilled since we observe outcomes within a six years gap (1999 and 2005). The assumption requires that the distribution of unobservables that determines whether parents are physically active or not, let's say in the experimental states, does not change between 1999 and 2005. A phenomenon that is contained in those unobservables is the aging of the individuals, whose distribution changes over time mainly because a relevant proportion of our dataset is a panel.

[24] We are grateful to a referee for suggesting this methodology for the identification of ATT in non-linear models.

[25] For a more formal discussion of the CiC estimator, and the use of covariates, see Appendix B.

The CiC estimator for discrete outcomes, without further assumptions, provides bounds for the effect of interest, rather than a point estimate. In some applications, as it is in our case, the bounds are too broad to provide a clear conclusion on the direction of the effect of a policy change. One of the alternatives proposed by Athey and Imbens (2006) to narrow the bounds is to impose a conditional independence assumption. One example in which the assumption holds is if the distribution of unobservables for individuals who are physically active in 1999, and reside in the experimental states, is equal to the distribution of unobservables for individuals who are physically active in 1999, and reside in the non-experimental states.

Summing up, we consider that for the policy under analysis the identifying assumption of the CiC estimator (under conditional independence) is less likely to be fulfilled than the identifying assumption of the DDD estimator. However, we accept that the assumptions behind the CiC estimator are more likely to hold than those of the DD estimator. For this reason, in Table 2.7, we present and compare the IATT for the three estimators, using non-linear models and no covariates.

Reassuringly, the conclusions we can make on the indirect effect of HED programs are consistent across the three estimators: there is a positive and significant effect of major changes in HED programs on fathers of children of elementary-school age, while mothers seem not to be affected by such policy reforms. Significant HED reforms increase fathers' probability of doing physical activity between 7.2 and 13.4 percentage points, depending on the estimator chosen. In general, the CiC estimates are quantitatively smaller than the DD and DDD comparable estimates. Note that the CiC estimates are closer to the DD estimates than DDD estimates. This might be because CiC and DD assumptions are more similar than DDD assumptions.

Table 2.7: IATT by type of treatment and gender. DD, CiC, and DDD estimators (non-linear models without covariates).

Group of experimental states	**Male**			**Female**		
	DD	**CiC**	**DDD**	**DD**	**CiC**	**DDD**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
S3: Moderate changes A	-0.029	-0.020	-0.042	0.003	-0.023	-0.057
	(0.053)	(0.032)	(0.059)	(0.066)	(0.067)	(0.104)
	[0.584]	[0.539]	[0.478]	[0.960]	[0.737]	[0.587]
S4: Moderate changes B	-0.030	-0.011	-0.047	0.075	0.036	0.016
	(0.059)	(0.062)	(0.087)	(0.072)	(0.042)	(0.117)
	[0.615]	[0.865]	[0.590]	[0.297]	[0.389]	[0.895]
S5: Major changes	0.100	0.072	0.134	-0.052	-0.040	-0.102
	(0.036)	(0.019)	(0.071)	(0.072)	(0.040)	(0.067)
	[0.005]	[0.000]	[0.059]	[0.474]	[0.313]	[0.125]

Notes: Each entry reports marginal effect of the corresponding treatment. No covariates in all models. Bootstrap robust standard errors clustered at state level (1,000 replicas). DD and CiC estimators computed using only sample of parents with children of elementary school age. The CiC estimators corresponds to the average treatment effect on the treated. For the CiC we ran separated estimations for female and males, and by treatment ($S3$, $S4$, $S5$). DD and CiC sample sizes: 1,819 males and 2,401 females. DDD sample sizes: 6,198 females and 4,828 males. To compute CiC estimators we use the MATLAB code written by Prof. Susan Athey and available in her webpage.

2.5.2 Other robustness checks

To determine whether our results are sensitive to the definition of the within-state control group, we perform two tests. First, we consider only parents with at least one child below elementary-school-age (parents with children below 6 years old) and we drop from the within-state control group those parents with children above elementary-school age. The marginal effects of the three treatments estimated from a linear probability model are reported in columns (1) and (2) of Table 2.8. Second, we consider only parents with at least one child above elementary-school-age (parents with children above 10 years old) and we drop from the within-state control group parents with children below elementary school age. The marginal effects of the three treatments estimated from a linear probability

model are reported in columns (3) and (4) of Table 2.8.[26] In both exercises the estimates of the effects of the three treatments are very similar to those obtained with the baseline model, indicating that the results are not sensitive to the definition of the control group.

Additionally, we analyze whether our results are sensitive to the definition of the non-experimental states. In our baseline model, the non-experimental states are both those that never had HED (group of states $S1$), and those states that had HED in 1999 but did not change its implementation between 1999 and 2005 (group of states $S2$). To test whether the results are sensitive to the exclusion of $S2$ as non-experimental states, we repeat the estimation keeping only $S1$ in this group. The results are reported in columns (5) and (6) of Table 2.8, and the conclusions are in line to those obtained with the baseline model. Moreover, in this specification the three treatments have a positive and higher effect on males, although the only significant effect is still for the group of states $S5$, implying that including $S2$ produces a downward bias in the estimates. This bias may be generated by the fact that the states in $S2$ are likely to be improving their HED policies, although this is not captured in NASBE or SHPPS databases.

Finally, the existence of movers may be a concern for the implementation of a DDD procedure. To check the robustness of the results to this issue, we performed the estimation dropping from the sample those individuals that have moved between states (4.3% of our sample) and we obtained the same results as in the baseline estimation.[27]

[26] All the robustness checks performed in this section are carried out with linear models. We do not use non-linear models because in these exercises sample sizes are smaller. Having a reduced number of observations limits the use of the bootstrapping procedure needed to compute the standard errors of marginal effects in non-linear models with the methodology proposed by Blundell, Dias, Meghir, and Reenen (2004)

[27] Results are available upon request.

Table 2.8: Sensitivity Analysis of control groups. IATT by type of treatment and gender. Linear Probability Models.

	Sensitivity 1 Control: Only parents with kids < 6		**Sensitivity 2** Control: Only parents with kids > 10		**Sensitivity 3** Non Experim. states: only states never had HED	
	DDD Male	DDD Female	DDD Male	DDD Female	DDD Male	DDD Female
	(1)	(2)	(3)	(4)	(5)	(6)
S3: Moderate	0.041	-0.012	-0.059	-0.088	0.138	-0.055
changes A	(0.058)	(0.065)	(0.049)	(0.061)	(0.083)	(0.063)
	[0.485]	[0.849]	[0.239]	[0.161]	[0.111]	[0.392]
S4: Moderate	-0.097	-0.011	0.049	0.014	0.139	0.003
changes B	(0.074)	(0.069)	(0.078)	(0.098)	(0.100)	(0.095)
	[0.196]	[0.876]	[0.533]	[0.891]	[0.178]	[0.972]
S5: Major	0.084	-0.035	0.095	-0.097	0.252	-0.069
changes	(0.048)	(0.043)	(0.048)	(0.061)	(0.081)	(0.053)
	[0.090]	[0.416]	[0.051]	[0.122]	[0.005]	[0.206]

Notes: Each entry reports marginal effect of the corresponding treatment. Robust standard errors reported in parenthesis are clustered at the state level. Sample size for sensitivity 1: 7,075 , Sample size for sensitivity 2: 8,624, Sample size for sensitivity 3: 4,424. All regressions include the following covariates: age, age squared, race, gender, marital status, number of children, children of high school-age, years of education and its square, employment status, full-time/part-time employment, log of family income per capita, and state fixed effects.

2.6 Conclusions

We find evidence for positive spillovers of HED imparted in elementary schools on the probability of parents engaging in light physical activity. However, our results suggest that fathers and, on average, not mothers are those affected by the HED reforms. We also investigate about the existence of other heterogeneous effects, along several dimensions: educational attainment and income levels of parents, employment status, type of employment, and gender of the child receiving the HED program. We only find that impacts of HED reforms are larger for parents with a lower educational attainment, and find no statistically different effects for the other types of groups compared. We discuss whether the evidence about heterogeneous effects allows to state some channels giving

rise to spillovers of HED on parents. We conclude that this evidence seems to be consistent with mechanisms of role modeling in parenting and of information sharing between children and parents.

Also, our results highlight the importance of clearly distinguishing the existence of several dimensions in the implementation of a policy. In our case, it is important for policy evaluation to consider the two dimensions in HED reforms, changes in topics and enforcements, as well as the distinction between "Moderate changes" and "Major changes" in HED requirements. Our main result shows spillovers only in states that carried out deep reforms in their HED programs.

Spillovers of HED on parents' lifestyles indicate that the interaction between children and parents plays a role in the formation of healthy lifestyles within the household. Therefore, taking these spillovers into account is important in the cost-benefit analysis of health education in schools, as well as to properly design policy interventions aimed at increasing the adoption of healthy lifestyles.

Chapter 3

Investing in Myself?: Informality, Occupational Choice and Investments in Human Capital

3.1 Introduction

Countries differ greatly in their levels of schooling and also in their rates of entrepreneurship. At the same time, the share of the so-called "shadow economy" -informal economic activities- is very large in some countries and very small in others.[1] This paper explores some key channels that connect these three phenomena. In particular, it focuses on assessing whether the extent to which firms can hide from tax authorities -i.e., operate in the informal economy- may affect the incentives of individuals to invest in human capital and also distort their occupational choices.

The cross country data shows that the levels of educational attainment, rates of entrepreneurship and the level of informality are connected. First, across countries there is a positive association between rates of entrepreneurship and the sizes of the informal sector. Second, the difference in the skill premium received by entrepreneurs and workers is negligible for economies with low levels of informality, while it becomes positive and increasing for more informal economies. Third, in more informal economies the fraction of high-skilled individuals that choose to become entrepreneurs is larger. Moreover, the

[1] As defined in Schneider, Buehn, and Montenegro (2011), the shadow economy is *"all market-based legal production of goods and services that are deliberately concealed from public authorities...to avoid paying taxes or meeting certain standards or complying with certain administrative procedures"*.

share of the labor force that is skilled and the size of the informal economy are related in a non-linear way: for low levels of informality the share of skilled individuals first decreases but then it rapidly stabilizes for countries with sufficiently large informal sectors.

To account for these facts, I develop an occupational choice model with human capital investment and an informal sector. I adapt Lucas (1978) span-of-control model to a life-cycle economy in which investments in human capital can positively affect the returns to entrepreneurship as well as the efficiency of labor.[2] In addition, the economy features credit constraints which arise as a result of the possibility of hiding the collateral and eluding the fiscal authority, as in Amaral and Quintin (2006).

In the model economy, every period a cohort of measure one of two-period lived agents is born. In the first period, agents split their time between unskilled work and education (investment in human capital). Agents are heterogeneous in their endowment of innate ability. The production function of human capital combines ability and time spent in education when young. In the second period, agents can supply unskilled or skilled labor. They have the option of becoming entrepreneurs instead of workers, and operate a technology that combines physical capital, skilled and unskilled labor, in which the human capital of the manager plays the role that innate ability plays in Lucas (1978). This technology is also characterized by capital-skill complementarity.

Managers can operate in the formal or the informal sector, and in both sectors they can self-finance part of their physical capital with savings from the first period. In addition, managers can use part of their savings as a collateral to get loans from banks, but they can also choose to default bearing a cost proportional to their income. Given this possibility, there is a cost of enforcing contracts that implies that some agents will end up being credit constrained. In the model, the higher these costs are, the larger will be the number of managers deciding to operate in the informal sector. Therefore, higher costs of contract enforcement is the model's correlate of a more informal economy.

In this model, the link between informality, entrepreneurship, and human capital operates in other dimensions as well. With high costs of enforcing contracts (high informality) entrepreneurs only receive a limited amount of lending from banks, and therefore choose to operate with low amounts of physical capital. Given capital-skill complementarity, this translates into a low demand for skilled labor and into relatively low earnings for skilled workers. As a result, in countries with high informality, workers do not have much

[2] Van der Sluis, Van Praag, and Vijverberg (2008) and Parker and Van Praag (2006) review the evidence about the effects of education on the returns to entrepreneurship and conclude that there exists a positive association.

incentives to invest in skills. In contrast, the returns to education for entrepreneurs can be high since education enhances the productivity of their operations, which can compensate for the lack of physical capital.

Given a parametrization of this model economy that can generate an equilibrium with a positive mass of individuals choosing each one of the six possible occupations (unskilled workers, skilled workers, informal unskilled managers, informal skilled managers, formal unskilled managers, and formal skilled managers), I analyze theoretically how all these effects interact with one another when the costs of contract enforcement increase. I conclude that the model is able to reproduce the three empirical facts mentioned above.

This work is mainly related to three strands of literature. First, it is related to the literature studying the relationship between occupational choices and informality. In particular, this work is close to Amaral and Quintin (2006), who construct an occupational choice model that is able to describe how skilled and unskilled labor are competitively assorted into formal and informal sectors, without any type of segmentation in the labor markets. However, Amaral and Quintin (2006) do not include the possibility of investment in managerial abilities, which is a key aspect to be considered in order to account for the differential incentives that a higher informality implies for the investments in human capital of managers and workers. This work is also related to the research addressing the effects of market imperfections on occupational choices, for instance the effects of entry costs (Antunes and Cavalcanti, 2007), of taxes on financial intermediaries (Erosa, 2001), of other financial frictions that increase credit costs (Buera, Kaboski, and Shin, 2011), or of size-dependent policies (Guner, Ventura, and Xu, 2008). However, none of these works analyze human capital investments.

Second, this work is also in line with the research analyzing the interplay between education and occupational choices, for instance Poschke (2010), Boháček (2006) or Bhattacharya, Guner, and Ventura (2013). Poschke (2010) studies the relationship between educational attainment and the prevalence of low-productivity versus high-productivity entrepreneurship, but his model does not explicitly model human capital investments nor does include an informal sector in order to study its impacts on the relationship between education and entrepreneurship. On the contrary, Boháček (2006) and Bhattacharya, Guner, and Ventura (2013) do model investments in human capital, and, of particular interest for the present work, they model the investments for developing managerial skills but not the one made by workers.

Last, this paper contributes to the rich literature on cross-country differences on educational attainment (Bils and Klenow, 2000, Schoellman, 2008, Córdoba and Ripoll, 2009, Hanushek and Woessmann, 2010, Erosa, Koreshkova, and Restuccia, 2010, Hendricks, 2010) by analyzing a mechanism that produces differential incentives to investing in human capital across occupations.

The rest of the paper is organized as follows. Section 3.2 describes in detail the empirical facts that motivate the connection bewteen informality, occupational entrepreneurship and education. The model economy is presented in Section 3.3. In Section 3.4 I provide a characterization of the equilibrium choices in terms of the cutoffs for occupations and educational levels. Section 3.5 describes what are the effects of an increase in the costs of enforcement and links these effects to the empirical motivation. Section 3.6 concludes.

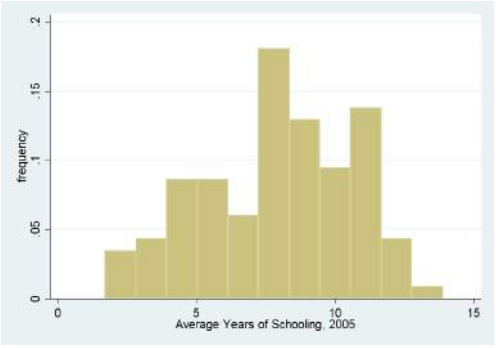
3.2 Empirical facts

Across countries in the world, the average years of schooling for the adult population (15+ years old) ranges from about 2 years to more than 12 years (Figure 3.1(a)). The size of the informal economy also varies significantly (Figure 3.1(b)), ranging from 8% of GDP for a country like the United States to 60% of GDP for a country like Bolivia (Schneider, Buehn, and Montenegro, 2011). Furthermore, Figure 3.1(c) shows that the rate of entrepreneurship, measured as the business ownership rate, is also very dispersed across countries.

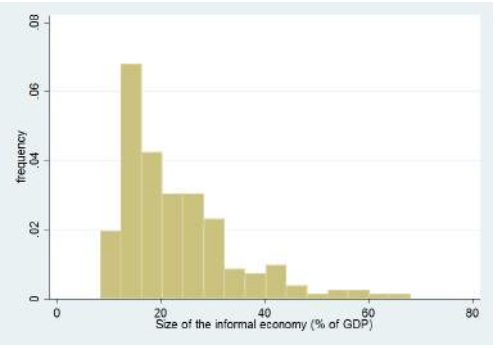
This paper explores the connection between these three magnitudes. The main hypothesis is that the level of informality in an economy affects individuals' decisions about human capital investments as well as occupational choices. Cross-country evidence reveals three key facts in line with this hypothesis. First, the business ownership rate is positively correlated with informality, as shown in Figures 3.2(a) and 3.2(b).[3]

Second, in countries with small informal sectors the Mincerian returns to education for entrepreneurs and for workers do not differ much, but a gap widens up as the level of informality becomes relatively high (Figure 3.3(a)). This evidence suggests that with high informality the returns to education for entrepreneurs may be larger than for workers,

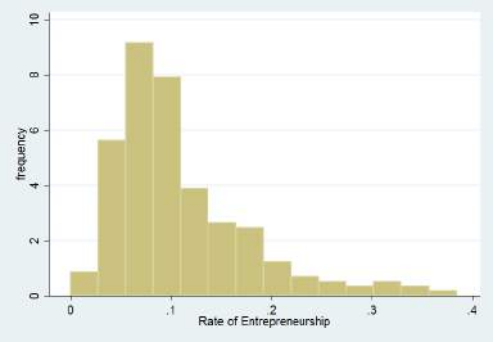
[3]Figures 3.2(a) and 3.2(b) only differ in the measure of informality used. The first measure (size of the informal economy) is the share of the GDP produced in the informal sector, and it is taken from Schneider, Buehn, and Montenegro (2011).The second measure is the share of vulnerable employment over total employment, according to the definition in the WDI (World Development Indicators, World Bank).



(a) Schooling years, 2005. *Source:* Barro and Lee database.



(b) Size of the informal economy (% of GDP), pooled years 2001-2007. *Source:* Schneider, Buehn, and Montenegro (2011).



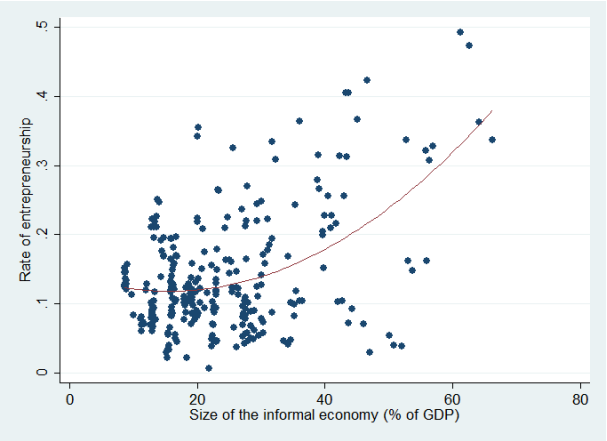
(c) Rate of entrepreneurship, pooled years 2001-2008. *Source:* Global Entrepreneurship Monitor (GEM) Database.

Figure 3.1: Cross-country distributions of schooling, informality, and entrepreneurship.

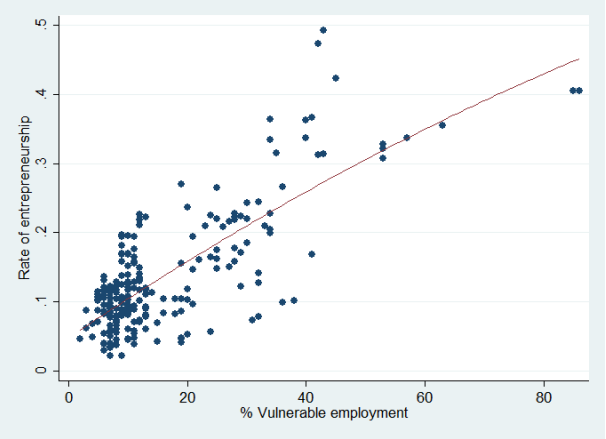
which is the same to say that in such economies there is a wage premium for skilled individuals that choose to be entrepreneurs instead of salaried workers. Another piece of similar evidence is shown in Figure 3.3(b) which, for a subset of countries (Latin American plus United States), shows that the relationship between this wage premium and the share of the shadow economy is specially present when we compare the wages of skilled informal entrepreneurs to those of skilled formal workers.[4] Since there exists vast evidence suggesting that education increases the returns to entrepreneurship[5], some entrepreneurs may be more inclined to invest in education as a way to overcome the low productivity of their businesses when informality is high (availability of credit is low). This is as to say that managers invest in their own human capital instead of in physical

[4]The definition of informality used is based on the productive characteristics of the occupations, according to which informal workers or entrepreneurs are those individuals who work in firms with less than five employees, irrespective of whether they contribute to social security systems, which corresponds to a more legalistic definition of informality. However, both ways of defining informality produce measures that are very much correlated.

[5]Parker (2004), Hartog, Van Praag, and Van Der Sluis (2010) and Block, Hoogerheide, and Thurik (2011) present evidence showing how education affects the returns to entrepreneurship.



(a) Business ownership rate and the informal economy. *Sources:* GEM Database and Schneider, Buehn, and Montenegro (2011).

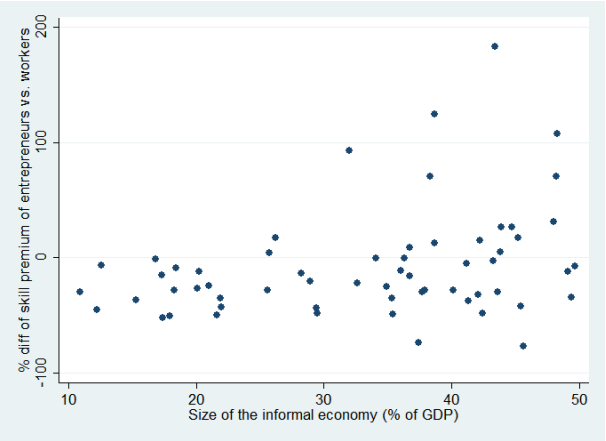


(b) Business ownership rate and vulnerable employment. *Sources:* GEM Database and WB-WDI.

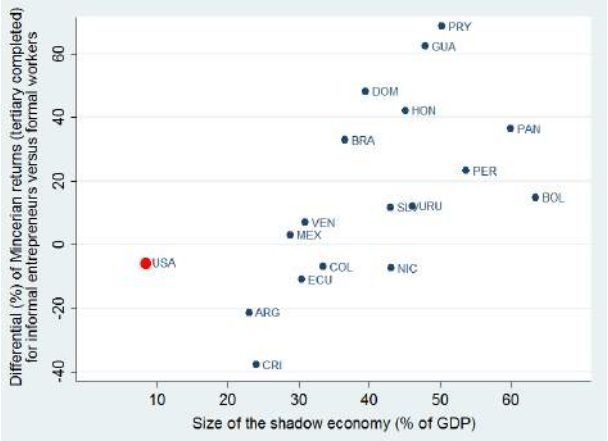
Figure 3.2: Fact 1 - The rate of entrepreneurship increases with the size of the informal economy.

capital. On the other hand, when informality is very low (and access to credit is broad) investing in education is an attractive alternative for workers due to the relatively higher wages paid to skilled workers.

Third, in countries with relatively large informal sectors, a larger fraction of skilled individuals choose to be entrepreneurs. This fact is shown in Table 3.1, where the mean ratio of skilled entrepreneurs to skilled labor force is higher for countries with a larger informal sector. Figure 3.4 presents the distributions of this ratio for countries with very low and very high shares of the informal economy, and shows that for the former group skilled entrepreneurs are as frequent as skilled individuals in the labor force (distributions is highly concentrated around the number 1, left panel), while for the latter group of countries (right panel in Figure 3.4) this figure shows that skilled entrepreneurs are more frequent



(a) Mincerian returns (%) to education (more than high school) for entrepreneurs minus those returns but for workers, as a function of the size of the informal economy. *Sources:* Household surveys for 88 countries, and Schneider, Buehn, and Montenegro (2011).



(b) Mincerian returns (tertiary education completed) for **informal** entrepreneurs (less than 5 employees) minus Mincerian returns for **formal** workers (in firms with 5+ employees), as a function of the size of the informal economy. *Sources:* SEDLAC and Gluzmann, Jaume, and Gasparini (2011), and Schneider, Buehn, and Montenegro (2011).

Figure 3.3: Fact 2 - Differences in skill premium (Mincerian returns) by occupations as a function of the size of the informal economy

than skilled persons in the labor force (the distribution is biased towards numbers greater than 1).

These facts suggest that the returns for skilled informal entrepreneurs increase with the extent of informality in the economy (fact 2). They also suggest that not only more business start up when informality is high (fact 1), but also that some of these business are run by skilled individuals, generating the fact that skills are more concentrated among

Table 3.1: Distribution of skilled individuals across occupations, for very low-informality and very high-informality countries.

Group of countries	**Description**	**Ratio: $\frac{\text{\% of skilled entrepreneurs}}{\text{\% of skilled labor force}}$**		
		Min	Max	Mean
Very low-informality	Countries in the bottom 25% of the distribution of sizes of informal economy	0.59	1.42	1.02
Very high-informality	Countries in the top 25% of the distribution of sizes of informal economy	0.58	1.69	1.12

Sources: GEM database and Schneider, Buehn, and Montenegro (2011).

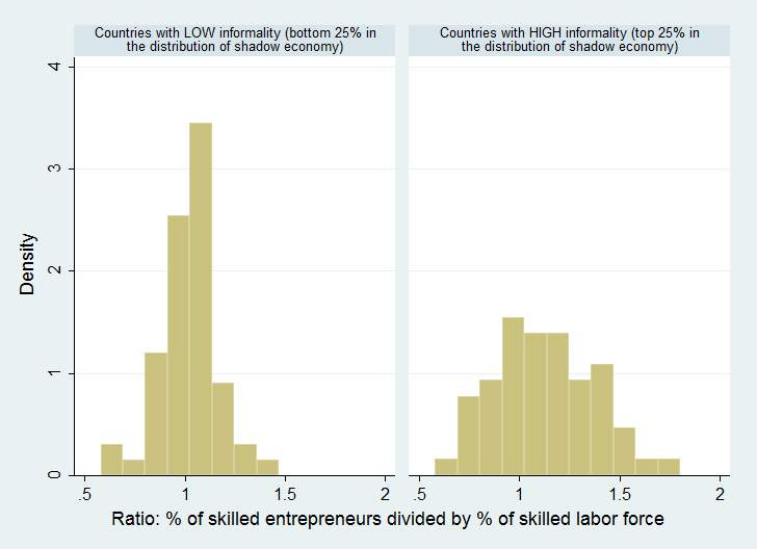
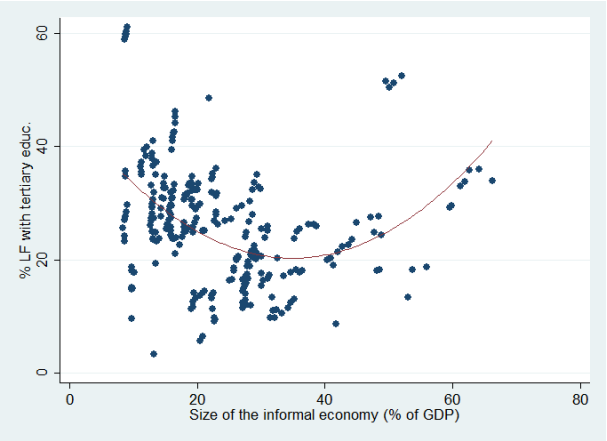
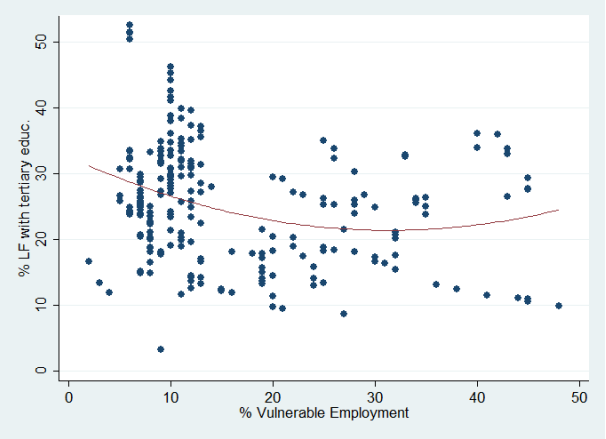


Figure 3.4: Fact 3 - Concentration of skills by occupation in countries with very low or very high levels of informality. *Sources:* GEM Database and Schneider, Buehn, and Montenegro (2011).

entrepreneurs the larger is the size of the informal economy (fact 3). Hence, pervasive informality in the economy may induce some individuals to invest in human capital in order not to become salaried workers in the formal sector, but to run their own business probably in the informal sector. As a result of this mechanism, the share of skilled individuals do not fall as much as it would otherwise. As shown in Figures 3.5(a) and 3.5(b), the correlation between the share of the labor force with post-secondary education (skilled) and the size of the informal economy appears to be indeed non-linear: the share of the skilled workforce first declines and then it rapidly stabilizes, or even raises, as the level of informality increases.



(a) Years of schooling and Informal Economy. *Sources:* World Bank EdStats and Schneider, Buehn, and Montenegro (2011).



(b) Education and Vulnerable Employment. *Sources:* World Bank EdStats and World Bank WDI.

Figure 3.5: Educational attainment of the labor force and the size of the informal sector.

3.3 The Economy

Consider the following model populated by agents who live for two peirods. The time is discrete and every period a new cohort of measure one of two-period lived agents is born. Agents are heterogeneous in their endowment of innate ability, denoted by $z \in [0, 1]$, which is distributed according to $\Gamma(z)$. There are three factors of production: skilled and unskilled labor -l_s and l_u, that receive salaries w_s and w_u in competitive labor markets- and capital k.

Each individual is endowed with one unit of time that can be offered in the market for unskilled workers, both when young and when old. In the first period, agents can also split their unit of time between unskilled work and education (investment in human capital).

I denote by $t_e \in \{t_e^U, t_e^S\}$, with $t_e^U < t_e^S$, the fraction of time devoted to education when young. To simplify notation, and as a normalization, I let $t_e^U = 0$, while $0 < t_e^S \leq 1$ represents the fraction of one model-period that needs to be allocated to the formation of skills.[6] That is, $(1 - t_e^S)$ is the quantity of unskilled labor supplied by a young agent that decided to invest in human capital. Next period this individual will have $\tilde{z}$ units of human capital, which is formed according to

$$\tilde{z} = \tilde{z}(t_e, z) = z^{\theta(\frac{1}{\theta} - t_e)}, \tag{3.1}$$

where $0 < \theta < \frac{1}{t_e^S}$ is a parameter that guarantees that this technology is: increasing in z and t_e; concave in z; $\tilde{z}(0, z) = z$ and $\tilde{z}(t_e, 0) = 0$, $\forall z$ and $\forall t_e$; and bounded such that $\tilde{z} \in [0, 1]$.[7]

In the second period, agents can be workers or become entrepreneurs (managers), and their amount of human capital $\tilde{z}$ can then be allocated to two alternative uses: managerial ability, denoted by m, or units of skilled labor, l_s. The agent that did not invest in skills when young and continues as a worker when old supplies her unit of labor $l_u = 1$ in the unskilled labor market in the second period of her life, as she did in the first one.

All production is carried out by entrepreneurs, who operate a technology

$$y = m^{\gamma} F(k, l_u, l_s)^{1-\gamma}, \tag{3.2}$$

that exhibits capital-skill complementarity, and in which $F(k, l_u, l_s)$ has constant returns to scale.[8] The share of the profits that goes to the manager is γ. Capital depreciates entirely from one period to the next.

There can be unskilled managers (with $m = z$, because they had chosen $t_e = 0$) as well as skilled ones (with $m = z^{\theta(\frac{1}{\theta} - t_e)} > z \ \forall z$, because they chose $t_e = t_e^S$ when young). The interpretation of these modeling choices indicates that managerial ability can be increased by investing time in education, and that innate ability z also intervenes in its formation. Moreover, managerial ability increases the productivity of the firm.[9]

[6] For instance, for a model economy with a period-length of 20 years (in which agents are born at age 20) the value t_e^S can be set to 1/4, which is the average time invested in post-secondary education (5 years).

[7] As described next, investing in skills in the first period is costly not only due to the forgone income when young, but also due to a direct cost c per unit of time spent to education.

[8] For instance, the production technology can take the form of a nested CES with perfect capital-skill complementarity: $y = m^{\gamma} F(k, l_u, l_s)^{1-\gamma} = m^{\gamma} [\min\{bl_s, k\}]^{\alpha(1-\gamma)} l_u^{(1-\alpha)(1-\gamma)}$.

[9] Evidence supporting this assumption can be found in Van der Sluis, Van Praag, and Vijverberg (2008).

The entrepreneurs (or managers) can act in the formal or the informal sector of the economy. In both sectors managers can self-finance part of the physical capital with savings from the first period, but they can also borrow money from a financial intermediary in order to rent the capital they need to run their businesses. In the formal sector, profits are taxed at $\tau > 0$.[10] In the informal sector, managers do not pay taxes. The financial intermediary lends at rate r, which is exogenously given, and formal managers can choose to default bearing a cost proportional to their income (η). Informal managers can easily hide any collateral from the intermediary, that is, they do not face a cost η in case of defaulting. Preferences are such that $U(c_1, c_2) = logc_1 + \beta logc_2$, where $\beta \in (0, 1)$ and $\beta(1 + r) \leq 1$.

For a given level of managerial ability m, and a given demand for capital k, the profits of entrepreneurs before paying taxes are

$$\Pi(k, m) = \max_{l_u, l_s \geq 0} m^{\gamma} F(k, l_u, l_s)^{1-\gamma} - (1 + r)k - w_s l_s - w_u l_u.$$

In a world with perfect contract enforcement ($\eta = 1$) formal managers would employ the uniquely defined optimal level of physical capital $k^*(m) = \arg\max_{k \geq 0} \Pi(k, m)$. However, here managers have the option to default and credit contracts must be self-enforcing (as in Amaral and Quintin, 2006). Therefore, the net profits of managers are

$$\begin{aligned} W(a, m; \eta, \tau) &= \max_{s \leq a, d \geq 0} (1 - \tau)\Pi(s + d, m) \qquad (3.3) \\ \text{s.t.} \quad (1 - \tau)\Pi(s + d, m) + a(1 + r) &\geq (1 - \eta)(1 - \tau)[\Pi(s + d, m) + (s + d)(1 + r)] \\ &+ (a - s)(1 + r), \end{aligned}$$

where d is the loan obtained from the financial intermediary and s is the collateral used to obtain that loan, which has to be lower than the savings from the first period (a). The solution to this maximization problem has to satisfy the incentive compatibility constraint that says that the contract has to be such that the intermediary will only lend an amount d that makes default sub-optimal. The left-hand side of this constraint is exactly equal to the net income of the manager if she repays. The right-hand side is her net income in the case of defaulting, where the manager saves the principal plus the interest that otherwise would have gone to the intermediary. I denote by $s(a, m; \eta, \tau)$, $d(a, m; \eta, \tau)$, $l_u^d(a, m; \eta, \tau)$, $l_s^d(a, m; \eta, \tau)$ the solutions to the problem of a manager with savings a and managerial skills m. Entrepreneurs choose the formal sector when their access to outside

[10] The proceeds from taxation are dissipated.

financing is sufficient to offset the fact that they become subject to taxation, that is, when $W(a, m; 0, 0) \leq W(a, m; \eta, \tau)$.

3.3.1 Individuals' choices

The individual with ability z solves the following problem of maximizing her lifetime utility by solving

$$
\begin{aligned}
V(z) &= \max_{a\geq 0,\ t_e\in\{t_e^U, t_e^S\}, \phi_w\in\{0,1\}, \phi_f\in\{0,1\}} \log(c_1) + \beta \log(c_2), \qquad (3.4)\\
&\text{subject to}\\
c_1 &= (1-t_e)w_u - ct_e - a,\\
c_2 &= a(1+r) + \phi_w[(1-\frac{t_e}{t_e^S})w_u + \frac{t_e}{t_e^S} w_s \tilde{z}(z, t_e)] +\\
&\quad (1-\phi_w)[\phi_f W(a, \tilde{z}(z, t_e); \eta, \tau) + (1-\phi_f) W(a, \tilde{z}(z, t_e); 0, 0)],\\
\text{and}\quad \tilde{z} &= z^{\theta(\frac{1}{\theta} - t_e)}.
\end{aligned}
$$

Note that in the second period she has her asset income, $a(1+r)$, and if the agent chooses to be unskilled, i.e. $t_e = t_e^U = 0$, and decides to be a worker, i.e. $\phi_w = 1$, then she also earns w_u. If she decides to be a manager, she uses her $\widetilde{z} = z$ units of skills to run a firm. The firm can be formal, and in this case the manager earns $W(a, \widetilde{z}(z, t_e); \eta, \tau)$. If the firm is informal, on the other hand, the net profit of the manager is given by $W(a, \widetilde{z}(z, t_e); 0, 0)$. For an agent who decides to become skilled, the second period income is $w_s \widetilde{z}(z, t_e)$ is she decides to be a worker. If a skilled agent decides to work as a manager, she uses her managerial ability $\widetilde{z}(z, t_e^S) > z$ either as a formal or as an informal manager.

The solution to this problem gives the agent's decision on how much to save (i.e., $a(z; \eta, \tau)$), the amount of time spent investing in her human capital when young (i.e., $t_e(z; \eta, \tau) \in \{0, t_e^S\}$), her occupation when old (i.e., $\phi_w \in \{0, 1\}$), and, if she chooses to be a manager, the sector in which to operate (i.e., $\phi_f \in \{0, 1\}$).[11]

[11] We focus on equilibria in which wages are constant over time (denoted by w_s and w_u).

3.3.2 Labor markets

In each period, the aggregate demand for skilled labor is given by

$$\begin{aligned} L_s^d(w_s, w_u; \eta, \tau) &= \int_{z\in[0,1]} l_s^d(a(z), m(z, t_e(z)); \eta, \tau)[1-\phi_w(z)]\phi_f(z)\Gamma(z)dz \\ &+ \int_{z\in[0,1]} l_s^d(a(z), m(z, t_e(z)); 0, 0)[1-\phi_w(z)][1-\phi_f(z)]\Gamma(z)dz. \end{aligned} \tag{3.5}$$

Similarly, the aggregate demand for unskilled labor is

$$\begin{aligned} L_u^d(w_s, w_u; \eta, \tau) &= \int_{z\in[0,1]} l_u^d(a(z), m(z, t_e(z)); \eta, \tau)[1-\phi_w(z)]\phi_f(z)\Gamma(z)dz \\ &+ \int_{z\in[0,1]} l_u^d(a(z), m(z, t_e(z)); 0, 0)[1-\phi_w(z)][1-\phi_f(z)]\Gamma(z)dz. \end{aligned} \tag{3.6}$$

In each period, the aggregate supply of skilled labor is

$$L_s^s(w_s, w_u; \eta, \tau) = \int_{z\in[0,1]} \tilde{z}(z, t_e(z))\frac{t_e(z)}{t_e^S}\phi_w(z)\Gamma(z)dz. \tag{3.7}$$

The aggregate supply of unskilled labor is

$$\begin{aligned} L_u^s(w_s, w_u; \eta, \tau) &= \int_{z\in[0,1]} [(1-t_e^S)\frac{t_e(z)}{t_e^S} + (1-\frac{t_e(z)}{t_e^S})]\Gamma(z)dz \\ &+ \int_{z\in[0,1]} \phi_w(z)(1-\frac{t_e(z)}{t_e^S})\Gamma(z)dz. \end{aligned} \tag{3.8}$$

3.3.3 Equilibrium

Given η, τ, and Γ, a steady state equilibrium for this economy is a pair $\{w_s, w_u\}$ of wage rates and a list of policies for each z-type agent such that: (i) policies are optimal for all agents (they solve the problem stated in (3.4)); and (ii) labor markets for both types of labor clear, that is

$$L_s^d(w_s, w_u; \eta, \tau) = L_s^s(w_s, w_u; \eta, \tau),$$

and

$$L_u^d(w_s, w_u; \eta, \tau) = L_u^s(w_s, w_u; \eta, \tau).$$

3.4 Characterization of the equilibrium

This section is intended to explore the main features of an equilibrium for the model economy described above. To do so, we first inspect the main features of the demand for credit in this model economy, and then the key aspects regarding occupational and educational choices.

It is important to note that in the model economy, and for the existence of an equilibrium with positive production, there has to be some agents who choose to be workers and some others who choose to be entrepreneurs. Furthermore, given the technology to produce goods, in the equilibrium there must be skilled and unskilled workers supplying labor to entrepreneurs. Needless to say, the exact equilibrium occupational choices for each ability level will depend on the values of the parameters values of the parameters characterizing preferences (basically β), the technology for producing goods (γ, α and b)[12], the technology for human capital formation (t_e^S, θ, and the direct costs of education, c), and those shaping the distribution of innate ability (μ_z and σ_z).[13] However, any quantitative version of this economy that tries to resemble key aspects of the data -in which both formal and informal sectors exist and in which both type of managers can be either skilled or unskilled-, will need a set of parameter values that not only produces an equilibrium with six types of occupations (unskilled workers, skilled workers, informal unskilled managers, informal skilled managers, formal unskilled managers, and formal skilled managers) but also satisfies the allocation of credit and the order of the cutoffs that are described next.

3.4.1 The demand for credit

In order to characterize the demand for credit, first note that the incentive compatibility constraint can be written as

[12] Where b is the technical coefficient in a nested CES with perfect capital-skill complementarity: $y = m^{\gamma}[\min\{bl_s, k\}]^{\alpha(1-\gamma)} l_u^{(1-\alpha)(1-\gamma)}$.

[13] Occupational choices will of course also depend on the exact functional forms of preferences and technologies. The key technological assumption for the results is that there is a sufficiently high degree of capital-skill complementarity in the production function of goods.

$$\eta(1-\tau)\Pi(s+d,m)+s(1+r)[1+\eta+\eta(1-\tau)]\geq d(1-\eta)(1-\tau)(1+r), \tag{3.9}$$

which allows us to show that $s(a,m;\eta,\tau)=a$, i.e., those managers that can access to credit will pledge all their savings as the collateral for the loan.[14] It is also immediate from inequality (3.9) that this incentive compatibility constraint will be binding at the optimum.[15] Figure 3.6 illustrates this result.

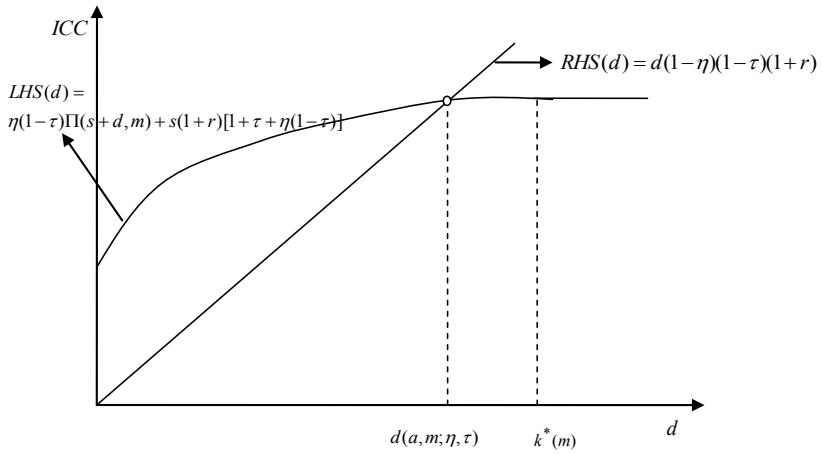


Figure 3.6: The incentive compatibility constraint (ICC) and the demand for loans.

On the other hand, the amount of credit that a manager is able to get from the intermediary depends on her level of human capital (which affects the overall productivity of the firm she runs), as well as on the costs of contract enforcement (η).[16] In particular, the amount of loans demanded (and granted) for a manager with savings $a<k^*(m)$ (i.e., constrained) is increasing in m and η. These results are shown in Figures 3.7(a) and 3.7(b).[17]

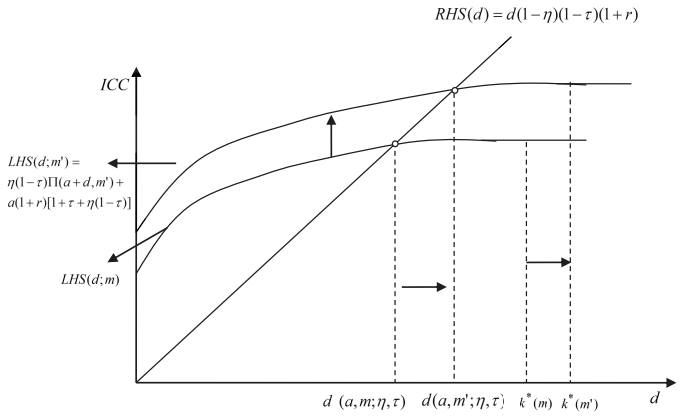
[14] In the inequality (3.9) it is easy to see that the left-hand side is increasing in s while the right-hand side is a linear function of d, given the parameters. In addition, since the objective function is also increasing in s, the constraint $s\leq a$ in the individual's maximization problem will be binding at the optimum.

[15] The LHS in (3.9) is a linear increasing and concave function of d, given a, m and the parameters τ,η. The RHS is increasing in d up to the level of optimal use of capital, $k^*(m)$ -which results from solving the unconstrained version of the maximization problem in (3.3)-, and for all $d>k^*(m)$ the RHS is constant. Since the objective function is also increasing in d, the demand for loans $d(a,h;\eta,\tau)$ can be found in the intersection between the LHS and the RHS.

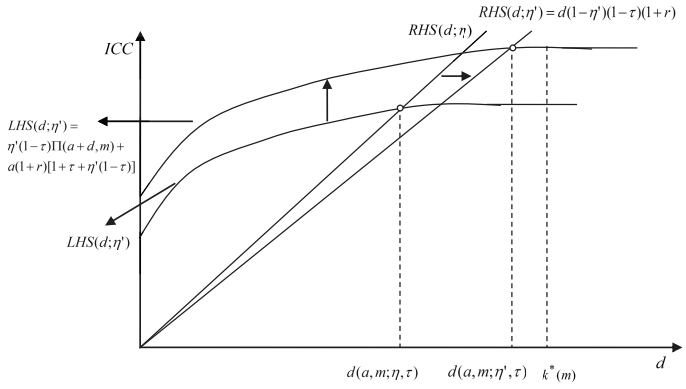
[16] Of course, the amount of credit that the intermediary is willing to lend to the entrepreneur will also depend on her savings, because this affects the amount of resources that can be used as a collateral. Note that the result stating that $s(a,h;\eta,\tau)=a$, together with the fact that the LHS in (3.9) is increasing in s for all possible values of d, produce this result.

[17] For the first of these results, notice that a manager with a high m runs more efficiently her business compared to a manager with low levels of managerial skills. This higher productivity or profitability makes more reliable the promise of repayment and, as consequence, the intermediary can lend a higher

Finally, in the model economy while formal entrepreneurs are able to borrow from financial intermediaries, informal managers are not able to do so. This result follows from the fact that for informal managers $\eta = \tau = 0$. As a result, the constraint (3.3) becomes $0 \geq d(1+r)$. Therefore, informal managers must self-finance the physical capital they use in their operations with their savings from the first period.



(a) Loan increasing in m ($m' > m$).



(b) Loan increasing in η ($\eta' > \eta$).

Figure 3.7: Characterization of the demand for loans.

amount to the more skilled manager (Figure 3.7(a)). Second, an improvement in the enforcement of credit contracts (higher η) increases the loan d, because even in case of default lenders can regain a larger share of the loan, as shown in Figure 3.7(b).

3.4.2 Occupational and educational choices

Given a set of parameter values that produce an equilibrium with a positive mass of individuals choosing each one of the six possible occupations, the order of the cutoffs over the support of innate ability ($z \in [0, 1]$) can be characterized. First note that given that the equilibrium requires the use of at least some amount of unskilled labor, and because the value for unskilled workers is independent of z, it has to be that the less talented individuals choose to be unskilled workers. Furthermore, since m and k are complementary, managers with the highest levels of managerial ability will choose the formal sector to operate their businesses. Finally, for any z higher than the cutoff from which entrepreneurs switch from the formal to the informal sector, all managers will also be formal, that is, managers will not revert their sector decision.[18] On the other hand, individuals that were born with very high levels of ability (those with $z \to 1$) will choose not to invest in their own human capital, i.e., they will choose to be formal unskilled managers.[19] Hence, it is possible to characterize the occupations in the lower tail (unskilled worker) and in the upper tail (formal unskilled manager) of the distribution of innate ability.

For the rest of the occupations, it is important to note that skilled informal managers need to be abler than unskilled informal managers. Since acquiring education is costly, only abler individuals among informal managers will find profitable to invest in their own human capital.[20] As a result, we end up with four possible configurations of the occupational cutoffs. In these four cases the bottom part of the distribution of z is occupied by unskilled workers, while in the top there are unskilled formal managers. Each case differs in where the mass of agents that choose to be skilled workers is located. The first case is represented in Figure 3.8, and the other three cases can be found in Figures C.1, C.4, and C.7 in Appendix C.[21]

[18] If a manager of ability z accepts to pay taxes in exchange of getting access to the credit market, then a manager with a higher ability ($z' > z$) will also prefer to do so, because of the complementarity between ability and physical capital.

[19] This is a result of the shape of the technology for human capital formation (stated in equation (3.1)), in which for $z \to 1$ the contribution of education to increase m is close to zero. Anecdotically, one can think in Bill Gates or Steve Jobs as two examples of highly productive and formal entrepreneurs that are college dropouts.

[20] This is true as long as informal managers are not too able, that is, as long as they lie in the "middle" of the support for innate ability. This condition is likely to be fulfilled because both types of formal managers (skilled and unskilled) have higher levels of innate ability z, and therefore they lie closer to 1 in the support of z.

[21] The notation used for the cutoffs identifies with a subscript the previous occupation and with a superscript the following occupation in the support of z. In Case 1 the order of the cutoffs is: $\hat{z}_{U,W}^{S,W}$, $\hat{z}_{S,W}^{U,I,M}$, $\hat{z}_{U,I,M}^{S,I,M}$, $\hat{z}_{S,I,M}^{S,F,M}$, and $\hat{z}_{S,F,M}^{U,F,M}$. In Case 2, the order is: $\hat{z}_{U,W}^{U,I,M}$, $\hat{z}_{U,I,M}^{S,W}$, $\hat{z}_{S,W}^{S,I,M}$, $\hat{z}_{S,I,M}^{S,F,M}$, and $\hat{z}_{S,F,M}^{U,F,M}$.

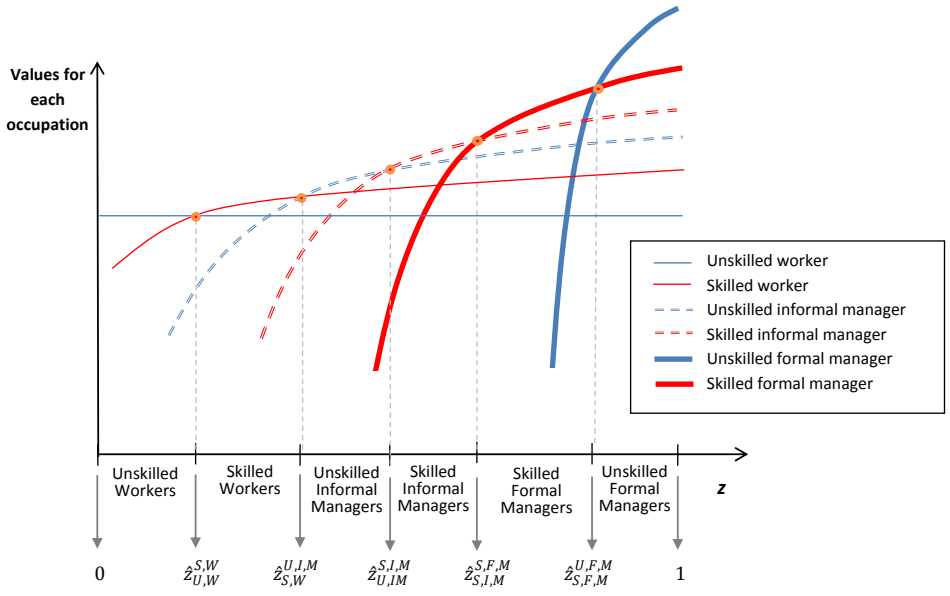


Figure 3.8: One plausible configuration of occupational, educational, and sector choices along the support of z.

3.5 The effects of higher costs of contract enforcement

We are now ready to analyze the effects of higher contract enforcement costs. When the cost of enforcing contracts is higher, the demand for credit of formal managers is lower (see Figure 3.7(b)), so is the use of capital in their operations. However, the use of capital of informal managers is not directly affected, since they self-finance the amount they pay for the services of physical capital. Therefore, through this channel, a moderate increase in the cost of enforcing contracts (lower η) will induce a fall in the value obtained by formal managers, and at the same time this will first leave unaffected the values obtained by informal managers (both skilled and unskilled).[22] Moreover, since formal managers use more intensively skilled labor -due to capital-skill complementarity in the production function-, in a scenario with higher costs of contract enforcement the demand for skilled labor will be reduced, which in equilibrium will imply lower relative earnings for skilled versus unskilled workers. These two are the key mechanisms at work when η

In Case 3 the order is: $\hat{z}^{U,I,M}_{U,W}$, $\hat{z}^{S,I,M}_{U,I,M}$, $\hat{z}^{S,W}_{S,I,M}$, $\hat{z}^{S,F,M}_{S,W}$, and $\hat{z}^{U,F,M}_{S,F,M}$. Last, in Case 4 the order is: $\hat{z}^{U,I,M}_{U,W}$, $\hat{z}^{S,I,M}_{U,I,M}$, $\hat{z}^{S,F,M}_{S,I,M}$, $\hat{z}^{S,W}_{S,F,M}$, and $\hat{z}^{U,F,M}_{S,W}$.

[22] Notice for instance that $W(a(z), m(z); \eta, \tau)$ is increasing in η (see Figure 3.7(b)) while $W(a(z), m(z); 0, 0)$ is independent of η.

falls, and they are illustrated in Figure 3.9 as movements in the values of formal managers and skilled workers. Of course, these are the first effects that are triggered, and in the general equilibrium the values for the rest of occupations will also be affected. However, the changes in the values of formal managers and skilled workers are of first order and will likely quantitatively dominate. In addition, the key results obtained below regarding changes in occupations and educational attainment of z-type agents will be preserved when adding these subsequent -general equilibrium- changes in the values of other occupations.[23]

As shown in Figures 3.9 and 3.10[24], these key movements of the value functions produced by a higher cost of enforcing contracts (lower η) will increase the number of entrepreneurs acting in the informal sector.[25] Hence, in the model economy there is a direct mapping between the cost of contract enforcement and the number of informal entrepreneurs. Moreover, the cutoff for becoming an entrepreneur will decrease (lower $\hat{z}_{S,W}^{U,I,M}$) when η is lower, i.e., when the level of informality in the economy raises. As a result, in an economy with equilibrium cutoffs as those in Figure 3.8, an increase in the costs of contract enforcement will induce not only a larger proportion of informal entrepreneurs, but also a larger number of entrepreneurs, amplifying the rate of entrepreneurship in the economy. This observation is consistent with the empirical fact 1 (Figure 3.2) that shows that countries with larger informal sectors also have larger shares of their labor force in entrepreneurial activities.

Furthermore, note that since there is no reason to think that the value obtained by skilled informal entrepreneurs will be lower if η falls (in fact, this value is likely to increase due to lower salaries paid to skilled labor), their skill premium will not be negatively affected. Since the salaries of skilled workers are now relatively lower because they are less demanded, then the difference in the skill premium of entrepreneurs and of workers changes, favoring more the entrepreneurs the lower is η. This result is consistent with the empirical fact 2 (Figure 3.3(b)) that shows that the gap between the premium received by skilled informal entrepreneurs and skilled workers is increasing with the importance of the informal sector in the economies.

A final remark about the effects of a lower value for parameter η is in order. As it was stated above, when costs of enforcing contracts increase less individuals choose to be skilled

[23]For instance, the values of informal managers are likely to be improved due to the lower w_s paid to skilled workers.

[24]Notice that these figures omit considering the underlying distribution of z-types, which is needed to properly count the shares of individuals who choose one or the other occupation or educational level. One way to easily incorporate in these Figures the distribution of z is to assume a uniform distribution. But the results hold true for other well-behaved (unimodal) distributions as well.

[25]While $\hat{z}_{S,W}^{U,I,M}$ is reduced, $\hat{z}_{S,I,M}^{S,F,M}$ is increased, leading to this result.

workers. The opposite occurs with the number of individuals who choose to be skilled informal managers. Moreover, the aggregate number of skilled managers, either formal or informal, does not decrease when η is reduced. Therefore, the share of skilled individuals that choose to become entrepreneurs in this economy increases when the enforcement of contracts becomes more costly. This result is related to the empirical fact 3 (skills are relatively more concentrated among entrepreneurs the more informal the economies are).

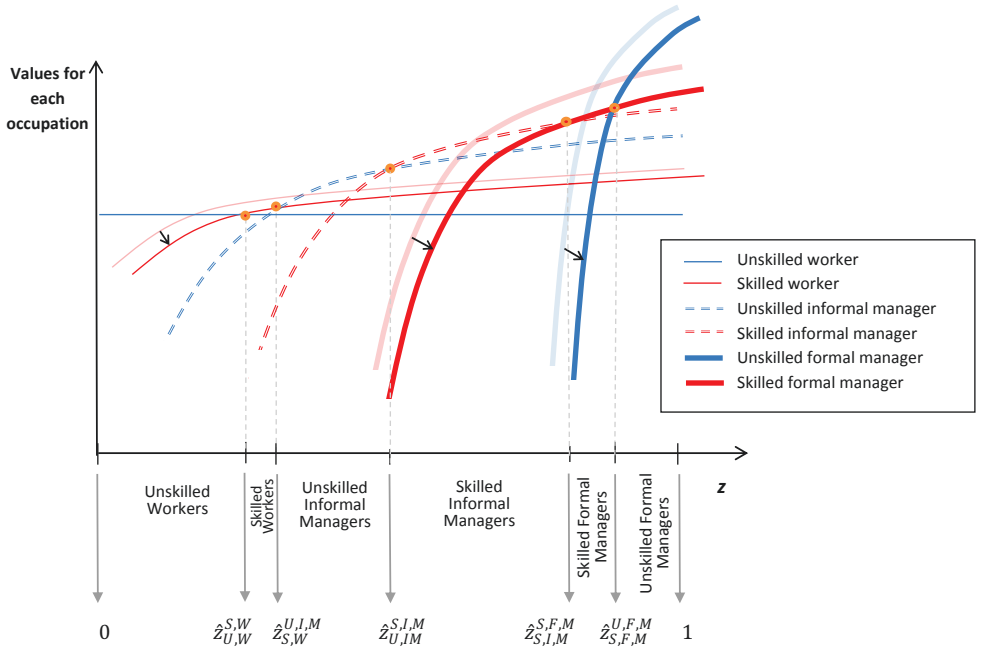


Figure 3.9: Changes of the cutoffs for occupational, educational, and sector choices along the support of z for higher costs of enforcing contracts (a lower η).

Analyzing the effects of higher costs of enforcing contracts for the other three possible configurations of the occupational cutoffs produces similar results, which are detailed in Appendix C (Figures C.2, C.5, and C.8).

3.6 Conclusions

Informality is pervasive in many developing countries, and its effects range from harming credit, reducing the stock of available physical capital, segmenting labor markets, depriving large shares of population from labor rights, and, as shown in this paper, to also affect

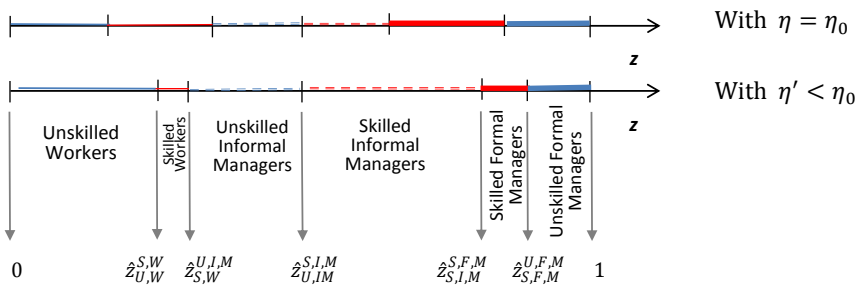


Figure 3.10: Occupational cutoffs for two values of η (η_0 and η', with $\eta_0 > \eta'$).

the incentives to invest in human capital across different occupations, as well as occupational choices themselves. In the current paper, the key mechanism producing these effects is also related to the impact of informality on the extent of financial intermediation and, as a result, on the use of capital in the production of goods and services.

This paper offers an analytical framework that is able to connect different empirical facts that *a priori* seem unrelated. In particular, these facts show a strong link between the extent of informal activities, the rate of entrepreneurship, and the distribution of educational attainment across occupations. More informal economies not only have more entrepreneurs (many of them are the so called 'subsistent' entrepreneurs), but are also characterized for paying relatively more to skilled entrepreneurs than to skilled workers, as compared with more formal economies. Also, in informal (less developed) economies the relatively scarce stock of skills is more concentrated among entrepreneurs. The model presented here links all these facts to the idea that the higher are the costs of enforcing contracts -in particular, credit contracts- the higher will be the extent of the informal economy, and there will exist more incentives to becoming an entrepreneur instead of a worker and to invest in human capital only if you are an entrepreneur and not so much if you are a worker.

The mechanisms at work start to operate through financial intermediation. When the costs of enforcing contracts are higher, financial intermediaries are reluctant to lend much money, and formal entrepreneurs (who are not excluded from the credit market) are more financially constrained and, therefore, less capable of hiring physical capital to operate

their businesses. Since the technology features capital-skill complementarity, this implies that formal entrepreneurs will demand less skilled workers, who in the new equilibrium for the labor market will be paid lower salaries. On the other hand, these changes in the market for credit will not impact directly those entrepreneurs acting in the informal sector, since they were already excluded from the possibility of being externally financed. However, some entrepreneurs will now not only be more inclined to act in the informal sector, but to also to invest 'in themselves'. That is, some individuals who otherwise would have chosen to be formal entrepreneurs, under higher costs of enforcing contracts will choose to act informally and also to spend time and other resources in the formation of their own human capital, as way to overcome the lack of physical capital. This happens because in the model economy the investments in human capital increase managerial skills, which improve the overall efficiency of the productive unit.

Therefore, more informality implies a different distribution of skills across occupations and sectors of activity, because it incentivizes investments in human capital of some managers, but it causes the opposite effect for workers. Importantly, informality affects crucially the occupational choices of individuals, making some of them to change their decision regarding being a worker or an entrepreneur, and also regarding in which sector of the economy to operate for the case of entrepreneurs.

Appendix A

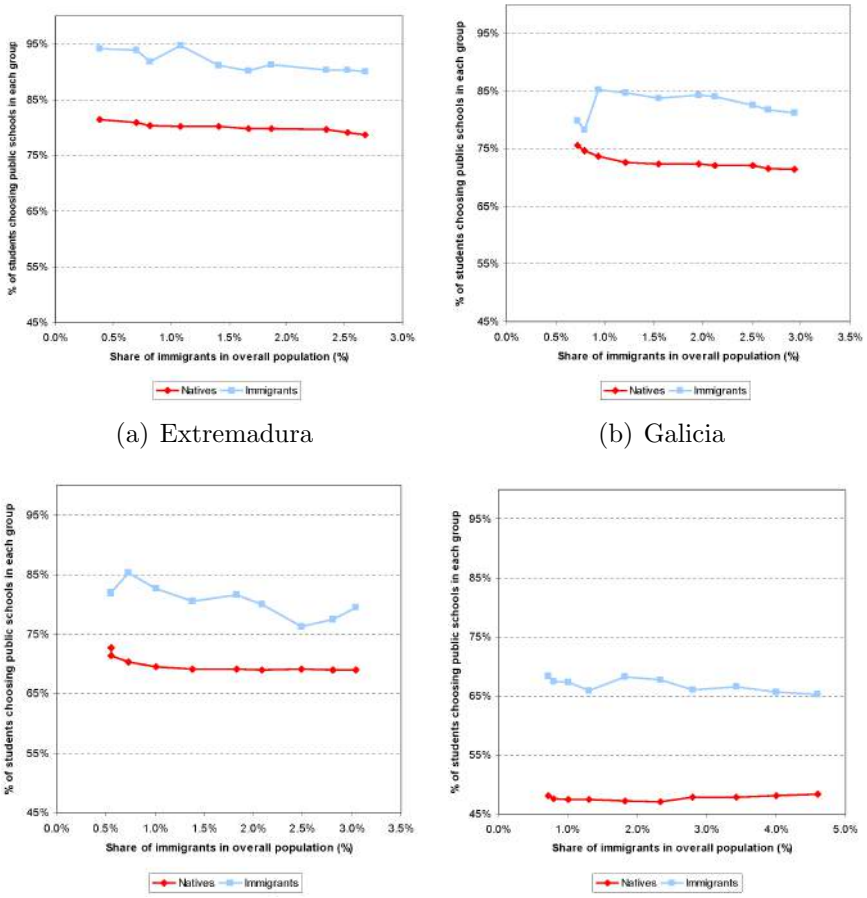
Appendix to Chapter 1

Discussion on other possible mechanisms leading to sorting of students

In this section I discuss other mechanisms that may be at work in the sorting of students across public and private alternatives assessed in this paper. I discuss the sorting by income, peer effects, and crowding-out hypotheses that usually are supported by this type of segregation.

It is possible that the sorting in Figure 1.1 was generated by a simple sorting by income process. For instance, if natives were becoming richer while immigrants poorer in this period of time, the income effect associated to the demand for education (assuming it is a normal good) may help to explain Figure 1.1. However, the four regions in Figures A.1(a) to A.1(d) were becoming wealthier as well. Figure A.2 shows that GDP per capita in these regions was increasing at the same pace as in Madrid. However, in none of these four regions private education started to be relatively more attractive for native parents, which contradicts the hypothesis of a mere income effect as a driver of the sorting of students across the two systems. On the other hand, there is no available data which allows for a comparison of the evolution of socio-economic status of immigrants versus natives from 1998 to 2006.[1]

[1]For Spain, the lack of microdata about individual characteristics in the two population groups limits severely the analysis that can be done in this direction. Some simple comparisons can be done. Data from the ENI (*Encuesta Nacional de Inmigrantes*, 2007) and the EPA (*Encuesta de Población Activa*) indicate that natives are on average more educated than immigrants, but differences among both groups in this dimension are not sharp. While 27% of immigrants have at least tertiary education, this number is 31% for natives. About the evolution of the type of immigrants arriving to Madrid, using the composition of



(a) Extremadura (b) Galicia

(c) Asturias (d) Basque Country

Figure A.1: Schooling choices of natives and immigrants in the four regions with less immigrants in Spain (1998-2007).

Another reason that may help to explain the widening gap between natives and immigrants schooling decisions is the presence of negative peer group effects on educational attainment in those schools with larger shares of foreign-born students. These negative peer effects are often suggested to be a consequence of language disadvantages and lower educational background of both parents and students with immigrant background. However, the importance of the role played by these peer effects still remains under discussion in the empirical literature on education production function.[2]

immigrants in each year and the HDI (Human Development Index) in their countries of origin, gives a vague idea of the average "quality" of immigrants in Madrid in 1998 and 2006. The weighted averages of this index for a representative immigrant in Madrid changed little from 1998 to 2006 (0.81 in 1998 and 0.78 in 2006). Computing the same weighted measure but just considering the education component in the HDI also provides evidence on the small changes in this measure: the representative immigrant in Madrid in 1998 has an education-level index of 0.84 in 1998 and of 0.85 in 2006. Of course, such computations are seriously flawed by the fact that they do not deal with selection issues of individuals who migrated.

[2]For instance, while Gould, Lavy, and Paserman (2009) find that more immigrants in a grade had a significant and large adverse effect on educational outcomes of native students, Angrist and Lang (2004)

Last, the usual crowding-out effect might be operating: a higher number of immigrant students may displace native students in the public education system. This crowding-out effect is usually related to some degree of capacity constraints or congestion in public schools. However, no signals of capacity constraints are observed neither in the case of Madrid nor in the case of Comunitat Valenciana in several indicators of capacity, such as spending per capita or the student-teacher ratio. The student-teacher ratio has been decreasing in both type of schools (public and private) at the same rate in Madrid and also in the case of Comunitat Valenciana (Figure A.3) and the spending per student in public schools has been increasing remarkably more than the number of students in those schools (Figure A.4).

Therefore, the recent experience of Spain shows that in spite of the fact that some of the other sorting forces (income differences across groups, peer effects, and crowding-out in public schools) might be at work, still socialization concerns play an important role in the sorting of students which often follows large-scale immigration.

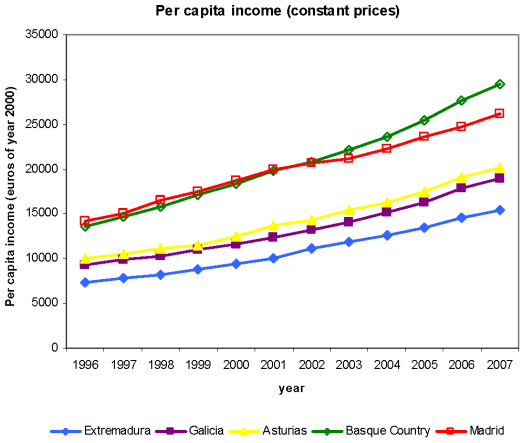


Figure A.2: Per capita income in the four regions with less immigrants in Spain and in Madrid.

conclude that peer effects from a desegregation program are modest and short lived. Also, for the case of Madrid, Anghel and Cabrales (2010) and Silaghi (2010) only find some small significant negative effects of having many more immigrants in a classroom and only on reading test scores. For instance, Silaghi (2010) finds that passing from a school with 0 immigrants to a school with 50% immigrants would decrease the results of the native students by 0.24 points in reading scores (on a scale from 0 to 10).

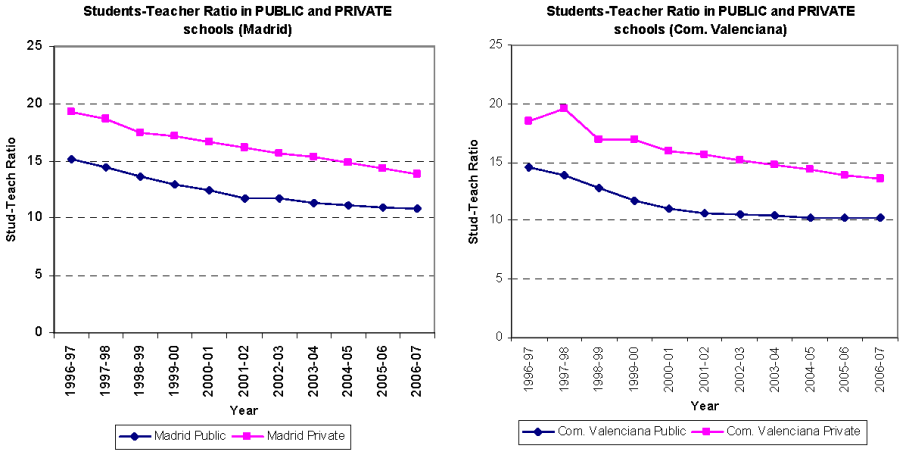


Figure A.3: Evolution of the student-teacher ratio in public and private schools in Madrid and Com. Valenciana.

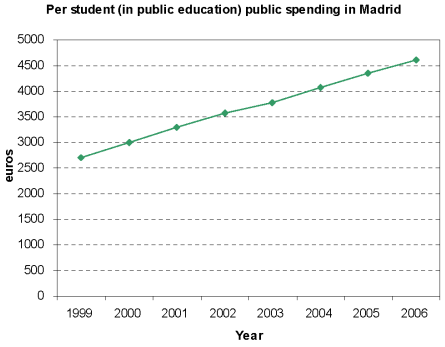


Figure A.4: Evolution of the spending per student in public schools in Madrid.

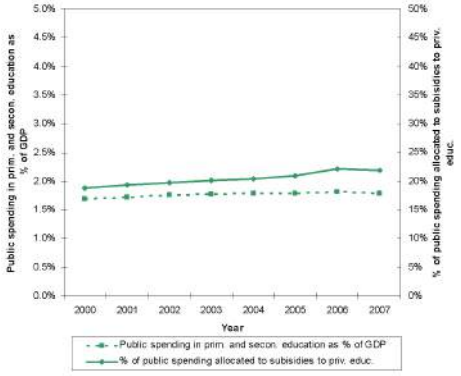


Figure A.5: Public spending in public and private (non-higher) education as a % of regional GDP (calibrated as τ), and the rate of subsidy for private education (calibrated as ϕ) in Madrid.

PISA results

Table A.1: Native-immigrant educational gap in Spain, according to PISA 2000, 2003, and 2006.

	Ratio natives' to immigrants' scores		
Year	Reading	Mathematics	Science
2000	1.06	1.03	1.09
2003	1.07	1.09	1.10
2006	1.11	1.12	1.13

Table A.2: Private-public schools educational gap in Spain, according to PISA 2000, 2003, and 2006.

	Ratio scores private/public schools		
Year	Reading	Mathematics	Science
2000	1.08	1.08	1.08
2003	1.08	1.07	1.07
2006	1.09	1.08	1.08

Data on housing prices

Table A.3: Housing prices and population by districts in Madrid.

Districts	Housing Price, 1998 (euros per m^2)	Total Population (July 1, 2002)	Cumulative Pop. (%)
"Bad" neighborhood (m_1)			
Villaverde	871	132848	4.3%
Villa De Vallecas	1022	63625	6.3%
Usera	1142	123175	10.3%
Puente Vallecas	1199	235723	17.9%
San Blas	1202	141174	22.5%
Vicálvaro	1208	56721	24.3%
Carabanchel	1265	229336	31.7%
Barajas	1293	39397	33.0%
Latina	1307	258948	41.4%
Fuencarral-Pardo	1325	210404	48.2%
Moratalaz	1400	108174	51.7%
Arganzuela	1520	141698	56.2%
Retiro	1594	126325	60.3%
Moncloa-Aravaca	1653	114886	64.0%
Ciudad Lineal	1683	231546	71.5%
Hortaleza	1683	151204	76.4%
"Good" neighborhood (m_2)			
Centro	1722	143113	81.0%
Tetuán	1746	147800	85.8%
Chamartín	1953	142270	90.4%
Chamberí	2078	150037	95.2%
Salamanca	2182	148343	100.0%

Source: Ayuntamiento de Madrid, http://www.munimadrid.es/UnidadesDescentralizadas/UDCEstadistica/Publicaciones/PUrbanoVivienda/MercadoVivienda/Ficheros/Distritos%20de%20Madrid/PVdic99_dic06ddat.xls.

Appendix B

Appendix to Chapter 2

DDD estimator in a non-linear model

To simplify notation, in this section we use the specification of the outcome equation, which does not include state classification, covariates, and gender interactions.

Considering that the outcome variable is binary, the expectation of the outcome equation measures the probability of doing light physical activity any positive number of times per week, and has the following form

$$\begin{aligned}\mathbb{E}[y_{it}|elem_i, S_i, \tau_t] = f\Big[&\beta_0 + \beta_1\tau_t + \beta_2 elem_i + \beta_3 S_i \\ &+ \beta_4(elem_i \times \tau_t) + \beta_5(S_i \times \tau_t) + \beta_6(elem_i \times S_i) \\ &+ \beta_7(\tau_t \times elem_i \times S_i)\Big],\end{aligned} \tag{B.1}$$

where f is the cumulative distribution function of idiosyncratic shocks (u_{it}).

As remarked in Blundell and Dias (2009), applying DD and DDD methods imposes additive separability of the error term conditional on the observables, an assumption that does not hold when the outcome of interest is a dummy variable. To overcome this limitation, we follow Blundell, Dias, Meghir, and Reenen (2004) by imposing the identifying assumption:

$$\begin{aligned}&\mathbb{E}(u_{i1} - u_{i0}|elem_i = 1, S_i = 1) - \mathbb{E}(u_{i1} - u_{i0}|elem_i = 1, S_i = 0) \\ &= \mathbb{E}(u_{i1} - u_{i0}|elem_i = 0, S_i = 1) - \mathbb{E}(u_{i1} - u_{i0}|elem_i = 0, S_i = 0),\end{aligned} \tag{B.2}$$

over the index, rather than over the probability itself. Assuming that the inverse probability function, f^{-1}, is known, the DDD estimator of the ATT is

$$\begin{aligned}\widehat{ATT} = \bar{y}_1^{1,1} - f\Big\{ & f^{-1}(\bar{y}_0^{1,1}) + [f^{-1}(\bar{y}_1^{1,0}) - f^{-1}(\bar{y}_0^{1,0})] \\ & + [f^{-1}(\bar{y}_1^{0,1}) - f^{-1}(\bar{y}_0^{0,1})] - [f^{-1}(\bar{y}_1^{0,0}) - f^{-1}(\bar{y}_0^{0,0})]\Big\},\end{aligned} \tag{B.3}$$

where $\bar{y}_t^{elem,S}$ is the average of the estimated outcome over individuals in group $elem$, residing in states S, at time t.[1]

Assuming that the idiosyncratic shocks have a normal distribution, f is the normal cumulative distribution function. We estimate the parameters of interest by maximum likelihood and compute robust standard errors clustered at the state level. A report of the estimated coefficients can be found in Table B.3 in the Appendix.

With the estimated parameters we compute the Indirect Average Treatment effects on the Treated (IATT), using equation (B.3), including the state classification, gender interactions, and covariates.

Average Treatment Effects: More details

ATT as a function of missing counterfactuals

In what follows we show how to recover the missing counterfactual $\mathbb{E}(y_{it}^0|elem_i = 1, S_i = 1, \tau_t = 1)$. If we assume that equation (B.2) holds, we have

$$\begin{aligned}&\mathbb{E}(y_{it}^0|elem = 1, S = 1, \tau_t = 1) = \mathbb{E}(y_{it}^0|elem = 1, S = 1, \tau_t = 0) \\ &+ [\mathbb{E}(y_{it}^0|elem = 1, S = 0, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 1, S = 0, \tau_t = 0)] \\ &+ [\mathbb{E}(y_{it}^0|elem = 0, S = 1, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 0, S = 1, \tau_t = 0)] \\ &- [\mathbb{E}(y_{it}^0|elem = 0, S = 0, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 0, S = 0, \tau_t = 0)].\end{aligned} \tag{B.4}$$

[1] In Section B, we show how we obtain the expression for the DDD estimator.

We can rewrite the ATT as a function of the unobserved counterfactual $\mathbb{E}(y_{it}^0|elem_i = 1, S_i = 1, \tau_t = 1)$

$$\begin{aligned} ATT = &\mathbb{E}(y_{it}^1|elem = 1, S = 1, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 1, S = 1, \tau_t = 0) \\ &- [\mathbb{E}(y_{it}^0|elem = 1, S = 0, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 1, S = 0, \tau_t = 0)] \\ &- [\mathbb{E}(y_{it}^0|elem = 0, S = 1, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 0, S = 1, \tau_t = 0)] \\ &+ [\mathbb{E}(y_{it}^0|elem = 0, S = 0, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 0, S = 0, \tau_t = 0)]. \end{aligned} \tag{B.5}$$

The sample analog of equation (B.5) is the DDD estimator of the ATT

$$\begin{aligned} \widehat{ATT} = &(\bar{y}_1^{1,1} - \bar{y}_0^{1,1}) - (\bar{y}_1^{1,0} - \bar{y}_0^{1,0}) \\ &- [(\bar{y}_1^{0,1} - \bar{y}_0^{0,1}) - (\bar{y}_1^{0,0} - \bar{y}_0^{0,0})], \end{aligned} \tag{B.6}$$

where $\bar{y}_t^{elem,S}$ is the average of the estimated outcome over individuals in group $elem$, residing in states S, at time t.

ATT in a non-linear model

We rewrite the identifying assumption as follows

$$\begin{aligned} &f^{-1}[\mathbb{E}(u_{it}|elem = 1, S = 1, \tau_t = 1)] - f^{-1}[\mathbb{E}(u_{it}|elem = 1, S = 1, \tau_t = 0)] \\ &- \{[f^{-1}[\mathbb{E}(u_{it}|elem = 1, S = 0, \tau_t = 1)] - f^{-1}[\mathbb{E}(u_{it}|elem = 1, S = 0, \tau_t = 0)]\} \\ &= f^{-1}[\mathbb{E}(u_{it}|elem = 0, S = 1, \tau_t = 1)] - f^{-1}[\mathbb{E}(u_{it}|elem = 0, S = 1, \tau_t = 0)] \\ &- \{f^{-1}[\mathbb{E}(u_{it}|elem = 0, S = 0, \tau_t = 1] - f^{-1}[\mathbb{E}(u_{it}|elem = 0, S = 0, \tau_t = 0)]\}. \end{aligned} \tag{B.7}$$

If equation (B.7) holds, the missing counterfactual is

$$\begin{aligned} \mathbb{E}(y_{it}^0|elem = 1, S = 1, \tau_t = 1) = f\Big\{ &f^{-1}[\mathbb{E}(y_{it}^0|elem = 1, S = 1, \tau_t = 0)] \\ &+ \{f^{-1}[\mathbb{E}(y_{it}^0|elem = 1, S = 0, \tau_t = 1)] - f^{-1}[\mathbb{E}(y_{it}^0|elem = 1, S = 0, \tau_t = 0)]\} \\ &+ \{f^{-1}[\mathbb{E}(y_{it}^0|elem = 0, S = 1, \tau_t = 1)] - f^{-1}[\mathbb{E}(y_{it}^0|elem = 0, S = 1, \tau_t = 0)]\} \\ &- \{f^{-1}[\mathbb{E}(y_{it}^0|elem = 0, S = 0, \tau_t = 1)] - f^{-1}[\mathbb{E}(y_{it}^0|elem = 0, S = 0, \tau_t = 0)]\}\Big\}, \end{aligned} \tag{B.8}$$

and the $ATT = \mathbb{E}(y_{it}^1|elem = 1, S = 1, \tau_t = 1) - \mathbb{E}(y_{it}^0|elem = 1, S = 1, \tau_t = 0)$, can be estimated replacing the expected values by their sample analogs

$$\begin{aligned}\widehat{ATT} = \bar{y}_1^{1,1} - f\Big\{ & f^{-1}(\bar{y}_0^{1,1}) + [f^{-1}(\bar{y}_1^{1,0}) - f^{-1}(\bar{y}_0^{1,0})] \\ & + [f^{-1}(\bar{y}_1^{0,1}) - f^{-1}(\bar{y}_0^{0,1})] - [f^{-1}(\bar{y}_1^{0,0}) - f^{-1}(\bar{y}_0^{0,0})]\Big\},\end{aligned} \tag{B.9}$$

where $\bar{y}_t^{elem,S}$ is the average of the estimated outcome over individuals in group $elem$, residing in states S, at time t.

CiC estimator (Athey and Imbens, 2006)

The CIC estimator introduced by Athey and Imbens (2006), generalizes the difference-in-difference estimator under fewer assumptions for consistent estimates. In particular, the CiC estimator is suitable when the policy change analyzed affects a group with different characteristics (observed and/or unobserved) than the group not affected, and the expected benefit of the policy may vary across groups. In the case of HED reforms, it means that the CiC estimator is consistent even if the policy change took place in those states with higher incidence of obesity and lower levels of physical activity among its population. For this reason, the CiC estimator may be an alternative to the DDD estimator presented so far, provided that the assumptions for consistency are fulfilled. The CiC is particularly appealing in our application since the authors developed an extension of the estimator to deal with discrete dependent variables.

The relevant population to implement a CiC estimator, is the same as the one we would use when applying a DD identification strategy. To evaluate the IATT of HED changes, the relevant population are parents of children of elementary-school age.

To discuss the assumptions behind the CiC estimator we will consider its simplest version, that is the one without covariates. Let's assume that in the absence of treatment, the outcome satisfy

$$y_i = h(u_i, \tau_i),$$

with $h(u, \tau)$ increasing in u. u are the unobservables that affect the decision of doing physical activity, and τ_i is a dummy variable equal to one in the post treatment period,

that is, in 2005. Additionally, consider a dummy variable S_i that takes the value one if the individual resides in a state that changed its HED program between 1999 and 2005.

Formally, the crucial assumption for identification with the CiC estimator, called the "Time Invariance Within Groups" assumption, is the following:

$$u \perp \tau | S.$$

In words, the unobservables that affect the decision of doing physical activity have to be orthogonal to the time period, but can be different between individuals residing in experimental and non-experimental states. Specifically, the distribution of u_i is allowed to vary across groups (treated vs. controls), but not over time within groups. In our case, the distribution of unobservables can differ between individuals residing in experimental and non-experimental states, something highly likely since the experimental states are those with higher proportion of population with weight problems, and higher proportion of physically inactive population. Additionally, the distribution of unobservables in both groups of states (experimental and non-experimental), cannot change over time. This part of the assumption we find difficult to be fulfilled since we observe outcomes within a six years gap (1999 and 2005). The assumption requires that the distribution of unobservables that determines whether parents are physically active or not, let's say in the experimental states, does not change between 1999 and 2005. A phenomenon that is contained in those unobservables is the aging of the individuals, whose distribution changes over time mainly because a relevant proportion of our dataset is a panel.

One could think that by introducing the age of the individual as a covariate, the assumption could be fulfilled. In fact, with covariates denoted in a vector X the identifying assumption is

$$u \perp X | S.$$

The distribution of X (age for example) can vary over time, and across groups, but the remaining unobservables should be orthogonal to the X in a given group. Let's say that u includes individual preferences toward doing physical activity. The assumption does not allow this preferences to vary with the age (and closely related the health status, family composition, time availability after work, etc.) of the individual, preferences that we believe are highly volatile over the life-cycle of an individual.

The CiC estimator for discrete outcomes, without further assumptions, provides bounds for the effect of interest, rather than a point estimate. In some applications, as it is in our case, the bounds are too broad to provide a clear conclusion on the direction of the effect of a policy change. Athey and Imbens (2006) propose two alternatives to narrow the bounds: using covariates and imposing a conditional independence assumption. The use of covariates requires the strong assumption previously discussed. The conditional independence assumption requires that

$$u \perp S|y, \text{ in a given time period.}$$

One example in which the assumption holds is if the distribution of unobservables for individuals who are physically active in 1999, and reside in the experimental states, is equal to the distribution of unobservables for individuals who are physically active in 1999, and reside in the non-experimental states. Although we are not fully confident that such an assumption is true in our study, we do think that conditional independence is more likely to hold than the assumption that includes covariates.

Summing up, we consider that for the policy under analysis the identifying assumption of the CiC estimator (under conditional independence) is less likely to be fulfilled than the identifying assumption of the DDD estimator. However, we accept that the assumptions behind the CiC estimator are more likely to hold than those of the DD estimator. For this reason we present and compare the IATT for the three estimators, using non-linear models and no covariates.

Reassuringly, the conclusions we can make on the indirect effect of HED programs are consistent across the three estimators: there is a positive and significant effect of major changes in HED programs on fathers of children of elementary-school age, while mothers are not affected by such policy reforms. Significant HED reforms increase fathers' probability of doing physical activity between 7.2 and 13.4 percentage points, depending on the estimator chosen. In general, the CiC estimators are quantitatively smaller than the DD and DDD comparable estimators. Note that the CiC estimators are closer to the DD estimators than DDD estimators. This might be because CiC and DD assumptions are more similar than DDD assumptions.

Table B.1: IATT by type of treatment and gender. DD, CiC, and DDD estimators (non-linear models without covariates).

Group of experimental states	**Male**			**Female**		
	DD (1)	**CiC (2)**	**DDD (3)**	**DD (4)**	**CiC (5)**	**DDD (6)**
S3: Moderate changes A	-0.029	-0.020	-0.042	0.003	-0.023	-0.057
	(0.053)	(0.032)	(0.059)	(0.066)	(0.067)	(0.104)
	[0.584]	[0.539]	[0.478]	[0.960]	[0.737]	[0.587]
S4: Moderate changes B	-0.030	-0.011	-0.047	0.075	0.036	0.016
	(0.059)	(0.062)	(0.087)	(0.072)	(0.042)	(0.117)
	[0.615]	[0.865]	[0.590]	[0.297]	[0.389]	[0.895]
S5: Major changes	0.100	0.072	0.134	-0.052	-0.040	-0.102
	(0.036)	(0.019)	(0.071)	(0.072)	(0.040)	(0.067)
	[0.005]	[0.000]	[0.059]	[0.474]	[0.313]	[0.125]

Notes: Each entry reports marginal effect of the corresponding treatment. No covariates in all models. Bootstrap robust standard errors clustered at state level (1,000 replicas). DD, and CiC estimators computed using only sample of parents with children of elementary school age. The CiC estimators corresponds to the average treatment effect on the treated. For the CiC we ran separated estimations for female and males, and by treatment ($S3$, $S4$, $S5$). DD and CiC sample sizes: 1,819 males and 2,401 females. DDD sample sizes: 6,198 females and 4,828 males.

Questions regarding light physical activity in PSID

In the 1999 questionnaire the questions are

How often do you participate in light physical activity -such as walking, dancing, gardening, golfing, bowling, etc.'-NUMBER OF TIMES

How often do you participate in light physical activity-such as walking, dancing, gardening, golfing, bowling, etc.?-TIME UNIT

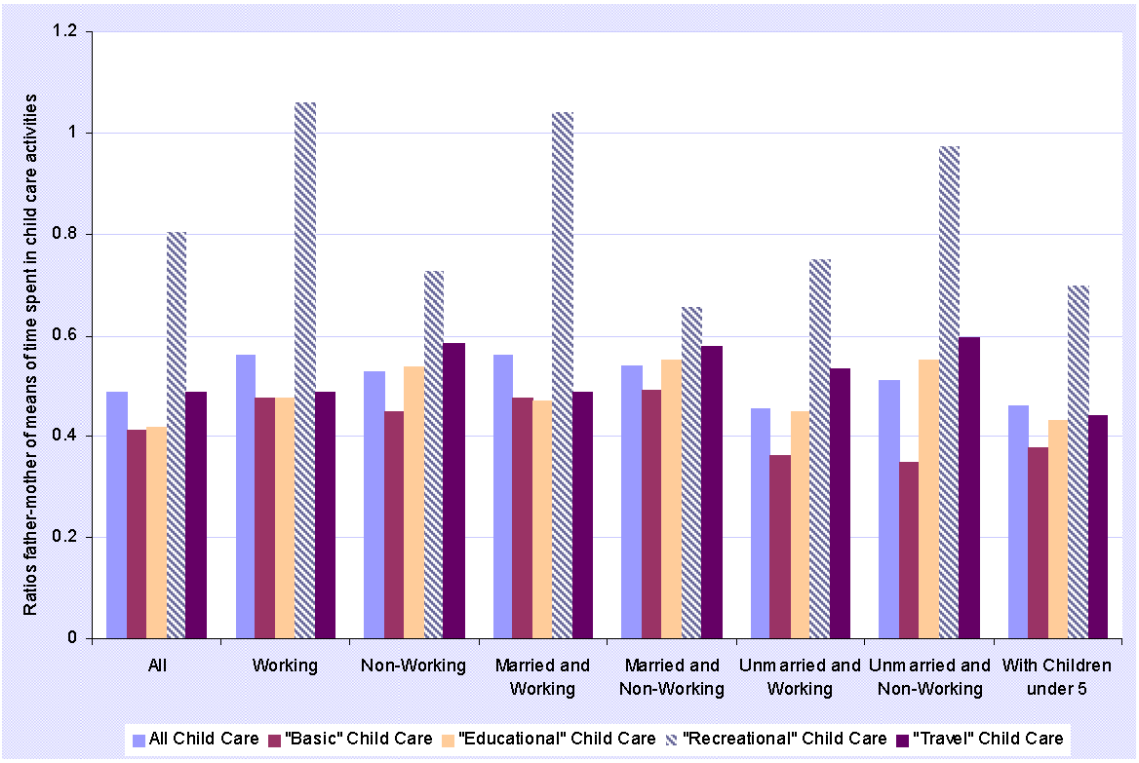
There were slight changes in the wording of the questions between 1999 and 2005, although according to PSID codebooks these variables are comparable across time. In the 2005 questionnaire, questions are

How often do you do light or moderate activities for at least 10 minutes that cause only light sweating or slight to moderate increases in breathing or heart rate?-NUMBER OF TIMES

How often does she do light or moderate activities for at least 10 minutes that cause only light sweating or slight to moderate increases in breathing or heart rate?-NUMBER OF TIMES

Specialization within the household: evidence from ATUS

Figure B.1: Ratios father-mother of means of time spent in childcare activities (hours per week), by demographic subgroups.



Source: Ratios computed using data in Table 1 in Guryan, Hurst, and Kearney (2008) based on the 2003-2006 waves of the American Time Use Survey (ATUS). Childcare activities are classified into: "Basic" childcare (breast feeding, rocking a child to sleep, general feeding, changing diapers, providing medical care to child, grooming child, etc.); "Educational" childcare (reading to children, teaching children, helping children with homework, attending meetings at a child's school, etc.); "Recreational" childcare (playing games with children, playing outdoors with children, attending a child's sporting event or dance recital, going to the zoo with children, taking walks with children, etc.); "Travel" childcare (any travel related to any of the three other categories of childcare). Samples include all individuals between the ages of 21 and 55 (inclusive) who had time diaries summing to a complete day and at least one child under the age of 18.

Tables

Table B.2: Correlation between individuals' health status and light physical activity in PSID.

Output	Output Description	Coefficient	S. Error	p-value
Self Reported Health Status (SRHS)	The higher the value of the variable the better the SRHS	-0.218	0.029	0.000
Bmi	Body mass index	-0.485	0.171	0.007
Stroke	Dummy variable for having suffered a stroke	-0.008	0.003	0.011
Hypertension	Dummy variable for having hypertension	-0.019	0.009	0.033
Diabetes	Dummy variable for having diabetes	-0.012	0.005	0.017
Emotional	Dummy variable for having an emotional illness	-0.020	0.007	0.005
Asthma	Dummy variable for having a asthma	-0.010	0.008	0.215
Mental	Dummy variable for having a metal illness	-0.002	0.002	0.379

Notes: Correlations, standard errors, and p-values obtained using linear specifications. Robust standard errors are clustered at the state level. All regressions include the following covariates: age, age squared, race, gender, marital status, number of children, children of high school-age, years of education and its square, employment status, full-time/part-time employment, log of family income per capita, and state fixed effects.

Table B.3: Probit Model: Probability of doing light physical activity at least once a week.

Number of obs= 11,026 Pseudo R2 = 0.0928
Log pseudo-likelihood = -4304.9867 (Std. Err. adjusted for 46 clusters in state)

Variable	Coefficient	(Std. Err.)	Variable	Coefficient	(Std. Err.)
female	-0.059	(0.116)	onleave	-0.179	(0.115)
τ	-0.207***	(0.058)	unemployed	-0.099	(0.104)
elem	0.179	(0.109)	retired	-0.563***	(0.179)
$\tau \times elem$	-0.091	(0.144)	disabled	-0.708***	(0.082)
S2	0.491***	(0.122)	housekeeper	0.019	(0.085)
S3	0.278*	(0.162)	student	0.22	(0.186)
S4	0.215	(0.163)	stated2	0.204***	(0.040)
S5	-0.432***	(0.125)	stated4	-0.499***	(0.021)
$S2 \times \tau$	-0.156*	(0.090)	stated5	0.684***	(0.045)
$S3 \times \tau$	-0.192	(0.147)	stated6	-0.162***	(0.019)
$S4 \times \tau$	-0.093	(0.256)	stated8	0.422***	(0.015)
$S5 \times \tau$	-0.242*	(0.145)	stated9	-0.430***	(0.026)
$S2 \times elem$	-0.057	(0.079)	stated10	-0.440***	(0.037)
$S3 \times elem$	0.058	(0.188)	stated12	0.579***	(0.054)
$S4 \times elem$	-0.031	(0.198)	stated13	-0.021	(0.023)
$S5 \times elem$	-0.356*	(0.206)	stated16	-0.240***	(0.049)
$female \times \tau$	-0.143	(0.097)	stated17	-0.292***	(0.025)
$female \times elem$	0.156	(0.149)	stated18	-0.260***	(0.030)
$female \times \tau \times elem$	0.015	(0.163)	stated19	-0.231***	(0.041)
$S2 \times female$	0.184	(0.144)	stated20	-0.301***	(0.029)
$S3 \times female$	0.043	(0.237)	stated21	-0.099***	(0.036)
$S4 \times female$	0.057	(0.178)	stated22	0.084***	(0.028)
$S5 \times female$	-0.138	(0.164)	stated23	0.240***	(0.033)
$female \times S2 \times \tau$	-0.018	(0.115)	stated24	-0.259***	(0.028)
$female \times S3 \times \tau$	0.202	(0.213)	stated25	-0.449***	(0.033)
$female \times S4 \times \tau$	0.124	(0.231)	stated26	-0.297***	(0.027)
$female \times S5 \times \tau$	0.331	(0.203)	stated28	0.044*	(0.023)
$female \times S2 \times elem$	-0.227**	(0.108)	stated29	-0.262***	(0.027)
$female \times S3 \times elem$	-0.343	(0.290)	stated30	-0.01	(0.045)
$female \times S4 \times elem$	-0.505**	(0.249)	stated31	0.307***	(0.032)
$female \times S5 \times elem$	0.482**	(0.221)	stated32	-0.360***	(0.034)
$S3 \times elem \times \tau$	-0.120	(0.241)	stated34	-0.159***	(0.015)
$S3 \times elem \times \tau \times female$	-0.161	(0.236)	stated35	0.762***	(0.024)
$S4 \times elem \times \tau$	-0.134	(0.374)	stated36	-0.474***	(0.021)
$S4 \times elem \times \tau \times female$	0.067	(0.456)	stated37	-0.262***	(0.029)
$S5 \times elem \times \tau$	0.418**	(0.202)	stated38	-0.374***	(0.036)
$S5 \times elem \times \tau \times female$	-0.426	(0.260)	stated39	-0.263***	(0.031)
jhs	0.085**	(0.035)	stated40	-0.115***	(0.021)
ch18	0.014	(0.055)	stated41	-0.004	(0.036)
age	-0.017	(0.015)	stated42	-0.428***	(0.029)
age^2	0.000	0.000	stated45	-0.165***	(0.015)
white	0.362***	(0.050)	stated47	-0.192***	(0.028)
edu	-0.033	(0.031)	stated48	0.671***	(0.057)
edu^2	0.004***	(0.001)	stated49	0.358***	(0.039)
single	-0.086	(0.052)	stated50	-0.342***	(0.059)
widowed	-0.257*	(0.148)	stated51	-0.408***	(0.029)
divorced	-0.032	(0.045)	stated54	-0.443***	(0.031)
separated	-0.154**	(0.066)	Intercept	0.584*	(0.303)
fulltime	-0.073*	(0.042)			
nchildren	0.025	(0.018)			
famincpc	0.058***	(0.014)			

Notes: Significance levels: * = 10%; ** = 5%; *** = 1%.
Description of variables in Table B.4.

Table B.4: Description of variables in Table B.3.

Name	**Description**
$female$	dummy variable equal to one if individual is female
τ	time fixed effect
$elem$	group of parent's of elementary school-age children fixed effect (group fixed effect)
Sk	groups of states k fixed effect (region fixed effect)
$elem \times \tau$	group time trend control (group-time interaction)
$Sk \times \tau$	group of states' time trend control (region-time interaction)
$Sk \times elem$	region-group interaction
$Sk \times elem \times \tau$	triple interaction (region-group-time interaction)
jhs	dummy variable equal to one if the individual has at least one children of junior-high-school age
$ch18$	dummy variable equal to one if the individual has at least one children older than 17 years.
age	age in years
age^2	square of age
$white$	white race dummy
edu	year of education completed
edu^2	square of edu
$married$	married or permanently cohabiting dummy
$widowed$	widowed dummy
$separated$	separated dummy
$divorced$	legally divorced dummy
$fulltime$	equal to one if the individual works less than 36 hours a week during the last year
$nchildren$	number of children (all ages)
$famincpc$	log of per-capita total family income
$onleave$	only temporarily laid off, sick leave or maternity leave dummy
$unemployed$	looking for work, unemployed dummy
$retired$	retired dummy
$disabled$	permanently or temporarily disabled dummy
$housekeeper$	housekeeper dummy
$student$	student dummy
$statedj$	state j fixed effect.

Notes: All variables of the form $X \times female$ are X variables interacted with the gender dummy $female$.

Table B.5: DD (linear): Marginal effects by school level (low vs high education)

	DD Male			**DD Female**		
	Education Level			Education Level		
	LOW	HIGH	Difference	LOW	HIGH	Difference
	(1)	(2)	(3)	(4)	(5)	(6)
S3: Moderate	-0.075	-0.032	-0.043	-0.017	-0.020	0.003
Changes A	(0.116)	(0.039)	(0.100)	(0.122)	(0.056)	(0.107)
	[0.517]	[0.409]	[0.670]	[0.890]	[0.718]	[0.977]
S4: Moderate	0.036	-0.039	0.075	0.028	0.057	-0.029
Changes B	(0.284)	(0.036)	(0.276)	(0.068)	(0.050)	(0.079)
	[0.900]	[0.278]	[0.786]	[0.680]	[0.259]	[0.717]
S5: Major	0.360	-0.019	0.379	0.045	-0.042	0.087
Changes	(0.069)	(0.031)	(0.072)	(0.086)	(0.044)	(0.060)
	[0.000]	[0.537]	[0.000]	[0.599]	[0.338]	[0.147]

Notes: Each entry reports marginal effect of the corresponding treatment. Robust standard errors reported in parenthesis are clustered at the state level. P-values reported in brackets. All regressions include the following covariates: age, age squared, race, gender, marital status, number of children, children of high school-age, years of education and its square, employment status, full-time/part-time employment, log of family income per capita, and state fixed effects.

Table B.6: HED topics and enforcements. Full list.

Topics List
1) *Alcohol- or Other Drug-Use Prevention*
2) *Emotional and Mental Health*
3) *Nutrition and Dietary Behavior*
4) *Physical Activity and Fitness*
5) *Tobacco-Use Prevention*
6) Human immunodeficiency virus (HIV) prevention
7) Accident or injury prevention
8) Sexually transmitted disease (STD) prevention
9) Pregnancy prevention
10) Suicide prevention
11) Violence prevention, for example bullying, fighting, or homicide

Enforcements List
1) *State requires districts or schools to follow national or state health education standards or guidelines*
2) *State requires students in elementary school to be tested on health topics*
3) *State requires each school to have a HED coordinator*
4) State uses staff development for HED teachers to improve compliance with HED standards or guidelines
5) State uses written reports from districts or schools to document compliance with HED standards or guidelines
6) State provides a list of one or more recommended elementary school HED curricula
7) State provides a chart describing the scope and sequence of instruction for elementary school HED
8) State provides lesson plans or learning activities for elementary school HED
9) State provides plans for how to assess or evaluate students in elementary school HED
10) State adopts a policy stating that newly hired staff who teach HED at the elementary school level will have undergraduate or graduate training in HED
11) State offers certification, licensure, or endorsement to teach HED
12) State adopts a policy stating that teachers will earn continuing education credits on HED topics to maintain state certification, licensure, or endorsement to teach HED

Notes: The topics and enforcements considered for the analysis are in italics.

Table B.7: HED programs: health topics required, by state and year.

	1999					2005				
State	**topic 1**	**topic 2**	**topic 3**	**topic 4**	**topic 5**	**topic 1**	**topic 2**	**topic 3**	**topic 4**	**topic 5**
Alabama	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Alaska	no	no	no	no	no	no	no	no	no	no
Arizona	no	no	no	no	no	no	no	no	no	no
Arkansas	no	no	no	no	no	yes	no	yes	yes	yes
California	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Colorado	no	no	no	no	no	no	no	no	no	no
Connecticut	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Delaware	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
District of Columbia	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Florida	no	no	no	no	no	yes	yes	yes	yes	yes
Georgia	yes	yes	yes	no	yes	yes	yes	yes	yes	yes
Hawaii	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Idaho	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Illinois	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Indiana	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Iowa	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Kansas (a)	.	.	.	.	.	.	.	.	.	.
Kentucky	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Louisiana	yes	no	no	no	yes	yes	yes	yes	yes	yes
Maine	yes	yes	yes	no	yes	yes	yes	yes	yes	yes
Maryland	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Massachusetts	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Michigan	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Minnesota	.	.	.	.	.	.	.	.	.	.
Mississippi	no	no	no	no	no	no	no	no	no	no
Missouri	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Montana	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Nebraska	yes	no	no	no	yes	yes	no	yes	yes	yes
Nevada	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
New Hampshire	.	.	.	.	.	yes	yes	yes	yes	yes
New Jersey	yes	no	no	yes	yes	yes	no	yes	yes	yes
New Mexico	no	no	no	no	no	yes	yes	yes	yes	yes
New York	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
North Carolina	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
North Dakota	yes	no	no	no	yes	yes	no	no	yes	yes
Ohio	yes	no	yes	yes	yes	yes	no	yes	yes	yes
Oklahoma	no	no	no	no	no	no	no	no	no	no
Oregon	yes	no	no	no	yes	yes	no	no	no	yes
Pennsylvania	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Rhode Island	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
South Carolina	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
South Dakota	no	no	no	no	no	no	no	no	no	no
Tennessee	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Texas (a)	no	no	no	no	no	yes	yes	yes	yes	yes
Utah	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Vermont	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Virginia	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Washington	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
West Virginia	yes	no	yes	yes	yes	yes	no	yes	yes	yes
Wisconsin	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Wyoming	no	no	no	no	no	no	yes	no	no	no

Source: NASBE Database and School Health Policies and Programs Study (SHPPS).

Notes: The data contained in this table was constructed cross-checking the information from both sources, and in most of the cases survey information from SHPPS coincides with the legal information summarized in NASBE. In those cases in which there is no coincidence, we rely on NASBE information only. In few cases NASBE does not provide complete information -i.e., cases in which the regulations contained in NASBE are not informative about the characteristics of the policy the state implements-, then we rely on SHPPS. Missing values indicate that the information cannot be recovered from any of the two sources.

(a) More details on this state can be found in the last section of this appendix.

Topic 1:Alcohol or other drug-use prevention; **Topic 2**: Emotional and mental health; **Topic 3**: Nutrition and dietary behavior; **Topic 4**: Physical activity and fitness; **Topic 5**: Tobacco-Use prevention.

Table B.8: HED programs: enforcements required, by state and year.

	1999			2005		
State	**enf 1**	**enf 2**	**enf 3**	**enf 1**	**enf 2**	**enf 3**
Alabama	yes	no	no	yes	no	yes
Alaska	no	no	no	no	no	no
Arizona	yes	no	no	yes	no	no
Arkansas	yes	no	no	yes	no	no
California	no	no	no	no	no	no
Colorado	no	no	no	no	no	no
Connecticut	no	no	no	no	no	no
Delaware	yes	no	yes	yes	no	yes
District of Columbia	.	.	.	.	.	.
Florida	yes	no	no	yes	no	no
Georgia	yes	no	no	yes	no	no
Hawaii	yes	no	no	yes	no	no
Idaho	no	no	no	no	no	no
Illinois	yes	no	no	yes	no	no
Indiana	yes	no	no	yes	no	no
Iowa	no	no	no	no	no	no
Kansas (a)	.	.	.	.	.	.
Kentucky	no	yes	no	yes	yes	no
Louisiana	yes	no	no	yes	no	no
Maine	yes	yes	no	yes	yes	no
Maryland	yes	no	no	yes	no	no
Massachusetts	yes	no	no	yes	no	no
Michigan	yes	no	no	yes	no	no
Minnesota	.	.	.	.	.	.
Mississippi	no	no	no	no	no	no
Missouri	yes	yes	no	yes	yes	no
Montana	yes	no	no	yes	no	no
Nebraska	no	no	no	no	no	no
Nevada	yes	no	no	yes	no	no
New Hampshire	.	.	.	yes	.	.
New Jersey	yes	.	.	yes	.	.
New Mexico	no	.	.	yes	.	.
New York (a)	no	.	.	no	.	.
North Carolina	yes	no	no	yes	no	no
North Dakota	no	no	no	no	no	no
Ohio (a)	.	.	.	.	.	.
Oklahoma	no	no	no	no	no	no
Oregon	no	no	no	yes	no	no
Pennsylvania (a)	yes	.	.	yes	.	.
Rhode Island	yes	yes	no	yes	yes	yes
South Carolina	yes	no	no	yes	yes	no
South Dakota	no	no	no	no	no	no
Tennessee	yes	no	no	yes	no	no
Texas	no	no	no	yes	no	no
Utah	yes	no	no	yes	yes	no
Vermont	yes	no	no	yes	yes	no
Virginia	yes	no	no	yes	no	no
Washington	yes	yes	no	yes	yes	no
West Virginia	yes	no	no	yes	no	no
Wisconsin	no	no	no	no	no	no
Wyoming	no	no	no	yes	no	no

Source: NASBE Database and School Health Policies and Programs Study (SHPPS).

Notes: The data contained in this table was constructed cross-checking the information from both sources, and in most of the cases survey information from SHPPS coincides with the legal information summarized in NASBE. In those cases in which there is no coincidence, we rely on NASBE information only. In few cases NASBE does not provide complete information -i.e., cases in which the regulations contained in NASBE are not informative about the characteristics of the policy the state implements-, then we rely on SHPPS. Missing values indicate that the information cannot be recovered from any of the two sources.

(a) More details on this state can be found in the last section of this appendix.

Enforcement 1: State requires districts or schools to follow national or state health education standards or guidelines.

Enforcement 2: State requires students in elementary school to be tested on health topics.

Enforcement 3: State requires each school to have a HED coordinator.

Table B.9: States classified by groups Sk.

NON-EXPERIMENTAL		**EXPERIMENTAL**	
State	# of obs.	State	# of obs.
S1	825	**S3**	1095
Alaska	11	Alabama	124
Colorado	219	Kentucky	162
Mississippi	481	Oregon	193
Oklahoma	61	South Carolina	522
South Dakota	53	Utah	87
		Vermont	7
S2	6,602		
Arizona	150	**S4**	1,193
California	1,112	Georgia	370
Connecticut	72	Louisiana	183
Delaware	12	Maine	28
Idaho	25	Nebraska	98
Illinois	366	New Jersey	303
Indiana	330	North Dakota	13
Iowa	235	Washington	198
Kansas	69		
Maryland	420	**S5**	1,311
Massachusetts	242	Arkansas	252
Michigan	557	Florida	414
Missouri	316	New Mexico	13
Montana	12	Texas	618
Nevada	66	Wyoming	14
New York	447		
North Carolina	508		
Ohio	478		
Pennsylvania	438		
Tennessee	221		
Virginia	333		
West Virginia	22		
Wisconsin	171		

Notes: We do not include the District of Columbia, Minnesota, and New Hampshire since the information regarding HED policies for these states is not precise in terms of when HED was implemented, making impossible their classification. Hawaii and Rhode Island not included because of lack of observations.

Clarifications on the classification of selected states

- Kansas: It has HED requirements at state level mandatory by legislation passed in 1979. There is no other legislation on HED until 2005. The legislation is not completely clear about which topics and which enforcements were in place, but we

are confident that there was HED implemented in 1979 and its situations did not change by 2005. Hence, the state is classified as $S2$.

- New York, Ohio, and Pennsylvania: The legislation in each of these states is not precise about the situation of some of the enforcements in 1999 and 2005, while it provides enough information on topics. Additionally, we know that until the year 2005 the last change in the legislation on HED took place in 1996, 1997, and 1998 respectively. So we include these states in the group of states $S2$.

- Texas: There exist evidence that by 1999 some educational districts had implemented a HED program, but we are confident that HED was not mandatory at state level until 2001. Since our definition of the policy is a "state HED program", we consider that going from non-mandatory HED programs designed at district level, to a coordinated HED program mandatory for all publics schools in the state, is a major change in the policy. Hence, the state is included in the group $S5$.

Appendix C

Appendix to Chapter 3

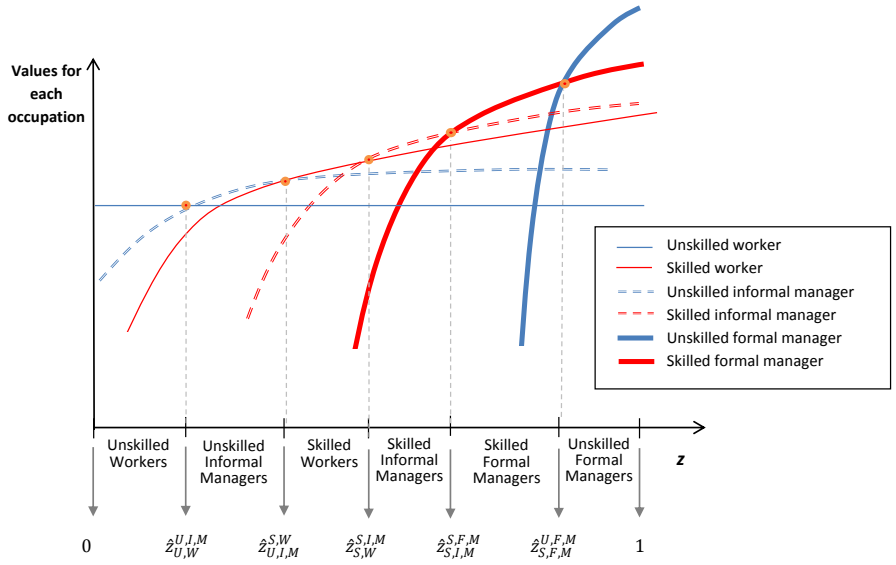


Figure C.1: Case 2: Cutoffs for occupational, educational, and sector choices along the support of z.

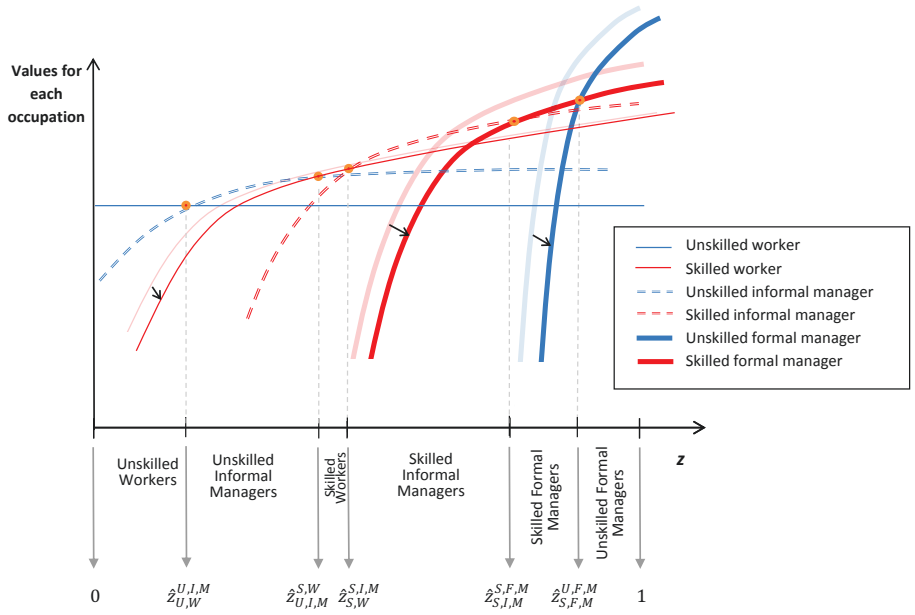


Figure C.2: Case 2: Changes of the cutoffs for occupational, educational, and sector choices along the support of z for higher costs of enforcing contracts (a lower η).

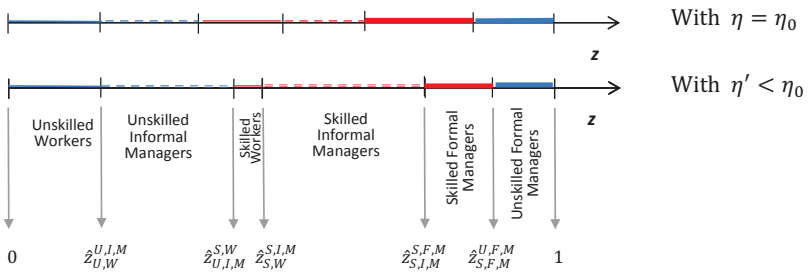


Figure C.3: Case 2: Occupational cutoffs for two values of η (η_0 and η', with $\eta_0 > \eta'$).

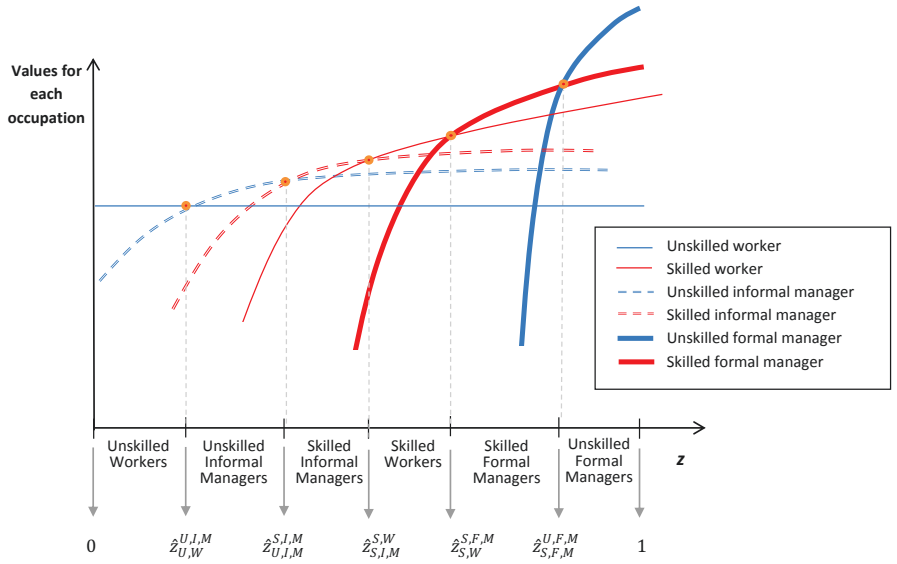


Figure C.4: Case 3: Cutoffs for occupational, educational, and sector choices along the support of z.

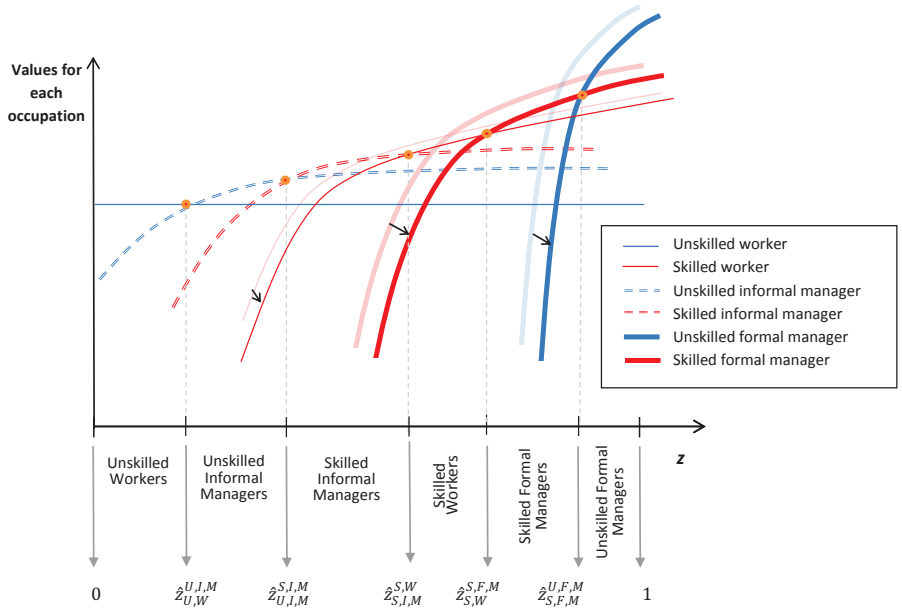


Figure C.5: Case 3: Changes of the cutoffs for occupational, educational, and sector choices along the support of z for higher costs of enforcing contracts (a lower η).

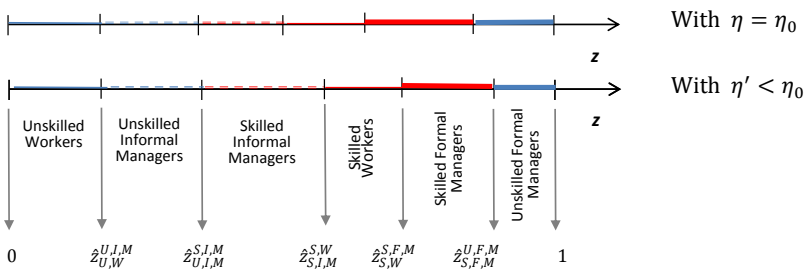


Figure C.6: Case 3: Occupational cutoffs for two values of η (η_0 and η', with $\eta_0 > \eta'$).

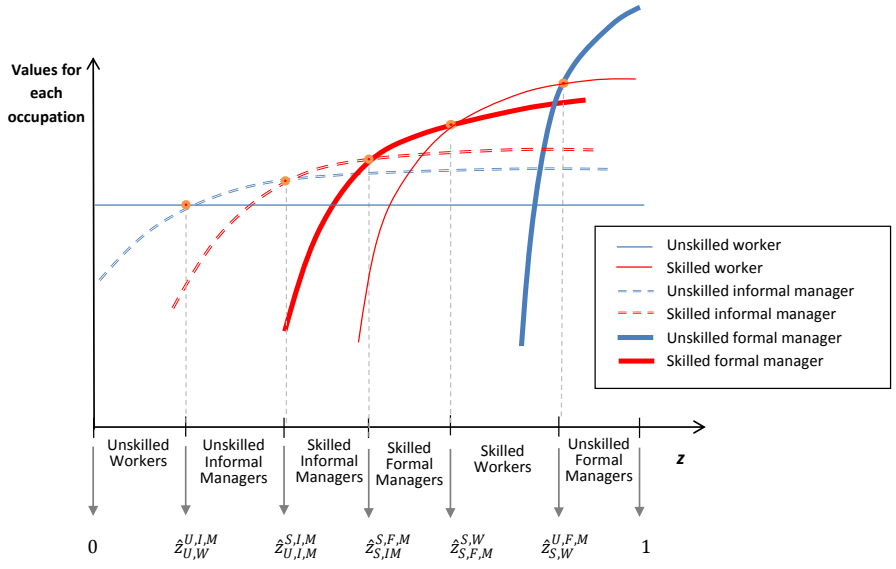


Figure C.7: Case 4: Cutoffs for occupational, educational, and sector choices along the support of z.

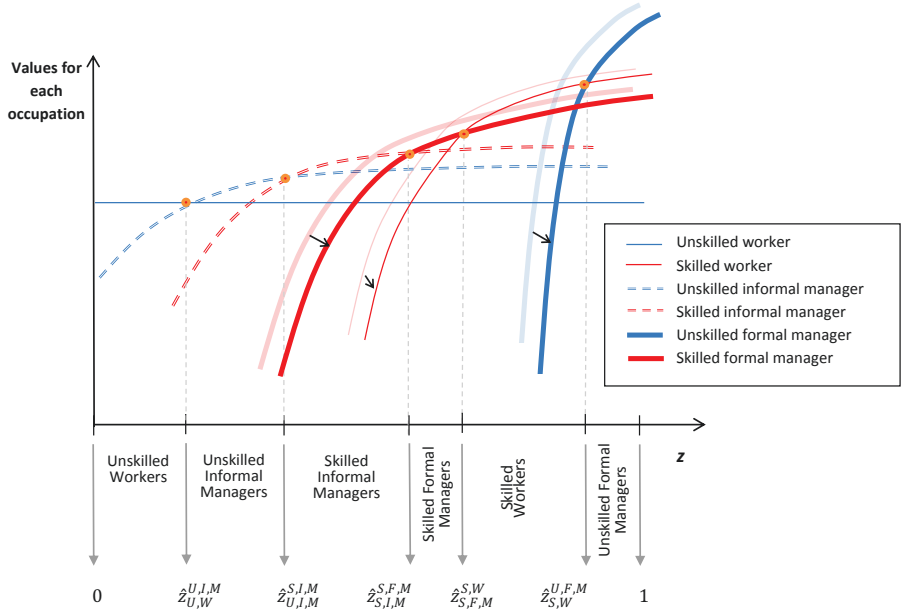


Figure C.8: Case 4: Changes of the cutoffs for occupational, educational, and sector choices along the support of z for higher costs of enforcing contracts (a lower η).

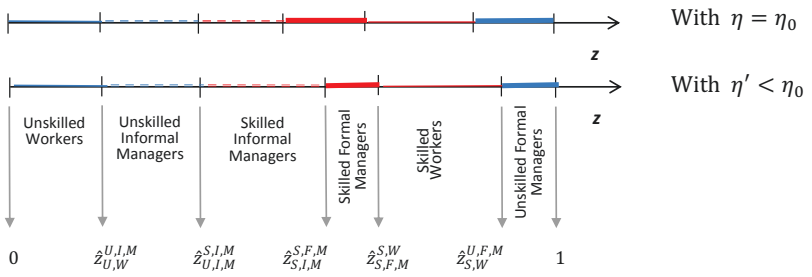


Figure C.9: Case 4: Occupational cutoffs for two values of η (η_0 and η', with $\eta_0 > \eta'$).

Bibliography

Albornoz, F., S. Berlinski, and A. Cabrales (2010): "Incentives, resources and the organization of the school system," *CEPR Discussion Papers 7964*.

Amaral, P., and E. Quintin (2006): "A competitive model of the informal sector," *Journal of Monetary Economics*, 53(7), 1541–1553.

Angelucci, M., and G. D. Giorgi (2009): "Indirect Effects of an Aid Program: How Do Cash Transfers Affect Ineligibles' Consumption?," *The American Economic Review*, 99(1), 486–508.

Anghel, B., and A. Cabrales (2010): "The Determinants of Success in Primary Education in Spain," *FEDEA, Documento de Trabajo*, 2010, 20.

Angrist, J., and K. Lang (2004): "Does school integration generate peer effects? Evidence from Boston's Metco Program," *American Economic Review*, 94(5), 1613–1634.

Antunes, A., and T. Cavalcanti (2007): "Start up costs, limited enforcement, and the hidden economy," *European Economic Review*, 51(1), 203–224.

Arellano, M., and G. Zamarro (2007): "The choice between public and private schools with or without subsidies in Spain," *Unpublished manuscript*.

Aspachs-Bracons, O., I. Clots-Figueras, J. Costa-Font, and P. Masella (2008): "Compulsory Language Educational Policies and Identity Formation," *Journal of the European Economic Association*, 6(2-3), 434–444.

Athey, S., and G. W. Imbens (2006): "Identification and Inference in Nonlinear Difference-in-Differences Models," *Econometrica*, 74(2), 431–497.

Bayer, P., F. Ferreira, and R. McMillan (2007): "A Unified Framework for Measuring Preferences for Schools and Neighborhoods," *Journal of Political Economy*, 115(4), 588–638.

Betts, J. (1995): "Does school quality matter? Evidence from the National Longitudinal Survey of Youth," *The Review of Economics and Statistics*, 77(2), 231–250.

——— (1996): "Is There a Link between School Inputs and Earnings? Fresh Scrutiny of an Old Literature," in *Does money matter?: The effect of school resources on student achievement and adult success*, ed. by G. Burtless.

Betts, J., and R. Fairlie (2001): "Explaining ethnic, racial, and immigrant differences in private school attendance," *Journal of Urban Economics*, 50(1), 26–51.

——— (2003): "Does immigration induce native-flight from public schools into private schools?," *Journal of Public Economics*, 87(5-6), 987–1012.

Bhattacharya, D., N. Guner, and G. Ventura (2013): "Distortions, endogenous managerial skills and productivity differences," *Review of Economic Dynamics*, 16(1), 11–25.

Bhattacharya, J., J. Currie, and S. J. Haider (2006): "Breakfast of Champions?: The School Breakfast Program and the Nutrition of Children and Families," *Journal of Human Resources*, XLI(3), 445–466.

Bils, M., and P. J. Klenow (2000): "Does schooling cause growth?," *The American Economic Review*, 90(5).

Bisin, A., and T. Verdier (2000): "Beyond the Melting Pot: Cultural Transmission, Marriage, and the Evolution of Ethnic and Religious Traits," *The Quarterly Journal of Economics*, 115(3), 955–988.

——— (2001): "The Economics of Cultural Transmission and the Dynamics of Preferences," *Journal of Economic Theory*, 97(2), 298–319.

——— (2010): "The Economics of Cultural Transmission and Socialization," in *Handbook of Social Economics*, ed. by J. Benhabib, A. Bisin, and M. Jackson.

Block, J. H., L. Hoogerheide, and R. Thurik (2011): "Education and entrepreneurial choice: An instrumental variables analysis," *International Small Business Journal*.

Blundell, R., and M. C. Dias (2009): "Alternative Approaches to Evaluation in Empirical Microeconomics.," *Journal of Human Resources*, 44(3), 565 – 640.

Blundell, R., M. C. Dias, C. Meghir, and J. V. Reenen (2004): "Evaluating the Employment Impact of a Mandatory Job Search Program," *Journal of the European Economic Association*, 2(4), 569–606.

Boháček, R. (2006): "Financial constraints and entrepreneurial investment," *Journal of Monetary Economics*, 53(8), 2195–2212.

Brustad, R. (2010): "The Role of Family in Promoting Physical Activity," *President's Council on Physical Fitness and Sports, Research Digest*, 10(3), 2–8.

Buera, F. J., J. P. Kaboski, and Y. Shin (2011): "Finance and Development: A Tale of Two Sectors," *The American Economic Review*, 101(5), 1964.

Burgess, S., D. Wilson, and R. Lupton (2005): "Parallel lives? Ethnic segregation in schools and neighbourhoods," *Urban Studies*, 42(7), 1027–1056.

Card, D., and A. Krueger (1992): "Does school quality matter? Returns to education and the characteristics of public schools in the United States," *Journal of Political Economy*, 100(1), 1–40.

——— (1996): "School resources and student outcomes: an overview of the literature and new evidence from North and South Carolina," *The Journal of Economic Perspectives*, 10(4), 31–50.

Card, D., A. Mas, and J. Rothstein (2008): "Tipping and the Dynamics of Segregation," *The Quarterly Journal of Economics*, 123(1), 177–218.

Cawley, J., D. Frisvold, and C. Meyerhoefer (2012): "The Impact of Physical Education on Obesity among Elementary School Children," NBER Working Papers 18341, National Bureau of Economic Research, Inc.

Cawley, J., C. Meyerhoefer, and D. Newhouse (2007): "The impact of state physical education requirements on youth physical activity and overweight," *Health Economics*, 16(12), 1287–1301.

Clark, A. E., and F. Etile (2006): "Don't give up on me baby: Spousal correlation in smoking behaviour," *Journal of Health Economics*, 25(5), 958–978.

Clots-Figueras, I., and P. Masella (2010): "Education, language and identity," *Unpublished manuscript*.

Cohen Zada, D. (2006): "Preserving religious values through education: Economic analyis and evidence from the US," *Journal of Urban Economics*, 60(3), 372–98.

Cohen-Zada, D., and M. Justman (2005): "The religious factor in private education," *Journal of Urban Economics*, 57(3), 391–418.

Cohen-Zada, D., and W. Sander (2008): "Religion, religiosity and private school choice: Implications for estimating the effectiveness of private schools," *Journal of Urban Economics*, 64(1), 85–100.

Córdoba, J. C., and M. Ripoll (2009): "Schooling and Development: The Role of Credit Limits, Public Education, Fertility and Mortality," *Unpublished manuscript*.

Dupas, P. (2011): "Do Teenagers Respond to HIV Risk Information? Evidence from a Field Experiment in Kenya," *American Economic Journal: Applied Economics*, 3(1), 1–34.

El País (2010): "La escuela pública mejora su nota," *www.elpais.com, March 28th*.

Ellen, I., K. O'Regan, A. Schwartz, and L. Stiefel (2007): "Racial segregation in multiethnic schools: Adding immigrants to the analysis," *Unpublished manuscript*.

Epple, D., and R. Romano (2003): "Neighborhood Schools, Choice, and the Distribution of Educational Benefits," in *The economics of school choice*, ed. by C. Hoxby. University Of Chicago Press.

Erosa, A. (2001): "Financial intermediation and occupational choice in development," *Review of Economic Dynamics*, 4(2), 303–334.

Erosa, A., T. Koreshkova, and D. Restuccia (2010): "How important is human capital? a quantitative theory assessment of world income inequality," *The Review of Economic Studies*, 77(4), 1421–1449.

Eurydice (2004): "Integrating Immigrant Children into Schools in Europe," *Eurydice website*.

——— (2009): "National summary sheets on education systems in Europe and ongoing reforms. Spain," *Eurydice website*.

Fairlie, R. (2006): *Racial Segregation and the Private-Public School Choice*. National Center for the Study of Privatization in Education, Teachers College, Columbia University.

Fairlie, R., and A. Resch (2002): "Is There White Flight into Private Schools? Evidence from the National Educational Longitudinal Survey," *Review of Economics and Statistics*, 84(1), 21–33.

Fernández, R., and R. Rogerson (1996): "Income Distribution, Communities, and the Quality of Public Education," *The Quarterly Journal of Economics*, 111(1), 135–164.

——— (1998): "Public education and income distribution: a dynamic quantitative evaluation of education-finance reform," *The American Economic Review*, 88(4), 813–833.

Ferreyra, M. (2007): "Estimating the effects of private school vouchers in multidistrict economies," *The American Economic Review*, 97(3), 789–817.

Figlio, D., and J. Stone (1999): "Are private schools really better?," *Research in Labor Economics*, 18(1), 115–40.

Gerdes, C. (2010): "Does Immigration Induce 'Native Flight' from Public Schools? Evidence from a Large Scale Voucher Program," *IZA Discussion Paper No. 4788*.

Gluzmann, P., D. Jaume, and L. Gasparini (2011): "Decisiones laborales en América Latina: el caso de los emprendedores. Un estudio sobre la base de encuestas de hogares," *CEDLAS, Documento de Trabajo*, (137).

Gould, E., V. Lavy, and M. Paserman (2009): "Does Immigration Affect the Long-Term Educational Outcomes of Natives? Quasi-Experimental Evidence," *The Economic Journal*, 119(540), 1243–1269.

Gradstein, M., and M. Justman (2002): "Education, social cohesion, and economic growth," *The American Economic Review*, 92(4), 1192–1204.

——— (2005): "The melting pot and school choice," *Journal of Public Economics*, 89(5-6), 871–896.

Gruber, J. (1994): "The Incidence of Mandated Maternity Benefits," *The American Economic Review*, 84(3), 622–41.

Guner, N., G. Ventura, and Y. Xu (2008): "Macroeconomic implications of size-dependent policies," *Review of Economic Dynamics*, 11(4), 721–744.

Guryan, J., E. Hurst, and M. Kearney (2008): "Parental education and parental time with children," *Journal of Economic Perspectives*, 22(3), 23–46.

Hanushek, E. (1986): "The economics of schooling: Production and efficiency in public schools," *Journal of Economic Literature*, 24(3), 1141–1177.

Hanushek, E., and L. Woessmann (2010): "The economics of international differences in educational achievement," *NBER Working Paper*.

Harre, N., and A. Coveney (2000): "School-based scalds prevention: Reaching children and their families," *Health Education Research*, 15(2), 191–202.

Hartog, J., M. Van Praag, and J. Van Der Sluis (2010): "If you are so smart, why aren't you an entrepreneur? Returns to cognitive and social ability: Entrepreneurs versus employees," *Journal of Economics & Management Strategy*, 19(4), 947–989.

Haskell, w., I.-M. Lee, R. Pate, K. Powell, S. Blair, B. Frankli, C. Macera, G. Heath, P. Thomson, and A. Bauman (2007): "Physical Activity and Public Health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association," *Medicine and science in sports and exercise*, 39(8), 1423–1434.

Hendricks, L. (2010): "Cross-country variation in educational attainment: structural change or within-industry skill upgrading?," *Journal of Economic Growth*, 15(3), 205–233.

INE (1995): "Encuesta de Financiación y Gastos de la Enseñanza Privada," *INE website*.

——— (2000): "Encuesta de Financiación y Gastos de la Enseñanza Privada," *INE website*.

——— (2005): "Encuesta de Financiación y Gastos de la Enseñanza Privada," *INE website*.

Ioannides, Y., and G. Zanella (2008): "Searching for the Best Neighborhood: Mobility and Social Interactions," *Working Paper, University of Siena*, 533.

Kahn, E. B., L. T. Ramsey, R. C. Brownson, G. W. Heath, E. H. Howze, K. E. Powell, E. J. Stone, M. W. Rajab, and P. Corso (2002): "The effectiveness of interventions to increase physical activity: A systematic review," *American Journal of Preventive Medicine*, 22(4, Supplement 1), 73 – 107.

Kann, L., N. D. Brener, and D. Allensworth (2001): "Health education: Results from the School Health Policies and Programs Study 2000," *Journal of School Health*, 71(7), 266–278.

Kann, L., S. Telljohann, and S. Wooley (2007): "Health Education: Results from the School Health Policies and Programs Study 2006," *Journal of School Health*, 77(8), 408–434.

Kenkel, D. S. (1991): "Health Behavior, Health Knowledge, and Schooling," *Journal of Political Economy*, 99(2), 287–305.

Kenkel, D. S. (2000): "Prevention," *Handbook of Health Economics*, 1, 1675–1720.

Knafo, A., A. Assor, S. Schwartz, and L. David (2009): *Culture, migration, and family value socialization: A theoretical model and empirical investigation with Russian immigrant youth in Israel*. The Transmission of Values within Cultures. New York: Oxford University Press.

Kremer, M., and A. Sarychev (2000): "Why Do Governments Operate Schools?," *Unpublished manuscript*.

Kristen, C. (2008): "Primary school choice and ethnic school segregation in German elementary schools," *European Sociological Review*, 24(4), 495.

Kuziemko, I. (2011): "Human Capital Spillovers in Families: Do Parents Learn from or Lean on their Children?," NBER Working Papers 17235, National Bureau of Economic Research, Inc.

Lalive, R., and A. Cattaneo (2006): "Social Interactions and Schooling Decisions," IZA Discussion Papers 2250, Institute for the Study of Labor (IZA).

Lazear, E. (1999): "Culture and language," *Journal of Political Economy*, 107(6), 95–126.

Lucas, R. (1978): "On the size distribution of business firms," *The Bell Journal of Economics*, 9(2), 508–523.

McGeary, K. A. (2009): "The Impact of State-Level Nutrition-Education Program Funding on BMI: Evidence from the Behavioral Risk Factor Surveillance System," NBER Working Papers 15001, National Bureau of Economic Research, Inc.

Miguel, E., and M. Kremer (2004): "Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities," *Econometrica*, 72(1), 159–217.

Munk, I. (2006): "Does the Quality of Public Education Affect Private School Demand?," *Unpublished manuscript*.

Nandha, B., and K. Krishnamoorthy (2007): "School-based health education campaign-a potential tool for social mobilization to promote the use of DEC-fortified salt towards elimination of lymphatic filariasis," *Health Education Research*, 22(4), 539–546.

Nechyba, T. (1999): "School finance induced migration and stratification patterns: The impact of private school vouchers," *Journal of Public Economic Theory*, 1(1), 5–50.

Nechyba, T. (2006): "Income and Peer Quality Sorting in Public and Private Schools," *Handbook of the Economics of Education*, 2, 1327–1368.

Parker, S., and C. Van Praag (2006): "Schooling, Capital Constraints, and Entrepreneurial Performance," *Journal of Business and Economic Statistics*, 24(4), 416–431.

Parker, S. C. (2004): *The economics of self-employment and entrepreneurship*. Cambridge University Press.

Poschke, M. (2010): "Who becomes an entrepreneur? Labor market prospects and occupational choice," *IZA Discussion Paper Series No. 3816*.

Rangvid, B. (2007): "Living and learning separately? Ethnic segregation of school children in Copenhagen," *Urban studies*, 44(7), 1329–1354.

Reardon, S., and J. Yun (2002): "Private School Racial Enrollment and Segregation," *The Civil Rights Project, Harvard University*, Unpublished manuscript.

Sáez-Martí, M., and A. Sjogren (2008): "Peers and Culture," *Scandinavian Journal of Economics*, 110(1), 73–92.

Salmon, J., M. L. Booth, P. Phongsavan, N. Murphy, and A. Timperio (2007): "Promoting Physical Activity Participation among Children and Adolescents," *Epidemiologic Reviews*, 29(1), 144–159.

Schneider, F., A. Buehn, and C. E. Montenegro (2011): "Shadow Economies all over the World: New Estimates for 162 Countries from 1999 to 2007," *Handbook on the Shadow Economy*, pp. 9–77.

Schnepf, S. V. (2007): "Immigrants' educational disadvantage: An examination across ten countries and three surveys," *Journal of Population Economics*, 20(3), 527–545.

Schoellman, T. (2008): "The Causes and Consequences of Cross-Country Differences in Schooling Attainment," *Unpublished manuscript*.

Silaghi, F. (2010): "Immigration and Peer Effects: Evidence from Primary Education in Spain," *Unpublished manuscript*.

Soderstrom, M., and R. Uusitalo (2010): "School Choice and Segregation: Evidence from an Admission Reform," *Scandinavian Journal of Economics*, 112(1), 55–76.

Timmerman, C., E. Vanderwaeren, and M. Crul (2003): "The second generation in Belgium," *International Migration Review*, 37(4), 1065–1090.

Tinsley, B. J. (2003): *How children learn to be healthy*. Cambridge University Press.

van der Goot, A. (1996): "Differentiation strategies in lesser used language education: a comparative analysis of Catalonia and Friesland," *Las lenguas en la Europa Comunitaria II*, p. 71.

Van der Sluis, J., M. Van Praag, and W. Vijverberg (2008): "Education and entrepreneurship selection and performance: A review of the empirical literature," *Journal of Economic Surveys*, 22(5), 795–841.

van Sluijs, E. M. F., A. M. McMinn, and S. J. Griffin (2007): "Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials," *BMJ*, 335(7622), 703.

WHO (1999): "Improving health through schools: national and international strategies," *http* : *//www.who.int/school_youth_health/media/en/*94*.pdf*.

——— (2003): "Health and Development Through Physical Activity and Sport," *http* : *//whqlibdoc.who.int/hq/*2003*/WHO_NMH_NPH_PAH_*03.2*.pdf*.

Wyatt, T., and J. Novak (2000): "Collaborative partnerships: a critical element in school health programs," *Family & Community Health*, 23(2), 1.