# THREE ESSAYS IN THE ECONOMICS OF EDUCATION

Deyin Jia

A dissertation
submitted to the Faculty of
the department of Economics
in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

Boston College
Morrissey College of Arts and Sciences
Graduate School

March 2024

**THREE ESSAYS IN THE ECONOMICS OF EDUCATION**

Deyin Jia

**Committee Chair:** Christopher Baum, Ph.D., Professor of Economics

**Committee Members:** Uzi Segal, Ph.D., Professor of Economics

Zhijie Xiao, Ph.D., Professor of Economics

## Abstract

This dissertation consists of three chapters studying topics in the economics of education.

Chapter 1 (joint with Wei Sun and Xuejie Yi) investigates how changes in pension policies affect households' investments in their children's education. In China, elderly individuals receive financial support from their children, in addition to pension benefits and personal savings. The researchers used a difference-in-differences (DID) analysis to compare the investment behavior of households with enterprise employees (who were affected by the 1997 pension reform) and public sector employees (who were not affected) on household investments in human capital and savings. The results showed that households expecting lower pension benefits increased their investments in education by around 2%. Additionally, a 10% decrease in the pension replacement rate corresponded to a 1.1% rise in households' investments in human capital. The study also looked at the 2015 pension reform, which aimed to reduce pensions for public sector employees, but the increase in education investment among these employees was not statistically significant, possibly due to the gradual 10-year transition period. The findings suggest that when pension income is expected to decrease, households invest more in their children's human capital development to compensate.

Chapter 2 (joint with Siddharth George and Kewei Zhang) studies how being admitted via affirmative action affects minority students in universities. This paper provides evidence on the effects of college admission preferential policy on students' self-perceptions, academic performance, and career intentions. We use regression discontinuity approach to compare students just below and above the cutoff with the same type of bonus points - ethnicity-based bonus points. Because of the bonus, students just below the cutoff may study in the same university as students above the

cutoff. Therefore, we are able to eliminate the "peer effect". Actual beneficiaries report negative self-perception compared with their peers, have lower college English test scores, and are less likely to get academic awards. As for their life plans, ethnicity-based beneficiaries are more inclined to find stable jobs and hope to get married sooner. Additionally, the placebo group in which students receive bonus points for academic achievements like math or physics Olympiad shows no impostor effects. These findings demonstrate that different categories of preferential policy have different effects on beneficiaries and provide insight into studying the impact of affirmative action in psychological aspect.

Chapter 3 (joint with Yixuan Liu) utilizes data from the China Family Panel Studies (CFPS) to investigate the effect of having a brother on women's educational attainment. The results indicate that gender discrimination persists in Chinese households' investment in human capital, with a significant negative impact of having a brother on women's education. The one-child policy, which limits family size and creates families without male offspring, has increased women's access to education by reducing competition with preferred siblings and decreasing opportunities for gender discrimination. The increase in women's average level of access to education since 1980s is the result of the combined effects of the reduction in the dilution of family resources and the reduction in opportunities for gender discrimination.

# Contents

# List of Tables

# List of Figures

# 1 Examining the Effects of Pension Reform on Families' Investment in Education: Evidence from China

## 1.1 Introduction

Education holds significant value as it contributes to the development of society, the family and the growth of the individual as a whole. East Asian countries attach particular importance to the education of their children. Education is also a way to invest in future income flows. China, in particular, places great emphasis on education, drawing inspiration from Confucianism, which highlights its importance and promotes filial piety towards parents. Moreover, Chinese law requires children to support their parents, both financially and emotionally, in their old age.[1] This legal obligation adds to the altruistic motivations for parents to invest in their children's education, ensuring that they will be well-equipped to provide for them in the future.

In general, people have two potential sources of income after retirement: private savings and pensions. In the case of China, where the law mandates obligations, older individuals may expect to have a third source of post-retirement income: support from their Children. This means that changes in retirement policies can have a significant impact on how households invest in human capital and personal savings.

Many countries have implemented pension policies to enhance retirement security. In the United States, the pension system is supported by social security, employer-provided 401K plans, and individual retirement accounts (IRA), providing multi-level security. China is aging even more rapidly than the U.S. In recent years, China's demographic structure has shown continuous changes, and is facing a more rapid aging population. As shown in Figure 1.1, the number and proportion of people aged 60 and over, and 65 and over, have increased significantly over the past 12 years, with approximately 19% of the population aged 60 or older and over 14% aged 65 or older in 2021. Considering the current retirement age in China (60 for men, 55 for white-collar women, and 50 for blue-collar women)[2], the actual percentage of retired population is likely to be higher. To

[1] From Law of the People's Republic of China on the Protection of the Rights and Interests of the Elderly (2015 Amendment): "Supporters of the elderly shall fulfill the obligations of providing for the elderly economically, taking care of them in daily life and comforting them mentally, and attend to their special needs. Where the supporters do not fulfill their obligations of providing for the elderly, the elderly shall have the right to ask the supporters for payment of support and other rights. The supporters shall not ask the elderly to do any work beyond their ability."

[2] The current retirement age is mandatory. A proposal to delay the retirement age was put forward in 2021, but there

ensure pension sustainability and expand coverage, the Chinese government has introduced reforms in 1997 and 2015, reducing pensions for urban enterprise workers and public sector employees, respectively. These reforms have had a significant impact.

This study utilizes a difference-in-differences (DID) approach to examine the impact of reduced pensions on households' investment in human capital and savings behavior, using China's pension reform as a natural experiment. The 1997 pension reform resulted in a significant decrease in pension benefits for employees in enterprises, lowering the replacement rate[3] from an average of approximately 75% to about 57.5%. In contrast, public sector[4] employees' pensions remained unchanged, ranging from 70% to 90% depending on length of service[5]. By comparing enterprise employees (treatment group) and public sector employees (control group), the study aims to isolate the causal effects of pension reduction on household behavior. Additionally, China's one-child policy, implemented in 1979, has led to a significant decrease in the number of children in Chinese families[6], simplifying fertility decision considerations in the analysis. In fact, the majority of households in the sample have only one child in school.

This study uses data from the China Household Income Project (CHIP) for 1995 and 2002, which provides a before and after comparison of the 1997 policy. The study focuses on two main outcome variables: investment in education and household savings. By employing a difference-in-differences (DID) regression, the study finds that households expecting a lower pension (the treatment group) invest 2% more of their income in their children's education compared to the control group (public unit households). Additionally, the treatment group shows a 6% increase in savings rate compared to the control group. To ensure the robustness of the results, the study tests various assumptions and uses different sample selections and control variable measures.

This study also uses the CHIP1999 survey data to conduct a difference-in-differences (DID) analysis, examining the impact of the 1997 policy on education investment two years after its implementation. The results indicate that the treatment group would have invested approximately

are no detailed plans or programs to implement the policy at this time.

[3]In this chapter, the term "replacement rate" refers to the percentage of an individual's annual employment income that is replaced by retirement income when they retire. It is calculated by the ratio of (gross income received in retirement) divided by (a pre-retirement gross income): Replacement Rate = Gross Income (retired) / Gross Income (pre-retirement)

[4]The public sector in this chapter refers primarily to government agencies, schools and universities, and other non-profit sectors or institutions.

[5]Detailed policy descriptions and replacement rate formulas are written in Section 1.2.1.

[6]China's population policy is described in Section 1.2.2.

1.6% more of their household income in education compared to the control group. This magnitude is slightly lower than the baseline analysis, likely due to the short time elapsed since the policy was introduced. This finding suggests that individuals had the ability to adapt quickly to the new policy and make changes in their investment decisions.

This study also analyzes the 2015 pension reform, utilizing CHIP 2013 and 2018 survey data, which reduced the future pensions of public sector employees without impacting enterprise employees. The reform can be viewed as a "symmetry" of the 1997 reform, as it eliminated the difference between the pensions of enterprises and public sectors (i.e., the "Dual-pension" system) that was created by the 1997 policy, which can also be referred to as "Pension Merger". In this study, the DID regression is performed by defining public sector employees as the treatment group and enterprise employees as the control group, and the results indicate that the treatment group invests approximately 1.8% more of their household income in education compared to the control group. However, the result is not statistically significant, which may be attributed to the ten-year transition period, resulting in a more moderate response to the policy. This chapter plans to continue researching this topic after the ten-year transition period (i.e., 2025).

China's current pension formula is publicly accessible, allowing this study to predict individuals' wages and calculate their future pension benefits and pension replacement rates using the formula. The results indicate a significant gap between the pre-policy and post-policy pension expectations of enterprise employees, with most pensions after the policy implementation concentrated between 40% and 80%, averaging 57.5%. This is notably lower than the pre-policy replacement rate. The study also explores the relationship between education investment and the replacement rate, finding that a 10% reduction in the replacement rate leads to a 1.1% increase in household income invested in education.

The chapter's final section focuses on developing an illustrative model to explore the relationship between pension expectations and family education investment decisions. By solving an optimization problem using the overlapping generations model (OLG), the chapter demonstrates that the partial derivative of the share of household investment in education with respect to the replacement rate is negative. This result aligns with the empirical findings.

In summary, the study shows that family education investment decisions are influenced by pension expectations, with lower pensions leading to increased investment in education in pursuit of

higher future intra-family transfers.

### Literature Review

This chapter contributes to the literature on the impact of social transfers on families' investment in their children's education, specifically in the context of China's pension reforms. Previous studies have shown that pension transfers can increase children's human capital as parents have more money to invest in their children's education and other activities that can improve their skills and knowledge. Ponczek [2011] shows that the 1991 Brazil pension reform with a substantial increase of pension amount had significant positive effects on schooling. de Carvalho Filho [2012] reaches similar results from Brazil pension reform and finds out that the effect is more significant for girls. Martinez [2004] finds positive effects of Bolivia's cash transfer pension program on household consumption and children's human capital. Edmonds [2006] documents large increases in schooling attendance when black South African families become eligible for fully anticipatable social pension income and provides with an explanation related to liquidity constraints perhaps because of schooling costs. However, some research has also found that parents are more likely to invest in their children's education and other forms of human capital if they know that their children will support them in their old age, which is consistent with the kinship story that family ties can provide incentives for parents to invest in their children because they know that this will pay off in the long run. Köthenbürger and Poutvaara [2006] proposes a theoretical framework to prove that reducing the social security contribution rate encourages investment in human capital. Some empirical research has found that parents are more likely to invest in their children's education and other forms of human capital if they know that their children will support them in their old age. In cultures where it is expected that children will support their elderly parents, family ties can provide incentives for parents to invest in their children because they know that this will pay off in the long run. Bau [2021] provides evidence that pension expansion decreases practices of kinship traditions to support old parents and investment in the education of children in Indonesia and Ghana. Herrmann et al. [2021] confirms the channel of children's support from a non-contributory pension scheme in Thailand by showing that older children benefit more from pension transfers.

This chapter also adds to the literature studying children's human capital accumulation in China and its relationship with the impact of China's pension reforms. İmrohoroğlu and Zhao [2018]

has shown that family support plays a prominent role in the well-being of the elderly in China and often substitutes for the lack of government-provided old-age support systems. Fang and Feng [2018] provides a detailed overview of the current state of the Chinese pension system, as well as its development, its problems and some ideas for future reforms. Cai and Cheng [2015] reviews the history of China's pension system especially the 1997 pension reforms. Additionally, research has examined the effect of pension reform on life satisfaction, total education expenditure, and local public spending on education, as well as the impacts of the New Rural Pension Scheme (NRPS) on intergenerational wealth dependence and child investment. Abruquah et al. [2019] examines the effect of pension reform with its existing inequalities across demographic and social groups on the life satisfaction of retired urban residents. Mu and Du [2017] shows that a significant increase in the total education expenditure is found to be attributable to pension expansion with urban China data. Their finding is consistent with the kinship story that when social security is established to provide pensions to parents, their reliance upon children for future financial support decreases, and their need to save for retirement also falls. Yuan et al. [2018] uses both theoretical and empirical results to confirm that pension privatization is adversely associated with local public spending on education in China. In terms of 1997 pension reforms, Feng et al. [2011] and He et al. [2019] research on the influences on household savings and labor supply, respectively. Recently, many research papers examine the impacts of New Rural Pension Scheme (NRPS). You and Niño-Zarazúa [2019] shows that the NRPS strengthens intergenerational wealth dependence for the richest while penalizing the poorest by having a negative effect on their net worth. Shan and Park [2023] studies how access to public pensions affects old-age support and child investment in traditional societies and argues that impact on child investment significantly differs by child gender: while adult parents increase educational investment in sons, their investment in daughters appears to decrease.

Overall, this chapter aims to provide a comprehensive analysis of the impact of China's pension reforms on families' investment in their children's education, taking into account the existing literature on social transfers, human capital accumulation, and pension reforms in China.

The remainder of this chapter is structured as follows: Section 1.2 presents the institutional background, including two urban pension reforms in 1997 and 2015, as well as background information on China's education and fertility policies. Section 1.3 describes the data used in the analysis and the empirical methodology employed, specifically the difference-in-differences (DID)

approach. Section 1.4 discusses the DID empirical results, robustness checks, and a case study for expected pensions. Section 1.5 illustrates the modeling framework. Section 1.6 concludes the chapter.

## 1.2 Institutional Background

This section provides an overview of the institutional context in which this study takes place, including two significant mandatory pension reforms implemented in 1997 and 2015, as well as a brief summary of China's educational background and changes in child policies.

### 1.2.1 Pension Policy

Table 1.1 provides an overview of the timeline of China's urban pension system reforms, including the significant "Dual Pension Scheme" in 1997 and the "Pension Merger" in 2015. The former reduced pensions for employees in enterprises, while the latter lowered pensions for employees in the public sector. Additionally, the New Rural Pension Scheme (NRPS) was introduced in 2009 to provide a basic income for older people in rural areas, and the Urban Residents Pension Scheme (URPS) was introduced in 2011 to expand pension coverage to all older persons living in urban areas. However, these non-mandatory policies are beyond the scope of this chapter.

Since 1951, China has operated a pay-as-you-go (PAYGO) pension system for employees in the public sector and state-owned enterprises. The replacement rate after retirement is determined by the number of years worked, with a higher replacement rate for those who have worked longer (Table 1.2). In practice, the replacement rate is generally between 70% and 90%.

The pension insurance system has several key characteristics:

(1) **A single level**. The state is primarily responsible for post-retirement life, and pensions are the primary source of income for employees after retirement.

(2) **State guarantee**. Retired workers can receive their pensions from their former organizations, regardless of the organization's production and operation conditions.

(3) **Non-contributory**. Employees do not pay social insurance contributions, including pension insurance. Pensions are financed by transfers from government fiscal revenues for public sector employees and by enterprises for state-owned enterprise employees.

(4) **Pay-as-you-go (PAYGO)**. Retirement formalities are handled in the original work unit, and the retirement salary is received in the original unit, but each work unit does not set up a pension insurance fund.[7]

The design of the system is highly welfare-oriented and not a social pension insurance system in the strict sense.

Since the reform and opening-up in 1978, marketization has had a significant impact on state-owned enterprises. The focus of the country's economic system reform shifted from rural to urban areas in the mid-1980s. The reform aimed to make enterprises self-managed, independently accountable, and self-sustaining economic entities. However, the age structure of employees varied among enterprises, with some having a large number and high rate of retired workers and others having very few retired workers, making the burden of pensions among enterprises different. To address this issue, some regions have begun to explore socialized pension insurance systems, coordinating pension costs among units to solve the problem of the unbalanced burden of retirement costs among state-owned enterprises and plan for the future pensions of workers in non-public enterprises.

In the early 1990s, the Chinese government proposed several goals, including establishing a multi-level pension insurance system, sharing pension insurance among the state, enterprises, and individuals, and implementing a combination of social coordination and individual accounts. Pilot policies have extended coverage from workers in state-owned enterprises to workers in other enterprises.

**1997 Pension Reform: Dual Pension Scheme** In 1995, the State Council issued *Circular on Deepening the Reform of the Pensionary Insurance System for Workers and Staff Members in Enterprises*, further clarifying the model of the basic pension insurance system, which combined social coordination and individual accounts for workers and staff members in enterprises. However, pension benefits remained unchanged in most provinces until 1997. In 1997, the State Council promulgated *Decision on the Establishment of a Unified Basic Pension Insurance System for Enterprise Employees*, which clarified the model of pension insurance combining social coordination and individual accounts.

The structure of pensions after the 1997 reform is shown in Table 1.3. The reform did not affect

[7] Only the National Federation of Trade Unions and trade unions at all levels withdrew transfers according to a certain rate, and after 1966 the transfers were also canceled

the retired population (those who retired before 1997), and a transitional benefit was added for employees who joined the workforce prior to the 1997 reform to compensate for their inability to contribute before the reform. Both enterprises and employees were required to contribute to pension accounts. Enterprises contributed 20% to the basic benefit account, while employees contributed 8% to their individual benefit account.[8] More detailed formulas for the calculation of the three types of pensions are shown in Table 1.4.

The basic and transitional benefits are related to the average local wage and the individual's wage before retirement, and the basic benefit is proportional to the number of years contributed by the individual. There is an actuarial assumption for individuals, which is based on life expectancy. For example, a man who retires at the age of 60 will receive a monthly individual benefit that is the total amount in the account divided by 139 and can be taken for 139 months (i.e. until the age of 71.58). The balance in the personal pension account can be inherited through inheritance.

The new pension insurance system has several key features compared to the previous system, including:

(1) **Multi-level structure**. The system consists of three levels - basic pension insurance, occupational pension, and commercial pension insurance. The basic pension insurance only covers the basic living expenses of retirees.

(2) **Special partial accumulation system**. The employee basic pension insurance system combines social integration and individual accounts, using a mixed model that includes both pay-as-you-go and funded systems.

(3) **Contributory**. Both insured employees and their work units contribute to form the pension insurance fund, which is supplemented by the government when necessary.

(4) **Socialization**. The basic pension is organized and implemented by the government according to the law, and is managed by social insurance agencies with the cooperation of employers.

**2015 Pension Reform: Pension Merger** The 1997 pension system created a significant disparity in retirement benefits between employees in the public sector and those in urban enterprises. In

[8]The policy announced in 1997 indicated that corporations and individuals together contributed 11% to individual retirement accounts, with individuals contributing 8% and corporations 3%. This also means that enterprises contribute 17% to the basic benefit account. However, the reform in 2015 and the latest pension calculators all consider the individual account to be an 8% personal contribution. Therefore, this chapter uses 8% when estimating pensions in Section 1.4.4.

2015, the State Council issued the *Decision on the Reform of the Pension Insurance System for Staff of Institutions and Agencies*, to reform the pension insurance system for institutional staff, introducing a uniform basic pension insurance system that combines social coordination and individual accounts for all employees, regardless of their sector. This decision effectively abolished the "Dual Pension Scheme" and implemented the "Pension Merger".

Under the reformed system, employers and employees of public sectors will contribute to pension funds in the same way as enterprises. The formula for calculating pensions remains the same as in Table 1.3 and Table 1.4. However, a 10-year transition period was established at the time of implementation. In short, the 2015 reform does not affect those who have already retired. However, for those who started working before September 2014 and will before September 2024, pensions are accounted for according to the old and new methods. If the new method of accounting treatment is lower than the old method of treatment standard, the treatment standard of the old method will be issued according to the old method of treatment standard, to maintain the treatment is not lowered; if the new method is higher than the old method of treatment standard, the first year of retirement (October 1, 2014 to December 31, 2015) issued 10% of the excess, the second year of retirement (January 1, 2016 to December 31, 2016) issued 20%, and so on, to 100% of the excess for those retiring in the last year of the transition period (January 1, 2024 to September 30, 2024). Those who retire after the end of the transition period will be subject to the new scheme.

In summary, the 2015 reform aims to align pension benefits for public sector employees with those of enterprise employees. The "merger" will not be fully implemented until October 2024.

### 1.2.2 Educational Background and Child Policy

**China's education system** Since 1986, China has practiced compulsory education for nine years, consisting of six years of elementary school and three years of middle school. The education system is illustrated in Figure 1.2. After middle school, students take a high school entrance exam and are streamed. Figure 1.3 shows the annual enrollment numbers at each level of education, indicating that approximately half of middle school students do not continue to high school. These students often attend vocational high schools to acquire practical skills. High school graduates undergo a college entrance examination, and in recent years, around half have been able to enroll in college. The others usually attend vocational colleges (or 2-year short-cycle colleges).

Since most Chinese families prioritize sending their children to college, they tend to invest more in education before the college entrance exam. Additionally, tuition fees for vocational high schools, vocational colleges, and colleges/universities are fixed and publicly available, not subject to changes in people's willingness to invest in education. Although college students may seek to enhance their skills by participating in extracurricular training courses (e.g., language courses such as TOEFL and GRE), they generally pay for these expenses out of their living allowances from their parents, which may not be considered household education expenditures. There could be some measurement error. The main analysis in Section 1.4 focuses on households with children in preschool, elementary, middle, and high school. However, this assumption is relaxed in the robustness tests.

**Child Policy** China's population policies have undergone significant changes over the past 40 years, with some reforms overlapping with pension reform. The timeline of major policy changes is summarized in Figure 1.4.

In the early 1970s, the Chinese Government began to promote the idea of having fewer children, and in 1973 it put forward the policy of "late, sparse, fewer". It advocated delaying the first birth, increasing the spacing between births, and having fewer children. However, the policy was not mandatory. In 1979, the Chinese Government formally implemented a strict one-child policy. With the exception of multiple births and some special cases,[9] all couples could have only one child. This chapter finishes a robustness test in Section 1.4.2 by excluding all households whose children were born before one-child policy.

From 1984 to 2011, the policy was gradually relaxed on a province-by-province basis for couples in which both spouses were only children (neither having siblings). In 2013, the policy was further liberalized to allow couples to have two children if one of them was an only child. By the end of 2015, the universal two-child policy was introduced, allowing all couples, regardless of their family background (especially if both spouses have siblings), to have two children. These reforms, particularly the 2013 and 2015 changes, are relatively close in time to the 2015 pension reform. To account for internal differences due to population policy, this chapter conducts separate regressions for each of the three types of households (i.e., those with one child, those with two children, and

[9]Exceptions include: the first child is a non-genetically disabled child who cannot grow into the workforce; remarried couples have only one child in total; rural couple with only one daughter; minorities.

those with three or more children) in Section 1.4.3.

## 1.3 Data and Empirical Strategy

This section presents the empirical data utilized in the study, specifically the Chinese Household Income Project (CHIP), and describes the sample attrition that occurred. Additionally, it outlines the difference-in-differences analysis framework employed in the study and provides some descriptive statistical results derived from the sample data.

### 1.3.1 Data

The empirical analysis in this chapter utilizes the China Household Income Project (CHIP) dataset, which is a repeated cross-sectional survey conducted by the China Institute of Income Distribution in collaboration with the National Bureau of Statistics (NBS). The CHIP survey covers rural households, urban households and rural-to-urban migrant populations. CHIP investigates respondents' demographic information, personal work and income status, information on family members, and information on household income, expenditures, and wealth. For rural households, the survey also covers the assets and liabilities of the farm household, sale and consumption of products, and purchase of means of agricultural production. A total of eight waves of data are currently available: CHIP1988, CHIP1995, CHIP1999 (urban), CHIP2002, CHIP2007, CHIP2008, CHIP2013 and CHIP2018. Of these, CHIP1999 was a pilot survey in which only urban households in six provinces were interviewed. The 2007 and 2008 surveys were part of the larger RUMiC (Rural-Urban Migrants in China) survey project, and the sampling methodology and sample structure were relatively different from the other years, especially the selection of provinces.

This chapter focuses on two pension reforms for urban residents in 1997 and 2015. Therefore, CHIP1995 and CHIP2002 are selected as pre-reform and post-reform, respectively, to study the impact of the 1997 pension reform on urban household' education investment and savings. And the two waves of CHIP2013 and CHIP2018 are used to study the impact of the 2015 Pension Merger on urban residents. Also, CHIP1999 is used as a comparison with 1995 as a robustness test to add to the picture (the results are summarized in Section 1.4.2).

In terms of sample selection, this chapter concentrates on urban households with working-age

heads or spouses (22-60 years old) who have school-age children. The main analysis concentrates on households where the head or spouse is eligible for a pension. Some restrictions are relaxed in the robustness tests, and samples with implausible data, such as small age differences between parents and children (less than 12 years old) or children older than their parents, are removed.

The chapter focuses on two explanatory variables: household investment in children's education and household savings. Household investment in children's education is measured in two dimensions: quantity and ratio to household income. The total education expenditure in the household income questionnaire is selected as the explanatory variable, and the breakdown of educational expenditures includes tuition fees, book expenditures, and other costs. The share of education in household income is determined by using the ratio of total education investment to total household income.

Household savings are derived from total household income minus household expenditure, and the savings rate is the ratio of savings to total household income. The chapter also examines the impact of multi-child families on educational expenditures, as most families in the data sample have only one child who is a student. For families with two or more student children, the chapter selects the average educational spending per child as the explanatory variable.[10] In the individual questionnaire, CHIP surveyed each household member's personal income sources throughout the year, including wage income for active workers, and pension and support income for retirees. In the household questionnaire, CHIP investigates the assets of the household, including financial assets, fixed assets, durable consumer goods, etc., as well as household debts, and a breakdown of the consumption expenditures of the entire household, including daily expenditures, education expenditures, alimony expenditures, etc.

Since only total educational inputs were recorded in the household finance questionnaire, multi-child families did not distinguish educational expenditures for each child. However, most families in the data sample have only one student.[11] Section 1.4.1 examines families with one student. For families with 2 or more student children, the chapter selects the average educational spending per child as the explanatory variable and reports the results of the robustness check in Section 1.4.2.

[10]Price levels are derived from Chinese Consumer Price Index (CPI) data in the World Bank database: https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=CN. Using 2010 as the base year (CPI = 100), the CPI for 1995 was 74.08, for 1999 it was 80.69, for 2002 it was 80.96, for 2013 it was 111.16, and for 2018 it was 121.56.

[11]In total, 90% of the families in the cleaned dataset had only one child who was a student.

The chapter also focuses on the cost of preschool, elementary, middle school, and high school education, as tuition fees for vocational high school, vocational college, or university education in China are relatively fixed and publicly available. Self-improvement expenses for college students, such as TOEFL training, are generally noted from the living expenses given by parents and are more difficult to measure.

### 1.3.2 Difference-in-differences (DID) Approach

In the context of China's pension reform in 1997, employees in urban areas who worked for enterprises faced a decrease in their future pension income, whereas public sector employees were not affected. In contrast, the 2015 reform led to a reduction in pension benefits for public sector employees, while enterprise employees saw no change in their pension. By comparing households affected by the policy (treatment group) to those not affected (control group), a difference-in-differences approach can be used to evaluate the impact of the policy.

$$Y = \beta_0 + \beta_1 D_{treat} + \beta_2 D_{policy} + \beta_3 D_{treat} \times D_{policy} + \gamma X + \varepsilon \tag{1.1}$$

The outcome variable $Y$ represents the household's investment in the child's education and household savings, both measured as a proportion of household income and amount of spending, respectively. The treatment group is defined using a dummy variable $D_{treat}$ that takes the value of 1 when the household belongs to the treatment group and 0 when it is the control group. In the 1997 reform, households working in enterprises are the treatment group. In the 2015 reform, households working in the public sector are in the treatment group. The treatment group is defined in three different dimensions: the head of the household is affected by the policy, the head or spouse is affected by the policy, and the head and spouse are affected by the policy.

The variable $D_{policy}$ measures whether the year is a post-policy year, taking the value of 1 for observations in 2002 for the 1997 reform and in 2018 for the 2015 reform. The interaction term $D_{treat} \times D_{policy}$ captures the differential trends in the outcome variables between the treatment and control groups, with its coefficient $\beta_3$ being the focus of the chapter.

The control variables $X$ include demographic information, years of education, and work-related variables of the head and spouse, as well as the gender, age, and educational stage of the children.

Household economic measures such as household income and household financial assets are also included. Descriptive statistics for all variables are presented in Table 1.5 and Table 1.6.

The modeling configuration assumes that there are no unaccounted variables that might affect the outcomes of both the treatment and control groups before and after the pension reform. Therefore, any differences in trends between the two groups are attributed to the effects of the pension reform. However, the enterprise reform, which resulted in significant layoffs of enterprise employees in the late 1990s, raises a concern about the composition of the treatment group. The treatment group in the dataset consists exclusively of survivors of the enterprise reform following the 1997 pension reform. To address this issue, Section 1.4.2 proposes a new definition of the treatment group that includes households in which the head is currently working in an enterprise, households in which the head is currently unemployed and the reason for unemployment is layoffs or business bankruptcy, and households in which the head's last job was in an enterprise. This new definition aims to mitigate the concern that the treatment group may not accurately represent the population affected by the pension reform.

### 1.3.3 Summary Statistics

Table 1.2 presents descriptive statistics for the samples from CHIP 1995 and CHIP 2002, broken down by work sector of the head of the household. The table shows means and standard deviations for four outcome variables: education expenditure as a share of total income, investment in education, savings rate, and savings. One notable feature of the data is that the mean value of savings is negative in both 1995 and 2002. This suggests that many households faced financial deficits and had to use past savings to supplement their spending in those years.

The table also includes means and standard deviations for several control variables, including demographic characteristics of the head and spouse, such as gender, age, ethnicity, and CPC membership, as well as variables related to the household's economic situation, such as household income and household assets. Among the control variables, adding "head" to the name of the variable means that it is a control variable related to the head of the household, adding "spouse" to the name of the variable means that it is a control variable related to the spouse, and adding "child" to the name of the variable means that it is a control variable related to the child. The main control variables include the gender of head, age, ethnicity, CPC membership, years of education, man-

ager and technical position of the head or spouse, and the child's gender, age and current stage of schooling: whether he/she is an elementary school student, middle school student, or high school student (preschool is used as the base group). The last two variables are household economic related variables in thousands. Asset finance represents the household's total financial assets, including fixed-term saving accounts, checking accounts, stocks, bonds, treasury bills, lending, production funds for family production/operations, and investments in enterprises or other business activities other than stocks and bonds. Household income represents the total household income for the year.

In terms of the control variables, the table shows that the means of most variables are relatively close across the two years. However, there are some differences in the proportions of certain variables, such as CPC membership, managerial positions, and technical positions. For example, the proportion of CPC members is higher in the public sector than in the enterprise sector, regardless of the year. Similarly, the proportion of managerial positions is higher in the enterprise sector than in the public sector, while the proportion of technical positions is lower in the enterprise sector than in the public sector.

Overall, the data suggest that household income and household assets have increased dramatically over time, reflecting the growth of the economy. However, the negative mean value of savings suggests that many households still face financial challenges and may be relying on past savings to make ends meet.

Table 1.6 presents descriptive statistics for the samples of CHIP2013 and CHIP2018, with variable definitions consistent with Table 1.5. Like Table 1.5, the means of most control variables are relatively similar, but differences in binary variables such as CPC membership, managerial positions, and technical positions are notable. Household income and household financial assets have increased significantly from 2013 to 2018, indicating societal development.

Figure 1.5 displays a histogram of support expenditures of children to parents as a share of the child's total household income for the CHIP1995 and CHIP2002 samples. The distribution of support expenditure ratios is similar in both years, with most households contributing a small portion (around 5%) of their expenditure to support their parents.

Figure 1.6 shows the mean pensions of retirees grouped by age in the CHIP 1995 and CHIP 2002 individual data, with confidence intervals of plus or minus one standard deviation from the mean. The pension amounts have been inflation-adjusted to 2010 price levels. The figure reveals that,

after the policy implementation, pensions in both the public sector and the enterprise sector have increased, but the gap between the two has grown. For most age groups of retirees, the difference between the two means is more than one standard deviation, indicating a widening gap between public and enterprise sector pensions.

## 1.4 Empirical Results

This section presents the empirical analysis's main results. Section 1.4.1 uses a DID approach with CHIP1995 and CHIP2002 to examine the 1997 reform's impact on reducing pensions for enterprise employees, studying its effect on household investment in education and savings. Section 1.4.2 performs several robustness checks on Section 1.4.1's findings. Section 1.4.3 analyzes the 2015 "Pension Merger" policy's impact on public sector employees' pensions, examining its effect on household education investment and savings. Section 1.4.4 conducts a case study to further explore the relationship between substitution rates and household investment in education by projecting future wages and pensions.

### 1.4.1 Educational Investment and Household Saving: 1997 Pension Reform

The CHIP1995 and CHIP2002 datasets contain samples from 11 and 12 provinces, respectively. 11 of which are identical, with province 50[12] appearing only in 2002. However, to ensure consistency in the sample structure and to facilitate comparison across years, the regression sample in Section 1.4 is limited to the 11 provinces that are common to both datasets. This allows for a repeated cross-sectional analysis of the impact of the pension reform on household investment in education and savings. The results of the all-province regressions are presented in Table 1.23 and Table 1.24 in Appendix A.1.

The analytical framework of this section is built upon Equation (1.1), which is used to examine the impact of the 1997 pension reform on household investment in education and savings. In this context, employees of enterprises serve as the treatment group, while employees of public sectors act as the control group. As such, Equation (1.1) can be rewritten as:

[12]In China, each province is assigned a unique two-digit numeric code. The CHIP data utilizes this same code system to identify provinces, ensuring consistency across all years of the survey.

$$Y = \beta_0 + \beta_1 D_{ent} + \beta_2 D_{2002} + \beta_3 D_{ent} \times D_{2002} + \gamma X + \varepsilon \tag{1.2}$$

where $Y$ is the explanatory variable that includes educational spending, household savings, and their ratios to household income. $\beta_0$ is the intercept. The binary variable, $D_{ent}$, identifies whether the household is employed in the enterprise sector or not. Three different dimensions are used to define the treatment group: the head of the household works in the enterprise, the head or spouse works in the enterprise, and both the head and spouse work in the enterprise. $\beta_1$ is the coefficient of dummy variable $D_{ent}$. $D_{2002}$ is the binary variable showing the policy treatment. $\beta_3$ is the coefficient for the interaction term. The control variables $X$, include personal information of the head of household and spouse, the education level of the children, and the economic status of the household, measured by self-reported household financial assets. When the outcome variable is a ratio, the control variable for household assets is the quartile of household financial assets, while when the outcome variable is an amount, the control variables representing household economic status are the amount of household financial assets as well as the amount of household income.

By estimating the coefficients of the treatment and dummy variables, the equation allows us to assess the effect of the pension reform on household investment in education and savings, while controlling for other factors that may influence these decisions.

The regression results of Equation (1.2) are presented in Table 1.7 and Table 1.8, using data from families with one student and examining the child's educational level across preschool, elementary school, middle school, and high school. The explanatory variables in Table 1.7 are education-income ratio and investment in education. And the explanatory variables in Table 1.8 are savings rate as well as savings. The treatment group is identified using three different dimensions:

- Column (1) and column (4): Households where the head works in an enterprise unit are considered the treatment group.

- Column (2) and column (5): A broader definition of the treatment group is used, including households where either the head or the spouse works in an enterprise, or in other words, households are identified as the control group only when neither the head nor the spouse works in an enterprise.

- Column (3) and column (6): A narrower scope is used to identify the treatment group, with both the head of household and the spouse working in the enterprise.

As can be seen in column (1) of Table 1.7, households with the head working in an enterprise increase their share of education expenditures in household income by about 2.1 percentage points compared to households with a head working in the public sector. This suggests that households may increase their spending on education in response to the expectation of a reduced pension. The results are similar for narrow calibers (column 3). However, in the second column, when the definition of the treatment group is relaxed (i.e., spouse working in firms but head working in the public sector is counted in the treatment group), the coefficient on the interaction term is relatively small (about 1.2%). This may be due to the generally greater influence of the head of the household on the household economy or on household decisions. For households in which the head works in the public sector and the spouse works in an enterprise, the head's expectations remain stable even if the spouse's future pension declines. The policy shock may not be as strong for such households. Thus the differences between the treatment and control groups are not as pronounced as under the other two definitions.

Before the 1997 policy (in 1995), the difference between the two types of households in terms of expenditure on investment in education as a share of household income was insignificant, but after the implementation of the policy, the share of education investment increases over time for both types of households, while it increases by about 2.1 percentage points more for workers in enterprises relative to workers in public sectors. As for the absolute amount spent on education, after controlling for variables such as household income and household assets, enterprise employees would increase more of their spending on education compared with public sectore employees (columns 4 and 6), but the difference is not statistically significant.

Table 1.8 shows the impact of policy on savings. The first and third columns show that the difference between the savings rates of the two types of households was not significant in 1995, whereas after the policy was implemented, on average, the savings rate of workers in enterprises increased by about 6 to 7 percentage points relative to that of workers in institutions. Also, enterprise workers save relatively more (columns (4) and (6)), but the coefficients of the interation term are not significant. Similar to the analysis of investment in education, there is no significant difference

between enterprise and public employees in the regression results under the broad-banded definition (column (2) and (5)). It is possible that policy shocks to spouses may not have a strong effect on households.

Overall, the results suggest that the 1997 pension reform had a positive impact on household investment in education and savings, especially for households with the head working in an enterprise.

For the analyses in Section 1.4.2, the treatment group is defined as the head working in an enterprise. Therefore columns (1) and (4) of Table 1.7 and Table 1.8 were chosen as the benchmark of comparison for the robustness checks.

### 1.4.2 Robustness

The first part of this section discusses the use of DID identification to account for the potential impact of layoffs on enterprise workers by expanding the definition of the treatment group. The second part of this section explores the various sample choices used in the study. In Section 1.4.1, the sample consists of families with only one child in school, and the educational levels of children are limited to preschool, elementary school, middle school, and high school. In contrast, Section 1.4.2 examines all levels of education for single-student families, restricts the sample to children born in 1980 or later (i.e., after the introduction of the one-child policy), and discusses educational expenditures in multi-child families. Section 1.4.2 discusses the different measures of family finances, while Section 1.4.2 evaluates the impact of the initial implementation of the policy on households by comparing the CHIP1999 pilot survey with the CHIP1995 survey.

**Identification** In Section 1.4.1, the treatment and control groups are defined based on the current work status of the head of household. However, as discussed in Section 1.3.2, the 1997 pension reforms had different impacts on employees of enterprise units and employees of institutions, and the enterprise reforms of the 1990s resulted in layoffs of enterprise employees. In contrast, permanent employees of public organizations have "iron rice bowl" jobs (or secure jobs) with no risk of unemployment, which means that current employees of enterprises can be considered "survivors". To address this issue, this section modifies the identification conditions for the treatment group and adds additional restrictions.

The CHIP dataset asked participants about their work status at their last job, including reasons for leaving and basic information about the workplace. Therefore, this section defines a broader condition by considering as a treatment group those households where the head of the household is currently unemployed due to layoff or firm bankruptcy (i.e., a separation that was not caused by the person's own subjective reasons), or where the head's last job was in an enterprise, regardless of their current work status. This expanded definition increases the sample size from 5054 to 5382. Additionally, the chapter excludes samples where the head did not start working before the policy implementation in 1997, based on the broad definition of the treatment group. The regression results are presented in Table 1.9 and Table 1.10, with the explanatory variables in Table 1.9 being education-related, and the explanatory variable in Table 1.10 being savings.

The outcome variables in columns (1) to (3) of Table 1.9 represent the percentage of household income invested in education, while the outcome variables in columns (4) to (6) represent the actual amount of money invested in education. Columns (1) and (4) of Table 1.9 are the benchmark results from column (1) and (4) in Table 1.7, and the treatment group is defined as the head working in an enterprise, while the treatment group in columns (2) and (5) is defined as households where the head works in an enterprise or has been affected by the layoff or bankruptcy, or has a last job was in an enterprise. The sample in columns (3) and (6) is further restricted to those who joined the workforce after 1997.

As shown in Table 1.9, the coefficients under the wide definition are generally similar to the baseline results, except for a slight increase in the magnitude of the coefficient of the interaction term in column (3). This suggests that those who joined the workforce after the policy did not experience the policy shock firsthand and did not feel as strongly about expected pension reductions. After excluding this part of the sample, the remaining treatment group invested a little more in education relative to the control group.

Table 1.10 displays the regression results for the savings rate and savings amounts of employees in enterprises and public sector employees after the policy was introduced. The structure of it is similar to that of Table 1.9, with columns (1) - (3) showing the regression results for the savings rate and columns (4) - (6) showing the regression results for savings. Columns (1) and (4) are benchmark results, consistent with Table 1.8. The table shows that the interaction term coefficients are relatively similar across different definitions of the treatment group, indicating that the policy

had a consistent effect on the savings behavior of employees in enterprises. Specifically, the results suggest that the savings rate of employees in enterprises was 6% higher than that of public sector employees, on average, after the policy was introduced. Additionally, the amount of savings for the treatment group is higher by about 1,400 RMB per year, although the result is not statistically significant.

**Different Sample Selection** The previous baseline regression in 5.1 focused on households with a child in school and only considered regressions where the child was in preschool, elementary school, middle school, or high school. This section expands the sample scope and presents the results of the regressions on education and savings in Table 1.11 and Table 1.12, respectively. Table 1.11 presents the results of the regressions on education and Table 1.12 presents the results of the regressions on savings. The tables provide a comprehensive overview of the impact of the policy on education and savings outcomes for households with children in different stages of education.

Table 1.11 presents the results of regressions on education expenditures and savings for households with children in different stages of education. Columns (1) through (4) show the regression results for the share of education expenditures, while columns (5) through (8) display the results for education expenditures. The baseline results are shown in columns (1) and (5), which are the same as columns (1) and (4) of Table 1.7, respectively.

Columns (2), (3), (6), and (7) focus on households with only one child who is a student. However, columns (2) and (6) include vocational high school, vocational college, and university education in addition to basic education. Columns (3) and (7) use households with children in basic education but impose additional restrictions on the sample. China's strict one-child policy since 1979 affects household fertility decisions as well as other aspects. The regressions exclude samples with children born before the one-child policy (before 1980), which means that the regression sample includes families with children younger than 16 years old in CHIP1995 and families with children younger than 22 years old in CHIP2002. Since students in high school and below are all under 22 in the sample, the restriction is of little significance for the latter.

The regression results in columns (2) and (3) are similar to the baseline results in column (1), indicating that households in the treatment group still invest about 2% more of their household income in their children's education relative to the control group.

Columns (4) and (8) of Table 1.11 expand the scope of the analysis by considering the entire sample and calculating the average educational spending per child and this average educational spending as a share of household income as the outcome variable. The regression results in column (4) show that the treatment group's average investment per child as a share of household income increases by 1.7 percent more compared to the control group, which is slightly smaller than the 2.1 percent increase in the baseline results.

Table 1.12 presents the results of regressions on savings rates and savings amounts for different stages of education of children. The baseline regression results are shown in columns (1) and (4), while columns (2) and (5) present the results for all stages of education. The coefficient on the interaction term in the sample that includes vocational education and college education is lower, at 3.4%, and not significant, possibly due to the fact that families with older parents have different saving behaviors. The treatment group saves about 691 RMB more than the control group, but the coefficient is not significant.

Columns (3) and (6) restrict families with children born in 1980 and later, and the results show that for households more strongly affected by the one-child policy, enterprise households save, on average, 5.4% more of their household income than households in the public sector, which is less than the baseline of 6.2%. This may be due to the fact that the one-child policy has changed fertility attitudes and decision-making, and in households with only one child, there is no need to save for more children, and pension policies do not affect household savings to the same extent.

**Different Ways to Measure Household Assets** In the regressions presented in Section 1.4.1, the total value of household financial assets is utilized as a proxy variable for household assets. Quartiles of household financial assets are selected as control variables in regressions where education-income ratio and savings rate are explanatory variables, while the amount of household financial assets is controlled in regressions where investment in education and savings are outcome variables. In order to test the robustness of the results, other measures of household assets are considered in this section. The regression results are displayed in Table 1.13 and Table 1.14, where Table 1.13 shows the outcome variables related to education, while Table 1.14 presents the outcome variables related to savings.

In addition to the benchmark regressions, the study also examines three alternative measures of

household assets:

**Total household asset**s. This measure includes the total value of household financial assets, durable consumer goods, the market value of owned productive fixed assets, the market value of owned housing, and the estimated market value of other assets. The corresponding regression results are presented in columns (2) and (6) of Table 1.13 and Table 1.14.

**Household net assets**. This measure is calculated by subtracting total household liabilities from total household assets. The corresponding regression results are shown in columns (3) and (7) of Table 1.13 and Table 1.14.

**Total household liquid assets**. This measure includes only highly liquid and liquidable assets, such as fixed-term saving accounts, checking accounts, stocks, bonds, and treasury bills, in the household's financial assets. It excludes lending, production funds for family production/operations, and investments in enterprises or other business activities other than stocks and bonds. The corresponding regression results are presented in columns (4) and (8) of Table 1.13 and Table 1.14.

The results of the benchmark regressions in columns (1) and (5) of Table 1.13 and Table 1.14 are similar to the findings in columns (1) and (4) of Table 1.7 and Table 1.8, respectively. Specifically, the coefficients on the interaction terms are approximately 2.1% in columns (1) through (4) of Table 1.13 and around 6% in columns (1) through (4) of Table 1.14. These findings support the conclusion that the treatment group invests and saves more in education relative to the control group, but the difference is not statistically significant.

In columns (5) through (8) of Table 1.13 and Table 1.14, the coefficients on the interaction terms are all positive but not significant, indicating that while the treatment group invests and saves more on education relative to the control group, the difference is not statistically significant. This suggests that the impact of the treatment on education spending and saving is not strong enough to be detected by the regression analysis.

Overall, the results of the regressions provide additional evidence that the treatment group invests and saves more in education relative to the control group, but the difference is not statistically significant. This supports the conclusion that the treatment has a positive effect on education outcomes, but further research is needed to confirm this finding.

Furthermore, given that household financial status can influence household spending decisions, this study splits the sample into four groups based on the stock of household financial assets and per-

forms DID regressions for each group separately to examine the pre-policy responses of households with varying levels of wealth. The findings are presented in Table 1.15.

The first column of Table 1.15 mirrors the benchmark regression in the first column of Table 1.7, while columns (2) through (5) display the results of segmenting the sample into four groups based on the order of household financial assets. The first group has the lowest household financial assets, and the fourth group has the highest. The interaction term coefficients reveal that the retirement policy has a weaker impact on the poorest and richest groups, with coefficients of 0.012 and 0.013, respectively, which are not statistically significant. The policy's effect is more pronounced for the middle two groups, particularly the second group, suggesting a potential wealth effect that may also need to be considered in assessing the policy's impact.

**Comparison of 1995 and 1999** In order to further investigate the impact of the 1997 pension reform, this section compares the CHIP data from 1999 and 1995. Since the samples are not identical, this section uses balanced mixed cross-section data, which includes data from the six provinces that are common to both samples. The regression results for the unbalanced sample are presented in Table 1.25 and Table 1.26 in Appendix A.1. The regression equation is shown in Equation (1.3).

$$Y = \beta_0 + \beta_1 D_{ent} + \beta_2 D_{1999} + \beta_3 D_{ent} \times D_{1999} + \gamma X + \varepsilon \tag{1.3}$$

where the explanatory variable $Y$ and control variable $X$ have the same meanings as in Section 1.4.1. $D_{1999}$ is a binary variable indicating the year, taking 1 when the year is 1999, and 0 when it is 1995. The treatment group is defined as households where the head works for an enterprise, and for robustness testing, the study also adopts a wider definition of the treatment group, which includes households where the head is currently working in an enterprise, or is currently unemployed and the reason for unemployment is layoff or firm bankruptcy, as well as households where the head's last job was in a firm regardless of their current job status. The sample is limited to families with only one child in school and the child's education level is preschool, elementary, middle school, or college. The regression results for education-related outcomes are presented in Table 1.16, while the saving-related results are in Table 1.17.

In Table 1.16 and Table 1.17, the treatment group is defined as households where the head of the

household is currently employed in an enterprise, as indicated by columns (1) and (3). In contrast, columns (2) and (4) use a broader definition of the treatment group, which includes households where the head is currently working in an enterprise, or is currently unemployed and the reason for unemployment is layoff or firm bankruptcy, as well as households where the head's last job was in a firm regardless of their current job status.

As shown in Table 1.16, the treatment group allocates approximately 1.6% more of their household income towards their children's education compared to the control group, which is less than the 2% observed in the benchmark regression. This could be due to some households reacting slower than others, resulting in a less pronounced effect. However, the difference in spending between the treatment and control groups is not statistically significant. Additionally, columns (3) and (4) reveal that the control group would have spent around 560 RMB more on their children's education in 1999 than in 1995, while the treatment group spends approximately 137 RMB more than the control group, but the coefficient is not statistically significant.

Interestingly, Table 1.17 shows that the coefficients on the interaction terms in columns (1) and (2) are negative, while the coefficients on the year dummy $D_{1999}$ are positive. This suggests that households' overall savings rate increased in 1999 compared to 1995, but enterprise households, which make up the treatment group, saved about 6% less of their household income than the control group. This finding contrasts with the results in Table 1.8 of Section 1.4.1. The difference in savings behavior between enterprise and public sector households may be attributed to the macro environment, specifically the period of severe corporate layoffs from 1998 to 2000, which affected enterprise households' saving behavior. The shock of lower future pensions, coupled with layoffs and uncertainty about future expectations, may have led to a savings behavior that deviates from that of public sector households.

### 1.4.3 "Pension Merger": 2015 Pension Reform

Similar to Section 1.4.1, CHIP2013 surveyed 14 provinces, while CHIP2018 surveyed 15 provinces, with province 15 appearing only in 2018. Therefore the sample used for the regressions in section 1.4.3 comes from the 14 provinces, and the results of the all-province regressions are in Table 1.27 and Table 1.28 in Appendix A.1.

This section takes a similar strategy as Section 1.4.1, comparing the three different dimensions

of the definition of treatment groups. The treatment group in this section is defined as public sector employees, as the target population of the 2015 reform is public sector employees who are allowed to start paying pension contributions and receive lower future pensions. The regression model used in this section is as follows:

$$Y = \beta_0 + \beta_1 D_{pub} + \beta_2 D_{2018} + \beta_3 D_{pub} \times D_{2018} + \gamma X + \varepsilon \tag{1.4}$$

The model includes an explanatory variable (Y) that captures educational spending, household savings, and their ratios to household income. The binary variable ($D_{pub}$) identifies whether the household works for the public sector or not. Three different dimensions are used in this section to define whether the household belongs to the treatment group: (1) the head of the household works in the public sector, (2) the head or spouse works in the public sector, and (3) both the head and spouse work in the public sector. The model also includes control variables ($X$) such as personal information of the head of household and spouse, education level of the children, and household economic status measured by self-reported household financial assets. When the outcome variable is a ratio, the control variable for household assets is the quartile of household financial assets, while when the outcome variable is an amount, the control variables representing household economic status are the amount of household financial assets as well as the amount of household income.

The sample selection for this section is similar to Section 1.4.1, with households having only one student and children in high school education or below being retained. Additionally, households that retire before 2025 are excluded from the 2018 sample to ensure that the sample only includes households that are affected by the ten-year transition period.

The regression results of Equation (1.4) are presented in Table 1.18 and Table 1.19. Like Table 1.7 and Table 1.8, the tables display the coefficients for the interaction terms between the policy year dummy and the various dimensions of the treatment group. In Table 1.18, the coefficients on the interaction terms in columns (1) - (3) are positive, with the coefficient on the interaction term in column (1), which represents the treatment group defined as the head of household working in the public sector, being 1.8%. This is similar in magnitude to the variables in Section 1.4.1, but the coefficients are not significant. This may be due to the fact that 2018 is still in the middle of the ten-year transition period, and the policy shock to the treatment group is not yet particularly

pronounced.

Table 1.19 shows that the coefficient on the interaction term is positive but not significant under the definition of the three dimensions of the treatment group. This suggests that institutional workers increase their savings rate relative to corporate workers, but the effect is not significant, possibly due to the ten-year transition period. The study will continue to monitor related data in this area and provide additional analysis of the impact of the pension merger policy on public employees after 2025.

**Two-child Policy: Regression by household category** From Section 1.2.2 about China's population policy, it can be seen that the 2015 universal two-child policy affects families where neither spouse is an only child. The 2013 policy, on the other hand, affects families where one of the spouses is not an only child. To address this, this section examines the impact of China's population policy on household savings rates, using a DID regression of Equation (1.4) for three categories of households based on the sibling status of the couple: both spouses are only children, one of the spouses is an only child, and neither of the spouses is an only child. The treatment group consists of households where the head works in the public sector. The sample attrition is the same as in Table 1.18 and Table 1.19, which includes households with one child at school, and the child is at pre-school, elementary, middle, or high school level. The results are presented in Table 1.20 and Table 1.21.

In Table 1.20 and Table 1.21, columns (1) and (4) are for families in which both spouses are only children, while columns (2) and (5) are for families in which only one of the spouses is an only child, and columns (3) and (6) are for families in which both spouses are not only children. However, the tables show an imbalance in the number of observations across the three categories, with approximately 6.57% of observations in the first category, 14.8% in the second, and 78.64% in the third. This disparity may affect the accuracy of the analysis.

In Table 1.20, columns (1) through (3), the investment in education expenditure for public sector households shows an increase relative to enterprise households, increasing by about 5% for both only children households and by about 6.8% for one only child households. However, this difference is not statistically significant. In contrast, columns (2) and (3) of Table 1.21 reveal that public sector households have higher savings rates compared to enterprise households in the one only child and

no only child family categories. This suggests that these households may be saving in advance for future fertility decisions.

### 1.4.4 Case Study: Pension Prediction

This section uses individual data from from CHIP 1995, CHIP 1999, and CHIP 2002 to forecast future earnings of individuals. This prediction enables the application of the formulas presented in Table 1.2 and Table 1.4 to estimate future pensions and assess the impact of the 1997 pension reform on expected pensions.

The first step in the analysis is to predict future wages. This is done by using individual-level data such as age, gender, ethnicity, education, years of work experience, province, and job-related variables (e.g. industry, job title) as control variables in a regression model. The explanatory variable is the logarithm of wages, which is inflation-adjusted using the World Bank's CPI data for China. The meanings of the variables and the regression results are presented in Table 1.29 in Appendix A.2. To account for clustering and heteroskedasticity, standard errors are calculated at the county level and are robust to both clustering and heteroskedasticity.

The next step is to calculate each individual's wage for every year from 1997 (or the first year of employment for those who started later than 1997) until retirement, while holding all control variables except age and years of employment constant. The wages are estimated using real wages for 1999 and 2002.

In the third step, the number of working years until retirement is calculated, and the pre-policy replacement rate and the pre-policy pension for the first year of retirement are determined using the formulas in Table 1.2. The pre-policy pension for the first year of retirement is calculated by multiplying the pre-policy replacement rate by the estimated salary for the year prior to retirement, which was determined in step two.

Step 4 then estimates the post-policy pension and replacement rate for enterprise workers in 1999 and 2002 using Table 1.4. $W_A$ in Table 1.4 is calculated from the predicted wage in the second step. For example, for an individual who retires at the end of 2008, the predicted wage for 2008 is chosen as the pre-retirement wage. $W_A$ is calculated by the average of the predict wages in the individual's province in 2007. From this, the basic benefit and the transitional benefit for the first year of retirement can be calculated. The individual pension account benefit is calculated by summing up

all the predicted wages from 1998 until retirement, multiplying them by 8%, and ignoring interest on pension accounts.[13] The individual account benefit for the first year of retirement is determined by dividing this total by the pension actuarial month and multiplying by 12. Finally, the post-policy pensions are calculated by summing up the basic benefit, transitional benefit, and individual account benefit for the first year of retirement of employees in enterprises in 1999 and 2002, and thus the post-policy replacement rate.

The number of years a retiree will receive a pension can be estimated by subtracting the retirement age from life expectancy. Assuming pensions are adjusted annually for inflation only, the total pension over an individual's lifetime can be calculated by multiplying the number of years of receipt by the first-year pension amount. Life expectancy is sourced from the 2005 Chinese life expectancy data in the World Bank database.[14]

Figure 1.7 shows the total lifetime pension amount that a sample of enterprise employees can expect to receive, broken down by age and gender, in 1999 and 2002. The dashed line represents the counterfactual pension estimate, or the total pension that employees would have received if the 1997 policy reform had not been implemented, while the solid line represents the pension expectation as affected by the policy. The graph shows that the policy has led to a significant reduction in the expected pension amount for both men and women. For example, a 40-year-old female employee in 1999 would have expected to receive a total pension of 150,000 RMB without the policy, but this amount was reduced to 75,000 RMB after the policy was implemented, a decrease of more than half. On average, men receive their pensions for a shorter period of time than women, but their later retirement age means they have longer working years, which suggests that men's and women's total pensions were expected to be roughly equal before the policy. However, after the policy was implemented, men's pensions were expected to be slightly lower than women's.

Figure 1.8 displays a histogram of the expected replacement rates for employees in enterprises from surveys conducted in 1999 and 2002. The vertical axis represents the density of the data, and the blue curve represents the kernel density estimate. The policy has caused a significant shift in

[13] Interest on pension accounts is ignored here. Since all amounts are inflation-adjusted, it is assumed here that the real interest rate on pension accounts is zero and that the amounts are only inflation-adjusted.

[14] According to the World Bank, in 2005, the life expectancy in China was 71.619 years for men and 76.819 years for women. This means that men can receive a pension for around 11.619 years, while women white-collar workers can receive a pension for approximately 21.819 years, and women blue-collar workers can receive a pension for about 26.819 years.

the distribution of replacement rates, with the majority of workers now expecting a rate between 40 and 80 percent, with an average of approximately 57.5 percent. This is in contrast to the pre-policy replacement rate, which was typically above 70 percent.

This section concludes with a regression analysis that examines the relationship between the proportion of a household's investment in education and various factors, including the replacement rate of the head of the household, demographic information, and financial assets. The regression equation is as follows:

$$h_{it} = \alpha + \beta \cdot p_{it} + \gamma_1 X_{it} + \gamma_2 D_t + \gamma_3 D_{ent,it} + \gamma_4 D_t \times D_{ent,it} + \varepsilon_{it}$$

where $h_{it}$ represents the proportion of the household's investment in education in year $t$, $p_{it}$ represents the predicted future replacement rate of the head of the household in year $t$, $X_{it}$ represents control variables such as demographic information and financial assets, $D_t$ represents year dummy variables, and $D_{ent}$ is a dummy variable indicating whether the head of the household is working in an enterprise. Province fixed effects are controlled, and robust standard errors are clustered at the county level. The results of the regression analysis are presented in Table 1.22.

Table 1.22 presents the results of three regression analyses:

- Column (1) displays the results of regressing the entire sample for the three years 1995, 1999, and 2000.
- Column (2) shows the results of regressing only the 1995 and 2002 samples.
- Column (3) presents the results of selecting only balanced provinces (i.e., the six provinces surveyed jointly by CHIP1995, CHIP1999, and CHIP2002).

The regression analysis reveals that the coefficient for the replacement rate is approximately 0.11. This implies that for every 1% decline in the replacement rate, households tend to allocate 0.11% more of their income towards education. In other words, a 10% decrease in the expected replacement rate leads to a 1.1% increase in education investment. Given the observed decline in the replacement rate for enterprise households, from approximately 75% to 57.5%, households are found to invest around 2% more of their income in education. This finding aligns with the results discussed in Section 1.4.1.

## 1.5 Model

This section examines the issue of intergenerational optimization for households using the OLG model, taking into account the impact of the one-child policy in China. The policy has significantly limited the ability of households to make decisions about having children, particularly after the 1980s. To maintain a simple and illustrative model, we focus on the aspects of household savings and fertility decisions, while acknowledging their importance in the decision-making process.

### 1.5.1 Settings

The model makes several assumptions about households, including that they are homogeneous and go through three distinct stages of life: studying, working, and retirement. For households in generation $t$, the studying stage is characterized by receiving financial support from their parents (generation $t-1$) to pursue education and develop their own human capital. During the working stage, households in generation t support their retired parents (generation $t-1$) and raise and educate their own children (generation $t+1$). Finally, in the retirement stage, households in generation t receive a pension and support from their children in generation $t+1$.

The studying stage can be viewed as a period of human capital accumulation, during which households do not make decisions, do not derive utility from consumption, and receive educational support from their parents for capital accumulation. According to Bercker, Murphy, and Tamura (1990), the formula for intergenerational accumulation of human capital can be expressed as follows:

$$H_{t+1} = A(\bar{H} + H_t)^{\beta} h_t \tag{1.5}$$

where the human capital of a household in generation $t+1$, $H_{t+1}$, is equal to the product of three factors: $A$, the sum of the initial endowment $\bar{H}$ and the human capital of the parental generation $H_t$, raised to the power of $\beta$, and the investment in education from generation $t$ to generation $t+1$, $h_t$. In other words, the human capital of the next generation is a function of the current generation's human capital, the initial endowment, and the investment in education. The coefficient A measures the productivity of investments, while $0 < \beta < 1$ represents the effect of scale on the accumulation of human capital.

During the working stage, households in generation $t$ derive utility from consumption, $C_{w,t}$, and earn wages that are a linear function of their capital accumulation, $\bar{H} + H_t$. The base wage, $\bar{H}$, can be seen as the wage that the offspring can earn in the future based on the fact that the parents are not actively investing in their education, but rather relying entirely on public education in society. Household expenditures at this stage include social security payments, education expenditures for the next generation, and support expenditures for the previous generation. The constraints for this phase can be written as:

$$C_{w,t} \leq (1 - \lambda_t - h_t - \phi)(\bar{H} + H_t) \tag{1.6}$$

where $\lambda_t$ represents the income tax rate, $h_t$ is the investment in education for the offspring as a share of household income, and $\phi$ stands for the support expenditure to the parents as a share of household income. The existence of the support expenditure can be considered as public information since it is mandated by Chinese law.

During the retirement phase, households in generation $t$ derive utility from consumption $C_{r,t}$. The two main sources of income at this stage are pensions and intra-family transfers from offspring (generation $t+1$). The pension replacement rate, $p_t$, affects the first source of income, which is the product of wages and the replacement rate. The second source of income, intra-family transfers, is represented by the term $(\bar{H} + H_{t+1})\phi$, where $\phi$ is the proportion of support paid by generation $t+1$ to their parents (generation $t$) as a percentage of their wages. This term can be interpreted as the minimum standard of support set by law. The retirement stage constraint can be written as:

$$C_{r,t} \leq (\bar{H} + H_t)p_t + (\bar{H} + H_{t+1})\phi \tag{1.7}$$

The model simplifies the consideration of fertility and private savings, making education expenditure the only decision variable. Households pay for their children's education during the working years and receive returns during retirement through intra-family transfers.

### 1.5.2 Household Optimization Problem

According to the analysis in section 1.5.1, households derive utility from consumption at work, $C_{w,t}$, and in retirement, $C_{r,t}$. Taking into account the change in the time value of money that exists in both periods, the optimization problem for generation $t$ households can be summarized as:

$$\max_{h_t} U = \log C_{w,t} + \delta \log C_{r,t}$$

subject to

$$C_{w,t} \leq (1 - \lambda_t - h_t - \phi)(\bar{H} + H_t)$$

$$C_{r,t} \leq (\bar{H} + H_t)p_t + [\bar{H} + A(\bar{H} + H_t)^{\beta} h_t]\phi$$

The optimal level of educational investment, $h_t$, can be found by solving the above problem, and it is found to be:

$$h_t = -\frac{(\bar{H} + H_t)^{1-\beta}}{A\phi(1+\delta)} \cdot p_t + \frac{\delta}{1+\delta}(1 - \lambda_t - \phi) - \frac{\bar{H}}{A(1+\delta)(\bar{H} + H_t)^{\beta}} \tag{1.8}$$

By taking a partial derivative of $h_t$ with respect to $p_t$, we can find that there is an inverse relationship between the substitution rate and family investment in education

$$\frac{\partial h_t}{\partial p_t} = -\frac{(\bar{H} + H_t)^{1-\beta}}{A\phi(1+\delta)} < 0$$

The two pension reforms of 1997 and 2015 lead to lower expected pensions for the target population, which in turn seeks more intra-family transfers in the future by increasing investment in education.

Using the replacement rates estimated in section 1.4.4, we can create a scatter plot of the proportion of investment in education and the replacement rate, with a fitted line (see Figure 1.9). The slope of this fitted line is around 0.11, as derived from section 1.4.4.

## 1.6 Conclusion

This chapter examines the impact of changes in pension expectations on household investment in human capital and savings. The 1997 pension reform in China reduced the future pensions of employees in enterprises, providing a natural experiment for studying the relationship between pension expectations and household behavior. The chapter uses a difference-in-differences (DID)

approach, comparing employees in enterprises (the treatment group) to public sector employees (the control group), to estimate the impact of the reform on household investment in education and savings.

The empirical analysis of CHIP1995 and CHIP2002 reveals that enterprise employees invested 2% more of their income in their children's education compared to public sector employees, and their household savings rate was 6% higher. These results suggest that households expecting a decline in future pensions invest more in their children and increase their personal savings to supplement their expected future income. The results are robust to various sensitivity checks, including redefining the treatment group, changing sample attrition, and using different measures of household assets. The chapter's findings, however, indicate that households with varying levels of wealth respond differently to policy, with the middle two groups, particularly the second group, being more sensitive to policy changes. In contrast, the policy's impact is not significant for the poorest and richest groups.

In the regressions for CHIP 1995 and CHIP 1999, the treatment group invested about 1.6 percent more than employees in public sectors, probably because 1999 was a short time after the policy was implemented and the effect was not as pronounced as in 2002. The difference is that the saving rate of the treatment group (i.e., enterprise employees) declined in 1999 compared to the control group. This may be due to the general macro environment.

Additionally, the chapter examines the "Pension Merger" reform in 2015, which reduced the pensions of workers in public sectors without affecting enterprise workers. Using a DID model to regress CHIP2013 and CHIP2018, the results show that public sector employees invested 1.8% more of their income in education compared to enterprise workers, but this result is not statistically significant. This may be due to the fact that 2018 is still in the ten-year transition period for the 2015 pension reform, and the policy shock is not yet significant.

The chapter also predicts individuals' future earnings and estimates their future pensions using the pension formula. The results show that there is a substantial decline in the expected future pensions of enterprise workers after the policy, with an estimated average replacement rate of 57.5%, which is much lower than the pre-policy pension income. Furthermore, a regression of the education spending ratio on the predicted replacement rate shows that the ratio of households' education spending to their income increases by 1.1% for every 10% drop in the replacement rate.

Finally, the chapter uses a simplified modeling framework based on the generational optimization problem of the OLG model to illustrate the results. The optimal solution shows a negative linear relationship between households' optimal human capital investment and the replacement rate, consistent with the empirical findings. When the replacement rate of the household decreases, the proportion of investment in education increases.

In conclusion, this chapter provides evidence that changes in pension expectations have a significant impact on household investment in human capital and savings. Households expecting a decline in future pensions invest more in their children and increase their personal savings to supplement their expected future income. The results are robust to various sensitivity checks and are consistent with the predictions of a simple modeling framework.

## 1.7 Tables and Graphs

Table 1.1: 1997 Reform of the Pension System in China

| Year | Pension Plan | Targeted Group | Pension Amount |
|---|---|---|---|
| 1951 | PAYGO | Public sector employees and workers in state-owned enterprises | High |
| 1995~1997 | Pension reform was directed at introducing a multipillar system with a declining replacement rate | | |
| **1997** | Dual Pension Schemes | Employees in enterprises | Middle |
| **2015** | Pension Merger | Public sector employees | Middle |

*Notes:* This table provides an overview of China's significant pension policies and reforms. The 1997 "Dual Pension Scheme" reform reduced the future pensions of employees in enterprises, thereby ending the PAYGO system for enterprises and creating disparities in pensions between the public and private sectors. The 2015 "Pension Merger" reform equalized pensions in the public sector to the level of those in enterprises.



Table 1.2: Pre-Reform Pension Replacement Rate

| Years of Work | Replacement Rate |
|---|---|
| 35 years or more | 90% |
| 30~34 years | 85% |
| 20~29 years | 80% |
| 10~19 years | 70% |
| Less than 10 years | 50% |

*Notes:* The table illustrates the criteria used to calculate replacement rates before the 1997 reform. The pre-policy replacement rate is determined solely by the length of service.

Table 1.3: Contributions and benefits before and after 1997 reform (for enterprise workers)

| | | Pre-reform | Post-reform | | |
|---|---|---|---|---|---|
| | | | New worker | Middle worker | Retiree |
| Benefits | | 70%-90% of wage before retirement | Basic benefit + individual account benefit | Basic benefit + individual account benefit + transitional benefit | Same as pre-reform |
| Contribution | Employer | Varying across regions, up to 3% | 20% of total wage | | - |
| | Employee | No contribution from employees | 4% payroll tax in 1997, increased gradually to 8% | | |

*Notes:* This table presents a comparison of the pension benefits and contribution status of employees in enterprises before and after the 1997 reform. The reform did not impact retired employees. Middle workers, who began their careers pre-1997 but retired post-1997, are shown separately. New workers, who joined the workforce after the reform, are also included. The table demonstrates that, following the reform, both employers and employees are required to contribute to pensions. Conversely, employees' pension benefits have decreased compared to the pre-reform pension. Middle workers, who had not contributed to a pension account before the reform, received a transitional benefit to offset this. The specific formula for each benefit is displayed in Table 1.4.

Table 1.4: Post-Reform Pension Formula

| | |
|---|---|
| Basic Benefit | $W_A(1+i)\times 0.5\times n\times 1\%$ |
| Individual Account Benefit | accumulated value of individual account (8% contribution) divided by **months** |
| Transitional Benefit | $W_A\times i\times$ (Years of work before policy) $\times 1.2\%$ |

*Notes*: This table shows the formula for calculating pensions. The parameters are as follows:
$W_A$: Average monthly salary of employees on duty in the province in the previous year at the time of retirement

$i$: average contributory wage index $= \begin{cases} 0.6, & \frac{\text{wage}}{W_A} \leq 0.6 \\ \frac{\text{wage}}{W_A}, & 0.6 < \frac{\text{wage}}{W_A} \leq 3 \\ 3, & \frac{\text{wage}}{W_A} > 3 \end{cases}$

$n$: Years of Contribution
**months**: Number of months of pension accrual. 139 months for retirement at age 60, 170 months for retirement at age 55, and 195 months for retirement at age 50.

Table 1.5: Summary Statistics (1995 & 2002)

| Variable | Enterprise | | | | Public | | | |
|---|---|---|---|---|---|---|---|---|
| | 1995 | | 2002 | | 1995 | | 2002 | |
| | mean | sd | mean | sd | mean | sd | mean | sd |
| *Outcome Variables* | | | | | | | | |
| $\frac{\text{Education Spending}}{\text{Household Income}}$ | 0.056 | 0.075 | 0.105 | 0.118 | 0.057 | 0.141 | 0.084 | 0.103 |
| Education Spending | 978.427 | 1566.887 | 2495.206 | 3747.107 | 1073.612 | 2183.392 | 2723.989 | 3753.516 |
| Saving Rate | -0.146 | 0.436 | -0.107 | 0.667 | -0.146 | 0.458 | -0.168 | 0.712 |
| Saving | -2118.378 | 8547.977 | -3968.181 | 25165.343 | -2159.516 | 9680.639 | -5672.169 | 26869.969 |
| *Control Variables* | | | | | | | | |
| Female head | 0.350 | 0.477 | 0.329 | 0.470 | 0.333 | 0.472 | 0.354 | 0.478 |
| Age head | 38.816 | 5.881 | 40.44 | 5.113 | 37.951 | 6.731 | 40.144 | 5.293 |
| Minority head | 0.037 | 0.189 | 0.034 | 0.181 | 0.034 | 0.182 | 0.050 | 0.218 |
| CPC member head | 0.232 | 0.422 | 0.286 | 0.452 | 0.414 | 0.493 | 0.439 | 0.497 |
| Educyear head | 10.258 | 2.827 | 11.176 | 2.762 | 11.995 | 3.116 | 12.808 | 2.854 |
| Manager head | 0.105 | 0.307 | 0.107 | 0.309 | 0.215 | 0.411 | 0.198 | 0.399 |
| Tech head | 0.491 | 0.500 | 0.510 | 0.500 | 0.397 | 0.489 | 0.421 | 0.494 |
| Age spouse | 38.065 | 5.814 | 39.838 | 5.148 | 37.070 | 6.602 | 39.495 | 5.295 |
| Minority spouse | 0.035 | 0.184 | 0.028 | 0.164 | 0.045 | 0.207 | 0.051 | 0.221 |
| CPC member spouse | 0.152 | 0.359 | 0.206 | 0.404 | 0.240 | 0.427 | 0.270 | 0.444 |
| Educyear spouse | 9.944 | 2.874 | 10.988 | 2.814 | 10.970 | 3.248 | 11.982 | 3.080 |
| Manager spouse | 0.081 | 0.273 | 0.095 | 0.294 | 0.137 | 0.344 | 0.138 | 0.345 |
| Tech spouse | 0.407 | 0.491 | 0.344 | 0.475 | 0.406 | 0.491 | 0.377 | 0.485 |
| Female child | 0.482 | 0.500 | 0.491 | 0.500 | 0.476 | 0.5 | 0.470 | 0.499 |
| Age child | 10.751 | 4.339 | 12.844 | 4.009 | 9.769 | 4.889 | 12.462 | 3.998 |
| Elementary school | 0.389 | 0.488 | 0.404 | 0.491 | 0.334 | 0.472 | 0.439 | 0.497 |
| Middle School | 0.271 | 0.444 | 0.277 | 0.448 | 0.212 | 0.409 | 0.266 | 0.442 |
| High school | 0.134 | 0.341 | 0.273 | 0.446 | 0.145 | 0.353 | 0.241 | 0.428 |
| Asset finance (K) | 14.252 | 20.808 | 46.632 | 63.212 | 14.915 | 19.548 | 60.522 | 177.054 |
| Household income (K) | 17.983 | 9.405 | 28.725 | 18.126 | 19.631 | 10.552 | 34.315 | 20.029 |
| Number of Observations | 2079 | | 1124 | | 1074 | | 777 | |

*Notes:* This table presents summary statistics for the CHIP 1995 and CHIP 2002 samples, broken down by year and work sector. The table includes means, standard deviations, and the number of observations for each variable. The outcome variables include households' education investment as a share of total income, total education investment, household savings rate, and household savings. The control variables include information on the head of the household, spouse, and children, as well as the economic status of the household. The table also includes variables for gender (female = 1), age, ethnic minority status (minority = 1), Communist Party of China (CPC) membership (CPC member = 1), years of schooling (Educyear), managerial status (Manager = 1), technical position status (Tech = 1), elementary school status (Elementary school = 1), middle school status (Middle school = 1), and high school status (High school = 1). Additionally, the table includes variables for total financial assets (Asset finance) and total household income, both in thousands of RMB.

Table 1.6: Summary Statistics (2013 & 2018)

| Variable | Enterprise | | | | Public | | | |
|---|---|---|---|---|---|---|---|---|
| | 2013 | | 2018 | | 2013 | | 2018 | |
| | mean | sd | mean | sd | mean | sd | mean | sd |
| *Outcome Variables* | | | | | | | | |
| $\frac{\text{Education Spending}}{\text{Household Income}}$ | 0.158 | 0.351 | 0.093 | 0.184 | 0.114 | 0.104 | 0.080 | 0.157 |
| Education Spending | 8088.107 | 9412.749 | 7314.844 | 10814.467 | 9023.426 | 10394.124 | 8218.276 | 11474.077 |
| Saving Rate | 0.235 | 0.409 | 0.187 | 0.535 | 0.154 | 2.389 | 0.285 | 0.386 |
| Saving | 23914.083 | 33105.048 | 30985.015 | 56585.707 | 30290.675 | 59571.434 | 46576.984 | 62849.825 |
| *Control Variables* | | | | | | | | |
| Female head | 0.212 | 0.409 | 0.266 | 0.442 | 0.231 | 0.422 | 0.327 | 0.470 |
| Age head | 41.287 | 5.207 | 41.643 | 6.118 | 40.756 | 4.783 | 41.290 | 5.484 |
| Minority head | 0.033 | 0.180 | 0.031 | 0.174 | 0.045 | 0.208 | 0.064 | 0.246 |
| CPC member head | 0.197 | 0.398 | 0.160 | 0.367 | 0.597 | 0.491 | 0.576 | 0.495 |
| Educyear head | 11.883 | 3.050 | 11.711 | 3.295 | 13.992 | 2.590 | 14.468 | 2.532 |
| Manager head | 0.042 | 0.200 | 0.076 | 0.264 | 0.080 | 0.271 | 0.142 | 0.350 |
| Tech head | 0.126 | 0.332 | 0.207 | 0.406 | 0.095 | 0.294 | 0.349 | 0.477 |
| Age spouse | 40.152 | 5.232 | 40.776 | 6.414 | 39.721 | 4.646 | 40.426 | 5.630 |
| Minority spouse | 0.038 | 0.190 | 0.049 | 0.215 | 0.050 | 0.219 | 0.067 | 0.250 |
| CPC member spouse | 0.126 | 0.332 | 0.107 | 0.309 | 0.276 | 0.448 | 0.316 | 0.466 |
| Educyear spouse | 11.669 | 3.168 | 11.487 | 3.323 | 13.167 | 2.758 | 13.761 | 2.947 |
| Manager spouse | 0.038 | 0.190 | 0.046 | 0.210 | 0.037 | 0.189 | 0.064 | 0.246 |
| Tech spouse | 0.066 | 0.248 | 0.134 | 0.340 | 0.090 | 0.287 | 0.346 | 0.476 |
| Female child | 0.483 | 0.500 | 0.412 | 0.492 | 0.432 | 0.496 | 0.464 | 0.499 |
| Age child | 12.389 | 4.093 | 12.226 | 4.167 | 12.374 | 4.161 | 11.938 | 4.497 |
| Elementary school | 0.448 | 0.498 | 0.437 | 0.496 | 0.432 | 0.496 | 0.375 | 0.485 |
| Middle School | 0.254 | 0.436 | 0.241 | 0.428 | 0.247 | 0.432 | 0.225 | 0.418 |
| High school | 0.208 | 0.406 | 0.221 | 0.415 | 0.231 | 0.422 | 0.257 | 0.438 |
| Asset finance (K) | 80.686 | 115.392 | 103.874 | 163.467 | 101.597 | 125.601 | 125.610 | 156.400 |
| Household income (K) | 70.684 | 46.866 | 100.859 | 83.503 | 82.337 | 91.441 | 135.504 | 210.257 |
| Number of Observations | 717 | | 1152 | | 377 | | 373 | |

*Notes:* This table provides summary statistics for the CHIP 2013 and CHIP 2018 samples, with data divided into sub-samples based on year and work sector. The table includes means, standard deviations, and the number of observations for each variable. The outcome variables include households' education investment as a share of total income, total education investment, household savings rate, and household savings. The control variables include information on the head of the household, spouse, and children, as well as the economic status of the household. The table also includes variables for gender (female = 1), age, ethnic minority status (minority = 1), Communist Party of China (CPC) membership (CPC member = 1), years of schooling (Educyear), managerial status (Manager = 1), technical position status (Tech = 1), elementary school status (Elementary school = 1), middle school status (Middle school = 1), and high school status (High school = 1). Additionally, the table includes variables for total financial assets (Asset finance) and total household income, both in thousands of RMB.

Table 1.7: DID estimates (1995 & 2002): Education Spending

| Variables | Education Spending (Ratio) | | | Education Spending | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head&Spouse | (4) Head | (5) Head/Spouse | (6) Head&Spouse |
| $D_{ent}$ | -0.003 | 0.004 | -0.002 | 30.216 | 159.987** | 45.370 |
| | (0.002) | (0.003) | (0.002) | (51.001) | (63.668) | (42.575) |
| $D_{2002}$ | 0.020*** | 0.025*** | 0.021*** | 760.634*** | 823.547*** | 742.731*** |
| | (0.005) | (0.005) | (0.005) | (152.822) | (140.222) | (173.652) |
| $D_{ent} \times D_{2002}$ | 0.021*** | 0.012** | 0.020*** | 38.587 | -40.789 | 113.405 |
| | (0.005) | (0.005) | (0.005) | (139.467) | (139.572) | (177.353) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,301 | 4,289 | 5,054 | 5,301 | 4,289 |
| R-squared | 0.082 | 0.085 | 0.076 | 0.189 | 0.191 | 0.196 |

*Notes:* This table shows the effect of the 1997 pension reform on education spending using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is education expenditure as a share of total income, and the explanatory variable in columns (4) through (6) is education expenditure. The treatment group definition for columns (1) and (4) is households where the head of the household works in enterprise. The treatment group definition for columns (2) and (5) is households where the head or spouse works in enterprise. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.8: DID estimates (1995 & 2002): Saving

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head & Spouse | (4) Head | (5) Head/Spouse | (6) Head & Spouse |
| $D_{ent}$ | -0.004 | -0.002 | -0.003 | -379.261 | -492.467 | -308.430 |
| | (0.016) | (0.018) | (0.013) | (388.008) | (401.939) | (310.838) |
| $D_{2002}$ | 0.000 | 0.037 | -0.005 | -1,687.593 | -143.793 | -2,190.089 |
| | (0.035) | (0.038) | (0.038) | (1,114.509) | (1,105.963) | (1,336.973) |
| $D_{ent} \times D_{2002}$ | 0.062* | -0.009 | 0.071** | 1,392.803 | -889.436 | 1,982.078 |
| | (0.033) | (0.035) | (0.031) | (1,187.806) | (1,096.289) | (1,231.435) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,301 | 4,289 | 5,054 | 5,301 | 4,289 |
| R-squared | 0.013 | 0.011 | 0.018 | 0.021 | 0.021 | 0.027 |

*Notes:* This table shows the effect of the 1997 pension reform on saving using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is saving. The treatment group definition for columns (1) and (4) is households where the head of the household works in enterprise. The treatment group definition for columns (2) and (5) is households where the head or spouse works in enterprise. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.9: Robustness: Identification (Education)

| Variables | Education Spending (Ratio) | | | Education Spending | | |
|---|---|---|---|---|---|---|
| | (1) Benchmark | (2) Wide Definition | (3) Work Pre-Policy | (4) Benchmark | (5) Wide Definition | (6) Work Pre-Policy |
| $D_{ent}$ | -0.003 | -0.003 | -0.002 | 30.216 | 39.492 | 34.828 |
| | (0.002) | (0.002) | (0.002) | (51.001) | (46.746) | (51.417) |
| $D_{2002}$ | 0.020*** | 0.021*** | 0.017*** | 760.634*** | 758.364*** | 714.609*** |
| | (0.005) | (0.005) | (0.005) | (152.822) | (145.363) | (161.804) |
| $D_{ent} \times D_{2002}$ | 0.021*** | 0.022*** | 0.025*** | 38.587 | 38.556 | 98.734 |
| | (0.005) | (0.004) | (0.004) | (139.467) | (138.289) | (152.656) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,382 | 5,062 | 5,054 | 5,382 | 5,062 |
| R-squared | 0.082 | 0.091 | 0.084 | 0.189 | 0.191 | 0.189 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on educational investment using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is education spending as a percentage of household income, and the explanatory variable in columns (4) through (6) is education spending. The treatment group definition for columns (1) and (4) is households where the head of the household works in enterprise, and is the same as columns (1) and (4) in Table 1.7, respectively. The treatment group definition for columns (2), (3), (5) and (6) is households where the head works in enterprise, or the head is currently unemployed because of layoff or bankruptcy, or the head's last job was in an enterprise. Columns (3) and (6) exclude households where the head started working after 1997. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.10: Robustness: Identification (Saving)

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Benchmark | (2) Wide Definition | (3) Work Pre-Policy | (4) Benchmark | (5) Wide Definition | (6) Work Pre-Policy |
| $D_{ent}$ | -0.004 | -0.003 | -0.004 | -379.261 | -376.682 | -382.085 |
| | (0.016) | (0.017) | (0.016) | (388.008) | (377.688) | (387.141) |
| $D_{2002}$ | 0.000 | -0.020 | 0.001 | -1,687.593 | -1,789.321* | -1,747.001 |
| | (0.035) | (0.037) | (0.036) | (1,114.509) | (1,044.499) | (1,149.961) |
| $D_{ent} \times D_{2002}$ | 0.062* | 0.063* | 0.060* | 1,392.803 | 1,400.015 | 1,444.239 |
| | (0.033) | (0.034) | (0.033) | (1,187.806) | (1,134.619) | (1,208.945) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,382 | 5,062 | 5,054 | 5,382 | 5,062 |
| R-squared | 0.013 | 0.011 | 0.013 | 0.021 | 0.020 | 0.021 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on saving using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is saving. The treatment group definition for columns (1) and (4) is households where the head of the household works in enterprise, and is the same as columns (1) and (4) in Table 1.8, respectively. The treatment group definition for columns (2), (3), (5) and (6) is households where the head works in enterprise, or the head is currently unemployed because of layoff or bankruptcy, or the head's last job was in an enterprise. Columns (3) and (6) exclude households where the head started working after 1997. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.11: Robustness: Different Sample Selection (Education)

| Variables | Education Spending (Ratio) | | | | Education Spending | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Benchmark | (2) All Edu. Level | (3) Born after 1980 | (4) Average Spending | (5) Benchmark | (6) All Edu. Level | (7) Born after 1980 | (8) Average Spending |
| $D_{ent}$ | -0.003 | 0.001 | -0.003 | 0.001 | 30.216 | 88.496 | 26.344 | 71.949 |
| | (0.002) | (0.003) | (0.002) | (0.002) | (51.001) | (58.897) | (55.555) | (52.878) |
| $D_{2002}$ | 0.020*** | 0.023*** | 0.012** | 0.028*** | 760.634*** | 810.124*** | 555.213*** | 833.721*** |
| | (0.005) | (0.006) | (0.006) | (0.005) | (152.822) | (172.464) | (154.488) | (163.604) |
| $D_{ent} \times D_{2002}$ | 0.021*** | 0.020*** | 0.022*** | 0.017*** | 38.587 | 57.434 | 45.297 | 58.484 |
| | (0.005) | (0.005) | (0.005) | (0.004) | (139.467) | (146.844) | (137.600) | (129.264) |
| Control Variables | Y | Y | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,732 | 4,627 | 6,617 | 5,054 | 5,732 | 4,627 | 6,617 |
| R-squared | 0.082 | 0.095 | 0.094 | 0.072 | 0.189 | 0.222 | 0.201 | 0.196 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on educational investment using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 are retained. The explanatory variable in columns (1) through (4) is education spending as a percentage of household income, and the explanatory variable in columns (5) through (8) is education spending. The treatment group in this table is households where the head of the household works in enterprise. Columns (1) and (5) are benchmark results, and are the same as columns (1) and (4) in Table 1.7, respectively. Columns (2) and (6) retain households with one child at school and include all education stage of the child. Columns (3) and (7) excludes households with children born before one-child policy. Columns (4) and (8) study all households and select the average education spending (ratio) per child as the outcome variable. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.12: Robustness: Different Sample Selection (Saving)

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Benchmark | (2) All Educational Level | (3) Born after 1980 | (4) Benchmark | (5) All Educational Level | (6) Born after 1980 |
| $D_{ent}$ | -0.004 | -0.005 | -0.002 | -379.261 | -252.427 | -271.419 |
| | (0.016) | (0.016) | (0.015) | (388.008) | (376.502) | (348.178) |
| $D_{2002}$ | 0.000 | 0.010 | 0.002 | -1,687.593 | -1,327.606 | -1,800.757 |
| | (0.035) | (0.033) | (0.039) | (1,114.509) | (1,088.617) | (1,157.417) |
| $D_{ent} \times D_{2002}$ | 0.062* | 0.034 | 0.054* | 1,392.803 | 691.348 | 1,294.147 |
| | (0.033) | (0.031) | (0.032) | (1,187.806) | (1,098.552) | (1,166.549) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,838 | 4,713 | 5,054 | 5,732 | 4,627 |
| R-squared | 0.013 | 0.014 | 0.010 | 0.021 | 0.022 | 0.020 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on saving using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is saving. The treatment group in this table is households where the head of the household works in enterprise. Columns (1) and (4) are benchmark results, and are the same as columns (1) and (4) in Table 1.7, respectively. Columns (2) and (5) retain households with one child at school and include all education stage of the child. Columns (3) and (6) excludes households with children born before one-child policy. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.13: Robustness: Different Measures of Household Asset

| Variables | Education Spending (Ratio) | | | | Education Spending | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Benchmark | (2) Total Asset | (3) Net Asset | (4) Liquid Asset | (5) Benchmark | (6) Total Asset | (7) Net Asset | (8) Liquid Asset |
| $D_{ent}$ | -0.003 | -0.003 | -0.003 | -0.003 | 30.216 | 29.536 | 28.863 | 30.989 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (51.001) | (51.026) | (50.798) | (50.245) |
| $D_{2002}$ | 0.020*** | 0.022*** | 0.021*** | 0.022*** | 760.634*** | 727.549*** | 715.804*** | 748.625*** |
| | (0.005) | (0.006) | (0.006) | (0.005) | (152.822) | (150.157) | (149.501) | (151.499) |
| $D_{ent} \times D_{2002}$ | 0.021*** | 0.021*** | 0.021*** | 0.021*** | 38.587 | 46.136 | 50.074 | 39.832 |
| | (0.005) | (0.005) | (0.005) | (0.005) | (139.467) | (139.412) | (139.237) | (139.579) |
| Control Variables | Y | Y | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 |
| R-squared | 0.082 | 0.083 | 0.082 | 0.082 | 0.189 | 0.190 | 0.190 | 0.190 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on educational investment using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (4) is education spending as a percentage of household income, and the explanatory variable in columns (5) through (8) is education spending. The treatment group in this table is households where the head of the household works in enterprise. Columns (1) and (5) are benchmark results, and are the same as columns (1) and (4) in Table 1.7, respectively, and the financial asset is used as a proxy variable for the household economy. Columns (2) and (6) uses total asset as a proxy of household economy. Columns (3) and (7) uses net asset. Columns (4) and (8) uses liquid asset. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.14: Robustness: Different Measures of Household Asset

| Variables | Saving Rate | | | | Saving | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Benchmark | (2) Total Asset | (3) Net Asset | (4) Liquid Asset | (5) Benchmark | (6) Total Asset | (7) Net Asset | (8) Liquid Asset |
| $D_{ent}$ | -0.004 | -0.002 | -0.002 | -0.002 | -379.261 | -361.344 | -372.122 | -368.712 |
| | (0.016) | (0.017) | (0.016) | (0.016) | (388.008) | (391.392) | (388.010) | (389.637) |
| $D_{2002}$ | 0.000 | 0.008 | -0.003 | -0.019 | -1,687.593 | -1,121.827 | -1,536.892 | -1,776.591 |
| | (0.035) | (0.038) | (0.039) | (0.034) | (1,114.509) | (1,061.671) | (1,073.263) | (1,114.062) |
| $D_{ent} \times D_{2002}$ | 0.062* | 0.056* | 0.058* | 0.064* | 1,392.803 | 1,245.089 | 1,346.445 | 1,393.121 |
| | (0.033) | (0.033) | (0.033) | (0.032) | (1,187.806) | (1,168.128) | (1,177.428) | (1,190.553) |
| Control Variables | Y | Y | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y | Y | Y |
| Obs | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 | 5,054 |
| R-squared | 0.013 | 0.014 | 0.014 | 0.016 | 0.021 | 0.022 | 0.021 | 0.022 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on saving using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (4) is saving rate, and the explanatory variable in columns (5) through (8) is saving. The treatment group in this table is households where the head of the household works in enterprise. Columns (1) and (5) are benchmark results, and are the same as columns (1) and (4) in Table 1.7, respectively, and the financial asset is used as a proxy variable for the household economy. Columns (2) and (6) uses total asset as a proxy of household economy. Columns (3) and (7) uses net asset. Columns (4) and (8) uses liquid asset. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.15: Robustness: Subgroup Regressions Based on Wealth Level

| Variables | Education - Income Ratio | | | | |
|---|---|---|---|---|---|
| | (1) Benchmark | (2) Tier 1 | (3) Tier 2 | (4) Tier 3 | (5) Tier 4 |
| $D_{ent}$ | -0.003 | 0.006 | -0.008* | -0.010** | 0.004 |
| | (0.002) | (0.009) | (0.004) | (0.004) | (0.006) |
| $D_{2002}$ | 0.020*** | 0.031*** | 0.008 | 0.027*** | 0.014 |
| | (0.005) | (0.011) | (0.010) | (0.009) | (0.009) |
| $D_{ent} \times D_{2002}$ | 0.021*** | 0.012 | 0.038*** | 0.025** | 0.013 |
| | (0.005) | (0.012) | (0.010) | (0.009) | (0.012) |
| Control Variables | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y |
| Obs | 5,054 | 1263 | 1264 | 1263 | 1264 |
| R-squared | 0.082 | 0.132 | 0.063 | 0.137 | 0.110 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on saving using DID regression in Equation (1.2). Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable is education-income ratio. The treatment group in this table is households where the head of the household works in enterprise. Columns (1) is the benchmark result, and are the same as columns (1) in Table 1.7. Tiers 1 through 4 represent four classifications of household wealth levels from low to high. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.16: Robustness: DID Estimates 1995&1999 on Education Spending

| Variables | Education Spending (Ratio) | | Education Spending | |
|---|---|---|---|---|
| | (1) Head | (2) Wide Definition | (3) Head | (4) Wide Definition |
| $D_{ent}$ | -0.010** | -0.010** | -157.267** | -159.101** |
| | (0.004) | (0.004) | (58.910) | (58.760) |
| $D_{1999}$ | 0.010 | 0.011 | 560.772*** | 567.845*** |
| | (0.011) | (0.011) | (186.104) | (186.893) |
| $D_{ent} \times D_{1999}$ | 0.016* | 0.017* | 136.649 | 105.257 |
| | (0.009) | (0.009) | (186.851) | (190.856) |
| Control Variables | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y |
| Obs | 2,967 | 3,040 | 2,967 | 3,040 |
| R-squared | 0.042 | 0.043 | 0.107 | 0.108 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on educational investment using DID regression in Equation (1.3). Households in CHIP1995 and CHIP1999 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) and (2) is education spending as a percentage of household income, and the explanatory variable in columns (3) and (4) is education spending. The treatment group definition for columns (1) and (3) is household where the head works in enterprise. The treatment group definition for columns (2) and (4) is households where the head works in enterprise, or the head is currently unemployed because of layoff or bankruptcy, or the head's last job was in an enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.17: Robustness: DID Estimates 1995&1999 on Saving

| Variables | Saving Rate | | Saving | |
|---|---|---|---|---|
| | (1) Head | (2) Wide Definition | (3) Head | (4) Wide Definition |
| $D_{ent}$ | 0.025 | 0.025 | 294.867 | 291.494 |
| | (0.030) | (0.030) | (568.810) | (567.550) |
| $D_{1999}$ | 0.194*** | 0.191*** | 1,642.950* | 1,614.930* |
| | (0.043) | (0.044) | (839.057) | (843.037) |
| $D_{ent} \times D_{1999}$ | -0.060 | -0.069* | 14.323 | 105.387 |
| | (0.039) | (0.039) | (755.611) | (750.764) |
| Control Variables | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y |
| Obs | 2,967 | 3,040 | 2,967 | 3,040 |
| R-squared | 0.034 | 0.033 | 0.067 | 0.067 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on saving using DID regression in Equation (1.3). Households in CHIP1995 and CHIP1999 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) and (2) is saving rate, and the explanatory variable in columns (3) and (4) is saving. The treatment group definition for columns (1) and (3) is household where the head works in enterprise. The treatment group definition for columns (2) and (4) is households where the head works in enterprise, or the head is currently unemployed because of layoff or bankruptcy, or the head's last job was in an enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.18: DID estimates (2013&2018): Education Spending

| Variables | Education Spending (Ratio) | | | Education Spending | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head&Spouse | (4) Head | (5) Head/Spouse | (6) Head&Spouse |
| $D_{pub}$ | -0.052*** | -0.053*** | -0.027** | 269.515 | 787.914 | -787.512 |
| | (0.014) | (0.016) | (0.012) | (830.923) | (809.747) | (1,055.704) |
| $D_{2018}$ | -0.066*** | -0.076*** | -0.051*** | -1,098.594** | -1,047.912* | -1,645.496** |
| | (0.012) | (0.014) | (0.010) | (556.230) | (566.528) | (751.889) |
| $D_{pub} \times D_{2018}$ | 0.018 | 0.029 | 0.016 | -2,460.591** | -2,475.885** | -1,993.222 |
| | (0.018) | (0.019) | (0.016) | (1,110.421) | (1,085.282) | (1,390.088) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 2,604 | 2,866 | 2,074 | 2,209 | 2,439 | 1,741 |
| R-squared | 0.046 | 0.049 | 0.053 | 0.159 | 0.150 | 0.146 |

*Notes:* This table shows the effect of the 2015 pension reform on education spending using DID regression in Equation (1.4). Households in CHIP2013 and CHIP2018 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is education expenditure as a share of total income, and the explanatory variable in columns (4) through (6) is education expenditure. The treatment group definition for columns (1) and (4) is households where the head of the household works in public sector. The treatment group definition for columns (2) and (5) is households where the head or spouse works in public sector. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in public sector. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.19: DID estimates (2013&2018): Saving

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head&Spouse | (4) Head | (5) Head/Spouse | (6) Head&Spouse |
| $D_{pub}$ | -0.099 | -0.077 | -0.201 | -921.403 | -149.884 | 2,467.235 |
| | (0.116) | (0.088) | (0.211) | (2,495.554) | (2,352.642) | (2,825.581) |
| $D_{2018}$ | -0.048** | -0.054** | -0.057** | -6,719.381*** | -7,606.795*** | -6,097.719** |
| | (0.022) | (0.021) | (0.026) | (1,889.665) | (1,871.405) | (2,375.230) |
| $D_{pub} \times D_{2018}$ | 0.127 | 0.122 | 0.289 | 1,804.991 | 3,627.994 | 4,782.311 |
| | (0.101) | (0.083) | (0.186) | (3,772.079) | (3,230.852) | (5,059.669) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 2,604 | 2,866 | 2,074 | 2,209 | 2,439 | 1,741 |
| R-squared | 0.011 | 0.010 | 0.015 | 0.548 | 0.584 | 0.520 |

*Notes:* This table shows the effect of the 2015 pension reform on saving using DID regression in Equation (1.4). Households in CHIP2013 and CHIP2018 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is saving. The treatment group definition for columns (1) and (4) is households where the head of the household works in public sector. The treatment group definition for columns (2) and (5) is households where the head or spouse works in public sector. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in public sector. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.20: DID estimates (2013-2018) by Household Type: Education Spending

| Variables | Education Spending (Ratio) | | | Education Spending | | |
|---|---|---|---|---|---|---|
| | (1) Both Only Children | (2) One Only Child | (3) No Only Child | (4) Both Only Children | (5) One Only Child | (6) No Only Child |
| $D_{pub}$ | -0.086 | -0.042 | -0.050*** | -5,894.690 | 2,070.116 | 632.982 |
| | (0.097) | (0.029) | (0.016) | (4,409.723) | (2,973.178) | (869.378) |
| $D_{2018}$ | -0.092 | -0.043** | -0.066*** | -6,083.352*** | -1,896.458 | -444.359 |
| | (0.061) | (0.017) | (0.014) | (2,288.287) | (1,308.236) | (621.575) |
| $D_{pub} \times D_{2018}$ | 0.050 | 0.068 | 0.011 | 4,761.539 | -3,151.546 | -2,712.040** |
| | (0.111) | (0.043) | (0.019) | (4,924.705) | (3,171.220) | (1,208.821) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 171 | 385 | 2,047 | 143 | 325 | 1,740 |
| R-squared | 0.269 | 0.175 | 0.051 | 0.480 | 0.294 | 0.135 |

*Notes:* This table shows the effect of the 2015 pension reform on education spending using DID regression in Equation (1.4) by different household category. Households in CHIP2013 and CHIP2018 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is education expenditure as a share of total income, and the explanatory variable in columns (4) through (6) is education expenditure. The treatment group definition for this table is households where the head of the household works in public sector. Columns (1) and (4) report results of households where both the couples are the only children. Columns (2) and (5) report results of households where one of the couples is the only child. Columns (3) and (6) report results of households where both the couples have siblings. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.21: DID estimates (2013-2018) by Household Type: Household Saving

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Both Only Children | (2) One Only Child | (3) No Only Child | (4) Both Only Children | (5) One Only Child | (6) No Only Child |
| $D_{pub}$ | 0.031 | -0.048 | -0.127 | -631.072 | -5,854.863 | -1,448.760 |
| | (0.091) | (0.060) | (0.145) | (13,946.577) | (7,455.680) | (2,762.599) |
| $D_{2018}$ | 0.000 | -0.128** | -0.034 | -3,489.619 | -15,094.484** | -6,462.053*** |
| | (0.064) | (0.062) | (0.025) | (8,438.439) | (5,909.204) | (1,787.197) |
| $D_{pub} \times D_{2018}$ | -0.012 | 0.165 | 0.145 | -17,783.739 | 9,704.550 | 3,811.737 |
| | (0.099) | (0.105) | (0.126) | (14,726.834) | (10,632.909) | (4,218.454) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 171 | 385 | 2,047 | 143 | 325 | 1,740 |
| R-squared | 0.163 | 0.135 | 0.014 | 0.633 | 0.587 | 0.564 |

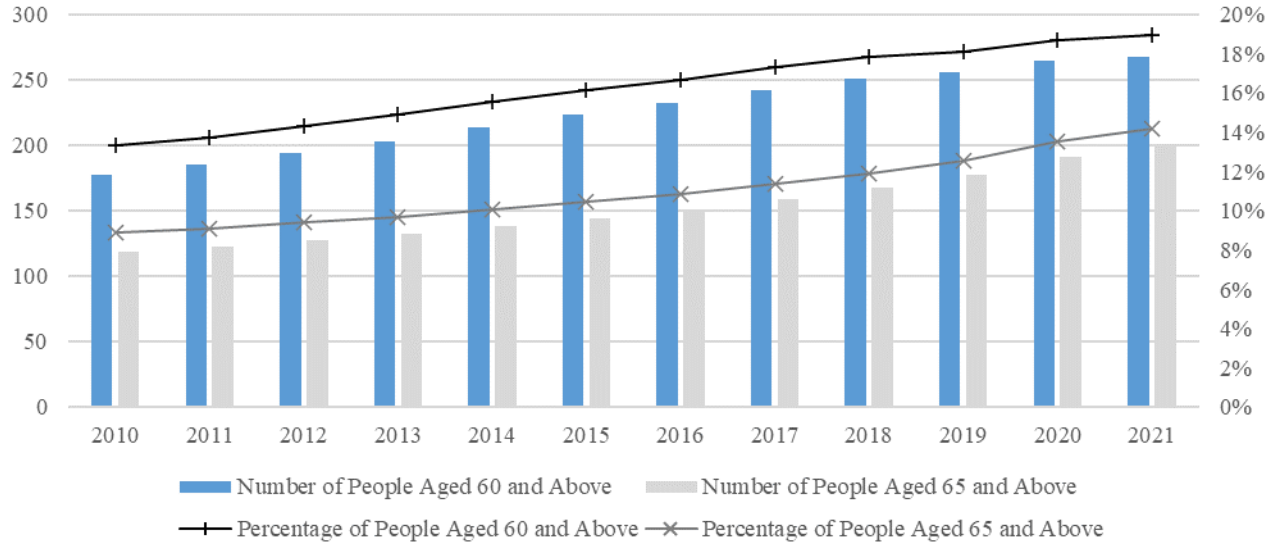
*Notes:* This table shows the effect of the 2015 pension reform on saving using DID regression in Equation (1.4) by different household category. Households in CHIP2013 and CHIP2018 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is education saving. The treatment group definition for this table is households where the head of the household works in public sector. Columns (1) and (4) report results of households where both the couples are the only children. Columns (2) and (5) report results of households where one of the couples is the only child. Columns (3) and (6) report results of households where both the couples have siblings. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.22: Pension Prediction

| Variables | Education Spending (Ratio) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Replacement Rate | -0.108*** | -0.121*** | -0.098*** |
| | (0.025) | (0.036) | (0.029) |
| $D_{1999}$ | 0.017*** | | 0.021*** |
| | (0.006) | | (0.008) |
| $D_{2002}$ | 0.022*** | 0.022*** | 0.029*** |
| | (0.005) | (0.005) | (0.008) |
| $D_{ent}$ | 0.001 | 0.002 | 0.004 |
| | (0.002) | (0.002) | (0.004) |
| $D_{1999} \times D_{ent}$ | -0.026*** | | -0.025** |
| | (0.010) | | (0.010) |
| $D_{2002} \times D_{ent}$ | -0.008 | -0.012 | -0.004 |
| | (0.009) | (0.012) | (0.011) |
| Control Variables | Y | Y | Y |
| No. of Provinces | 12 | 12 | 6 |
| Province FE | Y | Y | Y |
| Obs | 6,505 | 5,186 | 3,944 |
| R-squared | 0.061 | 0.069 | 0.061 |

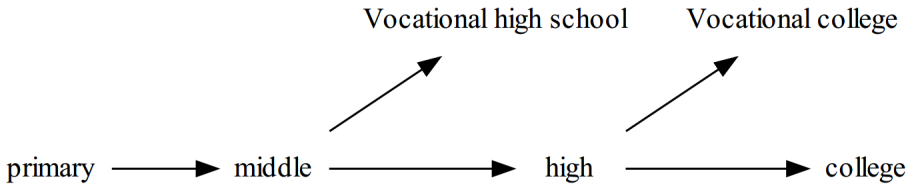
*Notes:* This table presents regressions of the education spending - income ratio on the predicted replacement rate. Column (1) includes all related households from CHIP1995, CHIP1999 and CHIP2002. Column (2) reports results from CHIP1995 and CHIP2002. Column (3) reports results from CHIP1995, CHIP1999 and CHIP2002 with the 6 balanced provinces. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1.1: Demographic Structure of China (2010 - 2021)



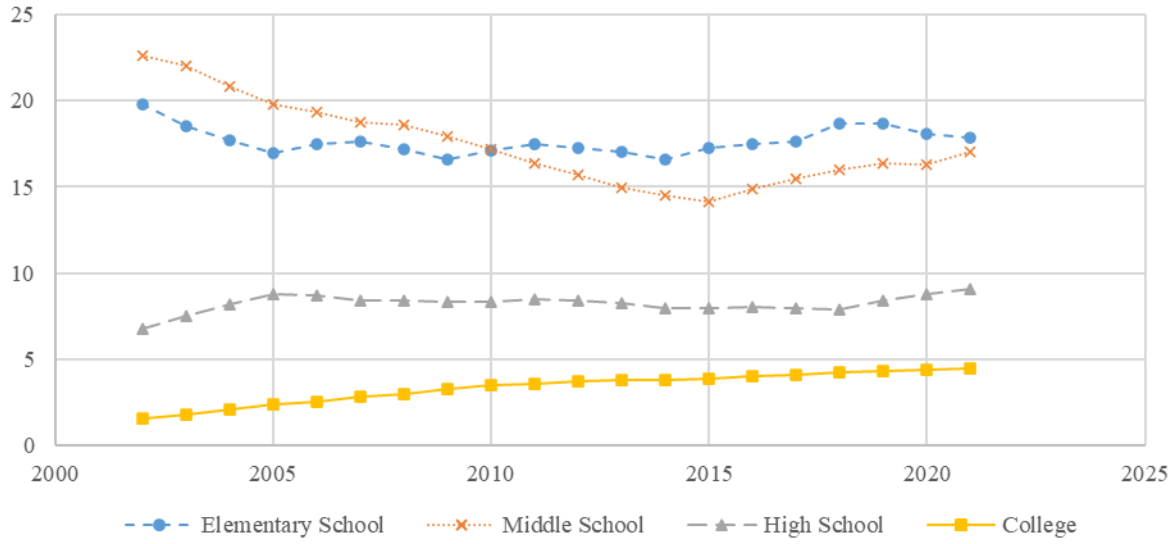

*Notes:* This graph shows the change in the number of elderly people and their share of the total population from 2010 to 2021. The left vertical axis is in millions.

Figure 1.2: China's Education Structure




*Notes:* This figure shows the stages of education in China.

Figure 1.3: Number of Entrants Per Year by Levels of Education (in millions)



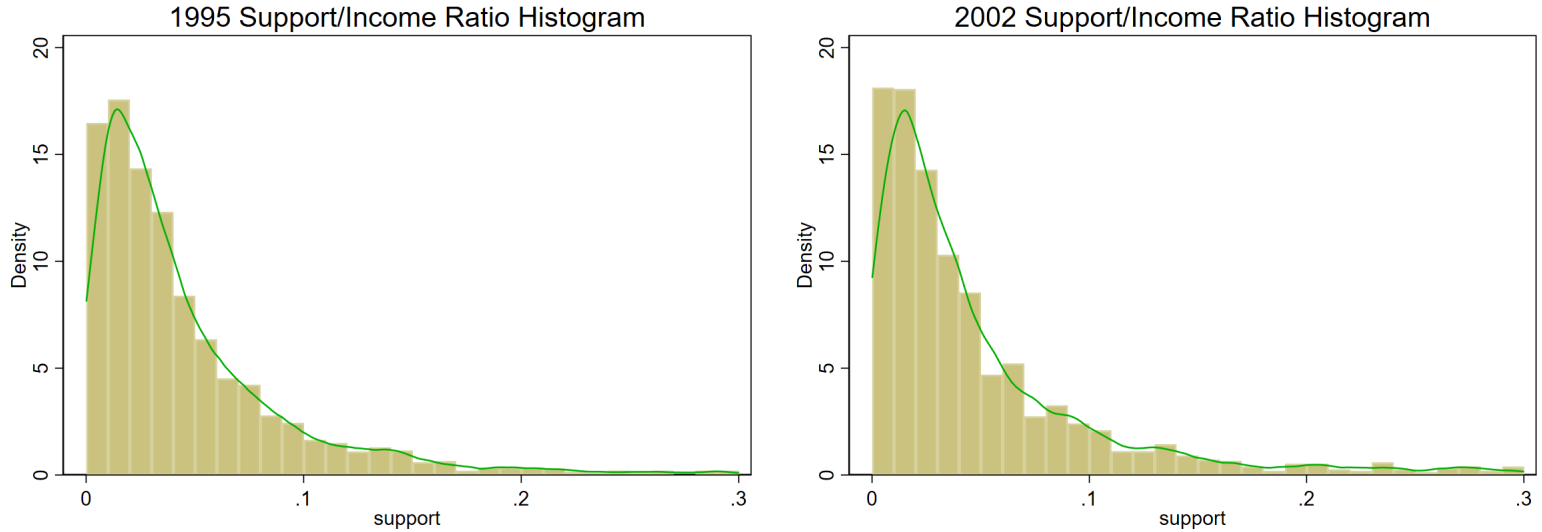

*Notes:* This figure shows the number of new students at each level of education for each year from 2002 to 2021. The vertical axis is in millions.

Figure 1.4: Child Policy Reform Timeline

| | |
|---|---|
| July 1973 | Beginning of birth control - "Late, Sparse, Few" |
| June 1979 | One-child policy |
| Apr 1984 | If both parents are only children, they can have two children (One province) |
| Nov 2011 | If both parents are only children, they can have two children (All provinces) |
| Nov 2013 | If one parent is an only child, they can have two children |
| Oct 2015 | Two-child policy (universal) |
| May 2021 | Three-child policy (universal) |

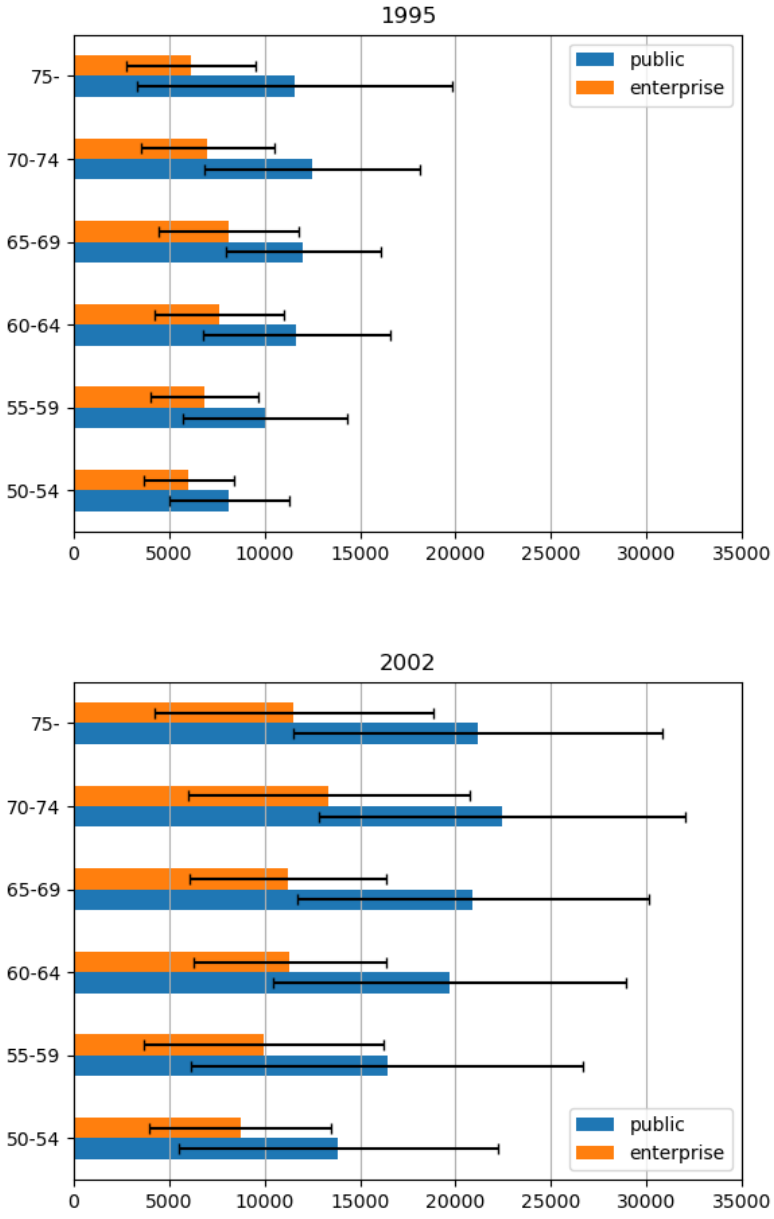
*Notes:* This figure shows the timeline of China's child policy.

Figure 1.5: Support of Children to Parents as a percentage of Children's Household Income



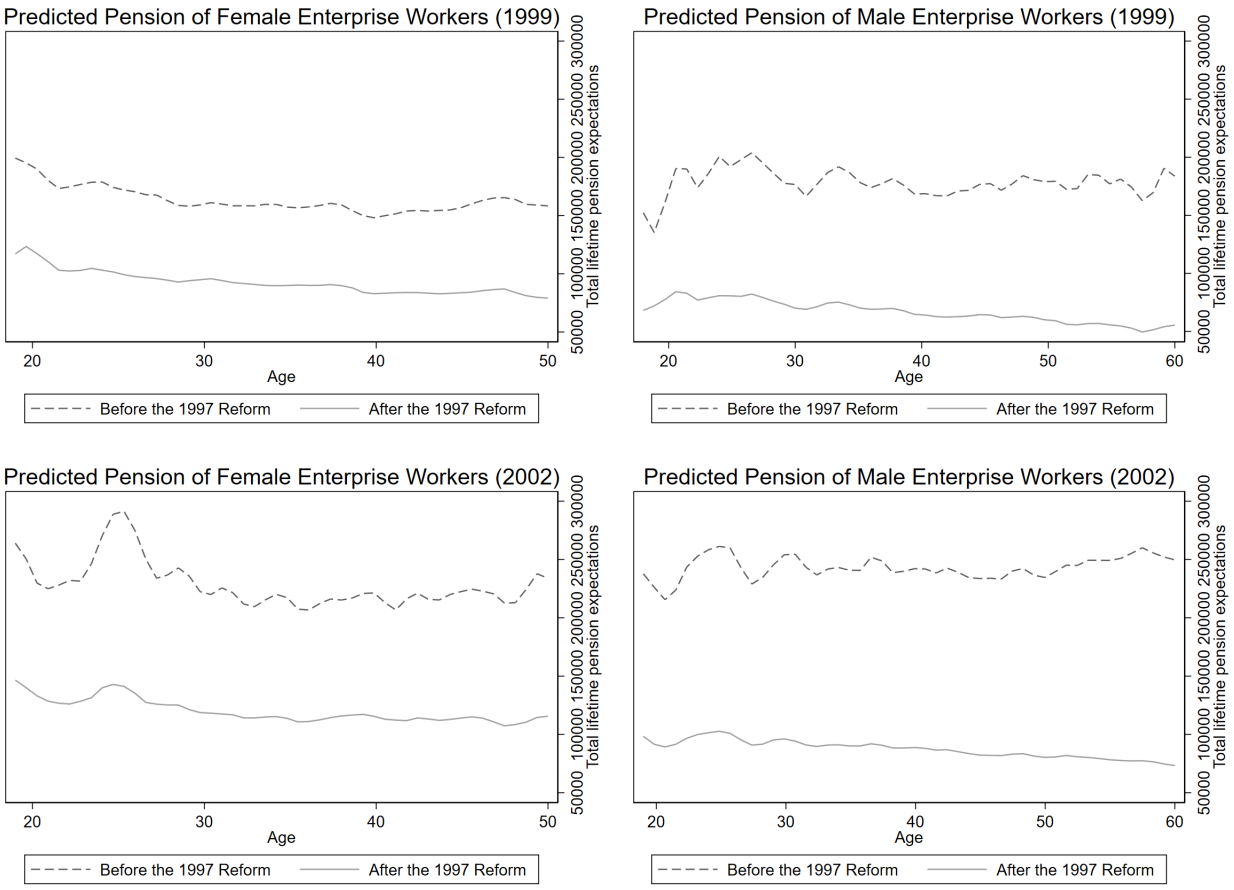

*Notes:* This figure shows the distribution of people's support to their parents as a ratio of their total household's income. Green curves present the kernel density.

Figure 1.6: Average Pension for Retirees by Age Group



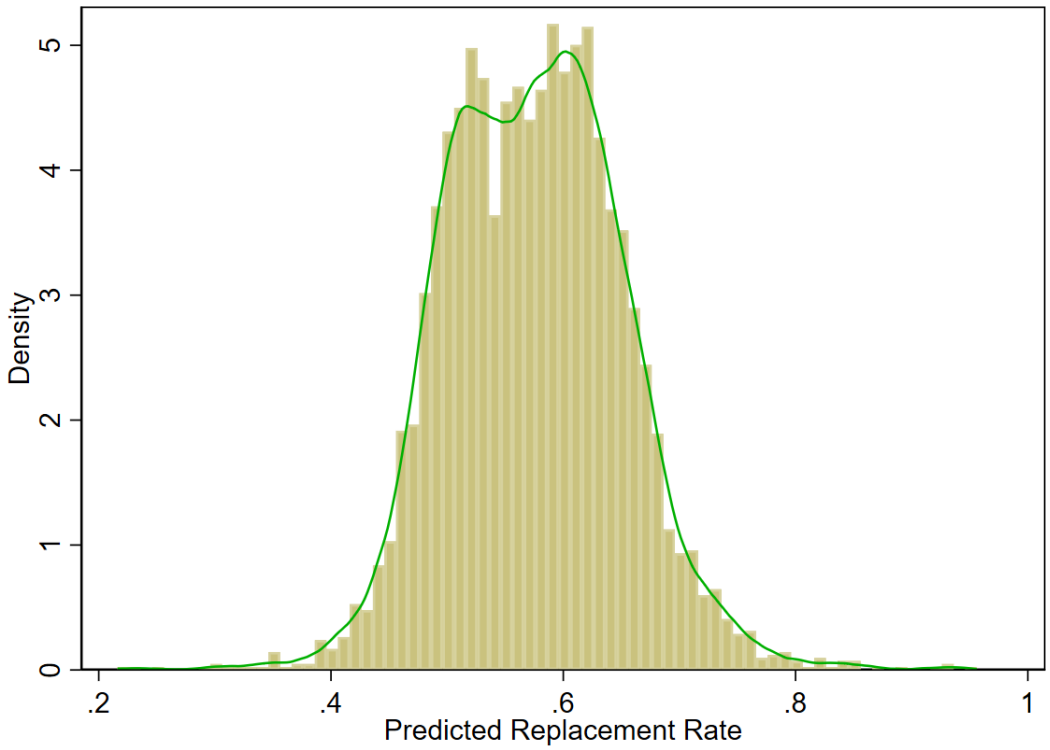

*Notes:* This figure shows the average pension for retirees by age group in the survey years 1995 and 2002 for different work sectors.

Figure 1.7: Estimated Pension Wealth



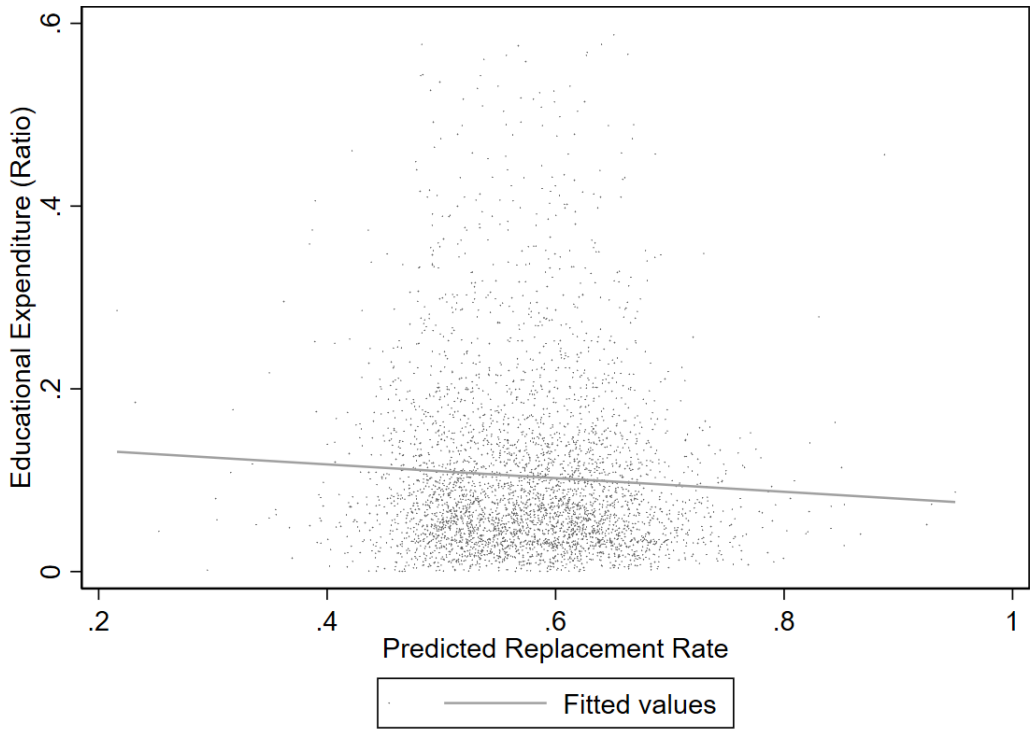

*Notes.* This figure shows the predicted post-policy and counterfactual pre-policy pensions for enterprise employees by year and gender.

Figure 1.8: Histogram of the Replacement Rate of Employees in Enterprise after the 1997 Reforms




*Notes.* This figure shows a histogram of predicted post-policy replacement rates for enterprise households. The green curve is the Kernel density

Figure 1.9: Linear Fit of Educational Investment (Ratio) to Predicted Replacement Rates




*Notes.* This figure shows a scatter plot of household education expenditure-income ratio as well as the predicted post-policy replacement rates of head who works in enterprises and its fitted line.

## 1.8 Appendix

### A.1. Regression Results for Unbalanced Provinces

Table 1.23: DID estimates (1995 & 2002): Education Spending (Unbalanced Provinces)

| Variables | Education Spending (Ratio) | | | Education Spending | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head & Spouse | (4) Head | (5) Head/Spouse | (6) Head & Spouse |
| $D_{ent}$ | -0.003 | 0.004 | -0.002 | 29.040 | 156.575** | 42.034 |
| | (0.002) | (0.003) | (0.002) | (50.224) | (62.936) | (41.961) |
| $D_{2002}$ | 0.019*** | 0.024*** | 0.021*** | 754.048*** | 820.954*** | 742.520*** |
| | (0.005) | (0.005) | (0.005) | (150.856) | (138.033) | (170.522) |
| $D_{ent} \times D_{2002}$ | 0.023*** | 0.013*** | 0.021*** | 54.258 | -34.973 | 125.438 |
| | (0.005) | (0.005) | (0.005) | (135.223) | (135.432) | (172.155) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,140 | 5,395 | 4,351 | 5,140 | 5,395 | 4,351 |
| R-squared | 0.085 | 0.088 | 0.077 | 0.191 | 0.193 | 0.197 |

*Notes:* This table shows the effect of the 1997 pension reform on education spending using DID regression in Equation (1.2). The meaning of the columns in this table is the same as in Table 1.7, except that this table includes unbalanced provinces, while Table 1.7 shows balanced provinces. Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is education expenditure as a share of total income, and the explanatory variable in columns (4) through (6) is education expenditure. The treatment group definition for columns (1) and (4) is households where the head of the household works in enterprise. The treatment group definition for columns (2) and (5) is households where the head or spouse works in enterprise. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.24: DID estimates (1995 & 2002): Saving (Unbalanced Provinces)

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head & Spouse | (4) Head | (5) Head/Spouse | (6) Head & Spouse |
| $D_{ent}$ | -0.004 | -0.002 | -0.004 | -394.408 | -502.507 | -308.430 |
| | (0.016) | (0.018) | (0.013) | (382.838) | (406.594) | (310.838) |
| $D_{2002}$ | 0.005 | 0.041 | -0.009 | -1,605.276 | -102.304 | -2,190.089 |
| | (0.035) | (0.038) | (0.038) | (1,099.128) | (1,093.233) | (1,336.973) |
| $D_{ent} \times D_{2002}$ | 0.055* | -0.013 | 0.079** | 1,279.039 | -934.686 | 1,982.078 |
| | (0.033) | (0.035) | (0.030) | (1,156.909) | (1,076.960) | (1,231.435) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 5,140 | 5,395 | 4,351 | 5,140 | 5,395 | 4,351 |
| R-squared | 0.013 | 0.011 | 0.018 | 0.021 | 0.021 | 0.018 |

*Notes:* This table shows the effect of the 1997 pension reform on saving using DID regression in Equation (1.2). The meaning of the columns in this table is the same as in Table 1.8, except that this table includes unbalanced provinces, while Table 1.8 shows balanced provinces. Households in CHIP1995 and CHIP2002 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is saving. The treatment group definition for columns (1) and (4) is households where the head of the household works in enterprise. The treatment group definition for columns (2) and (5) is households where the head or spouse works in enterprise. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.25: Robustness: DID Estimates 1995&1999 on Education Spending (Unbalanced Provinces)

| Variables | Education Spending (Ratio) | | Education Spending | |
|---|---|---|---|---|
| | (1) Head | (2) Wide Definition | (3) Head | (4) Wide Definition |
| $D_{ent}$ | -0.004 | -0.004 | -62.277 | -63.668 |
| | (0.003) | (0.003) | (40.415) | (40.617) |
| $D_{1999}$ | 0.013 | 0.013 | 574.166*** | 582.761*** |
| | (0.010) | (0.010) | (170.101) | (170.752) |
| $D_{ent} \times D_{1999}$ | 0.012 | 0.013 | 76.572 | 45.214 |
| | (0.007) | (0.008) | (175.150) | (178.628) |
| Control Variables | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y |
| Obs | 4,391 | 4,464 | 4,391 | 4,464 |
| R-squared | 0.050 | 0.052 | 0.123 | 0.124 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on educational investment using DID regression in Equation (1.3). The meaning of the columns in this table is the same as in Table 1.16, except that this table includes unbalanced provinces, while Table 1.16 shows balanced provinces. Households in CHIP1995 and CHIP1999 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) and (2) is education spending as a percentage of household income, and the explanatory variable in columns (3) and (4) is education spending. The treatment group definition for columns (1) and (3) is household where the head works in enterprise. The treatment group definition for columns (2) and (4) is households where the head works in enterprise, or the head is currently unemployed because of layoff or bankruptcy, or the head's last job was in an enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.26: Robustness: DID Estimates 1995&1999 on Saving (Unbalanced Provinces)

| Variables | Saving Rate | | Saving | |
|---|---|---|---|---|
| | (1) Head | (2) Wide Definition | (3) Head | (4) Wide Definition |
| $D_{ent}$ | -0.000 | -0.000 | 0.336 | 2.758 |
| | (0.017) | (0.017) | (328.411) | (328.977) |
| $D_{1999}$ | 0.182*** | 0.180*** | 1,592.592** | 1,565.986* |
| | (0.036) | (0.037) | (762.402) | (767.502) |
| $D_{ent} \times D_{1999}$ | -0.042 | -0.053* | 156.444 | 231.919 |
| | (0.031) | (0.031) | (610.998) | (609.562) |
| Control Variables | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y |
| Obs | 4,391 | 4,464 | 4,391 | 4,464 |
| R-squared | 0.030 | 0.029 | 0.074 | 0.074 |

*Notes:* This table shows robustness checks of the effect of the 1997 pension reform on saving using DID regression in Equation (1.3). The meaning of the columns in this table is the same as in Table 1.17, except that this table includes unbalanced provinces, while Table 1.17 shows balanced provinces. Households in CHIP1995 and CHIP1999 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) and (2) is saving rate, and the explanatory variable in columns (3) and (4) is saving. The treatment group definition for columns (1) and (3) is household where the head works in enterprise. The treatment group definition for columns (2) and (4) is households where the head works in enterprise, or the head is currently unemployed because of layoff or bankruptcy, or the head's last job was in an enterprise. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.27: DID estimates (2013&2018): Education Spending (Unbalanced Provinces)

| Variables | Education Spending (Ratio) | | | Education Spending | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head&Spouse | (4) Head | (5) Head/Spouse | (6) Head&Spouse |
| $D_{pub}$ | -0.053*** | -0.054*** | -0.028** | 268.992 | 812.003 | -742.749 |
| | (0.014) | (0.016) | (0.012) | (827.326) | (809.977) | (1,049.812) |
| $D_{2018}$ | -0.065*** | -0.076*** | -0.051*** | -1,100.626** | -1,018.459* | -1,686.889** |
| | (0.012) | (0.015) | (0.010) | (557.114) | (565.053) | (751.254) |
| $D_{pub} \times D_{2018}$ | 0.018 | 0.027 | 0.015 | -2,525.542** | -2,634.221** | -1,972.984 |
| | (0.018) | (0.019) | (0.015) | (1,091.670) | (1,074.882) | (1,347.741) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 2,697 | 2,977 | 2,137 | 2,302 | 2,550 | 1,804 |
| R-squared | 0.047 | 0.050 | 0.053 | 0.159 | 0.150 | 0.146 |

*Notes:* This table shows the effect of the 2015 pension reform on education spending using DID regression in Equation (1.4). The meaning of the columns in this table is the same as in Table 1.18, except that this table includes unbalanced provinces, while Table 1.18 shows balanced provinces. Households in CHIP2013 and CHIP2018 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is education expenditure as a share of total income, and the explanatory variable in columns (4) through (6) is education expenditure. The treatment group definition for columns (1) and (4) is households where the head of the household works in public sector. The treatment group definition for columns (2) and (5) is households where the head or spouse works in public sector. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in public sector. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.28: DID estimates (2013&2018): Saving (Unbalanced Provinces)

| Variables | Saving Rate | | | Saving | | |
|---|---|---|---|---|---|---|
| | (1) Head | (2) Head/Spouse | (3) Head&Spouse | (4) Head | (5) Head/Spouse | (6) Head&Spouse |
| $D_{pub}$ | -0.099 | -0.080 | -0.199 | -535.663 | -120.400 | 2,837.487 |
| | (0.116) | (0.089) | (0.210) | (2,519.840) | (2,384.154) | (2,828.334) |
| $D_{2018}$ | -0.049** | -0.054** | -0.056** | -6,853.905*** | -7,530.192*** | -5,993.581** |
| | (0.021) | (0.021) | (0.026) | (1,877.671) | (1,855.314) | (2,363.221) |
| $D_{pub} \times D_{2018}$ | 0.134 | 0.129 | 0.286 | 2,493.917 | 3,826.338 | 4,784.548 |
| | (0.102) | (0.082) | (0.189) | (3,654.990) | (3,157.162) | (4,840.194) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y | Y |
| Obs | 2,697 | 2,977 | 2,137 | 2,302 | 2,550 | 1,804 |
| R-squared | 0.011 | 0.010 | 0.015 | 0.542 | 0.576 | 0.511 |

*Notes:* This table shows the effect of the 2015 pension reform on saving using DID regression in Equation (1.4). The meaning of the columns in this table is the same as in Table 1.19, except that this table includes unbalanced provinces, while Table 1.19 shows balanced provinces. Households in CHIP2013 and CHIP2018 with one child in school and whose child's educational level is preschool, elementary, middle or high school are retained. The explanatory variable in columns (1) through (3) is saving rate, and the explanatory variable in columns (4) through (6) is saving. The treatment group definition for columns (1) and (4) is households where the head of the household works in public sector. The treatment group definition for columns (2) and (5) is households where the head or spouse works in public sector. The treatment group definition for columns (3) and (6) is households where both the head and spouse work in public sector. All regressions include control variables and control for province fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

## A.2. Wage Prediction

Table 1.29: Pension Prediction

| Variables | Wage Prediction Model (log wage) | |
|---|---|---|
| | Variable Meaning | Coefficients |
| Obs | | 21,790 |
| R-squared | | 0.443 |
| Constant | | 7.634*** |
| | | (0.087) |
| age | Individual's age | 0.068*** |
| | | (0.004) |
| age_sq | Square of age | -0.001*** |
| | | (0.000) |
| female | Gender (Female = 1, Male = 0) | -0.103*** |
| | | (0.007) |
| minor | Ethnicity (Minority = 1, Han = 0) | 0.304*** |
| | | (0.010) |
| workyr | Years of working experience | 0.013*** |
| | | (0.001) |
| Province dummy variables (province 11 is the base) | | |
| pvc14 | Province 14 | -0.541*** |
| | | (0.020) |
| pvc21 | Province 21 | -0.356*** |
| | | (0.016) |
| pvc32 | Province 32 | -0.124*** |
| | | (0.016) |
| pvc34 | Province 34 | -0.470*** |
| | | (0.018) |
| pvc41 | Province 41 | -0.458*** |
| | | (0.017) |
| pvc42 | Province 42 | -0.393*** |
| | | (0.017) |
| pvc44 | Province 44 | 0.230*** |
| | | (0.020) |
| pvc50 | Province 50 | -0.309*** |
| | | (0.027) |
| pvc51 | Province 51 | -0.352*** |
| | | (0.016) |
| pvc53 | Province 53 | -0.350*** |
| | | (0.017) |
| pvc62 | Province 62 | -0.469*** |
| | | (0.017) |

| Variables | Wage Prediction Model (log wage) | |
|---|---|---|
| | Variable Meaning | Coefficients |
| Occupation Category dummy variables (other is the base) | | |
| jobtype1 | Owner or manager of private or individual enterprise | 0.120** |
| | | (0.052) |
| jobtype2 | Professional or technical worker | 0.171*** |
| | | (0.018) |
| jobtype3 | Head of institution | 0.186*** |
| | | (0.023) |
| jobtype4 | Division head in institution | 0.190*** |
| | | (0.020) |
| jobtype5 | Office worker | 0.110*** |
| | | (0.018) |
| jobtype6 | Skilled worker | 0.113*** |
| | | (0.018) |
| jobtype7 | Unskilled worker | -0.012 |
| | | (0.020) |
| Economic sector codes dummy (other is the base) | | |
| jobcode1 | Agr/forestry/animal husbandry/fishing/water conservancy | -0.006 |
| | /mining and geological survey and prospecting | (0.039) |
| jobcode2 | Manufacturing | -0.062* |
| | | (0.035) |
| jobcode3 | Construction | -0.016 |
| | | (0.039) |
| jobcode4 | Transport/communications/posts/telecommunications/commerce | 0.017 |
| | /restaurants&catering/materials supply/warehousing | (0.035) |
| jobcode5 | Real estate/public utilities/personal & consulting services | 0.129*** |
| | | (0.037) |
| jobcode6 | Health, physical culture and social welfare | 0.110*** |
| | | (0.037) |
| jobcode7 | Education, culture, arts and broadcasting | 0.070* |
| | | (0.036) |
| jobcode8 | Scientific research and technical services | 0.044 |
| | | (0.041) |
| jobcode9 | Finance, insurance | 0.190*** |
| | | (0.040) |
| jobcode10 | Government and Party organs, social organizations | 0.035 |
| | | (0.036) |
| Work unit dummy variables (other is the base) | | |
| enterprise | An enterprise | 0.106*** |
| | | (0.033) |
| gov | A government organization or institution | 0.080** |
| | | (0.033) |

| Variables | Wage Prediction Model (log wage) | |
|---|---|---|
| | Variable Meaning | Coefficients |
| Educational Level dummy variables (middle school is the base) | | |
| educ_lv1 | Below elementary school | -0.293*** |
| | | (0.108) |
| educ_lv2 | Elementary school | -0.109*** |
| | | (0.023) |
| educ_lv4 | High school | 0.082*** |
| | | (0.010) |
| educ_lv5 | Vocational high school | 0.135*** |
| | | (0.012) |
| educ_lv6 | Vocational college | 0.228*** |
| | | (0.012) |
| educ_lv7 | College or above | 0.345*** |
| | | (0.015) |
| Ownership of the workplace dummy variables (other is the base) | | |
| owner1 | State-owned, at central or provincial level | -0.135*** |
| | | (0.015) |
| owner2 | Local publicly-owned | -0.339*** |
| | | (0.015) |
| owner3 | Urban collective | -0.514*** |
| | | (0.020) |
| owner4 | Private enterprise, including partnership | -0.272*** |
| | | (0.054) |
| owner5 | Self-employed business/individual enterprise | -0.249*** |
| | | (0.094) |
| owner6 | Sino-foreign joint venture | 0.055 |
| | | (0.039) |
| owner7 | Foreign owned | 0.303*** |
| | | (0.074) |
| owner8 | State-controlled enterprises | -0.062** |
| | | (0.030) |
| owner9 | Other shareholding enterprises | -0.200*** |
| | | (0.025) |
| owner10 | Township and village enterprise | -0.369** |
| | | (0.160) |
| owner11 | Individual rural ownership | -0.216 |
| | | (0.273) |

*Notes:* This table presents the results of the regressions used to estimate individual wages, where the explanatory variable is the logarithm of wages. The meaning of the explanatory variables, regression coefficients and standard errors are shown in the table. Robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

# 2 Does Affirmative Action Discourage Its Beneficiaries? Evidence from Chinese College Admissions

## 2.1 Introduction

Education plays a crucial role in the development of a country. In most part of the world, exams are employed, at least to some extent, in the college admission process as a reliable method for evaluating students and improving fairness. The National College Entrance Examination (NCEE, or Gaokao in mandarin) in China has been known for decades for its strict process: students' priorities are solely based on scores. Gaokao determines the fates of millions of aspiring high school graduates every year. While there are some drawbacks to this system, such as the high-stakes nature of the exam and the potential for students from disadvantaged areas to be at a disadvantage, it has been a longstanding tradition in China. Additionally, there are concerns that students who excel in certain areas may not be able to attend top universities due to poor performance in other subjects.

To address the limitations of the college entrance examination system, certain preferential policies have been implemented, offering bonus points to students who meet specific criteria. These policies aim to provide more equal access to higher education, but have also been met with controversy. In 2015, some of these policies were abolished as part of new reforms. Researchers have studied the fairness of the preferential system, and this chapter aims to investigate the impact of bonus points from a psychological perspective, with a focus on the actual beneficiaries. The study uses data from students who took the college entrance examination in 2006 and 2008, allowing for an analysis of the effect of the preferential policy before the reform.

Affirmative action in admissions to Chinese universities provides a unique natural experiment to study mis-perception of ability and is easy to quantify. Like other contexts, ethnic minority students benefit from affirmative action. But unlike affirmative action in US which is invisible to students, ethnic minority students receive bonus points in college admission. Students know exactly how many bonus points he/she received and for what reason they got those bonus points. Also, after the admission process, they would know each college's cutoff, so they know if they qualified on their ability (test score) or through bonus points. More importantly, how many bonus points a student receives can be considered private information to her - peers and students generally do not know

and it is seldom discussed.

In this chapter, we divide the bonus points into two groups according to the policy classification: ethnicity-based bonus points and merit-based bonus points. The former means that the reason for getting bonus points is due to a specific identity. In our dataset, almost all students in this category are ethnic minorities, so we call this type ethnicity-based bonus points. The reason for the latter is due to students' own specialties, such as the Olympiad and excellent student leader. The priorities of students are solely based on the score[15], and the cutoff of each university is the lowest score among all the admitted students. Therefore, students whose test scores are below the cutoffs may also be admitted. If we define the "below" group as students with raw *test score*$<$*cutoff*$\leq$*raw test score* + *bonus points*, and define the "above" group as students with *raw test score* $\geq$ *cutoff*, then all students with bonus points can be divided into 4 categories: ethnicity-below, merit-below, ethnicity-above and merit-above. The first two categories are real beneficiaries.

We identify the causal effect of qualifying via affirmative action on minority students using an Regression Discontinuity (RD) design. Focusing on minority students, we compare students who scored just above the cutoff (i.e., ethnicity-above) against students who scored just below the cutoff (i.e., ethnicity-below). All students attend the same college and track, so our RD identifies the causal effect of how a student qualified for a given college rather than which college a student attends. Moreover, since bonus points are private information, we should interpret the treatment effect of scoring just below the cutoff as the effect of knowing that you qualified through affirmative action. As a placebo, we estimate the same RD specification with students who receive bonus points for merit-based reasons (like winning an academic competition). We present three main empirical findings.

First, our study reveals that minority students admitted to college via affirmative action have a lower self-assessment of their academic abilities compared to those admitted based on merit. This negative impact on self-image is observed in various aspects, including happiness, social connections, and emotional well-being. Moreover, we find that students from rural areas, disadvantaged backgrounds, and those attending more elite colleges are particularly affected by this negative psychological impact.

[15] test score+bonus points (if any). The "test score" in this chapter refers to the score directly obtained from taking the test, exclude any bonus points.

Second, our research shows that students admitted via affirmative action perform less well academically, with lower standardized test scores, fewer A-grades, and reduced likelihood of earning academic awards.

Third, our study indicates that the mode of admission can have long-term effects on minority students' career plans. Students admitted via affirmative action are more likely to be undecided about their future career, express a preference for stable public sector careers, and show less interest in entrepreneurship. They are also less likely to be members of the Communist Party.

Overall, our findings suggest that while affirmative action may have been implemented with the intention of promoting diversity and equality, it may have unintended negative consequences on the self-image and academic performance of minority students.

This study contributes to the broader literature on the impact of Affirmative Action, specifically addressing the concern that it may harm intended beneficiaries by placing them in academic programs for which they are ill-prepared (Fabregas, 2020). By comparing similar-ability students who attended the same college, we eliminate college or peer effects and isolate the effect of affirmative action. Our findings suggest that affirmative action may trigger impostor feelings among minority students, with the bonus points being the sole mechanism responsible for this effect.

Our research also adds to the growing body of literature on elite college admission in China. Unlike previous studies that compared students who were admitted versus those who were not, we exploit the cutoff with a college and examine the impact of ability mis-perception.

The chapter is organized as follows: Section 2.2 provides background information on the Chinese college admission system and preferential policies. Section 2.3 discusses the data sources and variables used in the study. Section 2.4 presents the empirical strategy and results. Finally, Section 2.5 concludes the chapter.

## 2.2 Institutional Background

The **National College Entrance Examination** (also known as the Gaokao) is a crucial institution in China, serving as the sole academic criterion for college admission since 1952. Chinese colleges and universities rely on exam scores to evaluate and admit students, which appears to be a relatively reliable method for distributing educational opportunities equally. However, it is acknowledged that relying solely on exam scores to allocate educational resources is not perfectly equitable, particu-

larly in a country with a large population and diverse ethnic groups. To address this issue, China has implemented affirmative action policies in college admission to promote greater equality in access to higher education. We will discuss the details of affirmative action in the Chinese college admission system below.

### 2.2.1 College Admission (Gaokao)

In China, the college admission process primarily involves three stages: **examination**, **application submission**, and **admissions**. Wu and Zhong [2014] provide an overview of the system, and Table 2.1 illustrates the timeline of the various events in the admission process for the year 2006.

**Examination** Every year in early June[16], third-year high school students in China take the National College Entrance Examination (NCEE) in their respective residential provinces, competing for spots in college. The NCEE has two separate tracks: science and liberal arts (or humanities), each with its own exams, admission quotas, and matching processes. Students choose their track at the end of their first year of high school. The total score for both tracks is 750 points in most provinces, with Chinese, English, and Mathematics each worth 150 points. Liberal arts students also take exams in politics, history, and geography (300 points total), while science students take exams in physics, chemistry, and biology (300 points total). The provincial educational authorities oversee administration, grading, and admission procedures separately for each track, designing, administering, and grading the exams independently to ensure equity in education resource allocation and align with provincial curricula.[17] Exam scores are comparable only within a given province, year, and track.

Students can access their test scores approximately two to three weeks after the National College Entrance Examination (NCEE), which takes place around June 24th every year. Some provinces also release information on the distribution of student scores across the province. The Ministry of Education in China has categorized all four-year colleges into three admission tiers based on their quality. Colleges only accept students with NCEE scores above the threshold for their respective

[16]The college entrance examination is generally not postponed unless there are extremely special circumstances. For example, in the 2008 Wenchuan Earthquake, NCEE in the affected areas (Sichuan, etc.) was delayed until early July. Also, due to the COVID-19, the national college entrance examination in 2020 was postponed for one month.

[17]Note that although a few provinces employ the exam papers provided by the Ministry of Education for some subjects, those provinces still have full discretion in grading the exam.

admission tier (Davey, De Lian, & Higgins, 2007). The number of students admitted to Tier 1 and Tier 2 in liberal arts and sciences in each province is relatively fixed each year, with the thresholds determined by the score distribution and quota of candidates in that year. The thresholds are announced at the same time as the students' scores, and are specific to each province, year, and track.

**Preference Submission** Every year, the quotas for each college in each province are determined and announced in advance. Students are provided with a handbook containing information on enrollment quotas and majors, and they then submit their rank-ordered lists based on their preferences. The sequence in which students submit their preference lists and receive their test scores varies depending on the policy of the province and the year. In some cases, students submit their preference lists before taking the exam, while in other cases, they submit their lists after taking the exam but before learning their exam scores. In still other cases, students submit their lists after learning their exam scores, as shown in Table 2.1.

The number of preferences a student can submit in a rank-ordered list is determined by the policy of the province, which also affects the admission mechanism used. Some provinces use non-parallel rank-ordered lists, where students can only submit one university in each sub-tier.[18] The admission process for these sub-tiers is based on the Immediate Acceptance (IA) mechanism. If a student is not admitted to a university in their current sub-tier, they will be considered by universities in the next sub-tier, which may have lower admission standards.

To address this issue, Hunan province introduced a Chinese Parallel (CP) matching system in 2001, which can be considered a "truncated" Deferred Acceptance Mechanism. Under this system, students can choose up to five colleges in their preference order, and admission will not stop until all preferences in the current tier have been considered. This approach allows students to have a greater chance of being admitted to their preferred college.

Following Hunan's lead, more provinces have gradually adopted the CP mechanism. By 2008, over 20 provinces still used the IA mechanism, but as of 2016, almost all provinces have adopted the CP mechanism (Bo et al. [2019]).

[18]Each tier has two sub-tiers. For example, Tier 1 can be divided into Tier 1A and Tier 1B, and threshold in tier A is higher than in tier B

**Admission** After students submit their rank-ordered lists and scores, the admission process begins. Admissions are processed chronologically, starting with Tier 1A and ending with Tier 2B. In some cases, there may be an advanced admission (Tier 0) before the admission of Tier 1. Tier 0 majors are limited and include minor languages and national defense students.

The admission process is conducted jointly by provincial admission offices and colleges, following a predetermined matching procedure. The admission mechanism for each track in each province can be considered a "truncated" Deferred Acceptance algorithm (IA or CP Mechanism). Students' priorities in the matching process are determined solely by their total scores (test score + possible bonus points) in the NCEE, and all colleges share a common priority ranking over students. Colleges are not allowed to reject students assigned to them by the matching algorithm, and one student can only be admitted by at most one college. The cutoff of each university in a certain province is the lowest score among admitted students, and the cutoffs are specific to each college, province, year, and track.

Although the admission process considers bonus points, it's possible that a student with a test score below the cutoff can still be admitted if their test score + bonus points are not lower than the cutoff. The bonus points are determined before the exam and can only be assigned to students who meet certain conditions.

In this context, students have private information about their test scores, bonus points, and cutoffs, and they may have a perception of "can I be admitted by my current university without bonus points". However, many students and their families are unfamiliar with the matching algorithm and only care about the admission outcomes. In this setting, the matching procedure and policies do not affect the analysis.

### 2.2.2 Preferential Policies for NCEE

While relying solely on exam scores to admit students may seem like the fairest approach, China's unified admission system still raises concerns about unequal access to higher education, particularly for the country's large and diverse population. The sixth national census reports a total population of 1.34 billion, with ethnic minorities making up around 9%. However, there are disparities in educational resources and quality between regions, which can result in inequities in college access for students from different backgrounds. For instance, students from underdeveloped areas or minority

communities may have fewer educational resources, leading to a lower quality of education. As a result, adopting the same cutoff for all students may widen the gap in access to higher education between affluent and disadvantaged regions within a province.

Moreover, the high-stakes nature of the "once-a-year" exam can discourage parents from investing in their children's education, especially for socially disadvantaged groups. This is because the exam's high stakes can lead to a lower perceived return on investment in education, making it less appealing for families to invest in their children's human capital. To address these disparities and promote social stability, the Chinese government has introduced affirmative action policies that grant bonus exam points to ethnic minority students. This effectively lowers the cutoff scores for regular admissions, making it easier for minority students to gain access to higher education.

Each province in China has its own unique affirmative action policies for ethnic minority students, with varying levels of bonus points granted based on students' ethnicity.[19] For instance, Hui students in Ningxia Hui Autonomous Region are granted 20 bonus points in college admissions, while other minorities receive 10 points. Some provinces and autonomous regions only provide bonus points to specific ethnic groups, such as Inner Mongolia Autonomous Region, which limits its bonus points to Daur, Ewenki, Mongolian, and Oroqen students. In other cases, ethnic minority students from compact minority communities (minority autonomous counties) may receive preferential treatment over those from non-compact areas. Hebei Province, for example, awards 10 extra points to minority students residing in ethnic autonomous counties, while those living in non-minority communities receive only 5 points. As a result, the affirmative action policies for minority students are approximately idiosyncratic at the county level, with varying levels of bonus points received by the same ethnic minority both within and across provinces.

The implementation of affirmative action policies in China's score-based college admission system offers a unique opportunity to study the effect of these policies in a quantitative manner, which is often challenging in the US context. In the US, colleges consider a range of factors beyond academic performance, such as extracurricular activities and personal background, making it difficult to quantify the admissions threshold for each college. Additionally, it is often unclear which mi-

[19] A student can be recognized as an ethnic minority if one or both of their parents are ethnic minorities. In a mixed ethnic family, parents are free to choose whichever of their two ethnicities for their children. The social norm in China is to follow the father's ethnicity. However, there is an increasing trend in ethnic minority identification, particularly in a minority-Han family, that parents choose minority status for their children for the sake of preferential policies (Jia and Persson [2021]).

nority students were admitted through affirmative action and who would have been admitted based on merit alone. This lack of transparency makes it difficult to study the effect of affirmative action policies.

In contrast, China's affirmative action policies provide a more transparent and quantifiable context. Minority students are awarded bonus points in the college admissions process, and the number of bonus points is known to the students before they take the exam. This allows for a direct comparison between minority and Han students, which can help to isolate the potential effects of affirmative action. However, it is important to note that the incentive to study hard may be lower for minority students than for Han students, which could affect the interpretation of the results.

Moreover, the privacy of the admission process in China allows for a more accurate estimation of the impact of affirmative action policies. Teachers in colleges cannot find out how students are admitted or how many bonus points a student receives, which helps to prevent biases and confounding variables. By comparing minority students who qualified for college through affirmative action and those who qualified on merit, we can preclude the concern that differential treatment from teachers confounds the interpretation of the results.

In summary, the institutional context of China's score-based college admission system, combined with the transparency and privacy of the affirmative action policies, provides a unique opportunity to study the effect of these policies in a quantitative and reliable manner.

Figure 2.1(a) illustrates the distribution of bonus points awarded to minority students in our sample. The graph shows that the majority of students received bonus points ranging from 5 to 20, with nearly half of the students receiving 10 points. However, there are some instances where students were granted more than 30 points, such as in Xinjiang, where students from specific ethnic groups and minority communities receive 50 points. Although the bonus points make up a small proportion of the total exam scores, their impact on college attainment for minority students is significant. In 2010, minority students scored 18 points lower than Han students on average, but their college acceptance rates were higher. Notably, the effect is more pronounced in first-tier or elite college admissions, with 16.8% of ethnic minority students being admitted, which is about 5 percentage points higher than for Han students. Despite the acknowledged disparity, there is limited understanding of the short- and long-term effects of affirmative action policies on beneficiaries, both economically and psychologically. Furthermore, the existing literature lacks clear evidence on how

affirmative action influences students' beliefs and behaviors. Our study aims to address this gap by examining the impact of affirmative action on students' self-image, academic performance, and decision-making behaviors, leveraging a unique RD setting in Chinese college admission.

### 2.2.3 Other Preferential Policies in Chinese College Admissions

In addition to ethnic minorities, several other groups are granted preferential treatment in the Chinese college admissions process. These groups include children of martyrs[20], overseas Chinese, military personnel, and residents of Hong Kong, Macau, and Taiwan. They receive bonus points ranging from 10 to 20, depending on their status. However, these groups constitute a relatively small proportion of beneficiaries, accounting for approximately 0.22% of the sample.

Unlike the ethnicity-based bonus policies, which are only available to specific groups based on their ethnicity or family background, there is a parallel merit-based bonus policy that aims to encourage the development of students' specialties. This policy provides bonus exam points to students who have exceptional talents in sports, music, science, or math, such as national athletes or students who have won prizes in high school science/math Olympiads. The number of merit-based bonus points varies slightly across provinces, and most students receive 10 or 20 bonus points for their talents, which is in the same range as the number of bonus points for minority students. However, unlike ethnicity-based bonus points, which are determined by the student's ethnicity, merit-based bonus points are obtained through personal effort and serve as an acknowledgment of students' talents and abilities. These students often receive respect and admiration from their peers in high school, which can boost their confidence. The analysis of the merit-based group provides a placebo test to further validate the main hypothesis and help understand the effects of affirmative action on minority students.[21]

[20] Martyr is an official designation for people who have sacrificed their lives for patriotic reasons.

[21] We do not study those who were admitted through independent recruitment programs, as colleges have full autonomy in independent recruitment, similar to the U.S. admissions system, and the program involves many subjective criteria such as interviews and recommendations in the review process. The relatively subjective criteria leave room for under-the-table deals and corruption. A notorious example of this came to light when the Chief Director of Admissions for a top Chinese University was arrested and prosecuted for corruption by fabricating and falsifying students' information in the independent recruitment admissions process (https://www.chinadaily.com.cn/china/2014-05/30/content_17554126.htm). Thus, it is difficult to tell why and how students are admitted in these cases.

## 2.3 Data and Variables

### 2.3.1 Data

The data utilized in this study were obtained from the baseline survey of the Beijing College Students Panel Survey (BCSPS), conducted by Renmin University of China in June 2009. The BCSPS aims to conduct systematic empirical research on the various challenges faced by the rapid expansion of higher education in China. To ensure the representativeness of the sample, a stratified and probability-proportional-to-size random sampling method was employed. The survey first selected 15 universities from all 54 public universities in Beijing, stratified by college affiliation and tiers.[22] Within each college, 15-25 majors were randomly selected, and 20 freshmen and juniors from each selected major (enrolled in 2006 and 2008, respectively) were surveyed. To protect the privacy of respondents, the questionnaires were completed individually and anonymously, and respondents were assured that the survey would only be used for research purposes and their personal information would be kept confidential. The survey achieved a high response rate of 93.5% (Wu [2017]), resulting in a total of 4771 students, including 2174 freshmen and 2283 juniors, providing complete information on the year they matriculated.

The content of the questionnaire of BCSPS 2009 is very rich, including 9 parts which investigate students' pre- and within-college life and cover a broad range of topics regarding Chinese college students themselves. Part A collects students' personal characteristics, including demographic information such as gender, age and ethnicity, as well as life habit such as their smoking, drinking and sleeping situation. It also asks students' emotional experience and love concept. Part B is the psychological scale, including 80 questions asking students' psychological feelings, learning attitudes and self-evaluation. We select 5 questions related to self-evaluation to construct ability perception index. Part C contains admission information such as the student's high school level, original test scores of the NCEE, bonus points and reasons for bonus points. The information in this part is very important for us to identify the type of bonus points and to judge the position of students to the

[22]There are six strata in the sampling design. The six strata are (1) Peking University, (2) Renmin University, (3) Tsinghua University, (4) "Project-211" universities affiliated with the Ministry of Education, (5) non-"Project-211" universities affiliated with the Ministry of Education, and (6) universities affiliated with the Beijing municipal government. "Project-211" is a designation for 100 universities selected by the Chinese Government, that are generally considered to be top-quality institutions. Since the enrollment scale of top universities is relatively small even after the rapid expansion of higher education in China, the survey stratified top universities separately in the sampling design to ensure enough sample size for those universities.

admission cutoff. Part D is for university studies, including the current grade and major, classwork, academic awards and college English test scores, as well as the evaluation of departments and colleges. We can extract some information about academic performance in this part. Part E provides information about students' participation in university political activities (e.g. Communist Party of China membership) and club activities. The closeness with classmates and faculties can also be found in this part. Part F asks students' expenses during college and part-time jobs outside of campus. Part G provides the students' career intentions and future life plans, including their plans after graduation (postgraduate or which occupation to pursue), the expected minimum monthly salary and the expected age of important life plans such as getting married and having children, etc. Part H asks about students' political views and attitudes towards national development. Part I is the family background of the interviewee, including family annually income, siblings condition, pre-college rural or urban residency (known as Hukou), as well as parents' education, industry, and Communist Party of China (CPC) membership. We use some of the background information in part A and G as additional controls in the robustness check.

One of the main challenges in studying the impact of affirmative action is the lack of consistent and quantitative data across different colleges. However, the BCSPS dataset provides a unique opportunity to examine the relationship between affirmative action policies and students' college experiences. The survey includes detailed information on the college admissions process, such as the student's admission method, college entrance exam score, and whether they received affirmative action or other preferential treatment. Additionally, if students are eligible for leniency in admissions, the survey specifies the type of policy and the number of bonus points awarded. Approximately 10.81% of students in the survey are eligible for ethnicity-based bonus points, while 9.08% receive merit-based bonus points. As shown in Figure 2.1, the distribution of bonus points received by students in our sample is concentrated around the 45th percentile of the college entrance exam score distribution, with affirmative action policies bringing minority students up to the 50th percentile on average.

In addition to the survey data, we also obtained administrative records of college admission outcomes from the Ministry of Education of China to supplement our data. We focused on freshmen and juniors who took the college entrance examination in 2008 and 2006, respectively. We identified the admission cutoffs of 15 universities in 31 provinces in Mainland China for those years. Since

the survey did not ask about students' tracks (science or liberal arts), we collected data on the final admission results of these universities, including the number of admitted students, highest and lowest scores for each major, and used this information to determine students' tracks.

After collecting the necessary data, we excluded a small number of students who did not take the college entrance examination in 2006 or 2008. Using the information from Part C of the survey, we determined which students received bonus points, the category of bonus (ethnicity-based or merit-based), and among those with bonus points, which students were the real beneficiaries (test score < cutoff). Our analytic sample consisted of 3756 students, with 747 students receiving bonus points. The breakdown of the bonus categories is shown in Table 2.2. Our sample included 406 minority students who benefited from affirmative action and 341 students who received merit-based bonus points. We used this subsample to conduct the placebo analysis. Of the students who received ethnicity-based bonus points, 48% entered college via affirmative action, while 52% qualified on merit.

### 2.3.2 Key Variables

The summary statistics presented in Table 2.3 provide an overview of the outcome variables and individual characteristics of students in both the ethnicity-based and merit-based groups. The outcome variables, which are the focus of the study, are shown in Panel (1).

**Self-image Assessment** One of the crucial variables we aim to investigate is the students' self-awareness, which has been adequately captured in Part B of the survey. To construct the Ability Perception Index, we utilize responses from survey questions that ask each student to rate the extent to which they agree with five statements that reflect higher self-efficacy. These statements include: "I am satisfied with my ability", "I feel as competent as others", "I can complete the most difficult academic tasks", "I am positive about myself", and "I feel I have good qualities". The responses to these statements are measured on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).[23] The Ability Perception Index (API) reveals a positive self-evaluation of the students' abilities. To address the issue of multiple hypothesis testing and minimize the risk of overlooking significant effects, we created a summary index by calculating z-scores for each component statement and then averag-

[23] All responses include "Strongly Disagree=1", "Disagree=2", "Undecided=3", "Agree=4", and "Strongly Agree=5"

ing them across all components. This approach allows us to reduce the number of statistical tests performed and increases the robustness of our findings.[24]

In addition to the Ability Perception Index, we also created an *Emotion Index* by calculating the average z-score for 6 negative self-evaluation scales. These scales include: "I feel that I am very worthless", "I lose hope for the future", "I feel life is meaningless", "I tend to think of myself as a loser", "I don't feel much proud of myself", and "I often think I am useless". The responses to these statements are measured on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). We then calculated the z-score for each scale and averaged them to obtain the Emotion Index.

Furthermore, we also used the Happiness level (1~100 scale) and its z-score to examine the impact of the Affirmative Action policy.

**Academic Performance** Academic performance during university can be regarded as an important indicator of the effort factor in the process of studying. Although the direct measure of academic performance, i.e. GPA, is not available in the data, the BCSPS still collected rich information on students' college academic activities, which can help us infer the academic performance of a student explicitly. We have selected 3 variables related to academic performance here. *Standardized English Test* is the logarithm of the score of college English test (CET-4). The CET-4 is a national English test that examines the English proficiency of Chinese college students from all majors. Since the CET-4 is a national standardized test and is graded consistently throughout China, scores of the test are comparable both within and across colleges. *No. of A courses* is the number of courses the student got an A grade. And *Academic Awards* is a dummy variables which equal one if the student has skipped class or has received academic awards.

**Future Plans** In addition to academic performance and personal characteristics, we also examine students' future plans as an important aspect of our empirical analysis. We use four dummy variables to measure this aspect: *Wait to Decide*, *Public*, *Private*, and *Entrepreneurship*.

The *Wait to Decide* variable is a dichotomous variable that indicates whether a student has yet to decide on their career plans upon graduation. A value of 1 for this variable means that the student has not made a decision.

[24]To ease the interpretation of the results, we standardized the each response variable such that they all have a mean zero and standard deviation of one.

The *Public*, *Private*, and *Entrepreneurship* variables are also dichotomous, and they represent a student's plans to work in the public sector, private sector, or start their own business, respectively. A value of 1 for any of these variables indicates that the student plans to pursue that particular career path.

Furthermore, we also include two variables that measure students' life planning: *Marriage* and *Baby*. These variables represent the latest age at which a student plans to get married and have a child, respectively.

By examining these variables, we can gain a better understanding of the various factors that influence students' career choices and life planning decisions.

**Other** We constructed a summary social connection index using a similar method as the self-image assessment index. Specifically, we calculated a z-score for each response variable based on the answers to questions about the closeness of three groups: other students, professors, and department staff. The questions had five response options, ranging from "not close at all" (or 1) to "very close" (or 5). We then averaged the z-scores across the three components to obtain the social connection index. Additionally, we examined students' political participation, specifically their membership in the Communist Party of China (CPC).

**Independent Variables** Panel (2) includes individual characteristics of students, such as demographic variables (*Male* and *Age*) and dichotomous variables (Father's Education, Mother's Education, Family Party Member, Rural, and Low Class) that capture information about the students' family background, education level, and socio-economic status. Additionally, the variable *Elite College* indicates whether the student's college is among the top 100 colleges in the 21st century, and *Younger* indicates whether the student is the younger sibling in their family. These variables are used as control variables in the robustness check to ensure that the results are not biased by other factors that may influence the relationship between the independent and dependent variables.

## 2.4 Empirical Strategy

### 2.4.1 Econometric Specification

To determine the causal impact of affirmative action on minority students, we utilize a regression discontinuity (RD) design that contrasts students who narrowly missed the admission cutoff (i.e., those who qualified through affirmative action) with students who narrowly exceeded the cutoff (i.e., those who qualified based on merit). Since all students attend the same college and track, our RD estimate reveals how a minority student's qualification for a particular college is influenced by affirmative action, rather than which college the student ultimately attends. The basic RD specification is as follows:

$$Y_{ipcyt} = \alpha + \beta \cdot \text{below}_{ipcyt} + \theta_1 f(\text{diff}_{ipcyt}) + \theta_2 f(\text{diff}_{ipcyt}) \times \text{below}_{ipcyt} + \gamma_y + \lambda_{pct} + \varepsilon_{ipcyt} \quad (2.1)$$

where $Y_{icpyt}$ is the dependent variable we are interested in for student $i$ from college $c$ in province $p$, cohort $y$ and track $t$. In our following analysis, the outcome variables include impostor index, academic performance, social relationship and career intention.

$\text{below}_{ipcyt} = I(\text{TestScore}_i < \text{Cutoff}_{pcyt})$, which is the indicator of whether the student's raw test score is below the cutoff of her university. Since the sample consists of students who are eligible to benefit from affirmative action, the dummy variable also captures students who qualified via affirmative action (actual beneficiaries). $\text{diff}_{ipcyt} = \text{TestScore}_i - \text{Cutoff}_{pcyt}$ means the distance of student $i$'s test score to the cutoff.

$f(\cdot)$ is the RD polynomial smooth function. We employ local linear and quadratic parametric method. We also allow the function to differ across the cutoff score by including the linear-interaction or quadratic-interaction terms of $f(\text{diff}_{ipcyt})$ with $\text{below}_{ipcyt}$. To ensure that our results are not driven by certain functional form of $f$, we employ both the local linear non-parametric method and the parametric method for this function. In the parametric case, we allow the function to differ across the cutoff score by including the linear-interaction or quadratic-interaction terms of distance to cutoff with below cutoff indicator.

We also include cohort fixed effects and province-college-track fixed effects: $\gamma_y$ refers to cohort

fixed effects and $\lambda_{pct}$ is the province-college-track fixed effects. All standard errors from parametric methods are two-way clustered at the college and province levels.

We employ the method developed by Calonico et al. [2020] to compute the optimal bandwidths, which fall in the range between 16 and 24 points across different outcomes in our analysis. Since the bonus points granted to ethnic minority students mostly fall in the 5- to 20-point range, we limit our analytic sample to those who fall within 20 points of the admission cutoff scores. As robustness checks, we also report estimates from specifications with a set of alternative bandwidths.

### 2.4.2 Validity of RD Specification

The validity of the RD design relies on the assumption that the assignment of students to colleges is randomly distributed around the discontinuity threshold, meaning that there should not be a non-random sorting of students either below or above the cutoffs. While students may have some control over their exam scores through studying, it is unlikely that they can manipulate their scores to precisely sort around the cutoffs or manipulate their placement in the college admissions process. The admissions cutoff scores vary across colleges and years, and students do not know what college they will attend or what the cutoffs are beforehand, making it difficult for them to manipulate their placement.

Figure 2.2 shows the distribution of exam scores in terms of the distance to the cutoff scores, with a smooth density estimate around the cutoffs. Additionally, a formal McCrary test was performed to check for discontinuity in the density at the cutoffs, and the p-value of 0.7475 suggests that there is no evidence of manipulation or bunching around the cutoffs, further supporting the validity of the RD design.[25].

Second, the local randomization assumption requires that students just below and above the cutoff scores are similar in their pre-college characteristics. This ensures that pre-treatment characteristics cannot influence the treatment assignment, and that the control group (i.e., those who qualified on merit) is an appropriate counterfactual of the treatment group (i.e., those who qualified via affirmative action). To test for balance, we conduct tests on students' individual characteristics and family backgrounds. We use the parametric estimation method with a quadratic polynomial under a 20-point bandwidth, consistent with the baseline estimation. Table 2.4 reports the cor-

[25] See McCrary [2008] for details on this procedure for inference.

responding estimates for the balance tests. The statistically insignificant results in Columns (1) and (2) indicate that there is no discontinuity in student demographic characteristics. Additionally, Columns (3) to (7), which show the balance for students' family background, further demonstrate that there are no substantial disparities in students' characteristics across the cutoff scores. These findings significantly increase our confidence in the validity of the RD design in our setting.

## 2.5 Empirical Results

### 2.5.1 Self-Image

The study's findings indicate that minority students who are admitted to college through affirmative action have lower self-image than those who are admitted based on merit. Figure 2.3 shows a clear discontinuity at the cutoff, with minority students who are admitted on merit having significantly higher self-image than those who are admitted with the help of ethnicity-based bonus points. The regression results in Table 2.5 show that affirmative action leads to a misperception of ability among ethnic minority students, with scoring below the cutoff reducing self-perception by 0.687 standard deviation on average. Additionally, the results suggest that scoring below the cutoff triggers stronger negative feelings, with a decrease of about 1 standard deviation in emotional well-being.

The study also includes a placebo test that compares students who were admitted on pure test score against students who were admitted with the help of merit-based bonus points. The results show that there is no difference between these two groups, suggesting that the treatment effect is not just from failing to qualify on merit, but rather from qualifying on the basis of ethnicity-based bonus points. This strengthens the claim that ethnicity-based affirmative action is causing its beneficiaries to have worse self-image.

Finally, the study checks whether scoring below the cutoff has any effects on happiness level. The results show that ethnicity-below students have lower happiness levels than ethnicity-above students, with a difference of about 0.9 standard deviation (or about 11 happiness level). However, for merit-based students, the intra-group comparison results are not significant for every approach.

### 2.5.2 Robustness Check

In this section, we conduct a series of robustness checks on our baseline RD results on *Ability Perception Index*.

**Alternative Bandwidths** Initially, we assess whether our findings may be influenced by the selection of bandwidth. In Table 2.6's regression, we utilized a bandwidth of 20 points. Specifically, this means that if we standardize the cutoff to zero, we compare students based on ethnicity within the intervals [-20, 0] and [0, 20]. To ensure the robustness of our base regression, we also explore various alternative bandwidths, including 10, 15, 25, and 30. The outcomes are depicted in Figure 2.2, where the blue dots represent the estimated coefficients of $\text{below}_{ipcyt}$, and the red lines denote the associated 90% confidence intervals.

Figure 2.4 illustrates the point estimates of the RD regression derived from Equation (2.1) across 18, accompanied by 90 percent confidence intervals, utilizing a range of alternative bandwidths from 10 to 30 points. Panels (A) and (D) present outcomes obtained from non-parametric local linear regressions, while others stem from parametric regressions employing either linear or quadratic polynomials. As depicted in the figures, the RD estimates remain consistent across different bandwidths. Notably, affirmative action exhibits a negative and statistically significant impact on self-image for minority students, whereas we do not observe a significant effect for the placebo group, comprising students benefiting from merit-based bonus points.

**Placebo Cutoffs** The underlying assumption stipulates the absence of abrupt shifts; the presence of such shifts would signify a misapplication of the RD estimation. In our primary regression, the most substantial disparity in students' test scores amounts to 40 points. Given that the total score for the college entrance examination is 750 points, a 40-point differential constitutes less than 5%. However, can we reasonably assert that two students with a 40-point variance possess identical abilities? Stated differently, is the divergence in self-perception we previously observed attributable solely to the 40-point variance in test scores? To explore this issue through placebo tests, we adopt the following approach:

$$Y_{ipcyt} = \alpha + \beta \cdot \mathbb{I}\left(\text{TestScore}_i < \text{Cutoff}'_{pcyt}\right) + \theta_1 f\left(\text{TestScore}_i - \text{Cutoff'}_{pcyt}\right) \\ + \theta_2 f(\cdot) \times \mathbb{I}(\cdot) + \gamma_y + \lambda_{pct} + \varepsilon_{ipcyt} \tag{2.2}$$

In line with our foundational specification and to circumvent the inclusion of samples near the cutoff where discontinuities are known to occur, we conduct RD regression using a 20-point bandwidth at intervals situated 20 points below and above the cutoff scores. Specifically, we perform estimations for students whose examination scores fall within the ranges of [-40, 0] and [0, 40] around the authentic cutoff scores. Consequently, two placebo cutoffs emerge, positioned at -20 and +20 concerning their distance from the actual cutoff scores, respectively.

Table 2.7 presents RD estimates at these placebo cutoffs for the self-image index. Although the point estimate derived from the local linear approach is marginally significant at the -20 placebo cutoff, none of the parametric specifications provide evidence supporting discontinuities at the placebo cutoffs.

**Additional Controls** In this section, we present outcomes while adjusting for student attributes and familial context, encompassing gender, age, family income, parental education level, and parental CPC status (refer to Table 2.8). As anticipated, the RD estimates across all specifications closely align with the baseline estimates for both minority students and placebo groups, exhibiting similar magnitudes and significance levels.

### 2.5.3 Heterogeneity Analysis

We investigate diversity across four distinct dimensions, analyzing in each instance how the impact of admission through ethnicity-based bonus points on self-image fluctuates with a specific characteristic. Additionally, various factors might influence students' self-perceptions. To explore the effects stemming from these other aspects, we employ a Difference-in-Differences (DID) specification. The regression utilized in this analysis is as follows:

$$Y_{ipcyt} = \alpha_1 + \alpha_2 \cdot \text{below}_{ipcyt} \times H_i + \alpha_3 \cdot \text{below}_{ipcyt} + \alpha_4 H_i + \gamma_y + \lambda_{pct} + \varepsilon_{ipcyt}.$$

In this context, $H_i$ represents certain personal attributes. We opt for five binary variables for examination. "Noncity" is a binary variable that takes the value of 1 if the student's family resides in a rural area. "Low-class" is set to 1 if the student perceives their family's economic status as falling within the middle or lower socio-economic stratum. "Younger sibling" indicates whether the student has an older sibling. A value of 1 for "Elite college" denotes that the college is part of Project-211 (signifying inclusion among the top 100 colleges in the 21st century). Similarly, "Freshmen" equals 1 if the student is currently in their first year of college.

The findings are detailed in Table 2.9. In Column (1), it is evident that admission through affirmative action notably exacerbates negative self-perceptions among minority students hailing from rural areas. Column (2) demonstrates that affirmative action admission further deteriorates the self-image of minority students from low socioeconomic backgrounds. Conversely, Column (3) indicates that individuals who are younger siblings, a demographic potentially susceptible to impostor feelings, do not exhibit a heightened negative response to admission through affirmative action. Moving to Column (4), it is revealed that attending an elite college amplifies the impostor feelings provoked by affirmative action admission. Finally, Column (5) illustrates that freshmen display a more pronounced negative self-evaluation compared to juniors.

### 2.5.4 Academic Performance, Career Intention, and Family Plans

In this section, we investigate outcome variables encompassing academic performance during college and current future life plans.

**Effect on Academic Performance** Table 2.10 presents the outcomes of academic performance. Panel A and Panel B display results for ethnicity-based and merit-based groups within a 20-point bandwidth, respectively.

As demonstrated by the local linear non-parametric estimate (Column (1)), scoring below the cutoff reduces the College English Test score by an average of 11.5%. Upon introducing linear interaction terms (Column (2)) and quadratic interaction terms (Column (3)), the estimates change to 8.3% and 22%, respectively. Additionally, we present the impact of scoring below the cutoff for the sample on "A" grade courses (Columns (4) to (6)) and academic awards (Columns (7) to (9)). For the ethnicity-based group, it is evident that students below the cutoff are less likely to achieve

an "A" in their college studies and are also less likely to receive academic awards compared to students above the cutoff. However, for the placebo group, merit-based students do not exhibit such significant differences.

**Effect on Career Intention** Given that the survey participants were all students in 2009, the questionnaire inquired about their future aspirations, encompassing anticipated career paths and family plans. Tables 2.11 and 2.12 present regression findings regarding the impact of scoring below the cutoff on career intentions and significant family plans, shedding light on how affirmative action admission influences students' future trajectories.

In columns (1) - (3), we observe that minority students admitted through affirmative action appear to express greater certainty regarding their career plans. Columns (4) - (6) suggest that they are more inclined towards pursuing careers in the public sector, whereas columns (10) - (12) indicate a decreased inclination towards entrepreneurship. Notably, the survey period coincided with a period of rapid economic growth in China, characterized by the burgeoning success of numerous technology start-ups, which conferred substantial wealth and prestige upon their founders. Simultaneously, an anti-corruption campaign curtailed the appeal of public sector roles, reducing their allure. Consequently, we interpret these findings as indicative evidence suggesting that students admitted through affirmative action harbor less confidence in their future prospects, favoring the stability offered by public sector careers and expressing doubt about their potential to excel in entrepreneurial ventures, where success hinges largely on exceptional performance.

The results in Table 2.13 Panel B further underscore this trend, revealing that students admitted via ethnicity-based bonus points are less inclined to become party members, indicating that the preference for government careers is not driven by an inherent affinity for government service but rather by the perceived stability of such career trajectories.

In Panel B, we present findings from our placebo test, which once again indicate negligible effects of admission via academic/merit-based bonus points on career choices. While our ability to track students over an extended period to observe long-term outcomes is limited, these insights into career plans serve as suggestive evidence that affirmative action may shape decisions made during university education, with enduring consequences.

Additionally, as further evidence of affirmative action's influence on individuals' future plans,

Table 2.12 illustrates its impact on marriage and childbirth intentions. Columns (1) - (3) suggest that minority students admitted via affirmative action tend to marry earlier, while columns (4) - (6) indicate an inclination towards earlier parenthood. Correspondingly, as observed previously, Panel B of Table 2.12 reveals no discernible effect of admission via merit-based bonus points on these outcomes.

### 2.5.5 Other Outcomes

In Table 2.13 Panel A, Columns (1) - (3) indicate that students admitted through ethnicity-based bonus points exhibit weaker social ties within the university community. Meanwhile, Columns (4) - (6) reveal a reduced likelihood of them being members of the CPC, despite their heightened preference for public sector careers. This discrepancy could stem from their inferior self-perception, weaker social connections, subpar academic performance, and generally lower aspirations. Given the enduring significance of CPC membership in China across various professions, both in the public and private sectors, this exemplifies a university choice or outcome that may exert long-term repercussions. In Panel B, all columns except for Column (5) once again indicate no discernible effect on either outcome stemming from admission via merit-based bonus points.

### 2.5.6 Discussion

What prompts the change in behavior among minority students admitted via affirmative action? We posit that peer and teacher responses are unlikely to account for this phenomenon. This is because minorities in China are generally difficult to identify based on their names (with Uyghurs and Tibetans being notable exceptions), and bonus points remain private information seldom discussed due to fear of negative stereotyping and loss of peer respect (Jia and Persson [2021]).

Additionally, our findings may be elucidated by disparities in majors between students admitted through affirmative action and those admitted based on merit. Specifically, if students enter through affirmative action, they are less likely to secure enrollment in their preferred majors as those spots may have been taken by other students with higher scores. Consequently, students assigned to majors not of their choosing might experience academic underperformance and feelings of self-doubt. However, the statistically insignificant effects observed in the placebo group suggest that our findings are not driven by students experiencing discomfort due to being in the "discomfort zone".

Furthermore, there is a concern that students admitted via affirmative action might be more frequently assigned to relatively "weaker" majors characterized by lower educational quality and less academically qualified faculty and peers. Such students may consequently perform worse than those admitted above the cutoff scores. To explore this possibility, we conduct balance tests on majors for minority students who score just below and above the cutoff scores. Following the approach of Jia and Li [2021], we categorize students into three major groups: Econ-Finance-Law, STEM, and Humanities. We then apply our baseline specification with each major indicator as the dependent variable using both parametric and nonparametric estimation methods. As depicted in Table 2.14, qualifying via affirmative action is not statistically associated with specific majors, suggesting no evidence of sorting across majors around the cutoff scores.

Instead, we posit that the adverse effect of affirmative action on performance stems from perceptions of low self-competence. Results from the placebo test indicate that qualifying based on merit provides a crude signal regarding one's own ability, which students take into consideration in their decisions regarding human capital investment. However, this inference relies on bounded rationality, limited attention, or rule-of-thumb behavior on the part of minority students, as they are aware of their position relative to the cutoff and know how close they were to gaining admission based on merit.

## 2.6 Summary

In this study, we investigate the impact of affirmative action on minority students, focusing on the unique context of Chinese college admissions, which provides suitable empirical variation for testing this hypothesis. With knowledge of the entrance exam cutoff for each college and the provision of bonus points to all minority students, we can ascertain whether a minority student was admitted to a specific college based on merit or with the assistance of bonus points. Our analysis reveals that approximately 48% of minority students in our sample attending Chinese colleges were admitted with the aid of affirmative action.

We employ a Regression Discontinuity (RD) design, contrasting minority students admitted on merit with those admitted to the same college and track via affirmative action. Our findings indicate that admission through affirmative action adversely affects self-image and short-term academic performance. Furthermore, it influences decisions such as career and family plans, as well as the

choice to join the CPC, which impact an individual's long-term prospects.

We propose that admission through affirmative action triggers impostor feelings among minority students. Supporting this notion, students admitted via merit- or academic-based bonus points do not exhibit the same negative outcomes. Moreover, affirmative action is particularly likely to induce these impostor feelings among low socioeconomic status (SES) students, those from rural areas, and those admitted to elite colleges.

Our study sheds light on the psychological impacts of affirmative action, an aspect that has received relatively scant attention in the economics literature thus far. The mechanism we uncover - the triggering of impostor feelings among admitted minority students through affirmative action - may help elucidate certain stylized facts in the literature, such as shedding light on the "mismatch hypothesis". Additionally, our findings may arguably constitute the first evidence of the impostor phenomenon in a natural or field setting.

However, despite the negative impacts of impostor feelings on educational performance, affirmative action may still be an attractive policy for several reasons. Firstly, it provides minority students with access to high-quality educational opportunities that would likely not otherwise be available. Secondly, many American universities justify affirmative action not only on equity grounds but also in terms of promoting socioeconomic and cultural diversity within their communities. This argument is unlikely to be affected by the presence of impostor feelings among minority students.

We aim for our results to aid policymakers in understanding how affirmative action can be more effectively utilized to address inequalities and enhance the life chances of talented minority students worldwide.

## 2.7 Tables and Figures

Table 2.1: Timeline of college admission in 2006

| | | |
|---|---|---|
| Exam Dates | June 7-8, 2006 | the same for all provinces |
| Score Announced | June 23-26, 2006 | may vary one or two days by province |
| Application Dates | one week slot | dates vary by province |
| Admission Dates | July 15 - Aug 3, 2006 | vary by province |
| | | One can be accpeted by at most **one** college |

*Notes:* This table shows the timing of different events in the Chinese college admissions in 2006, including the exam, college application and admission. The exam dates are the same for all provinces across China, while announcement, submission, and decision dates may vary a few days by province and by year.

Table 2.2: Sample Category

| | Ethnicity-based | Merit-based | No bonus | Total |
|---|---|---|---|---|
| above | 190 | 211 | 3009 | 3410 |
| below | 151 | 195 | - | 346 |
| Total | 341 | 406 | 3009 | 3756 |

*Notes:* This table shows the the number of sample observations in each student category. The row "above" means that student's test score is higher than the cutoff, and "below" means that student's test score is below the cutoff and that the student is admitted via affirmative action.

Table 2.3: Summary Statistics

| | Ethnicity-based Group | | | Merit-based Group | | |
|---|---|---|---|---|---|---|
| Variables | N | Mean | Std.Dev | N | Mean | Std.Dev |
| ***(1) Outcomes:*** | | | | | | |
| Ability Index | 341 | 0.028 | 0.778 | 405 | 0.018 | 0.814 |
| Emotion Index | 341 | -0.023 | 0.705 | 405 | -0.048 | 0.743 |
| Happiness | 341 | 84.120 | 11.348 | 406 | 84.323 | 10.944 |
| Zscore-happy | 341 | 0.038 | 0.965 | 406 | 0.055 | 0.931 |
| Standardized English test | 156 | 6.177 | 0.147 | 194 | 6.251 | 0.202 |
| No. of A courses | 337 | 8.513 | 10.081 | 403 | 10.32 | 11.601 |
| Academic awards | 341 | 0.387 | 0.488 | 406 | 0.475 | 0.500 |
| Wait to decide | 341 | 0.252 | 0.435 | 406 | 0.246 | 0.431 |
| Public | 341 | 0.507 | 0.501 | 406 | 0.495 | 0.501 |
| Private | 341 | 0.340 | 0.474 | 406 | 0.347 | 0.477 |
| Entrepreneurship | 341 | 0.062 | 0.241 | 406 | 0.044 | 0.206 |
| Marriage | 234 | 30.855 | 3.780 | 258 | 30.911 | 3.762 |
| Baby | 184 | 32.065 | 3.473 | 211 | 31.872 | 3.015 |
| Index_social | 341 | 0.025 | 0.794 | 406 | 0.066 | 0.770 |
| CPC Party Membership | 341 | 0.616 | 0.487 | 406 | 0.626 | 0.485 |
| ***(2) Individual characteristics:*** | | | | | | |
| Male | 341 | 0.499 | 0.501 | 406 | 0.539 | 0.499 |
| Age | 341 | 20.592 | 1.402 | 406 | 20.318 | 1.215 |
| Log(family income) | 339 | 10.485 | 1.147 | 394 | 10.828 | 1.141 |
| Father's education | 341 | 0.446 | 0.498 | 406 | 0.564 | 0.496 |
| Mother's education | 341 | 0.413 | 0.493 | 406 | 0.547 | 0.498 |
| Family party member | 341 | 0.463 | 0.499 | 406 | 0.596 | 0.491 |
| Rural | 341 | 0.296 | 0.457 | 406 | 0.202 | 0.402 |
| Low class | 341 | 0.419 | 0.494 | 406 | 0.313 | 0.464 |
| Elite college | 341 | 0.762 | 0.426 | 406 | 0.788 | 0.409 |
| Younger sibling | 341 | 0.323 | 0.468 | 406 | 0.148 | 0.355 |

*Notes:* The ethnicity-based and merit-based groups contain information for students who gained ethnicity-based bonus points and merit-based bonus points, respectively. Ability Perception Index is constructed by calculating a z-score for each component (perception related questions) and taking the average z-score across components. Standardized English Test is the logarithm of the score of college English test (CET-4). Skipped Class and Academic Rewards are dummy variables which equal one if the student has skipped class or has received academic awards. Wait to Decide, Public, Private, and Entrepreneurship are dichotomous variables about students' career plans. A value of 1 for Wait to Decide means that the student has not yet decided what she wants to do upon graduation. Public, private and entrepreneurship are dummies which equal 1 if the student plans to work in public sectors, private sector, and starts own business, respectively. Marriage and Baby variable measures student's life planning, which represent the latest age of the student's plan to get married and to have a child, respectively. Variables in panel (b) are students' individual characteristics. Father's Education and Mother's Education are dichotomous variables which equal one if the student's father or mother have a college degree or above. Family Party Member represents the Communist Party of China (CPC) membership of the student's parents. Rural and Low Class represent the family background, taking value of 1 if the student is from rural area, and the student's family economic level is considered to belong to lower stratum of society, respectively. Elite College equals one if the college is in Project-211 (meaning Top 100 colleges in 21st century). Younger indicates whether the student has older siblings or not.

Table 2.4: Balance Test

| | Male | Age | Log(family income) | Father's Education | Mather's Education | Rural | County |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Below Cutoff | 0.025 | -0.399 | -0.052 | -0.061 | -0.071 | -0.075 | -0.026 |
| | (0.103) | (0.294) | (0.463) | (0.174) | (0.190) | (0.136) | (0.116) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y |
| Observations | 215 | 215 | 215 | 215 | 215 | 215 | 215 |
| R-squared | 0.695 | 0.858 | 0.661 | 0.641 | 0.667 | 0.644 | 0.731 |

*Notes.* ***p<0.01, **p<0.05, *p<0.10. This table reports balance tests using the parametric method with quadratic interactions. The regressions in all columns use the ethnicity-based sample within the 20-point bandwidth. All regressions include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors are two-way clustered at the college and province levels.

Table 2.5: Effects of scoring below the cutoff on self-perception

| Polynomial Approach | Ability Perception Index | | | Emotion Index | | |
|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A: Ethnicity-based | | | | | | |
| *Below Cutoff* | -0.687*** | -0.583*** | -0.756** | 1.047*** | 0.677*** | 1.251*** |
| | (0.115) | (0.137) | (0.348) | (0.099) | (0.225) | (0.321) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College Province Track FE | Y | Y | Y | Y | Y | Y |
| #Observations | 215 | 215 | 215 | 215 | 215 | 215 |
| R-squared | | 0.676 | 0.688 | | 0.576 | 0.595 |
| Panel B: Merit-based | | | | | | |
| *Below Cutoff* | 0.070 | 0.095 | 0.206 | -0.030 | -0.028 | -0.009 |
| | (0.157) | (0.064) | (0.223) | (0.115) | (0.087) | (0.304) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College Province Track FE | Y | Y | Y | Y | Y | Y |
| #Observations | 253 | 253 | 253 | 253 | 253 | 253 |
| R-squared | | 0.380 | 0.383 | | 0.432 | 0.437 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' self-perception. The dependent variables are Self-ability Index constructed by calculating a z-score for each component (ability perception related questions) and taking the average z-score across components. The results in Column (1) and Column (4) are obtained from the local linear non-parametric estimation method, while other results are from the parametric method with either linear interaction or quadratic interactions. Column (1)-(3) and Column (4)-(6) report the results for positive self-evaluation and negative self-evaluation within the 20-point bandwidth, respectively. Panel A shows the result in ethnicity-base group and Panel B shows the result in merit-based group. All regressions include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.6: Effects of Scoring Below the Cutoff on Happiness

| Polynomial Approach | Happiness | | | Zscore-happy | | |
|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A: Ethnicity-based | | | | | | |
| *Below Cutoff* | -11.395*** | -7.618*** | -11.546*** | -0.969*** | -0.648*** | -0.982*** |
| | (1.387) | (1.545) | (0.855) | (0.118) | (0.131) | (0.073) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College Province Track FE | Y | Y | Y | Y | Y | Y |
| #Observations | 215 | 215 | 215 | 215 | 215 | 215 |
| R-squared | | 0.556 | 0.562 | | 0.556 | 0.562 |
| Panel B: Merit-based | | | | | | |
| *Below Cutoff* | -1.354 | -1.158 | 1.466 | -0.115 | -0.098 | 0.125 |
| | (1.772) | (2.647) | (3.656) | (0.151) | (0.225) | (0.311) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College Province Track FE | Y | Y | Y | Y | Y | Y |
| #Observations | 254 | 254 | 254 | 254 | 254 | 254 |
| R-squared | | 0.457 | 0.459 | | 0.457 | 0.459 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' happiness level. The dependent variables are happiness level rated by students themselves and the z-score for happiness. The results in Column (1) and Column (4) are obtained from the local linear non-parametric estimation method, while other results are from the parametric method with either linear interaction or quadratic interactions. Column (1)-(3) and Column (4)-(6) report the results for happiness level and z-score of happiness within the 20-point bandwidth, respectively. Panel A shows the result in ethnicity-base group and Panel B shows the result in merit-based group. All regressions include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.7: Robustness: Placebo Cutoffs on index-ability

| Cutoffs | -20 | | | 0 (baseline) | | | +20 | | |
|---|---|---|---|---|---|---|---|---|---|
| Polynomial Approach | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| *Below Cutoff* | -0.262* | -0.647 | 0.163 | -0.687*** | -0.583*** | -0.756** | -0.026 | -0.115 | -0.286 |
| | (0.149) | (1.265) | (0.871) | (0.115) | (0.137) | (0.348) | (0.145) | (0.260) | (0.563) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College Province Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| #Observations | 131 | 131 | 131 | 215 | 215 | 215 | 156 | 156 | 156 |
| R-Squared | | 0.762 | 0.764 | | 0.676 | 0.688 | | 0.697 | 0.707 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' self-image assessment using different placebo cutoffs. The dependent variable is Self-Image Index constructed by calculating a z-score for each component (self-image related questions) and taking the average z-score across components. The results in Columns (1), (4), and (7) are obtained from the local linear non-parametric estimation method, while other results are from the parametric method with either linear interaction or quadratic interactions. All columns report results for ethnicity-based group within 20-point bandwidth and include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.8: Robustness: additional controls

| Polynomial approach | Ethnicity-based | | | Merit-based | | |
|---|---|---|---|---|---|---|
| | Local | Parametric | Parametric | Local | Parametric | Parametric |
| | Linear | Linear | Quadratic | Linear | Linear | Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Below the cutoff | -0.600*** | -0.489*** | -0.684 | 0.030 | -0.065 | 0.351 |
| | (0.091) | (0.093) | (0.424) | (0.145) | (0.094) | (0.222) |
| Controls | Y | Y | Y | Y | Y | Y |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y |
| Observations | 129 | 129 | 129 | 190 | 190 | 190 |
| R-squared | | 0.487 | 0.504 | | 0.339 | 0.367 |

*Notes:* ***p<0.01, s**p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' ability perception controlling for students' idiosyncratic characteristics. The dependent variable is Ability Perception Index constructed by calculating a z-score for each component (ability perception related questions) and taking the average z-score across components. The individual-level controls include gender, age, family income, father's and mother's education level, and parent's CCP membership. The results in Column (1) and Column (4) are obtained from the local linear non-parametric estimation method, while other results are from parametric method with either linear interaction or quadratic interactions. Column (1) - (3) and Column (4) - (6) report the results for ethnicity-based and merit-based groups within the 20-point bandwidth, respectively. All regressions include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.9: Heterogeneity

| | Ability Perception Index | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Below the cutoff × Noncity | -0.606*** | | | | |
| | (0.134) | | | | |
| Below the cutoff × Low-class | | -0.254*** | | | |
| | | (0.0941) | | | |
| Below the cutoff × Younger Sibling | | | -0.083 | | |
| | | | (0.654) | | |
| Below the cutoff × Elite College | | | | -0.619*** | |
| | | | | (0.128) | |
| Below the cutoff × Freshmen | | | | | -0.437*** |
| | | | | | (0.077) |
| Controls | Y | Y | Y | Y | Y |
| Cohort FE | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y |
| Observations | 215 | 215 | 215 | 215 | 215 |
| R-squared | 0.461 | 0.682 | 0.691 | 0.456 | 0.695 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the difference-in-differences (DID) results of heterogeneous effects of scoring below the cutoff on students' ability perception. The dependent variable is Ability Perception Index constructed by calculating a z-score for each component (ability perception related questions) and taking the average z-score across components. Noncity and Low Class represent the family background, taking value of 1 if the student is from non-city area (county or other rural area), and the student's family economic level is considered to belong to lower stratum of society, respectively. Elite College equals one if the college is in Project-211 (meaning Top 100 colleges in 21st century). Younger indicates whether the student has older siblings or not. The individual-level controls include gender, age, family income, father's and mother's education level, and parent's CPC membership. All columns report results using full sample of ethnicity-based group and include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.10: Effects of scoring below cutoff on academic performance

| Polynomial approach | Standardized English test | | | "A" Course | | | Academic Awards | | |
|---|---|---|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Panel A: Ethnicity-based | | | | | | | | | |
| Below the cutoff | -0.115*** | -0.083*** | -0.220*** | -3.806*** | -3.733*** | -1.741 | -0.447*** | -0.446*** | -0.464*** |
| | (0.0121) | (0.00888) | (0.0416) | (1.212) | (1.148) | (1.675) | (0.0777) | (0.0805) | (0.166) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 106 | 106 | 106 | 213 | 213 | 213 | 215 | 215 | 215 |
| R-squared | | 0.925 | 0.937 | | 0.775 | 0.778 | | 0.600 | 0.606 |
| Panel B: Merit-based | | | | | | | | | |
| Below the cutoff | 0.030 | 0.037 | 0.063 | -0.015 | 0.430 | -0.335 | 0.119 | 0.140 | 0.129 |
| | (0.0239) | (0.0423) | (0.0605) | (1.810) | (0.244) | (0.652) | (0.0814) | (0.187) | (0.235) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 135 | 135 | 135 | 253 | 253 | 253 | 254 | 254 | 254 |
| R-squared | | 0.912 | 0.913 | | 0.713 | 0.713 | | 0.498 | 0.498 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' academic performance. Standardized English Test is the logarithm of the score of college English test (CET-4). Skipped Class and Academic Rewards are dummy variables which equal one if the student has skipped class or has received academic awards. The results in Columns (1), (4), and (7) are obtained from the local linear non-parametric estimation method, while other results are from parametric method with either linear interaction or quadratic interactions. Panel A and Panel B report results for ethnicity-based and merit-based groups within 20-point bandwidth, respectively. All columns include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.11: Effects of scoring below cutoff on career plan

| Polynomial approach | Wait to decide | | | Public Sector | | | Private Sector | | | Entrepreneurship | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Panel A: Ethnicity-based | | | | | | | | | | | | |
| Below the cutoff | 0.089 | 0.107*** | 0.078* | 0.432*** | 0.247* | 0.605*** | -0.081 | 0.045 | -0.135 | -0.166*** | -0.165*** | -0.179* |
| | (0.055) | (0.019) | (0.039) | (0.084) | (0.131) | (0.147) | (0.083) | (0.119) | (0.181) | (0.040) | (0.033) | (0.099) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 215 | 215 | 215 | 215 | 215 | 215 | 215 | 215 | 215 | 215 | 215 | 215 |
| R-squared | | 0.707 | 0.713 | | 0.576 | 0.611 | | 0.614 | 0.622 | | 0.583 | 0.588 |
| Panel B: Merit-based | | | | | | | | | | | | |
| Below the cutoff | 0.043 | 0.130 | 0.008 | 0.311** | 0.446 | 0.234 | -0.468*** | -0.541* | -0.419 | 0.025 | 0.010 | 0.007 |
| | (0.085) | (0.103) | (0.130) | (0.127) | (0.254) | (0.376) | (0.117) | (0.280) | (0.445) | (0.025) | (0.060) | (0.068) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 | 254 |
| R-squared | | 0.574 | 0.577 | | 0.468 | 0.476 | | 0.462 | 0.479 | | 0.536 | 0.553 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' aspirations for career. Wait to Decide, Public Sector, Private Sector, and Entrepreneurship are dichotomous variables about students' career plans. A value of 1 for Wait to Decide means that the student has not yet decided what she wants to do upon graduation. Public, private and entrepreneurship are dummies which equal 1 if the student plans to work in public sectors, private sector, and starts own business, respectively. The results in Columns (1), (4), (7), and (10) are obtained from the local linear non-parametric estimation method, while other results are from parametric method with either linear interaction or quadratic interactions. Panel A and Panel B report results for ethnicity-based and merit-based groups within 20-point bandwidth, respectively. All columns include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.12: Effects of scoring below cutoff on family expectation

| Polynomial approach | Marriage | | | Baby | | |
|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A: Ethnicity-based | | | | | | |
| Below the cutoff | -3.769*** | -2.731** | -5.641*** | -4.890*** | -4.401*** | -6.146** |
| | (1.020) | (1.057) | (1.810) | (0.762) | (0.920) | (2.334) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y |
| Observations | 153 | 153 | 153 | 120 | 120 | 120 |
| R-squared | | 0.355 | 0.379 | | 0.570 | 0.573 |
| Panel B: Merit-based | | | | | | |
| Below the cutoff | 0.065 | 0.294 | -3.250** | -2.185*** | -0.977 | -4.613* |
| | (0.594) | (0.459) | (1.266) | (0.708) | (1.497) | (2.164) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y |
| Observations | 164 | 164 | 164 | 137 | 137 | 137 |
| R-squared | | 0.680 | 0.711 | | 0.617 | 0.652 |

*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' family plan. Marriage and Baby variable measures student's life planning, which represent the latest age of the student's plan to get married and to have a child, respectively. The results in Columns (1) and Column (4) are obtained from the local linear non-parametric estimation method, while other results are from parametric method with either linear interaction or quadratic interactions. Panel A and Panel B report results for ethnicity-based and merit-based groups within 20-point bandwidth, respectively. All columns include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Table 2.13: Effects of scoring below cutoff on other outcomes

| Polynomial approach | Social Relationship | | | CPC Party Member | | |
|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Panel A: Ethnicity-based | | | | | | |
| Below the cutoff | -1.047*** | -0.768*** | -1.292*** | -0.346*** | -0.136** | -0.561*** |
| | (0.110) | (0.225) | (0.227) | (0.066) | (0.048) | (0.088) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y |
| Observations | 129 | 129 | 129 | 129 | 129 | 129 |
| R-squared | | 0.420 | 0.438 | | 0.371 | 0.414 |
| Panel B: Merit-based | | | | | | |
| Below the cutoff | -0.144 | 0.001 | -0.199 | 0.151 | 0.282*** | 0.069 |
| | (0.162) | (0.063) | (0.279) | (0.116) | (0.034) | (0.082) |
| Cohort FE | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y |
| Observations | 192 | 192 | 192 | 192 | 192 | 192 |
| R-squared | | 0.241 | 0.245 | | (0.283) | (0.300) |

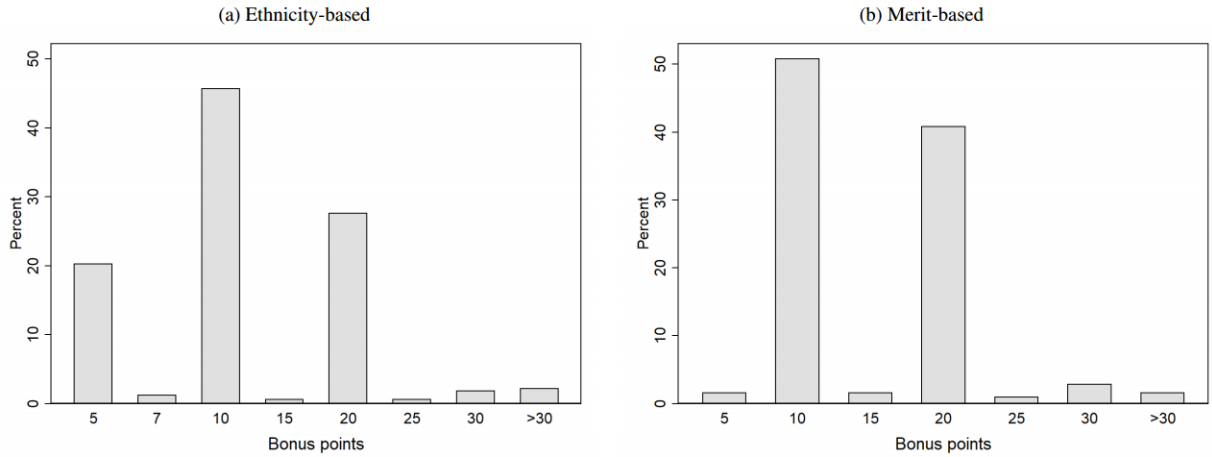
*Notes:* ***p<0.01, **p<0.05, *p<0.10. This table shows the RD results of effects of scoring below the cutoff on students' family plan. Marriage and Baby variable measures student's life planning, which represent the latest age of the student's plan to get married and to have a child, respectively. The results in Columns (1) and Column (4) are obtained from the local linear non-parametric estimation method, while other results are from parametric method with either linear interaction or quadratic interactions. Panel A and Panel B report results for ethnicity-based and merit-based groups within 20-point bandwidth, respectively. All columns include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels

Table 2.14: Effects of Scoring Below the Cutoff on Majors

| Polynomial approach | Major: Econ/Finance/Law | | | Major: STEM | | | Major: Humanities | | |
|---|---|---|---|---|---|---|---|---|---|
| | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic | Local Linear | Parametric Linear | Parametric Quadratic |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Panel A: Ethnicity-based | | | | | | | | | |
| Below the cutoff | -0.054 | -0.144 | 0.090 | -0.046 | 0.013 | -0.182 | 0.100* | 0.131 | 0.092 |
| | (0.071) | (0.122) | (0.109) | (0.061) | (0.034) | (0.171) | (0.055) | (0.119) | (0.103) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 212 | 212 | 212 | 212 | 212 | 212 | 212 | 212 | 212 |
| R-squared | | 0.621 | 0.632 | | 0.740 | 0.744 | | 0.739 | 0.742 |
| Panel B: Merit-based | | | | | | | | | |
| Below the cutoff | 0.039 | -0.045 | 0.106 | -0.096 | -0.053 | -0.203 | 0.057 | 0.098 | 0.097 |
| | (0.068) | (0.040) | (0.112) | (0.066) | (0.038) | (0.144) | (0.050) | (0.071) | (0.108) |
| Cohort FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| College × Province × Track FE | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 206 | 206 | 206 | 206 | 206 | 206 | 206 | 206 | 206 |
| R-squared | | 0.616 | 0.625 | | 0.785 | 0.790 | | 0.758 | 0.762 |

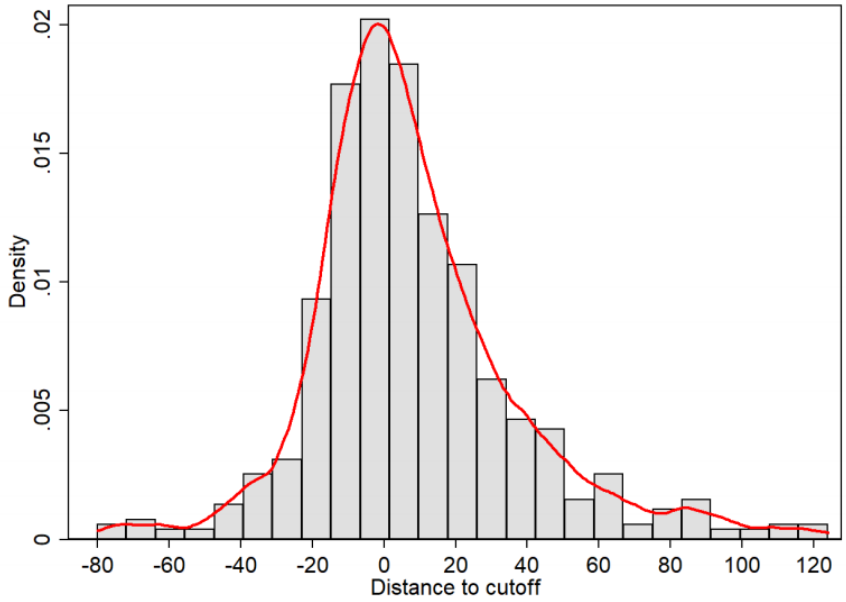
*Notes:* This table shows the RD results of effects of scoring below the cutoff on students' majors. The results in Columns (1), (4), and (7) are obtained from the local linear non-parametric estimation method, while other results are from the parametric method with either linear interaction or quadratic interactions. Panel A and Panel B report results for ethnicity-based and merit-based groups within 20-point bandwidth, respectively. All columns include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

Figure 2.1: Distribution of Bonus Points



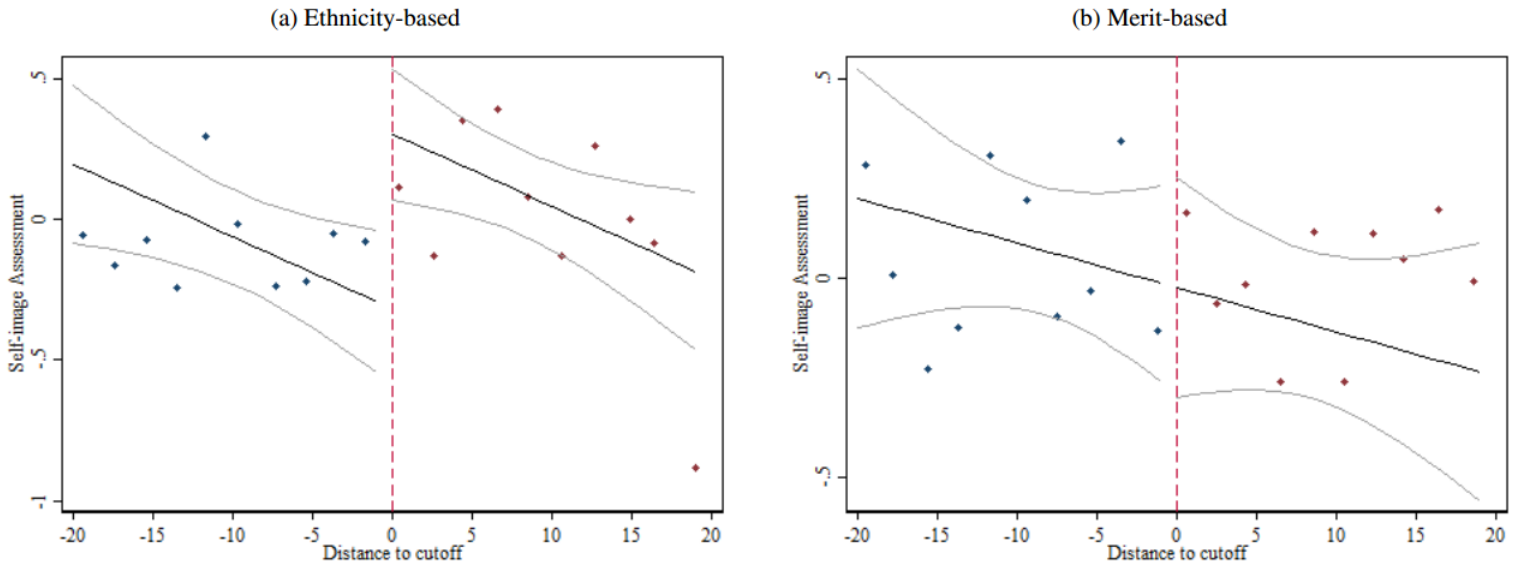

*Notes:* The figure depicts the distribution of ethnicity-based and merit-based bonus points Each bar represents the percentage of students who received each of the bonus points.

Figure 2.2: Student Distribution



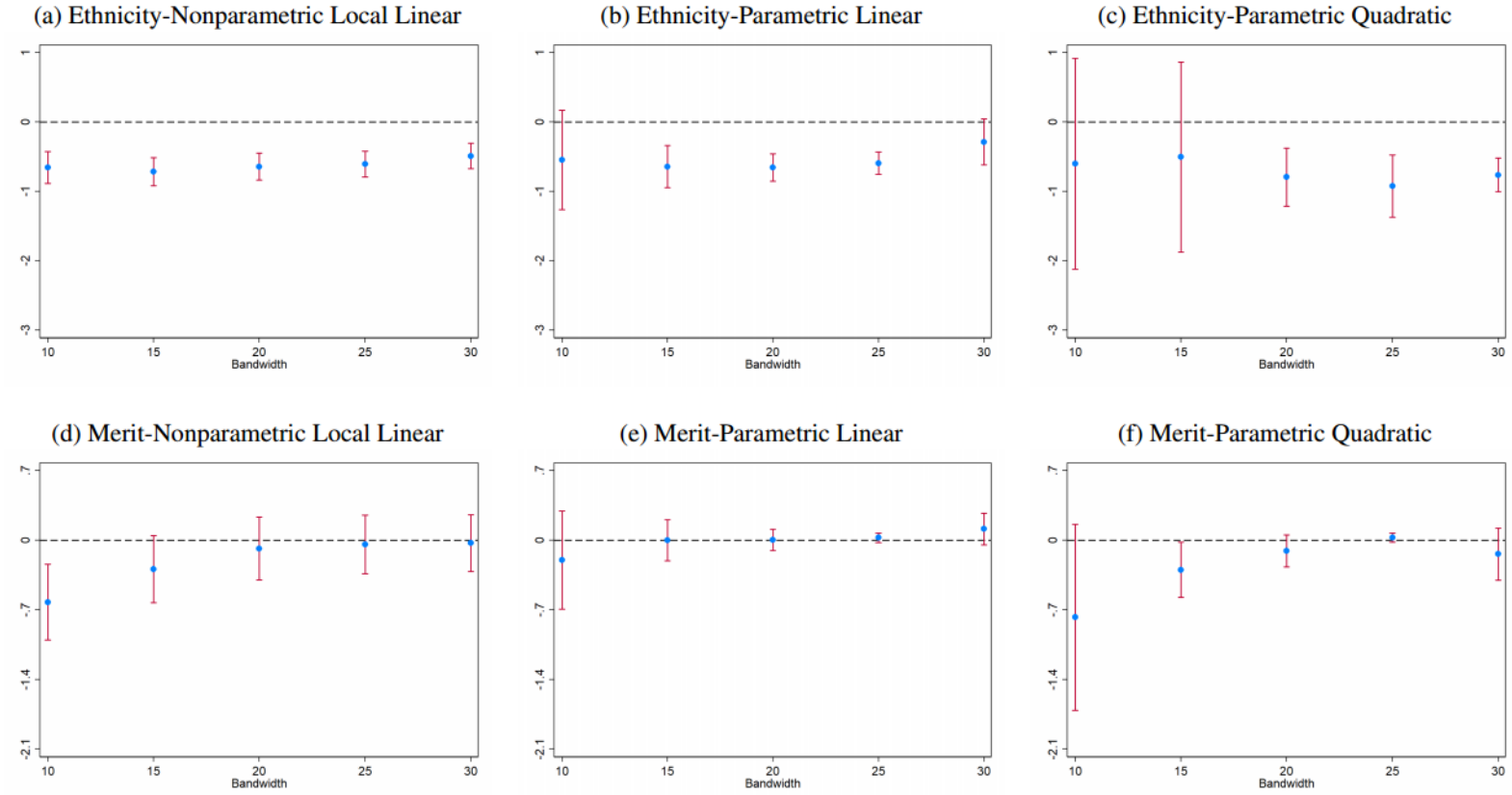

*Notes:* This figure depicts the distribution of exams scores in terms of the distance in points to the cutoff scores. Each bar represents the probability density of students within the bin. The red curve shows the kernel density estimate of the distribution, suggesting a smooth density around the cutoff.

Figure 2.3: Self-Image for Ethnicity-based and Merit-based Students




*Notes:* The figures plot the student's self-image assessment against distance to the cutoff scores. Each dot represents the self-image index averaged over 2-point bins. Black lines fit parametric linear regressions within 20-point bandwidth on both sides of the cutoff. Grey curves denote 90 percent confidence interval. Cohort fixed effects and a full set of college-province-track fixed effects are controlled for in both figures.

Figure 2.4: Robustness: Alternative Bandwidth




*Notes:* The figures plot RD estimates of effects of scoring below the cutoff on students' self-image assessment using alternative bandwidths along with the 90 percent confidence interval, ranging from 10-point to 30-point bandwidths. The dependent variable is Self-Image Index constructed by calculating a z-score for each component (self-image related questions) and taking the average z-score across components. The results in Panel (a) and Panel (d) are obtained from the local linear non-parametric estimation method, while other results are from the parametric method with either linear interaction or quadratic interactions. Panel (a), (b), (c) report results for ethnicity-based group, while last three are for merit-based group. All estimations include cohort fixed effects and a full set of college-province-track fixed effects. Standard errors for all parametric specifications are two-way clustered at the college and province levels.

# 3 Is Having a Brother Good for Women? A Study of Gender Discrimination in Family Education Investment

## 3.1 Introduction

Gender imbalances are notably present in Asian countries, particularly in China (Das Gupta, 1987; Coale & Banister, 1994; Chung, 2007; Ebenstein, 2010). China's unique history of implementing a mandatory one-child policy has led to a distinct pattern of gender imbalance compared to other countries. The issue of gender selection at birth remains serious in China. The observed sex ratio at birth (SRB) in China, according to the data from the Seventh National Population Census conducted in 2020, was 112.28, a figure that exceeds the natural rate of 105. Figure 3.1 summarizes the SRB in China in 2020. As can be seen, China's SRB for the first child in 2020 was slightly higher than normal level, the SRB for second child was normal, and the SRB for the third child and above was extremely distorted. There is even a serious preference for boys in urban areas. China launched its comprehensive two-child policy in 2016. Current trends show that more and more families are pursuing a "one-step" approach, i.e., sex-selection from the first child to obtain a boy, while sex-selection for the second child is less severe.

In contrast to the issues surrounding sex selection at birth, women in China are increasingly accessing higher education. Figure 3.2 illustrates the gender ratio of entrants across various educational stages. From the data, a trend is evident: in China, with the advancement of educational stages, the proportion of females grows. This trend is similar to that observed in numerous other countries. Driven by societal shifts, income growth, and international efforts to bridge gender gaps, women in many regions are reaping greater benefits from higher education opportunities.

Nonetheless, beneath this positive development lies an entrenched preference for sons within Chinese families. China's "one-child" policy was initially expected to improve the resource allocation for daughters within families, providing them with an equal standing to sons. However, in families with multiple children, daughters with brothers continue to be less favored due to the presence of male siblings. As illustrated in Figure 3.1, the sex ratio at birth for the third child and beyond is significantly higher than that for the first and second children.

Combining the preference for sons in Chinese families with the high proportion of women in

higher education, from a macro perspective, the education resources for born females are exchanged for those of unborn females. At the individual level, families with only daughters are compelled to allocate educational resources to them, while girls with brothers still face a reduction in educational resources. This phenomenon indicates a deeply ingrained issue of gender discrimination in China.

The phenomenon of "missing women" clearly shows extreme gender discrimination. Two main reasons account for gender discrimination at the family level. Firstly, as the return on investment for boys' education is higher due to women's labor income being lower than men's, leading parents to prefer investing in sons over daughters (Alderman & King, 1998; Zhang et al., 2005). Secondly, a strong preference for sons under patriarchal family culture, where parents rely on sons for old-age support, making investments in sons' education yield lifelong returns, while investments in daughters' education are seen as losses once daughters marry (Greenhalgh, 1985; Brinton, 1988; Yu and Su, 2006; Chu et al., 2007). This preference is deeply tied to cultural practices. In Chinese clan culture, males are seen as continuing the family lineage. As a result, parents may either reduce their investment in daughters' education or compel daughters to work early or marry to alleviate the family's economic burden, benefiting the education of younger siblings (Chu et al., 2007; Parish & Willis, 1993). This shows that in families with a son preference, the allocation of resources between sons and daughters is asymmetrical, making girls' education more vulnerable to the family's economic situation (Hannum, 2005).

These two factors contributing to gender discrimination are prevalent in China. First, despite its rapid GDP growth, China remains a developing country with a relatively low per capita national income. In 2022, the per capita GDP of China was merely 12720 dollars, ranking 76th globally[26]. Education represents a significant expenditure for most Chinese families, many of which face severe financial constraints when investing in their children's education. Second, the traditional preference for male children over female ones persists. In families, especially those facing tighter resource constraints, daughters are often seen purely as an economic burden. There's a tendency to sacrifice the quality of education for girls in favor of boys, with parents and brothers potentially exploiting the unpaid labor of unmarried sisters to recoup the costs of raising them and to enhance the family's living conditions (Greenhalgh, 1985; Parish and Willis, 1993). Therefore, it's anticipated

[26]Date Source: The World Bank https://databank.worldbank.org/indicator/NY.GDP.PCAP.CD/1ff4a498/Popular-Indicators#

that the phenomenon of educational crowding out exists within Chinese families, likely exhibiting significant gender disparities. Cultural impacts, perhaps more deep-rooted than those of economic development, continue to influence this scenario. Despite the shift towards a two-child policy, the impact of siblings on girls' access to resources remains unchanged.

Beyond the two common causes mentioned above, China's unique policies have also contributed to the phenomenon of "missing women." Many studies attribute the imbalance in China's sex ratio at birth to the one-child policy initiated in the 1970s (Li et al., 2011). The policy, encouraging just one child per couple, was formally established as a national policy by 1979. With the exception of multiple births and some special cases,[27] all couples could have only one child. However, facing challenges such as the vanishing demographic dividend, critically low birth rates, and an aging population, China gradually introduced the two-child policy for couples where both parents are only children (i.e., neither having sibling) in November 2011. In 2013, the policy was further liberalized to allow couples to have two children if one of them was an only child. By the end of 2015, the universal two-child policy was introduced, allowing all couples, regardless of their family background (especially if both spouses have siblings), to have two children. On May 31, 2021, the policy was further relaxed to allow couples to have three children. With the implementation of the universal "three-child" policy in 2021, China will see an increase in families with multiple children. Therefore, with the increase in larger families in China, a higher proportion of girls will have siblings in the future. The timeline of major child policy changes is summarized in Figure 3.3. Indeed, even during the time period of the one-child policy (1980s to 2010), there were large geographic variations in the strictness of the policy's implementation. In some regions it was possible to have more children by paying a certain amount of fine, which led to a large number of individuals having siblings even if they were born in 1980-2000. In Section 3.4.1, we will present more statistics on siblings based on the sample data.

In this study, we analyze the degree to which multi-child households in China prioritize girls, specifically investigating how the educational resources available to girls are impacted by the presence of brothers. The unique cultural context and policy shifts in China provide a background for analyzing gender discrimination within a patriarchal framework. Utilizing data from the 2010 China

[27] Exceptions include: the first child is a non-genetically disabled child who cannot grow into the workforce; remarried couples have only one child in total; rural couple with only one daughter; minorities.

Family Panel Survey, which offers detailed information on the family structure of respondents, the research reveals that girls with brothers face greater challenges in accessing quality education.

The remainder of this chapter is structured as follows: Section 3.2 presents the literature review. Section 3.3 describes the data used in the analysis and the empirical methodology employed, as well as some summary statistics from the sample. Section 3.4 discusses the empirical results. Section 3.5 concludes the chapter.

## 3.2 Literature Review

Existing research has substantiated that in the context of finite family resources, the allocation to each child is likewise limited (Becker and Lewis [1973]). The size of a family has a notable effect on the resources available for each child's upbringing, with larger sibling counts often resulting in inequitable distribution of resources within the household (Blake [1981]; Powell and Steelman [1990]; Chu et al. [2007]; Lu and Treiman [2008]). Commonly, as the number of children in a family increases, it is challenging for the educational investment to keep pace proportionally. Consequently, the share of educational resources each child receives tends to diminish with the addition of more siblings; in larger families, every child may receive less economic and non-economic resources conducive to cognitive development, potentially leading to a decrease in average child quality (Anastasi [1956]). However, there are divergent viewpoints on this assertion within the literature.

Some studies suggest that the presence of siblings has a significant impact only on specific minority groups, or may not even have a noticeable effect at all. Butcher and Case [1994] investigated individuals born between 1920 and 1961, finding that while sibling gender composition had no effect on boys, girls with sisters attained less education than those with only brothers. Kaestner [1996] examined the impact of sibling gender composition on educational attainment among individuals born between 1958 and 1961. The results indicated that sibling gender composition only significantly affected adult African Americans and African American youth aged 15 to 18. Concurrently, Hauser and Kuo [1998] argued that the conclusions of Butcher and Case [1994] were merely interesting hints rather than robust findings, asserting that there was no evidence of significant impact of sibling gender composition on educational attainment in 20th-century America. Similarly, Caldwell and Caldwell [1987] found no substantial negative correlation between the number of siblings and the level of education among families in sub-Saharan Africa, attributing the lack of a

significant relationship to the vast family sizes and the dispersion of educational resources. Angrist et al. [2010], using census data from Israel in 1983 and 1995, did not find evidence that a reduction in the number of children per family led to improved educational outcomes. Liu [2014] arrived at comparable conclusions using data from China's CHNS.

However, other studies have acknowledged the existence of sibling competition, which manifests in terms of both quantity and structure. In the 1970s, Becker and Lewis [1973] introduced the Quality-Quantity Trade-off Theory, hypothesizing a negative correlation between the number of children and their quality, thereby laying the foundation for the theory of educational crowding out among siblings. Lindert [1977] noted that larger family sizes leave parents with less time, energy, and money to devote to each child, resulting in lower IQs, earlier school departure, lower status, and reduced earnings for children raised in such families. Downey [1995], using data from the National Education Longitudinal Study of eighth graders collected in 1988, demonstrated the variations in the acquisition of economic and non-economic resources among children based on the number of siblings, and established through rigorous multivariate regression analysis the significant explanatory power of these resources on the relationship between sibling count and children's academic achievements.

On the other hand, competition among siblings also arises from the structural differences within the sibling group. The composition of siblings as an aspect of family structure has garnered widespread interest among researchers. Factors such as birth order, age intervals, and gender makeup are included in this composition (Steelman et al. [2002]). A significant aspect of this is the gender composition of siblings (Butcher and Case [1994]), especially in societies where gender biases exist. Parents often prioritize sons over daughters, leading to a wealth transfer mechanism within the sibling group. Powell and Steelman [1989] observed that an increase in the number of brothers within a family typically results in less financial support from parents for their children's university education, increasing the likelihood that the children will bear the costs themselves. Consequently, boys with sisters in the same family tend to receive more education than those without sisters, whereas girls with brothers receive less education than those without brothers (Parish and Willis [1993]; Butcher and Case [1994]; Garg and Morduch [1998]). This internal family resource allocation with a "boy bias" is formed when parents favor sons over daughters (Greenhalgh [1985]). These empirical studies suggest that when families consider educational investments, they generally perceive a

higher return on investment for boys than for girls. Thus, under budget constraints for education, the allocation of educational resources tends to favor boys. This "sibling competition effect" intensifies as the constraints on resources for educational investments increase.

Recent studies in East Asian societies have also examined the effects of sibling structure on competition by incorporating a gender perspective. In line with the characteristics of Asian societies, Chu et al. [2007] analyzed data from Taiwan and discovered that families tend to allocate resources preferentially to certain children, directly forgoing educational opportunities for others. This resource allocation often sacrifices the educational chances of older daughters in favor of supporting the education of younger children, particularly boys, underscoring a significant bias within household dynamics. Parish and Willis [1993], using data from a survey of women and families in Taiwan, found that in economically disadvantaged families, parents invest less in the education of older daughters and compel them to enter the labor market early. The income of the older daughters is then used to finance the education of younger siblings. Lei et al. [2017], utilizing data from China's CFPS, arrived at similar conclusions, indicating a trend where the presence of brothers can affect the educational attainment of sisters within the household.

Research on gender discrimination in educational resources in China falls into two categories: those with a positive outlook and those with a negative perspective. Since the implementation of China's one-child policy, there has been a notable decrease in the number of offspring per family, accompanied by significant changes in family structure, including a sharp decline in the likelihood of females having brothers. From a positive viewpoint, even if parents still prefer sons, the restrictions imposed by the policy under the birth quota system prevent parents without sons from discriminating based on gender. Consequently, they are left with no choice but to allocate resources to their existing daughters (Zheng & Lu, 2017). This shift increases the likelihood of female descendants acquiring resources within the family, thereby enhancing their educational level and promoting gender equality in educational opportunities. The implementation of the one-child policy has reduced family size and eased constraints on family resources, thus improving girls' access to education (Tsui and Rich [2002]; Li et al. [2008]; Lee [2012]; Ye & Wu, 2011; Wu, 2012).

From a negative perspective, the traditional preference for boys within Chinese families places girls, especially those in larger families, at a disadvantage in the competition for family resources. The presence of brothers in a family tends to monopolize more resources compared to sisters, while

having sisters may, conversely, bring additional resources to the family (Zheng, 2013; Lei et al. [2017]; Zhong&Dong, 2018). With the relaxation of China's birth restrictions, the number of multi-child families is expected to rise, leading to more girls having brothers. Therefore, under the new policy framework, the distribution of educational resources within families is likely to change. This chapter aims to further investigate the preferences of Chinese families in the allocation of resources to their children, focusing on the impact on the education of girls who have brothers.

## 3.3 Data and Empirical Strategy

This section of the study describes the data used in the analysis, specifically the China Family Panel Studies (CFPS), and explains the methodology used to mitigate sample attrition. It also outlines the statistical techniques employed in the study and provides an overview of the sample data, including some descriptive statistics.

### 3.3.1 Empirical Framework

This study uses two variables to gauge the existence of gender discrimination opportunities: the number of siblings a woman has and whether she has a brother. The chapter aims to quantify the impact of these factors on women's educational attainment, using an econometric model illustrated in Equation 2.1.

$$Y = \alpha + \beta_1 D_{female} + \beta_2 D_{brother} + \beta_3 D_{female} \times D_{brother} + \beta_4 \times Sibling + \gamma X + \varepsilon \tag{3.1}$$

where $Y$ is the outcome variable which encompasses years of schooling, as well as dummy variables for high school or college diplomas and personal attitude questions. The gender of each observation is identified by the binary variable, $D_{female}$. The presence of brothers in the household is indicated by the dummy variable, $D_{brother}$. The interaction term, $D_{female} \times D_{brother}$, is the product of the gender and brother dummies, and its coefficient, $\beta_3$, is the primary focus of the study. The number of siblings (*Sbiling*) is also included in the model. The control variables, $X$, consist of various factors that may affect education level, such as urban or rural residence, ethnic minority status, parental education level, parental party membership, family genealogy, and ancestor worship practices. The error term is represented by $\varepsilon$, and the model includes province and birth year fixed

effects, with standard errors clustered at the county level.

### 3.3.2 Data and Variables

The China Family Panel Studies (CFPS) is a comprehensive, nationally representative survey of Chinese communities, families, and individuals that has been conducted annually since 2010 by the Institute of Social Science Survey (ISSS) of Peking University, China. The CFPS collects data at the individual, family, and community levels, covering a wide range of topics such as economic activities, education outcomes, family dynamics, migration, and health. The survey is a panel study, meaning that the same households are surveyed every year, providing valuable longitudinal data. The survey has been conducted every two years, with six waves completed so far, and the 2010 data serves as the base year. Sibling information for individuals is only available in the 2010 data. The 2010 adult database includes samples born in 1994 and earlier. Considering the relatively low probability of adding a new sibling in subsequent surveys in this part of the sample, our study focuses on the 2010 base year data.

A total of 33,598 adults were included in the CFPS 2010 adult questionnaire. To ensure sufficient variation in the "having a brother or not" variable and to exclude individuals who were not affected by the one-child policy, adults born before 1973 were removed from the study.[28] Individuals who were attending school were excluded from the analysis of years of schooling since their current level of education was not necessarily their final level.

Table 3.1 presents the summary statistics of key variables, broken down by gender. The table shows means and standard deviations for five outcome variables. *edu_year* means years of schooling. *high* and *college* represents the dummy variable indicating whether the respondent has a high school degree or college degree, respectively. *family_name* is the z-score of the answer to the question "How important do you think it is to have a child (son) to carry on family name?", which is answered on a scale of 1-5, where 1 means "not important" and 5 means "very important". Since children usually take their father's family name, this question can also be thought of as an indicator of the respondent's attitude toward "having a son" (or "son preference"). *child_success* is the

[28]The CFPS 2010 questionnaire for adults had limited variables on personal characteristics of parents and a higher number of missing values, primarily due to the fact that adults' parents were deceased or living separately, and were given values of not applicable, unable to determine, or don't know. This affected the regression observations and introduced bias into the sample. The year 1973 was chosen as the cutoff because it marked the beginning of family planning policies in China, which led to a significant decrease in the percentage of women having brothers (see Figure 3.5).

z-score for the question, "How important do you think it is for your child to be successful?", again on a scale of 1-5, where 1 is "not important" and 5 is "very important".

Table 3.1 also includes means and standard deviations for various control variables, such as demographic characteristics of the individual (ethnicity and living area), parents' education and job-related variables, and family tradition-related variables. The control variables are identified by adding "f" for father-related variables and "m" for mother-related variables. The *party* variable is a dummy variable indicating whether a parent is a party member. *isei* and *siops* are two proxies in the CFPS database that measure the socioeconomic status of parents' jobs, but only parents' jobs of individuals with living parents are included in CFPS2010, which is used for robustness checks. *Genealogy* is a dummy variable indicating whether the household has a genealogy entry, which typically includes the name of the male in the household and serves as a proxy variable for the household's preference for boys. *Worship_ancestors* is a proxy variable indicating whether the household had ancestor worship in the last year, which suggests that the family is more traditional and emphasizes the transmission of the family name, a reason for the preference of boys over girls.

## 3.4 Empirical Analysis

### 3.4.1 Preliminary Analysis

In this section, we provide an overview of the siblings of the surveyed individuals using data from the China Family Panel Studies (CFPS) 2010 sample. This information helps to shed light on some of the effects of China's population policy.

Figure 3.4 shows the average number of offspring per family in China from 1949 to the 1990s. The graph reveals that Chinese families had a relatively high number of children in the early years, but the number decreased steadily over time. The average number of siblings per individual dropped significantly after the implementation of the one-child policy in 1979, with individuals born in the 1990s having only about one sibling on average. The two red vertical lines in the graph mark the years 1973 and 1979, which represent the beginning of the birth limitation policy and the implementation of the one-child policy, respectively.

The one-child policy implemented in China over the past three decades has had a significant impact on the educational attainment of girls in families. Prior to the policy, families had an incentive

to have multiple children in order to increase their chances of having a male offspring. However, with the implementation of the policy, families are now limited in the number of births they can have, and this has led to a decline in the proportion of girls with brothers. According to Figure 3.5, the proportion of girls with brothers has decreased sharply, from over 80% in the 1970s to less than 60% in the 1990s. Interestingly, the proportion of males with a brother has also declined dramatically, from over 80% before 1970 to only about 30% in the 1990s. This suggests that the number of "one-son" families is increasing, and the concept of family has shifted from "many sons, many blessings" to "having a son is good".

The implementation of the one-child policy has led to a decrease in the number of offspring in families, and Figure 3.5 highlights a concurrent shift in family structure. The probability of a woman having a brother has decreased significantly, indicating a change in the traditional gender roles and preferences within families. Although parents still tend to favor boys, the policy restricts their ability to practice gender discrimination, and they are forced to invest in their daughters' education and well-being. As a result, female offspring are more likely to have access to resources within the household, which in turn enhances their educational attainment and contributes to gender equality in access to education.

Using data from CFPS, we examined changes in family structure over time. Figure 3.6 shows the distribution of the number of siblings for individuals born in different years. In the 1950s, more than half of the individuals had four or more siblings, while only a few were only children. However, since the late 1960s, the distribution of the number of siblings has shifted, and the proportion of families with multiple children has decreased. Interestingly, even though the one-child policy was implemented for over 10 years in the 1990s, only about 25% of individuals were only children, and about 50% had one sibling. This suggests that many families have more than one child (by paying fines), and the implementation and effectiveness of the one-child policy are not as effective as previously thought. In other words, allowing for two or three children per family would not provide much incentive for childbearing, as most families have already given birth to two or more children during the one-child policy era.

Since the establishment of the People's Republic of China, and particularly after the implementation of the one-child policy, the size of Chinese families has been decreasing. This shrinkage in family size has led to a continuous decline in the proportion of women with brothers, which in turn

reduces the likelihood of families favoring sons over daughters and enhances women's educational opportunities. Despite the long-standing implementation of the one-child policy, it has only curbed the opportunities for family gender discrimination, but the preference for boys over girls persists. The detrimental impact of gender discrimination on women's educational attainment still exists. In the subsequent sections, we employ regression methods to assess the effect of whether parents have sex discrimination opportunities on female educational attainment.

### 3.4.2 Impact of "Number of Siblings" and "Having a Brother" on Education Attainment and Personal Attitude

We utilize the Ordinary Least Squares (OLS) method to estimate Equation 3.1 using all available samples. The results are presented in Column (1) of Table 3.2. The estimation reveals that "Having brothers" and its interaction term with gender are statistically significant, indicating that when the number of peers is constant, men with brothers have approximately 0.765 years more education than women with brothers. This suggests that having brothers has a more pronounced negative impact on women's education compared to men's. Additionally, the coefficient of sibling number is significantly negative, with a value of $-0.291$.

We analyze the impact of "having brothers" on women's education level separately in urban and rural areas, taking into account the potential difference in attitudes towards human capital investment. The results are shown in Columns (2) and (3) of Table 3.2. The findings indicate that "having brothers" has a significant negative effect on the educational attainment of both rural and urban women, and that individuals with more brothers and sisters tend to have lower educational attainment. Notably, the coefficient of the regression result for the urban subsample is even more negative, which may be related to the higher cost of education in cities. Interestingly, the coefficient of female suggests that, on average, urban women have higher educational attainment than urban men, while rural women have lower educational attainment than rural men. This may be related to the stricter one-child policy in cities. In summary, the coefficients of female and the interaction term reveal that even in cities, women with brothers have fewer educational opportunities, which underscores the persistence of gender discrimination in education. The improvement of women's educational attainment hinges on the reduction of brothers, that is, the absence of gender discrimination in families with only daughters.

We reevaluated the regression results by gender and found that the coefficient on sibling number is significantly negative for the female subsample. This means that compared to women with the same number of siblings and similar circumstances, women with brothers tend to have lower educational attainment. Specifically, a woman with brothers will have approximately half a year less education than a woman without brothers. In contrast, the coefficient on sibling number is negative but smaller for the male sample than for the female sample. This suggests that the impact of "having brothers" on men's educational attainment is smaller than the impact of "having brothers" on women's educational attainment. Moreover, the negative impact of the number of siblings on women's years of education is greater than that of men. The coefficients are $-0.340$ for the female sample and $-0.236$ for the male sample. These results support the hypothesis that gender discrimination exists in Chinese family human capital investment to some extent.

Furthermore, we investigated the impact of "having brothers" on personal attitudes, utilizing two psychological scale questions. We calculated z-scores for the outcome variables and analyzed the data. The first question aimed to assess the importance of having children (sons) to carry on the family name, while the second question focused on the significance of children's success. Both questions were measured on a scale of 1-5, with higher values indicating greater importance.

The regression results, presented in Table 3.3, reveal that women, compared to men, consider it less important to have a son to carry on the family name. Additionally, individuals with brothers also attach less importance to this aspect compared to those without brothers. This may be due to the fact that people with brothers believe that their brothers' children can also inherit their family names, thus diminishing the importance of having a son. Moreover, women with brothers tend to have more traditional views and place greater emphasis on having a son to carry on the family name. This may be connected to the family education they received during their childhood.

The results also show that women with brothers place more importance on their children's success. This may be because women with brothers have more traditional values and emphasize individual contributions to the family.

### 3.4.3 Robustness Checks

**Parents' job-related information** In the CFPS2010 data, the employment information of living parents is surveyed, and we include parents' occupational information as control variables in our

analysis. We display the regression results of Equation 3.1 in Table 3.4, which includes the CFPS's two measures of parents' occupational socioeconomic status: isei and siops. The regression results for the full sample and the rural sample show that the coefficients of the interaction term of gender and "having brothers" are still significantly negative, but the coefficient size has increased from about 0.7 to more than 0.8. However, the coefficient of the interaction term and the coefficient of the number of siblings in the urban subsample are not significant, which may be due to selection error caused by more missing information in urban samples (reduced from 3191 samples to 794).

**Alternative Measure of Education** This section employs an alternative method to assess women's educational attainment by examining whether they have attended college and high school. Since these variables are binary, a logit model is utilized for estimation, controlling for interaction terms between gender and all control variables. The marginal effects over gender are reported in Table 3.5.

Columns 1 and 2 reveal that having a brother decreases the probability of women attending college by approximately 3.5%, while the effect on men is not significant. Additionally, living in a city significantly increases the probability of attending college for both men and women.

Columns 3 and 4 show that having a brother reduces the probability of attending high school for both men and women, with a greater effect on women. Moreover, an increase in the number of siblings also decreases an individual's probability of attending high school. Lastly, urban individuals are more likely to attend high school than rural individuals.

**"Having a Sister" for Male** Our analysis highlights the adverse effects of gender discrimination on women's educational attainment. We have observed that having brothers negatively impacts women's educational attainment, whereas it has no significant effect on men's educational attainment. For instance, Chu et al. (2007) noted that some families in Taiwan prioritize boys over girls, leading to a sacrifice in girls' educational opportunities and even using girls' income to support boys' education. Conversely, having sisters but not brothers positively affects men's educational attainment. The regression results for male educational attainment are presented in Table 3.6, which shows that overall, having sisters increases a man's education level by about half a year, with a more pronounced effect in rural samples.

The findings of the robustness tests suggest that when there is an opportunity for gender discrimination, women's educational attainment is negatively affected, and the initial results in Table 3.2 are reliable. Gender preference is still prevalent in Chinese families' human capital investment, and gender discrimination has a significant negative impact on women's educational attainment. The implementation of the one-child policy has led to an improvement in women's educational attainment, as families have fewer opportunities to discriminate against girls. However, if the limit on the number of children is lifted and families can continue to have children of their preferred gender, women may face reduced access to education due to gender discrimination once again. Therefore, it is crucial to promote gender equality and raise awareness to mitigate the potential decline in rural women's educational level that may result from future adjustments to child policies.

## 3.5 Conclusion

The study examines the impact of having brothers on women's educational attainment, finding that it has a significant negative effect. The results indicate that having brothers reduces the average number of years of education for women by approximately 0.5 years and decreases the probability of women attending college by around 3.5%. Additionally, the study finds that the more brothers and sisters in a family, the greater the negative impact on women's educational attainment. The study also suggests that having brothers tends to be associated with more traditional gender roles and a preference for boys.

The one-child policy has had a profound impact on various aspects of society, and has led to a decrease in the number of children in families and a reduction in the likelihood of girls having brothers. These changes have, in turn, diminished the negative impact of gender discrimination on women's educational attainment, resulting in a significant improvement in women's education levels. The study revealed that the availability of gender discrimination opportunities has a substantial negative effect on women's access to high school and college education.

In conclusion, the study reveals that gender preferences in human capital investment still exist in China, despite the reduction in gender discrimination in education. The one-child policy, which limited family size, inadvertently reduced the dilution of family resources and created a large number of families without boys, thereby increasing women's access to education. However, with the relaxation or elimination of restrictions on family size, families may regain the opportunity to engage in

gender discrimination, potentially reducing their investment in female offspring and favoring male offspring instead. This could harm women's educational opportunities, and therefore, it is essential to promote gender equality in education and protect women's right to education, particularly in the context of adjusting fertility policies.

## 3.6 Tables and Figures

Table 3.1: Summary Statistics

| Variable | Female | | | Male | | |
|---|---|---|---|---|---|---|
| | N | mean | sd | N | mean | sd |
| *Outcome Variable* | | | | | | |
| edu_year | 5551 | 9.069 | 4.207 | 4995 | 9.752 | 3.679 |
| high | 5551 | 0.305 | 0.460 | 4995 | 0.339 | 0.473 |
| college | 5551 | 0.053 | 0.224 | 4995 | 0.053 | 0.225 |
| family_name | 5549 | -0.195 | 1.047 | 4994 | -0.050 | 0.984 |
| child_success | 5549 | 0.002 | 1.002 | 4994 | -0.103 | 1.111 |
| *Control Variable* | | | | | | |
| brother | 5551 | 0.675 | 0.468 | 4995 | 0.465 | 0.499 |
| sibling | 5551 | 1.784 | 1.391 | 4995 | 1.453 | 1.311 |
| urban | 5551 | 0.476 | 0.499 | 4995 | 0.476 | 0.499 |
| minority | 5539 | 0.098 | 0.297 | 4983 | 0.089 | 0.285 |
| f_college | 5176 | 0.012 | 0.109 | 4770 | 0.013 | 0.111 |
| f_high | 5176 | 0.143 | 0.350 | 4770 | 0.141 | 0.348 |
| f_middle | 5176 | 0.294 | 0.456 | 4770 | 0.304 | 0.460 |
| f_primary | 5176 | 0.298 | 0.457 | 4770 | 0.276 | 0.447 |
| m_college | 5247 | 0.004 | 0.060 | 4819 | 0.004 | 0.063 |
| m_high | 5247 | 0.081 | 0.273 | 4819 | 0.082 | 0.274 |
| m_middle | 5247 | 0.200 | 0.400 | 4819 | 0.209 | 0.406 |
| m_primary | 5247 | 0.283 | 0.451 | 4819 | 0.237 | 0.425 |
| f_party | 4553 | 0.128 | 0.334 | 4488 | 0.130 | 0.337 |
| m_party | 4627 | 0.026 | 0.158 | 4519 | 0.025 | 0.155 |
| f_isei | 2834 | 28.917 | 11.563 | 2893 | 29.542 | 12.113 |
| m_isei | 2479 | 26.442 | 9.500 | 2526 | 26.473 | 9.329 |
| f_siops | 2834 | 39.260 | 7.586 | 2893 | 39.14 | 8.162 |
| m_siops | 2479 | 39.553 | 6.166 | 2526 | 39.271 | 6.313 |
| genealogy | 5495 | 0.235 | 0.424 | 4946 | 0.247 | 0.431 |
| worship_ancestors | 5528 | 0.713 | 0.452 | 4973 | 0.714 | 0.452 |

*Notes.* This table presents summary statistics for the CFPS2010 samples, broken down by gender. The table includes means, standard deviations, and the number of observations for each variable. The outcome variables include years of education, having college degree, having high school degree and two psychological scale questions. The control variables include demographic information of observations, as well as the information of parents.

Table 3.2: The Effect of "Having a Brother" on Years of Schooling

| Variable | Full Sample | Urban | Rural | Female | Male |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Female | -0.020 | 0.450*** | -0.528** | | |
| | (0.128) | (0.139) | (0.209) | | |
| Brother | -0.100 | -0.272 | -0.012 | -0.522*** | -0.429*** |
| | (0.125) | (0.171) | (0.161) | (0.130) | (0.135) |
| Female#Brother | -0.765*** | -0.727*** | -0.631*** | | |
| | (0.143) | (0.203) | (0.205) | | |
| Sibling | -0.291*** | -0.366*** | -0.215*** | -0.340*** | -0.236*** |
| | (0.041) | (0.060) | (0.056) | (0.056) | (0.056) |
| Control Variables | Y | Y | Y | Y | Y |
| Province FE | Y | Y | Y | Y | Y |
| Age FE | Y | Y | Y | Y | Y |
| Obs | 7,070 | 3,191 | 3,879 | 3,590 | 3,480 |
| R-squared | 0.421 | 0.353 | 0.316 | 0.484 | 0.369 |

*Notes.* This table shows the effect of "having brothers" on years of education of female using regression in Equation (3.1). The explanatory variable is years of education. Column (1) shows the results for full sample. Columns (2) and (3) represent the results for urban subsample and rural subsample, respectively. Columns (4) and (5) are results for female subsample and male subsample, respectively. All regressions include control variables and control for province and age fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3.3: The Effect of "Having a Brother" on Personal Attitude

| Variable | Having Children (Sons) to Carry on Family Name | Child Being Successful |
|---|---|---|
| | (1) | (2) |
| Female | -0.219*** | 0.020 |
| | (0.035) | (0.041) |
| Brother | -0.082** | 0.010 |
| | (0.035) | (0.039) |
| Female#Brother | 0.153*** | 0.134** |
| | (0.044) | (0.053) |
| Sibling | 0.004 | 0.024** |
| | (0.012) | (0.010) |
| Control Variables | Y | Y |
| Province FE | Y | Y |
| Age FE | Y | Y |
| Obs | 7,067 | 7,067 |
| R-squared | 0.044 | 0.060 |

*Notes.* This table shows the effect of "having brothers" on personal attitudes using regression in Equation (3.1). The explanatory variables are two attitude questions. All regressions include control variables and control for province and age fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3.4: Robustness: Parents' Job

| Variable | Full Sample | | Urban | | Rural | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Female | 0.091 | 0.100 | 0.307 | 0.322 | -0.097 | -0.097 |
| | (0.182) | (0.187) | (0.296) | (0.311) | (0.250) | (0.250) |
| Brother | 0.022 | -0.011 | -0.447 | -0.470 | 0.158 | 0.129 |
| | (0.191) | (0.190) | (0.281) | (0.284) | (0.232) | (0.229) |
| Female#Brother | -0.861*** | -0.873*** | -0.592 | -0.599 | -0.864*** | -0.868*** |
| | (0.223) | (0.228) | (0.407) | (0.427) | (0.285) | (0.287) |
| Sibling | -0.290*** | -0.315*** | -0.123 | -0.171 | -0.305*** | -0.317*** |
| | (0.075) | (0.073) | (0.144) | (0.141) | (0.089) | (0.088) |
| Control Variables | Y | Y | Y | Y | Y | Y |
| Parents Job | ISEI | SIOPS | ISEI | SIOPS | ISEI | SIOPS |
| Province FE | Y | Y | Y | Y | Y | Y |
| Age FE | Y | Y | Y | Y | Y | Y |
| Obs | 2,825 | 2,825 | 794 | 794 | 2,030 | 2,030 |
| R-squared | 0.345 | 0.337 | 0.370 | 0.359 | 0.290 | 0.283 |

*Notes.* This table shows the effect of "having brothers" on years of education of female using regression in Equation (3.1). The explanatory variable is years of education. Column (1) shows the results for full sample. Columns (2) and (3) represent the results for urban subsample and rural subsample, respectively. Columns (4) and (5) are results for female subsample and male subsample, respectively. All regressions include control variables, parents' job related information, and control for province and age fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3.5: Robustness: Alternative Measure of Education - Marginal Effect

| Variable | College | | High School | |
|---|---|---|---|---|
| | Female | Male | Female | Male |
| | (1) | (2) | (3) | (4) |
| Brother | -0.035*** | -0.011 | -0.051*** | -0.039** |
| | (-3.54) | (-1.00) | (-3.75) | (-2.16) |
| Sibling | -0.009** | -0.001 | -0.048*** | -0.018** |
| | (-2.00) | (-0.14) | (-7.73) | (-2.55) |
| City | 0.063*** | 0.050*** | 0.196*** | 0.199*** |
| | (6.12) | (5.01) | (11.01) | (9.03) |
| Province FE | Y | | Y | |
| Age FE | Y | | Y | |
| Obs | 6292 | | 6977 | |
| pseudo R-squared | 0.265 | | 0.296 | |

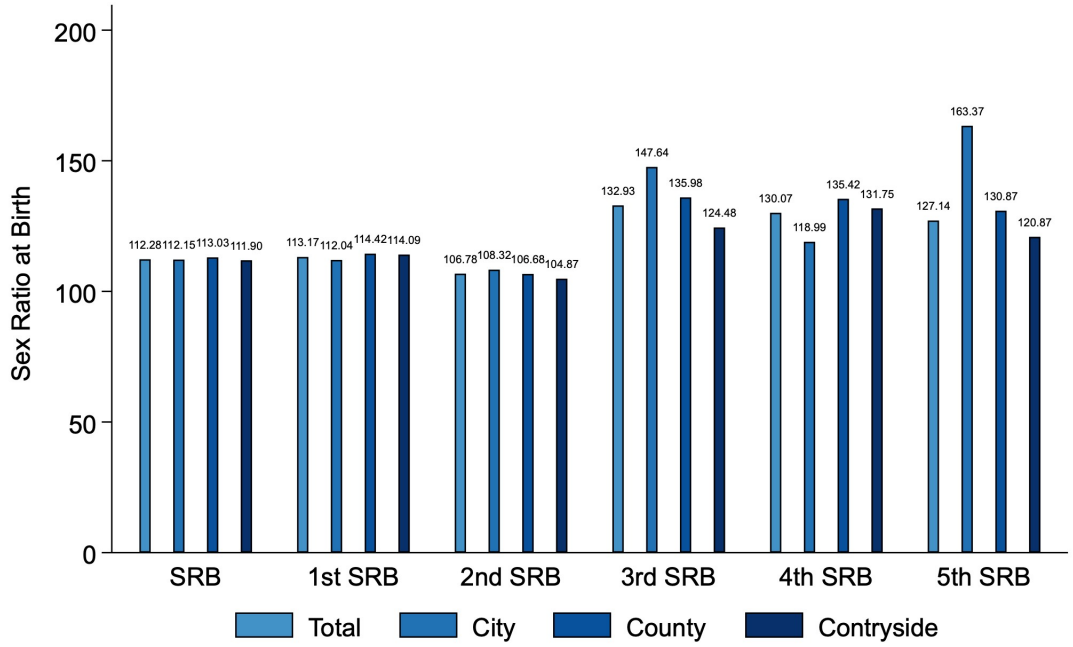
*Notes.* This table shows the effect of "having brothers" on female education attainment using logit regression. The explanatory variables are college dummy and high school dummy. Marginal effects are reported in this table. All regressions include control variables and control for province and age fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3.6: Robustness: the Effect of "Having a Sister" for Male

| Variable | Full Sample | Urban | Rural |
|---|---|---|---|
| | (1) | (2) | (3) |
| Male | 0.244* | -0.173 | 0.697*** |
| | (0.140) | (0.155) | (0.206) |
| Sister | -0.060 | 0.114 | -0.070 |
| | (0.126) | (0.167) | (0.182) |
| Male#Sister | 0.522*** | 0.361 | 0.460* |
| | (0.173) | (0.226) | (0.235) |
| Sibling | -0.390*** | -0.540*** | -0.272*** |
| | (0.049) | (0.074) | (0.066) |
| Control Variables | Y | Y | Y |
| Province FE | Y | Y | Y |
| Age FE | Y | Y | Y |
| Obs | 7,070 | 3,191 | 3,879 |
| R-squared | 0.419 | 0.347 | 0.315 |

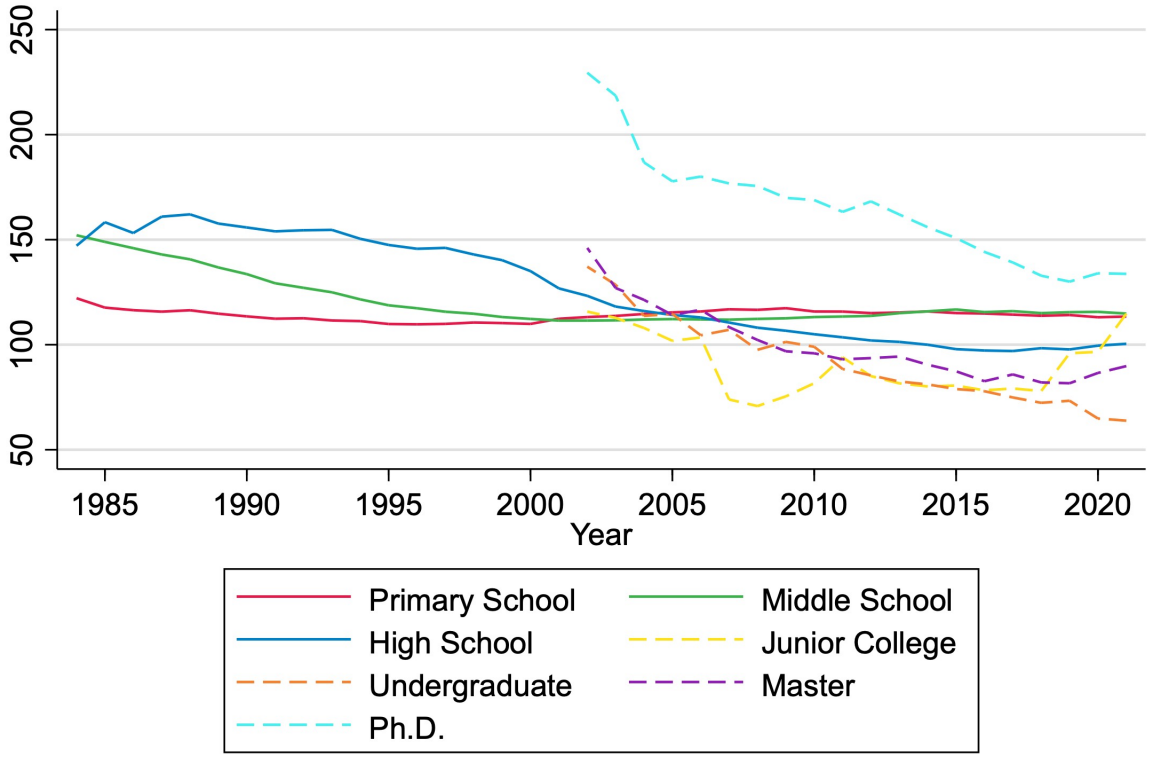
*Notes.* This table shows the effect of "having sisters" on years of education of male using regression in Equation (3.1). The explanatory variable is years of education. Column (1) shows the results for full sample. Columns (2) and (3) represent the results for urban subsample and rural subsample, respectively. All regressions include control variables and control for province and age fixed effects, and robust standard errors are clustered at the county level and are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 3.1: Sex Ratio at Birth in 2020




*Notes.* Data are from China's Seventh National Population Census. This graph shows data on the Sex Ratio at Birth (SRB) for different levels in China, labeled as "Total," "City," "County," and "Countryside." The *y*-axis represents the Sex Ratio at Birth. The *x*-axis has categories for SRB, 1st SRB, 2nd SRB, 3rd SRB, 4th SRB, and 5th SRB. The term "SRB" refers to the national sex ratio at birth. The other categories represent different birth orders, i.e., the sex ratio for the first child, the second child, and so on.

Figure 3.2: Gender Ratio (Male per 100 Female) of Entrants in Each Education Level



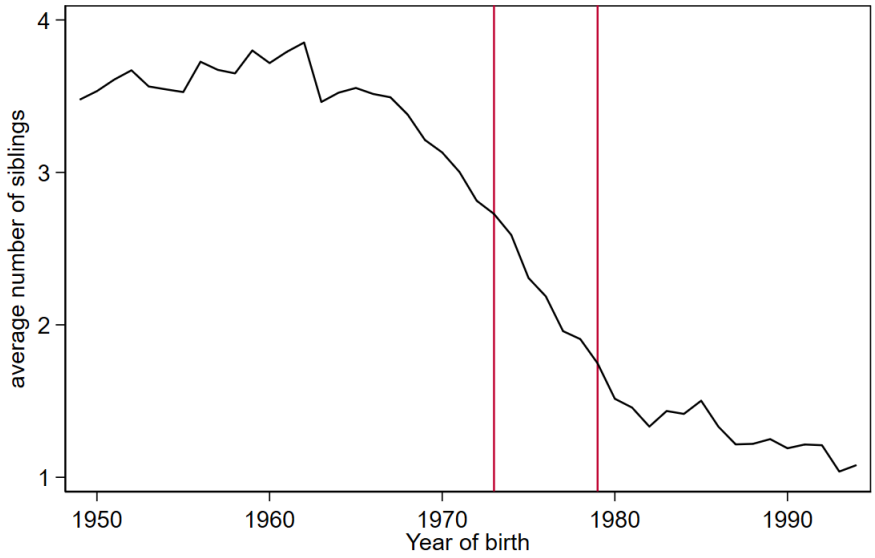

*Notes.* The data in Figure 3.2 are from the China Statistical Yearbooks between 1984 and 2021. Different lines represent the sex ratios of students enrolled at various educational stages in China. Prior to 2001, China did not separate the statistics for undergraduate and associate degree students; therefore, the gender ratios for these groups have been compiled starting from 2002. Additionally, data for graduate and doctoral students were also missing before 2001. To maintain consistency with the undergraduate and associate degree data, the information for graduate and doctoral students is presented only for the years 2002 to 2021.

Figure 3.3: China's Child Policy Timeline

| | |
|---|---|
| July 1973 | Beginning of birth control - "Late, Sparse, Few" |
| June 1979 | One-child policy |
| Apr 1984 | If both parents are only children, they can have two children (One province) |
| Nov 2011 | If both parents are only children, they can have two children (All provinces) |
| Nov 2013 | If one parent is an only child, they can have two children |
| Oct 2015 | Two-child policy (universal) |
| May 2021 | Three-child policy (universal) |

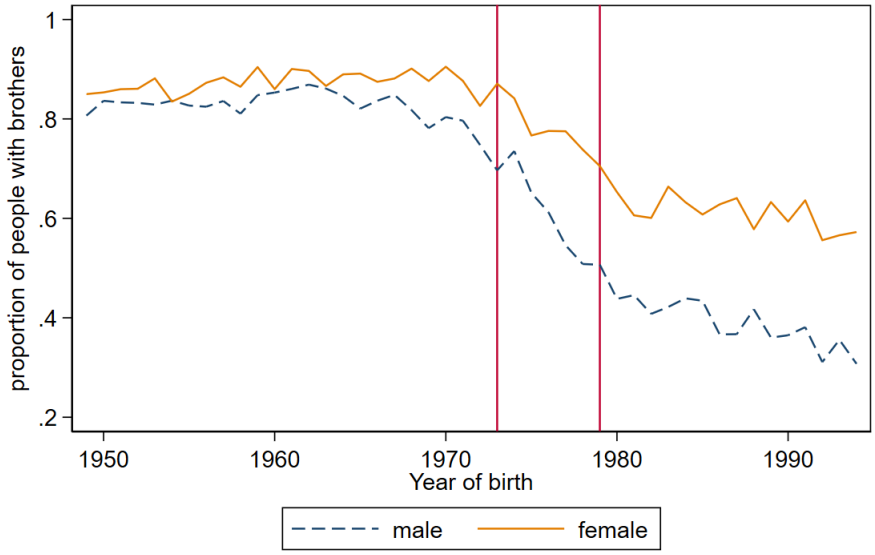
*Notes:* This figure shows the timeline of China's child policy.

Figure 3.4: Average Number of Siblings



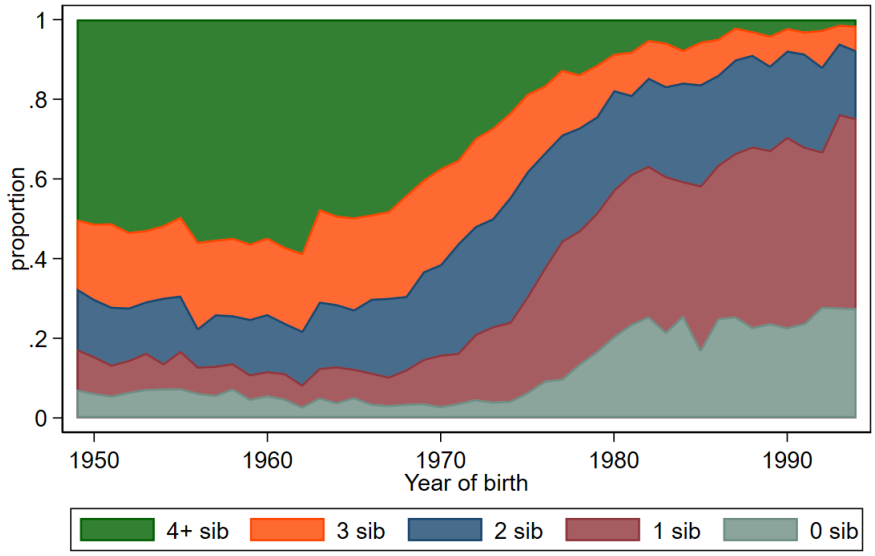

*Notes.* This figure shows the average number of siblings by year of birth for individuals born after 1949. The source of the data is the CFPS 2010 adult questionnaire. The two red vertical lines indicate 1973 and 1979, two important years for population policy.

Figure 3.5: Propotion of People Who Have Brothers (by Year of Birth)




*Notes.* This figure shows the proportion of people having brothers by year of birth for individuals born after 1949. The source of the data is the CFPS 2010 adult questionnaire. The two red vertical lines indicate 1973 and 1979, two important years for population policy.

Figure 3.6: Proportion of Number of Siblings (by Year of Birth)




*Notes.* This figure shows the proportion of people with different numbers of siblings by year of birth for individuals born after 1949. The source of the data is the CFPS 2010 adult questionnaire.

# References


Lucille Aba Abruquah, Xiuxia Yin, and Ya Ding. Old age support in urban china: the role of pension schemes, self-support ability and intergenerational assistance. *International journal of environmental research and public health*, 16(11):1918, 2019.

Anne Anastasi. Intelligence and family size. *Psychological Bulletin*, 53(3):187, 1956.

Joshua Angrist, Victor Lavy, and Analia Schlosser. Multiple experiments for the causal link between the quantity and quality of children. *Journal of Labor Economics*, 28(4):773–824, Oct 2010.

Natalie Bau. Can policy change culture? government pension plans and traditional kinship practices. *American Economic Review*, 111(6):1880–1917, 2021.

Gary S Becker and H Gregg Lewis. On the interaction between the quantity and quality of children. *Journal of political Economy*, 81(2, Part 2):S279–S288, 1973.

Judith Blake. Family size and the quality of children. *Demography*, 18(4):421–442, 1981.

Shiyu Bo, Jing Liu, Ji-Liang Shiu, Yan Song, and Sen Zhou. Admission mechanisms and the mismatch between colleges and students: Evidence from a large administrative dataset from china. *Economics of Education Review*, 68:27–37, 2019.

Kristin F Butcher and Anne Case. The effect of sibling sex composition on women's education and earnings. *The Quarterly Journal of Economics*, 109(3):531–563, 1994.

Yong Cai and Yuan Cheng. Pension reform in china: Challenges and opportunities. *China's Economy: A Collection of Surveys*, pages 45–62, 2015.

John C Caldwell and Pat Caldwell. The cultural context of high fertility in sub-saharan africa. *Population and development review*, pages 409–437, 1987.

Sebastian Calonico, Matias D Cattaneo, and Max H Farrell. Optimal bandwidth choice for robust bias-corrected inference in regression discontinuity designs. *The Econometrics Journal*, 23(2): 192–210, 2020.

CY Cyrus Chu, Yu Xie, and Ruoh-rong Yu. Effects of sibship structure revisited: Evidence from intrafamily resource transfer in taiwan. *Sociology of education*, 80(2):91–113, 2007.

Irineu Evangelista de Carvalho Filho. Household income as a determinant of child labor and school enrollment in brazil: Evidence from a social security reform. *Economic Development and Cultural Change*, 60(2):399–435, 2012.

Douglas B Downey. When bigger is not better: Family size, parental resources, and children's educational performance. *American sociological review*, pages 746–761, 1995.

Eric V Edmonds. Child labor and schooling responses to anticipated income in south africa. *Journal of development Economics*, 81(2):386–414, 2006.

Hanming Fang and Jin Feng. The chinese pension system. Technical report, National Bureau of Economic Research, 2018.

Jin Feng, Lixin He, and Hiroshi Sato. Public pension and household saving: Evidence from urban china. *Journal of Comparative Economics*, 39(4):470–485, 2011.

Ashish Garg and Jonathan Morduch. Sibling rivalry and the gender gap: Evidence from child health outcomes in ghana. *Journal of population economics*, 11:471–493, 1998.

Susan Greenhalgh. Sexual stratification: The other side of" growth with equity" in east asia. *Population and development review*, pages 265–314, 1985.

Robert M Hauser and Hsiang-Hui Daphne Kuo. Does the gender composition of sibships affect women's educational attainment? *Journal of Human Resources*, pages 644–657, 1998.

Hui He, Lei Ning, and Dongming Zhu. *The impact of rapid aging and pension reform on savings and the labor supply*. International Monetary Fund, 2019.

Tabea Herrmann, Attakrit Leckcivilize, and Juliane Zenker. The impact of cash transfers on child outcomes in rural thailand: Evidence from a social pension reform. *The Journal of the Economics of Ageing*, 19:100311, 2021.

Ayşe İmrohoroğlu and Kai Zhao. Intergenerational transfers and china's social security reform. *The Journal of the Economics of Ageing*, 11:62–70, 2018.

Ruixue Jia and Hongbin Li. Just above the exam cutoff score: Elite college admission and wages in china. *Journal of Public Economics*, 196:104371, 2021.

Ruixue Jia and Torsten Persson. Choosing ethnicity: The interplay between individual and social motives. *Journal of the European Economic Association*, 19(2):1203–1248, 2021.

Robert Kaestner. Are brothers really better? sibling sex composition and educational achievement revisited, 1996.

Marko Köthenbürger and Panu Poutvaara. Social security reform and investment in education: Is there scope for a pareto improvement? *Economica*, 73(290):299–319, 2006.

Ming-Hsuan Lee. The one-child policy and gender equality in education in china: Evidence from household data. *Journal of family and economic issues*, 33:41–52, 2012.

Xiaoyan Lei, Yan Shen, James P Smith, and Guangsu Zhou. Sibling gender composition's effect on education: evidence from china. *Journal of population economics*, 30:569–590, 2017.

Hongbin Li, Junsen Zhang, and Yi Zhu. The quantity-quality trade-off of children in a developing country: Identification using chinese twins. *Demography*, 45(1):223–243, 2008.

Peter H Lindert. Sibling position and achievement. *Journal of Human Resources*, pages 198–219, 1977.

Haoming Liu. The quality–quantity trade-off: evidence from the relaxation of china's one-child policy. *Journal of Population Economics*, 27:565–602, 2014.

Yao Lu and Donald J Treiman. The effect of sibship size on educational attainment in china: Period variations. *American sociological review*, 73(5):813–834, 2008.

Sebastian Martinez. Pensions, poverty and household investments in bolivia. *Department of Economics, University of California at Berkeley*, 2004.

Justin McCrary. Manipulation of the running variable in the regression discontinuity design: A density test. *Journal of econometrics*, 142(2):698–714, 2008.

Ren Mu and Yang Du. Pension coverage for parents and educational investment in children: Evidence from urban china. *The World Bank Economic Review*, 31(2):483–503, 2017.

William L Parish and Robert J Willis. Daughters, education, and family budgets taiwan experiences. *Journal of Human Resources*, pages 863–898, 1993.

Vladimir Ponczek. Income and bargaining effects on education and health in brazil. *Journal of Development Economics*, 94(2):242–253, 2011.

Brian Powell and Lala Carr Steelman. The liability of having brothers: Paying for college and the sex composition of the family. *Sociology of Education*, pages 134–147, 1989.

Brian Powell and Lala Carr Steelman. Beyond sibship size: Sibling density, sex composition, and educational outcomes. *Social Forces*, 69(1):181–206, 1990.

Xiaoyue Shan and Albert Park. Access to pensions, old-age support, and child investment in china. *Journal of Human Resources*, 2023.

Lala Carr Steelman, Brian Powell, Regina Werum, and Scott Carter. Reconsidering the effects of sibling configuration: Recent advances and challenges. *Annual review of sociology*, 28(1): 243–269, 2002.

Ming Tsui and Lynne Rich. The only child and educational opportunity for girls in urban china. *Gender & Society*, 16(1):74–92, 2002.

Binzhen Wu and Xiaohan Zhong. Matching mechanisms and matching quality: Evidence from a top university in china. *Games and Economic Behavior*, 84:196–215, 2014.

Xiaogang Wu. Higher education, elite formation and social stratification in contemporary china: Preliminary findings from the beijing college students panel survey. *Chinese Journal of Sociology*, 3(1):3–31, 2017.

Jing You and Miguel Niño-Zarazúa. The intergenerational impact of china's new rural pension scheme. *Population and Development Review*, pages 47–95, 2019.

Cheng Yuan, Chengjian Li, and Lauren A Johnston. The intergenerational education spillovers of pension reform in china. *Journal of Population Economics*, 31:671–701, 2018.