The Intergenerational Effects of Economic Sanctions*

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Abstract

Economic sanctions have become the defining foreign policy tool of the 21st century. While sanctions are successful in achieving political goals, can hurt the civilian population. A large literature has documented the negative welfare effects of sanctions on current generations, but these effects could be even more detrimental and long-lasting for future generations. This paper quantifies the effects of the United Nations Security Council sanctions imposed on Iran in 2006 on investment in children's education. Exploiting variation in the strength of sanctions across industries and using unique survey data with detailed information on children's education and living circumstance, I obtain two main findings. First, the sanctions decreased children's total years of schooling by 0.1 years and the probability of attending college by 4.8 percentage points. This effect is larger for children at crucial ages and children from low-wealth families. Second, households reduced expenditure on children's education by 58% - particularly on expenditure for school tuition. This finding indicates households respond to the sanctions by substituting away from higher-quality private schools towards lower-quality public schools for their children. This negative effect on education expenditure is larger for children from middle-wealth families. The sanctions impact on children's education is larger than implied by the income elasticity estimates from the previous literature likely because sanctions have persistent effects on parent income. Taken together the results imply that sanctions have a larger effect on permanent income of children than their parents. Therefore, ignoring the effects of sanctions on future generations significantly understates their total economic costs.

Keywords: Education; Parental investment; Economic sanctions; Intergenerational effects.
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1 Introduction

Economic sanctions have become the defining foreign policy tool of the 21st century, sometimes as a prelude to warfare, and sometimes as an alternative to it.[1] While humanitarian impacts often feature prominently in the debate about economic sanctions, traditional estimates of the effects of sanctions have mainly focused on the effectiveness of sanctions in achieving political objectives (Ahn and Ludema (2019); Draca et al. (2019); Hufbauer et al. (2010)). More recent literature has investigated the adverse consequences of sanctions on the civilian population while sanctions are in place (Petrescu (2016)). However, as the effects of sanctions may last beyond the lifting of sanctions, effects on current generation may not fully capture the negative impacts of sanctions. In particular, if sanctions reduce the educational attainment of young people, the effects of sanctions may last long after they are lifted. As early human capital investment is hard to substitute with the investment in later life (Heckman (2011)), sanctions could put children at a disadvantage for the rest of their lives. Moreover, human capital is an important factor in productivity growth and economic development. These negative externalities caused by disinvestment in human capital are not documented in the current literature of adverse consequences of economic sanctions. In this paper, I study important negative externalities of economic sanctions, in particular I evaluate how targeted sanctions affect investment in children's education by using Iranian data.

The theoretical effect of sanctions on children's education is ambiguous. Sanctions significantly reduced household income, which is the major source of education funding in Iran.[2] How income matters for children's education is a hotly debated issue. On the one hand, a rich theoretical literature following Becker and Tomes (1986) argues that parental resources may affect educational decisions through budget and credit constraints because education is a consumption good, not only an investment. On the other hand, another influential literature following Cameron and Heckman (2001) argues that parental investment in children's human capital needs not be related to parental income. One possible reason for this disagreement is that temporary and persistent, small and large changes in household income may have different effects on children's education. Households are more likely to reoptimize the consumption in response to large and persistent shocks. Therefore, a large and persistent reduction in household income would be expected to affect children's education, whereas a small and temporary reduction in household income will not necessarily affect children's education. As Browning and Crossley (2009) suggests, households who are temporarily constrained

[1] Economic sanctions are trade and financial restrictions imposed against a targeted country by one or more countries. Sanctions are designed to pressure the targeted countries to change offending policies, and/or to weaken the ability of them to govern (Askari et al. (2001)). For the first time, the United Nations (UN) applied multistate sanctions to Southern Rhodesia in 1991. Since that date, the Security Council has established 25 sanctions regimes, in South Africa, the former Yugoslavia, Haiti, Al-Qaida and the Taliban, Iraq, Iran, etc. Today, there are 14 ongoing sanctions regimes which focus on supporting the political settlement of conflicts, nuclear non-proliferation, and counter-terrorism.

[2] Household expenditure on education as a percentage of GDP is 5% and government expenditure on education is 4% of GDP in 2006. Moreover, like most Middle Eastern countries, a large share of Iranian government spending on education is allocated to post-secondary education in large urban areas. The main reason for this allocation is that governments are very sensitive to demands of the urban middle class, and college education is very important for this group (Richards and Waterbury (1996)).

(if they are unable to smooth through borrowing) will cut back more on goods that exhibit high intertemporal substitution, e.g., luxuries because the utility cost of fluctuations would be lower. Thus, parents can invest in their children's education by reducing other expenditures, selling assets, or raising their own working effort. However, a persistent reduction in household income hampers their ability to consumption smoothing, especially when the shock increased uncertainty about future income (Stephens Jr (2001)). Moreover, the same shock can have different effects on households consumption depend on households' characteristics including budget constraints, adjustment costs, and their preferences.[3] Even when parental spending on children's education reduces, much of which may be offset by financial aid, e.g. college loans. Economic sanctions may also affect children's education through changes in government spending. While direct benefits of public spending on education are widely agreed upon, the effect of sanctions on public spending is unclear. Economic sanctions target government revenues by imposing trade and financial restrictions. However, the effect of a government revenue shock on sub-categories of government expenditures (e.g., expenditure on education) is not clear and depends on fiscal and political institutions.

The key empirical challenge of measuring the effects of sanctions on children's education is one of identification. Sanctions that are not confounded with other factors, that also affected children's education, are difficult to come by. Farjo (2011) finds a reduction in primary school enrollment during 1990-2003 when the UN imposed economic sanctions on Iraq. However, its causal implications are limited because this study does not distinguish the effects of sanctions from the effects of several other relevant factors such as war and political instability.[4] Credible estimates of sanction effects on children's education require a solution to the identification problem. The second challenge is a dearth of reliable data. In most cases, the presence of conflicts poses a substantial obstacle to the collection of survey data especially on the displaced populations and people in conflict areas (Barakat et al. (2002)). Even if data are collected, their accuracy is an open question.

In this paper, I investigate the effects of the 2006 UN sanctions against Iran to identify the impacts of sanction on children's education. For estimation of the sanction effects on children's education, the Iranian setting is well suited for two reasons. First, other factors which affect children's education (e.g., political stability) arguably remain unchanged after the sanctions (Borszik (2016)). Second, there are rich data, Iranian Household Income and Expenditure Survey (HIES), that roughly span the four decades from the 1980s to 2010s (before, during, and after the sanctions). These

[3] On average, changes in household income or liquidity cause significant changes in household spending among households with low liquid wealth or low income, even when the shock is predictable (Johnson et al. (2006); Stephens Jr (2008); Jappelli and Pistaferri (2014)). Moreover, adjustment costs vary across households depends on their consumption commitments. For example, an adjustment is more costly for homeowners who have to pay the mortgage, especially in the short run. Consumption of many other durable goods (vehicles, furniture) and services (insurance, utilities) may also be difficult to adjust (Chetty and Szeidl (2007)).

[4] Although there are a few studies which analyze the education trends during the years of sanctions, there is a growing literature on the effect of armed conflict on schooling. The results of these studies cannot be generalized to the sanctions cases. Besides that the overall evidence is mixed (depending on the context of conflict and intensity of recruitment during warfare), channels through which education might have been affected are different. Children's education usually decreases during the war because of child soldiering, forced migration and displacement, household labor allocation decisions, security shock, changes in returns to education, and changes in quality and availability of school facilities (Verwimp and Van Bavel (2013), Justino (2011)).

surveys collected detail information on the children's years of schooling and their family income and expenditure including spending on education.

On 23 December 2006, the UN Security Council passed Resolution 1737 and imposed economic sanctions after Iran declined to suspend its uranium enrichment program. The UN sanctions include trade and financial restrictions. Trade restrictions targeted specific firms and individuals including oil and gas production and shipping companies, nuclear research and production companies, and military and security services companies owned or controlled or performing on behalf of the Islamic Revolutionary Guard Corps (IRGC) and Setad Ejraie Foundation. Theses sanctions mostly targeted investments in and export of oil and gas. Financial restrictions include any transactions with the Central Bank of Iran, disconnecting Iranian bank from the SWIFT, and freezing assets of specific firms and individuals. A consequence, crude oil exports declined to less than one million barrels per day and the growth rate reached -6% in 2012. The targeted sanctions were associated with large, sudden reductions in households' income and consumption. As Figure 1 shows, very shortly after the implementation of the sanctions, the average real income of Iranian households decreased and the decreasing trend lasted for seven years. During 2007-2013, households' real income on average decreased by 35%. As a result, households cut their spending on education by 43%. The reduction in education spending reflects both young children not attending school and parents cutting back on school expenditures.

My identification strategy uses variation in the impact of sanctions on labor income across industries. The empirical strategy to evaluate this shock relies on the synthetic control method (SCM) (Abadie and Gardeazabal (2003) , Abadie et al. (2010)). I define households in which the head works in the oil and gas industry and energy supply as the treated group because these households experienced large reduction in their labor earning by the sanctions. Oil and gas industry is directly affected by the sanctions and energy supply industry is highly dependent on exports of the Oil and gas industry. I use household level data from other industries to construct a synthetic control group which matches households in the oil and gas industry and energy supply for a 12-year period before the sanctions was implemented. The synthetic control group includes information, education, and health industries with weights 0.148, 0.169, and 0.683 respectively. There are little income changes for households in these industries, as they are heavily regulated by the government. Therefore, the sanctions have little effects on wages and employment levels of these sectors. Moreover, these industries are not dependent on trade, thus making them unaffected by the changes in the exchange rate. I also use SCM at the industry-sector level because the effects of the sanctions are different across the public and private sectors.

My analysis reveals two main findings. First, sanctions decreased the years of schooling significantly by 0.1 years (0.3 years among children ages 15-24 years) and probability of attending a four-year college by 4.8 percentage points. This effect on children's education is more than two times larger than previous estimates of the effect of family income on attending college (e.g., Acemoglu and Pischke (2001); Blanden and Gregg (2004); Hilger (2016)) likely because of the persistent shock

and lack of adjustment possibilities.[5] I also find this effect is larger for children at crucial ages (high school dropout age and matriculation at a university). In particular, the economic sanctions decreased the probability of attending college at age 18 (the average age of matriculation) by 15.4 percentage points and decreased the enrollment rate at the high school by 4.3 percentage points among children at high school dropout age (16 years old). I consider a simple back of the envelope calculation to understand the economic significance of these results. My calculation shows if these children were able to enroll in college at the same rate as college enrollment in the year 2006 and have the wage rates of the year 2006, their lifetime earnings would increase by 41%. I also find that 45% of the costs to the society associated with the reduction in earnings comes from decreased earning for the current workers, and 55% comes from decreased earning for the next generation. It suggests that the cost estimates using only earnings of current generation may only capture less than half of the overall cost.

Second, I examine the effects of the sanctions on investment in children's education by looking at household spending on education. I find that after the sanctions, households reduced expenditure on education by 58% - particularly on expenditure for school tuition. This finding indicates households respond to the reduction in income by switching their children from higher-quality, more expensive private schools to lower-quality, free public schools.[6] This negative effect on education expenditure is larger than implied by the income elasticity estimates from the previous literature (Acar et al. (2016); Huy (2012); Qian and Smyth (2011)). Most of these studies find that the income elasticity of education spending is significantly less than one.[7] I find an income elasticity of 3.3, indicating households allocate a smaller share of their budgets to education spending after the sanctions.

Overall, after the sanctions, both educational attainment and investment in education measured by family education spending have decreased. This reduction in children's education will reduce their future earnings (by 41%) such that affected children will experience a larger decline in their earnings than their parents. Although the effects of sanctions depend on the context and severity of the sanctions and how government and households cope with this shock, establishing this potential negative shock to human development can edify future policy regarding the use of the economic sanctions.

This paper also contributes to the literature on the effect of family income on children's education in several ways. First, my analysis adds to recent quasi-experimental literature that exploits income shocks by estimating the effect of a persistent income shock caused by the 2006 UN sanctions and lasted seven years (2007-2013). As explained before, persistent changes in family income could have different effects on children than do temporary changes. Most of previous studies exploits temporary

[5] Acemoglu and Pischke (2001) find a 10% decrease in family income is predicted to decrease college enrollment by 1-1.4 percentage point. Other studies find even smaller effects, for example, Hilger (2016) finds a father's layoff reduces children's college enrollment by less than half of one percentage point, despite dramatically reducing current and future parental income (by 14% initially and 9% after 5 years). He explains that much of reduction in parental spending on education may be offset by greater financial aid.

[6] In contrast, expenditures on consumption goods, health, savings, etc did not decrease as much as the expenditure on education.

[7] Previous studies find that even for those group of household that education spending is a luxury good, income elasticity is less than 2.

income shocks generated by, for example, lotteries, cash transfer, tax credit, housing prices, and oil revenue (Bleakley and Ferrie (2016); Bulman et al. (2016); Dahl and Lochner (2012); Duryea et al. (2007); Løken et al. (2012); Lovenheim (2011); Lovenheim and Reynolds (2013); Manoli and Turner (2018)). The estimated results vary widely (from more than one percentage point per $1,000 to less than one percentage point per $100,000) likely because the research designs (the affected populations, the size, and timing of changes) are different (Bulman et al. (2016)). Despite these differences, all of these papers look at the case in which the exogenous shock in family income is temporary and find small effects compared to my results. Even when the shock is large e.g. lotteries, as Bulman et al. (2016) and Manoli and Turner (2018) show, households usually spend lump-sum transfers on durable goods e.g. housing. Therefore, these shocks have small effects on children's education. In the case of parental job loss that the shock has a long-run effect on family income, in developed countries much of reduction in parental resources is offset by greater financial aid e.g college loans (Coelli (2011); Hilger (2016); Pan and Ost (2014)). There are a few studies examine the effect of parental job loss on children schooling in cases that other financial resources are not available to children. Skoufias and Parker (2006) and Duryea et al. (2007) find no effect and positive effect on children schooling during economic crises in Mexico and Brazil, respectively. During recessions, the opportunity cost of education decreases. Moreover, people anticipate economic recovery sooner or later. Thus, recessions may have a positive effect on children's education. Di Maio and Nisticò (2016) show parental loss job caused by a conflict in the Occupied Palestinian Territories increases child school dropout. My study complements these papers by studying a case in which the income shock is persistent and the exception is different because people could not predict whether sanctions would be lifted or not.

Second, I add to the distributional debate about the burden of family income effects. Unlike the existing studies, I estimate differential effects on education investment for households with low, average, and high level of financial resources. As explained before, households respond to an income shock could vary across different income quantiles.[8] The results of existing studies that exploit persistent income shocks are limited to a specific population. For example, Akee et al. (2010) and Bastian and Michelmore (2018) evaluate persistent income changes generated by a casino revenue and tax credits policy respectively. They find larger effects compared to the above studies (1.3 and 4.3 percent increases the likelihood of high school and college completion per $1,000). Different responses of households to a persistent versus a temporary income shock could explain these larger effects. The results of these studies are limited to the population of low-income households.[9] Thus, there was no change for middle and high income households. Contrary, the sanctions affect treated households at any level of income. Therefore, I can estimate the effects for high income households as well as low income households. Moreover, these studies look at positive shocks in the family

[8]For example, as many studies show, lower income families have a higher income elasticity of education expenditure whereas the higher income families have a lower income elasticity of education.

[9]The casino revenue studied in Akee et al. (2010) is distributed to all Indian households regardless of their characteristics. However, American Indians are a particular group with a low level of income and a high rate of poverty. EITC studied in Bastian and Michelmore (2018) is an antipoverty program that focuses on families whose incomes lie between 75% and 150% of the poverty line.

income. Household responses to upward versus downward shocks could be asymmetric. My paper complements this literature by studying the effects of a negative persistence shock in the family income. By comparing the effects for heterogeneous groups of households, I find that the effect of sanctions on income of low and middle-income household is larger (24% and 20%, respectively) and significantly different from the average effect (15%).[10] I also find the negative effects on schooling outcomes are larger for children from low and middle-wealth families. In particular, only children from the lowest wealth quantile experienced a reduction in the years of schooling. Also, sanctions decreased investment in education most for children from the middle-wealth households.[11]

This paper proceeds as follows. In section 2, I provides the institutional setting. In section 3, I discuss mechanisms behind the impacts of the 2006 UN economic sanction on children's education and outline a simple model of investment in schooling. In section 4, I describe the data and present the identification strategy. In section 5, I present the main empirical results on the impacts of the 2006 UN economic sanction on family income and children's education. Section 6 reports some robustness checks. Section 7 explores heterogeneous effects. Section 8 concludes the paper.

2 Institutional Setting

2.1 The 2006 UN Sanctions

On 23 December 2006, after Iran declined to suspend its program for uranium enrichment, the UN Security Council passed Resolution 1737 and imposed economic sanctions against Iran. While Iran's programs to enrich uranium were stopped in 2002, they restarted in late 2005. In July 2006, the UN Security Council in Resolution 1696 had expressed concern at the intentions of Iran's nuclear program and asked Iran to stop its uranium enrichment program by August 31. Although, Iran did not comply with the requirements of the Security Council and the International Atomic Energy Agency (IAEA), the Council did not show any action after the ultimatum, because Iran warned it would break off all talks over nuclear program if any sanctions were imposed. Unexpectedly, in December 2006, the Council imposed trade and financial sanctions on Iran targeting the oil and gas industry (by imposing restrictions on investments in oil and gas productions, and exports of refined petroleum products) and the Iranian Revolutionary Guard Corps (IRGC) and Setad Ejraie Foundation (by banning any business dealings with them). Trade restrictions targeted specific firms and individuals including oil and gas production and shipping companies, nuclear research and production companies, and military and security services companies owned or controlled or acting on behalf of the IRGC and Setad. Financial restrictions encompass banking and insurance transactions (including any transactions with the Central Bank of Iran, disconnecting Iranian bank from the SWIFT, and freezing assets of specific firms and individuals). The 2006 sanctions were effective to pressure Iran to negotiate on its nuclear program. In 2013, Iran accepted negotiation for a framework deal with permanent members of the UN Security Council (China, France, Russia, the

[10] sanctions has no significant effect on income of household who are rank above the 90th percentile.

[11] These effects are not significant for children from high-wealth families.

United Kingdom, and the United States) and Germany (P5+1). On 2 April 2015, they finalized an agreement (Joint Comprehensive Plan of Action (JCPOA)) known as the Iran deal. Thus, the UN Security Council, the European Union, and the United States have terminated all nuclear-related resolutions and sanctions in January 2016.[12] However, the United States withdrew from the deal in May 2018 and reimposed the sanctions in November 2018.

The 2006 sanctions are the most severe sanctions ever put on Iran because most countries including the European Union stopped buying oil from Iran. Moreover, the United States has introduced sanctions for punishing other countries that buy oil from Iran. Furthermore, since sanctions limited access to many products and technologies needed in the oil and energy industries, many oil companies withdrew from Iran oil industry and Iran's oil production decreased. Therefore, Iran lost $160 billion oil revenue. In addition, more than $100 billion in Iranian assets was held in restricted accounts outside the country. As a result, Iran's economy got 15-20% smaller than it would have been absent the sanctions (U.S. Treasury Secretary Jacob Lew report, 2015). Since Iran's economy depends heavily on oil exports and goods imports, economic activity declined which led to a two-year recession. The growth rate has reached an all-time low of -6% in 2012. Meanwhile, the value of the Rial (the currency of Iran) declined by 56%, and inflation reached 35%. As Figure 1 shows, very shortly after the implementation of the sanctions, the average real income of Iranian households have decreased. During 2007-2013, households' real income on average decreased by 35%. As a result, households cut their total expenditure and spending on some classes of goods. Households' spending on education showed the highest drop of -43%.

2.2 Educational Trends in Iran

Although Iran's economy has faced many challenges during 1995-2006, the years before the sanctions were instituted, educational attainment and household spending on children's education have never stopped growing.[13]

Educational attainment in Iran has improved substantially in the past four decades. Education has expanded in MENA faster than in any other region of the world (World Bank). Some countries such as Iran, Turkey, Egypt, and Jordan experienced more growth in education. In Iran, enrollment rates exceed 90% at the primary and secondary levels, comparable to that of Western countries. Thus, the youth literacy rate has increased from 56% in 1976 to 97% in 2006 (World Bank).[14]

[12] United Nations Security Council Resolution 2231, passed on 20 July 2015, suspends UN sanctions and sets out a schedule for lifting them gradually. This resolution also considers reimposing the sanctions in case of Iran's failure to comply with the framework agreement. Resolution 1737 was terminated on the day of implementation of the Joint Comprehensive Plan of Action (JCPOA), 16 January 2016, by Resolution 2231 of the United Nations Security Council.

[13] Over these years, Iran's economy has been under various economic sanctions. The first economic sanctions on Iran were imposed by the United States following the Iranian Revolution of 1979. US sanctions were gradually expanded to the present level with a total embargo on all bilateral trade and investment. The studies show US sanctions' economic and political effects have been insignificant (Alikhani (2000); Askari et al. (2001)). According to Hufbauer et al. (2012), the average welfare loss caused by US sanctions on Iran over the period 1984-2005 was around $80 million, less than 1% of Iranian GDP over that period.

[14] The youth literacy rate is the percentage of people ages 15 to 24 who can read, write, and understand a short simple statement about their everyday life.

The rapid growth in the education sector is supported by both private and public spending. The average private and public investment in education as a percentage of GDP is 5% and 4% in 2006, respectively. Over the past three decades, because of increases in youth population and demand for education, the Iranian government has shown a strong commitment to funding public education and promoting access to fee free public schools at all level of education.[15] However, like most Middle Eastern countries, a large share of Iranian government spending on education is allocated to post-secondary education in large urban areas.[16] Thus, public universities are of high quality and free-tuition, but the number of places at public universities is limited. A highly competitive university entrance examination rations these free-tuition places at public universities.[17] The competition to succeed in school and the public universities entrance examination have encouraged parents to spend on their children's education such as sending on private schools and private tutoring to help their children in this competition (Salehi-Isfahani (2012)).[18] As Figure 1 shows, Iranian households' spending on education, which is the major source of education funding in Iran, has increased by 67% during 1995-2006. Spending on primary and secondary schools tuition is a significant share of total household expenditure on education in Iran. Many of the best overall primary and secondary schools in Iran are privately funded. Parents believe that private primary and secondary schools offer a better education, an environment more conducive to learning, additional resources, and better policies and practices. Indeed, results from value added to cognitive achievement show that private school students averaged higher than their public school counterparts. Moreover, children who attend private schools perform better in school final exams and the public universities entrance examination and have better academic outcomes than those in public schools (Dolatabadi (1997); Rabiei and Salehi (2006)).

Evidence of how the 2006 sanctions affected children's education can be found in the time series trends. While the enrollment rates did not change for primary and secondary education, the enrollment rate in the undergraduate program dropped after the sanction. Over 2007-2013, the enrollment rates in primary and secondary school were always around 97% and 89% respectively. At the same time, the number of first-year students in four-year college decreased by 11.5% (source: Statistics Centre of Iran).

Moreover, over the years of sanctions, the investment in children's education measured by household spending on education has decreased. Households' spending on education on average decreased by 43%. This reduction in households' education spending could be because young children do not attend school and/or parents cut spending on school expenditures, for instance, choosing free public school instead of private school. The data shows although the enrollment rates did not change for

[15] Based on the article 30 of the Constitution of the I.R. of Iran, "the government is obliged to provide free of charge education for all individuals up to the end of the secondary level of education and to facilitate free higher education up to achieving self-sufficiency" (Source: UNESCO, the World Education Forum report for Iran (2015)).

[16] Tertiary education was nearly all public until the 1980s. In 2006 about half of all university students were enrolled in public universities.

[17] Only 10% of students who take the university entrance exam, win that scholarship.

[18] For instance, in HIES, 58% of pre-university students receive private tutoring to increase their probability of success at the university entrance examination. Such tutoring spending is a significant item in households' education expenditure (52%).

primary and secondary, the proportion of primary and secondary students who were enrolled in private schools decreased from 21% in 2006 to 10% in 2013 (source: Iranian Households Income and Expenditures Surveys).

3 Conceptual Framework

In this section, I explore the mechanisms by which economic sanctions may decrease investment in children's education and then I outline a simple model of investment in schooling based on Acemoglu and Pischke (2001).

3.1 Mechanisms behind Sanctions

The sanctions affect children education through changes in demand side (labor income and relative prices) and supply side of schooling (government budget).

One mechanism by which the sanctions affect children education is through labor income. As explained before, the sanctions targeted Iran's oil and gas industry. Therefore, the growth rate in this industry has reached an all-time low of -37% in 2012.[19] As a result, labor earnings decreased in this industry. The changes in labor income may affect investment in children's education through two channels: family budget constraint and changes in returns to education.

First, labor income shocks may affect children's education through family budget constraint. In influential work, Acemoglu and Pischke (2001) provide theoretical and empirical support for the idea that parental resources can affect education decisions through budget and credit constraints because education is not a pure investment and can be a consumption good too. Since children are dependent on others, their family's economic circumstances make them enter or avoid poverty. Children cannot change their family conditions, at least until they reach adulthood (Brooks-Gunn and Duncan (1997)). Reduction in family income after the sanctions may have made it harder for children to attend school. However, as explained before, households might adjust this shock to mitigate the impact of sanctions on children. For example, they can draw down savings or sell off assets to smooth consumption in response to a negative income shock (Browning and Lusardi (1996); Deaton (1992)). However, if sanctions increased uncertainty about future income, households consume less and save more (Sandmo (1970)). I find no significant effect of sanctions on family savings and debt (Table C.4).[20] Thus, there is no evidence that sanctions changed family saving.

Second, labor income shocks may affect children's education by decreasing returns to education, a theoretical possibility explored formally by Eckstein and Zilcha (1994). The accumulation of human capital is an investment decision. Since education is costly (tuition fees and foregone earnings), individuals will invest in additional schooling only if sufficiently higher future earnings compensate for these costs. Therefore, optimal investment in children's education requires parents to take into account their children's income gain due to their education. Falling labor income due to economic

[19] The average growth rate for oil value added is -6.4% during the years of the sanctions.

[20] The family saving is not reported in the data used in this paper. I calculate the saving by subtracting total consumption from total family income (saving=income-consumption).

sanctions affects the returns to education. However, the effect of this change on education is not clear. On the one hand, it can decrease educational attainment by reducing expected earnings from additional schooling. On the other hand, poor labor market opportunities could increase the incentive for investment in human capital by increasing competition. Moreover, the wage rate decreased for all levels of education. As a result, the income of some low education levels that used to be above the poverty line moved down to below the poverty line after the sanction. Thus, the incentive to invest in education can increase after the sanctions. Since the effect could go either way, I need a structural model incorporating different features of the sanctions to identify the effect of this channel. It is left for future work. In this paper, I estimate the overall impact of sanctions on children's education.

Another mechanism by which economic sanctions may affect children's education is through changes in the government's budget. The 2006 UN sanctions did not affect public spending on education. The sanctions affected Iranian government revenue and its internal composition because on average 60% of Iranian government revenues come from oil and gas which was affected by the sanctions.[21] However, as Farzanegan (2011) shows the Iranian government only reduced the military and security spending after the sanctions. Other social spendings of the Iranian government including health and education does not show a significant response to this shock.[22] Moreover, the composition of public spending for primary to tertiary education has not changed after the sanctions (source: World Bank and Government Budget documents).

Economic sanctions may also affect children education through changes in the relative prices. In addition to the reduction in household income, rising prices decreased households' spending capacity after the sanctions. Over the years of sanctions, prices of many commodities spiraled upwards and inflation reached 35%. However, the magnitude of this change is different across goods and services. In particular, the prices of tradables (typically goods) have risen significantly relative to non-tradables (typically services). Thus, the relative prices and so the budget shares of the different commodities have changed.[23] Although education prices doubled, the changes are not as much as other commodities.[24]

3.2 A Model of Investment in Schooling

I now outline a simple model to identify the channels (illustrated in the previous part) through which sanctions affect children's education. People live for two periods. In period one, parents work,

[21] Iranian government spending includes current and capital expenditures. Current expenditures include all spending on government employees' wage and pensions, military, health, education, and cultural and social activities. Spending on defense and security expenditures is the major component of Iranian government spending, followed by spending on education (Farzanegan (2011)).

[22] Habibi et al. (2001) also shows that oil revenue fluctuations in Iran and other Middle Eastern oil exporting countries did not affect the basic social spending on education, health, and welfare.

[23] The budget shares of the various commodities are related to the real total expenditure and relative prices (Deaton and Muellbauer (1980)). Indeed, the descriptive analysis showed that sanctions significantly changed the households' consumption pattern. The most significant change is related to the expenditure share allocated to food. While food prices became sixfold in 2013 since expenditure on food is necessary expenditure and unsubstitutable, expenditure share on food increased by 6% (from 40% to 46%).

[24] Education Price Index (EPI) have increased in average 8% less than the overall rate of inflation.

consume, save, and decide how much money to spend on their children's education. Households receive utility from consuming goods and children's human capital:

$$U = u(c, c') + h(HC)$$

where c and c' are the first period and second period household's consumption, respectively. Children's human capital (HC) is determined by quantity (Edu) and quality ($QEdu$) of education. Parents expect payoffs (in terms of higher income later for their children) from their investment in children's education. Parents may value children's education for a number of reasons. First, in the second period, they depend on their children and highly educated children will be better providers. I assume parents receive μ percent of their children's income in the second period. Second, the happiness of children may make parents happier ($h(HC)$), so they have an incentive to spend money on children's education. The cost of schooling for a family is $exp(Edu, QEdu, \theta)$, where θ is children's ability which is transmitted from parents. Parents' ability reflects in their income. Thus, this model allows for heterogeneity among households. A low quality education is provided by the government which is costless for parents. Low educated workers receive w^u and return to education for any additional year of schooling is w^e and to any additional spending on schooling is w^q. The household maximization problem with income y is choosing consumption (c and c') and children's education (Edu and $QEdu$) subject to:

$$c + exp(Edu, QEdu, \theta) + s \leq y$$
$$c' = \mu[w^u + w^e(1 + w^q QEdu)Edu] + s$$

where s is household saving in period one ($s \geq 0$). Therefore, the cost of investment in children's education is lower consumption in the first period. If parent's income and/or return to education are high enough, parents would like to spend on their children's education. From a comparative static analysis, total derivatives are:

$$dEdu = constant + f_y(.)dy + f_e(.)dw^e + f_q(.)dw^q + f_u(.)dw^u$$
$$dQEdu = constant + g_y(.)dy + g_e(.)dw^e + g_q(.)dw^q + g_u(.)dw^u$$

Amusing u and h are strictly concave functions, $g_u, f_u < 0$ and sign of f_y, f_e, f_q, g_y, g_e, and g_q are positive (for more detail see Online Appendix). Labor income shocks caused by sanctions may affect family income (y) and/or return to education (w^e, w^q) and thus discourage parents from investing in children's education (e.g., if $dy < 0$ then $f_y(.)dy < 0$ and $g_y(.)dy < 0$). However, sanctions also decease wage rates for low educated workers ($dw^u < 0$ then $f_u(.)dw^u > 0$ and $g_u(.)dw^u > 0$). Thus, the incentive to invest in education can increase after the sanctions. The overall effect is ambiguous and depends on the relative strength of different effects. I empirically test the overall impact of sanctions.

4 Data and Identification Strategy

4.1 Data

The main data source is the Iranian Households Income and Expenditures Surveys (HIES). This sample covers near 40,000 households every year. It is conducted yearly by the Statistics Centre of Iran (SCI). These surveys which are rotating panels gather extensive data on expenditures of households including detail information on education spending.[25] Moreover, this data contains rich information at the individual level including age, gender, years of education, income, marital status, and relation with the head of family.[26]

The Iranian data are ideal for studying the effects of family income shock on children for two reasons. First, I can link children to their parents and observe their family characteristics (such as family income, parents' education, family size, and family expenditure). Second, the HIES contains child years of schooling, enrollment at different levels of education, and family education spending. Education spending includes payments for books, tuition, private tutoring, and donation to the school for the different levels of education (pre-primary and primary, secondary, post-secondary non-tertiary, tertiary, and education not definable by level).

I restrict my main sample to the households with children aged 6-24 because children start school at age 6 and most individuals complete their education by age 24 in Iran.[27] Children aged six who born at the start of the academic year (September 23th) or later are excluded because they are not eligible to enroll in school.

I choose my sample period to include all observations from years 1995 to 2013 (1374 to 1392 in Persian Calendar), 12 years before and 7 years after the sanctions imposed in 2007. I exclude the years 2014 and 2015 when Iran and P5+1 were negotiating over the nuclear program, and people would expect the sanctions to be terminated. I re-conduct the analysis including 2014 and 2015 as robustness check in section 6.

For the main analysis, I study households who live in urban regions of the country because there are differences between rural and urban areas in factors affecting education spendings. Computed elasticities indicate that spending on education by rural households is more sensitive to changes in income compared with urban households (see, for example, Mussa (2013)). Moreover, education opportunities are different between cities and rural communities, in particular all rural schools are public. Also, private supplementary tutoring are not available to students in rural areas. I do not lose too much of the sample because 75% of the population live in urban areas.

[25] HIES reports detail information on household expenditures on education according to the Classification of Individual Consumption According to Purpose (COICOP). The rotating nature of the panel can not be used in this study because households' id is changed for confidentiality protection in the version available to researchers.

[26] HIES reports detail information on labor income including permanent and non-permanent incomes, and non-labor incomes for each member of the family.

[27] Less than 5% of students are aged above 25.

4.2 Identification Strategy

The empirical strategy relies on the synthetic control method (SCM) (Abadie and Gardeazabal (2003); Abadie et al. (2010); Abadie et al. (2015)). I evaluate the 2006 economic sanctions using the synthetic control group to calculate a simple difference-in-differences estimates. The first difference is over time. The second difference is across groups of households. The difference-in-difference comparison is implemented by estimating regressions of the following type:

$$Y_{ispt} = \alpha + \gamma \ (Treat_i \times Post2007_t) + \beta \ Treat_i + \lambda_t + X_{ispt}^{'}\delta + \phi_p + \psi_s + \varepsilon_{ispt} \tag{1}$$

where Y_{ispt} is the outcome variable of interest (family income, family education spending, and children education outcomes) of individual (or household) i in province p and industry s at time t. The variable $Treat_i$ is a dummy for treatment households to control for group-specific differences; $Post2007_t$ is a dummy to reflect sanctions being imposed in 2007; λ_t is a vector of time fixed effects to control for changes in macroeconomic conditions. I also add province and industry fixed effects, ϕ_p and ψ_s, to control for time-invariant local market and industry characteristics that affect family income but are not observable to me. The vector X_{ispt} is a set of individual or region specific characteristics to control for any observable differences that might confound the analysis (for instance age for estimation years of schooling). Since outcome variables, e.g. income are likely to be correlated within local labor markets and industry levels, all observations are clustered at province and industry levels to account for correlation within observations, which may result in an underestimation of standard errors. Since there are few clusters at the industry level, t tests based on cluster-robust variance estimator (CRVE) tend to be over-rejected (MacKinnon and Webb (2018)). Moreover, different variants of the wild cluster bootstrap can over-reject or under-reject.[28] To solve this problem and calculate p-values, I follow MacKinnon and Webb (2018) and apply the correction for the small number of clusters by using wild bootstrap randomization inference (WBRI). The coefficient of interest is γ which measures the average effect of the economic sanctions on the treated group relative to the comparison group, using variation over time. I also examine gender differences in the impact of sanctions by estimating following equation:

$$\begin{aligned} Y_{ispt} = \alpha &+ \gamma_1 \ (Treat_i \times Post2007_t) + \gamma_2 \ (Female \times Treat_i \times Post2007_t) \\ &+ \beta_1 \ Treat_i + \beta_2 \ (Female \times Treat_i) + Female + \lambda_t + X_{ispt}^{'}\delta + \phi_p + \psi_s + \varepsilon_{ispt} \end{aligned} \tag{2}$$

I follow the approach of Abadie and Gardeazabal (2003) and Abadie et al. (2010), weighting industries to construct a synthetic counterfactual that replicates the characteristic of affected households before exposure to the sanctions.

Synthetic Control Group Strategy. The SCM is based on the idea that when an intervention affects a small number of units, a combination of unaffected unites provides a better comparison group, specially when no single unit alone is comparable to the affected units (Abadie (2019)).

[28] When a few clusters are treated, in many cases the restricted wild cluster bootstrap under-rejects, and the unrestricted wild cluster bootstrap over-rejects (MacKinnon and Webb (2018)).

In the ideal case, sanctions would be an independent random event for targeted industries that had no spillover effect to other industries. As explained before, based on detailed policy documents, the 2006 sanctions targeted specific firms and individuals mostly in oil and gas industry.[29] Also, 50 firms in other industries (including 14 firms in rubber,plastic, and mineral products, 8 firms in the financial sector, 6 firms in the motor vehicles, 5 firms in the basic metals, and 3 firms in the pharmaceuticals) that owned or control by IRGC and Setad were directly affected by the sanctions (Draca et al. (2019) and sanctions documents). Since the name of firms are not observable in the main data used in this paper, I discard all industry subcategories that included one of these targeted firms.[30] The present analysis is not such an ideal case because Iran's economy is dependent on oil exports. Thus, sanctions indirectly impacted other industries through the government budget and exchange rates.

I define households in which the head works for either oil and gas industry or energy supply (electricity, gas, steam and air conditioning supply) as the treated group.[31] The average real annual income of households that the head works in the oil and gas industry decreased from 198 to 110 million Rials (-44%). The reduction in household income can be related to a decline in working hours or wage rate (or both). The working hours have not changed over the years of sanctions. However, the average real wage per hour in this industry decreased from 45 in 2006 to 25 thousand Rials in 2013 (-45%). Although the sanctions affected some other sections of Iran's economy, the severity is different across industries. Income of households in other industries were either not affected or affected by less than 10% but household in the energy supply whose decreased by 47%. While this effect is indirect because it is big and immediately after imposing the sanction (21% reduction in 2008), I include households in the energy supply industry in the treated group.

The definition of the comparison group is crucial, as it should capture counterfactual outcomes trends in the absence of the sanctions. One potential comparison group would be households in which the head works for non-oil and energy industries. This group is not a good comparison group because these households differ from households in oil and energy industries in characteristics that are thought to be related to the potential for children's education. In fact, the pre-treatment trends of family income and education outcomes are not parallel for these two groups. Also, there is no single unaffected industry that provides a comparison for the affected industries. I use the SCM to find a combination of industries not (or less) affected by the sanctions as a comparison and estimate the counterfactual for treated households.

I construct a weighted average of potential control industries as the synthetic control group. I consider all other industries but financial, real state, and administrative and support service indus-

[29] United Nations Security Council Resolutions 1696, 1737, 1747, 1803 and 1929

[30] I use SCI classifies industries according to International Standard Industrial Classification (ISIC).

[31] I define the household head as the person earning the highest monetary income, mostly the same as the person reported as the head of the household. Some families reported the eldest person (grandparent) as the head of the household.

tries in donor pool (11 industries),[32] though I check the sensitivity of results using different selected donor industries. Since there are more than one treated unit, based on Abadie et al. (2010), I aggregate the treated units into a single unit (pooled SCM). Pooled SCM can yield poor unit-specific fits. Thus, I check the fit for each treated unit and find good fit mostly because the characteristics of households in affected units are similar (Figure D.1). Moreover, following Ben-Michael et al. (2019), I use the partially pooled SCM as robustness check and find similar results. Weights are determined to maximize the similarity between the synthetic control and the treatment units in terms of pre-treatment family income. The values of pre-treatment family income for the affected industries does not fall inside the convex hall of the corresponding values for the donor pool and yield an imperfect fit. Thus, I use a modified SC estimator by Ferman and Pinto (2019) and demean the data using information from the pre-treatment period, and then construct the synthetic control using the demeaned data. For main analysis, following Botosaru and Ferman (2019),[33] I consider only pre-treatment outcome as matching variable. As robustness check, I include observed covariates (parent's education, employment status, age, etc.) and find similar results. In particular, I find that algorithms that minimize the distance between the treated units and the weighted average of control unites put small and ignorable variable weights for covariates if more pre-treatment outcomes are included.

The optimal weights are positive for three industries information, education, and health with values 0.148, 0.169, and 0.683 respectively and take value zero for the other potential controls. Households in these industries experienced the lowest incidence of family income changes after the sanctions. Two features of these industries protect them from the sanctions. First, these industries are heavily regulated by the government. Therefore, their wages and employment size are little responsive to the market conditions. Second, these industries are not dependent on trade, thus making them unaffected by the changes in the exchange rate due to trade restrictions after the sanctions. Figure 2a displays the average real family income for affected households (households in oil and gas industry and energy supply) and their synthetic counterpart in the period 1995-2015. Figure 2b plots the gap in predicted error. The gap between the actual and counterfactual family income widens from around zero, over years before the sanctions, to 45% in 2013.

I also use SCM at the industry-sector level. In addition to different effects of the sanction across industries, these effects are different across the public and private sectors. In particular, in the

[32] Since the synthetic control is supposed to reproduce the outcome variables for treated industries in the absence of the sanctions, I discard financial, real state, and administrative and support service industries from the donor pool. As explained before, some firms in financial sector that owned or control by IRGC and Setad are targeted by the sanctions, but in HIES only the sector is observable not the firms. I also exclude households in real state and administrative and support service sectors for two reasons: first, these households experience a large reduction in family income with a lag; second, these households are unsuitable controls because of large difference in their characteristics relative to treated households (Abadie (2019)). Moreover, I exclude industries for which data are not consistently available in the HIES: arts, entertainment and recreation; activities of households as employers; undifferentiated goods- and services- producing activities of households for own use; professional, scientific and technical activities; activities of extraterritorial organizations and bodies.

[33] Botosaru and Ferman (2019) show as long as there is a perfect match on pre-treatment outcomes, a perfect match on covariates is not required. Ben-Michael et al. (2019) and Doudchenko and Imbens (2016) also use only the lagged outcomes as matching variables and show including covariates has no effects on synthetic control.

education industry, while workers in the private sector experience a 20% reduction in their income, workers in the public sector were not affected by the sanctions. For the treated group, households in oil and gas industry and energy supply in both public and private sectors are affected by the sanctions. Using industry-sector level synthetic control analysis, the optimal weights are positive for information (public: 0.071), education (public: 0.180), health (public: 0.640, private: 0.055), and other service activities (public: 0.053) industries. Figure 2c shows the average real family income for treated households and their synthetic counterpart at the industry-sector level during the period 1995-2013, and 2d plots the gap in predicted error.

Table 1 reports households' and children's characteristics of the synthetic group (at both industry and industry-sector levels) comparing to treated households in the absence of the sanctions. The variables overall are well balanced between these groups. In appendix D, I check validity of synthetic control for counterfactual by checking the sensitivity of results to the choice of different matching methods (different matching variables, different matching year range, and different methods for selecting weights) and different selected donor industries. The results show that the synthetic control is not sensitive to these choices.

5 Results

I analyze the direct impact of the 2006 economic sanctions on family income and the indirect effects on children education. First, I document the effects using the synthetic control method at the industry level (Section 5.1 and Section 5.2). I then report the effects using the synthetic control method at the industry-sector level (Section 5.3). For all specifications, I report the results estimated using OLS regressions.

5.1 Effect on Family Income

I first examine how the sanctions affected family income. To do so, I look at the effects on total family income as well as labor market earnings, wage rates, and employment. UN sanctions targeted investments in and exports of oil, gas, and petrochemicals. As a result, crude oil exports had declined from 2.5 million barrels per day to less that one million in 2013. This change could potentially affect the income of workers in the oil and gas industry and energy supply through unemployment, inflation and falling wages.

Table 2 lists the estimated effect of the sanctions on family income under various model specifications. All specifications include dummy variables for year, industry, and province. Models 2 and 3 include head's education, age, and age square controls, with the latter using a province by year set of fixed effects. The results are similar between all specifications. Total income and labor income of families that the head works in treated industries decreased by 15% and 16%, respectively (panel A). Panel B shows that the real wage rate in the treated industries decreased by 11% after the sanctions. In fact, the nominal wage rate increased, but it had not been synchronized with the rate of inflation. There is no significant effect on working hours. In particular, the sanctions had no

effect on full/part-time employment. This reduction in income is independent of worker's abilities since it is due to a shock in the economy whose effects do not depend on skills and abilities.

Placebo Studies. To assess the credibility of my results, following Abadie et al. (2015), I examine in-space placebos. To do so, I apply the synthetic control model to each 11 industries and 22 industry-sections in the donor pool, assuming it was treated at the year 2007. If the placebo effects are as large as the main estimate, then it is likely that the estimated effect on family income was observed by chance. Figure 3 shows the distribution of the post/pre-treatment ratios of root mean squared prediction errors (RMSPE) For actual treated group and all the industries in the donor pool (3a at industry level and 3c at industry-sector level).[34] The actual treated unit (oil & gas and energy supply) clearly stands out with the highest RMSPE ratio. For the actual treated unit, the post-sanctions gap is about 14 times larger than the pre-sanctions gap at the industry level (13 times larger at the industry-sector level). Also, Figures 3b and 3d display the average family income gap between the actual treated unit and its synthetic (bold line) as well as the rerespective gaps from 11 placebo industries and 22 industry-sections, respectively. As the Figure shows, whereas there are no significant difference in the family income between the actual treated households and the synthetic control in pre-sanction period, it experienced large negative effects over the years of sanctions. No other placebo industries experiences a similar change. Thus, the placebo tests suggest that these results are not due to chance. Section 6 provides further robustness checks by considering in-time placebos, different time periods, and different covariates.

5.2 Effect on Children's Education

As a results of a reduction in the family income (-15%), households reduced the total spending by 11% (Table 3). Although spending decreased for most components, it did not decrease by the same rate. As Table 3 shows, households cut spending on education by 58%. Moreover, spending share on education decreased by 5%. The reduction in education spending reflects the combination of young children not attending school and parents cutting back on school expenditures. For instance, parents may choose free public school instead of private school for their children. In this section, I evaluate the effects of the sanction on children's education outcomes (enrollment rate, completed years of education, and education spending). The sample consists of all children aged 6-24 years over the period 1995-2013.

5.2.1 Effect on Enrollment and Years of Schooling

First, I find the impact of the sanctions on the educational attainment measured by the enrollment rates and years of education. Table 4 presents the effects on school enrollment, attending any college,

[34] RMSPE measures the magnitude of the difference between each industry and its synthetic control in the outcome variable. A small preintervention RMSPE and a large postintervention RMSPE can be indicative of a large effect of the intervention.

and years of schooling.[35] In Iran, education is compulsory until the end of high school one (grade 9). Therefore, nonsignificant effect on enrollment in these grades (column 1) can interpret as the falsification test, because this group of children attends school anyway. Also, the sanctions had no significant effect on enrollment in high school two (column 2). If there were more dropouts before entering college and thus reduction in the proportion of high school graduates, it was hard to separate the effects on college attendance from those on high school or earlier education. The third column of this Table shows that the probability of attending college significantly decreased by 4.8 percentage points after the sanctions. I Also find years of schooling significantly decreased by 0.1 years for the whole sample (column 4), and decreased by 0.3 years for children aged 15-24 years who completed grade 9 (column 3). Also, a simple calculation (Average Years of Schooling $= \sum_{S_i=0}^{22} (P_i S_i)$ where S_i is years of schooling and P_i is percentage of children age 6-24 at different level of education) confirm that at the prior rates of college attendance and enrollment at different education levels, years of education on average decreased by about 0.1 years after the sanctions. Panel B of Table 4 shows that the effects are not different across gender.

I compare my results to current literature and the overall effects on the current generation to find how big these negative effects on children's education are. My finding is consistent with the literature documenting a connection between family income and children's education(Acemoglu and Pischke (2001); Blanden and Gregg (2004); Akee et al. (2010); Løken (2010); Coelli (2011); Lovenheim (2011); Lovenheim and Reynolds (2013); Pan and Ost (2014); Bastian and Michelmore (2018); Bleakley and Ferrie (2016); Hilger (2016); Manoli and Turner (2018)). My result is large compared to other studies. I find that a 15% decrease in family income is predicted to decrease college enrollments by 4.8 percentage points. Acemoglu and Pischke (2001) find that a 10% increase in family income increases college enrollments by 1-1.4 percentage points. Bulman et al. (2016) find the modest per-dollar effects of a positive income shock caused by lottery. They find the relationship is weakly concave, with a high upper bound for amounts greatly exceeding college costs. They also find the effects are smaller among low income households because lump-sum transfers are more likely to be spent on durable e.g. housing. My results are also larger compared to the results of existing studies that exploit persistent income shocks generated by, for example, tax credit and job loss. For example, Hilger (2016) finds a father's layoff reduces children's college enrollment by less than half of one percentage point, despite dramatically reducing current and future parental income (by 14% initially and 9% after five years). He explains that much of reduction in parental spending on education may be offset by greater financial aid. Such financial aids, e.g. college loans are not available to Iranian children. Therefore, the large effects estimated in this paper are expected because of the persistent shock and lack of adjustment possibilities to the shock.

I consider a simple back of the envelope calculation to understand the economic significance of these results. Children growing up after the imposition of sanctions may have lower earnings

[35] The sample for grades 1-9 and high school two are children of the age group who are officially eligible to enroll in these grades (6-14 and 15-18 years old for grades 1-9 and high school two, respectively). The sample for college is high school graduates who are under the typical college graduation age ($\leq$24 years old).

throughout their adult lives. Sanctions can affect the lifetime income of the next generation through two channels: lower wage rates and lower education levels. To find the children's earnings loss due to the sanctions, I compare the present value of future lifetime earning of children with and without the sanctions.

$$I_j = \sum_{t=0}^{T} \beta^t (w_j^H Income_{tj}^H + w_j^C Income_{tj}^C) \quad , j = s, ns \tag{3}$$

where I_s and I_{ns} are children's lifetime earning with and without the sanctions respectively. w_j^H and w_j^C are the percentage of children with a high school or less and the percentage of children with university degree, respectively. T is the number of working years and β is the discount rate (0.95). I do not observe $Income^H$ and $Income^C$ (real annual income at different ages for high school graduates and college graduates) because these children who are affected by the sanctions are not yet old enough to directly measure their earnings. Children's future annual income may be imputed from the information on children's levels of education, using the relationship between earnings and education in observed data. I consider different scenario for their income: (i) median/average of (all/oil and gas) workers' income in the last year of sanctions (year 2013),[36] and (ii) median/average of (all/oil and gas) workers' income before the sanctions (year 2006).[37] Since HIES is a cross-sectional survey, I observe single-year measures of the earnings. Short-run measures of workers' earnings include both measurement error and transitory fluctuations in earnings. Thus, I select a period to observe the representative-workers when their earnings are most likely to accurately reflect permanent earnings, ages 30-50 (the prime earnings years). Similarly, I estimate the present value of lifetime earning of current generation employing the annual income before and after the sanctions to find parents' earnings loss.

The first exercise is to calculate what the expected magnitude of the children income would be if the sanctions had not been imposed. As mentioned before, the sanctions can affect the lifetime income of the next generation through two channels: lower wage rates and lower education levels. To find the total effect, I compare the case where college enrollment rate has decreased, and the real income is constant at its lowest value in the last year of sanctions (year 2013), to the case where children were able to enroll in college at the same rate as college enrollment in the year 2006 (before the sanction), and real income equals to its highest value in the year 2006. A back of the envelope calculation shows a 41% reduction in children's lifetime earnings. I also decompose the total effect of the sanctions on the children lifetime income into the sole effect of the reduction in education levels and the sole effect of the reduction in the wage rates. My calculation shows that the reduction in college enrollment rates will decrease children's future lifetime earnings by 3-4%. A similar calculation shows that the reduction in wage rates will decrease children's future lifetime earning by 38%.[38]

[36] For this scenario, I assume the wage rates cannot recover after the lifting sanctions.

[37] For this scenario, I assume the wage rates will recover after the lifting sanctions.

[38] If children were able to enroll in college at the same rate as college enrollment before the sanction, but the wage rates decreased from the rate in 2006 to the rate in 2013.

It is also interesting to ask, how large is the children income loss in economic terms? One way to assess the size of this loss is to compare it with earnings loss of the current workers due to the sanctions, and real GDP. My calculations suggest that a one dollar reduction in parents' permanent earnings leads to a subsequent reduction in children's earnings of 1.2 dollars.[39] I also find that the costs to the society associated with the reduction in earnings after the implementation of the sanctions total about 18% of Iranian GDP over the years of sanctions. 45% of this reduction comes from decreased earning for the current workers, and 55% comes from decreased earning for the next generation. It suggests that the cost estimates using only earnings of current generation may only capture less than half of the overall cost.

There is, however, some potential drawbacks of this method. First, this procedure relies on the assumption that cohort effects on the earnings profile are minimal. Second, this simple calculation ignores individual characteristics that can affect children's earning.

5.2.2 Effect on Education Spending

So far, I have looked at the educational attainment measured by the enrollment rate and years of education. Now, I examine the effect of the sanctions on investment in children's education measured by household spending on education.[40] The education spending is the explicit costs associated with payments in cash such as school tuition, university tuition, books, private tutoring, donation, and other education expenditures (for instance extra classes). Based on HIES, before the sanctions, the average percentage of family educational spending was about 2%.[41] The school tuition fee constituted a significant proportion of total education costs (21%).

Table 3 presents the effect of the sanctions on education spending by items (they include zero for non-enrolled children. I add one to values of these variables and then log-transformed). For school tuition, the sample consists of all children aged 6-24 who have not graduated high school. For university tuition, the sample consists of high school graduates who aged below 24 years. For spending on books and private tutoring, I have considered all children aged 6-24. As this table shows, households cut spending on education by 58%. In particular, households spent less on school tuition by 40% (its share decreased by 3%.). Knowing that the sanctions had no effect on enrollment in primary and high schools, this finding indicates that households respond to the sanctions by

[39] This effect is larger to previous studies. Oreopoulos et al. (2008) using Canadian data find that a one dollar reduction in father's permanent earnings due to a job loss leads to a subsequent reduction in his son's earnings of 66 cents. One possible reason for this difference is that previous studies looked at cases that affect the lifetime income of the next generation only through a reduction in the education levels. In the case of Iran, the economic condition, e.g., wage rates have also changed after the sanctions. Moreover, as Grawe (2001) shows the intergenerational earnings mobility in the developing countries is larger because of the larger credit constraints.

[40] While the effect of high-quality education on the returns to schooling and economic growth is well known (Castelló-Climent and Hidalgo-Cabrillana (2012)), the effect on household spending on education is not documented in the current literature. Previous research has largely focused on children's educational attainment.

[41] For Canada and UK, the percentages were about 1.1 and 1.2% respectively in 2009. Furthermore, according to Huston's study (1995) using 1990-1991 Consumer Expenditure Survey for the US, the household educational expenditure consisted of about 1.95% of total household income. For the 25 EU countries, the private expenditure on education as a percentage of total household consumption during 1995-2004 ranged from 0.1 to 2.9%. The average was about 1% (Lin and Lin (2012)). The share of education expenditure in household expenditure is 4.3% in all India (Azam and Kingdon (2013)).

substituting away from higher-quality private schools towards lower-quality public schools for their children. Moreover, households spent 71% less on university tuition, which is consistent with a reduction in college enrollment found in the previous section. Although the number of seats at public universities is limited, a shift from private universities to public universities may explain some of this reduction in spending on university tuition. For example, before the sanctions, some students in large cities would choose to remain in their cities and enroll in private universities instead of enrolling in public universities in small cities. The reduction in family income could force these students to move to fee-free public universities. Immigration date do not confirm this hypothesis. Although the type of university is not observable in the data, the cross-country migration for education decreased from 9% before the sanction to only 4% in 2012.[42]

Also, spending on books and private tutoring decreased by 34% and 54%, respectively. A large share of spending on private tutoring is for pre-university students to increase their probability of success at the public universities entrance examination. Thus, children from treated households faced a decline in the financial resource available to enroll in private universities, as well as a reduction in receiving private tutoring, which may have increased their chance of getting placed in a public university.

I also test the effect of the sanctions on the education spending per child (Table 3, last column). The decline of fertility in Iran over the past decades can explain the reduction in household education spending. The average number of students in households decreased from 2.2 in 1995-2006 (pre-sanctions) to 1.5 in 2007-2013 period (post-sanctions).[43] The results show that the spending on school and university tuition for each child significantly decreased by 38% and 74%, respectively. Moreover, households cut their spending on books and private tutoring for each child by 34% and 34%, respectively.

5.2.3 Income Elasticity of Education Spending

To compare these negative effects on education spending to the current literature, I calculate the income elasticities of education spending. Following Grimm (2011), I use a 2SLS estimator and instrument income with the interaction effect being a child in a treated household after the sanctions conditional on being in a treated household and the time effects. As explained before, since HIES is a cross-sectional survey, I observe single-year measures of the earnings which include both measurement error and transitory fluctuations in earnings. Following Tansel and Bircan (2006), I use total family expenditure as a proxy for family income because total expenditure represents permanent income better than current income. Moreover, there are fewer errors in measuring total expenditure than in measuring income. I also use family income itself as a robustness check. I estimate the following equation:

$$lnEdu\_exp_{ipt} = \alpha + \xi \widehat{lnTotal\_exp_{ipt}} + \beta\ Oil_i + \lambda_t + X'_{ispt}\delta + \phi_p + \psi_s + \varepsilon_{ispt} \quad (4)$$

[42] Sanction had no effect on immigration.

[43] The average number of children in households who are enrolled in schools (primary and high schools) and universities decreased from 2 to 1.4 and from 0.2 to 0.1, respectively.

where $\widehat{lnTotal\_exp_{ipt}}$ is the fitted value of total household expenditure derived from the the first stage equation given by

$$lnTotal\_exp_{ipt} = \upsilon + \gamma\ (Oil_i \times Post2007_t) + \iota\ Oil_i + \kappa_t + X'_{ispt}\nu + \varphi_p + \Psi_s + \varsigma_{ispt} \tag{5}$$

where i denotes family, p denotes province, s denotes industry, and t denotes time. Edu_exp_{ipt} is household education spending and $Total\_exp_{ipt}$ is total household expenditure as a proxy for family income. The vector Z_{ipt} is a set of family specific characteristics that are correlated with both educational spending and income like parents' education. Since education spending and total household expenditure are both in logarithmic form, ξ denotes elasticity. I use the Tobit model for the second stage because education spending is zero for some households. Thus, this variable is censored at zero.[44]

Table 5 presents the maximum likelihood estimation results of Eq (4) (the unconditional marginal effects). I find that income elasticity is significantly greater than one (3.284). Thus, as total expenditure decreases, education spending decreases more rapidly. The F-statistic in the corresponding first-stage regression is far above the critical value, indicating that the used instrument is relevant.

This negative effect on education spending is large compared to studies which have found the income elasticity of education spending (Qian and Smyth (2011); Huy (2012); Acar et al. (2016)). The findings of these studies suggest that the income educational expenditure elasticity is different across countries, level of family income, and other household characteristics such as parents' occupation. However, most of these studies find that the income elasticity of education spending is significantly less than one implying that education is a necessity item. For those group of household that education is a luxury good, income elasticity is less than two. I find an income elasticity of more than three. Using family income, the estimated elasticity of education spending is smaller (2.049), but still large compared to existing studies (the last column of Table 5).

Overall, after the sanctions, both the educational attainment (measured by enrollment rates and years of schooling) and investment in children's education (measured by family education spending) have decreased. First, the sanctions decreased the probability of attending college. Therefore, the years of schooling decreased. Second, spending on school tuition significantly decreased that suggests households respond to the shock by switching their children from higher-quality, more expensive private schools to lower-quality, free public schools. Reduction in children's education will reduce their future earnings such that affected children will experience a larger decline in their earnings than their parents.

5.3 The Sanctions Effects using Synthetic Control at Industry-Sector Level

As an alternative approach, I apply the synthetic control analysis at industry-sector level (explained in section 4.2). As explained before, using industry sector level SCM, the optimal weights are positive for information (public: 0.071), education (public: 0.180), health (public: 0.640, private: 0.055), and

[44] Zero values for education spending are also included. As explained before, since I used this variable in log form, I added one to values of this variable and then log-transformed.

other service activities (public: 0.053) industries. For this analysis, I use households in oil and gas industry and energy supply (both public and private sectors) as the treated group.

Table 6 reports the effects on family income and education outcomes using SCM at industry-sector level. As the Table shows, the total income and education spending of treated households decreased by 17% and 70%, respectively, compared to households in the synthetic control. Also, the sanctions decreased college enrollment and years of schooling by 5.7 percentage point and 0.2 years (0.3 years for children age 15-24 who completed grade 9), respectively. Overall, the results are slightly larger than those of SCM at industry level because households in the public sector of several industries that indirectly affected by the sanctions (e.g., households in the private sector of the education industry) are removed from the synthetic control group.

6 Robustness Checks

I provide two groups of robustness checks. First, I examine the sensitivity of the composition of the synthetic control group to alternative implementations of the synthetic control method (different matching variables, different matching year range, different methods for selecting weights, and different selected donor industries). The results in appendix D show that the original synthetic control and the main results are not sensitive to these choices. Second, I consider several robustness checks of the main results. First, following Abadie et al. (2015), I examine in-time placebos. Second, I analyze whether considering different periods (1995-2015) and excluding the years 2007 and 2009 affects the results. Then, I compare the results with and without control variables. My results pass these robustness tests. Finally, I discuss whether the estimated effects are related to the sanctions or other changes in economic and political factors.

As an in-time placebo test, I estimate the effects by reassign the treatment to occur during the pretreatment period. Although the SCM estimates a substantial effect of sanctions on children's education, such findings would not be valid if the SCM also estimated significant effects for fake treatment years. I rerun the model for the case when the sanctions is reassigned in the year 2000. Figure 4 displays the results of this in-time placebo study. The synthetic control almost exactly reproduces the family income for the treated industries for the 1995-2000 period. Most importantly, the family income trajectories of treated industries and its synthetic counterpart do not diverge considerably during the 2000-2006 period. Table E.1 lists the insignificant effects on family income and education outcomes using this placebo synthetic control.

For the main analysis, I restrict the data to 1995-2013 period and exclude the negotiation years (2014 and 2015) because the end of sanctions might be expected by Iranian people when Iran and P5+1 started negotiation over the nuclear program in 2013. I re-conduct the analysis using a different period including 2014 and 2015. I also consider the robustness of my results by excluding the years 2007 and 2009. First, I exclude the first year of the sanctions, the year 2007, because Iran could have come up with some ways to avoid sanctions after the first year when sanctions imposed unexpectedly. Second, I exclude 2009 because the 2009 presidential election (in Iran and the US) could affect the

Iranian economy. For all cases, the results are close to the original results. In particular, the 2009 election results are unlikely to change the long run economic trend largely because Ahmadinejad's policies in the second term were similar to his policies in the first term.

Finally, I perform an analysis excluding covariates altogether to compare the results with and without control variables. The idea is that if the results are not affected, successful randomization would be confirmed. The outcome of this exercise is not significantly different from the baseline model.

Table E.2 reports the results of all robustness checks. Overall, these sensitivity tests verify the robustness of the original results.

Other Factors

To make sure the estimated effects are solely due to the sanctions, I check whether there were other changes in economic (including Great Recession and oil price changes) or political factors that affected the treated and control groups differently.

First, I discuss two events (Great Recession and oil price changes) that can affect the time trend of the treated and control groups differently. While the sanctions period (2007-2013) includes the Great Recession of 2008-2009, Iran's economy experienced few effects from the global recession because as a result of economic sanctions Iran had been a closed economy. Moreover, reduction in households' income started immediately after imposing sanctions in 2007 before the recession started in 2008. The other important factor is oil prices. The Iranian economy is vulnerable to fluctuations in oil prices (Farzanegan and Markwardt (2009); Berument et al. (2010)). However, oil prices were steadily rising from $50 to $80 during sanctions, except for a spike followed by a sharp drop. Thus, I assume that there are no significant events that affect the time trend of the sample groups differently.

Finally, I show during the sanction years no major political changes took place. As Borszik (2016) shows economic sanctions did not weaken the Iranian regime. In Iran, the Supreme Leader, who ranks above the President, is the ultimate political and religious authority, and sets the national course. From 2005 to 2013, Ahmadinejad was the president who had adopted the same policies consistent with the Supreme Leader strategic preferences. While Iran's nuclear program was stopped in 2002, Ahmadinejad, shortly after taking office, announced the restarting of uranium enrichment activities. These policies led to the economic sanctions (Meier (2013)).

Although there were no major changes in Iran's policies between 2005 and 2013, sanctions led to some political changes in 2013. As a result of such adverse economic impacts of the sanctions, the political elite agreed that the nuclear strategy needs to be revised (Borszik (2016)). On June 2013, the moderate Hassan Rouhani won the presidential election. President Rouhani's campaign promised to improve economic growth and unemployment. He also emphasized the need to negotiate with the Security Council over nuclear program by highlighting the negative effects of the UN sanctions on Iran's economy. As a result of such adverse economic impacts of the sanctions, the political elite agreed that the nuclear strategy needs to be revised. President Rouhani and his team were successful

in finalizing the nuclear deal and terminating the sanctions.

7 Heterogeneous Effects of the Economic Sanctions

In this section, I examine whether the effects of 2006 economic sanctions are heterogeneous across different contexts. The estimates results in Section 5 show the average impact of the sanctions. However, these effects could also be heterogeneous across demographic groups. Finding heterogeneous effects is important to understand the distribution of the costs associated with the sanctions. Thus, I can determine the groups of children who are more vulnerable to the changes from the sanctions.

7.1 Heterogeneous Effects on Family Income

I first examine how the sanctions affected family income across different quantiles. Based on results in Section 5, the total income of families that the head works in the treated industries on average decreased by 15%. Table 7 (and Figure 5) presents estimated coefficients from OLS and quantile regression for family income. As this Table shows, the effect of sanctions on income of low and middle-income household is larger (24% and 20%, respectively) and significantly different from the average effect (OLS coefficient=15%). There is no significant effect on income of household who are rank above the 90th percentile.

7.2 Heterogeneous Effects on Children's Education

I also find the impact of sanctions on children's education (enrollment, years of schooling, and education spending) across different contexts (by age, family financial resources, and structure). Table 8 presents estimates of the effects of the sanctions on the enrollment rate by crucial ages. Age plays an important role in the enrollment. The crucial ages for children's enrollment/dropout rates are at the entrance to the first grade (6 years old), high school dropout age (16 years old) and matriculation at a university (18 years old). As this Table shows, the economic sanctions increased the probability of dropping out from high school. The enrollment rate of children at high school dropout age (16 years old) decreased by 4 percentage points. As panel B shows, this effect is larger for girls. Moreover, the economic sanctions decreased the probability of attaining college at age 18 by 15 percentage points. Lack of access to financial resources for post-secondary education prevents marginal students from making such investments (Bound and Turner (2007); Zimmerman (2014)). Consequently, some students may perceive a reduced benefit from a high school degree if they are unable to access post-secondary education.

To further explore heterogeneity in the effects of the sanctions, individuals are grouped based on their family financial resources (as measured by family wealth and family nonlabor income). I approximate wealth using an asset index based on Filmer and Pritchett (1999) that aggregates various assets of a household relying on principal component analysis (PCA). In HIES, respondents were asked about their ownership of durable goods (e.g. car, bicycle, TV, radio) and housing ownership and characteristics (e.g. size, number of rooms, and appliances). I use this information as

asset indicators to construct an asset index. To drive weights, I use principal component analysis. I also group individuals based on their family non-labor income which is summation of the non-labor income of each member of a household including financial transferred aids, real estate incomes, subsidies, interest on bank deposits, bonds yield and share dividends, scholarships and cash gifts from others. Table C.5 in the appendix C shows that the wealth index and non-labor income (and their components) are not affected by the sanctions.

Table 9 presents the effects on years of schooling and education spending over the wealth and non-labor income distributions. As this table shows, only children from poor families experienced a reduction in the years of schooling. Children (aged 6-24) from the 25th percentile (in total family wealth and non-labor income) experienced 0.2 years reduction in years of schooling. This effect is not significant for children from families with middle and high level of financial resources. I also find parents of children from middle class families (in wealth and non-labor income) spent less on their children's education by 54%-61%. The effect is not significant for children from low and high wealth families. Low wealth families are less likely to spend money on education even before the sanctions, for example, most of these children go to public schools.[45] Overall, children from low wealth families are more affected in term of the educational attainment, and children from middle wealth families are more affected in term of investment in education. The sanctions have no significant effect on the education of children whose family rank above the 95th percentile.

I also look at the effects by mother's employment and income. There are several ways that maternal employment may affect children's education. First, maternal working brings more income to the family, which can be used to spend on children's education. Second, mothers who have income have more bargaining power on the decision regarding the children's education. Third, maternal employment may increase children's education if working mothers serve as role model. Last, all else equal, a working mother will spend less time with her child than one who does not work. Depending on the quality of mother-child time together and the quality of the alternative, this may either improve or decrease a child's education. To explore this heterogeneity, I estimate Eq (1) separately for individuals in different groups based on their mother's employment and income. Table 10 presents the results of these estimations. The sanctions decreased years of schooling of children whose mother is not employed by 0.15 years. I also find a 64% reduction in education spending among this group of children. The effect of sanctions is insignificant on the education of children whose mother has a job. Since mothers can have income from other sources than wages and salaries, I also estimate the effects of mother's income on children's education. The results are similar: for children whose mother's income is zero, years of schooling and education spending decreased by 0.12 years and 56%, respectively, after the sanctions.. The effect of sanctions is insignificant on educational outcomes of children whose mother has a positive income.

In sum, the sanctions had a negative effect on children's education, and the effect is larger for children at crucial ages, children from low and middle wealth families, and children's whose mother

[45] While middle and high wealth households spent an average of 26 (2% of their total consumption) and 83 (3%) thousand Rials on education in 2006 respectively, households in the lowest wealth quantile spent only 4 thousand Rials on education (0.4% of their total consumption).

has no income.

8 Conclusion

This paper analyzes the negative externalities of economic sanctions on current generation (through changes in labor income) and next generation (through changes in children's education and their lifetime earnings). Economic sanctions either as a prelude or best alternative to warfare found new prominence in the 21st century. Recent evidence has indicated that economic sanctions pose significantly adverse impacts on the current generation. While the short term effects of economic sanctions on the current generation are well explored, little is known about their long lasting effects on the next generation. This paper seeks to fill the gap by examining the effects of UN economic sanctions against Iran on children's education. These targeted sanctions were associated with large, sudden reductions in households' income that last for seven years.

Relying on a synthetic control approach and using a sub-sample of data on the Iranian Households' Income and Expenditure (oil, gas, and energy supply industries as the treated group; the weighted average of information, education, and health industries as the synthetic control group), the empirical analysis suggests that the sanctions had a significant negative impact on the family income and children's education. The analysis reveals two main findings. First, the sanctions decreased children's probability of attending college by 4.8 percentage points and years of schooling by 0.1 years. Second, households reduced spending on children's education by 58% - particularly on expenditure for school tuition. This finding indicates that households respond to the shock by substituting away from higher-quality private schools towards lower-quality public schools for their children. The sanctions impact on children's education is larger than implied by the income elasticity estimates from the previous literature likely because sanctions have persistent effects on parent income. Overall, after the sanctions, both educational attainment (quantity of education) and investment in education (quality of education) have decreased. Reduction in children's education will reduce their future earnings (by 41%) such that affected children will experience a larger decline in their earnings than their parents.

This paper also investigates the cause of the heterogeneity. I find that the negative effect of the sanctions on children's education is larger for children at crucial ages, children from low and middle wealth families, and children's whose mother has no income. First, the enrollment rate of children at high school dropout age (16 years old) and matriculation at a university (18 years old) decreased by 4.3 percentage points and 15.4 percentage points, respectively. Moreover, only children from poor families experienced a reduction in the years of schooling (0.2 years of schooling). Second, I find parents of children from middle wealth families spent less on their children's education by 54-61%. The effect is not significant among children from high wealth families. Third, while the effect of sanctions is insignificant on the education of children whose mother has income, there are negative effects on years of schooling and education spending among children whose mother is not employed or has no income.

This paper completes the literature documenting the negative effects of economic sanctions. Current studies show the negative effects of sanctions on economic growth and living standards and humanitarian situation of the civilian population during the years of sanctions. In the case of Iran, Iran's economy got 15-20% smaller than it would have been absent the sanctions (U.S. Treasury Secretary Jacob Lew report, 2015). Moreover, previous studies find adverse impacts of the 2006 UN sanction on the current generation by showing a reduction in the total welfare level of final consumers (Ezzati and Salmani (2017)) and public health (Karimi and Haghpanah (2015)). My results go beyond these studies and show that economic sanctions have long lasting consequences on children's well-being even after they are lifted by a reduction in children's education. Moreover, human capital is an important factor in productivity growth and economic development. These negative externalities caused by disinvestment in human capital are not documented in the current literature of adverse consequences of economic sanctions. I find that the costs to the society associated with the reduction in earnings after the sanctions total about 18% of Iranian GDP over years of sanctions. 45% of this reduction comes from decreased earning for the current workers, and 55% comes from decreased earning for the next generation. It suggests that the cost estimates using only earnings of current generation may only capture less than half of the overall cost. This paper also adds to the literature on the effect of family income on children's education. I find larger effects compared to previous studies because the income shock is persistent and large. Moreover, other financial resources had not been available to children during the years of sanctions.

The estimates presented in this paper suggest that although economic sanctions against Iran were successful in term of political goals, such negative effects on human development are not ignorable. The effect of sanction on children's education depends on the context and severity of the sanctions and how government and households cope with this shock. However, establishing this potential negative shock to human development can edify future policy regarding the use of economic sanctions.

There are several worthwhile directions for future research. First, a structural model incorporating different features of the sanctions may offer other policy counterfactual implications. Second, estimating the impacts of the lifting sanctions on children's education using the data for years after the lifting of the sanctions would be interesting. The households' responses to positive and negative changes in income may be asymmetric. Third, it would be fruitful to estimate the long term effects of the sanctions on labor market outcomes of affected children.

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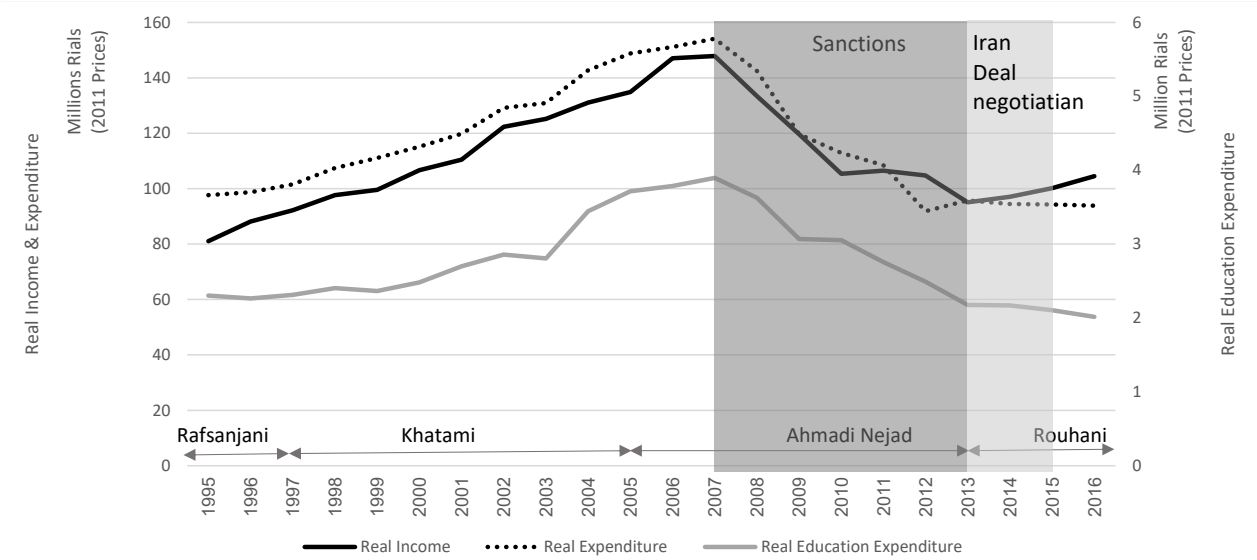
A Figures

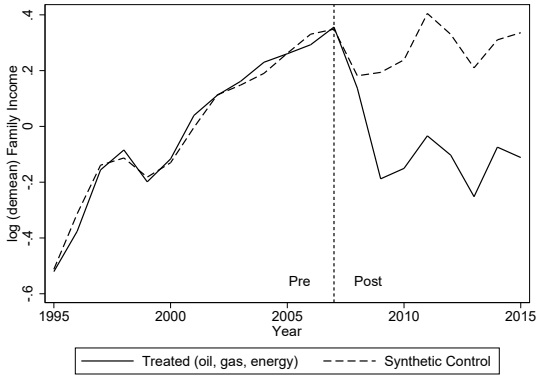
Figure 1: Average Real Income, Expenditures and Education Expenditures for Iranian Household



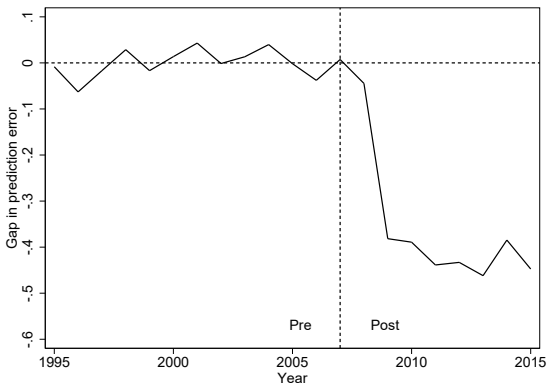
Note: Figure shows the decreases in average real annual income, expenditures and education expenditures for Iranian household during the economic sanctions.
Source: Author's calculations from HEIS data.

Figure 2: Average Real Income for Treated and Synthetic Control

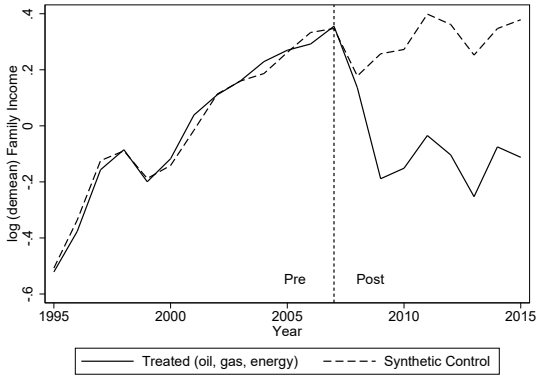
(a) Average Family Income (industry level)



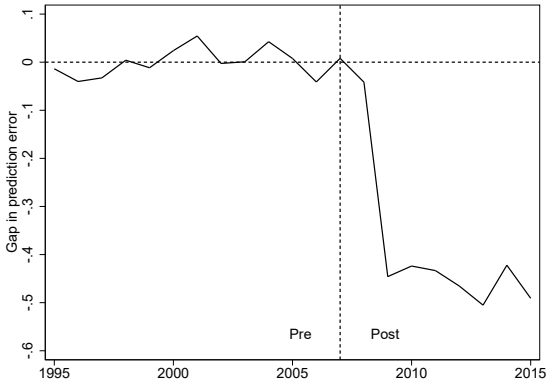
(b) Gap in Prediction Error (industry level)



(c) Average Family Income (industry-sector level)



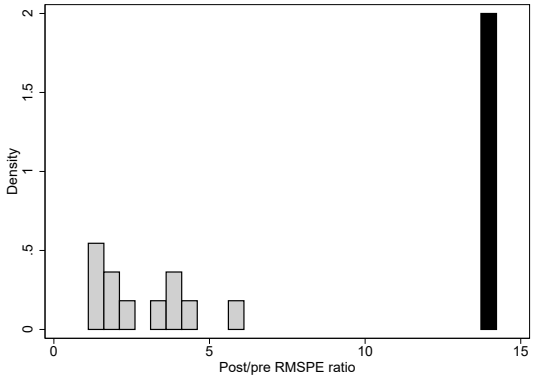
(d) Gap in Prediction Error (industry-sector level)



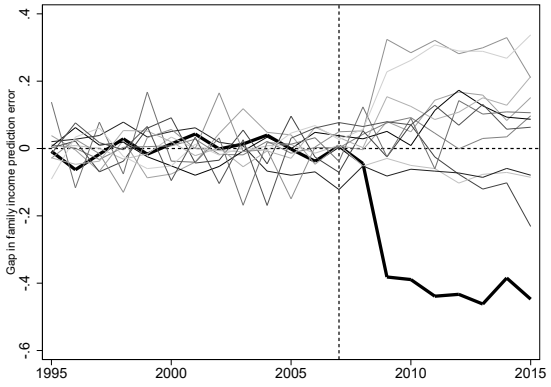
Note: Figure reports synthetic control analyses at industry (top panel) and industry-sector level (bottom panel). The left figures show the average real family income for treated households in the oil and gas industry and energy supply (solid line) and the synthetic control (dashed line) in the period 1995-2015. For industry level analysis, Figure (a), the industries with positive weight in the synthetic control are information (0.148), education (0.169), and health (0.683). For industry-sector level analysis, Figure (b), the industries with positive weight in the synthetic control are information (public: 0.071), education (public: 0.180), health (public: 0.640, private: 0.055), and other service activities (public: 0.053). The right figures ((b) and (d)) show the gap in prediction errors.

Figure 3: Distribution of post/pre RMSPE ratio and Gap in Prediction Error for Placebo Estimates

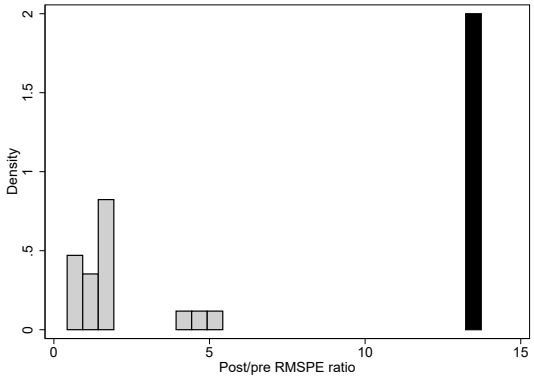
(a) post/pre RMSPE ratio (at industry level)



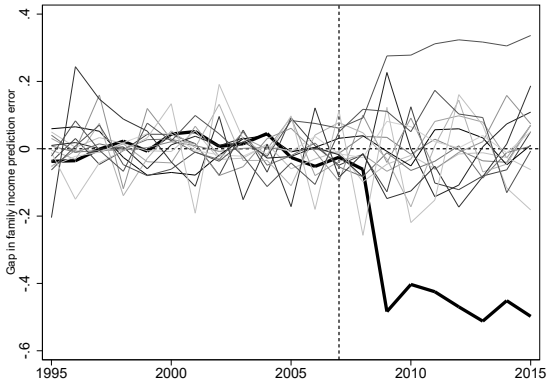
(b) Gap in Prediction Error (at industry level)



(c) post/pre RMSPE ratio (at industry-sector level)

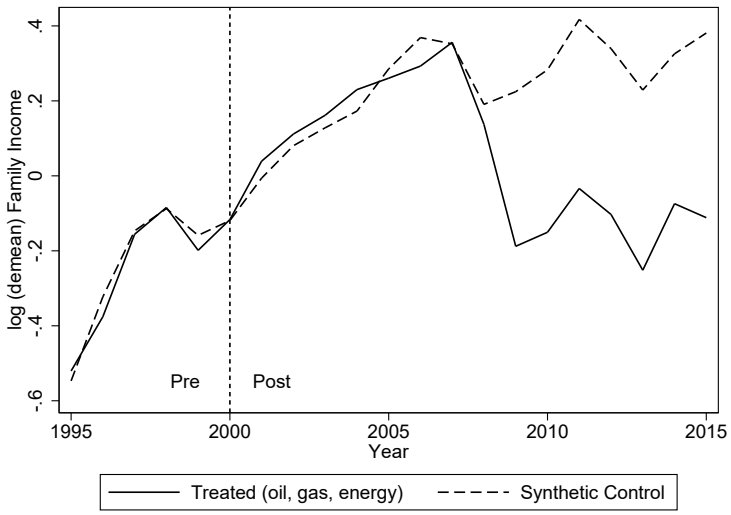


(d) Gap in Prediction Error (at industry-sector level)



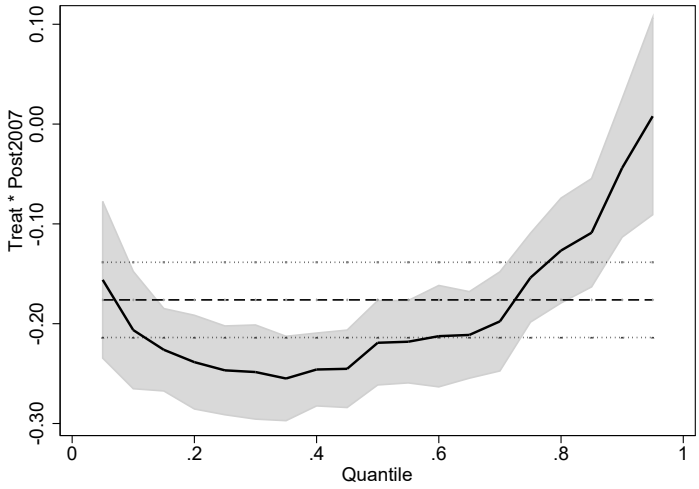
Note: Figure reports synthetic control placebo analyses at industry (top panel) and industry-sector level (bottom panel) in the period 1995-2015. The left figures ((a) and (c)) show the post/pre RMSPE ratio for placebo estimates. The black ones indicate the post/pre RMSPE ratio using the actual treated industries (oil and gas industry and energy supply). The right figures ((b) and (d)) show the gap in prediction errors for placebo estimates, with actual treated industries (oil and gas industry and energy supply) in black solid line.

Figure 4: Placebo Sanctions in the Year 2000-Trends in Family Income



Note: Figure displays the results of an in-time placebo by reassigning the sanctions to the middle of the pretreatment period in the year 2000.
Treatment group: Oil and Gas, Energy Supply industries
Synthetic control group: Education (0.483) and Health (0.517) industries

Figure 5: Heterogeneous Effects on Family Income



Note: Figure shows the heterogeneous effects on family income (coefficients of $Treat \times Post2007$ in Eq (1), with 95-percent confidence interval). The Dependent variable (total family income) is log transformed, and have been deflated by CPI which equals 100 in year 2011. The horizontal dash line shows the OLS coefficient (average effects of sanctions on family income). The solid line shows quantile coefficients.
Treatment group: Oil and Gas, Energy Supply industries
Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

B Tables

Table 1: Descriptive Statistics (before the 2006 UN Economic Sanctions)

	(1) Treatment	(2) Synthetic Control (industry level)	(3) Synthetic Control (industry-sector level)
Household-level variables			
Ln(Total Family income)	18.59	18.50	18.47
	(0.60)	(0.74)	(0.69)
Ln(Labor income)	18.15	18.02	18.00
	(0.61)	(0.78)	(0.70)
Ln(Education Expenditure)	12.21	12.17	12.22
	(4.78)	(4.84)	(4.69)
Observations	2,282	10,405	9,950
Child-level variables ($6 \leq age \leq 24$)			
Age (female)	14.47	14.55	14.47
	(4.96)	(5.01)	(4.97)
Age (male)	14.41	14.28	14.18
	(4.88)	(4.86)	(4.84)
Years of schooling: girls	7.26	7.68	7.64
	(3.84)	(4.10)	(4.08)
Years of schooling: boys	7.24	7.38	7.37
	(3.75)	(3.87)	(3.88)
% In school: girls	77.51	78.63	79.21
% In school: boys	79.28	81.30	82.10
% In school: girls 6-18	93.01	93.36	93.39
% In school: boys 6-18	92.84	93.60	93.88
Observations	6,295	25,076	24,074

Notes: Table reports summary statistics of household and child-level data by treatment status. All variables are averaged for the 1995-2006 period, the years before the sanctions. Standard deviations are in parenthesis. Family incomes and expenditures are deflated by CPI which equals 100 in year 2011. Tests do not reject equality of means for treatment and control groups.

Treatment group (column 1): Oil and Gas, Energy Supply industries, synthetic control group at industry level (column 2): Information (0.148), Education (0.169), and Health (0.683) industries, synthetic control group at industry-sector level (column 3): Information (public: 0.071), Education (public: 0.180), Health (public: 0.640, private: 0.055), and Other Service Activities (public: 0.053) industries

Table 2: Effect on Family Income

Panel A: Real Family Income	Total Income			Labor Income		
	(1)	(2)	(3)	(1)	(2)	(3)
Treat × Post2007	-0.154***	-0.149***	-0.144***	-0.160***	-0.155***	-0.154***
	(0.036)	(0.026)	(0.020)	(0.035)	(0.025)	(0.022)
R-squared	0.197	0.429	0.460	0.173	0.348	0.372
Observations	20,731	20,731	20,731	20,731	20,731	20,731
Panel B:	Real Wage Rate			Weekly Working Hours		
	(1)	(2)	(3)	(1)	(2)	(3)
Treat × Post2007	-0.111***	-0.115***	-0.097***	-0.731	-0.654	-0.734
	(0.037)	(0.032)	(0.030)	(0.782)	(0.804)	(0.745)
R-squared	0.204	0.403	0.429	0.218	0.230	0.271
Observations	9,951	9,951	9,951	9,951	9,951	9,951
Demographic controls	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province & Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Province × Year	No	No	Yes	No	No	Yes

Notes: This table presents estimated coefficients from a linear model for household's income, wage rate, and weekly working hours. Dependent variables (total income, labor income, and wage rates) are log transformed and deflated by CPI which equals 100 in year 2011. The time period for household's income (total and labor income) is 1995-2013. Weekly working hours was not asked before 2006. Thus, the time period for wage rate and weekly working hours is 2006-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group (at industry level): Information (0.148), Education (0.169), and Health (0.683) industries

Table 3: Effect on Education Expenditure of Households

Dependent Variable	Share (2006)	log	share	per child (log)
A. Total Expenditure		-0.111***	-	-
		(0.016)	-	-
B. Categories				
Education	2.14%	-0.575***	-0.051**	-0.565***
		(0.137)	(0.021)	(0.134)
School Tuition	21.02%	-0.393***	-0.033***	-0.384***
		(0.139)	(0.009)	(0.131)
University Tuition	51.02%	-0.713***	-0.010	-0.739***
		(0.381)	(0.026)	(0.378)
Books	39.54%	-0.344***	0.001	-0.337***
		(0.082)	(0.008)	(0.078)
Private Tutoring	6.21%	-0.537***	-0.020**	-0.337***
		(0.186)	(0.008)	(0.078)
non-Education	97.86%	-0.111***	0.002**	-
		(0.022)	(0.001)	-
Observations		20,731		

Notes: This table presents estimated coefficients of Treat × Post2007 (γ in Eq (1)). Dependent variables are family expenditure on education (by item) and non-education goods and services according to COICOP classification. Dependent variables are deflated by CPI which equals 100 in year 2011. The sample includes all households with at least one member at age 6-24. For school spending the sample consists of all children aged 6-24 who have not graduated high school. For university spending the sample consists of children aged 6-24 who have graduated high school. For spending on books, I consider all children aged 6-24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Table 4: Effect on Enrollment Rate and Years of Education

	Enrollment in grade 1-9 (6-14 yr old)	Enrollment in High School II (15-18 yr old)	Attending Any College (HSG, ≤24 yr old)	Years of Education (15-24 yr old)	Years of Education (6-24 yr old)
A. No differences across gender					
Treat × Post2007	0.001	-0.001	-0.048**	-0.262***	-0.117***
	(0.005)	(0.005)	(0.024)	(0.077)	(0.047)
R-squared	0.013	0.014	0.143	0.948	0.708
B. Allowing differences across gender					
Female × Treat × Post2007	0.001	-0.014*	0.007	0.127	-0.063
	(0.006)	(0.054)	(0.054)	(0.238)	(0.155)
Female × Treat	-0.003	0.010*	-0.009	-0.458***	-0.062
	(0.004)	(0.006)	(0.028)	(0.071)	(0.041)
Female	0.001	-0.002	-0.026*	0.358***	0.059**
	(0.002)	(0.002)	(0.016)	(0.044)	(0.026)
R-squared	0.010	0.012	0.145	0.956	0.739
Mean	98.95%	81.76%	59.59%	10.49	7.70
Observations	22,560	8,231	6,217	20,450	43,011

Notes: This table presents estimated coefficients from a linear model for enrollment and years of schooling. Dependent variable for the first column is being students enrolled in grade 1-9 as a falsification test. The sample for this analysis is children of the age group that officially corresponds to each level. In the panel B, I examine gender differences by estimating Eq (2). The time period is 1995-2013. I control for age, age-squared, and parents' education effects. I also add time, province, and industry fixed effects. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Table 5: Income Elasticity of Education Spending

Dependent variable: Ln(Household Spending on Education)		
	2SLS	Robustness Check
Variables	IV: Ln(Expenditure)	IV: Ln(Income)
IV	3.284**	2.049**
	(1.374)	(0.850)
First stage		
IV: Treat × Post2007	-0.111***	-0.149***
F-stat	353.74	553.24
R-squared	0.316	0.419
Observations	20,731	20,731

Notes: This table presents estimated coefficients of Eq (4) and (5). Dependent variable is Ln(Household Spending on Education). Since education spending and total household expenditure are both in logarithmic form, ξ denotes elasticity. I also use family income itself as a robustness check. Additional controls include household size, head's age, and head's education. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Table 6: Sanctions Effects, Industry-Sector Level Synthetic Control Analysis

	Family Income (log)	Education Expenditure (log)	Attending college (HSG,≤24 yr)	Years of Schooling (15-24 yr)	Years of Schooling (6-24 yr old)
Treat × Post2007	-0.170***	-0.702***	-0.057**	-0.338***	-0.161***
	(0.027)	(0.137)	(0.025)	(0.078)	(0.047)
R-squared	0.413	0.115	0.152	0.948	0.709
Observation	19,732	19,732	6,106	20,731	43,862

Notes: This table presents estimated coefficients of Eq(1) using synthetic control method (SCM) at the industry-sector level. Family income and education expenditure are log transformed and deflated by CPI which equls 100 in year 2011. The sample for the attending college is high school graduates who are aged less than 24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (public: 0.071), Education (public: 0.180), Health (public: 0.640, private: 0.055), and Other Service Activities (public: 0.053) industries

Table 7: Heterogeneous Effect on Family Income

	Average Effect	Quantile Regression			
	(OLS)	0.25	0.50	0.75	0.90
Treat × Post2007	-0.149***	-0.237^{+***}	-0.200^{+***}	-0.129***	-0.025^{+}
	(0.026)	(0.022)	(0.023)	(0.028)	(0.038)
R-squared	0.429	0.117	0.117	0.120	0.110
Observations	20,731	5,183	10,366	5,182	2,073

Notes: This table presents estimated coefficients from OLS and quantile regression for family income. Dependent variable (total family income) is log transformed and deflated by CPI which equals 100 in year 2011. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level. $^{+}$Significantly different quantile regression coefficient from OLS coefficient at the 5% significant level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Table 8: Heterogeneous Effect on Enrollment Rate (School/College) by crucial ages

	Age		
	6	16	18 (HSG)
A. No differences across gender			
Treat × Post2007	0.041	-0.043**	-0.154**
	(0.032)	(0.023)	(0.062)
R-squared	0.279	0.075	0.157
B. Allowing differences across gender			
Female × Treat × Post2007	0.043	-0.122***	-0.072
	(0.005)	(0.036)	(0.104)
Female × Treat	-0.025	0.077***	0.035
	(0.003)	(0.021)	(0.057)
Female	0.038**	0.003	-0.143***
	(0.002)	(0.013)	(0.032)
R-squared	0.029	0.076	0.169
Mean	91%	92%	47%
Observations	1,019	3,011	1,437

Notes: This table presents estimates of the average and gender differences effects of the sanctions on the enrollment rate by crucial ages: enrollment in the first grade at age 6, high school at age 16 (high school dropout age) and matriculation at a university at age 18 among high school graduates. In the panel B, I examine gender differences. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.
Treatment group: Oil and Gas, Energy Supply industries
Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Table 9: Heterogeneous Effect on Education by percentiles of Family Resources

	Family Wealth			Family non-labor Income		
	<25th	25-95	>95th	<25th	25-95	>95th
A. Years of Schooling						
Treat × Post2007	-0.235**	-0.105	0.066	-0.225**	-0.038	0.323
	(0.113)	(0.097)	(0.308)	(-0.110)	(0.096)	(0.221)
R-squared	0.676	0.732	0.792	0.683	0.721	0.834
Observations	11,701	31,699	2,347	11,496	31,963	2,288
B. Education Spending						
Treat × Post2007	-0.399	-0.613***	1.551	-0.021	-0.539***	0.365
	(0.350)	(0.150)	(1.309)	(0.362)	(0.153)	(1.029)
R-squared	0.139	0.089	0.064	0.157	0.099	0.048
Observations	5,478	14,237	1,014	5,067	14,662	1,000

Notes: This table presents the effects on years of schooling and household education spending over the wealth and non-labor income distributions. The sample for this analysis is children aged 6 to 24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Table 10: Heterogeneous Effect on Education
by Mothers Activity and Income

	Mother's Employment		Mother's Income	
	employed	non-employed	positive	zero
A. School Enrollment				
Treat × Post2007	0.042	-0.151***	-0.314	-0.121**
	(0.187)	(0.055)	(0.250)	(0.056)
R-squared	0.803	0.689	0.782	0.689
Observations	11,305	34,442	12,781	32,966
C. Education Spending				
Treat × Post2007	-0.062	-0.635***	-0.432	-0.559***
	(0.296)	(0.163)	(0.278)	(0.167)
R-squared	0.120	0.123	0.114	0.125
Observations	5,836	14,893	6,614	14,115

This table presents the effects on years of schooling and household education spending over mother's employment status and income. The sample for this analysis is children aged 6 to 24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

C Appendix: Identification Assumptions

In this appendix, I provide analysis on the validity of identification assumptions. Since the data is repeated cross sections, I need to make sure the composition of the sample is not changed between periods. This assumption is necessary so that if any trend change occurs between groups, I can attribute the deviation from the time trend to the effect of the sanctions, not to the change in the composition of the group members. For observed characteristics, I check the covariate balance and labor movement.

Households Composition. First, I check the balance of control variables. As Pei et al. (2018) show, a powerful test of the identifying this assumption is to put the control variable on the left-hand side of the regression (Eq (1)) instead of the outcome variable (balancing test). A zero coefficient on the causal variable of interest then confirms the identifying assumption. Table C.1 reports the estimated coefficient γ of balancing test for all control variables (X) including parent's education, age, etc. As the results show, the coefficient of interest (γ) is not significantly different from zero. These results show that the selection does not change differentially in terms of gender, age, family size, head's education, and employment status of mother and father.

Table C.1: Balancing Test and Selection on Observables

	Children		Household			
	Female	Age	Family Size	Head's Education	Employed Mother	Employed Father
Treat × Post2007	0.018	0.750	-0.011	0.331	-0.022	-0.008
	(0.015)	(0.470)	(0.083)	(0.240)	(0.017)	(0.009)
R-squared	0.002	0.031	0.313	0.150	0.084	0.019
Observations	43,011	43,011	20,731	20,731	20,731	20,731

Notes: Table shows the coefficient γ and standard errors from OLS regressions (Eq (1)) for each variable. The results are not significantly different from zero. Thus, the sanction had not any significant effect gender, age, family size, head's education, and employment status of mother and father. The sample is households with children aged 6 to 24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.
Treatment group: Oil and Gas, Energy Supply industries
Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Although, the sanctions did not affect the family size (the number of observed people in the household), it could affect household composition. In particular, if older children are more likely to be in the household as the result of the sanctions, this would bias the estimates. Thus, I also conduct an analysis of cohort size to make sure the sanctions did not affect household composition. As Table C.2 shows, the sanction had not any significant effect on household composition in term of age and relation to the head. Also, sanctions had no effect on the probability of young adults (18-24) to live with their parents.

Table C.2: The Effect of Sanctions on Household composition

	children		living with parents	relation to the head			
	0-5 yr old	6-17 yr old	(18-24 yr old)	child	parent	sibling	other
Treat × Post2007	0.011	0.001	-0.033	0.019	-0.000	0.001	0.001
	(0.021)	(0.021)	(0.024)	(0.010)	(0.000)	(0.001)	(0.001)
R-squared	0.129	0.107	0.310	0.016	0.003	0.004	0.003
Observations	20,731	20,731	10,037	20,731	20,731	20,731	20,731

Notes: Table shows the coefficient γ and standard errors from OLS regressions (Eq (1)) for each variable. The results are not significantly different from zero. Thus, the sanction had not any significant effect on household composition in term of age and relation to the head. The sample is households with children aged 6 to 24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

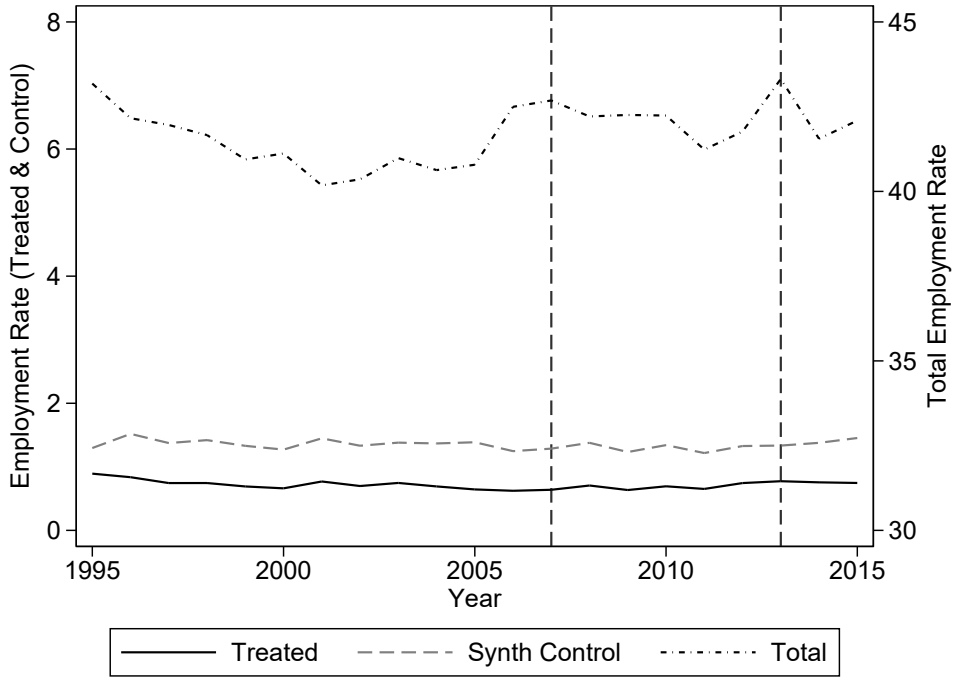
Labor Movement. I also check whether the sanctions significantly affect moving workers within industries. Workers movement across sectors could bias estimates of sanctions effects obtained by comparing outcomes according to the family's head economic activity (Rosenzweig and Wolpin (1988)). As mentioned before, the 2006 UN sanctions mostly affected the oil and gas industry and energy supply. Since real wage decreased in these industries, it is possible that the workers in the affected industries leave their job and move to other industries. To provide evidence on the impact of the sanctions on labor composition, I check changes of both quantity (employment rate and employment share) and quality (measured by years of schooling) of labor across industries in the main sample and a bigger sample from Iranian Labor Force Survey (ILFS). Figure C.1 shows a stable employment rates over time in treatment and control industries despite fluctuations in the total employment rate. The employment rate of treated and control industries were always about 1.0% and 1.2%, respectively.

I examine the effects of sanctions on job separation rate and years of schooling of employees and unemployed individual who used to work in each industry using Iranian Labor Force Surveys (ILFS). Although the main data is a rotating panel, this feature of the panel can not be used in this study because households' id is changed for confidentiality protection in the version available to researchers. Moreover, using this data, I cannot check quality and quantity of unemployed individuals who used to work in treated and control industries. Thus, I use another data Iranian Labor Force Survey (ILFS). The advantage of ILFS data is that it provides some information about the former job of unemployed individuals.[46] Using ILFS, I look at changes of three variables: the job separation rate, average years of schooling of workers, and average years of schooling of unemployed individuals who used to work

[46]In particular, the ILFS offers detailed information about the respondents' demographic characteristics, labor supply, residential area, recent migration, the current job for employees, previous job and reasons for leaving for unemployed. The data are repeated cross sections collected under rotating panel design on the same reference population. The ILFS collects the data on over 400,000 individuals quarterly using random sampling.

in treated and synthetic control industries. As Table C.3 shows, the sanctions had no signification effects on these variables. I also observe the reason of the leaving job for unemployed individuals (low income, getting fired or layoff, the company went out of business, family circumstances, temporary job, position ended, going back to school, illness, relocating, retiring, etc). Only 7% of unemployed individuals who used to work in treated industries have left their job because their income was low and this percentage is constant over time (years before and after the sanctions).

Figure C.1: Total/treated/ Control Employment rate



Note: Figure shows a stable employment rates over time in treatment and synth control industries despite fluctuations in total employment rate. The employment rate of treated and control industries were always about 0.7% and 1.3%, respectively.

Table C.3: Effect on Job Separation and Years of Education

		Years of Education	
	Job Separation	Employees	Unemployed
Treat × Post	-0.005	0.032	0.254
	(0.006)	(0.285)	(0.320)
R-squared	0.018	0.208	0.319
Observations	162,836	156,922	5,914

Notes: Table present the effct of sanction on sepration rate and years of schooling (as a proxy for skills) for employees and unemployed individuals who use to work in treated or synthetic control. The sample is from IRFS and time period is 2005-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

Workers did not move at least for three reasons. First, during the sanction years, the unemployment rate was high (more than 10%) and increasing, and duration of unemployment after losing a job was one year on average. In fact, the Iranian labor markets were sticky even before the sanctions. Second, different skills needed among industries is another obstacle for the labor movement; for example, oil engineers and technicians have little chance of obtaining employment in other industries. Third, although the real wage of the oil and gas industry was decreasing after the sanctions, the level was higher compared to many other industries. For example, the wage rate of accountants had been higher in the oil and gas industry during the sanctions years. Thus, although they had experience or qualifications to work in other industries, they did not move. Because of these reasons, the sanctions effects on labor movement are ignorable, and most of the members in the treated and control groups remain the same.

For unobserved characteristics, the assumption is that there is no unobserved group specific changes that (1) are correlated with the sanction change and (2) are correlated with group specific changes in the outcome variables. Since outcome variables, e.g. income are likely to be correlated within local labor market and industry levels, all observations are clustered at province (29 provinces) and industry (3 industries in the main identification and 4 industries using synthetic control method) level (87 clusters in the main identification and 116 clusters using synthetic control method) to account for correlation within observations, which may result in an underestimation of standard errors. As explained before, since there are few clusters at the industry level, I calculate p-values using wild bootstrap randomization inference (WBRI).

As explained before, households might adjust this shock by using their saving to mitigate the impact of sanctions on children. However, if sanctions increased uncertainty about future income,

households may consume less and save more. Table C.4 show that the sanctions had no significant effect on family savings and debt.

Table C.4: Effect on Family Savings and Debt

	Savings		Debt	
	log	share	log	share
Treat × Post	0.535	0.007	-0.569	-0.056
	(0.364)	(0.019)	(0.374)	(0.242)
R-squared	0.123	0.186	0.072	0.025
Observations	20,731	20,731	20,731	20,731

Notes: This table presents estimated coefficients from a linear model for household's savings and debt. Dependent variables are log transformed and deflated by CPI which equals 100 in year 2011. The share values are share of total family income. The time period is 2005-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

For heterogeneous effects analysis based on family financial resources, I need to make sure that the wealth index (based on Filmer and Pritchett (1999)) and non-labor income were not affected by the sanctions. Table C.5 shows that the sanction had no effect on the wealth index and non-labor income (and their components).

Table C.5: Sanction Effects on Wealth Index and non-Labor Income

Dependent Variable		Treat × Post2007
Wealth Index		-1.641
		(3.284)
components:	durable goods	0.042
		(0.045)
	housing ownership	-0.013
		(0.021)
	housing characteristics	-1.641
		(3.284)
non-Labor Income	(*log*)	-0.100
		(0.112)
	(*share*)	-0.001
		(0.006)
components (log):	scholarships and cash gifts	0.018
		(0.106)
	transferred aids	-0.035
		(0.118)
	interest on bank deposits, bonds yield, and share dividends	-0.082
		(0.519)
	real estate incomes	0.227
		(0.196)

Notes: Table shows the coefficient γ and standard errors from OLS regressions (Eq (1)) for wealth index and non-labor income. Non-labor incomes are deflated by CPI which equals 100 in year 2011. The results are not significantly different from zero. Thus, these two variables (and their components) were not affected by the sanctions. The sample is households with children aged 6 to 24. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Information (0.148), Education (0.169), and Health (0.683) industries

D Appendix: Robustness Check for the Synthetic Control

In this appendix, I conducted several sensitivity tests to assess the sensitivity of the synthetic control to alternative implementations of the SCM. First, I evaluate the effects of the choice of matching variables, matching year range, and methods for selecting weights. Then, I check the sensitivity of results using different selected donor industries. Overall, these sensitivity tests verify the robustness of the original synthetic.

following Cavallo et al. (2013), I check validity of synthetic control for counterfactual by checking the sensitivity of results to the choice of matching variables. For the main analysis, following Botosaru and Ferman (2019), I consider only pre-treatment family income as matching variable. As robustness check, I include observed covariates (parent's education, employment status, age, etc.). I also include some (but not all) lags of family income in the list of matching variables and check whether the synthetic control matches well the treated households. Table D.1 (the first column) reports RMSPEs as a measure of the pretreatment fit for the different model choices. As the Table shows, changing the list of matching variables has no large effect on matching results ($0.034 \leq \text{RMSPE} \leq 0.051$). In particular, I find that if more pre-treatment family income are included, the variable weights for covariates are small and ignorable. Overall, using different matchings, the synthetic controls closely match the treated industries in the pretreatment period. However, the choice of matching method could affects the results if it influence the selected industries for the synthetic control. Table D.1 (panel A) lists the industries weights for different matchings. For all cases but one, the health industry receives the largest weight ($0.647 \leq w \leq 0.831$). The weight of the education industry is zero in some cases and the weight of the water supply is positive in three cases. Thus, the composition of the synthetic control group is sensitive to the matching method. However, as the panel B shows, the main results are similar.

As explained before, I discard financial, real state, and administrative and support service industries from the donor pool. I exclude financial sector because some firms in this industry that owned or control by IRGC and Setad are targeted by the sanctions, but in HIES the name of firms are not observable. I also exclude households in real state and administrative and support service sectors for two reasons: first, these households experience a large reduction in family income with a lag; second, these households are unsuitable controls because of large difference in their characteristics relative to treated households (Abadie (2019)). As a robustness check, I include these industries. The new synthetic control includes real state as well as information, education, and health industries with a small weight (0.067) for the real state industry. The root mean squared prediction error (RMSPE) is 0.030, very close to the RMSPE of the original synthetic control (0.034). Since households in this industry experienced a reduction in their income over the years of sanction, using this synthetic control may result in an underestimation of the effects of the sanction. However, since the weight of the real state is relatively small, the results are not significantly different from the main results.

Also, for the leave-one-out test (Abadie et al. (2015)), I iterate over the model to leave out one potential control industry each time to assess whether one of the donor industries is driving the results. The leave-one-out synthetics closely match the original synthetic that includes three

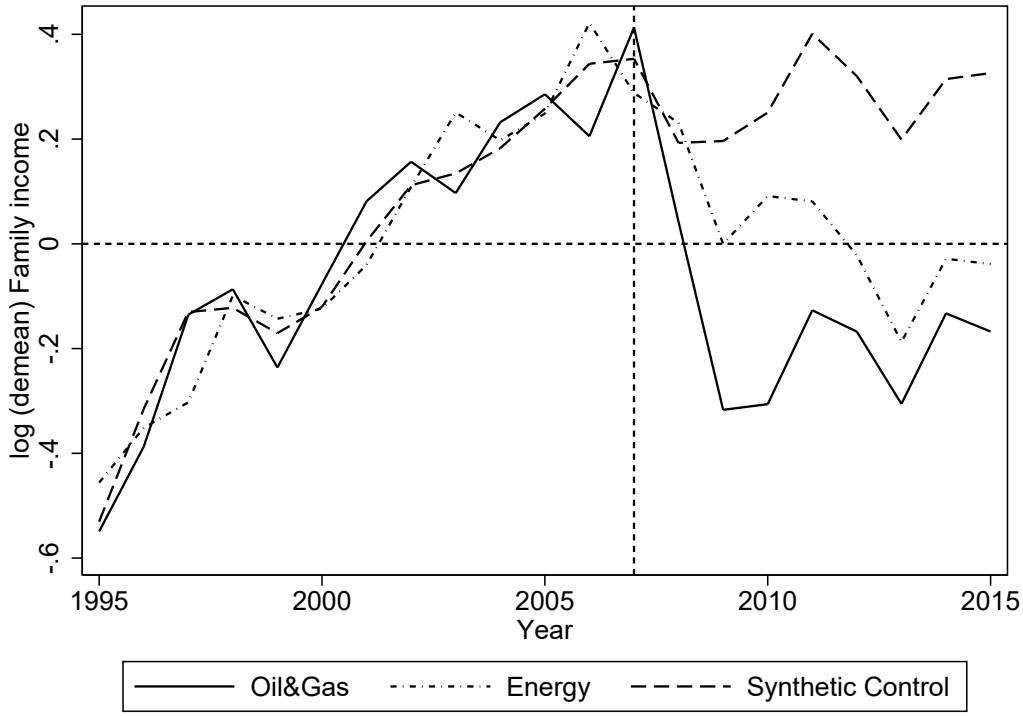
industries (information, education, and health).

Table D.1: Synthetic Control groups for Various Matchings and the Effects on the Main Results

		A. Weights				B. Effects on the Main Results			
	RMSPE	Information	Education	Health	Water Supply	Family Income	Education Spending	Years of Schooling	Attending College
Main Model	0.034	0.148	0.169	0.683	-	-0.149***	-0.575***	-0.262***	-0.048**
Matching variables									
predictors, no lags	0.047	-	-	0.647	0.353	-0.125***	-0.535***	-0.367***	-0.028**
predictors + lags	0.035	0.148	0.169	0.683	-	-0.149***	-0.575***	-0.262***	-0.048**
Family Income lags									
2000-2006	0.035	0.169	-	0.831	-	-0.130***	-0.537***	-0.329***	-0.031**
1995,2000,2006	0.039	0.169	-	0.831	-	-0.130***	-0.537***	-0.329***	-0.031**
2000,2006	0.051	0.169	-	0.831	-	-0.130***	-0.537***	-0.329***	-0.031**
1995,2000	0.039	0.169	-	0.831	-	-0.130***	-0.537***	-0.329***	-0.031**
1995,2006	0.042	0.169	-	0.831	-	-0.130***	-0.537***	-0.329***	-0.031**
Matching year range									
2000-2006	0.026	0.215	-	0.703	0.082	-0.125***	-0.524***	-0.347***	-0.031**
Method for selecting weights									
Nested (Main Model)	0.034	0.148	0.169	0.683	-	-0.149***	-0.575***	-0.262***	-0.048**
Standard	0.035	0.187	-	0.804	0.010	-0.129***	-0.534***	-0.332***	-0.031**

Notes: Table reports RMSPEs (root mean squared prediction error) as a measure of the pretreatment fit for the different model choices, the industries weights for different matchings, and the main results using different synthetic controls. The composition of the synthetic control group is sensitive to the matching method. However, as the panel B shows, the main results are similar using different synthetic controls.

Figure D.1: Average Real Income For Treated (by industry) and Synthetic Control



Note: Figure shows the average real family income for treated households (seprated by industry: oil and gas industry, energy supply) and synthetic control (information (0.148), education (0.169), and health (0.683) industries) in the period 1995-2013.

E Appendix: Robustness Check for the Main Results

Table E.1: Effects of the Placebo Sanctions in the Year 2000

	Family	Education	Attending college	Years of Schooling	
	Income (log)	Expenditure (log)	(HSG,≤24 yr)	(15-24 yr)	(6-24 yr old)
Treat × Post2007	0.006	0.193	0.004	0.009	0.069
	(0.025)	(0.112)	(0.034)	(0.087)	(0.051)
R-squared	0.451	0.137	0.136	0.947	0.719
Observation	11,877	11,877	3,585	13,941	29,396

Notes: This table presents estimated coefficients of Eq(1) for the in-time placebo sanctions 2000. Family income and education expenditure are log transformed and deflated by CPI which equals 100 in year 2011. The sample for the attending college is high school graduates who are aged less than 24. The time period is 1995-2006. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group: Education (0.483) and Health (0.517) industries

Table E.2: Robustness Checks

	Family Income (log)	Education Expenditure (log)	Attending college (HSG,≤24 yr)	Years of Schooling (15-24 yr)	Years of Schooling (6-24 yr old)
A. Main Model					
Treat × Post2007	-0.149***	-0.575***	-0.048**	-0.262***	-0.117***
	(0.026)	(0.137)	(0.024)	(0.077)	(0.047)
B. Including 2014, 2015					
Treat × Post2007	-0.158***	-0.473***	-0.051**	-0.266***	-0.109***
	(0.026)	(0.124)	(0.022)	(0.069)	(0.042)
C. Excluding 2007					
Treat × Post2007	-0.149***	-0.541***	-0.044**	-0.259***	-0.108***
	(0.027)	(0.138)	(0.063)	(0.077)	(0.047)
D. Excluding 2009					
Treat × Post2007	-0.146***	-0.457***	-0.033**	-0.208**	-0.083*
	(0.027)	(0.145)	(0.017)	(0.082)	(0.050)
E. Excluding Covariates					
Treat × Post2007	-0.154***	-0.851***	-0.030**	-0.169**	-0.437***
	(0.036)	(0.145)	(0.016)	(0.081)	(0.085)

Notes: This table presents the results of robustness test. Family income and education expenditure are log transformed and deflated by CPI which equls 100 in year 2011. The sample for the attending college is high school graduates who are aged less than 24. The time period is 1995-2013. Heteroskedasticity-consistent standard errors accounting for clustering at the province and industry level in parentheses. P-values are calculated using wild bootstrap randomization inference (WBRI). *Significant at 10% level; **significant at 5% level; ***significant at 1% level.

Treatment group: Oil and Gas, Energy Supply industries

Synthetic control group (at industry level): Information (0.148), Education (0.169), and Health (0.683) industries