Essays on Women's Empowerment and Economic Development in Iran

Sara Taghvatalab

Dissertation submitted to the faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Economics

Djavad Salehi-Isfahani, Chair
Kwok P. Tsang
Suqin Ge
Wen You

June 25, 2015
Blacksburg, Virginia

Keywords: Women empowerment, Infrastructure, Electrification, Fertility, Education, Time-use

Essays on Women's Empowerment and Economic Development in Iran

Sara Taghvatalab

(ABSTRACT)

This dissertation consists of three essays on women empowerment in Iran. In the first two chapters, we examine the impact of the rapid expansion of electricity to rural areas of Iran after the 1979 revolution on two important determinants of women's empowerment, fertility and female literacy. We use the timing of provision of electricity to villages to identify its impact on the child-woman ratio and the literacy rate of adult women and men. We use difference-in-differences (DID) method as well as instrumental variables (IV) to account for the potential endogeneity of electrification. Our findings for the impact of electricity on fertility is highly sensitive to the method of identification. The DID results imply that electrification lowers fertility whereas the IV estimates suggest the opposite. The results on literacy are consistent across estimation methods, both showing that electrification increases female literacy.

In the third chapter, we focus on the role of education in the empowerment of women. The positive effects of education on female empowerment through lower fertility and greater labor force participation are well known. Female empowerment is also closely identified with greater participation in market work and access to an independent source of income. In the past two decades Iranian women have increased their education, lowered their fertility, but their labor force participation remains low. In this chapter we examine the role of education in the empowerment of Iranian women through their allocation of time between domestic work, child education, and market work. We find evidence that more educated women spend more time in market related activities and child education, but less in domestic work. The behavior of women in time allocation to market work and childcare exhibits similar patterns and both are quite different from house or domestic work. These findings are consistent with the hypothesis that education empowers women by increasing their ability to earn more income as well as through their ability to invest in the education of their children. [1]

[1] This paper is supported by a grant from the Economic Research Forum in Cairo.

Acknowledgments

I would like to sincerely thank Professor Djavad Salehi-Isfahani, my advisor for his valuable guidance, understanding, and all his time during my doctoral studies. He not only shared his research insights with me and helped me to develop my research and teaching interests and skills, but also helped me in other aspects of my life.

I would also like to thank the members of my Ph.D. committee, Dr. Kwok Tsang, Dr. Suqin Ge, and Dr. Wen You, for their valuable discussions, comments, and guidance to make my dissertation much stronger. I would also like to express my gratitude to Dr. Richard Ashley for his helpful advice to improve my research and Dr. Steve Trost for his guidance and support during my teaching experience.

I am also grateful to all my wonderful friends and classmates at Virginia Tech for making my Ph.D. studies an enjoyable and unforgettable experience. I would like to gratefully appreciate all their contributions. I wish the space would allow me to individually thank all of my friends and highlight their names. This dissertation would not have been possible without their kind supports and valuable feedback. Special thanks to kind and supportive staffs of department of economics, Amy Stanford, Sara Tickle, and Will Bebout for all their helps.

I am also grateful to the department of economics and Economics Research Forum at Cairo for their financial support to pursue my graduate studies.

Most importantly, I am deeply and forever thankful to my my mother, Nasrin Yazdianpour, for her unconditional love and support throughout my life, and my father, Mohsen Taghvatalab, for supporting, inspiring and encouraging me to pursue my goals. I would also like to thank my sister, Golnaz for helping me to go through stressful moments of my life and for sharing her experiences with me.

Contents

List of Figures

List of Tables

Chapter 1

Rural electrification and female empowerment in Iran: decline in fertility

1.1 Introduction

It is widely acknowledged that a good public infrastructure is essential for economic development. The value of good roads and reliable electricity supply for business investments is well established. A growing literature is asking how specific services, such as roads, electricity, clean water, and communication services affect economic growth (Agénor and Moreno-Dodson 2006; Canning and Pedroni 1999b; Canning and Pedroni 1999a; Barnes 1988; Barkat, Khan, Rahman, Zaman, Poddar, Halim, Ratna, Majid, Maksud, Karim, et al. 2002; Fluitman 1983; Henderson, Storeygard, and Weil 2011; Merrick 1985), producing information that is essential for allocation of limited public funds for investment in infrastructure. An important channel through which infrastructure promotes economic development is by changing the behavior of families, an area that has been less explored.

Recent theories of development place a great emphasis on the family as an agent of economic development. Theories of Becker (1992), Lucas (2002), and others, sometimes known as the unified growth theory (Galor 2004), pay particular attention to behavior of families in fertility and investment in human capital. Lucas' theory, for example, links the Industrial Revolution in Europe to the emergence of technologies that increased the returns to human capital and induced families to have fewer children and invest more in the education of each child. At the heart of these theories is a transformation in the role of women in the household and society that can best be characterized as empowerment: moving away from traditional roles in procreation and house work to new roles in market work and the production of human capital at home.

In this chapter we take up the question of how the extension of electricity to rural areas of Iran has affected the fertility of rural women, an important determinant of their empowerment. Women's empowerment in Islamic Iran may seem paradoxical because the Islamic revolution of 1979 empowered a strong conservative current in the Iranian society that considered the role of women confined to home duties, as mothers and homemakers. In particular, for the first ten years of the revolution, the state strongly advocated large families. The revolution brought with it another equally strong current, a populist development-oriented movement, which manifested itself in the Reconstruction Crusade in the rural areas, which revolutionaries believed had been neglected by the Pahlavi regime they had overthrown (Salehi-Isfahani 2009). The populist streak lost no time in getting on with rural development, with rural electrification as its banner program. During its first ten years (1978-1988), despite a devastating war that ranged for 8 of the ten years, it raised the percentage of rural families with electricity from 22.6% to 68.5%, and during its second decade to 93.7% (Statistical Center of Iran, Expenditures and Income Surveys, various years, http://amar.sci.org.ir). Beginning in 1989, in a turnabout, the Islamic government advocated family planning and embarked on an ambitious family planning program in rural areas (Abbasi-Shavazi, McDonald, and Hosseini-Chavoshi 2009; Salehi-Isfahani, Abbasi-Shavazi, and Hosseini-Chavoshi 2010). (The leadership of Islamic Republic has now come to regret this particular policy and the government has passed legislation undoing the incentives for smaller families.) The contradictory objectives of the revolutionaries not withstanding, life for rural women improved considerably in the first two decades of the Islamic Republic. Fertility dropped from above 7 birth per woman to just 2 in a period of 20 years (see Figure 1.1).

Our aim is to quantify the causal impact of the extension of electricity to rural areas on village-level child-woman ratios. We know electrification has promoted a host of other development initiatives that are correlated with fertility, including rural health clinics that were instrumental in promoting the health of rural women and their children, and enabling them to achieve their desired level of fertility. We are not able to identify the multiple channels through which electrification may have contributed to lower rural fertility. Instead, we employ a reduced form method that allows us to estimate the total impact of electrification through the multiple channels.

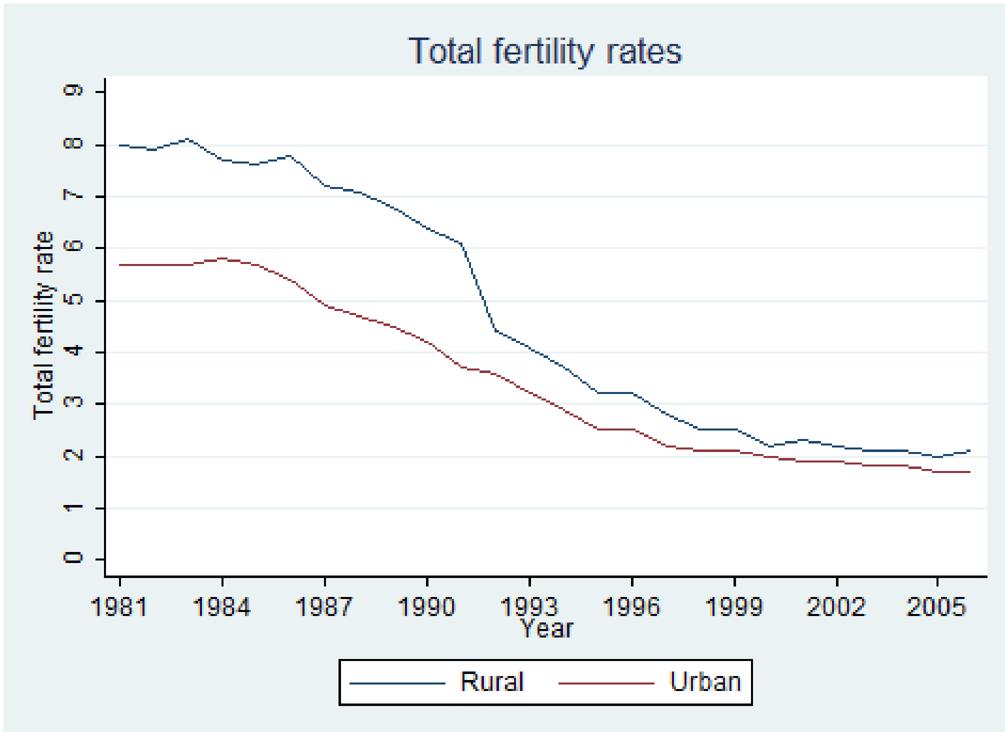
To do this we exploit the timing of extension of electricity to rural areas. Since allocation of electricity to villages is in principle not completely random, we employ different strategies to deal with the potential endogeneity of program placement. We first use difference-in-differences (DID) method under the assumption that conditional on certain village characteristics, the placement of electricity in a village was exogenous. We define a control group as those villages without electricity in census year 1996 and a treatment group as those that received electricity between 1986 and 1996. It allows us to compare the changes in village-level fertility in the census years 1986 and 1996 between these two groups. DID estimates can be biased if conditioning on observable village characteristics does not make program placement fully random or if the assumption of "parallel time trends" is violated. The latter assumes that whatever happened to villages without electricity would have happened to those with it if they remained without electricity until 1996.

The assumption of conditional independence requires accounting for all variables that influence program placement. When this is in doubt, researchers use instrumental variable (IV) estimation. A reliable instrument in our case is topography, which changes the cost of infrastructure without directly affecting the outcome of interest. We use as instrument village elevation from the sea level relative to the district mean where villages are located in. Dinkelman (2011) uses land gradient in South Africa as instrument to estimate the impact of electrification on women's employment (see also Grogan (2011), Grogan and Sadanand (2012)). We believe that elevation is a valid instrument because it is unlikely to be directly related to fertility; any correlation it has with fertility is through electrification.

The IV results are strikingly different from DID (and OLS) estimates. Whereas DID estimates imply that electricity reduces fertility, IV estimates indicate the opposite. One way to reconcile these two results is to assume that DID estimates are biased downward because electrification is endogenous to the level of village development, which is correlated with fertility, and our controls in the DID regression fail to satisfy the conditional independence assumption that is necessary for unbiased DID estimates. If more developed villages that also had lower fertility received electricity earlier, and we were able to control for all the variables that affect the timing of electrification, DID estimates would be unbiased. One source of bias of the DID results is therefore inadequate control for these variables. If this is the case, then removing the bias reveals that the exogenous effect of electrification may well be to raise fertility, perhaps through its positive income effect. This seems plausible because the negative price effect of electricity on fertility might be small relative to its income effect since electrification reduces the time women need for food preparation (freezers and refrigerators) and general household chores (vacuum cleaners). This is also plausible because rural women in Iran either do not engage in market work or when they do they work at home, which is less in competition with childcare.

Our analysis focuses on the period before 1996 during which major changes took place in provision of electricity to villages as well as in rural fertility. By the time of the next census, 2006, the variation in CWR is much lower because fertility transition had extended to the entire rural population. In 1996 more than 50% of villages in our sample had CWRs greater than 0.5 (about TFR greater than 3), whereas in 2006 only 3% were in that category.

Figure 1.1: Fertility decline in rural and urban areas



The plan of this chapter is as follows. The next section provides a conceptual framework for the impact of electricity on women's fertility. section 1.3 introduces background information on electrification history in Iran. Section 1.4 describes our data and provides summary statistics. Section 1.5 discusses the DID and IV regressions. Section 1.6 presents the empirical results using the two methods, and section 1.7 offers our concluding remarks.

1.2 Conceptual framework

Rural electrification can affect fertility in multiple ways, through improvement in child health, education, and farm and home production technologies. Theoretically, it is not possible to determine the direction in which electrification affects fertility behavior (Grogan and Sadanand 2009). By lowering the cost of family planning services and schooling, electrification can lower fertility. Electrification may also affect demand for female labor, or otherwise increase the opportunity cost of women's time, leading to lower fertility. Availability of electricity reduces the cost of capital in farm production and, if children are valued as farm labor or investment goods, reduce the incentive for larger families. Finally, electrification can increase women's participation in market work (Dinkelman 2011), which is often associated with lower demand for children.

On the other hand, the general positive income effect from electrification can increase demand for children. In the standard model of home production by Gronau (1977), women would spend more time on home production if it becomes more efficient. If children are consumption goods, their shadow price would decrease with more efficient home production technology. Greenwood et al. (2005) explain the baby boom in the US as a result of the introduction of electric appliances in homes.

Because in theory the effect of electrification on fertility is ambiguous, it is an empirical question. Existing empirical studies provide mixed evidence on this relationship. Harbison and Robinson (1985) conclude that rural electrification decreases fertility five to ten years after village access to electricity and so it might act as a key variable for modernization. Cornwell and Robinson (1988) evaluate the effects of electrification on farm women's fertility in the US during the period 1930-1950 and find that electrification reduces fertility in southern counties, but is positively associated with fertility in richer non-southern counties. In contrast, Bailey and Collins (2011) conclude a negative association between fertility and the extent to which women have access to electricity and appliances during their reproductive year. Peters and Vance (2011) find a positive relationship between fertility and electricity for urban households contrasted by a negative association for rural households.

Most of the early studies of the relationship between electrification and fertility are not concerned with causality. Grogan (2011) attempts to identify the causal impact of household electrification status on birth propensities of women employing recursive bivariate Probit model. She uses the information on the historical development level (literacy rate) of the main town in a Colombian municipality and topographical information (slope gradient of land) to proxy the relative cost of extending the grid from town to rural areas. These variables then are used to identify the probability that a household has electricity. Grogan's paper demonstrates that household electrification causes a reduction in yearly birth propensities of about 6 percent.

Dinkelman (2011) also accounts for endogeneity of the placement of infrastructures to determine the causal impact of rural electrification on employment growth rate in South Africa. This study also uses the land gradient, which affects the cost of electricity grid expansion, as an instrument for project placement. Grogan and Sadanand (2012) use two proxies for the cost of electrification, population density and the mean slope gradient to identify the impact of electrification on labor supply of adults. Lipscomb, Mobarak, and Barham (2013) estimate the development effects of electrification by taking geographic inputs, i.e. river gradient, water flow, and Amazon into their engineering model and construct a time series of hypothetical electricity grids. In this study we use an instrumental variable that measures the difference in elevation between each village and the district's mean to identify the impact of rural electrification on fertility.

1.3 Electrification of rural Iran

After the 1979 revolution, government attention to rural development increased. A new organization, Jahad-e Sazandegi (Reconstruction Crusade), was created for the purpose of building rural infrastructures, with rural electrification as one of its main objectives (Hooglund 2009).

The 1966 census counted only 653 villages with electricity, less than 2 percent of all villages (Table 1.1). The pace of electrification picked up considerably after 1981, when the proportion of villages with electricity increased to 38 percent in 1986, and by 2006 to 91 percent. Figure 1.2, shows the expansion of the electricity network from the viewpoint of households with access to electricity. Whereas all urban households enjoyed access to electricity in their

Table 1.1: Distribution of villages by the year of electrification

	Electrified villages	
Year of obs	Number	Percent
1966	653	1.50
1973	1360	3.12
1976	2588	5.93
1981	9793	22.44
1986	16899	38.71
1988	19494	44.66
1996	30260	69.32
2006	39845	91.28
No. of obs	43650	100

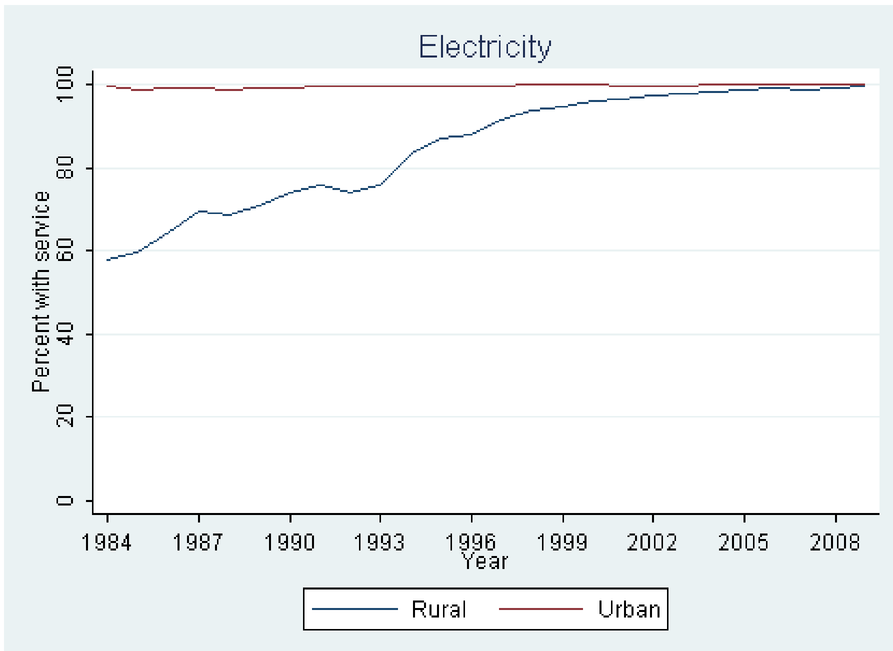
homes since the early 1980s, less than 60 percent of rural households did. This gap narrowed rapidly in the 1980s and 1990s, so that by early 2000s it had disappeared.

The pace of this expansion was not random and villages closer to urban areas received electricity first, while the more distant or harder to reach villages where the cost of connection was higher would get electricity later.

In general, the cost of providing electricity depends on the distance of the village from existing electricity substations, population density, and land gradient (Dinkelman 2011). We take advantage of the large variation in the cost of electricity provision due to geographic position of Iranian villages. Specifically, we use the difference in elevation between a village and the mean elevation of villages in the district as an instrument for electrification.

Table 1.2 shows the relationship between the timing of electrification and village elevation. In 1986, villages with electricity were on average below district mean while those without electricity were above. In later years, un-electrified villages were located at higher elevations and those with electricity were closer to the mean district elevation.

Figure 1.2: Rural-urban gap in household access to electricity, 1984-2009



Source: Authors' calculations using HEIS data files.

Table 1.2: Summary statistics for village elevation by electrification status

	1986		1996		2006	
	Unelectrified	Electrified	Unelectrified	Electrified	Unelectrified	Electrified
Elevation	1.38	1.27	1.41	1.31	1.36	1.33
	(0.66)	(0.70)	(0.62)	(0.69)	(0.60)	(0.68)
Elevation deviation	0.04	-0.05	0.08	-0.02	0.08	-0.00
	(0.29)	(0.24)	(0.33)	(0.25)	(0.37)	(0.27)
No. of obs	11112	9177	4246	16043	648	19641

Note: Standard deviations are in parentheses. Elevation unit is kilometer.

1.4 Data

Our unit of observation is the village. For each village we have information on the year in which it received electricity, and its child-woman ratio. Most of our data come from various censuses of population. We have supplemented census information with data on availability of electricity and other village facilities from administrative data provided by the Ministry of Agriculture and Reconstruction. The census years 1986 and 1996 are chosen since the data on village child-woman ratio (fertility) can only be employed from census data source. Data also consists of information on availability of schools (primary, middle and high school), religion characteristics (availability of mosque and whether village has Shia [1] majority), village population in the year 1986, topographical information (whether the village is located on the plain, forest or mountain area), quality of the village roads to the towns for the year 2006, and number of health houses per 1000 women at the district level.

We measure village-level fertility with the child-woman ratio (CWR), the ratio of children less than 5 years of age to women aged 15 to 49. For smaller villages this variable is not a good proxy for fertility because small movements of population in and out of the village can cause large changes in the CWR unrelated to fertility. We exclude villages with fewer than 100 residents and in addition drop villages from the sample whose CWR are less than 200 or more than 1500 children per 1000 women.

For the DID estimation we set up a quasi-experiment in which villages without electricity in 1986 are divided into two groups of program (treated) that received electricity by 1996 and Comparison (untreated) that did not [2]. As a result, we lose 13,090 villages that had electricity before 1986 or received it after 1996. Then the impact of the treatment on child-woman ratio is examined for the years 1986 and 1996, that is the changes in CWR during 1986-1996 are compared for control and program villages.

[1] Shia is the majority of Islam sect in Iran and contains about 90 percent of the population.

[2] The data on rural electrification shows that a main phase of electrification expanded during 1986 to 1996 (table 1.2). So we define our treatment as receiving electricity during this period.

The sample for IV estimation relies on the earliest year in which a village was listed as having electricity. This is not necessarily the year that it first had electricity, because our data cover specific years only. As a result, the distribution of the years of exposure is not smooth. The IV identification strategy takes advantages of village elevation, which is an exogenous variation in the cost of extending rural electricity. The data on elevation of villages is downloaded from the website of National Cartographic Center of Iran. Data on 24,625 villages is available from this source. Merging the data set of village elevation with our village data on facilities and demographic characteristics decreases the sample size to about 14,400 villages in our IV estimations.

Table 1.3 shows summary statistics for the DID sample by treatment status as well as the sample for IV estimation. About 32 percent of the DID sample are comparison villages and the rest are program ones. The data indicates that CWR is lower in program villages compared to the control group in 1986 (0.98 vs 1.02) and declines dramatically in both groups during 1986-96. But this decline is greater for program villages. Program villages are also on average larger, and have higher probability of having schools, mosque, shia majority in 1986, and easier access to their closest towns. The health house coverage in 1986 at district level is greater for treated villages. The t-statistics of comparing mean village characteristics between program and control villages along with their corresponding two-tailed p-values are presented in the last two columns of the table. The t-tests suggest that the differences in means for each village characteristic between two groups are significantly different from 0. More interestingly, there are significant differences between geographical characteristics of these two groups of villages. 35 percent of the treated villages are on plain and about 60 percent of them are located on mountain, while 83 percent of control villages are mountainous villages.

The differences in village characteristics in 1986 across two groups confirm that there is some selection in electricity provision during 1986-1996 based on village population, schools availability, religion characteristics, and health house coverage (correlated with development level of the villages), as well as topographical conditions. Therefore, these characteristics are controlled in our DID estimation to make the comparison between similar villages and try to make the electrification placement exogenous.

The second part of the table 1.3 shows the summary statistics for IV sample. Average CWR for the sample of all villages is 970 children per 1000 women in 1986, declining to 510 in 1996. We include information on population, village years of exposure to electricity, primary, middle, and high school till 1996 and religion characteristics for the year 1986. The mean population of the whole sample is 600 persons. Villages are having electricity on average for 9 years till 1996 but they have been exposed to primary school for longer period (26.40 years). The data indicates that an average village receives middle school and high school after provision of electricity. The religion variables show that 83 percent of the villages have mosque in 1986 and in 89 percent of them Shia is the majority of the population. The data on geographic characteristics indicates that 50 percent of sample villages are located on plain area, 49 percent on mountain and only 2 percent on forest. So Iran is relatively a mountainous country.

The village-level data captures well the changes in fertility over the 1986-1996 period. The figure 1.3 shows the evolution of the distribution of village child-woman ratio by treatment status. In 1986, the distributions of CWRs are almost the same between control and treatment groups with greater mean in control villages. By 1996, the CWR distribution of both groups had shifted to the left but the corresponding shift in treatment group is more striking.

1.5 Methodology

Our principal means of identification is the timing of village electrification and we use it in two ways. In one method, we set up the impact evaluation problem in a difference-in-differences framework, defining treatment as having received electricity in a ten year interval (1986-1996) and control as not having it by 1996. In the second method we define an intensity of treatment variable, measured by the number of years a village has been "exposed" to

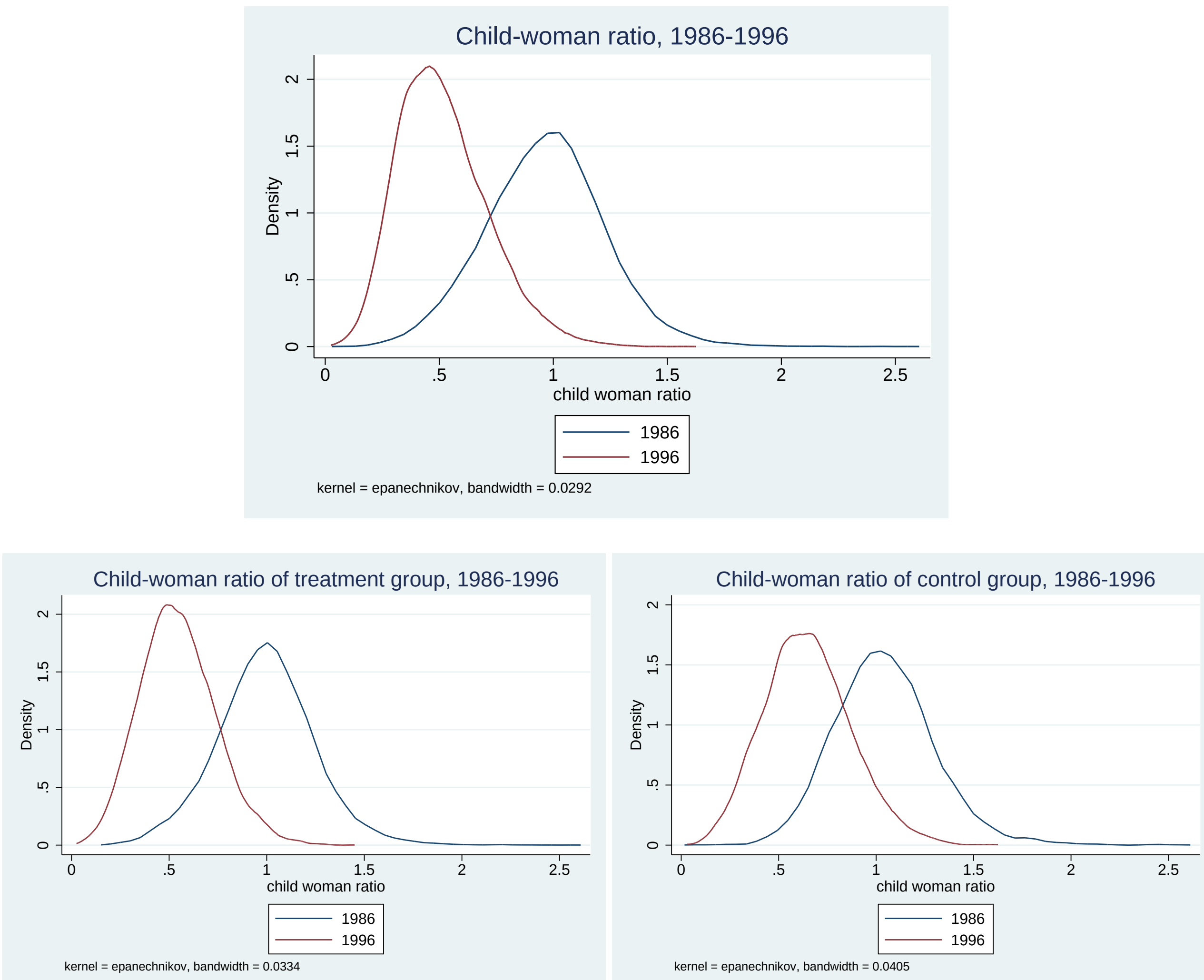
Table 1.3: Summary statistics for DID and IV estimations of CWR

	Full sample		Control		Program		t-test	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	t-stat	p-value
Child-woman ratio 86	0.99	0.22	1.02	0.22	0.98	0.22	8.63	0.00
Child-woman ratio 96	0.58	0.20	0.65	0.22	0.55	0.18	26.96	0.00
Village population 86	387.52	344.64	286.61	249.85	434.76	371.71	-22.95	0.00
Health house coverage 86	1.10	0.81	1.07	0.74	1.11	0.84	-2.74	0.01
Proportion of villages with								
Primary school	0.93	0.25	0.89	0.32	0.95	0.21	-14.52	0.00
Middle school	0.09	0.29	0.04	0.19	0.12	0.32	-14.36	0.00
High school	0.01	0.11	0.00	0.07	0.02	0.13	-5.59	0.00
Mosque	0.76	0.42	0.69	0.46	0.80	0.40	-13.83	0.00
Shia majority	0.78	0.41	0.70	0.46	0.82	0.38	-15.28	0.00
Asphalt road	0.42	0.49	0.19	0.39	0.53	0.50	-38.33	0.00
Village geography								
Plain	0.29	0.45	0.16	0.36	0.35	0.48	-22.79	0.00
Mountain	0.69	0.46	0.83	0.37	0.63	0.48	23.79	0.00
Forest	0.02	0.12	0.01	0.09	0.02	0.14	-4.76	0.00
No. of observations	12594		4016		8578			
Degrees of freedom							12592	

Summary statistics for IV sample

	Mean	Std. Dev.	Min	Max
Child-woman ratio 86	0.97	0.23	0.20	1.50
Child-woman ratio 96	0.51	0.18	0.20	1.36
Village population	600.03	601.41	100	7545
Electricity exposure 96	9.09	6.64	0	30
Elevation	1.32	0.68	-0.10	2.95
Primary school exposure 96	26.40	8.16	0	46
Middle school exposure 96	3.68	7.50	0	30
High school exposure 96	1.14	5.38	0	30
Proportion of villages with				
Mosque	0.83	0.38	0	1
Shia majority	0.89	0.32	0	1
Asphalt road	0.66	0.47	0	1
Village geography				
Plain	0.50	0.50	0	1
Mountain	0.49	0.50	0	1
Forest	0.02	0.12	0	1
No. of observations	14416			

Figure 1.3: Child-woman ratio by treatment status



electricity. The latter formulation allows us to deal with the problem of endogeneity of program placement using an instrumental variable, which measures the difference between the elevation of the village (from the sea) and the mean elevation of the district in which the village is located. We assume that this variable is correlated with the the timing of the extension of electricity but is not directly correlated with fertility.

1.5.1 Difference-in-differences

The DID estimator is favored because of its straightforward interpretation. Assuming that treatment is random and the underlying average trend in the outcome of interest is the same for treated and untreated groups of villages, one can attribute any differences in the trends between the two groups to treatment. The first assumption is less restrictive. The more one can account for the initial difference between the two groups, so that one can think of treatment as randomly assigned. The second assumption, known as parallel trends is not testable and has to be maintained in order to interpret the results.

The idea of DID method in identifying the effect of electrification on fertility is to compare the decrease in fertility between program and comparison groups. In difference-in-differences estimation the first difference is over time for each group which eliminates the effect of unobservable time invariant factors on village fertility. The second difference is the difference between these differences. In order to compare fertility between observationally equivalent villages that only differ in the timing of their electrification, the observable differences between groups have to be controlled. We do this by controlling the village characteristics that showed to be different between two groups in table 1.3.

The following formulation of the DID estimator closely follows those in Wagstaff et al. (2009) and Salehi-Isfahani, Abbasi-Shavazi, and Hosseini-Chavoshi (2010), and relates village-level fertility to village characteristics, year of observation, and treatment status. For program villages this relation can be written as:

$$Y_{it}^{P} = H_{it} + f(X_{it}) + \mu_i^P + \theta_t^P + u_{it}^P$$

where Y_{it}^P is fertility in village i in year t= 1986 and 1996, H_{it} is fertility decline due to the presence of electricity, X_{it} is a vector of observable village characteristics that influence fertility, μ_i^P captures the unobservable, village-specific effects that are potentially correlated with program status, and θ_t^P is the time-specific effect. The same relation for comparison villages is ($H_{it} = 0$):

$$Y_{it}^{C} = g(X_{it}) + \mu_i^C + \theta_t^C + u_{it}^C$$

Calculating the changes in fertility between 1986 and 1996 for each group helps to eliminate the μs (we also drop the time subscript because we compare only two periods):

$$\Delta Y_i^P = H_i + f(\Delta X_i) + \Delta\theta^P(X_i) + \Delta u_i^P,$$

$$\Delta Y_i^C = g(\Delta X_i) + \Delta\theta^C(X_i) + \Delta u_i^C$$

The DID estimator is then simply the difference between these differences:

$$\Delta Y_i^P - \Delta Y_i^C = H_i + f(\Delta X_i) - g(\Delta X_i) + \Delta\theta^P - \Delta\theta^C + \Delta u_i^P - \Delta u_i^C \qquad (1.1)$$

The simplest formulation of DID omits Xs from 1.1 (as in Wooldridge 2002). In our case the Xs only have the 1986 values, so they are eliminated in the first differentiating. Some of the Xs, such as religion variables, simply do not change while other influence fertility only slowly, so we keep them in the DID regressions because they influence not just the level but also the trends in fertility. In other words, we assume that the parallel trends assumption ($\Delta\theta^P - \Delta\theta^C = 0$) holds conditional on observable village characteristics. Thus we condition on these characteristics in the DID regressions.

The DID regression takes the usual form with Xs on the right hand side:

$$Y_{it} = \alpha + \beta D_i + \gamma Year + \delta(D_i * Year) + X_{it}\psi + \epsilon_{it} \tag{1.2}$$

where Y_{it} is the child-woman ratio of village i in year t, D is a dummy variable which takes the value of one if the village has electricity in year 1996, $Year = 1$ if 1996 and zero otherwise. The value of β is the estimate of the initial difference in CWR between program and comparison villages, γ is the common time trend, and δ is the program effect, which is the DID estimator.

District-level fixed effect is used in estimation process to factor out unobservable impacts which are fixed within each district and differ between them.

1.5.2 Instrumental variables

There is no easy way to combine IV estimation with DID, so we employ regression of fertility on the intensity of treatment, measured by the number of years before 1996 that the village had electricity. We use village elevation deviation from its district mean to instrument for village electricity exposure. We control for the number of years that village had primary, middle and high school till 1996 as well as other village characteristics in 1986.

Our identification assumption is that conditional on village characteristics, deviation of village altitude from district mean should not affect the village fertility independently of its influence through electrification.

The first-stage regression for electricity exposure of village i is therefore:

$$E_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 X_i + \upsilon_i \tag{1.3}$$

where E_i is the number of years of electricity exposure by the time of observation till 1996, Z_i is the village elevation from the sea level (instrumental variable), and X_i is a set of village characteristics.

The second-stage equation of estimation is:

$$Y_{it'} = \alpha + \beta \hat{E}_i + X_i \psi + \epsilon_i \tag{1.4}$$

where t' is 1996, and $\hat{E}_i$ is the estimation of years of electricity exposure till 1996 which yields from the first stage. The coefficient of interest, β, shows the changes in CWR for each additional year of exposure to electricity. We control for district-level fixed effects in our regressions, so our instrumental variable, village elevation, is interpreted as deviation of village elevation from its district mean. The electricity is mostly extended from the existing substation infrastructures and high voltage lines. These substations are distributed over district and are not necessarily located in main cities. As a result, mean district elevation is acceptable as the base of our elevation comparison.

1.6 Results

1.6.1 Difference-in-differences

We first examine the impact of electrification in a quasi experimental method. As noted above, we are comparing the changes in fertility during 1986-96 between the comparison (control) group, which is composed of villages that did not have electricity in 1986 and 1996, and the program (treatment) group, consisting of those that received electricity sometime during 1986-96. Table 1.4 presents the difference-in-differences results in three different equations. The estimates in column 1 are the unconditional DID results, which in principle are not valid because they do not control for program placement. The average decline in CWR is 368 children per 1000 women and the initial difference in CWR between the program and comparison groups is 37 children per 1000 women. The program effect estimated at 64 children per 1000 women. Adding the controls in column 2 reduces the difference in CWR between the two groups to 19 children per 1000 women, which indicates that our conditioning is effective. The common time trend and the program effect do not change. The last column controls for district-level fixed effects. The initial gap in fertility between the program and comparison groups falls to only 5 children per 1000 women and is not significant.

Other village characteristics on availability of schools, mosque, and Shia majority have expected signs from development aspect. Villages with primary school, middle school, and high school have significantly lower CWR. Availability of mosque can be interpreted as religiosity or the wealth of the village. If the later is true, it provides evidence that richer villages have lower fertility. Defining a village in Shia majority decreases CWR as well. Predictably, whether the village is located on mountain is not correlated with village fertility. The larger the number of health houses per 1000 women in district the lower child-woman ratio in village. This coefficient confirms the effect of family planing provision on fertility of rural women.

1.6.2 Instrumental variables

The OLS and IV estimates are presented in table 1.5 using the years of exposure to electricity till 1996 as treatment. Column 1 is the OLS result showing the impact of exposure at reducing 3 children per 1000 women per year. Columns 2 and 3 use an instrument – the difference between village elevation and the district mean – and find the opposite result. In column 2, the program impact is to add 9 children per 1000 women per year. This result is theoretically plausible given the ambiguity we noted earlier in Section 1.2.[3]

The first stage results in column 3 show that our instrument is valid because it is negatively related to the timing of electrification. The relevancy of the instrument is tested by

[3]The estimates of impact on fertility maybe too high in DID compared to exposure because binary designation of treatments that vary in intensity tend to be higher (Angrist and Imbens 1995).

Table 1.4: DID estimates of the impact of exposure to electricity on fertility

	(1)	(2)	(3)
Program village	-0.037**	-0.019**	-0.005
	(0.004)	(0.004)	(0.004)
Time trend	-0.368**	-0.368**	-0.368**
	(0.005)	(0.005)	(0.004)
Program effect	-0.064**	-0.064**	-0.064**
	(0.006)	(0.006)	(0.005)
Village had in 1986			
Primary school		-0.032**	-0.031**
		(0.006)	(0.006)
Middle school		-0.082**	-0.059**
		(0.005)	(0.004)
High school		-0.038**	-0.013
		(0.011)	(0.010)
Mosque		-0.099**	-0.040**
		(0.003)	(0.004)
Shia majority		-0.054**	-0.038**
		(0.003)	(0.004)
Village geography			
Mountain		-0.001	-0.003
		(0.003)	(0.003)
Forest		-0.081**	-0.021*
		(0.011)	(0.009)
Asphalt road		-0.004	-0.011**
		(0.003)	(0.003)
Log population		0.031**	0.023**
		(0.002)	(0.002)
Health house coverage		-0.008**	
		(0.002)	
Constant	1.020**	0.997**	0.969**
	(0.003)	(0.013)	(0.013)
R2	0.499	0.533	0.602
Observations	25188	25188	25188

Notes: Column 3 is district-level fixed effects. Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$.

F-statistics once all controls have been accounted for. Since F-statistics at the first stage is larger than 10 (81.37), the instrument would be a potentially strong one. A one kilometer increase in village elevation difference from district mean level reduces the exposure to electricity by 2.13 years.

The OLS estimations of village characteristic coefficients mostly appear with expected signs. Predictably, larger years of exposure to primary school and middle school significantly decrease fertility. Villages with mosque and Shia majority in 1986 have lower CWR in 1996 indicating higher acceptance of Islamic government messages. Villages on mountain and forest indicate less fertility than plain villages. As expected, villages that are connected to towns by asphalt roads are more likely to have smaller CWR as a result of more access to health centers and facilities. IV estimates of schooling exposure coefficients, mosque, Shia majority, and asphalt road are consistent with OLS results though showing larger effects on fertility. Exposure to high school, village located on forest, and population now have no significant effect on fertility.

1.7 Conclusions

The dramatic decline in rural fertility in the 1990s in Iran raises important questions about policy. How did millions of less educated women living in traditional and conservative areas of the country decide to adopt family planning and reduce their fertility from one of the highest in the world to replacement level? Besides the family planning program, rural electrification stands as the most important rural development policy in post-revolution Iran. In this chapter we examine its impact on rural fertility.

The main challenge in identifying the impact of infrastructure on household behavior is that its placement is rarely random, so researchers must be careful to determine what would have been the impact if placement had been random. We employ DID and instrumental variables methods to obtain unbiased estimates of impact. To our surprise, the two methods

Table 1.5: IV estimates of the impact of exposure to electricity on fertility

	OLS	2SLS	first-stage
Elevation			-2.135**
			(0.177)
Electricity exposure 96	-0.003**	0.009**	
	(0.000)	(0.003)	
Primary school exposure 96	-0.002**	-0.003**	0.053**
	(0.000)	(0.000)	(0.006)
Middle school exposure 96	-0.003**	-0.004**	0.087**
	(0.000)	(0.000)	(0.009)
High school exposure 96	0.001**	0.000	0.040**
	(0.000)	(0.000)	(0.013)
Village had in 1986			
Mosque	-0.039**	-0.050**	0.973**
	(0.005)	(0.006)	(0.150)
Shia majority	-0.017**	-0.018**	0.172
	(0.006)	(0.006)	(0.179)
Village geography			
Mountain	-0.006*	0.020**	-1.588**
	(0.003)	(0.007)	(0.108)
Forest	-0.017*	-0.006	-0.882*
	(0.009)	(0.010)	(0.359)
Asphalt road	-0.022**	-0.050**	2.121**
	(0.003)	(0.007)	(0.106)
Log population	0.014**	-0.009	1.848**
	(0.002)	(0.006)	(0.075)
Constant	0.584**	0.645**	-2.403**
	(0.013)	(0.027)	(0.705)
R2	0.376	0.268	0.485
Observations	14416	14416	14416
F-statistics			81.37

Notes: Dependent variable in OLS and 2SLS regressions is child-woman ratio (1996) and in the first-stage regression is years of exposure to electricity till 1996. Regressions are district-level fixed effects. Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$.

produce very different estimates. Whereas the DID estimates are negative, indicating that electrification reduced fertility, the IV estimates show that it increased fertility. These results, while contradictory, are not mutually inconsistent. One explanation for the difference is bias in the DID results due to incomplete accounting for placement of electricity. If electricity was placed earlier in villages with higher fertility which later fell for whatever reason, it would seem that electricity contributed to decline in fertility. The IV estimates are less likely to be affected by this problem because they are in principle based on the exogenous variation in placement of electricity.

Since theory is not a good guide in which direction the impact should be, which impact estimate one believes depends on one's evaluation of the validity of the techniques used. We cannot decide for the reader as which estimate is more credible, but we can say that at the very least the evidence is ambiguous on the contribution of electrification to rural fertility decline. This means that other factors, working at the family or state level, are still candidates for this historic change in Iranian family behavior.

This conclusion acquires particular significance in the context of the current reversal of objective and policy on fertility and family planning in the Islamic Republic of Iran. The assumption behind the expression of regret by Iran's leaders about the sharp decline in fertility and the call to reverse it is that the decline was primarily the consequence of state policies. The results of this study, in enunciation with Salehi-Isfahani et al. (2010) that show less than 20 percent of fertility decline was due to family planning clinics, suggest that fertility decline may not be amenable to state policy.

Chapter 2

Rural electrification and female empowerment in Iran: rise of literacy

2.1 Introduction

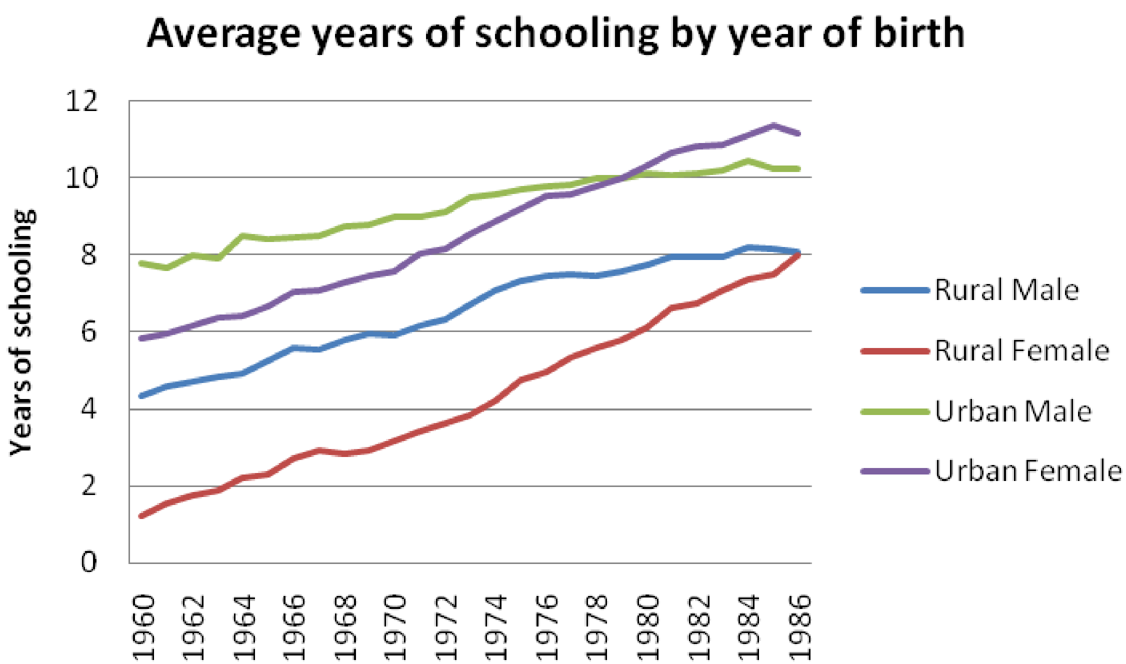
Provision of infrastructure plays an important role in economic development. Investments in schools, health facilities, and basic services such as electricity and water have been shown to contribute to economic development (Duflo 2001; Rosenzweig and Schultz 1982a; Barnes 1988; Barkat, Khan, Rahman, Zaman, Poddar, Halim, Ratna, Majid, Maksud, Karim, et al. 2002; Fluitman 1983; Henderson, Storeygard, and Weil 2011; Merrick 1985). In Iran, infrastructure investment, especially in rural areas after the 1979 revolution, has been credited with improvements in literacy and fertility transition. But there has been little systematic analysis linking investments in infrastructure to the improvement in these outcomes in Iran. Salehi-Isfahani, Abbasi-Shavazi, and Hosseini-Chavoshi (2010) and Hashemi and Salehi-Isfahani (2013) explain fertility transition by investment in health infrastructure, rural health clinics in particular. However, there has been no study of the impact of basic infrastructure on development outcomes. It is a fact of life that provision of education and health infrastructure themselves depend on basic services.

The provision of basic infrastructure such as electricity allows most villages to obtain schools, by reducing the cost of school construction, which makes education available to a large group of population. Also the direct benefit of electrification comes from better lighting conditions, which provides extended hours of study and in turn causes better educational achievements (Khandker, Barnes, and Samad 2009). In addition, in Iran, a general push for rural development after the revolution provides a motivation for lower social class parents to believe that their children could be able to have equal opportunities to improve and get better jobs as urban children, if they were educated. In order to raise educated children, parents, particularly mothers, need to educate themselves first. In most of developing countries specially in Iran, mothers are effective teachers for their children at home (Behrman and Rosenzweig 1999; Salehi-Isfahani 2001), therefore, increasing demand for quality of children raises the value of mother's education (Behrman and Rosenzweig 2002).

In this chapter, we study the impact of the rapid spread of electricity across rural areas of Iran during the 1980s and 1990s on an important development outcome, literacy of adult rural women. In other words, our study examines the role of infrastructure on empowerment of women because education is strongly associated with the status of women in the Iranian society. The study of women's empowerment in Iran raises interesting issues because the Islamic revolution of 1979 brought with it two seemingly opposed objectives. A strong conservative current wanted to promote the role of women as mothers and homemakers and strongly supported large families. Another current, championed populist development policies, especially in rural areas (Salehi-Isfahani 2009) with rural electrification as their main goal. Before the revolution only 21 percent of rural households had access to electricity, but by 2006 access had become nearly universal. Another policy, seemingly contradictory with the conservative Islamic view of women's status in society, was the active promotion of family planning in rural areas, starting in 1989 (Abbasi-Shavazi, McDonald, and Hosseini-Chavoshi 2009; Salehi-Isfahani, Abbasi-Shavazi, and Hosseini-Chavoshi 2010).

Meanwhile, during these two decades the rural literacy improved significantly. In 1978, 35.6% of rural households did not have any literate members; by 1988, it had dropped to 22.5%

Figure 2.1: Average years of shcooling by birth year



and by 1998 to 12.1%. At the time of the 1979 revolution, more than 90 percent of rural women aged 15 to 49 were illiterate, while three decades later more than three-fourth were literate. The education of rural women seems to have improved even more. The average women born in the 1960s would have about 1.5 years of schooling by the time she reached adulthood; those born a generation later, in the 1980s, would have about 8 years (see Figure 2.1). These changes transformed life in rural areas as well as urban areas. Urban areas grew mainly as rural people moved to cities and rural areas grew to become towns.

In this study we use village-level data to examine the extend to which rural electricity has been responsible for the rise of rural women's literacy and can therefore be considered as an engine for rural life transformation. Particularly, we try to measure the causal impact of rural electrification on village-level female literacy rates. We use the timing of extension of electricity to rural areas to identify this impact. While there is a strong and positive correlation between electricity provision and economic outcomes, the question is which one causes the other. Endogenous placement of infrastructure in both time and location makes the causal inferences more difficult. In this study, we use difference-in-differences (DID) and instrumental variable methods to deal with the potential endogeneity of program placement.

In DID method, we divide the sample of villages into a program (treatment) group which received electricity during 1986-1996 and a comparison (control) group which did not have electricity by the end of this period. Then we compare the rates of increase in village-level literacy among these two groups during 1986-1996, while controlling for the observable differences between them that may have affected their selection into the program group. But we are primarily interested in the impact of electrification on female literacy. We also perform the same identification strategy on male literacy for comparison and to learn whether electricity had a more general impact on literacy. The DID results show that conditioning on village's observable characteristics, villages that received electricity during 1986-1996 experienced a greater increase in adult female literacy rate compared to villages that received it after 1996. However, the rate of increase in male literacy in program villages was smaller than comparison villages. Our results suggest that the electrification has a positive impact on female literacy and not male.

The DID estimates can be biased if we could not condition on all village characteristics that affect program placement, which means the conditional independence assumption is violated. We use instrumental variable (IV) estimation of program impact, which is preferable when such information is incomplete. We report IV estimates in which village elevation deviation from its district mean is used as an instrumental variable to control for potential endogeneity in access to electricity. We believe that elevation is correlated with the cost of electrification and therefore the likelihood of having electricity earlier. But it is not directly correlated with our outcome variable of interest, literacy rate, and its correlation with literacy is through changing the time of village electrification. The topographical variables have been used in the literature (Dinkelman (2011), Grogan (2011), Grogan and Sadanand (2012)) as a proxy for the relative cost of electricity provision.

The IV result for the impact of electrification on female literacy is in the same direction as DID estimates, indicating that electricity increases adult female literacy. However, the impact of electrification on male literacy depends on the method of identification. IV estimate suggests that electricity increases male literacy, whereas DID estimate shows the opposite.

Our overall conclusion is that electrification increases women's empowerment because of the strong effect of increased female literacy on other aspects of women's life including fertility and health. Our study contributes to the growing literature on the role of public infrastructure in developing countries by defining a potentially strong instrumental variable. In addition, our data allows us to study the effect of electrification on village level literacy.

We limit our analysis to the period before the census 1996 when major changes in rural electrification and literacy have been occurred. A convergence in literacy rates between 1996 and 2006 reduces the precision with which we can estimate the impact of electricity on female (male) literacy.

The chapter is organized as follows. The next section offers an overview of Iran's rural electrification program. Section 2.3 describes our village data and provides our sample's summary statistics. Section 2.4 describes the identification strategy in the DID and IV methods. Section 2.5 presents the empirical results of the two methods, and section 2.6 concludes.

2.2 Electrification of rural Iran

Development and modernization of rural areas in Iran became an ideological purpose in the early years of the 1979 revolution. [1] The leaders of the Islamic revolution believed that the Pahlavi monarchy had neglected rural and agricultural economic development. Therefore, they considered the rural areas as deprived sectors which deserve development programs. In 1979, about 53 percent of Iran's population were living in rural areas, so the government's

[1]For more information about rural development projects in Iran see Hooglund (2009)

new concerns about rural residence were politically as well as ideologically important.

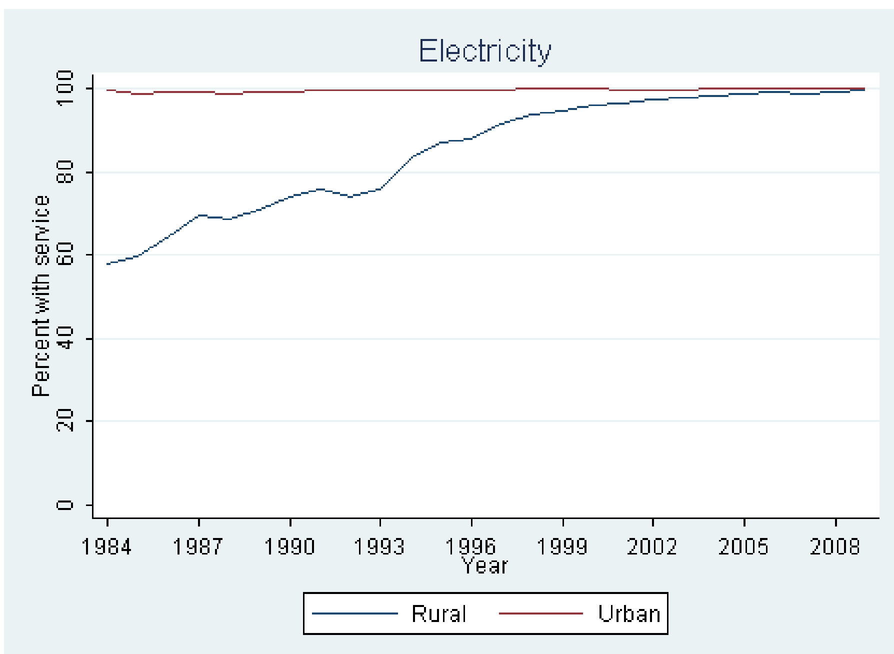
In 1979, the proponents of rural development pushed some pressure on Iran's government to create an organization, the Jehad-e Sazandegi (Reconstruction Crusade) in order to act against rural deficits. In practice, the organization's purpose was defined as a mission to provide basic infrastructures to all villages of Iran. Through the 1980s and 1990s, Jehad implemented three kinds of development projects: rural infrastructure, social facilities, and assistance in agricultural techniques. The rural infrastructure projects contained construction of rural roads and electrification of villages. These projects were costly for the large, mountainous, and underdeveloped country like Iran in 1979.

In the domain of rural electrification, only 6 percent of the total of 43,000 villages had access to electricity before the revolution. These villages were mainly located close to cities or close to national power lines. However, by 2001 electricity extended to 99 percent of all rural households. Figure 2.2 indicates the gap in access to electricity between urban and rural households in early years of the revolution. This gap has narrowed rapidly during the first two decades after the revolution.

Moreover, the nature of most physical infrastructure networks (electricity, piped water, phone, rail, and road) is that all identical consumers cannot be connected to the network simultaneously. In other words, households would be connected in some orders. The cost of extending network plays a central role in determining the allocation of projects to different places. As a case in point, areas with lower average cost per electricity connection may have priorities than others in getting electricity.

Three factors would affect the average cost per electricity connection for a village (Dinkelman 2011). First, the distance of the village from the existing electricity substation and high voltage lines that are necessary for access, is a key cost factor. Second, the density of households in a village influences the average cost of extending grid, because once a village gets electricity grid, shorter cables with lower costs are needed to extend electricity to households within the village. Third, land gradient which adds the transportation cost of personnel and

Figure 2.2: Rural-urban gap in household access to electricity, 1984-2009



Source: Authors' calculations using HEIS data files.

Table 2.1: Summary statistics for village elevation by electrification status

	1986		1996		2006	
	Unelectrified	Electrified	Unelectrified	Electrified	Unelectrified	Electrified
Elevation	1.34	1.24	1.38	1.27	1.35	1.29
	(0.67)	(0.72)	(0.62)	(0.71)	(0.60)	(0.70)
Elevation deviation	0.04	-0.05	0.10	-0.02	0.11	-0.00
	(0.34)	(0.26)	(0.37)	(0.29)	(0.45)	(0.30)
No. of obs	8909	8141	3377	13673	470	16580

Note: Standard deviations are in parentheses. Elevation unit is kilometer.

equipment.

In this study, we mainly focus on elevation deviation of a village from its district mean as an exogenous factor that influences the cost of village electrification. Table 2.1 presents the summary statistics of village elevation and elevation difference from its district mean for the samples of electrified and unelectrified villages over time. The data shows that unelectrified villages in 1986 and 1996 are mainly the villages that are above district mean elevation. The difference elevation of villages from their district mean is even greater for unelectrified villages in 1996 compare to those in 1986 which indicates villages that were closer to district mean elevation received electricity earlier. The data confirms the fact that difference village elevation from district mean level may be a key cost variable, though electrified and unelectrified villages are not significantly different based on their mean elevation differences. By 2006 almost all of the villages in sample had electricity.

2.3 Data

Our unit of analysis is a village and we measure the literacy outcomes for women and men at the village level. The villages are picked from the sample of all 60,000 villages of Iran. We obtain information on when electricity first became available to the village as well as other village facilities from the Ministry of Agriculture and Reconstruction recorded since 1956.

We obtain village-level literacy rates for women and men from three censuses of population in 1986, 1996, and 2006. We define the percentage of women (men) aged 15-49 who are literate as our measure of literacy. The national censuses also provide information on an array of village characteristics such as village population, presence of schools (primary, secondary, and high school), presence of a mosque, whether or not the village population is shia majority, and village topography (whether the village is located in the plain, the mountains, or a forest area) as well as the quality of roads to nearby towns or cities in 2006.

Each census of population counted approximately 120,000 villages in Iran, many of which are hamlets and small settlements. We exclude villages with fewer than 100 people because their literacy rates are highly dependent on the age structure of their population, which may have changed due to migration rather than changes in educational behavior. We also drop villages which population doubled or became less than half during 1986 to 1996 in order to count for immigration issues.

In DID method, we use data on the timing of electrification of villages to divide them into two groups, those that received electricity during 1986-1996 (treatment group) and those without electricity in 1996 (control group). Then we measure the impact of this treatment on village-level literacy rates for the period of 1986-1996. The main idea is to compare the increase in literacy rates between treated and untreated villages during this period. Matching the sample of villages containing data on facilities from the census of 1986 and geographic information for the year 2006, with the other data set on village-level literacy rates from the censuses of 1986 and 1996, the sample size reduces to about 9,186 and 11,237 villages for female and male samples. These are our village samples for DID estimations. These samples exclude villages with electricity before 1986 and those which receive electricity after 1996.

Our sample of IV estimates is based on the earliest year in which the Ministry of Agriculture data reports the village as having access to electricity. Our instrument, village elevation is obtained from the National Cartographic Institute of Iran, which lists data on the elevation of each village. The elevation data is limited to 24,625 nationally representative villages.

Merging elevation data with the sample of village characteristics yields the working samples of 12,542 and 12,544 observations, respectively for the IV estimations of female and male literacy impact of electrification.

Furthermore, the samples for female and male literacy impact evaluations are not the same because of the way outliers from different outcomes have been dropped. Tables 2.2 and 2.3 provide summary statistics for the four samples, two for each dependent variable, female and male literacy rates. The upper part of each table presents the summary statistics for the DID sample by treatment status as well as full sample. The difference between control and program villages in their 1986 characteristics is of our interest since the DID identification strategy is based on the comparison of similar villages. In these tables, specially the t-tests suggest that there is some selection in the location of electricity provision based on literacy, population, availability of schools and mosque, shia majority, and topographical characteristics. In the year 1986, the ratio of literate women was 13 percent in control group compared to 18 percent in program group. Although female literacy rates increased in both groups during 1986 to 1996 but the raise was greater in program villages. The data on male literacy rates indicates the smaller increase in program villages compared to control villages during the same period. In order to identify the program impact, we employ village characteristics in 1986 that may have affected the selection of villages into program group, as noted above. By controlling for these characteristics, the comparison of villages is more likely to be the comparison of those that only differ in term of treatment status.

The lower parts of the tables show the summary statistics for the samples of IV estimations in which the village-level literacy rate in 1996 is defined as the dependent variable. The data indicates that villages had access to electricity for an average of 9.5 years till 1996 but they had primary school on average 17 years before provision of electricity. However, the middle schools came to the villages after receiving electricity. Topographical information indicates that almost half of the villages are located on plain area, while 47 percent are mountainous. We use village elevation as an instrument for village electricity exposure till 1996.

Table 2.2: Summary statistics for DID and IV estimations of female literacy

	Full sample		Control		Program		t-test	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	t-stat	p-value
Female literacy rate 86	0.17	0.15	0.13	0.12	0.18	0.15	-16.06	0.00
Female literacy rate 96	0.52	0.18	0.44	0.19	0.55	0.17	-25.14	0.00
Village population 86	420.08	360.22	319.65	297.94	454.03	372.92	-15.74	0.00
Proportion of villages with								
Primary school	0.96	0.20	0.94	0.24	0.96	0.19	-4.47	0.00
Middle school	0.12	0.32	0.06	0.24	0.14	0.35	-10.30	0.00
High school	0.02	0.13	0.01	0.08	0.02	0.14	-4.66	0.00
Mosque	0.78	0.41	0.70	0.46	0.81	0.39	-11.76	0.00
Shia majority	0.84	0.36	0.78	0.41	0.87	0.34	-10.17	0.00
Asphalt road	0.49	0.50	0.23	0.42	0.58	0.49	-30.24	0.00
Village geography								
Plain	0.32	0.47	0.19	0.39	0.37	0.48	-16.02	0.00
Mountain	0.66	0.47	0.80	0.40	0.61	0.49	17.01	0.00
Forest	0.02	0.13	0.01	0.09	0.02	0.15	-4.09	0.00
No. of observations	9186		2321		6865			
Degrees of freedom							9184	

Summary statistics for OLS and IV sample

	Mean	Std. Dev.	Min	Max
Female literacy rate 86	0.27	0.18	0.00	0.96
Female literacy rate 96	0.61	0.18	0.01	1
Village population 86	605.52	587.33	100	7372
Electricity exposure 96	9.50	6.63	0	30
Elevation	1.27	0.69	-0.10	2.95
Primary school exposure 96	26.48	8.21	0	46
Middle school exposure 96	3.97	7.77	0	30
Proportion of villages with				
Mosque	0.82	0.39	0	1
Shia majority	0.92	0.26	0	1
Asphalt road	0.69	0.46	0	1
Village geography				
Plain	0.52	0.50	0	1
Mountain	0.47	0.50	0	1
Forest	0.02	0.13	0	1
No. of observations	12542			

Table 2.3: Summary statistics for DID and IV estimations of male literacy

	Full sample		Control		Program		t-test	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	t-stat	p-value
Male literacy rate 86	0.44	0.20	0.35	0.20	0.48	0.19	-33.33	0.00
Male literacy rate 96	0.73	0.15	0.66	0.17	0.76	0.13	-33.86	0.00
Village population 86	387.28	337.60	288.88	258.64	430.99	358.73	-20.99	0.00
Proportion of villages with								
Primary school	0.93	0.26	0.88	0.32	0.95	0.22	-12.24	0.00
Middle school	0.10	0.30	0.04	0.20	0.12	0.33	-13.83	0.00
High school	0.01	0.12	0.00	0.06	0.02	0.13	-5.98	0.00
Mosque	0.76	0.43	0.68	0.47	0.79	0.40	-13.54	0.00
Shia majority	0.80	0.40	0.70	0.46	0.85	0.36	-18.48	0.00
Asphalt road	0.44	0.50	0.20	0.40	0.55	0.50	-36.59	0.00
Village geography								
Plain	0.31	0.46	0.18	0.39	0.36	0.48	-19.58	0.00
Mountain	0.67	0.47	0.81	0.39	0.61	0.49	20.57	0.00
Forest	0.02	0.13	0.01	0.10	0.02	0.14	-4.38	0.00
No. of observations	11237		3456		7781			
Degrees of freedom							11235	

Summary statistics for OLS and IV sample

	Mean	Std. Dev.	Min	Max
Male literacy rate 86	0.57	0.20	0.01	1
Male literacy rate 96	0.80	0.13	0.04	1
Village population 86	604.85	587.53	100	7372
Electricity exposure 96	9.48	6.63	0	30
Elevation	1.27	0.70	-0.03	2.95
Primary school exposure 96	26.44	8.25	0	46
Middle school exposure 96	3.96	7.77	0	30
Proportion of villages with				
Mosque	0.82	0.39	0	1
Shia majority	0.92	0.27	0	1
Asphalt road	0.69	0.46	0	1
Village geography				
Plain	0.52	0.50	0	1
Mountain	0.47	0.50	0	1
Forest	0.02	0.13	0	1
No. of observations	12544			

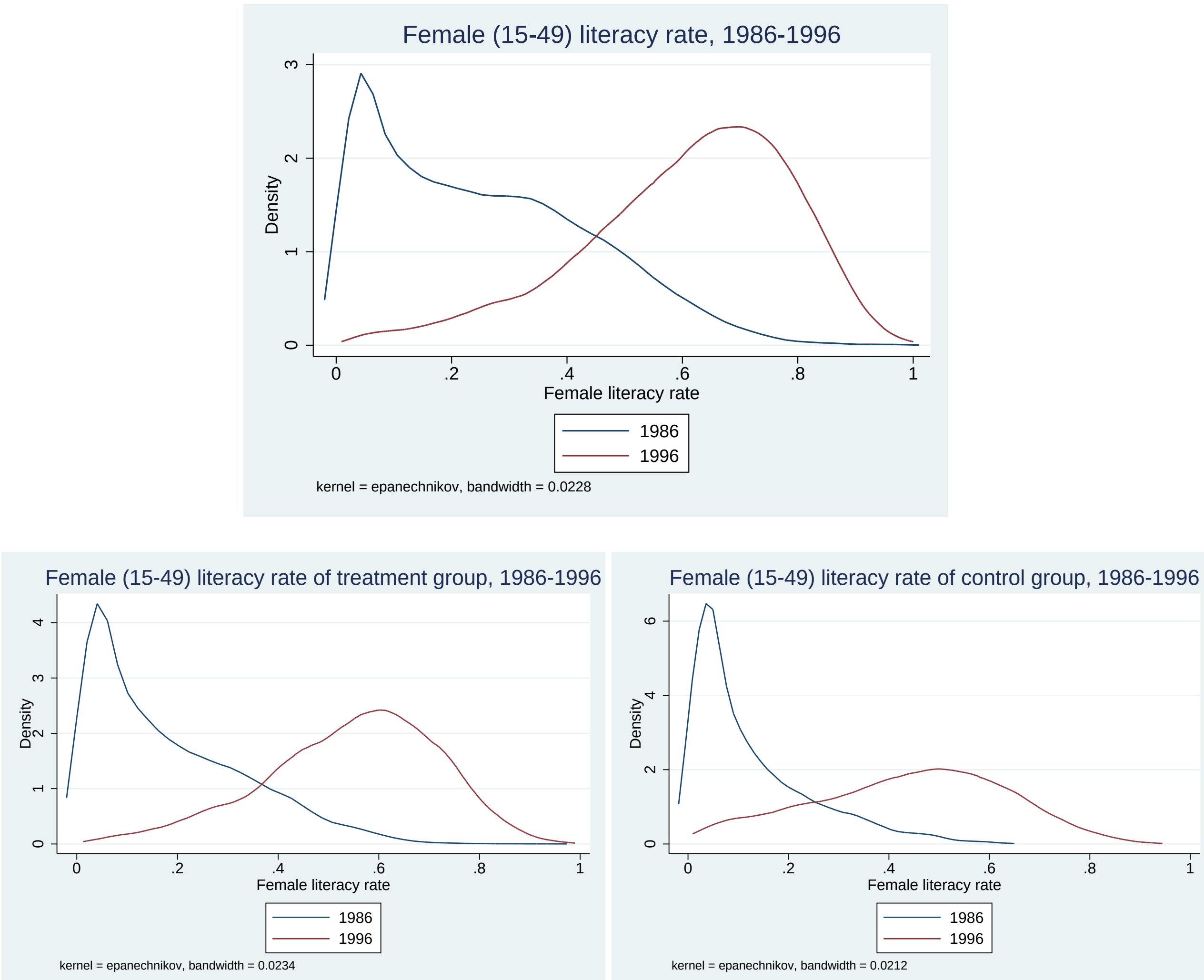
Figures 2.3 and 2.4 compare the distribution of village literacy rates for female and male aged 15-49, by treatment status over time. In 1986, the distributions of women literacy rates were skewed to the left, with the majority of villages having literacy rates below 30 percent in both treatment and control groups. But by 1996, the distributions had shifted to the right, indicating that more villages reached female literacy rates of 80 percent in both groups. However, the distribution of literacy rate in control group is more smooth than treatment group in 1996. The corresponding shifts in the distribution of literacy rates for male are much less striking. In general, the evidence of this section shows that women experienced a faster increase in their literacy rates during late 1980s and early 1990s than men. So we mainly focus on the rise in literacy rate of women during this period and then conduct the same analysis for the literacy of men to see if they respond to the provision of electricity in the same way.

2.4 Methodology

Our basic approach is to use the timing of extension of electricity to villages to identify its causal impact on female and male education. We first use a difference-in-differences methodology to measure the effect of electrification on our main outcome variables. We compare the rise in literacy rates between two census years 1986 and 1996 for two groups of villages, those that have received and not received electricity during this interval. In this method we assume that provision of electricity is exogenous conditional on village observable characteristics, such as the presence of schools and mosque, whether the village is Shia majority, topography information, and the quality of roads. The more we could control for the initial difference among the treatment and control groups, the more we could think of electricity as randomly assigned to the villages.

Next, we estimate the impact of the years since the extension of electricity to the village (years of exposure) on female and male literacy using the instrumental variable methodology.

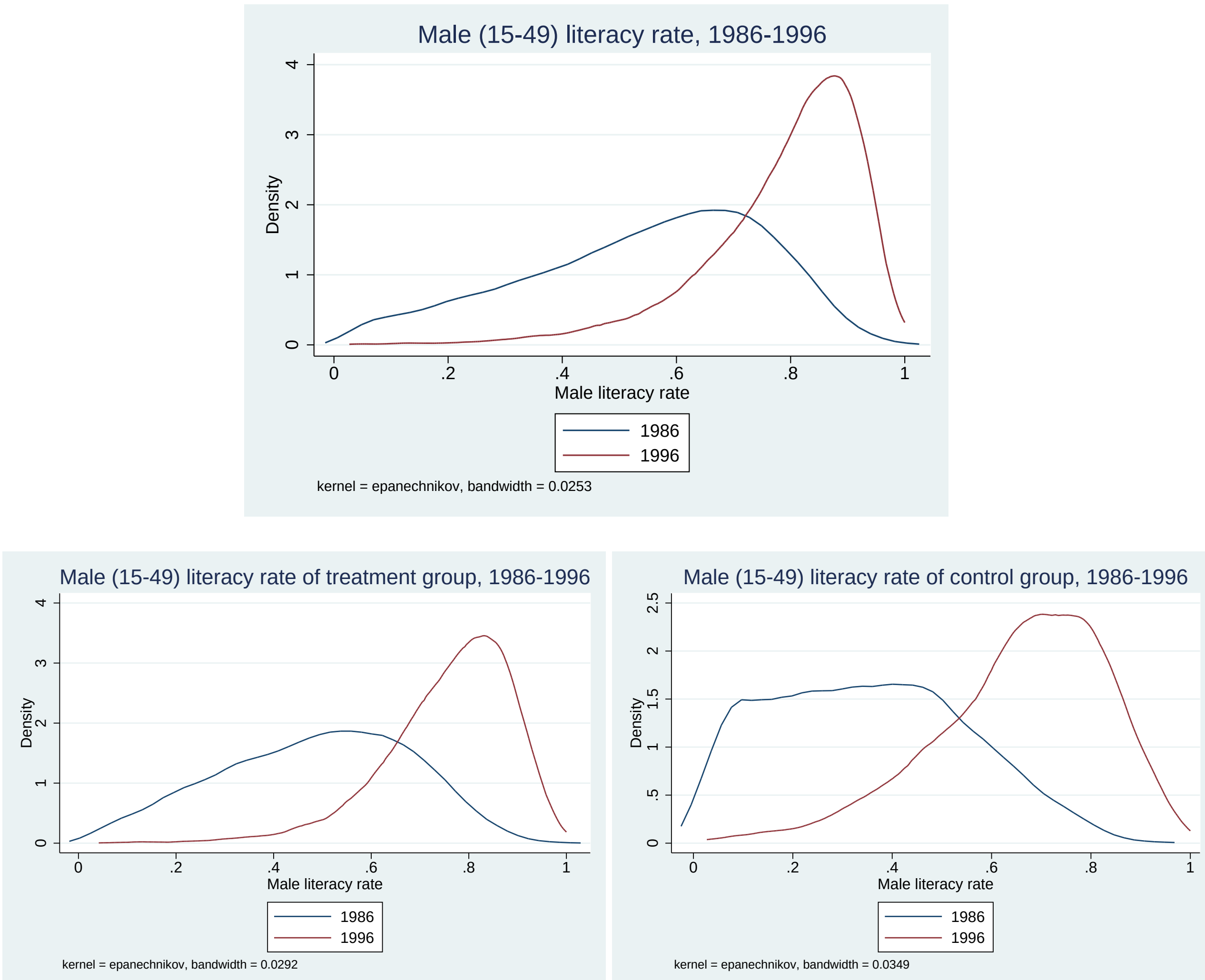
Figure 2.3: Female literacy rates by treatment status



This method has the advantage of allowing us to control for the potential endogeneity of electricity placement that may still exist after controlling for village characteristics.

Exogenous variation in the cost of extending electricity to a village is used to predict the years of exposure to electricity. We take advantages of information on elevation of villages to proxy for the relative cost of infrastructure provision to rural areas. We employ the elevation deviation of the village from its district mean elevation as our instrumental variable. Our assumption is that this variable is correlated with the electrification status of the village, but

Figure 2.4: Male literacy rates by treatment status



not with the error term in the estimation equation. Our data confirms that the timing of electrification is correlated with elevation, so this instrument passes the relevance condition.

2.4.1 Difference-in-differences

The DID estimator assumes that the underlying trends in the outcome of interest are the same for both treatment and control groups in the absence of the program, known as common trends assumption. Therefore, any difference between the trends of the two groups can be attributed to the program. In DID estimation the first difference is over time which eliminates the influence of time-invariant factors on the outcome of interest, female and male literacy, in each group. The second difference measures the difference between these differences. If the first stage factors out all of the important unobserved differences between two groups, the DID result would be an unbiased estimator of the causal impact of electrification on female and male literacy. We also use district-level fixed effects to remove unobserved factors that are constant within each district but vary among districts.

We follow the DID estimator formulation used in Wagstaff et al. (2009) and Salehi-Isfahani, Abbasi-Shavazi, and Hosseini-Chavoshi (2010), and link village-level literacy rate to village characteristics, year of observation, and treatment status. This relation can be written for program villages as:

$$Y_{it}^P = H_{it} + X_{it}^P \psi + \mu_i^P + \theta_t^P + u_{it}^P$$

where Y_{it}^P is female (male) literacy rate in village i in year t= 1986 and 1996, H_{it} is the effect of the electrification, X_{it} is a vector of observable village characteristics that affect literacy, μ_i^P are unobservable village-specific effects, and θ_t^P is the time-specific effect. The same relation for comparison villages (where $H_{it} = 0$) can be written as:

$$Y_{it}^C = X_{it}^C \psi + \mu_i^C + \theta_t^C + u_{it}^C$$

Taking the first difference over 1986 and 1996 for each group yields (we also drop the time subscript because we compare only two years):

$$\Delta Y_i^P = H_i + \Delta X_i^P \psi + \Delta \theta^P (X_i) + \Delta u_i^P,$$

$$\Delta Y_i^C = \Delta X_i^C \psi + \Delta \theta^C (X_i) + \Delta u_i^C$$

Then the DID estimator is derived from the difference between these two differences which is the sum of program effect, difference in observable characteristics, and difference in unobservable time trends:

$$\Delta Y_i^P - \Delta Y_i^C = H_i + (\Delta X_i^P - \Delta X_i^C)\psi + (\Delta\theta^P - \Delta\theta^C) + (\Delta u_i^P - \Delta u_i^C) \tag{2.1}$$

Conditioning on observable characteristics, and assuming that the error term is well-behaved, the DID estimator is unbiased if and only if $\Delta\theta^P - \Delta\theta^C = 0$, which indicates the "common trends" assumption.

The DID estimator can be implemented using the regression of the form (Angrist and Pischke 2008):

$$Y_{it} = \alpha + \beta D_{it} + \gamma Year + \delta(D_{it} * Year) + X_{it}\psi + \epsilon_{it} \tag{2.2}$$

where Y_{it} is village i female (male) literacy rate in year t, D_{it} is a dummy variable which takes the value of one for program villages that received electricity during 1986 and 1996, and zero for comparison villages, $Year = 1$ for the year 1996 and zero otherwise, and X_{it} is a vector of village characteristics. The value of β is the estimate of the initial difference in literacy rates between program and comparison villages, γ is the common time trend or the change in the literacy rate in comparison group, and δ is the DID estimator or the program effect. This equation is used as our basic equation for DID estimation.

2.4.2 Instrumental variables

In our instrumental variable method, we model literacy rate of a village as a function of its exposure to electricity, primary, and middle school till 1996, and other village characteristics in 1986, the first year for which we have a complete set of such characteristics. The base of our identification in IV estimation is therefore:

$$Y_{it'} = \alpha + \beta E_i + X_i \psi + \epsilon_i \tag{2.3}$$

where t' is the year 1996, and E_i is the number of years of electricity exposure by the time of observation till 1996, and X_i is a set of village characteristics in the base year, 1986 as well as school exposure years till 1996. The IV estimation uses elevation as an instrument for E. We control for district level fixed effects in our IV estimations. Therefore, our instrumental variable is interpreted as village elevation difference from its district mean. We also take into account the possible asymmetric cost of extending electricity at different elevation levels and define nonlinear measures of our instrumental variable to examine the sensitivity of our results. The results do not change significantly for different measures of instrumental variable.

2.5 Results

2.5.1 Difference-in-differences

We first examine the impact of rural electrification on literacy using difference-in-differences method. Our comparison (control) group are villages that did not have electricity in 1986 and 1996, and the program (treatment) group consist of villages that received electricity between 1986 to 1996. Tables 2.4 and 2.5 indicate the DID results of electrification impact on female and male literacy. Columns 1 in both tables are the unconditional DID estimates. These are good benchmarks for comparison with the conditional estimates presented in columns 2 and 3, which try to control for selection into program. The unconditional program impact is estimated at 51 more literate women per 1000, indicating that women's literacy rate raised faster in program villages compared to control villages. However, for men the unconditional program effect is estimated at 32 less literate men per 1000. The initial difference in literacy rates between the program and comparison villages is 56 women per 1000 and 133 men per 1000. The estimated average increase in village-level literacy or time trend indicates an strong increase in literacy rates unexplained by electrification, which is 313 per 1000 for women and 306 per 1000 for men.

However, these unconditional estimates of program impact are more likely to be biased because provision of electricity during 1986-1996 may be the consequence of higher literacy rates than vice versa. As shown in tables 2.2 and 2.3, the village-level literacy rates were higher in 1986 for program villages, by 5 per 100 for women and 13 per 100 for men. Therefore, the unconditional DID results may underestimate the actual impact of the program. This may explain the negative program impact for male literacy. The conditional program effects are presented in the next two columns. The initial difference in female literacy in 1986 between program and comparison groups is much lower when we control for initial village characteristics. This difference which is 56 per 1000 for women and 133 per 1000 for men in the unconditional estimates, declined to 26 and 88 when we condition on village characteristics. It shows that the conditional estimations in both female and male samples are comparing villages with and without electricity which are more similar in terms of their initial literacy rates. However, the difference between program and comparison villages in literacy stays relatively large and significant as we add controls. This indicates that program endogeneity is perhaps more severe in the case of literacy. The conditional estimates of electrification impact and time trend are the same as unconditional estimates in both samples of female and male.

The coefficients of all characteristics of the villages have their expected signs and are statistically significant. The effects of primary, middle and high schools are to increase both female and male literacy rates. The availability of middle school is the most important in female literacy while for male the primary school affects the most among school variables. Religion characteristics are also matter. The effect of Shia majority on literacy rate is the greatest among dummy variables in both women and men regressions, about 102 per 1000 for women and 105 per 1000 for men. The Sunni minority lives mostly in disadvantaged area of Iran such as Khorasan, Sistan and Baluchestan, Kurdistan, and West Azerbaijan. So villages with Shia majority could be interpreted as having more resources and advantages. Whether the village is mountainous is also important. The villages that are difficult to reach have lower women and men literacy rates compared to plain villages. Finally, if a village has an asphalt road to connect to the nearest city, it would have higher women and men literacy rates.

The third columns of tables 2.4 and 2.5 control for district-level fixed effects. The estimated program effects and time trends are the same as before for both women and men, while the initial difference in literacy rates between two groups increases for women. The effects of most village characteristics are in the same direction as before but their magnitudes are mostly smaller for both men and women regressions.

2.5.2 Instrumental variables

The OLS and IV estimations of electricity impact on female and male literacy are indicated in tables 2.6 and 2.7, respectively. In these tables, we specifically examine the impact of village years of exposure to electricity till 1996 on literacy rates in 1996. The OLS estimates in columns 1 show the effect of each additional year of exposure to electricity at 7 more literate women per 1000 and 4 more literate men per 1000. The coefficients of all village characteristics follow those in DID method in terms of significance and signs for both women and men, except Shia majority which no longer is important in male literacy.

The IV estimates in columns 2 suggest an increase of 25 literate women per 1000 and 15 literate men per 1000 per year as electricity impact. The impacts of most village characteristics are the same as OLS. The exceptions are years of exposure to middle school, which become insignificant for both female and male literacy in IV estimations. Coefficients of village topography, whether on mountain or forest and village access to asphalt road appear to be unimportant, indicating that their effects are captured by village elevation.

Finally, it is worth considering the first stage estimates of our IV method shown in the third

Table 2.4: DID estimates of the impact of exposure to electricity on female literacy

	(1)	(2)	(3)
Program village	0.056**	0.026**	0.035**
	(0.003)	(0.003)	(0.003)
Time trend	0.313**	0.313**	0.313**
	(0.005)	(0.004)	(0.004)
Program effect	0.051**	0.051**	0.051**
	(0.005)	(0.005)	(0.004)
Village had in 1986			
Primary school		0.022**	0.031**
		(0.006)	(0.005)
Middle school		0.092**	0.056**
		(0.004)	(0.003)
High school		0.041**	0.032**
		(0.009)	(0.008)
Mosque		0.052**	0.041**
		(0.003)	(0.003)
Shia majority		0.102**	0.051**
		(0.003)	(0.004)
Village geography			
Mountain		-0.034**	-0.024**
		(0.002)	(0.002)
Forest		0.046**	-0.026**
		(0.009)	(0.007)
Asphalt road		0.039**	0.030**
		(0.002)	(0.002)
Log population		-0.044**	-0.028**
		(0.002)	(0.002)
Constant	0.127**	0.249**	0.193**
	(0.002)	(0.011)	(0.010)
R2	0.551	0.616	0.737
Observations	18372	18372	18372

Notes: Column 3 is district-level fixed effects. Standard errors in parentheses,* $p < 0.05$, ** $p < 0.01$.

Table 2.5: DID estimates of the impact of exposure to electricity on male literacy

	(1)	(2)	(3)
Program village	0.133**	0.088**	0.088**
	(0.004)	(0.004)	(0.004)
Time trend	0.306**	0.306**	0.306**
	(0.004)	(0.004)	(0.004)
Program effect	-0.032**	-0.032**	-0.032**
	(0.005)	(0.005)	(0.004)
Village had in 1986			
Primary school		0.095**	0.075**
		(0.005)	(0.005)
Middle school		0.089**	0.061**
		(0.004)	(0.003)
High school		0.039**	0.036**
		(0.008)	(0.008)
Mosque		0.040**	0.054**
		(0.003)	(0.004)
Shia majority		0.105**	0.045**
		(0.003)	(0.004)
Village geography			
Mountain		-0.022**	-0.024**
		(0.002)	(0.002)
Forest		0.004	-0.021**
		(0.009)	(0.007)
Asphalt road		0.043**	0.031**
		(0.002)	(0.002)
Log population		-0.023**	-0.017**
		(0.002)	(0.002)
Constant	0.352**	0.298**	0.330**
	(0.003)	(0.011)	(0.011)
R2	0.436	0.521	0.602
Observations	22474	22474	22474

Notes: Column 3 is district-level fixed effects. Standard errors in parentheses,* $p < 0.05$, ** $p < 0.01$.

columns. Predictably, the village elevation negatively influences the village years of exposure to electricity indicating our instrument is valid. A one kilometer increase in village elevation deviation from district mean, decreases the electricity exposure by 1.5 years for both women and men samples. All other controls appear with expected signs and are significant except of Shia majority. We test the relevancy of our instrument by F-statistics. Our instrument appears to be potentially strong since the F-statistics are 96.59 and 98.86 (greater than 10) for women and men regressions, respectively.

2.6 Conclusions

According to recent theories of development, changing in the role of women in the household and society from traditional role in procreation to production of human capital, known as empowerment, is an integral part of economic development. Women's education is widely considered as an important determinant of empowerment. In Iran, education of rural women increased significantly from 1.5 years of schooling for average women born in 1960s, to about 8 years for those born a generation later, in 1980s. During the first two decades after the 1979 revolution, the revolutionary government in Iran implemented programs which favor rural areas in allocating public investment resources. Among these rural development programs were rural Health Network System (HNS), rural electrification and provision of schools, specially for girls. In this study, we examine the impact of rural electrification program on literacy of adult women and men to explore whether electrification can improve development through changes in the behavior of the households.

The main issue in identifying the causal impact of electricity on our variables of interest is that infrastructure placement in general, and electricity projects in particular are unlikely to be randomly assigned. We use DID and instrumental variable methods at the village level to deal with the endogeniety of program placement. Using the data on the timing of the electrification in rural areas, we define program villages as those that received electricity

Table 2.6: IV estimates of the impact of exposure to electricity on female literacy

	OLS	2SLS	first-stage
Elevation			-1.502**
			(0.163)
Electricity exposure 96	0.007**	0.025**	
	(0.000)	(0.004)	
Primary school exposure 96	0.002**	0.001**	0.053**
	(0.000)	(0.000)	(0.007)
Middle school exposure 96	0.002**	-0.000	0.103**
	(0.000)	(0.000)	(0.008)
Village had in 1986			
Mosque	0.047**	0.032**	0.907**
	(0.004)	(0.006)	(0.157)
Shia majority	0.036**	0.033**	0.234
	(0.005)	(0.006)	(0.189)
Village geography			
Mountain	-0.030**	0.006	-1.644**
	(0.003)	(0.008)	(0.114)
Forest	-0.008	0.009	-0.946*
	(0.008)	(0.011)	(0.390)
Asphalt road	0.047**	0.005	2.232**
	(0.003)	(0.009)	(0.113)
Log population	-0.015**	-0.048**	1.824**
	(0.002)	(0.007)	(0.077)
Constant	0.486**	0.567**	-3.086**
	(0.011)	(0.027)	(0.729)
R2	0.599	0.381	0.471
Observations	12542	12542	12542
F-test			96.59

Notes: Dependent variable in OLS and 2SLS regressions is female literacy rate (1996) and in the first-stage regression is years of exposure to electricity till 1996. Regressions are district-level fixed effect. Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$.

Table 2.7: IV estimates of the impact of exposure to electricity on male literacy

	OLS	2SLS	first-stage
Elevation			-1.509**
			(0.162)
Electricity exposure 96	0.004**	0.015**	
	(0.000)	(0.003)	
Primary school exposure 96	0.003**	0.002**	0.054**
	(0.000)	(0.000)	(0.006)
Middle school exposure 96	0.001**	-0.000	0.103**
	(0.000)	(0.000)	(0.008)
Village had in 1986			
Mosque	0.035**	0.026**	0.920**
	(0.004)	(0.005)	(0.157)
Shia majority	0.006	0.003	0.293
	(0.005)	(0.005)	(0.186)
Village geography			
Mountain	-0.018**	0.005	-1.643**
	(0.002)	(0.006)	(0.114)
Forest	-0.005	0.005	-0.930*
	(0.007)	(0.008)	(0.380)
Asphalt road	0.031**	0.005	2.254**
	(0.002)	(0.007)	(0.113)
Log population	-0.011**	-0.032**	1.840**
	(0.002)	(0.005)	(0.077)
Constant	0.713**	0.779**	-3.267**
	(0.009)	(0.022)	(0.730)
R2	0.425	0.259	0.476
Observations	12544	12544	12544
F-test			98.86

Notes: Dependent variable in OLS and 2SLS regressions is male literacy rate (1996) and in the first-stage regression is years of exposure to electricity till 1996. Regressions are district-level fixed effect. Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$.

during 1986-1996 and control villages as those that did not have electricity by 1996. We then compare the increase in female and male literacy rates during 1986-1996 between these two groups, controlling for their observable characteristics that may have influenced villages selection into the program.

We find evidence that villages which received electricity during 1986-96 experienced faster increase in female literacy rates compared to those that received it after 1996. Although male literacy also increased in both groups but the rate of increase was smaller in treatment villages compared to control villages. One explanation could be program villages were experiencing higher rate of male literacy in 1986 and conditioning on village characteristics does not completely account for the negative bias of electricity placement. The other explanation could be because the male literacy rates change by the migration of more educated men that cannot be explained by program effect. This is less likely to happen for female literacy rate since Iran's experience shows that migration from rural to urban areas is greater among men and particularly educated ones.

The IV estimates indicate positive effects of electrification on both female and male literacy. But the program effect is much larger on female literacy, 25 more literate women per 1000 per year compared to 15 more literate men per 1000. So in this chapter we have found evidence that, as theory would suggest, electrification had an unambiguously positive effect on female literacy. We also find that controlling for endogeneity of program placement, the impact is four times as large for both women and men. Our main conclusion is that extension of electricity plays an important role in improvement of the status of rural women. This is one of the channels through which electrification has contributed to rural development in Iran.

Chapter 3

Education and empowerment of Iranian women: evidence from a time-use survey

3.1 Introduction

Empowering women is about increasing their ability to participate in decisions that affect their lives at home and in the society at large. According to Alsop and Heinsohn (2005), "If a person or group is empowered, they possess the capacity to make effective choices; that is, to translate their choices into desired actions and outcomes." Education is the most important way to promote women's empowerment because it not only increases their capacity to make good decisions, such as how many children they will have and how they will raise them, it also increases their ability to influence collective decisions, most importantly on those made with their husbands.

In this chapter we examine the role of education in empowerment of Iranian women through their allocation of time. There is a large literature that seeks to identify women's empowerment by examining the intrahousehold allocation of expenditures and time (eg, Hoddinott and Haddad 1995; Anderson and Eswaran 2009; Kantor 2003), but little is available for the Middle East and North Africa (MENA) and none for Iran as far as we are aware.[1] The literature on women's empowerment has emphasized market work as the main channel through which education leads to greater female empowerment. It has been shown that women who work outside the home and earn an independent income can increase their participation in intrahousehold allocation of resources and shift household resources in the direction of child health and education (Mammen and Paxson 2000; Rosenzweig and Schultz 1982b).

If we measure empowerment by the extent of market work only, we would have to conclude that women in Iran, and in the rest of the Middle East for that matter, suffer from low empowerment because their participation in market work is low. And, since they are relatively well educated, we would also conclude that education has not contributed much to their empowerment. But this would be a wrong conclusion to reach because we know that at least one important manifestation of empowerment, lower fertility, is closely related to education. This aspect of empowerment has been well documented in the case of Iran, where in one generation women have doubled their average years of schooling while having one-third as many children on average. Furthermore, we know that lower fertility is correlated with greater investment in child health and education, which means that educated women are more involved in the most important household decision– how to raise good children.

Widening the possible channels through which education can empower women means we should consider the role of education in the type of home activities that enhance women's decision making power within the family. In particular, we need to better understand how education affects women's investment in child education.

The literature on women's empowerment rarely brings the women's time invested in children into an equal footing with market work. By implication, teaching children at home (not to be confused with home schooling, which is a phrase used in the US for not sending chil-

[1] Hoodfar (1997) offers an ethnographic view of women's activities in Cairo and Hendy (2010) examines the impact of marriage on women's market work using time-use data.

dren to schools), while considered a productive activity, is rarely considered as empowering (Kranichfeld 1987). This issue is particularly important for understanding the empowerment of women in Iran (and in MENA) because their participation in market work is low while private tutoring is prevalent. The prevalence of private tutoring suggests that a significant part of educational investments are made outside schools, likely involving parents as well as private tutors. There is widespread belief that the low quality of MENA education coupled with the tight competition to enter into high quality public universities has led to greater use of private resources in child education (Salehi-Isfahani 2012). The question is whether women's own time is one such resource and if women's role in home education is a substitute for market work in terms of their empowerment.

The recent time allocation models allow us to treat women's time spent on childcare as a separate category from home production. It has been a long time that economists have proved that the standard labor/leisure model of Robbins (1930) is not adequate for explaining mother's time allocation. The labor/leisure framework was based on the microeconomics theory assuming paid work does not provide direct utility and it only increases the worker's utility indirectly through the purchased goods by the earned income (outcome utility). In addition, the theory assumes that all leisure time yields direct utility (process utility). Later, in the early 1960s, the New Home Economics models, such as Becker (1965), argued that a large portion of time not spent on paid work is spent on home production which is separate from leisure [2]. Gronau (1977) and Graham and Green (1984) also consider three categories of time allocation as market work, home production, and pure leisure. In their model, "home work" is defined as time spent at home to produce a good that is a perfect substitute to those in the market. In Gronau's approach the process of home production yields no direct utility. This approach indeed relegates women's time in child development at home to non-market activities and lumps it together with home production, including bearing and rearing children.

[2] Becker (1965) 's model focuses on the production of commodities provided for final consumption. But because the final commodities are difficult to identify, this model has been difficult to use empirically.

However, parental childcare is usually considered as imperfect substitute for childcare in the market. In addition, it has been argued that parental childcare is different from house work activities in terms of the received utility. Most parents obtain utility from some portion of caregiving time (Kimmel and Connelly 2007). Parents consistently report time spent with their children specially in educational childcare as being among their most enjoyable time, particularly in comparison with other house work activities (Juster 1985; Krueger, Kahneman, Schkade, Schwarz, and Stone 2009; Robinson and Godbey 2010). So the best solution to study the time allocation of mothers is to expand the traditional three time-use categories analysis and explicitly treat time spent on child care as a separate category. There is also some evidence in the literature that childcare is considered differently than housework or leisure.[3] In this chapter we examine the allocation of time of Iranian women into three types of activities: market work, childcare, and house work. We categorize the residuals as leisure.

Our available time use data allows us to consider even more detailed stratification of time allocation and distinguish between time spent on teaching children, known as educational childcare, and other child related activities, such as feeding them. One would expect that the time spent on activities that could be described as enhancing child's human capital, might increase with education. This is a key hypothesis that we test. Existing evidence from advanced economies suggests that more educated women spend more time in raising their children compared to less educated women (Hill and Stafford 1980; Bryant and Zick 1996; Hofferth 2001; Bianchi, Cohen, Raley, and Nomaguchi 2004; Sayer, Gauthier, and Furstenberg 2004; Kalenkoski, Ribar, and Stratton 2005; Craig 2006; Kimmel and Connelly 2007; Guryan, Hurst, and Kearney 2008).

Greater allocation of time by educated women to child education is a standard implication of the economics of allocation of time. More educated mothers are able to monitor homework, supervise private tutors and teach their children. Because the cost of home teaching is lower

[3] Bryant and Zick (1996), Bianchi (2000), Sandberg and Hofferth (2001), Bianchi et al. (2005), Aguiar and Hurst (2006), Howie et al. (2006), Kimmel and Connelly (2007), Guryan et al. (2008)

for them, they do more of it.

It is also an integral part of the particular brand of economic development theory advanced by Becker et al. (1990) and Lucas (2002). They argue that the transformation of the family from procreator to producer of human capital is a precondition for a country to embark on the phase of sustained modern economic growth. They thus view the rise of female education and lower fertility as part of a historic shift in family behavior in favor of human capital accumulation. They argue that in response to technological change that increases the rate of return to education, families switch from the strategy of high fertility and low investment in child education to low fertility and high investment in child education. In these models the allocation of household time between market and child development depends critically on returns to education.

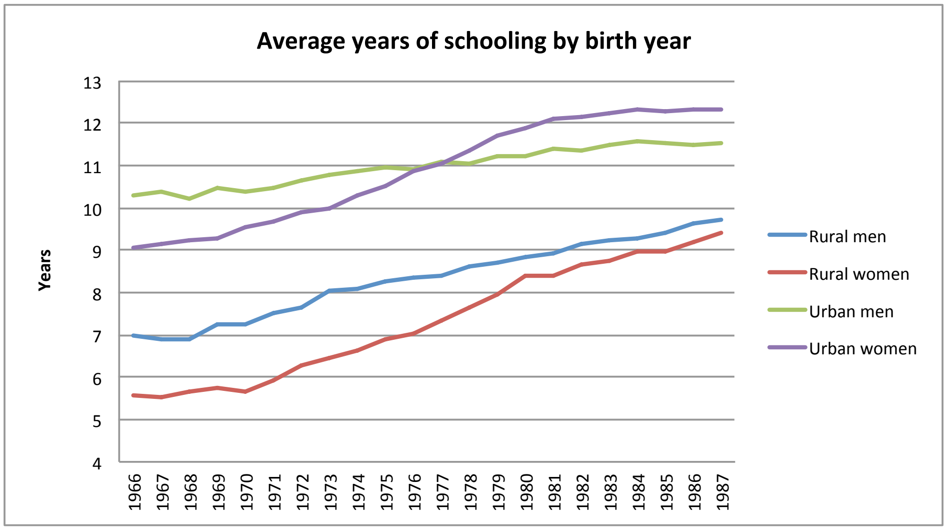
Comparative advantage between men and women in market versus home work may elicit different responses to increased education from husbands and wives. Women may decide to specialize in child development while men increase their market work. So, in the context of the Becker-Lucas model, a higher return to education may increase women's time in producing education at home while men continue to work in the market. More educated parents who are more productive in home teaching may decide that the woman allocates more time to home teaching while the husband continues to supply labor to the market.

Theoretically speaking, a positive association between the education of women and the time she spends in home production of human capital and in market work is very plausible. Our data show that both market work and child investments at home are positively associated with female education. What is difficult to establish is that either activity empowers women. Not all market work empowers women nor all non-market activities have the same effect on their empowerment. Sundaram and Vanneman (2008) presents evidence that greater participation in market work does not always lead to greater empowerment. This is intuitively obvious. For example, a powerful husband who sends his wife to earn money by cleaning other people's homes does not necessarily empower her. Conversely, an educated woman may enjoy greater say in family matters without engaging in economic activities inside or outside the home. Few would disagree that rising education of women increases their ability to influence decisions at the societal level independently of their labor force participation; the same could be true of decisions at home. The greatest advance in women's empowerment in the Middle East has been from rapid fertility decline, which has occurred despite their low participation in market work and mostly as a consequence of more education.

We divide women's time into four main categories of childcare (as general childcare or educational childcare), market work, domestic work, and leisure, which is determined as a residual. We find that the impact of education on the time spent in the first two activities regardless of childcare measure are very similar and increasing in education, while domestic work decreases with education. We interpret this finding to mean that female empowerment resulting from education can demonstrate itself in market as well as in time spent with children at home. Our results are therefore consistent with the hypothesis that lack of participation in market work does not imply lack of empowerment, though they do not amount to a direct test of this hypothesis. The choice of market work and child time are clearly dependent on the level of education. Illiterate women have ample working opportunities while have low returns to home teaching. Educated women also have opportunities outside the home, but as their education increases so does the value of their time in home teaching.

The plan of this chapter is as follows. The next section describes important changes in the lives of Iranian women in terms of education and fertility that influence their time use and pertain to their allocation of time between labor market and child care. Section 3.3 presents a simple model of time-use of women that helps us to focus on the main ideas of the chapter and highlight the factors that we believe affect the allocation of time to child care. Section 3.4 describes the survey data we use to estimate the role of education in the allocation of married women's time; section 3.5 describes the main pattern of time use observed in the data with respect to women's education, age, and household wealth. Section 3.6 provides our empirical model and variables. Section 3.7 describes our estimation results and Section 3.8 offers conclusions based on our results.

Figure 3.1: Rising education of Iranian women



3.2 Iranian context

The time-use behavior of Iranian women should be considered in the context of two important changes in their lives, lower fertility and rising education.

Following a historically unprecedented decline in fertility, from about 6 to 2 births per woman during 1985-2000, they spend much less time in giving birth and raising children (Salehi-Isfahani et al. 2010). Comparing the pace of decline in fertility and child mortality in Iran with Turkey, Child mortality declined smoothly in both countries while Iran's fertility decline was much more rapid.

During the same time Iranian women have become much better educated: the average years of schooling of young mothers has doubled in a generation. Figure 3.1 shows the impressive gains of women by birth cohort.

In addition, home production technology has also improved with all urban homes now enjoying home appliances that have been shown to reduce women's time spent in housework (Ramey 2009). But, despite these changes, women's participation in market work has not increased substantially (Esfahani and Shajari), and remains very low compared to, for example, Malaysia, a Muslim country with similar fertility and female education profiles, where women are three times more likely to work than Iran.

One possible explanation for the low labor force participation of women and low empowerment is patriarchy, which originates from culture or religion (Karshenas 2001; Moghadam 1993). A less ethnocentric and more structural explanation, due to Ross (2008), emphasizes on oil income. These explanations go some distance in explaining women's low participation in market work, but they are open to criticism because they do not distinguish between the type of work women do outside the home, menial vs. skilled, and they seem to give little value to education as an empowering factor. After all, more educated women who are more empowered should be able to supply their desired number of hours to the market.

An alternative explanation of low participation of women in market work pays attention to the type of work women do at home and suggests that low participation can be consistent with greater empowerment. If women spend more time at home because they wish to invest more in their children's human capital – helping them with their school work, teaching them skills that schools do not adequately provide, such as reading and writing, sports and arts – they may be doing so from a position of power rather than weakness. If on the other hand they engage in more traditional housework, such as cooking and cleaning, one could argue that lower fertility and greater education have failed to empower them. The idea that the value of women's time at home – their reservation wage – depends on the productivity of home production is well known (Gronau 1977). But home production is more than primary activities that are more characteristic of rural households. For urban women, which are the subject of this study, the interpretation of some part of home production as investment in child human capital is more appropriate.

The implications of the patriarchy and oil-income hypotheses for women's allocation of time are different from the home production of human capital hypothesis. The former imply that following fertility decline and greater availability of household appliances women do more housework or enjoy more leisure. The patriarchy hypothesis is consistent with more housework by women if husbands use their power to enforce demand more work from their spouses and enforce even a less equal division of time inside the household. The prediction of the oil-income hypothesis follows from the plausible assumption that leisure is a normal good and therefore responds positively to income from oil. By contrast, the human capital hypothesis suggests that an increase in the rate of return to home-produced education can increase women's time spent at home at the expense of market work. This can happen in the course of economic development and rising returns to education, as a result of decline in the quality of public schools, or an increase in competitiveness of selection into universities, which often requires tutoring at home. This hypothesis also suggests that more educated women do not necessarily spend more time in the labor force because their marginal product in home teaching can increase at the same or a higher rate as their market wage.

3.3 Model

The purpose of this model is to lay out more clearly our assumptions about women's time use and to show how increase in women's education can lead to more time spent with children. The positive effects of education on female empowerment are often associated with the positive impact of education on market work. But when returns to education in home teaching and child development are high, educated women may opt for more time with their children, which may compete with market work. In a simplified version of the model in which leisure and domestic work are fixed and child time competes directly with market work, this is relatively easy to show. However, in the more general model one would expect both child time and market work to compete with leisure and domestic work and therefore allow for the possibility that education increases both child time and market work. This version, which we do not derive explicitly, corresponds more closely to our empirical results.

We model the time allocation of a woman who has to choose between market work (L_m), domestic work (L_d) and investment in children (L_h). We assume that she lives for one period and take leisure as fixed. One can think of this as a unitary household model in which the husband's time allocation is fixed and in which the only important decisions are about the wife's time allocation. The woman (or the household) maximizes a one-period utility $U = U(X_m, X_d, h)$, where X_m is consumption of market goods and X_d is both production and consumption of a home good, and h is child education. The budget constraint shows that expenditures on market goods and education (pe) are paid for by the woman's income from market work $w(H).L_m$ plus other income v (husband's plus non-earned income). The market wage, w is an increasing but concave function of woman's education, H, so that $w'(H) > 0$ and $w''(H) < 0$; p and e are the price and quantity of education purchased in the market. The price of X_m is normalized to one.

$$X_m + pe = w(H)L_m + v$$

Child education is produced at home using mother's time and with complementary market-purchased schooling:

$$h = HL_h + e^{\alpha}$$

This formulation of work at home as child teaching is different from Gronau's distinction between work at home and leisure. He considers "work at home" as time use that generates services which have a close substitute in the market, while leisure has only poor market substitutes. In our model child education is distinct from market goods, but it can be purchased from the market or produced at home. Therefore our formulation shares the diminishing marginal productivity of home production with Gronau's model but not the perfect substitutability between home production and market goods. Our formulation is closer to Graham and Green (1984) and Kerkhof and Koorman (2003) who maintain perfect substitutability between market and home goods but allow home production to use market and home inputs.

Our aim is to determine the effect of H on time allocation, especially between time in home teaching L_h and in the market L_m.

The woman's decision problem can be written as:

$$\max \quad U = U(X_m, X_d, h) \tag{3.1}$$

$$s.t. \quad X_m + pe = w(H)L_m + v \tag{3.2}$$

$$X_d = f(L_d) \tag{3.3}$$

$$h = HL_h + e^\alpha \tag{3.4}$$

$$T = L_m + L_d + L_h \tag{3.5}$$

Except for the fact that we assume leisure is fixed, this is a typical household maximization problem in the tradition of Becker (1965) and Gronau (1977) in which household labor L_h is combined with a market provided input e for the home production of h. The function relating human capital to home teaching and schooling assumes that more educated mothers are more effective in teaching their children.

The woman's problem is to allocate her time to three different uses, market work, home teaching and domestic work. At the margin, the benefits of spending an extra hour in the market is evaluated by the benefits it generates from higher consumption of X_m and more child human capital h by paying for more schooling. The benefits of an extra hour spent on domestic work is measured by increase in X_d, and the additional time on home teaching by the increase in child human capital h. In equilibrium, all these returns would be the same. This maximization helps to determine how the woman's level of education, H, affects the optimal levels of L_m, L_d and L_h.

In principle, an increase in H increases the value of the woman's time at home and in the market, and depending on the interactions of the home production technologies and the price of schooling, it is possible for an increase in H to raise L_h and lower L_m, or to increase both. It can be easily shown that the effect of an increase in H is to allocate time away from domestic work to the other two uses. So, we simplify the model by assuming that the time allocated to housework plus leisure is fixed and focus on the allocation of the woman's time between home teaching and market work. We should keep in mind that since domestic work decreases with H, in principle a more educated woman can allocate more time to both of these activities.

Eliminating the choice of domestic production X_d and its associated labor input L_d, simplifies the maximization to (for brevity we drop the subscript h from L_h):

$$\begin{aligned} \max \quad U &= U(X_m, h) && (3.6) \\ s.t. \quad X_m + pe &= w(H)L_m + v && (3.7) \\ h &= HL + e^{\alpha} && (3.8) \\ T &= L_m + L && (3.9) \end{aligned}$$

Substituting for X_m, L_m, and h, the maximization problem reduces to finding the optimum levels of home teaching and schooling from,

$$\max \quad U(w(H)(T-L) + v - pe, HL + e^{\alpha})$$

The first order conditions are:

$$\frac{\partial U}{\partial L} = -U_1 w(H) + U_2 H = 0 \qquad (3.10)$$

$$\frac{\partial U}{\partial e} = -U_1 p + U_2 \alpha e^{\alpha-1} = 0 \qquad (3.11)$$

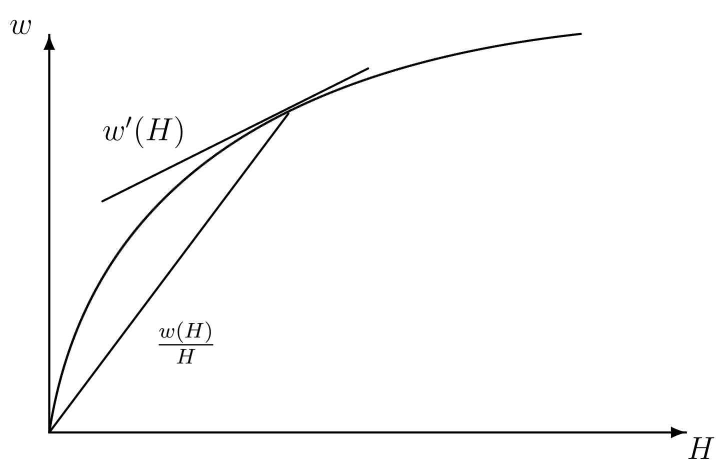
These conditions yield the demand for schooling as a function of the woman's human capital:

$$e = (\frac{\alpha w(H)}{pH})^{\frac{1}{1-\alpha}}. \qquad (3.12)$$

Equation 3.12 yields the optimum value of $e^* = e(H)$ as a function of H. Demand for home education is then obtained by replacing e with its optimum value in the first order conditions. As one would expect, demand for schooling is positively related to productivity of schooling α in creating human capital and negatively to the price of schooling. The effect of mother's education on demand for schooling is determined by

$$e'(H) = \frac{\beta}{pH} C^{\beta}(w'(H) - \frac{w(H)}{H}),$$

where $\beta = \frac{\alpha}{(1-\alpha)}$ and $C = \frac{\alpha w}{pH}$. The sing of $e'(H)$ depends on the sign of $w'(H)H - w(H)$, which is negative if the returns to education, $w''(H) < 0$, is concave (see Figure below). In this case education would increases home teaching (and reduce market work) because it increases income and therefore demand for child education h, which we assume is a normal good, resulting in $\frac{dL}{dH} > 0$.



The concave function of wage

The condition $w''(H) < 0$ is often assumed because of the diminishing marginal productivity of education, but it may not always be true if, for example, wages are administratively set. Indeed, empirical estimates of returns to schooling in Egypt, Iran, and Turkey, appear convex, with returns increasing with education (Salehi-Isfahani et al. 2010). In $w''(H) > 0$ for high levels of H, returns to education could reach high enough to induce mothers to work more and increase h by buying schooling. But even in that case it is still possible for $\frac{dL}{dH} > 0$ if the additional time comes from reduced leisure or domestic work. In terms of the model, it would require additional conditions.

Other interesting comparative results (to be derived) relate to the impact of falling productivity of public schools, which in our model is captured by a smaller value of α. This is particularly relevant as a potential explanation for the lack of a positive response in terms of higher labor force participation of Iranian (and MENA) women to lower fertility, higher education, and time-saving home technologies, such as refrigerators, vacuum cleansers, clothes washers, gas and electric stoves. This explanation would emphasize the simultaneous demand for greater home schooling with these developments, resulting in balance in little appreciable increase in market work. It is noteworthy that most of the increase in labor force participation that has occurred has come from unmarried women.

3.4 Data

The data for this study come from a time-use survey conducted by the Statistical Center of Iran (SCI) for four rounds (seasons) between fall 2008 to summer 2009 (September 21, 2008 to September 20, 2009). The survey is nationally representative consisting of 12,880 urban households (3220 households in each round and a total of 33,757 individuals). The survey has a stratified, two-stage sampling design. In each round, 1,610 primary sampling units (PSU) were chosen at random using the census 2006 frame and two households were selected from each PSU. The survey is weighted to adjust for the probability of selection and nonresponse.

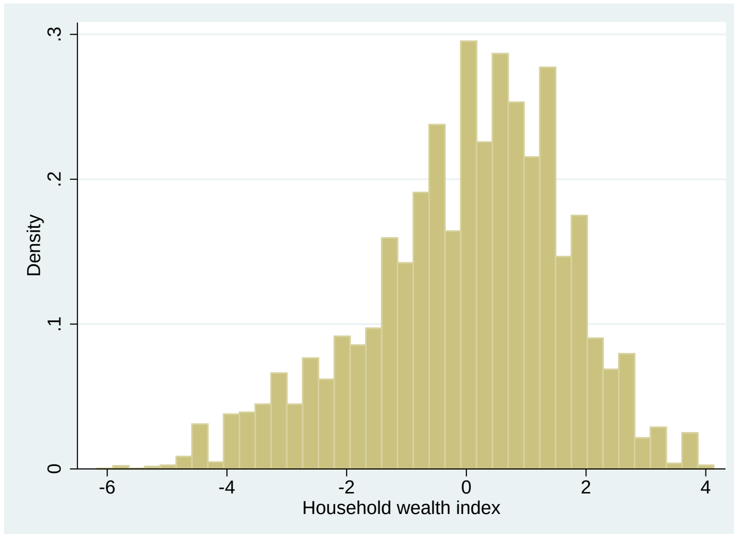
Time use data were collected for all individuals 15 years and older who were present in the household at the time of the first visit by the interviewer. Each individual recorded his or her activities in 15-minutes intervals on 24-hour diary sheets. Individuals chose the day to report their activities as long as it was between the 10th and 16th of the last month of each season (it could be a week day or a weekend day or a special holiday).

The activities recorded include market work, eating, sleeping, childcare, housework, and leisure activities. The participants were also asked to distinguish between their main and a secondary activities, which they performed in parallel with the main activity. The context in which each main activity took place was also recorded –location, whether other people were present, the person or institution for which the activity was carried out, and whether it was paid or unpaid work.

The survey includes the standard demographic information as well as information on assets owned by the household, such as car and appliances, but not household income or consumption expenditures. We use the method of Principal Component Analysis described in Filmer and Pritchett (2001) to aggregate the binary asset ownership variables into a single household wealth index. The assets we use are car, motorcycle, phone, computer, gas stove, refrigerator, freezer, vacuum, washing machine, dishwasher, microwave, TV, video, and sewing machine. Information on access to basic services such as electricity, gas and water are not provided. The resulting wealth index has a plausible distribution (see Figure 3.2) and is correlated with other indicators of household socio-economic status, such as women's education.

Since we are interested in the relationship between house work, child rearing and child educating activities, and market work for women, our primary sample includes married women between the ages of 15 and 60 whose husbands are present and have at least one child under age 18. Table 3.1 presents the summary statistics for this sample. There are 6,488 observations in our primary sample. The average age of women is about 36 and have two children. Their husbands are 5 years older and slightly more educated. There are some

Figure 3.2: The distribution of the household wealth index



women who are more educated than their husbands. 32 percent of the women report the presence of another adult other than their husbands in the household. Approximately 1/4 of the time use diaries are recorded in the summer and 16 percent in the weekends or holidays. The ratio of summer observations indicates that the data is collected evenly during the year. The majority of the women in the sample had a basic (44.8%) or high school education (22.8%). About 15% are illiterate and 17% have education above high school.

The time-use survey exhibits a high level of consistency with other household data sets. The distribution of age and education presented in this table compares well with census and the more standard Household Expenditure and Income Surveys also collected by SCI. Ghazie-Tabatabai, Mehri, and Messkoub (2013) have also used this survey to estimate the value of women's time at home.

Researchers categorize their time use data according to their needs. For example, Aguiar et al. (2013) separate out work into wage work and other income generating work because they are interested in the impact of the Great Recession on the allocation of time at the margin between market work and home production. Aguiar and Hurst (2006), Kimmel and Connelly (2007), and Hendy (2010) combine wage work with other income generating

Table 3.1: Summary statistics

	Mean	Std. Dev.	Min	Max
Mother's age	35.95	8.14	16	59
Husband's age	41.04	9.07	21	90
Age difference of couple	5.10	4.83	-15	45
Mother's education years	7.97	4.62	0	23
Husband's education years	8.64	4.57	0	23
Education difference	0.67	3.70	-12	18
Household size	4.27	1.22	3	12
# children	2.22	1.16	1	10
# children<6	0.49	0.60	0	3
# children 6-11	0.54	0.65	0	4
# children 12-17	0.68	0.74	0	5
Presence of disabled	0.03	0.17	0	1
Presence of other adults	0.32	0.47	0	1
Presence of other literate adults	0.31	0.46	0	1
Summer	0.24	0.43	0	1
Weekend	0.16	0.37	0	1

Distribution of mother's education (15-59)

	Number	Percent
Illiterate	999	15.40
Basic	2,908	44.82
High school	1,482	22.84
Associate	590	9.09
College and Postgraduate	509	7.85
Total	6,488	100.00

Note: The sample includes married women aged 15-59 who live with their husbands and have at least one child under age 18.

activities into one group, which they call market work, because they are interested in the choice between women's time spent at home versus in the market. Our three main categories of time use are closer to the latter researches because we are also interested in a similar division. Ghazie-Tabatabai et al. (2013) categorize unpaid work into domestic work, care of children and adult, and education of children in order to estimate the monetary value of unpaid domestic work of married women. The choice of these categories is due to the fact that they can be valued at market price. We group categories of activities into four aggregated categories that correspond to the distinctions made in our model: market work, house work, childcare, and leisure. The latter is determined as a residual.

The coding of activities in Iran's time use survey follows the "International Classification of Activities for Time-Use Statistics" (ICATUS), developed by the United Nations. The ICATUS classifies activities into 15 main categories:

1. Formal sector work: corporations/quasi-corporations, non-profit institutions and government
2. Work for household in primary production activities
3. Work for household in non-primary production activities
4. Work for household in construction activities
5. Work for household providing services for income
6. Providing unpaid domestic services for final use within household
7. Providing unpaid care-giving services to household members
8. Providing community services and help to other households
9. Learning
10. Socializing and community participation

11. Attending/visiting cultural, entertainment and sports events/venues
12. Hobbies, games and other pastime activities
13. Indoor and outdoor sports participation and related courses
14. Mass media
15. Personal care and maintenance

We define market work as the sum of the first five categories, which includes both market work at home and outside the home. Housework activities are defined as unpaid domestic services for final use of household members only, in category 6. This category includes time spent in household core chores, time devoted to obtain goods and services, as well as time spent on other home production such as outdoor cleaning, gardening, home maintenance, vehicle repair, etc. Examples of time spent in household core chores contain preparation of meal and cleanup, indoor household cleaning, vacuuming, indoor design and maintenance, and doing laundry. Time spent in obtaining goods and services contains grocery shopping, buying items online, going to the post office, and going to the bank. We also include care of other household members rather than children in housework category.

Childcare activity falls within the category 7. However, only some portion of mothers' time with their children is defined as childcare time. Our primary childcare time includes basic childcare, educational childcare, and recreational childcare. Basic childcare is defined as time spent on the basic needs of children such as general feeding, breast feeding, rocking a child to sleep, providing medical care, and so on. Educational childcare is defined as time spent developing cognitive skills of children such as reading to children, teaching children, helping children with homework, talking with children, and similar activities. Recreational childcare includes going to the zoo or museum with children, taking walk with children, attending a child's sporting event, and so on. Then we focus on time spent on child education by separating educational childcare time from our primary childcare. We add the remaining childcare activities (i.e. basic childcare and recreational childcare) to house work, now called domestic work. This more detailed stratification of child care time allows us to get a better understanding of how mothers' education affects their choices of educational childcare time compare to choices of childcare, housework, and market work.

We define the residuals of these three categories as leisure time. Our leisure category is different from its general definition as the time generating utility directly. In fact, we do not estimate the determinants of the leisure time since it is too heterogeneous in terms of contained activities.

We exclude childcare reported as a secondary activity because it is more likely to be routine childcare, such as minding children, and because we want our measure of childcare to correspond more closely to the notion of purposeful time spent with children for child development. We believe that by categorizing childcare time in this way, mothers indicate something about the quality of the interactions with their children. For housework and market work we stick to main activities as well so that the time remaining from 24 hours equals leisure.

3.5 Patterns of time use

Before reporting on the results of our multivariate analysis, in this section we provide tabulations of the allocation of time by mother's education, age, and household wealth. Much of the patterns observed in these simple tabulations are reproduced by the multivariate regressions.

Tables 3.2 and 3.3 indicate the average hours spent in the three time categories per day for women and their husbands by woman's education. We stratify the analysis by the age of the youngest child to determine whether the relationship between mother's education and time allocation differs when children are not of school age versus when they are. We present total time spent in childcare in table 3.2 as well as child caregiving broken to educational childcare in table 3.3. The division of labor within the household follows the familiar traditional

Table 3.2: Time allocation of married couples on childcare, housework, and market work by wife's education

Youngest child 0-5		**Women**			**Men**		
	# children<18	Childcare	Housework	Market	Childcare	Housework	Market
Mother's education							
Illiterate	3.00	1.08	6.13	0.31	0.17	1.10	6.32
	(1.28)	(1.46)	(1.97)	(1.04)	(0.43)	(1.59)	(4.05)
Basic	2.04	1.37	5.91	0.36	0.21	1.06	7.12
	(0.94)	(1.60)	(2.09)	(1.35)	(0.52)	(1.60)	(4.07)
High school	1.56	1.78	5.47	0.31	0.23	0.98	7.36
	(0.72)	(1.88)	(2.12)	(1.27)	(0.52)	(1.52)	(4.09)
Associate	1.56	1.70	5.12	0.97	0.33	1.26	6.88
	(0.72)	(1.79)	(2.22)	(2.36)	(0.77)	(1.68)	(3.97)
College, postgraduate	1.41	1.68	4.57	1.93	0.38	1.23	6.70
	(0.57)	(1.74)	(2.35)	(3.28)	(0.78)	(1.57)	(3.76)
Total	1.86	1.53	5.57	0.59	0.24	1.08	7.05
	(0.96)	(1.72)	(2.18)	(1.84)	(0.58)	(1.59)	(4.03)

Youngest child 6-17		**Women**			**Men**		
	# children 6-17	Childcare	Housework	Market	Childcare	Housework	Market
Mother's education							
Illiterate	1.76	0.22	6.13	0.60	0.09	1.30	5.43
	(0.93)	(0.55)	(2.29)	(1.74)	(0.35)	(1.73)	(4.31)
Basic	1.61	0.46	6.20	0.36	0.11	1.23	6.20
	(0.74)	(0.88)	(2.24)	(1.37)	(0.34)	(1.70)	(4.36)
High school	1.46	0.74	5.89	0.61	0.14	1.17	6.43
	(0.63)	(1.17)	(2.29)	(2.01)	(0.37)	(1.68)	(4.25)
Associate	1.50	0.76	5.24	1.52	0.22	1.22	6.47
	(0.60)	(1.12)	(2.33)	(2.72)	(0.69)	(1.67)	(3.99)
College, postgraduate	1.54	0.66	4.58	2.50	0.29	1.38	6.48
	(0.57)	(0.99)	(2.33)	(3.24)	(0.62)	(1.69)	(3.99)
Total	1.60	0.51	5.95	0.68	0.13	1.24	6.14
	(0.74)	(0.94)	(2.31)	(1.95)	(0.41)	(1.70)	(4.29)

Notes: Standard deviations in parentheses.

Table 3.3: Time allocation of married couples on child education, domestic, and market work by wife's education

Youngest child 0-5		**Women**			**Men**		
	# children<18	Child edu	Domestic	Market	Child edu	Domestic	Market
Mother's education							
Illiterate	3.00	0.20	7.02	0.31	0.12	1.15	6.32
	(1.28)	(0.47)	(2.42)	(1.04)	(0.32)	(1.63)	(4.05)
Basic	2.04	0.32	6.97	0.36	0.13	1.14	7.12
	(0.94)	(0.59)	(2.41)	(1.35)	(0.33)	(1.70)	(4.07)
High school	1.56	0.47	6.78	0.31	0.16	1.05	7.36
	(0.72)	(0.75)	(2.54)	(1.27)	(0.38)	(1.60)	(4.09)
Associate	1.56	0.47	6.35	0.97	0.17	1.42	6.88
	(0.72)	(0.70)	(2.71)	(2.36)	(0.37)	(1.91)	(3.97)
College, postgraduate	1.41	0.39	5.86	1.93	0.22	1.38	6.70
	(0.57)	(0.62)	(2.87)	(3.28)	(0.43)	(1.76)	(3.76)
Total	1.86	0.37	6.73	0.59	0.15	1.18	7.05
	(0.96)	(0.65)	(2.56)	(1.84)	(0.36)	(1.71)	(4.03)

Youngest child 6-17		**Women**			**Men**		
	# children 6-17	Child edu	Domestic	Market	Child edu	Domestic	Market
Mother's education							
Illiterate	1.76	0.07	6.28	0.60	0.06	1.33	5.43
	(0.93)	(0.28)	(2.33)	(1.74)	(0.24)	(1.78)	(4.31)
Basic	1.61	0.20	6.47	0.36	0.08	1.26	6.20
	(0.74)	(0.48)	(2.33)	(1.37)	(0.28)	(1.72)	(4.36)
High school	1.46	0.31	6.32	0.61	0.09	1.21	6.43
	(0.63)	(0.68)	(2.39)	(2.01)	(0.31)	(1.70)	(4.25)
Associate	1.50	0.38	5.62	1.52	0.10	1.33	6.47
	(0.60)	(0.63)	(2.48)	(2.72)	(0.35)	(1.82)	(3.99)
College, postgraduate	1.54	0.33	4.91	2.50	0.15	1.51	6.48
	(0.57)	(0.57)	(2.51)	(3.24)	(0.40)	(1.85)	(3.99)
Total	1.60	0.22	6.24	0.68	0.08	1.28	6.14
	(0.74)	(0.53)	(2.40)	(1.95)	(0.29)	(1.74)	(4.29)

Notes: Standard deviations in parentheses.

pattern in which women specialize in work at home and men in the market for both tables. Table 3.2 indicates that on average married women (15-59) with at least one child at school age work 7.14 hours per day, 5.95 hours of which is housework and 0.51 hours is childcare, their husbands work on average 7.51 hours per day, 6.14 hours of which is market work and only 0.13 hours is childcare. Women with small children and their husbands work more hours on average, about 7.69 and 8.37 hours respectively, perhaps because they are on average younger. Women in this group work about the same number of hours on market work and less 0.5 hour on housework, with the biggest difference being in child care (about one hour per day). Their husbands spend less time on housework but more on the market relative to sample of married men with older children. However, table 3.3 shows that there is no significant difference between time allocated to child education for women with and without small child, only about 0.12 hours per day.

In terms of magnitude, table 3.2 shows that housework takes the bulk of married women's time with small child, about 5.57 hours per day, with 1.53 hours spent on childcare and only 0.59 hours in market work. Although child time is small relative to housework, it is larger than hours spent in market work. This is important if childcare time is to explain labor market behavior of married women.

The main message of both tables is that women's time spent on child increases with education, as does their time spent in market work, while house or domestic work decreases with education. The increased time on children is especially interesting because more educated women also have fewer children, meaning that they spend even more time per child than less educated women. This clearly seen from the top half of the tables, which is about women with small children. In table 3.2, women with a high school education or above spend approximately 0.7 hour more per day on childcare relative to illiterate women (1.78 hours compared to 1.08 hours). The increase in time devoted to childcare is between illiterate and women with basic (elementary or middle school) education (0.29 hours), and between basic and high school education (0.41 hours). Above high school, education have lower impact on childcare. In contrast, market work increases most with collage education and above, with

Table 3.4: Time allocation of married women on childcare, housework, and market work by age

	Youngest child 0-5				Youngest child 6-17			
	# children<18	Childcare	Housework	Market	# children 6-17	Childcare	Housework	Market
Age group:								
15-29	1.41	1.73	5.42	0.35	1.28	1.23	5.79	0.50
	(0.65)	(1.76)	(2.10)	(1.40)	(0.51)	(1.40)	(2.03)	(1.68)
30-39	2.24	1.42	5.67	0.80	1.78	0.69	5.88	0.71
	(0.96)	(1.72)	(2.23)	(2.18)	(0.75)	(1.01)	(2.32)	(1.97)
40-49	2.56	0.93	5.97	0.85	1.54	0.33	6.04	0.70
	(1.23)	(1.24)	(2.41)	(2.03)	(0.76)	(0.77)	(2.33)	(2.02)
50-59	2.52	0.05	4.49	0.00	1.25	0.15	5.96	0.58
	(1.02)	(0.11)	(2.61)	(0.00)	(0.54)	(0.48)	(2.38)	(1.71)
Total	1.86	1.53	5.57	0.59	1.60	0.51	5.95	0.68
	(0.96)	(1.72)	(2.18)	(1.84)	(0.74)	(0.94)	(2.31)	(1.95)

Note: The sample includes married women ages 15-59 with at least one child under age 18.

no discernible difference in the time spend in market work between illiterate and women with basic education (about 0.05 hours per day). This is probably related to the low returns to education below the college level, as found by Salehi-Isfahani et al. (2010). College educated women and above spend about 1.93 hours per day on market work, which is almost twice as much as those with associate degrees and six times as much as those with high school education. The same conclusion about the relationship between women's education and their allocation of time to child education can be shown in table 3.3.

Tables 3.4 and 3.5 show how the allocation of time for women with small children and those with older children changes by age group. Women less than 30 years old and with small children spend the most amount of time on child care, about 1.73 hours per day, after which it declines to less than one hour for women in their 40s and only a few minutes for those in their 50s (only 6 women had children under 6 in this age group). Women with the youngest child at school age also reduce their time devoted to children as they become older. The same pattern of time use can be seen in time allocated to child's education in table 3.5. Age

Table 3.5: Time allocation of married women on child education, domestic, and market work by age

	Youngest child 0-5				Youngest child 6-17			
	# children<18	Child edu	Domestic	Market	# children 6-17	Child edu	Domestic	Market
Age group:								
15-29	1.41	0.38	6.77	0.35	1.28	0.54	6.48	0.50
	(0.65)	(0.61)	(2.52)	(1.40)	(0.51)	(0.80)	(2.31)	(1.68)
30-39	2.24	0.39	6.70	0.80	1.78	0.30	6.26	0.71
	(0.96)	(0.71)	(2.60)	(2.18)	(0.75)	(0.59)	(2.43)	(1.97)
40-49	2.56	0.22	6.69	0.85	1.54	0.13	6.24	0.70
	(1.23)	(0.47)	(2.64)	(2.03)	(0.76)	(0.42)	(2.39)	(2.02)
50-59	2.52	0.05	4.49	0.00	1.25	0.06	6.04	0.58
	(1.02)	(0.11)	(2.61)	(0.00)	(0.54)	(0.27)	(2.41)	(1.71)
Total	1.86	0.37	6.73	0.59	1.60	0.22	6.24	0.68
	(0.96)	(0.65)	(2.56)	(1.84)	(0.74)	(0.53)	(2.40)	(1.95)

Note: The sample includes married women ages 15-59 with at least one child under age 18.

does not seem to matter for housework, domestic, and market work until age 50 for those with small children and even higher ages for those with older children. market work increases with age until age 50 and declines afterwards.

Tables 3.6 and 3.7 present the patterns of time use of married women living in households in five quintiles of household wealth, for women with small children and those whose youngest child is 6-17. Both tables indicate that wealth has a weak positive association with time spent on children, with more wealthy women with small children spending more time in childcare and child education. Wealth dose not seem to matter for time spent on childcare and child education for women with older children. Wealthy women also spend more time in market work and less on housework or domestic work. The wealth index proves inconsequential in our regressions below, perhaps because it is highly correlated with education. Table 3.8 shows how wealth and education are correlated for married women. Only 5.6 percent of wealthy women in the top quartile are illiterate compared to 30.23 percent for women in the bottom quartile. About 18 percent of women in the top quartile are college educated or

Table 3.6: Time allocation of married women on childcare, housework, and market work by quintiles of household wealth

	Youngest child 0-5				Youngest child 6-17			
	# children<18	Childcare	Housework	Market	# children 6-17	Childcare	Housework	Market
Quintile								
1	2.06	1.44	5.94	0.37	1.82	0.46	6.15	0.59
	(1.18)	(1.62)	(2.14)	(1.42)	(0.90)	(0.85)	(2.28)	(1.78)
2	1.87	1.51	5.77	0.40	1.60	0.55	6.12	0.45
	(0.95)	(1.70)	(2.17)	(1.33)	(0.77)	(0.99)	(2.27)	(1.53)
3	1.72	1.58	5.57	0.46	1.61	0.53	5.96	0.57
	(0.86)	(1.79)	(2.04)	(1.52)	(0.74)	(0.98)	(2.28)	(1.74)
4	1.79	1.55	5.29	0.69	1.55	0.51	5.83	0.79
	(0.86)	(1.84)	(2.17)	(2.05)	(0.67)	(1.00)	(2.28)	(2.11)
5	1.82	1.60	5.04	1.14	1.49	0.51	5.81	0.87
	(0.77)	(1.68)	(2.32)	(2.72)	(0.65)	(0.90)	(2.39)	(2.26)
Total	1.86	1.53	5.56	0.58	1.60	0.51	5.95	0.68
	(0.96)	(1.72)	(2.18)	(1.84)	(0.75)	(0.95)	(2.31)	(1.95)

Note: The sample includes married women ages 15-59 with at least one child under age 18.

above compared less than one percent for the bottom quartile.

3.6 Empirical model

In order to better understand the relationship between women's time allocation and their education, we require a multivariate analysis. Our basic estimation model is a system of three linear time allocation equations as follows:

$$t_j = \beta_{0j} + \beta_{1j} X + \varepsilon_j \tag{3.13}$$

where t_j is the number of hours per day a mother choose to spend in activity j. Activity j includes child caregiving, housework or market work. Although the choices of time spent in different activities are made jointly, the empirical literature on the determinants of time

Table 3.7: Time allocation of married women on child education, domestic, and market work by quintiles of household wealth

	Youngest child 0-5				Youngest child 6-17			
	# children<18	Child edu	Domestic	Market	# children 6-17	Child edu	Domestic	Market
Quintile								
1	2.06	0.33	7.05	0.37	1.82	0.17	6.44	0.59
	(1.18)	(0.63)	(2.50)	(1.42)	(0.90)	(0.46)	(2.36)	(1.78)
2	1.87	0.35	6.94	0.40	1.60	0.25	6.42	0.45
	(0.95)	(0.56)	(2.49)	(1.33)	(0.77)	(0.57)	(2.35)	(1.53)
3	1.72	0.43	6.73	0.46	1.61	0.24	6.24	0.57
	(0.86)	(0.79)	(2.43)	(1.52)	(0.74)	(0.57)	(2.36)	(1.74)
4	1.79	0.38	6.45	0.69	1.55	0.21	6.13	0.79
	(0.86)	(0.58)	(2.58)	(2.05)	(0.67)	(0.56)	(2.39)	(2.11)
5	1.82	0.40	6.25	1.14	1.49	0.21	6.10	0.87
	(0.77)	(0.66)	(2.79)	(2.72)	(0.65)	(0.48)	(2.49)	(2.26)
Total	1.86	0.37	6.72	0.58	1.60	0.22	6.24	0.68
	(0.96)	(0.65)	(2.56)	(1.84)	(0.75)	(0.53)	(2.40)	(1.95)

Note: The sample includes married women ages 15-59 with at least one child under age 18.

Table 3.8: Distribution of married women's education by quirtiles of household wealth

	Bottom 25 percent		Top 25 percent	
	Number	Percent	Number	Percent
Mother's education				
Illiterate	491	30.23	93	5.60
Basic	864	53.20	511	30.78
High school	199	12.25	519	31.27
Associate	57	3.51	236	14.22
College, postgraduate	13	0.80	301	18.13
Total	1,624	100.00	1,660	100.00

Note: Married women 15-59 years old with at least one child under age 18.

use does not generally use a simultaneous system of estimation. Most authors simply use ordinary least squares (OLS) or instrumental variables methods to estimate each equation separately. But this fails to take into account the dependence of allocation of time between tasks and therefore does not satisfy the statistical properties of the time use data. Time spent in one activity is not available to be spent in another. In order to deal with this problem, we assume that the error terms, ε_j are correlated across these three equations. This situation is analogous to Seemingly Unrelated Regressions (SUR) (Kimmel and Connelly 2007). [4] So the correlation among the error terms leads us to estimate the system of three equations jointly using SUR.

Unlike our theoretical model we do not assume leisure to be fixed and we define it as the residual time. However, it is not important for our estimation process that all 24 hours of a day to be estimated. Since we estimate fewer than 24 hours in our system of equations, the correlation between the equations is accounted for through cross-equation covariances rather than cross-equation coefficient restrictions.

The vector of explanatory variables, X, in equation 3.13 includes standard demographic characteristics of the mothers, Z_i, household characteristics, H_i, and characteristics of the diary day. The vector Z_i contains mother's education level and age. We do not have strong theoretical predictions regarding the effect of these variable on time allocation of the mothers.

The vector H_i includes variables such as presence of other adults in the household (individuals older than 17 who are not the mother or her husband and are not disabled), presence of disabled in the household, three variables of the number of children in the household aged zero to five, six to eleven, and twelve to seventeen, child gender ratio, husband-wife age and education years difference, and household wealth index. Other studies include the age of the youngest child and the total number of children in the household as controls, but we expect that children affect differently on mother's time allocation at different ages. The reason for

[4]Our empirical estimation follows those in Kimmel and Connelly (2007) except they use a nonlinear estimation method, Tobit equations, to account for the lower limit constraints in three of their four equations of time allocation. They only estimate their equation for leisure time by OLS.

this division of age of children is that children less than 6 years are not at school age and are usually not left alone. Six-to eleven-year-olds are in school most of the day which does free up some part of mother's time but they are not left alone before and after the school time, while twelve-to seventeen-year-olds are often left alone. Children older than 11 could also help with childcare and housework which could free up mother's time. The presence of other adults in the household may influence the mother's time allocation but the direction of the impact is ambiguous. They could contribute to the household income which free up mother's time for childcare and home production but they could also contribute to childcare and housework which free up mother's time for market work. On the other hand, they may increase house work time for mothers because of their needs. However, we expect that the presence of disabled in the household has more clear impact on mother's time use since they could not be able to contribute to childcare, home production, or income and their only effect would be to increase home production time.

In addition to the usual explanatory variables, we introduce two variables that may be correlated with female bargaining power, the couple's age and education differences (husbands minus wife).[5] The time use survey also provides an opportunity to understand gender preference of Iranian households. For women with at least one child younger than 18 we define child gender ratio as the number of boys less than 18 divided by the total number of children less than 18. We also control for household wealth or economics statues using our household asset index introduced in section 3.4. Assuming that household wealth is exogenous, it plays the role of nonlabor income in our equations which expected to reduce all types of "work" time (housework and market work) as its level increases. But the effect of wealth on childcare is not clear.

We control for the season of the year in which time use survey is collected using a dummy variable for summer. We expect that summer affects time use of mothers with young children differently from other seasons because of school vacation and changes in sleep patterns and type of activities of children.

[5] We dropped a few observations that had age differences outside the range defined by -9 and 25 years.

3.7 Regression results

In this section we present the regression results of time allocated to three uses, market work, house work, and childcare or child education on various characteristics of the household. We estimate a system of three equations in which the dependent variables are the hours per day spent by mothers. In addition, since time-use patterns are very different among weekdays and weekends for many households, we divide our sample into weekdays and weekends, and estimate separate regressions for each of them[6]. As a result, we have time diary information for 5,321 observations in weekdays and 1,047 observations for weekends.

Table 3.9 reports our regressions for the three main components of women's time on weekdays while table 3.10 shows the results for weekends. We limit our sample to married women aged 15-59 with at least one child younger than 18. Table 3.9 shows that the childcare and market work equations explain 22% and 11% of the variation in their respective dependent variables, but in house work this is only 9%. Education above high school is significantly associated with more time in the market and on childcare, but not domestic work. More educated women on average spend less time in home production work. College and postgraduate educated women spend on average 0.29 hours per day more on child care and 1.98 hours more in the market relative to illiterate women. They spend 1.35 hours less on house work relative to illiterate women.

Age also matters, with older women spending less time in child care, and more in the market and on house work. The education difference and age difference between wife and husband do not seem to affect the time allocation of women in any task during week days. The presence of other adults does decrease time spent on childcare and market work by 0.14 and 0.23 hours per day, but does not affect home production time. Presence of disabled in the household and household wealth index appear to have no effect on any of the components of time use.

[6] Kimmel and Connelly (2007) divide their sample in the same way. Indeed, market work in weekend is referred to work in non-formal sectors which contains all categories of market work except the first category of its classification

The coefficient of the number of children under age 6 in the household is, as expected, positive and significant in child care but has no effect on house work and in market work on week days. Each additional child in this age leads to 0.5 extra hours per day on childcare time. Older children aged 6 to 11 have similar effects on women's time use, but as expected their effect on childcare time is smaller in magnitude. For older children, aged 12 to 17, childcare time reduces significantly for each additional child while house work increases. Each additional child at this age increases mother's time on home production by 0.11 hours per day in weekdays. Interestingly, as one might expect, the variable indicating boy ratio to total number of children less than 18 is only significant in the childcare equation. Having larger ratio of boys raises the time allocated to childcare, but not in the other two regressions.

The coefficient of the dummy variable indicating summer has a negative sign for childcare, housework, and market work indicating leisure takes the place of these activities.

Table 3.10 summarizes the results of women time allocation for weekends. The coefficients of women education on child care are no longer significant. This could be because the sample is smaller but may also indicate that time spent with children during the weekends is different than during week days when school work may require mother's attention. Education also losses its effect on market work mainly because the type of market work in weekends is not formal which requires no education. In these regressions child care time declines faster with age (-0.17 compared to -0.08 in our week days regression) but this is not the case with house work and market work during the weekend. Focusing on household variables reveals that childcare time, house work, and market are no longer affected by the presence of other adults, child gender, and number of children aged 12 to 17 on weekends. However, the effect of younger children on time allocation is the same as week days.

In order to focus on women's investment in their children's human capital, we separate the time spent on educational childcare from total child caregiving. The results of the new categories of women time allocation are presented in tables 3.11 and 3.12 for week days and weekends, respectively. Table 3.11 indicates that more educated women spend more time on child education and market work and less on domestic work. However, college and postgraduate educated have no effect on child education time. Our results are consistent with the notion that child education, as purposeful investment in child development, is more like market work than domestic work.

Age has a significant positive effect on child education time during week days. It may be explained by the fact that older mothers have better understood the value of investment in their children human capital. However, age is no longer important in domestic work since as we combine basic childcare with housework, the negative effect of age on basic childcare may cancel out its positive effect on home production activities. The variable measuring the education difference of the couple, which we believe represents male bargaining power, is important and is negatively correlated with time spent in child education. It would seem that more educated women with greater bargaining power are spending more time on child education which suggests that child education and market activities are more similar to each other and both are different from domestic work.

The coefficients for number of children at different ages provide interesting results. The number of small children does not affect the mother's time on child education but they are important in domestic work since they need basic childcare. Older children aged 6-11 influence both mother's time in child education and domestic activities which means they still need some basic care. Child gender ratio now matters in domestic work indicating mothers have preferences for boys in basic child care rather than child education.

The same regressions run for time use during the weekend which are shown in table 3.12. The results indicate a weak effect of education on women's time allocated to child education, domestic work and market work. The difference between weekdays and weekends is significant in the way that most of the determinants of time use during the weekdays are no longer important in weekends.

Table 3.9: Regression results for time allocation of married women to childcare, housework, and market work in week days

	Childcare	House work	Market work
Mother's education			
Basic	0.062	0.195	-0.039
	(0.061)	(0.102)	(0.088)
High school	0.346**	-0.175	0.181
	(0.077)	(0.128)	(0.110)
Associate	0.338**	-0.611**	0.704**
	(0.092)	(0.155)	(0.133)
College, Postgraduate	0.286**	-1.351**	1.983**
	(0.103)	(0.173)	(0.148)
Age	-0.082**	0.141**	0.068*
	(0.019)	(0.032)	(0.027)
Age^2	0.001**	-0.002**	-0.001
	(0.000)	(0.000)	(0.000)
Husband-wife age difference	0.001	-0.013	-0.011
	(0.004)	(0.007)	(0.006)
Husband-wife education years difference	0.001	0.001	0.005
	(0.005)	(0.009)	(0.008)
Presence of other adults	-0.145**	0.122	-0.234**
	(0.052)	(0.087)	(0.075)
# of children 0-5	0.511**	0.051	-0.077
	(0.039)	(0.064)	(0.055)
# of children 6-11	0.148**	0.098	0.070
	(0.031)	(0.052)	(0.045)
# of children 12-17	-0.085**	0.115*	-0.056
	(0.031)	(0.052)	(0.045)
Child gender ratio	0.126**	0.052	0.016
	(0.043)	(0.072)	(0.062)
Presence of disabled	0.115	0.222	-0.095
	(0.107)	(0.178)	(0.153)
Summer	-0.381**	-0.459**	-0.174**
	(0.041)	(0.068)	(0.058)
Household wealth index	0.008	-0.043	0.003
	(0.013)	(0.022)	(0.019)
Constant	2.443**	3.496**	-0.525
	(0.378)	(0.633)	(0.544)
R-squared	0.219	0.090	0.110
Observations	5321	5321	5321

Note: The sample includes married women ages 15-59 with at least one child under age 18. Regressions are province-level fixed effects. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$.

Table 3.10: Regression results for time allocation of married womento childcare, housework, and market work in weekend days

	Childcare	House work	Market work
Mother's education			
Basic	0.056	-0.228	-0.051
	(0.118)	(0.233)	(0.162)
High school	0.100	-0.167	-0.044
	(0.145)	(0.288)	(0.200)
Associate	-0.058	-1.033**	0.755**
	(0.176)	(0.347)	(0.242)
College, Postgraduate	0.320	-0.999**	0.511
	(0.194)	(0.383)	(0.267)
Age	-0.168**	0.201**	0.086
	(0.038)	(0.076)	(0.053)
Age^2	0.002**	-0.003**	-0.001
	(0.001)	(0.001)	(0.001)
Husband-wife age difference	-0.007	-0.027	-0.015
	(0.008)	(0.016)	(0.011)
Husband-wife education years difference	-0.012	0.028	-0.007
	(0.011)	(0.021)	(0.015)
Presence of other adults	0.018	0.341	-0.026
	(0.101)	(0.200)	(0.139)
# of children 0-5	0.501**	-0.119	-0.021
	(0.072)	(0.143)	(0.100)
# of children 6-11	0.197**	-0.177	0.091
	(0.062)	(0.122)	(0.085)
# of children 12-17	-0.056	0.156	0.009
	(0.062)	(0.122)	(0.085)
Child gender ratio	0.089	-0.083	-0.118
	(0.083)	(0.164)	(0.114)
Presence of disabled	-0.043	0.353	0.119
	(0.204)	(0.403)	(0.280)
Summer	-0.180*	-0.509**	-0.017
	(0.090)	(0.178)	(0.124)
Household wealth index	0.019	-0.020	-0.001
	(0.026)	(0.051)	(0.035)
Constant	3.920**	2.585	-0.565
	(0.755)	(1.492)	(1.039)
R-squared	0.267	0.104	0.071
Observations	1047	1047	1047

Note: The sample includes married women ages 15-59 with at least one child under age 18. Regressions are province-level fixed effects. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$.

Table 3.11: Regression results for time allocation of married women to child education, domestic, and market work in week days

	Child education	Domestic work	Market work
Mother's education			
Basic	0.024	0.232*	-0.039
	(0.026)	(0.113)	(0.088)
High school	0.128**	0.043	0.181
	(0.032)	(0.142)	(0.110)
Associate	0.174**	-0.446**	0.703**
	(0.039)	(0.171)	(0.133)
College, Postgraduate	0.068	-1.131**	1.982**
	(0.043)	(0.191)	(0.148)
Age	0.018*	0.041	0.068*
	(0.008)	(0.035)	(0.027)
Age^2	-0.000**	-0.001	-0.001
	(0.000)	(0.000)	(0.000)
Husband-wife age difference	0.003	-0.014	-0.011
	(0.002)	(0.008)	(0.006)
Husband-wife education years difference	-0.005*	0.006	0.005
	(0.002)	(0.010)	(0.008)
Presence of other literate adults	-0.098**		
	(0.023)		
Presence of other adults		0.078	-0.236**
		(0.097)	(0.075)
# of children 0-5	0.011	0.551**	-0.078
	(0.016)	(0.071)	(0.055)
# of children 6-11	0.075**	0.171**	0.069
	(0.013)	(0.058)	(0.045)
# of children 12-17	-0.061**	0.090	-0.057
	(0.013)	(0.058)	(0.045)
Child gender ratio	0.008	0.170*	0.016
	(0.018)	(0.079)	(0.062)
Presence of disabled	0.019	0.319	-0.095
	(0.045)	(0.198)	(0.153)
Summer	-0.203**	-0.636**	-0.174**
	(0.017)	(0.075)	(0.058)
Household wealth index	-0.001	-0.033	0.003
	(0.006)	(0.025)	(0.019)
Constant	0.028	5.912**	-0.527
	(0.159)	(0.701)	(0.544)
R-squared	0.109	0.088	0.110
Observations	5321	5321	5321

Note: The sample includes married women ages 15-59 with at least one child under age 18. Regressions are province-level fixed effects. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$.

Table 3.12: Regression results for time allocation of married women to child education, domestic, and market work in weekend days

	Child education	Domestic work	Market work
Mother's education			
Basic	0.073	-0.246	-0.051
	(0.053)	(0.254)	(0.162)
High school	0.140*	-0.208	-0.044
	(0.066)	(0.314)	(0.200)
Associate	0.068	-1.160**	0.756**
	(0.079)	(0.379)	(0.242)
College, Postgraduate	0.103	-0.784	0.511
	(0.087)	(0.418)	(0.267)
Age	0.002	0.032	0.086
	(0.017)	(0.082)	(0.053)
Age^2	-0.000	-0.001	-0.001
	(0.000)	(0.001)	(0.001)
Husband-wife age difference	-0.005	-0.028	-0.015
	(0.004)	(0.018)	(0.011)
Husband-wife education years difference	-0.008	0.024	-0.007
	(0.005)	(0.023)	(0.015)
Presence of other literate adults	-0.034		
	(0.048)		
Presence of other adults		0.384	-0.025
		(0.218)	(0.139)
# of children 0-5	0.010	0.371*	-0.021
	(0.033)	(0.156)	(0.100)
# of children 6-11	0.081**	-0.063	0.091
	(0.028)	(0.133)	(0.085)
# of children 12-17	-0.035	0.134	0.009
	(0.028)	(0.133)	(0.085)
Child gender ratio	-0.046	0.051	-0.118
	(0.037)	(0.179)	(0.114)
Presence of disabled	-0.024	0.332	0.119
	(0.092)	(0.439)	(0.280)
Summer	-0.171**	-0.518**	-0.017
	(0.041)	(0.194)	(0.124)
Household wealth index	-0.008	0.007	-0.001
	(0.012)	(0.055)	(0.035)
Constant	0.354	6.142**	-0.564
	(0.341)	(1.627)	(1.039)
R-squared	0.118	0.090	0.071
Observations	1047	1047	1047

Note: The sample includes married women ages 15-59 with at least one child under age 18. Regressions are province-level fixed effects. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$.

3.8 Conclusions

The purpose of this paper is to better understand how mother's education affects the allocation of her time into three types of activities: investment in child education, market work, and domestic work. We were particularly interested in how the allocation of time between the first two categories changes as education increases, and whether more educated women allocate time away from both child education and domestic work to participate more in the market or if they increase time to both child education and market work at the expense of domestic work. We found some evidence in favor of the latter hypothesis. We find in Iran married women with at least one child less than 18 treat child education and market work the same way in the sense that as they become more educated and the value of their time in the market increases, they are also likely to spend more time with their children at home and cut back on domestic work. Domestic work provides the balance. The main implication of our analysis of time use data in Iran is that education may well enhance female empowerment through women's greater participation in market work as well as in investment in human capital.

This paper also offers an explanation of the MENA puzzle of low labor force participation of educated women with few children. Both lower fertility and more education is supposed to raise their labor force participation, but the share of women in MENA labor force remains low. The answers to this puzzle so far have been along two lines. One set of explanations blame patriarchy and Islam (Moghadam 1993) and another emphasizes the role of rent income from oil(Ross 2008). The present paper suggests a third explanation based on the increased role of women in home production of human capital. This view notes that more education may increase the time allocated to child education at home, especially when labor markets do not provide enough formal jobs that are compatible with Islamic values of gender separation in the public space.

One important drawback of this paper is that we have modeled the time allocation of women in a partial equilibrium framework, separate from similar decisions by their husbands. Naturally, the two are closely related. A more realistic approach would model the time-use of the wives and the husbands jointly in a non-unitary way. Such a model would help us pose interesting questions such as whether husbands of women who spend more time in child care share more equally in domestic chores.

Bibliography

Abbasi-Shavazi, M. J., P. McDonald, and M. Hosseini-Chavoshi (2009). *The Fertility Transition in Iran: Revolution and Reproduction*. New York: Springer.

Agénor, P.-R. and B. Moreno-Dodson (2006). Public infrastructure and growth: New channels and policy implications. World Bank Policy Research Paper 4064.

Aguiar, M. and E. Hurst (2006). Measuring trends in leisure: The allocation of time over five decades. Technical report, National Bureau of Economic Research.

Aguiar, M., E. Hurst, and L. Karabarbounis (2013). Time use during the great recession. *American Economic Review 103*(5), 1664–96.

Alsop, R. and N. Heinsohn (2005). Measuring empowerment in practice : Structuring analysis and framing indicators. World bank policy research working paper 3510, Washington, DC.

Anderson, S. and M. Eswaran (2009). What determines female autonomy? evidence from Bangladesh. *Journal of Development Economics 90*(2), 179–191.

Angrist, J. D. and G. W. Imbens (1995). Two-stage least squares estimation of average causal effects in models with variable treatment intensity. *Journal of the American Statistical Associaiton 90*(430), 431–442.

Angrist, J. D. and J.-S. Pischke (2008). *Mostly harmless econometrics: An empiricist's companion*. Princeton university press.

Bailey, M. J. and W. J. Collins (2011). Did improvements in household technology cause the baby boom? evidence from electrification, appliance diffusion, and the amish. *American Economic Journal: Macroeconomics 3*(2), 189–217.

Barkat, A., S. Khan, M. Rahman, S. Zaman, A. Poddar, S. Halim, N. Ratna, M. Majid, A. Maksud, A. Karim, et al. (2002). *Economic and social impact evaluation study of the rural electrification program in Bangladesh*. NRECA International, Limited.

Barnes, D. F. (1988). *Electric power for rural growth: how electricity affects rural life in developing countries*. Douglas Barnes.

Becker, G. S. (1965). A theory of the allocation of time. *Economic Journal 75*(299), 493–517.

Becker, G. S. (1992). Fertility and economy. *Journal of Population Economics 5*(3), 185–201.

Becker, G. S., K. M. Murphy, and R. Tamura (1990). Human capital, fertility, and economic growth. *Journal of Political Economy 98*(5), S12–26.

Behrman, J. R. and M. R. Rosenzweig (1999). The returns to schooling: New evidence from twins data. *Economics of Education Review 18*(2), 159 – 67.

Behrman, J. R. and M. R. Rosenzweig (2002). Does increasing women's schooling raise the schooling of the next generation? *American Economic Review 92*(1), 323–334.

Bianchi, S., P. N. Cohen, S. Raley, and K. Nomaguchi (2004). 'inequality in parental investments in child-rearing: Expenditures, time, and health. *Social inequality*, 189–219.

Bianchi, S., V. Wight, and S. Raley (2005). Maternal employment and family caregiving: Rethinking time with children in the atus. In *ATUS early results conference*, pp. 5–6. Citeseer.

Bianchi, S. M. (2000). Maternal employment and time with children: Dramatic change or surprising continuity? *Demography 37*(4), 401–414.

Bryant, W. K. and C. D. Zick (1996). An examination of parent-child shared time. *Journal of Marriage and the Family*, 227–237.

Canning, D. and P. Pedroni (1999a). The contribution of infrastructure to aggregate output. *The World Bank Policy Research Working Paper 2246*.

Canning, D. and P. Pedroni (1999b). Infrastructure and long run economic growth. *Consulting Assistance on Economic Reform II Discussion Paper 57*.

Cornwell, G. T. and W. C. Robinson (1988). Fertility of us farm women during the electrification era, 1930–1950. *Population Research and Policy Review 7*(3), 277–291.

Craig, L. (2006). Parental education, time in paid work and time with children: an Australian time-diary analysis. *The British Journal of Sociology 57*(4), 553–575.

Dinkelman, T. (2011). The effects of rural electrification on employment: New evidence from south africa. *The American Economic Review*, 3078–3108.

Duflo, E. (2001). Schooling and labor market consequences of school construction in Indonesia: evidence form an unusual policy experiment. *American Economic Review Papers and Proceedings 91*(4), 795–813.

Esfahani, H. S. and P. Shajari. Gender, education, family structure, and the allocation of labor in Iran. *Middle East Development Journal 4*(2).

Filmer, D. and L. H. Pritchett (2001). Estimating wealth effects without expenditure data—or tears: An application to educational enrollments in states of India. *Demography 38*(1), 115–132.

Fluitman, F. (1983). Socio-economic impact of rural electrification in developing countries: a review of evidence. Technical report, International Labour Organization.

Galor, O. (2004). From stagnation to growth: Unified growth theory. In P. Aghion and S. Durlauf (Eds.), *Handbook of Economic Growth*, Volume 1, Chapter 4, pp. 171–293. New York: elsevier.

Ghazie-Tabatabai, M., N. Mehri, and M. Messkoub (2013). What is unpaid female labour worth? evidence from the time use studies of Iran in 2008 and 2009. Working paper # 564, International Institute of Social Studies, The Hague, Netherlands.

Graham, J. W. and C. A. Green (1984). Estimating the parameters of a household production function with joint products. *The Review of Economics and Statistics 66*(2), 277–282.

Greenwood, J., A. Seshadri, and M. Yorukoglu (2005). Engines of liberation. *The Review of Economic Studies 72*(1), 109–133.

Grogan, L. (2011). Household electrification and fertility in poor countries.

Grogan, L. and A. Sadanand (2009). Electrification and the household. *University of Guelph, Economics Department, Guelph, Ontario. Processed*.

Grogan, L. and A. Sadanand (2012). Electrification and labour supply in poor households: Evidence from nicaragua. *World Development 43*, 252–265.

Gronau, R. (1977). Leisure, home production, and work- the theory of the allocation of time revisited. *Journal of Political Economy 85*(6), 1099–1123.

Guryan, J., E. Hurst, and M. S. Kearney (2008). Parental education and parental time with children. Technical report, National Bureau of Economic Research.

Harbison, S. F. and W. C. Robinson (1985). Rural electrification and fertility change. *Population Research and Policy Review 4*(2), 149–171.

Hashemi, A. and D. Salehi-Isfahani (2013). From health service delivery to family planning: The changing impact of health clinics on fertility in rural Iran. *Economic Development and Cultural Change 61*(2), 281–309.

Henderson, V., A. Storeygard, and D. N. Weil (2011). A bright idea for measuring economic growth. *The American Economic Review*, 194–199.

Hendy, R. (2010). Rethinking time allocation of Egyptian women: A matching analysis. In *Economic Research Forum Working Papers*, Number 526.

Hill, C. R. and F. P. Stafford (1980). Parental care of children: Time diary estimates of quantity, predictability, and variety. *Journal of Human Resources*, 219–239.

Hoddinott, J. and L. Haddad (1995). Does female income share influence household expenditures? evidence from côte d'ivoire. *Oxford Bulletin of Economics and Statistics 57*(1), 77–96.

Hofferth, S. L. (2001). Women's employment and care of children in the united states. *Women's employment in a comparative perspective*, 151–74.

Hoodfar, H. (1997). *Between marriage and the market: Intimate politics and survival in Cairo*. Berekeley, CA: University of California Press.

Hooglund, E. (2009). Thirty years of the Islamic Revolution in Rural Iran. *39*(250).

Howie, P., J. Wicks, J. M. Fitzgerald, D. Dalenberg, and R. Connelly (2006). Mothers time spent in care of their children and market work: a simultaneous model with attitudes as instruments. *Applied Economics Letters 13*(8), 503–506.

Juster, F. T. (1985). Preferences for work and leisure. *Time, goods, and well-being*, 335–51.

Kalenkoski, C. M., D. C. Ribar, and L. S. Stratton (2005). Parental child care in single-parent, cohabiting, and married-couple families: Time-diary evidence from the united kingdom. *American Economic Review*, 194–198.

Kantor, P. (2003). Women's empowerment through home–based work: Evidence from india. *Development and change 34*(3), 425–445.

Karshenas, M. (2001). Economic liberalization, competitiveness and women's employment in the Middle East and North Africa. In D. Salehi-Isfahani (Ed.), *Labor and Human Capital in the Middle East: Studies of Markets and Household Behavior*. London: Ithaca Press.

Kerkhof, M. and P. Koorman (2003). Identification and estimation of a class of household production models. *Journal of Applied Econometrics 18*(3), 337–369.

Khandker, S. R., D. F. Barnes, and H. A. Samad (2009). Welfare impacts of rural electrification: a case study from bangladesh. *World Bank Policy Research Working Paper Series, Vol.*

Kimmel, J. and R. Connelly (2007). Mothers time choices caregiving, leisure, home production, and paid work. *Journal of Human Resources 42*(3), 643–681.

Kranichfeld, M. L. (1987). Rethinking family power. *Journal of Family Issues 8*(1), 42–56.

Krueger, A. B., D. Kahneman, D. Schkade, N. Schwarz, and A. A. Stone (2009). National time accounting: The currency of life. In *Measuring the subjective well-being of nations: National accounts of time use and well-being*, pp. 9–86. University of Chicago Press.

Lipscomb, M., M. A. Mobarak, and T. Barham (2013). Development effects of electrification: evidence from the topographic placement of hydropower plants in brazil. *American Economic Journal: Applied Economics 5*(2), 200–231.

Lucas, R. E. (2002). *Lectures on Economic Growth*. Cambridge: Harvard University Press.

Mammen, K. and C. Paxson (2000). Women's work and economic development. *Journal of Economic Perspectives 14*(4), 141–164.

Merrick, T. W. (1985). The effect of piped water on early childhood mortality in urban brazil, 1970 to 1976. *Demography 22*(1), 1–24.

Moghadam, V. M. (1993). *Modernizing women: gender and social change in the Middle East*. Boulder, Co.: Colorado Univeristy Press.

Peters, J. and C. Vance (2011). Rural electrification and fertility–evidence from côte d'ivoire. *The Journal of Development Studies 47*(5), 753–766.

Ramey, V. A. (2009). Time spent in home production in the twentieth-century United States: New estimates from old data. *The Journal of Economic History 69*(01), 1–47.

Robbins, L. (1930). On the elasticity of demand for income in terms of effort. *Economica* (29), 123–129.

Robinson, J. and G. Godbey (2010). *Time for life: The surprising ways Americans use their time*. Penn State Press.

Rosenzweig, M. R. and T. P. Schultz (1982a). Child mortality and fertility in colombia: individual and community effects. *Health policy and education 2*(3), 305–348.

Rosenzweig, M. R. and T. P. Schultz (1982b). Market opportunities, genetic endowments, and intrafamily resource distribution: Child survival in rural india. *American Economic Review 72*(4), 803–15.

Ross, M. L. (2008). Oil, Islam and Women. *American Political Science Review 102*(1).

Salehi-Isfahani, D. (2001). *Labor and Human Capital in the Middle East: Studies of Markets and Household Behavior*. ISBS.

Salehi-Isfahani, D. (2009). The Revolution and the rural poor. *Radical History Review 2009*(105), 139–144. Special issue: The Iranian Revolution Turns Thirty.

Salehi-Isfahani, D. (2012). Education, jobs, and equity in the Middle East and North Africa. *Comparative Economic Studies 54*(4), 843–861.

Salehi-Isfahani, D., M. J. Abbasi-Shavazi, and M. Hosseini-Chavoshi (2010). Family planning and fertility decline in rural Iran: The impact of rural health clinics. *Health Economics 19*(S1), 159–180.

Sandberg, J. F. and S. L. Hofferth (2001). Changes in childrens time with parents: United states, 1981–1997. *Demography 38*(3), 423–436.

Sayer, L. C., A. H. Gauthier, and F. F. Furstenberg (2004). Educational differences in parents' time with children: Cross-national variations. *Journal of Marriage and Family 66*(5), 1152–1169.

Sundaram, A. and R. Vanneman (2008). Gender differentials in literacy in india: The intriguing relationship with women's labor force participation. *World Development 36*(1), 128–143.

Wagstaff, A., M. Lindelow, G. Jun, X. Ling, and Q. Juncheng (2009). Extending health insurance to the rural population: An impact evaluation of China's new cooperative medical scheme. *Journal of Health Economics 28*(1), 1–19.

Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data*. The MIT Press.