The Impact of Durable Goods on Child Outcomes: Evidence from China

Amanda Kerr*

This version: December 30, 2017

Abstract

This paper uses a time allocation framework to examine how the presence of household durable goods impacts child outcomes. I use micro-level data from the China Health and Nutrition Survey (CHNS) to test the hypothesis that the presence of time-saving household appliances caused a decrease in time allocated to housework, increase in school enrollment rates, and decrease in labor force participation rates for children aged 12-18 in China over the last two decades. To control for endogeneity of household durable goods, I instrument household ownership of each time-saving appliance by the average ownership rate of that appliance among households with no children living in the same community. I estimate that living in a household that owns a washing machine: (1) decreases the average time dedicated to housework by 78 minutes per week, (2) increases the probability of being enrolled by 12 percentage points, and (3) decreases the probability of being employed by 48 percentage points.

*Schroeder School of Business, University of Evansville, 1800 Lincoln Avenue, Evansville, IN 47722
Online Appendix available at: sites.google.com/site/amandackerr/research

1 Introduction

The allocation of time within a household has been widely discussed since Becker's seminal work (1965). Recent literature has incorporated time-saving appliance ownership into Becker's model to explain increases in female labor force participation (Greenwood, Seshadri, and Yorukoglu, 2005). This model has been empirically tested with data from the United States (Coen-Pirani, León, and Lugauer, 2010) and China (Tewari and Wang, 2016), and has been adjusted to incorporate children's time allocation in conjunction with parents' time allocation in a broader family context (Skoufias, 1993). I combine these models to analyze family appliance ownership and children's time allocation.

Household ownership of time-saving durable goods in China has increased dramatically during recent decades. Washing machine ownership rates have increased from less than 5 percent in the 1980s to over 90 percent by 2004. Refrigerator ownership has increased from less than 5 percent in the 1980s to 24 percent in 1994, most recently reaching 88 percent in 2014.[1] Previous researchers have studied the effect of time-saving durable goods only on adult female outcomes, finding an increase in the probability of labor force participation among women who live in households that own a time-saving durable good.[2] I expand the analysis to include a larger population of individuals potentially affected by the introduction of a new technology. Since children, and specifically female children, allocate a large portion of time to household production,[3] it is important to look at the effect of ownership of time-saving appliances on child outcomes.

This paper examines the impact of the diffusion of time-saving household durable ap-

[1] http://www.economist.com/news/international/21603031-how-chilled-food-changing-lives-cool-developments; http://www.worldwatch.org/system/files/Appliances.pdf

[2] Some articles that analyze appliance ownership include: Cardia (2008), Coen-Pirani, León, and Lugauer (2010), Greenwood, Seshadri, and Yorukoglu (2005), and Tewari and Wang (2016). Dinkleman (2011) finds that electrification, which is necessary for most appliances, significantly raises female employment within five years.

[3] See Skoufias (1993). In the CHNS dataset women between the ages 19-44 spend an average of 581.5 minutes per week (roughly 9.7 hours) performing housework. Males between 19-44 years old spend an average of 124.7 minutes per week (roughly 2 hours) on housework. Male and female children between 12-18 years old spend 45.9 minutes per week (less than one hour) and 132.7 minutes per week (roughly 2.2 hours) on housework, respectively.

pliances on child outcomes in nine Chinese provinces. Using data from the China Health and Nutrition Survey (CHNS), time-series and cross-sectional variation in household appliance ownership along with multiple child outcomes, I identify the impact that access to time-saving durable goods had on the reallocation of time to leisure and schooling for older children. To address the concern of endogenity of household durable goods arising from unobserved preferences, I instrument household ownership of a time-saving appliance by the average ownership rate among households with no children living in the same community. In order to control for household wealth, I develop a wealth index by applying factor analysis to household data on assets and infrastructure.

My empirical results indicate that children aged 12-18 living in households that own a time-saving appliance experience a decrease in average time dedicated to housework, have a higher probability of being enrolled in school, and have a lower probability of being employed. These results are largest for females. For households that invest in time-conserving washing machines, females aged 12-18 experience a 187 minute decrease in average time dedicated to housework per week and a 17.8 percentage point increase in the probability of school enrollment. Both genders experience a significant decrease in the probability of being employed. Results support the predictions obtained through the time allocation model. The presence of time-saving appliances provides children the opportunity to reallocate their time from housework to other time-using activities. The model predicts that time allocated to both housework and employment for a child may decrease if time dedicated to other activities, such as schooling and leisure, increase by a similar magnitude. I find a smaller magnitude increase in the probability of enrollment than the decrease in the probability of employment. However, I am unable to estimate with precision the change in time dedicated to leisure activities. Viewing time allocation in the broader context of the family unit, there is potential for time allocation changes among mothers to affect time allocation outcomes for children. In particular, if household investments in time-saving capital induce mothers to reduce time in household production and increase time in market work, a potential outcome for children

is to reduce time allocated to *both* household production and market work. Results in this paper support that proposition.[4] If child labor is viewed as a negative outcome, then investments in household appliances may be beneficial to a range of child outcomes, including education and consumption of leisure.

These results have significant policy implications. Gender equality and women's empowerment is a top priority among both developed and developing countries, having been discussed heavily at the 71st United Nations General Assembly.[5] One past Millennial Development Goal was to reach parity among boys and girls at the primary school level. With this goal having been achieved in many countries, providing girls secondary education is the next step. Policymakers believe secondary education for female children is an "enormous lever" for economic success.[6] Achieving this goal requires more than increasing access to secondary schools, but also releasing daughters from their duties at home. Observing a handful of household activities, the results presented in this paper strongly suggest that in order to increase a female child's secondary enrollment, there must be a decrease in their obligations within the household. Time-saving appliances are a tool that provide the requisite decrease in average time dedicated to housework.

2 China Background

2.1 Education in China

The education system in China consists of five years of primary education, four years of junior secondary education, and three years of senior secondary education. Children begin primary education by the age of seven.

[4]Coen-Pirani, León, and Lugauer (2010) and Tewari and Wang (2016) find an increase in adult female labor force participation when time-saving appliances are purchased. The effect of a mother's employment on child outcomes is discussed in Section 6.2.

[5]Some articles highlighting the discussion and goals include: http://www.un.org/apps/news/story.asp?\\NewsID=54973#.V-1fUJMrKRs; http://www.un.org/apps/news/story.asp?NewsID=55034#.V-1fR5MrKRs.

[6]See http://time.com/4493733/melinda-gates-unga/.

While primary school enrollment rates have always been high, with gross enrollment above 100 percent from 1989-2011,[7] secondary enrollment rates have seen a significant increase during the last 25 years. According to the World Bank, secondary gross enrollment was 38 percent in 1989, which is the first year of data available in the CHNS. This rate increased to over 86 percent by 2011, the most recent year of available data. The "Law of Compulsory Education" of 1986 provides all children with nine years of compulsory schooling, yet gross junior secondary completion rate (nine years of schooling) was still at 55 percent in 1991, reaching 73 percent in 1997, and finally entering the 90 percent range in 2008.

Determinants of school enrollment have been investigated by multiple authors. Brown and Park (2002) examine the effects of individual, family, and school characteristics on educational attainment. Connelly and Zheng (2003) use a logit model to analyze the effect of rural residence, parental education, and family size on enrollment and completion. Yi et al. (2012) hypothesize that poverty, poor academic performance, and rising opportunity costs are contributing factors to school dropout rates.

All three studies agree that a major factor in the decision to attend school is the cost of schooling. Children whose families do not pay school fees are not allowed to attend school. Brown and Park's (2002) survey data show that many parents are less willing to pay for the education of their daughters, with "inability to pay high fees" being the most frequent response to why female children drop out.[8] A household must also consider the opportunity costs of foregone wages and home production when deciding if a child is to attend school (Connelly and Zheng, 2003). With an increase in unskilled wages in China, the opportunity cost of schooling increases, especially for older children. Students older than 14 have a dropout rate of 37.4 percent, compared to 9.1 percent for students younger than 14 (Yi et al., 2012).

[7]Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the primary education level (World Bank Data). Children in poor areas tend to enroll at older ages, so many 13-15 year old children are in primary school, rather than junior secondary school, which allows the primary gross enrollment to be higher than 100 percent.

[8]The Compulsory Education Law 2006 amendment abolished tuition fees for nine-year compulsory education in rural areas. However, fees are still legal and present for senior secondary education.

For younger children, Brown and Park (2002) find that the number of siblings decreases the probability of dropping out, due to older siblings substituting their household duties for those of their younger siblings, or through complementarity among siblings with respect to learning outcomes and savings in the cost of school attendance.

The opportunity cost of foregone home production deserves additional attention in the literature. A child's time can be divided into four categories: school, leisure, market work, and household work. In less developed areas, children spend a great deal of time in home production. Some time-consuming tasks include cooking, cleaning, doing laundry, and caring for younger children. In the CHNS dataset, older children spend, on average, an hour and a half per week performing household chores.[9] Household durable goods that reduce the time required to perform those tasks provide the opportunity to reallocate a child's time to other activities, such as schooling. Appliances of a time-saving nature in the CHNS dataset include washing machines and kitchen appliances (refrigerators, microwave ovens, electric cooking pots, and pressure cookers). I hypothesize that the purchase of time-saving durable goods will alter children's time allocation within the household, lowering the opportunity cost of attending school and providing them with the opportunity to further their education. The hypothesized effect on children's employment is ambiguous, due to the fact that appliances lower the opportunity cost of working for both children and adult females. On one hand, household appliance investments might reduce the commitment of children at home, inducing them to directly substitute market work for household work. At the same time, however, mothers might take advantage of time saved by appliances to increase their own wage-earning market work. To some extent, that might entail substitution of mothers' market work for children's market work, thus conserving children's time for other uses. Resolution of these conflicting phenomena is therefore an empirical issue, and a principle objective of this paper.

[9]These household chores include: buying food, preparing food, and washing clothes for the household. This average excludes other probable household duties and is therefore a minimum average number of minutes per week dedicated to housework.

2.2 Appliance Ownership in China

Appliance ownership in China has increased during recent decades, with technological advancements, infrastructural improvements, and economic growth making household appliances more accessible to rural and low-income households. Between 1989 and 2011 washing machine and refrigerator ownership increased by 45 and 60 percent respectively in the CHNS dataset. Ownership of smaller kitchen appliances has increased to 70 percent. Entertainment appliances have also experienced large increases in ownership, with ownership of color televisions increasing by over 80 percent. Summary statistics from the CHNS are presented in Section 3.

Bowden and Offer (1994) distinguish between two types of household appliances: time-saving and time-using. Time-saving technologies embody appliances that reduce time required to perform housework. In the CHNS dataset, available time-saving appliances include washing machines, refrigerators, microwave ovens, electric cooking pots, and pressure cookers. Time-using goods enhance the quality of discretionary time and ownership rates of these goods typically increase at a faster rate than time-saving appliances. Examples of time-using goods in the CHNS dataset include air conditioners, cameras, color televisions, and electric fans.[10] According to Bowden and Offer (1994), consumers in the United States and Britain give greater priority to enhancing the quality of discretionary time rather than to increasing its quantity. This trend appears to be similar in China. One reason for this result is that time-using appliances affect the satisfaction of all household members, whereas time-saving appliances primarily affect the main users of these goods (typically adult females and children). Time-using appliances are also viewed as status goods and thus acquire higher priority for purchase than time-saving goods.

When a household purchases time-saving durable goods, individuals have the opportunity to reallocate their time to leisure, schooling, or market work. Previous literature has found

[10] Air conditioners and electric fans may be classified as non-time-altering rather than time-using appliances. However, they increase the quality of time spent in the household and are therefore grouped with time-using appliances in this discussion.

that adult females in China increase their labor force participation and decrease their time dedicated to home production (Tewari and Wang, 2016). In the United States, a similar result has occurred, as evidenced by increases in participation rates by married women (Coen-Pirani, León, and Lugauer, 2010). In contrast, purchasing time-saving appliances is found to produce no change in time dedicated to housework for household members in Australia (Bittman, Rice, and Wajcman, 2004), who find that owning domestic technology rarely reduces unpaid housework. With an increase in time-saving appliance ownership, households have additionally increased domestic production standards and output, decreased the use of domestic service workers, and added new tasks to household production.

Even if the housework hours remain the same, the workload becomes easier (Bowden and Offer, 1994). Time-conserving appliances are an alternative avenue used to strengthen women's bargaining power through providing them more efficient ways to perform tasks they typically partake in, making them more productive in the household. While it is still unclear whether appliances decrease total time dedicated to housework, there appears to be a consensus in the literature that these appliances increase productivity within the household. This paper adds to the discussion of the effect of appliances on household time allocation by studying children's time allocation. This topic has not yet been explored in previous literature. Since female children dedicate over twice as much time to housework than male children, determining the effect of time-saving appliances on female children's outcomes is crucial if researchers want to further understand gender inequality in China.

3 Data Description

The data are from the China Health and Nutrition Survey (CHNS).[11] A nine wave longitudinal dataset, which covers 23 years, is available across nine provinces which vary substantially in geography, economic development, public resources, and health indicators. The

[11]These surveys are conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention.

provinces are Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong.[12] The waves are surveys conducted in years 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. The surveys include individual, household, and community level data. Each household member's income, time allocation at home, and economic activities are described in detail. Information on water sources, condition of the home, and ownership of consumer durable goods are reported. Full income from both market and nonmarket activities are imputed. Data on community infrastructure (water, transport, electricity, communications, etc.), services (family planning and health facilities), and population are available.

This paper focuses on child outcomes, looking at children aged 12-18.[13] I observe 8,008 children, with 15,361 observations over the nine wave panel.[14] Summary statistics are presented in Table 1, dividing the sample into children in households that own a washing machine and children in households that do not own a washing machine.[15] The average age of children in the sample is 15.14 years old, with just under half of the sample being female and each individual completing 7.7 years of schooling on average. Children in households that own a washing machine complete 8.4 years of schooling, while children in households that do not own a washing machine only complete 7.1 years of schooling. The main variable of interest is whether an individual is currently enrolled in an educational institution. At the time of the survey, 73 percent of the sample was enrolled in school; 82 percent of children in households that own a washing machine were enrolled, compared to 65 percent of those in households that do not own a washing machine. The survey reports time allocation, with an average of 88 minutes per week spent on housework (buying food, preparing food, or washing clothes). Children in households that do not own a washing machine spend 45 minutes per

[12]Heilongjiang was added to the dataset in 1997 when Jiangsu was unable to participate. Jiangsu returned to the study in 2000.

[13]An analysis on younger children (aged 6-11) is done as a robustness check. These results are available upon request.

[14]On average, I observe these 8,008 individuals in 6.3 waves of data (including waves outside of the 12-18 age range), but only 2.2 times when I restrict the age range to 12-18 years old.

[15]Summary statistics for the sample not conditional on washing machine ownership are available in the Online Appendix, Table A1.

week on housework more than children in households that own a washing machine.

Household wealth is also presented in Table 1, with children living in households that own a washing machine being of a higher wealth status. A discussion on household income and creation of the wealth index is presented in the following section. 47 percent of children aged 12-18 live in households that own a washing machine. Among households that own washing machines, 55 percent also own refrigerators. Only 7 percent of households that do not own a washing machine own a refrigerator.[16]

Table 2 compares individual characteristics in the first two years of data available, 1989 and 1991, to the last two years of data available, 2009 and 2011, conditional on washing machine ownership.[17] Over this 23 year period, enrollment rates for older children have increased from 62 percent to 89 percent and completed years of schooling have increased by 1.32 years. These increases are observed for both children in households that do and do not own a washing machine. There has been a 30 minute decrease in average time dedicated to weekly housework. However, when the sample is divided by washing machine ownership status, it appears both groups experience a slight increase in average time dedicated to housework.[18] Visual representations of time trends in enrollment, washing machine ownership, and housework for older children are presented in Figures 1A-1C.

Households with children between the ages 12-18 have increased their ownership of washing machines from 29 percent to 74 percent over the 23 year period. Refrigerator ownership has increased from 9 percent to 62 percent. Given that a child lives in a household that owns a washing machine, their refrigerator ownership increased by nearly 50 percentage points. Households that do not own a washing machine also experience an increase in refrigerator

[16]In the primary empirical analysis, I confine the definition of time-saving appliances to washing machines and refrigerators, since they entail large purchases relative to income, and hence more substantial investments, for most households. In secondary analyses, I expand the definition to include smaller (and less costly) appliances. Results from the broader definition, which do not alter the conclusions of the study, are available on request from the author.

[17]A similar breakdown unconditional on washing machine ownership is presented in Columns 4-9 of Table A1 in the Online Appendix.

[18]These results suggest a Simpson's paradox, where a trend appears in different groups of data but disappears or reverses when these groups are combined.

ownership of 21 percentage points. Again, these durable appliances are considered time-saving appliances. Visual representations of time trends in washing machine and refrigerator ownership for both rural and urban households are presented in Figures 2 and 3.

Data for time allocated to housework are available from 1989 to 2000 for nearly all individuals. From 2004 to 2011, however, time allocations are missing for up to one half of the sample. I address the missing data challenge in two ways. First, partitioning the sample between the 1989-2000 and 2004-2011 subsets and estimate the model separately for each group, restricting the latter portion to observations without missing data. Results from the two sub-samples are similar, suggesting that missing data from the second group do not present a problem of sample selection bias. Second, in an auxiliary analysis, I construct an indicator distinguishing households for which the time allocation data are missing. I then regress that indicator on the complete set of covariates in the model. Results of that analysis suggest three covariates that are associated with missing data. Among females and in communities that have secondary schools, the probability of missing data decreases by 3.7 and 2.6 percentage points, respectively. An increase of one index point in the wealth index (to be described in Section 4), on the other hand, increases the probability of missing data by 1.1 percentage points. This suggests that observations with missing data might be slightly biased toward males living in wealthier households.

Summary statistics presented in this section highlight large increases in enrollment rates for older children and time-saving appliance ownership. The purpose of the empirical analysis is to ascertain the extent to which this difference is sustained in the multivariate context.

4 Wealth Index

I develop a wealth index to address the concern of time-saving appliances picking up a "wealth effect" rather than the direct behavioral effect of investments in appliances.

The CHNS provides data on household income for a sub-sample of households. I use

this variable as a validity check when creating the wealth index to verify that the index is consistent with household income for those households that reported income. Household income is not used in the empirical analysis for two reasons. First, household income is endogenous as it is fully determined by allocation of time. A household that allocates a significant amount of time to market work will have a higher household income than households who allocate less time to market work.[19] Second, data on household income are limited to households with above average income when compared to average household income reported at the community level.[20]

The wealth index is calculated using information on a household's ownership of non-time-saving appliances and household infrastructure, placing households on a continuous scale of relative wealth. Wealth indices are typically used in countries that lack reliable data on income and expenditures. Using a factor analysis approach and following steps similar to those developed by the Demographic and Health Surveys, I am able to assign household assets and infrastructure a weight (factor score) and combined these weights by household to rank each household's overall wealth.[21,22]

Figure 4 presents average household income reported at the household and the community level for the 23 year period of data, along with the computed wealth index. Average household income reported at the household level is 19,870 yuans and average household income reported at the community level is 14,522 yuans. This suggests that inclusion of household income in the specification of the model would bias the results by including only a wealthier subset of the sample.

[19]Using father's income rather than household income presents less of an endogeneity concern. I perform the full analysis using father's income as a control. Performing the analysis excluding father's income does not alter the magnitude or significance of any results presented in this analysis. The father's income variable is constructed using (1) directly reported father's income, (2) imputed father's income (imputed by the CHNS), and (3) average male income within a community if the first two measures are unavailable.

[20]Each year of the sample consists of between 188-219 communities.

[21]See: http://www.dhsprogram.com/topics/wealth-index/.

[22]From Kennedy (2008, pg. 200): Factor analysis produces linear combinations of subsets of variables that share maximum common variation in hopes to represent some unmeasured factor. Large numbers of possible explanatory variables are reduced to a smaller number of factors, with the highly collinear variables consolidated.

In constructing the wealth index, I use household assets that measure potential wealth but do not alter time dedicated to housework (non-time-saving appliances). These assets include: air conditioner, bedroom furniture, black and white television, bicycle, camera, car, cellphone, clock, color television, computer, DVD player, electric fan, living room furniture, motorcycle, satellite, sewing machine, stereo, telephone, tricycle, VCR, and water pump.[23] Ownership of each of these assets is indicated using dummy variables, with a value equal to one if a household owns the asset and zero otherwise.[24]

Infrastructure variables included in the wealth index are drinking water access, toilet facility access, main lighting source, main cooking fuel, and main water source. These variables are discrete variables. Drinking water access is indicated with a value between one and four, with one being the lowest wealth indicating drinking water (source outside of house or yard) and four being the highest wealth indicating drinking water (in-house tap). Toilet facility access is indicated with a value between one and seven, with one being the lowest wealth indicating toilet facility (earth open-pit) and seven being the highest wealth indicating toilet facility (in-house flush). Main lighting source is indicated with a value between one and two, with one being any lighting source other than electric lighting and two being the highest wealth indicating lighting source (electric). Main cooking fuel is indicated with a value between one and five, with one being the lowest wealth indicating cooking fuel (wood) and five being the highest wealth indicating cooking fuel (natural gas). Main water source is indicated with a value between one and five, with one being the lowest wealth indicating water source (open well) and five being the highest wealth indicating water source (water plant).

These infrastructure variables are used along with the ownership indicator variables in

[23]Modes of transportation (bicycle, motorcycle, and car) may alter time dedicated to housework. However, these assets are of a different category than the time-saving appliances observed in this analysis and are reliable measures of wealth so they are included in the wealth index.

[24]Slight adjustments of ownership for three variables are made: black and white television, tricycle, and motorcycle. If a household owns a color television I assume they are wealthy enough to own a black and white television and therefore set the dummy variable indicating ownership of a black and white television equal to one for households that own a color television. I do the same for bicycle ownership (reassigning ownership of a tricycle to one) and car ownership (reassigning ownership of a motorcycle to one).

a factor analysis approach to estimate factor scores for each household in each year of data available. I sum the factor scores within each household each year to create a wealth index between the values 0 and 4.38, with 0 representing the least wealthy households and 4.38 representing the wealthiest households in the sample. I compare the wealth index with available household income to verify that households which report higher incomes also obtain higher wealth indices. One concern with the wealth index is that the average wealth drops in the last year of data, 2011, suggesting that households in 2011 were less wealthy than households in the previous year of data available, 2009. The list of variables used to construct the wealth index in 2009 and 2011 are identical, meaning no new wealth indicating variables were introduced to the survey in 2011. Without introducing new measures of wealth, households in the previous wave of data who were categorized as "less wealthy" would have had sufficient time to save and purchase the assets that only wealthier households were able to purchase in the 2009 wave. This lowers the factor score for each variable, which decreases the overall wealth index. Additionally, in the last wave of data, two percent of the households report an average household income within the community over twice as large as the maximum community household income reported in the previous wave of data. Those households cause the standard deviation of community household income in 2011 to be over four times larger than the standard deviation in the 2009 wave. These two changes in the data cause the wealth index to be lower and average household income reported by community leaders to be higher in the 2011 wave. Controlling for both of these variables guarantees that the results are taking into account multiple channels of changes in household wealth. As a robustness check, I perform the analysis excluding the 2011 wave. Results are similar in magnitude and significance for all regressions.

The wealth index is available for 99.9 percent of the sample, while household income reported by the household (community leader) is only available for 69.5 (80.6) percent of the sample. Using the wealth index allows me to utilize a larger sample while controlling for wealth, which is an important determinant of both appliance ownership and child outcomes.

5 Empirical Model

The original model of time allocation was developed by Gary Becker in 1965. It has since been modified by many authors to understand different aspects of household production.[25] I present a further modification to analyze family appliance ownership and children's time allocation in the Online Appendix. Using detailed data from the CHNS I estimate this model and test the implication that as households purchase time-saving durable goods, children will reallocate their time to leisure, schooling, or market work.

In this section I outline the empirical model. I focus on three child outcome variables: housework, enrollment, and employment. Housework is the average number of minutes dedicated to household chores (specifically buying food, preparing food, and washing clothes for the household) every week. Enrollment (employed) is a dummy variable equal to one if the individual is currently enrolled (employed) and zero otherwise. An expression that estimates the relationship between appliance ownership and these dependent variables is presented in Equation 1.

$$Y_{ict} = \beta_0 + \beta_1 appliance_{ict} + X_{ict}\beta_2 + \varepsilon_{ict} \tag{1}$$

where $appliance_{ict}$ is a dummy indicating whether the individual lives in a household that owns a washing machine (refrigerator) at the time of the survey and X_{ict} is a vector of individual, household, and community control variables that would affect child outcomes. Individual controls include age, age squared, gender, and Han status. Household controls include place of residence (rural/urban), wealth index, father's income, and parental controls (parents' ages and educational attainments). Community controls include average household income and a set of dummy variables indicating availability in the community of convenient telephone service, public baths, and train transportation. Additional community-level dummy variables indicate if the community is located near a navigable river, near an open trade

[25] See Huffman and Lange (1989) and Skoufias (1993).

area, and whether there is a secondary school in the community.

A concern when estimating Equation 1 is the possibility that appliance ownership is correlated with unobserved factors that determine time allocation. Coen-Pirani, León, and Lugauer (2010) explain the potential biases that exist when using OLS to test the effect of appliance ownership on female labor force participation. An adapted version of their reasoning is relevant to my analysis: (1) households with many children in school are more likely to purchase appliances due to a higher need for these appliances, creating an upward bias or (2) households with a strong taste in home produced goods may invest heavily in both housework and household appliances, creating a downward bias. Parental preferences are unobserved and are likely to be determinants of a child's human capital investment. Parents may choose to invest in both schooling and appliances if they have a strong preference for child outcomes and believe that time-saving appliance ownership will relieve their children of household duties. Alternatively, negative selection bias may be present if parents purchase appliances for reasons other than to reduce a child's housework.[26]

Reverse causality is an additional concern when using OLS. With multiple years between each wave, I am unable to determine if the household first purchases a time-saving appliance and then due to the resulting decrease in time required to perform housework they enroll their child in school or if they initially enroll their child in school and then decide to purchase a time-saving appliance because children's time spent at school reduces their availability for work in the home. Controlling for variables such as parental and community characteristics will mitigate these biases, but there is always a possibility of other unobservables biasing my results. I perform 2SLS estimations in addition to OLS estimations in order to address these potential sources of endogeneity.

I use an instrumental variable strategy to identify the causal effect of owning a time-saving appliance on child outcomes. For the instrument to be valid, it must affect the

[26]An example of this negative selection would be if the parents who are purchasing appliances believe that home production skills will assist their daughter in the marriage market and thus purchase an appliance in order to give her an advantage. We would see an increase in appliance ownership, but possibly also a decrease in enrollment as the daughter approaches marital age.

potentially endogenous variable (living in a household that owns a time-saving appliance), but have no direct effect on the dependent variable (housework, enrollment, or employment). To determine the effect of household appliance ownership on married women's female labor force participation, Coen-Pirani, León, and Lugauer (2010) instrument a married woman's ownership of an appliance by the average ownership rate for that appliance among single women living in the same U.S. state. Since labor force participation among single women did not increase during the time period used in their sample, they argue that "observed temporal and cross-section variation in single women's ownership of home appliances is driven by the (unobserved) appliance costs rather than by changes in women's labor force participation rates" (Coen-Pirani, León, and Lugauer, 2010: pg. 504).

I implement a similar instrument as Coen-Pirani, León, and Lugauer (2010). I use appliance ownership decisions of households with no children as an instrument for ownership decisions of households with children. Households without children do not face the same trade-off decisions between child outcomes and appliance ownership as households with children. Therefore a change in ownership rates for childless households would be due to changes within the community not related to child outcomes (such as a price decrease due to a new store or the introduction of a lower cost model). The assumption is that households without children do not base their purchase decisions on a desire to alter a child's time allocated to housework. I calculate the average appliance ownership of households with no children between the ages 0-18 in each community.[27] Figure 5 (6) depicts the average washing machine (refrigerator) ownership for households with no children and the average washing machine (refrigerator) ownership for households with at least one child between the ages 0-18. Ownership for both groups appears to follow a similar trend.[28]

In the instrumented version of the model, I define household appliance ownership as a function of community ownership:

[27]There are 239 communities in this sample, with an average of 727 observations in each community.

[28]The overall average washing machine (refrigerator) ownership for childless households and households with at least one child are 56 and 53 percent (48 and 35 percent), respectively.

$$appliance_{ict} = \alpha_0 + \alpha_1 avgownership_{ict} + X_{ict}\alpha_2 + \xi_{ict}, \tag{2}$$

where $avgownership_{ict}$ is the average appliance ownership for households with no children living in the community which individual i resides in year t and X_{ict} is a vector of controls from Equation 1. The endogenous regressor ($appliance_{ict}$) is household specific, while the instrument ($avgownership_{ict}$) varies at the community-year level. The causal impact of living in a household that owns a time-saving appliance on child outcomes can be formalized as follows:

$$Y_{ict} = \beta_0 + \beta_1 \widehat{appliance}_{ict} + X_{ict}\beta_2 + \varepsilon_{ict}, \tag{3}$$

where $\widehat{appliance}_{ict}$ is estimated from estimation of Equation 2 in the first stage. Since average ownership for households with no children is a continuous instrument, I am estimating the average marginal treatment effect of living in a household that owns a time-saving appliance on child outcomes.

Using the panel aspect to control for time invariant household characteristics would be beneficial in this analysis. However, this dataset lacks sufficient variation to precisely estimate the model with household fixed effects. With gaps between each wave and a limited number of individual children observed in multiple, consecutive waves, running a household fixed effects model may be inappropriate using these data.[29] Additionally, there is not much variation in appliance ownership within households. When I condition on household fixed effects, the instrument becomes very weak, with a low F-statistic in the first stage (less than three for all samples). Using this instrument would result in inconsistent, biased estimates in the second stage. Thus, the instrumental variable approach described above provides a more complete understanding of the average effect of owning a time-saving appliance on child outcomes.

[29]This panel consists of waves with 2-4 year gaps, thus I only observe each child a maximum of three times during the secondary school age range (12-18 years old).

6 Results

The effects of appliance ownership on child outcomes are similar when analyzing either a washing machine or a refrigerator as the time-saving appliance. To conserve space I present full results for washing machine ownership and a summary of results for refrigerator ownership below. Full results using refrigerator as the time-saving appliance are available in the Online Appendix.

6.1 Ordinary Least Squares Results

Using Equation 1, I present OLS results in Table 3 (3A) of the effect of living in a household that owns a washing machine (refrigerator) on time dedicated to housework, enrollment, and employment for the sample.

The overall analysis discussed so far depends on the idea that time-saving appliances alter the family's allocation of children's time, providing them the opportunity to pursue other activities, specifically schooling. The CHNS has detailed data on time allocated to a handful of household chores, including: buying food, preparing food, and washing clothes.[30] The constructed measure of housework sums the total time a child dedicates to the three possible housework activities to estimate the average time dedicated to housework every week.[31]

Living in a household that owns either time-saving appliance decreases average time dedicated to housework each week by roughly 15 minutes (Column 1). When the sample is separated by gender, I find that living in a household that owns a washing machine (refrigerator) significantly decreases the average time dedicated to housework for female (male) children (Columns 2 and 3).

[30] Variables indicating time allocated to child care and cleaning house are also available. However, these variables are not included in the constructed measure of housework. Child care can be viewed as either a leisure activity or as part of housework, in which child care services have been developed with parents willing to pay to reduce their time spent with their children (Aguiar, Hurst, and Karabarbounis, 2013). The cleaning house variable was not introduced until the 1997 survey and is therefore not included in the constructed housework variable. This analysis has been performed omitting waves prior to 1997 to include data on time dedicated to cleaning house and has found similar results.

[31] These activities do not include all household chores and therefore the results presented can be thought of only as a rough estimate of the effect of household appliance ownership on time allocation.

Columns 4-6 present the results using enrollment as the child outcome variable. Living in a household that owns a washing machine (refrigerator) increases the probability of being enrolled by 5.3 (6.5) percentage points. This result is significant for both genders. The coefficient is larger for the gender that experiences the significant decrease in housework in the previous results: female children experience a significant decrease in time dedicated to housework and a larger increase in the probability of being enrolled than male children when living in a household that owns a washing machine (5.9 percentage point increase compared to 4.8 percentage point increase). Male children experience a significant decrease in time dedicated to housework and a larger increase in the probability of being enrolled than female children when living in a household that owns a refrigerator (8.3 percentage point increase compared to 5.1 percentage point increase). This suggests that the increase in enrollment is a result of the decrease in time dedicated to housework and the effect varies by gender and appliance.

Estimates for the employment outcome are presented in Columns 7-9. Data on employment status are available for individuals aged 16 and older in surveys prior to the 2004 survey and for all individuals not currently enrolled in the more recent surveys. The results indicate that living in a household that owns a washing machine (refrigerator) significantly decreases the probability of being employed by 13.0 (8.3) percentage points. Both gender samples experience significant decreases in the probability of being employed when living in a household that owns either time-saving appliance. Female children experience a larger decrease in the probability of being employed when living in a household that owns a washing machine (19.3 percentage point decrease). Male children experience a larger and more significant decrease in the probability of being employed when living in a household that owns a refrigerator (11.2 percentage point decrease).

The OLS results suggest that time-saving appliances have a significant effect on older child outcomes, with the presence of a washing machine (refrigerator) affecting female (male) children more than male (female) children. As mentioned in the previous section, OLS results

are biased due to the endogeneity of appliance ownership. The next subsection presents 2SLS results.

6.2 Two Stage Least Squares Results

First stage results, obtained using Equation 2, are reported in Table 4 and Online Appendix Table A3. I estimate how the average community ownership rate of a washing machine (refrigerator) among households with no children affects household washing machine (refrigerator) ownership for households with children. As noted earlier, the empirical analysis focuses on three family outcomes for children arising from appliance ownership: work at home, school enrollment, and employment outside the home. Accordingly, first stage results in Table 4 are shown for the samples corresponding to those respective outcomes. Within each outcome, the estimates are partitioned by gender. The estimates indicate that the likelihood of owning a washing machine (refrigerator) increases by 38 percentage points for households with children when the average ownership for households with no children in the same community increases.

Panel A of Table 5 (5A) presents OLS and 2SLS results side-by-side. I find that living in a household that owns a washing machine significantly decreases the average time dedicated to housework by 77.9 minutes per week.[32] This coefficient is over five times larger than the coefficient estimated using OLS, indicating that OLS estimates are biased downward.[33] Dividing the sample by gender, I find that the decrease in time dedicated to housework is driven by the female sample, where female children experience a 187 minute decrease in average time dedicated to housework each week. The results indicate that children living in households that own washing machines experience significant decreases in time allocated to housework.

[32]Using a refrigerator as the time-saving appliance, the 38 minute decrease in average time dedicated to housework is found to be insignificant.

[33]Recall from section 5 household tastes and parental preferences may cause a downward bias. Households with a strong taste in home produced goods may invest heavily in both housework and household appliances; Parents may purchase appliances for reasons other than to reduce a child's housework.

It is useful to view these point estimates in the context of the larger population. Children living in households that do not own a washing machine spend approximately 107 minutes per week on housework (Table 1). Thus, using for example the estimate in column 2 ($\hat{\beta} = -77.917$), or a decrease in average time dedicated to housework by 78 minutes per week, living in a household that owns a washing machine eliminates 73 percent of time dedicated to housework. The presence of a time-saving durable good appears to substantially reduce time dedicated to housework.

These estimates suggest that household ownership of washing machines is an effective time saver for children. I now investigate what children are doing with the time that was initially dedicated to housework. As the heads of the households decide how children allocate their time, I hypothesize that children will reallocate their time to an activity that will be beneficial for both the child and the head(s). Specifically, I anticipate children staying in school longer, rather than dropping out to assist with housework. I test this by looking at current enrollment rates for older children.

Panel B of Table 5 (5A) presents the effect of living in a household that owns a washing machine (refrigerator) on enrollment for children between the ages 12-18. I estimate a 12 percentage point increase in the probability of being enrolled when living in a household that owns a washing machine. Dividing the sample by gender, I find a 17.8 percentage point increase in the probability of being enrolled for female children and an insignificant increase for male children. These results are consistent with the results in Panel A: female children decrease their average time dedicated to housework and increase their probability of being enrolled when living in a household that owns a washing machine. For the population of children aged 12-18 living in households without washing machines, the proportion enrolled is estimated to be 65 percent (Table 1). Among females, the rate is 63 percent (not shown in Table 1). The estimated effect of living in a household that owns a washing machine for females ($\hat{\beta} = 0.178$; Panel B of Table 5, Column 6) suggests that the presence of a washing machine induces an increase in female enrollment rates of 28 percent. Both genders

experience significant increases in the probability of being enrolled when living in a household that owns a refrigerator (Table 5A). The female sample coefficient is of a larger magnitude than the male sample.

The final analysis performed estimates the effect of living in a household that owns a time-saving appliance on the probability of being employed. Child labor is typically viewed as a last resort for low-income families, where children enter the labor force only when the household income drops below a certain threshold (Basu and Van, 1998). Panel C of Table 5 finds that living in a household that owns a washing machine decreases the probability of being employed by 47.7 percentage points for children aged 12-18. Children living in a household that owns a refrigerator experience a 29.9 percentage point decrease in the probability of being employed (Panel C of Table 5A). The effects are similar in magnitude for both gender samples with male and female children experiencing a 48.8 and 53.1 percentage point decrease in the probability of being employed when living in a household that owns a washing machine, respectively. It is again useful to place the employment effects in the context of the child labor market in China. The overall employment rate among children aged 12-18 living in households that do not own washing machines is approximately 72 percent (Table 1). From that frame of reference, the estimated effect of living in a household that owns a washing machine ($\hat{\beta} = -0.477$; Panel C of Table 5, Column 2) suggests that washing machine ownership generates a 66 percent decrease in child labor force participation rates.

The employment results invite additional discussion, as the theoretical model suggests that when children decrease their time in household activities they will increase their time in schooling, leisure, and/or market work. However, the model represents the composite utility function of the household, not just the child's utility function. Adult labor and child labor are typically viewed as substitutes (Basu and Van, 1998). If, as previous literature has found, living in a household that owns a time-saving appliance increases adult female labor force participation, this would explain the large decrease in the probability of being employed for both genders. An increase in adult female labor force participation is accompanied by an

increase in household income and as household income increases, children are removed from the labor force. In these data, time dedicated to market work is unavailable and therefore I am unable to estimate the extent to which mother's labor force participation has increased.[34] However, when I include a control variable indicating if the mother is currently employed, I find that the magnitude of the effect on the probability of being employed for children in my sample decreases by three percentage points. Therefore, the results presented above are potentially picking up not only the effect of a decrease in time dedicated to housework for older children in the sample, but also an increase in time dedicated to market work for adult females in the sample.

6.3 At Least One Time-Saving Appliance Results

The analysis presented thus far observes the effect of ownership of a specific time-saving appliance on child outcomes. However, it is not the goal of this analysis to determine the importance of a specific appliance. Rather, I am interested in determining if appliances of similar functions (time-saving) affect child outcomes. Thus, I generate a variable indicating if a child lives in a household that owns at least one of the larger time-saving appliances (washing machine or refrigerator) to analyze if living in a household that owns at least one time-saving appliance alters child outcomes. These results are presented in Table 6 and are similar to results found when performing the analysis on each time-saving appliance separately.

Living in a household that owns at least one time-saving appliance decreases average time dedicated to housework by 75 minutes per week (Column 2 of Panel A). This result is driven by the female sample (Column 6). The presence of at least one time-saving appliance increases the probability of being enrolled by 10.9 (Column 2 of Panel B) percentage points. Again, this result is driven by the female sample (Column 6). Finally, the probability of

[34]Performing the same analysis and observing the outcome variable *mother employed*, I find no effect on the probability of being employed for mothers of children in the sample. However, I cannot determine if a mother allocates more time to working in the labor force once the household purchases a time-saving appliance.

being employed decreases by 46.5 percentage points when living in a household that owns at least one time-saving appliance (Column 2 of Panel C). Both genders experience a significant decrease in the probability of being employed (Columns 4 and 6).

Again, these results are very similar to results obtained when analyzing the effect of living in a household that owns a specific appliance, rather than either appliance. The similarities indicate that results found in sections 6.2 and 6.3 are likely being driven by time-saving mechanisms, rather than any particular appliance.

7 Conclusion and Discussion

Observing two time-saving appliances and three child outcomes, I find that living in a household that owns a time-saving appliance decreases average time dedicated to housework, increases the probability of being enrolled, and decreases the probability of being employed for children in the sample. The first two findings are driven by the female sample, while the probability of being employed decreases for both genders significantly.

I find that living in a household that owns a washing machine: (1) decreases the average time dedicated to housework by 77.9 minutes per week, (2) increases the probability of being enrolled by 12 percentage points, and (3) decreases the probability of being employed by 47.7 percentage points. Living in a household that owns certain time-saving appliances increases a child's educational outcome by providing a lower opportunity cost of staying in school and increasing the probability of being enrolled. One potential explanation for these results is that the presence of time-saving appliances directly affects the time a child is required to be at home performing housework. This is supported by results found when observing children living in households that own a washing machine. Another potential effect of time-saving appliances is an indirect effect on a child's education and employment due to time-saving appliances altering a mother's (or female child's) time allocation and bargaining power through an increase in her productivity within, and potentially outside,

the household. With an increase in bargaining power, women may be able to improve their children's outcomes (as well as own outcomes), specifically through higher education. The significant increases in the probability of being enrolled, along with the insignificant decreases in housework when living in a household that owns a refrigerator, suggest that there is more than just the direct effect of a reallocation of time occurring. Finding larger magnitudes and stronger significance in the female sample also supports the presence of an indirect effect. Changes in female bargaining power are likely additional forces causing the increase in the probability of being enrolled and decrease in the probability of being employed.

With a decrease in the time required to perform housework and a possible increase in female bargaining power as a result of appliance ownership, there may occur (1) a reduction in the need for child household labor and children reallocating their time to schooling, or (2) no reduction in the need for child household labor, but instead increases in child outcomes due to a spillover effect. In this case, the mother's increased bargaining power within the household leads to better child outcomes due to females attaching higher values to children's welfare (Mencher, 1988; Thomas, 1990; Behrman, 1992; Agarwal, 1994; Strauss et al., 2000; Duflo, 2012). Again, the first outcome is supported by results for washing machine ownership, and the second outcome is supported by results for ownership of refrigerators.

In previous literature there has been no established consensus regarding the consequences of investments in time-conserving household capital on time allocation within the household. On one hand, appliances reduce time required for home production and consequently release time for other uses, such as school enrollment or market production. On the other hand, since household capital increases productivity in home-based work, household members might increase their allocation of time to home production. Evidence in this paper suggests there might be a change in composition of who performs household chores and who elects the options of schooling or market work. This invites further investigation of time reallocation within households as a result of investments in household appliances.

Between December 2007 and January 2013, the "Home Appliances to the Countryside"

subsidy program was available in rural China, providing households 13 percent rebates on certain household appliances. This program was intended to stimulate rural consumption and boost the country's economic growth,[35] extending rebates to the appliances in my analysis. With such impressive decreases in average time dedicated to housework, increases in the probability of being enrolled, and decreases in the probability of being employed for children in this sample, a continuation and extension to the "Home Appliances to the Countryside" subsidy program may have additional effects on not only consumer spending but also child outcomes in rural China. These important policy implications point to the need for continued research in this area.

[35]http://www.chinadaily.com.cn/business/2013-01/08/content_16094148.htm

Tables

Table 1: Summary Statistics

	Owns Washing Machine			Does Not Own Washing Machine		
Variable	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
completed primary	0.976	0.152	5312	0.901	0.299	6680
years of schooling	8.427	2.248	5012	7.134	2.287	6430
currently enrolled	0.819	0.385	5194	0.649	0.477	6431
currently employed	0.438	0.496	2023	0.717	0.450	3525
buy food (avg minutes/week)	13.314	56.979	4318	6.557	38.816	5936
prepare food (avg minutes/week)	24.201	131.676	4282	59.284	237.114	5890
wash clothes (avg minutes/week)	32.792	97.411	4204	51.199	118.948	5734
housework(avg minutes/week)	63.130	197.235	4431	107.396	289.948	6058
female	0.482	0.500	7214	0.475	0.499	8057
han	0.882	0.323	7088	0.808	0.394	7926
rural	0.641	0.480	7214	0.844	0.363	8057
own refrigerator	0.551	0.497	7211	0.066	0.248	8057
own color television	0.814	0.389	7199	0.295	0.456	8010
wealth index	2.783	0.846	7214	1.956	0.687	8057
father's income	10.672	13.195	6503	6.563	8.599	6511
father's age	42.816	5.431	4828	44.405	6.172	6103
father completed primary	0.915	0.279	4729	0.763	0.426	6033
mother's age	41.109	4.852	4959	42.476	5.621	6284
mother completed primary	0.784	0.412	4906	0.454	0.498	6236

Table 2: Summary Statistics Breakdown

	Owns Washing Machine						Does Not Own Washing Machine					
	1989-1991			2009-2011			1989-1991			2009-2011		
Variable	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
completed primary	0.953	0.211	1118	0.990	0.100	896	0.849	0.358	2702	0.968	0.175	253
years of schooling	7.978	2.262	1039	8.452	2.146	896	6.541	2.296	2592	7.621	2.054	253
currently enrolled	0.727	0.446	1066	0.899	0.302	897	0.582	0.493	2593	0.846	0.362	253
currently employed	0.711	0.454	764	0.325	0.470	123	0.871	0.335	1978	0.261	0.444	46
buy food (avg minutes/week)	6.417	47.660	1014	22.929	68.869	860	4.554	32.264	2481	24.471	58.376	242
prepare food (avg minutes/week)	50.816	213.145	993	34.448	114.183	887	100.408	323.041	2450	86.296	139.134	247
wash clothes (avg minutes/week)	36.729	87.585	984	35.709	113.662	889	55.062	132.875	2412	54.145	89.893	249
housework (avg minutes/week)	84.123	260.654	1028	86.417	222.575	892	148.969	378.150	2512	150.583	220.178	252
female	0.517	0.500	1165	0.466	0.499	1729	0.479	0.500	2820	0.49	0.500	594
han	0.898	0.302	1064	0.836	0.371	1723	0.787	0.409	2709	0.801	0.400	593
rural	0.527	0.499	1165	0.741	0.438	1729	0.841	0.366	2820	0.872	0.334	594
own refrigerator	0.279	0.449	1163	0.751	0.432	1729	0.010	0.099	2820	0.224	0.417	594
own color tv	0.384	0.486	1152	0.997	0.059	1729	0.042	0.201	2773	0.919	0.273	594
wealth index	2.677	0.773	1165	2.826	0.749	1729	1.808	0.611	2820	2.350	0.703	594
father's income	4.295	3.328	644	19.085	20.896	1683	3.507	4.232	1425	16.052	19.36	580
father's age	45.118	6.295	1002	41.532	4.420	771	45.551	6.560	2450	42.873	5.802	204
father completed primary	0.829	0.377	1000	0.946	0.226	726	0.658	0.474	2449	0.854	0.354	192
mother's age	42.588	5.442	1023	40.255	3.954	793	43.375	6.048	2536	41.154	4.953	201
mother completed primary	0.591	0.492	1023	0.903	0.296	776	0.287	0.452	2533	0.701	0.459	187

Table 3: OLS - Effect of Living in a Household that Owns a Washing Machine on Y_{ict}

	Housework			Enrollment			Employment		
	All	Male	Female	All	Male	Female	All	Male	Female
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
own washing machine	**-14.749****	**-3.848**	**-28.995*****	**0.053*****	**0.048*****	**0.059*****	**-0.130*****	**-0.076*****	**-0.193*****
	(6.087)	(4.784)	(10.675)	(0.013)	(0.015)	(0.018)	(0.023)	(0.029)	(0.034)
individual controls:									
age	18.106	33.856**	1.397	0.312***	0.354***	0.269***	-0.319***	-0.383**	-0.254
	(25.017)	(15.840)	(47.120)	(0.038)	(0.055)	(0.052)	(0.109)	(0.163)	(0.166)
age squared	-0.303	-1.015*	0.458	-0.014***	-0.015***	-0.012***	0.012***	0.015***	0.010*
	(0.864)	(0.537)	(1.623)	(0.001)	(0.002)	(0.002)	(0.003)	(0.005)	(0.005)
female	77.195***			-0.015			0.017		
	(8.565)			(0.011)			(0.019)		
han	14.814	3.347	30.524	-0.007	-0.009	0.003	0.016	0.008	0.024
	(16.300)	(10.994)	(31.182)	(0.024)	(0.025)	(0.032)	(0.041)	(0.056)	(0.045)
household controls:									
rural	-11.721	-8.770	-18.709	-0.069***	-0.079***	-0.055***	0.143***	0.164***	0.105***
	(12.267)	(6.399)	(21.388)	(0.016)	(0.019)	(0.021)	(0.028)	(0.037)	(0.037)
wealth index	-21.012***	-8.291***	-33.788***	0.046***	0.038***	0.054***	-0.071***	-0.084***	-0.055***
	(4.775)	(2.937)	(8.644)	(0.008)	(0.009)	(0.011)	(0.013)	(0.017)	(0.018)
father's income	-0.158	-0.119	-0.132	0.000	0.000	0.000	-0.001	0.000	-0.002
	(0.166)	(0.178)	(0.262)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)
father's age	-1.399	-0.796	-1.564	-0.001	-0.000	-0.002	-0.006**	-0.006	-0.006
	(1.066)	(0.808)	(1.867)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)
father completed primary	-21.231**	5.065	-46.864**	0.073***	0.044*	0.105***	-0.080**	-0.083**	-0.069*
	(10.138)	(8.137)	(19.351)	(0.019)	(0.025)	(0.025)	(0.031)	(0.042)	(0.041)
mother's age	0.192	0.028	-0.082	-0.000	0.000	-0.001	0.006*	0.006	0.007
	(1.074)	(0.926)	(1.922)	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)	(0.004)
mother completed primary	-9.587	-9.141*	-11.577	0.045***	0.040**	0.051**	-0.129***	-0.153***	-0.104***
	(7.256)	(5.284)	(14.304)	(0.014)	(0.017)	(0.021)	(0.026)	(0.037)	(0.035)
community controls:									
average household income	-0.063	0.082	-0.175	-0.000	-0.001	-0.000	-0.000	-0.001	0.000
	(0.280)	(0.423)	(0.374)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
telephone	15.671	15.073**	20.171	0.029*	0.008	0.050**	-0.045	-0.046	-0.037
	(12.066)	(7.499)	(20.487)	(0.017)	(0.020)	(0.023)	(0.033)	(0.045)	(0.041)
public baths	-6.796	-11.013*	-6.384	0.033**	0.046**	0.015	-0.041	-0.057	-0.027
	(6.421)	(5.810)	(11.172)	(0.017)	(0.020)	(0.023)	(0.029)	(0.041)	(0.038)
train station	-7.542	-6.869	-9.364	0.018	-0.001	0.042**	-0.003	0.003	-0.006
	(8.346)	(6.117)	(14.503)	(0.015)	(0.019)	(0.016)	(0.031)	(0.037)	(0.039)
near open trade area	-5.149	5.590	-16.787	-0.005	-0.011	0.001	-0.013	0.005	-0.035
	(7.060)	(6.169)	(12.678)	(0.013)	(0.016)	(0.017)	(0.026)	(0.031)	(0.036)
near navigable river	23.101*	8.452	32.206	-0.012	-0.020	0.004	0.007	0.012	-0.004
	(13.792)	(7.810)	(24.424)	(0.017)	(0.019)	(0.027)	(0.028)	(0.035)	(0.042)
secondary school	14.841	0.736	35.146**	0.025	0.034	0.013	-0.068**	-0.051	-0.084*
	(9.233)	(9.219)	(15.284)	(0.021)	(0.025)	(0.026)	(0.034)	(0.046)	(0.043)
average washing machine ownership	0.444	0.439	0.448	0.473	0.473	0.473	0.408	0.408	0.409
average Y_{ict}	75.185	37.803	113.941	0.750	0.757	0.742	0.450	0.437	0.465
N	6656	3388	3268	7278	3794	3484	2737	1425	1312
R^2	0.098	0.094	0.103	0.301	0.305	0.312	0.243	0.247	0.260

Notes: All columns include province and year fixed effects, province linear time trends and exclude observations from the year 1989 due to lack of data on community variables: average household income and secondary school. Standard errors are presented in parentheses. * denotes significance at 10 percent, ** denotes significance at 5 percent, *** denotes significance at 1 percent. Standard errors are clustered at the community level.

Table 3A: OLS - Effect of Living in a Household that Owns a Refrigerator on Y_{ict}

	Housework			Enrollment			Employment		
	All	Male	Female	All	Male	Female	All	Male	Female
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
own refrigerator	**-16.140****	**-15.635*****	**-16.335**	**0.065*****	**0.083*****	**0.051*****	**-0.083*****	**-0.112*****	**-0.066**
	(6.462)	(5.705)	(11.449)	(0.014)	(0.017)	(0.019)	(0.027)	(0.033)	(0.042)
wealth index	-21.047***	-6.245**	-36.411***	0.043***	0.031***	0.054***	-0.077***	-0.077***	-0.074***
	(4.997)	(3.012)	(9.297)	(0.008)	(0.010)	(0.011)	(0.015)	(0.018)	(0.020)
average refrigerator ownership	0.271	0.274	0.268	0.304	0.310	0.296	0.232	0.244	0.219
average Y_{ict}	75.208	37.814	113.976	0.750	0.757	0.742	0.450	0.436	0.465
N	6654	3387	3267	7277	3794	3483	2736	1425	1311
R^2	0.098	0.096	0.102	0.301	0.308	0.310	0.235	0.248	0.240

Notes: Full results of these regressions are available in Online Appendix A2. All columns include province and year fixed effects, province linear time trends and exclude observations from the year 1989 due to lack of data on community variables: average household income and secondary school. Standard errors are presented in parentheses. * denotes significance at 10 percent, ** denotes significance at 5 percent, *** denotes significance at 1 percent. Standard errors are clustered at the community level.

Table 4: First Stage - Effect of Average Washing Machine Ownership Among Households with No Children on the Probability of a Child Living in a Household that Owns a Washing Machine

	Housework			Enrollment			Employment		
	All	Male	Female	All	Male	Female	All	Male	Female
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
avg community washing machine ownership (no kids)	**0.375*****	**0.403*****	**0.341*****	**0.377*****	**0.405*****	**0.342*****	**0.376*****	**0.403*****	**0.337*****
	(0.041)	(0.042)	(0.051)	(0.040)	(0.040)	(0.050)	(0.055)	(0.063)	(0.072)
individual controls:									
age	-0.015	-0.021	-0.013	0.005	0.005	-0.003	-0.089	-0.159	-0.018
	(0.039)	(0.050)	(0.058)	(0.037)	(0.046)	(0.056)	(0.112)	(0.150)	(0.160)
age squared	0.001	0.001	0.001	-0.000	-0.000	0.000	0.003	0.005	0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.005)	(0.005)
female	0.010			0.006			0.028*		
	(0.010)			(0.010)			(0.016)		
han	0.096***	0.118***	0.082*	0.082**	0.105***	0.066	0.102***	0.125***	0.077
	(0.037)	(0.038)	(0.043)	(0.036)	(0.035)	(0.042)	(0.037)	(0.038)	(0.047)
household controls:									
rural	-0.056*	-0.043	-0.072**	-0.049*	-0.038	-0.067**	-0.073**	-0.026	-0.145***
	(0.029)	(0.030)	(0.034)	(0.026)	(0.028)	(0.031)	(0.034)	(0.036)	(0.044)
wealth index	0.141***	0.142***	0.139***	0.144***	0.145***	0.142***	0.127***	0.133***	0.121***
	(0.011)	(0.014)	(0.015)	(0.011)	(0.013)	(0.015)	(0.014)	(0.020)	(0.018)
father's income	0.001	0.001	0.000	0.000	0.001	-0.000	0.001	-0.001	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
father's age	-0.004	-0.005*	-0.002	-0.004*	-0.005*	-0.003	-0.002	-0.004	0.000
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
father completed primary	0.055**	0.046	0.062***	0.056***	0.045	0.067***	0.094***	0.096***	0.082***
	(0.022)	(0.029)	(0.024)	(0.022)	(0.028)	(0.024)	(0.025)	(0.033)	(0.031)
mother's age	0.001	0.002	-0.000	0.001	0.001	0.000	0.002	0.003	0.000
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
mother completed primary	0.111***	0.109***	0.114***	0.104***	0.105***	0.104***	0.115***	0.096***	0.129***
	(0.022)	(0.025)	(0.025)	(0.021)	(0.024)	(0.025)	(0.025)	(0.030)	(0.031)
community controls:									
average household income	0.001	0.001	0.001*	0.001*	0.001	0.001**	0.002	0.001	0.006*
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
telephone	0.028	0.016	0.044	0.037	0.028	0.049*	0.023	0.010	0.040
	(0.024)	(0.028)	(0.028)	(0.024)	(0.028)	(0.027)	(0.029)	(0.037)	(0.034)
public baths	0.057**	0.044	0.064**	0.040	0.032	0.045	0.080**	0.095**	0.041
	(0.026)	(0.029)	(0.030)	(0.025)	(0.027)	(0.028)	(0.034)	(0.037)	(0.044)
train station	0.025	0.008	0.040	0.026	0.015	0.037	0.042	-0.020	0.104**
	(0.030)	(0.029)	(0.037)	(0.027)	(0.026)	(0.034)	(0.041)	(0.042)	(0.051)
near open trade area	-0.022	-0.015	-0.029	-0.017	-0.019	-0.014	-0.034	0.000	-0.072**
	(0.021)	(0.024)	(0.025)	(0.019)	(0.022)	(0.022)	(0.024)	(0.029)	(0.031)
near navigable river	0.054*	0.066**	0.040	0.042	0.053*	0.030	0.061*	0.048	0.066
	(0.030)	(0.034)	(0.032)	(0.028)	(0.032)	(0.030)	(0.034)	(0.038)	(0.041)
secondary school	0.049*	0.036	0.061	0.038	0.027	0.046	0.070**	0.069*	0.080
	(0.029)	(0.026)	(0.041)	(0.027)	(0.025)	(0.038)	(0.035)	(0.038)	(0.055)
average washing machine ownership	0.444	0.439	0.448	0.473	0.473	0.473	0.408	0.408	0.409
N	6656	3388	3268	7278	3794	3484	2737	1425	1312
R^2	0.416	0.434	0.406	0.422	0.436	0.415	0.405	0.416	0.420
F-Statistic	82.201	92.189	43.726	90.146	104.193	46.690	45.957	41.090	22.152

Notes: All columns include province and year fixed effects, province linear time trends and exclude observations from the year 1989 due to lack of data on community variables: average household income and secondary school. Standard errors are presented in parentheses. * denotes significance at 10 percent, ** denotes significance at 5 percent, *** denotes significance at 1 percent. Standard errors are clustered at the community level.

Table 5: 2SLS - Effect of Living in a Household that Owns a Washing Machine on Y_{ict}

	All		Male		Female	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Housework						
own washing machine	**-14.749****	**-77.917****	**-3.848**	**-5.426**	**-28.995*****	**-186.954*****
	(6.087)	(31.459)	(4.784)	(29.479)	(10.675)	(66.690)
N. Obs.	6656		3388		3268	
average washing machine ownership	0.444		0.439		0.448	
average housework	75.185		37.803		113.941	
Panel B: Enrollment						
own washing machine	**0.053*****	**0.120****	**0.048*****	**0.098**	**0.059*****	**0.178****
	(0.013)	(0.055)	(0.015)	(0.066)	(0.018)	(0.088)
N. Obs.	7278		3794		3484	
average washing machine ownership	0.473		0.473		0.473	
average enrollment	0.750		0.757		0.742	
Panel C: Employment						
own washing machine	**-0.130*****	**-0.477*****	**-0.076*****	**-0.488*****	**-0.193*****	**-0.531*****
	(0.023)	(0.131)	(0.029)	(0.151)	(0.034)	(0.182)
N. Obs.	2737		1425		1312	
average washing machine ownership	0.408		0.408		0.409	
average employment	0.450		0.437		0.465	

Notes: All columns include individual controls, household controls, community controls, province and year fixed effects, province linear time trends and exclude observations from the year 1989 due to lack of data on community variables: average household income and secondary school. Standard errors are presented in parentheses. * denotes significance at 10 percent, ** denotes significance at 5 percent, *** denotes significance at 1 percent. Standard errors are clustered at the community level.

Table 5A: 2SLS - Effect of Living in a Household that Owns a Refrigerator on Y_{ict}

	All		Male		Female	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Housework						
own refrigerator	**-16.140****	**-37.683**	**-15.635*****	**-40.929**	**-16.335**	**-45.852**
	(6.462)	(28.626)	(5.705)	(26.404)	(11.449)	(44.683)
N	6654	6654	3387	3387	3267	3267
R^2	0.098	0.097	0.096	0.091	0.102	0.101
average refrigerator ownership	0.271		0.274		0.268	
average housework	75.208		37.814		113.976	
Panel B: Enrollment						
own refrigerator	**0.065*****	**0.175*****	**0.083*****	**0.163****	**0.051*****	**0.211*****
	(0.014)	(0.057)	(0.017)	(0.080)	(0.019)	(0.071)
N	7277	7277	3794	3794	3483	3483
R^2	0.301	0.294	0.308	0.304	0.310	0.294
average refrigerator ownership	0.304		0.310		0.296	
average enrollment	0.750		0.757		0.742	
Panel C: Employment						
own refrigerator	**-0.083*****	**-0.299*****	**-0.112*****	**-0.338****	**-0.066**	**-0.294****
	(0.027)	(0.104)	(0.033)	(0.138)	(0.042)	(0.141)
N	2736	2736	1425	1425	1311	1311
R^2	0.235	0.215	0.248	0.226	0.240	0.219
average refrigerator ownership	0.232		0.244		0.219	
average employment	0.450		0.436		0.465	

Notes: All columns include individual controls, household controls, community controls, province and year fixed effects, province linear time trends and exclude observations from the year 1989 due to lack of data on community variables: average household income and secondary school. Standard errors are presented in parentheses. * denotes significance at 10 percent, ** denotes significance at 5 percent, *** denotes significance at 1 percent. Standard errors are clustered at the community level.

Table 6: 2SLS - Effect of Living in a Household that Owns At Least One Appliance on Y_{ict}

	All		Male		Female	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Housework						
own at least one appliance	**-18.680*** **	**-75.140** **	**-5.672**	**-7.847**	**-33.673*** **	**-174.127*** **
	(5.937)	(31.844)	(4.834)	(28.632)	(10.689)	(64.787)
N	6656	6656	3388	3388	3268	3268
R^2	0.099	0.090	0.094	0.094	0.103	0.071
average appliance ownership	0.714		0.713		0.716	
average housework	75.186		37.802		113.941	
Panel B: Enrollment						
own at least one appliance	**0.064*** **	**0.109** **	**0.060*** **	**0.059**	**0.070*** **	**0.209** **
	(0.013)	(0.053)	(0.016)	(0.066)	(0.018)	(0.083)
N	7279	7279	3795	3795	3484	3484
R^2	0.302	0.300	0.306	0.306	0.313	0.298
average appliance ownership	0.776		0.783		0.769	
average enrollment	0.750		0.757		0.742	
Panel C: Employment						
own at least one appliance	**-0.136*** **	**-0.465*** **	**-0.096*** **	**-0.488*** **	**-0.189*** **	**-0.518*** **
	(0.023)	(0.131)	(0.029)	(0.162)	(0.034)	(0.171)
N	2738	2738	1426	1426	1312	1312
R^2	0.244	0.179	0.249	0.157	0.259	0.197
average appliance ownership	0.640		0.651		0.627	
average employment	0.450		0.437		0.465	

Notes: All columns include individual controls, household controls, community controls, province and year fixed effects, province linear time trends and exclude observations from the year 1989 due to lack of data on community variables: average household income and secondary school. Standard errors are presented in parentheses. * denotes significance at 10 percent, ** denotes significance at 5 percent, *** denotes significance at 1 percent. Standard errors are clustered at the community level.

Figure 1A: Enrollment

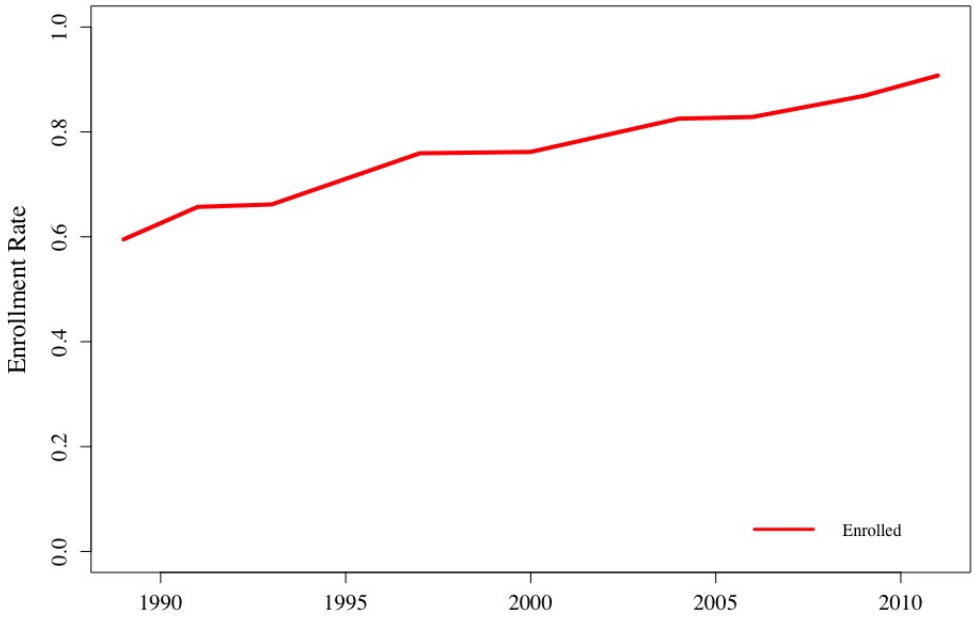


Figure 1B: Washing Machine Ownership

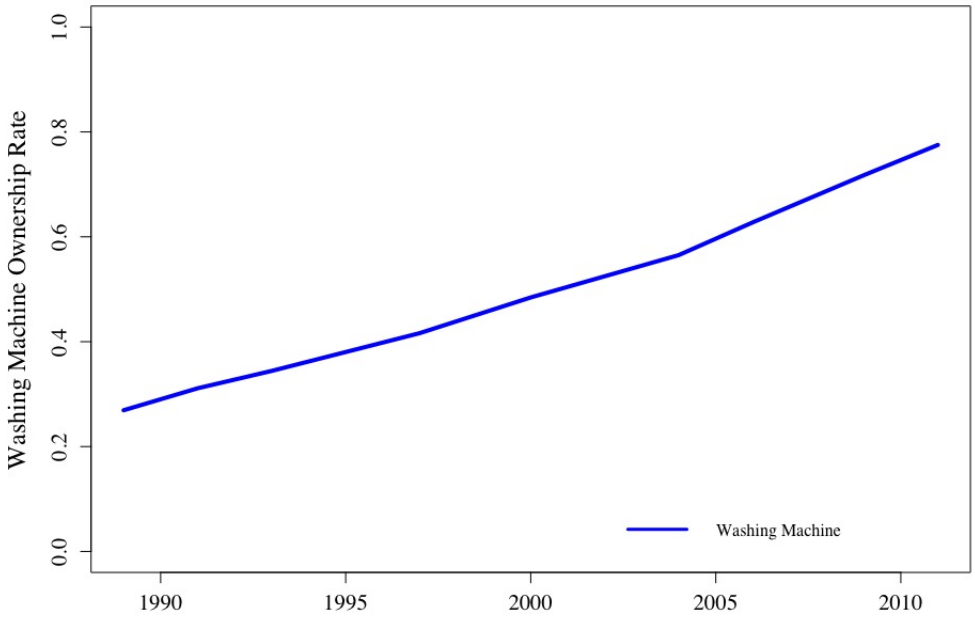


Figure 1C: Housework

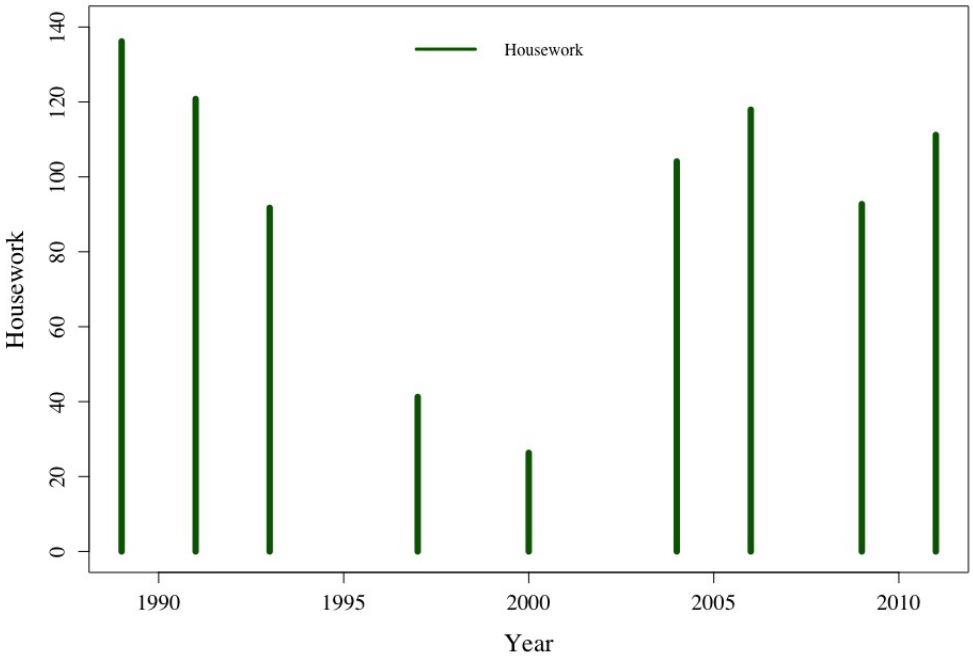


Figure 2: Washing Machine Ownership

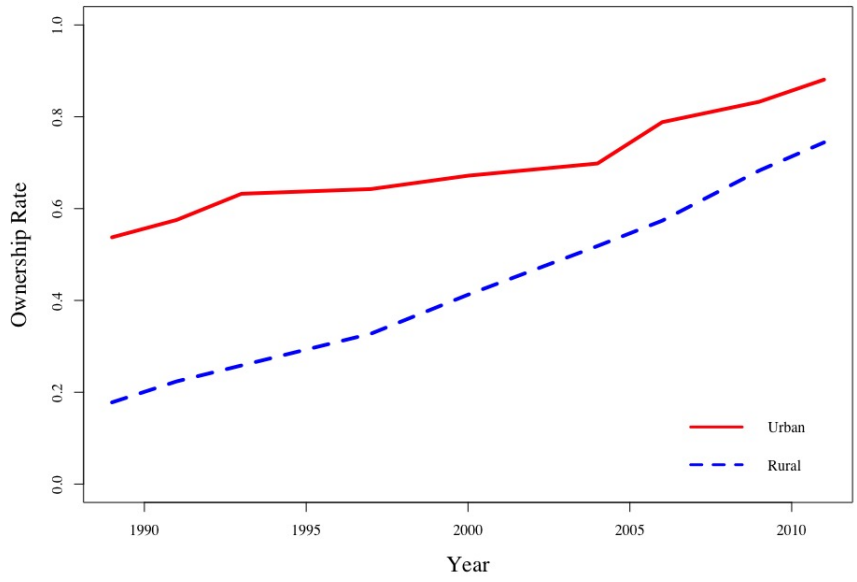


Figure 3: Refrigerator Ownership

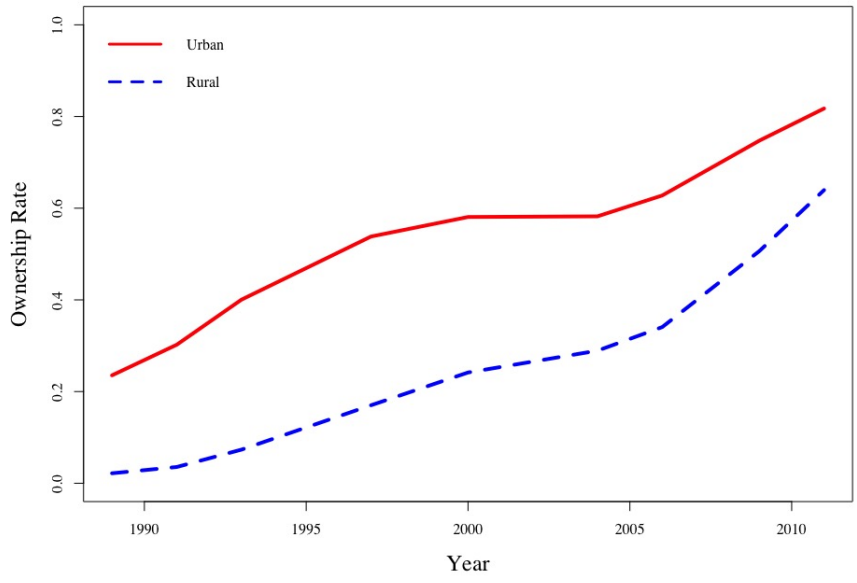


Figure 4: Income and Wealth Measures

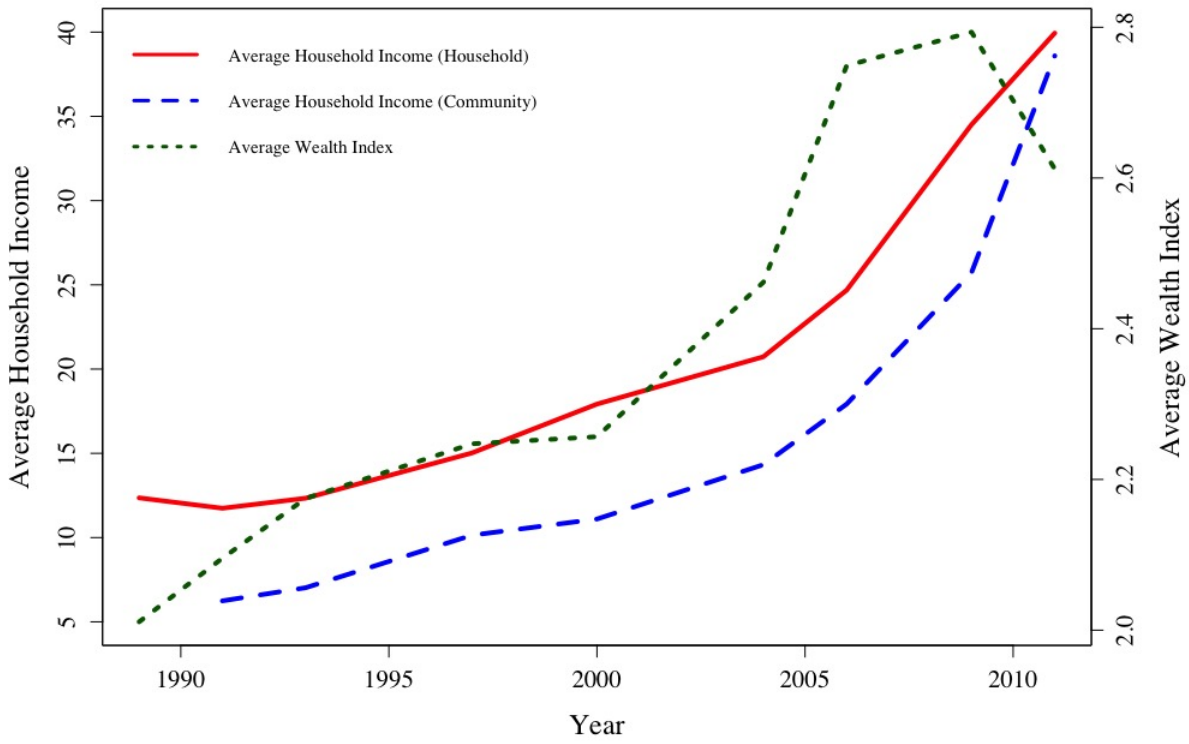


Figure 5: Washing Machine Ownership in Households With and Without Children

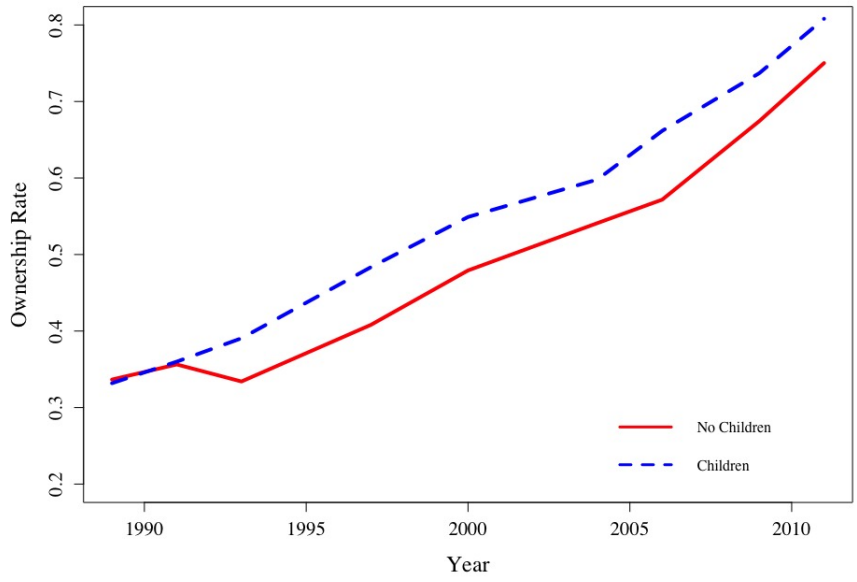
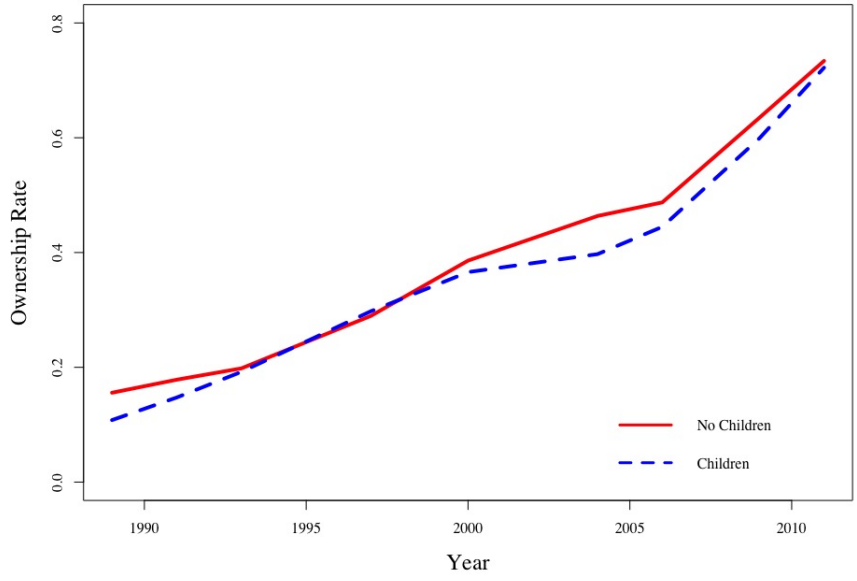


Figure 6: Refrigerator Ownership in Households With and Without Children



References

Agarwal, Bina. A field of one's own: Gender and land rights in South Asia. Vol. 58. Cambridge University Press, 1994.

Aguiar, Mark, Erik Hurst, and Loukas Karabarbounis. "Time use during the great recession." The American Economic Review 103.5, pp. 1664-1696. 2013.

Ashenfelter, Orley, and James Heckman. "The estimation of income and substitution effects in a model of family labor supply." Econometrica: Journal of the Econometric Society, pp. 73-85. 1974.

Basu, Kaushik, and Pham Hoang Van. "The economics of child labor." The American Economic Review, pp. 412-427. 1998

Becker, Gary S. "A Theory of the allocation of time." The Economic Journal, pp. 493-517. 1965.

Behrman, Jere R. "Intrahousehold allocation of nutrients and gender effects: a survey of structural and reduced-form estimates." Nutrition and Poverty, pp. 287-320. 1992.

Bittman, Michael, James Mahmud Rice, and Judy Wajcman. "Appliances and their impact: the ownership of domestic technology and time spent on household work." The British Journal of Sociology 55.3, pp. 401-423. 2004.

Bowden, Sue, and Avner Offer. "Household appliances and the use of time: the United States and Britain since the 1920s1." The Economic History Review 47.4, pp. 725-748. 1994.

Brown, Philip H., and Albert Park. "Education and poverty in rural China." Economics of Education Review 21.6, pp. 523-541. 2002.

Cardia, Emanuela. "Household technology: was it the engine of liberation." University de Montreal and CIREQ Working Paper. 2008.

Cardia, Emanuela, and Paul Gomme. "The household revolution: childcare, housework, and female labor force participation." 2013.

Coen-Pirani, Daniele, Alexis León, and Steven Lugauer. "The effect of household appliances on female labor force participation: Evidence from microdata." Labour Economics 17.3, pp. 503-513. 2010.

Connelly, Rachel, and Zhenzhen Zheng. "Determinants of school enrollment and completion of 10 to 18 year olds in China." Economics of Education Review 22.4, pp. 379-388. 2003.

de V. Cavalcanti, Tiago V., and José Tavares. "Assessing the "Engines of Liberation: home appliances and female labor force participation." The Review of Economics and Statistics 90.1, pp. 81-88. 2008.

Dinkelman, Taryn. "The effects of rural electrification on employment: New evidence from South Africa." The American Economic Review, pp. 3078-3108. 2011.

Duflo, Esther. "Women Empowerment and Economic Development." Journal of Economic Literature 50(4), pp. 1051-1079. 2012.

Greenwood, Jeremy, Ananth Seshadri, and Mehmet Yorukoglu. "Engines of liberation." Review of Economic Studies 72, pp. 109-133. 2005.

Gronau, Reuben. "The intrafamily allocation of time: The value of the housewives' time." The American Economic Review 63.4, pp. 634-651. 1973.

Huffman, Wallace E., and Mark D. Lange. "Off-farm work decisions of husbands and wives: joint decision making." The Review of Economics and Statistics, pp. 471-480. 1989.

Kennedy, Peter. "A Guide to Econometrics." 6th Edition. Blackwell Publishing Ltd. 2008.

Kishore, Avinash, and Dean Spears. "Having a Son Promotes Clean Cooking Fuel Use in Urban India: Womens Status and Son Preference." Economic Development and Cultural Change 62.4, pp. 673-699. 2014.

Koolwal, Gayatri, and Dominique Van de Walle. "Access to water, womens work, and child outcomes." Economic Development and Cultural Change 61.2, pp. 369-405. 2013.

Li, Lixing, and Xiaoyu Wu. "Gender of children, bargaining power, and intrahousehold resource allocation in China." Journal of Human Resources 46.2, pp. 295-316. 2011.

Mencher, Joan. "Women's work and poverty: Womens contribution to household maintenance in South India." A home divided: Women and income in the Third World, pp. 99-119. 1988.

Michael, Robert T. "Education and the derived demand for children." Economics of the Family: Marriage, Children, and Human Capital. University of Chicago Press, pp.120-159. 1974.

Rong, Zhao, and Yang Yao. "Public service provision and the demand for electric appliances in rural China." China Economic Review 14.2, pp. 131-141. 2003.

Schultz, Theodore W. "The value of children: an economic perspective." The Journal of Political Economy, pp. S2-S13. 1973.

Skoufias, Emmanuel. "Labor market opportunities and intrafamily time allocation in rural households in South Asia." Journal of Development Economics 40.2, pp. 277-310. 1993.

Strauss, John, Germano Mwabu, and Kathleen Beegle. "Intrahousehold allocations: a review of theories and empirical evidence." Journal of African Economies 9.Supplement 1, pp. 83-143. 2000.

Tewari, Ishani, and Yabin Wang. "Durable ownership, time allocation and female labor force participation: Evidence from China's "Home Appliances to the Countryside" rebate." 2016.

Thomas, Duncan. "Intra-household resource allocation: An inferential approach." Journal of Human Resources, pp. 635-664. 1990.

Van de Walle, Dominique P., et al. "Long-term impacts of household electrification in rural India." World Bank Policy Research Working Paper 6527. 2013.

Yi, Hongmei, et al. "Dropping out: Why are students leaving junior high in China's poor rural areas?" International Journal of Educational Development 32.4, pp. 555-563. 2012.