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Forecasting Chinese Households' Demand from Home Production

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Abstract

As the Chinese market economy expands and market institutions become stronger, there will be more incentives for Chinese households to substitute market activity for home production. The goal of this paper is to provide a quantitative analysis of the potential Chinese consumer demand for household services. Using dataset from the American Time Use Survey and the China Health and Nutrition Survey, I compare households' demand for services and home production between US and China. A standard choice-theoretic model of the household is used to estimate the structural parameters and to quantitatively forecast Chinese households' service demand.

1 Introduction

Over the next decades emerging markets have the potential to become a major source of consumer demand in the world economy. The Chinese economy will play an important role, not only for its size, but also because it is bound to experience a dramatic change in its growth model . Three factors that will reshape China's development are: 1) an impending shortage of cheap labor, a so-called Lewis turning point, 2) the current account imbalance and 3) a demographic transition that will bring about a large increase in the dependency ratio. Among the other changes necessary for China to avoid a middle-income trap, its growth model will have to shift towards domestic consumption. Where the demand of Chinese households is heading becomes a question of utmost importance. This paper explores the potential consumer demand arising through a specific mechanism— changes in home production. As China's market economy develops, more and more needs that have been addressed within the household through home production will have to be satisfied by the market.

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This argument is based on the hypothesis that home production in China has absorbed a disproportionately high fraction of economic activity because of distortions typical of a developing country, such as market failures and low opportunity cost of time for individuals in their 50s and 60s. I provide support for this hypothesis by a comparative study of time allocation between China and US. I use data from the American Time Use Survey and the Chinese Health and Nutrition Survey between 2004 and 2009. The results offer a very clear picture. While home production hours are higher in China than in the US, in the past decade time allocation in China has tended towards US levels. However, the time allocation pattern shown by Chinese data still display features that are typical of a developing country. First, retired individuals are very active in home production (in China a retired individual works at home 5 hours per week more than an American retired individual), which is due to the low statutory retirement age and informal intergenerational transfers. Second, there is a large and growing gender gap in home production hours (the gender gap is around 5 hours per week in US and around 10 hours per week in China).

If time allocation in China converges to US configurations or some of its most striking imbalances are eliminated (e.g. reducing the gender gap to US levels), then important adjustments in average home work hours and home production are going to take place. The goal of this paper is to measure the effects of these adjustments on consumer demand. Everything else equal, a reduction in home production results in an equivalent increase in demand for market substitutes (such as dining, housecleaning, home repairs and care work). Thus by valuing the changes in time spent in home production it is possible to obtain an estimate of the potential demand for market susbtitues.

As regards the methodolgy of this paper, I evaluate home output first using two standard methods: the market cost method and the opportunity cost method. Then I introduce an additional method that uses a structural approach. I estimate the structural parameters of a standard choice-theoretic model of the household . Results show that the estimated home output value using the structural method is close to the other two methods when applied to the Chinese dataset. The structural method has a number of advantages compared to the other two methods, most importantly it allows to take into account the role of retired people, technology and capital, such as electrical appliances.

The final goal of this paper is to quantitatively forecast Chinese households' service demand in response to the changing economic situation. I study a number of different scenarios. If China fully converges to the US level of home production time, the weekly increase in consumer demand as a proportion of a typical household weekly income is forecasted to be in the range 8-12%. Allowing

for an increase in the usage of electrical appliances (and thus limiting the need to resort to market goods) provides a lower bound to the forecast, around 4%. Policies that address the gender gap or the retirement gap can also generate relevant increases in consumer demand.

The paper is organized as follows. Part 2 provides a review of related literature. In part 3 I describe the patterns of time allocation in China and in the US. Part 4 offers two traditional methods and a theoretical model of home production that can be used to analyze the data. In part 5, I quantify the potential changes in consumer expenditure. Part 6 offers some concluding remarks.

2 Review of the Literature

This paper contributes to several strands of the literature:

1. The measurement of home production in a national accounting framework.

   The problem of measuring the value of home production dates back to Nordhaus and Tobin (1972), but there have been many contributions since then. Key methodologies and findings are surveyed in Hawrylyshyn (2012). Empirical studies that attempt to measure the value of household production typically indicate that it is large. For example, the survey study of Hawrylyshyn (2012) finds that estimates of home produced output are around one third of measured gross national product. To my knowledge this literature does not include any empirical comparative study between developing and developed countries.

2. Theory of household time allocation

   The theory of home production can be dated back to Gary Becker (1965)'s seminal paper that modeled consumer behavior using a household production function approach. This approach sees agents as choosing not simply between work and leisure, but between work in the home, work in the market and leisure. These theories have been used to study many different issues, such as long run trends in time use, lifecycle patterns of expenditures and labor supply and the allocation of time over the business cycle, as surveyed by Aguiar et al. (2012).

   The relation between home production and economic development has not been a major topic in this literature yet. A key paper is Parente et al. (2000). The authors introduce home production into the neoclassical growth model. They assume that differences in economic de-

velopment arise from policies that distort capital accumulation. They find that such policies decrease hours worked in the market, increasing home production hours, and this magnifies the effect on income. The predictions of this model have not been tested systematically, although a cross-country study would be feasible given the current availability of time use data. My comparative study of China and US is perhaps the first piece of evidence in support of this theory.

Additionally studies of long-run trends in time use may also be relevant to the development issue. For instance, Ramey (2009) shows that in the US from 1900 to 2005 older invididuals took over more home production through time from the working-age female, resulting in an increasing female labor force participation. In a study on Russian data, Gronau (2006) finds that the switch from a controlled economy to a market economy resulted in significant increase in home productivity and an increase in the free time enjoyed by both Russian men and women.

3. Chinese economy

There is a large and growing literature on the economics of Chinese households, but it focuses mainly on issues such as savings and migration. There is no previous study of time allocation in Chinese families. My research contributes also to the macroeconomic literature on the Chinese economy. Many studies have argued that China's private consumption is exceptionally low (for example Kuo and N'Diaye 2010). The home production framework I use distinguishes between households' consumption and demand. While China's private demand is low, aggregate household consumption is larger, because it is satisfied in part by home production. Thus, rebalancing the Chinese economy towards more private demand is also a matter of shifting consumption from the household into the market. A further benefit of this approach is to help quantifying the potential gains in private demand.

3 Time Use in China and in the US

A. Data Description

The datasets that I use in this paper are the China Health and Nutrition Survey (CHNS) and the American Time Use Survey (ATUS).

The CHNS survey data is documented from 1989 to 2009 that covers nine provinces. The survey has information on time allocation among home work, market work and leisure. Time records

include the time spent on cooking, cleaning, housework and childcare. Other key socio-economic variables such as demographic information and income are also recorded. Table 1 gives a summary of the CHNS sample. Table 2 focuses on home production time at household level[1]. The dataset covers around 15300 observations at individual level, and 4337 observations at household level[2]. In my study, I define home production as hours per week spent on taking care of children, and certain kinds of housework including doing grocery, cooking, cleaning, and doing laundry. Work hours is defined as weekly working hours spent on primary occupation. Leisure hours include weekly time spent on physical activities (such as martial arts, gymnastics, swimming, track & field and etc.) and sedentary activity (such as watching tv and video, reading, surfing on the internet and so on.) Annual income is calculated as annual salary in the previous year plus the total value of all bonuses for the previous entire year. Older female is defined as a female who is no younger than 55 years old and older male is defined as a male who is no younger than 60 years old[3].

[1]Table1 uses waves from 1997 to 2009 to ensure a better quality of the dataset.To obtain a more complete dataset for key variables, Table2 uses panel for the year 2004 to 2009, which contains three waves of survey: 2004, 2006 and 2009.

[2]The educational attainment is documented as education index, and the average education of 20.13 roughly represents the sample mean is about 1 year lower middle school of formal education.

[3]The way I define older female and older male is consistent with the retirement age in China.

Table 1: Descriptive Statistics - CHNS

	Obs	Mean	Std.Err.	Min	Max
A. Demographic Variables					
Age	15659	47.04	14.3314	13.2	93.13
Fraction female	15659	.53	.4993	0	1
Married	15659	.87	.3358	0	1
Education	15500	20.13	8.4494	0	36
Fraction retired	15659	.18	.3836	0	1
Household size	15659	1.94	.8841	1	7
Number of olders	15659	.46	.7105	0	3
B. Geographic Variables					
Rural	15659	.55	.4972	0	1
Urban	15659	.45	.4971	0	1
C. Time Allocation					
Work hours	12505	39.71	19.9694	1	126
Home hours	15659	15.73	17.8016	0	266
Leisure hours	14827	19.49	15.9163	0	248
D. Income					
Annual income	5110	15580.72	20973.92	480	480000
Retirement wage	2720	13726.28	11131.31	240	119988

Table 2: Statistics on Home Production Time - CHNS

	Obs	Mean	Std.Err.	Min	Max
A. Different Age Groups					
All age cohorts	14287	15.72	16.9187	0	266.00
Young female	4961	21.88	19.0661	0	266.00
Young male	4827	7.29	10.3710	0	151.50
Older female	2975	23.03	17.0262	0	227.33
Older male	2064	10.08	12.1302	0	165.50
B. Household Level					
Individual	7648	14.11	16.6121	0	227.33
Spouse	6876	18.16	17.1378	.12	227.33
Elder mother	853	25.05	19.6719	1.17	162.75
Elder father	598	11.52	12.0115	.12	94.00
Household	4145	32.21	23.4179	0.47	248.50

Table 3: Provincial Level Summary - CHNS

Province	Obs	Age	Female	Edu	Retired	Married	Urban	Income	Work	Home	Leisure
Liaoning	1819	53.13	.55	22.48	.30	.90	.59	15830	44.99	16.87	21.62
Heilongjiang	1579	47.91	.52	22.68	.15	.91	.45	16964	43.51	16.22	20.57
Jiangsu	2517	52.48	.55	19.30	.22	.89	.54	16196	38.83	16.49	17.69
Shandong	1472	51.17	.51	19.74	.25	.86	.54	15200	45.26	14.04	22.26
Henan	1640	48.90	.53	19.52	.12	.87	.34	13279	38.52	17.32	18.73
Hubei	1657	50.38	.53	19.65	.17	.87	.40	15200	37.42	15.84	19.60
Hunan	1269	50.49	.49	22.00	.17	.86	.50	20677	39.53	15.70	23.28
Guangxi	1806	49.29	.51	20.16	.13	.82	.35	11162	38.90	16.26	17.23
Guizhou	1900	51.15	.53	16.85	.09	.85	.28	15473	34.03	16.28	16.79
National	15696	50.68	.53	20.13	.18	.87	.45	15581	39.71	12.30	19.49

The ATUS survey is a multi-year survey from 2003 to 2010. It contains about 112000 observations. The survey provides information on the amount of time people spend in many activities, such as housework, childcare, exercising, and relaxing. Demographic information such as sex, age, educational attainment, and income are also available. Table 4 gives a summary of the ATUS sample. Table 5 focuses on home production time.

Table 4: Descriptive Statistics - ATUS

	Obs	Mean	Std.Err.	Min	Max
A. Demographic Variables					
Age	112038	46.19	17.5814	15	85
Fraction female	112038	.57	.4957	0	1
Married	112038	.63	.4822	0	1
Education	112038	40.11	2.8996	31	46
Fraction retired	112038	.32	.4651	0	1
Household size	112038	2.83	1.5319	1	16
Number of children	25152	2.14	1.0766	1	12
B. Geographic Variables					
Rural	112038	.13	.3385	0	1
Urban	112038	.60	.4891	0	1
C. Time Allocation					
Work hours	60830	38.98	11.8532	0	99
Home hours	112038	11.24	16.4993	0	190.17
Leisure hours	112038	25.71	22.1635	0	165.32
D. Income					
Annual income	60830	42130.21	31992.78	0	149999.7

Table 5: Statistics on Home Production Time - ATUS

	Obs	Mean	Std.Err.	Min	Max
Different Age Groups					
All age cohorts	112038	11.24	16.4993	0	190.17
Young female	42292	17.23	20.8604	0	190.17
Young male	38236	6.06	11.0860	0	161.00
Older female	21059	11.85	13.2627	0	121.10
Older male	10451	4.75	8.1765	0	113.75

B. A Converging Pattern in Time Allocation between China and US

Figure 1: Hours at Work, Home and Leisure over Time

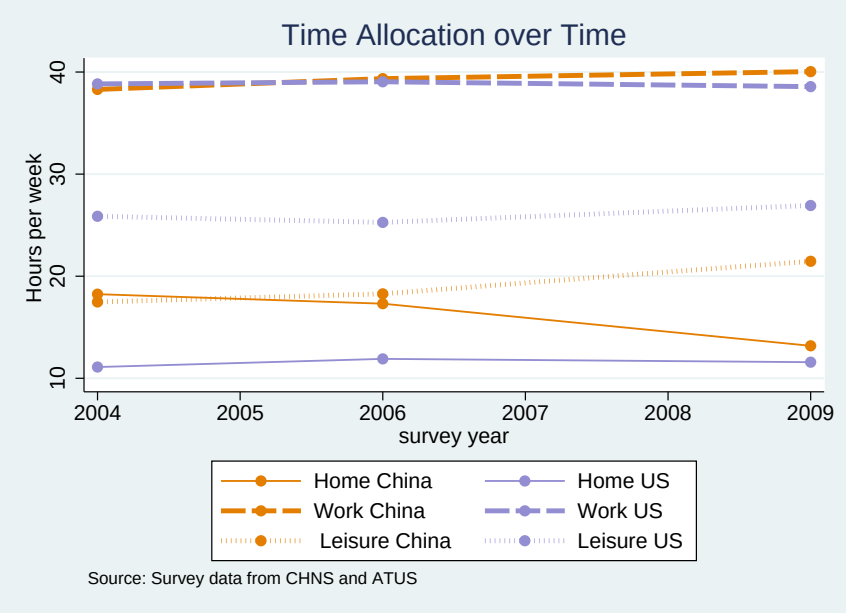


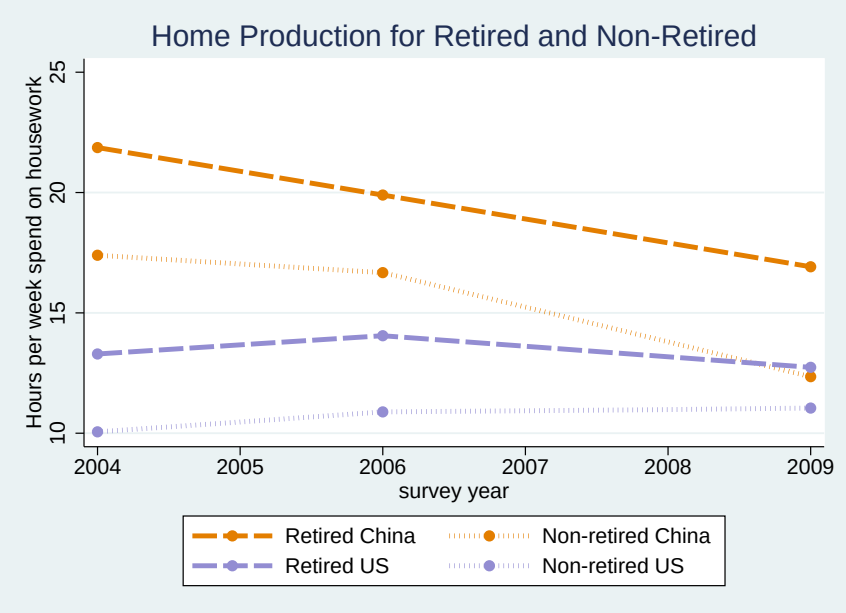
Figure1 shows the general trend of average hours per week people spend in working on the job, doing home work and enjoying leisure for the survey years 2004, 2006 and 2009 for both Chinese and US datasets. I report time use at the individual level. The average hours per week spent in doing home work for Chinese individuals (solid orange line) drop significantly from 18 hours in 2004 to 13 hours in 2009, approaching the overall level of American individual's average home working hours (solid blue line). Over this time period, the average working hours per week in China only slightly increase from 38 to 40 hours (dashed orange line), indicating that only a small proportion of time reduction from home work goes to market work in China. There is a steady increase in the amount of hours spent in leisure during the same time range (dotted orange line).

In general, Chinese people spend more time at home work compared to American people, but less time at leisure. However, this difference is becoming less striking over the years due to the economic growth in China. One explanation is that increases in the real wage in China have both income and substitution effects, providing incentives for many individuals to substitute leisure and market activity for home production. Secondly, the market for services suffers from a number of imperfections in developing countries and, as it is well known, is especially underdeveloped in China. However, this situation is rapidly changing. As the Chinese market economy expands and market institutions become stronger, the imperfections in the service sector are disappearing.

These two factors may lead to a further reduction in the home production time allocated by Chinese households, resulting in a converging pattern of home production between US and China.

C. The Key Role of Retired Individuals in China

Figure 2: Home Production for Retired vs. Non-Retired Individuals



It is useful to look how home production varies with retirement status. Figure 2 shows how home production hours have changed for retired vs. non-retired individuals from 2004 to 2009. For both countries, a retired individual on average spends more time on housework than a non-retired individual. The gap of home production between retired and non-retired appears to be larger in China than in US.

One reason why the retired gap is large in China is that the retirement age in China is relatively low compared to more developed countries: the Chinese statutory retirement age for blue-collar women is 55 and for blue-collar men is 60. The combination of a low statutory retirement age and increased longevity has resulted in a low opportunity cost of time for individuals in their 50s and 60s. A complementary explanation of the different participation level of old people in home production is that there is a stronger pattern of intergenerational transfers in China. Traditional family-based informal mechanisms of support for the elderly give rise to an upward transfer within households in China, from younger couple to old parents (see for example Cai et al. 2006). While elders rely on adult children for support, they also in turn provide their children with services (Lee and Xiao 1998).

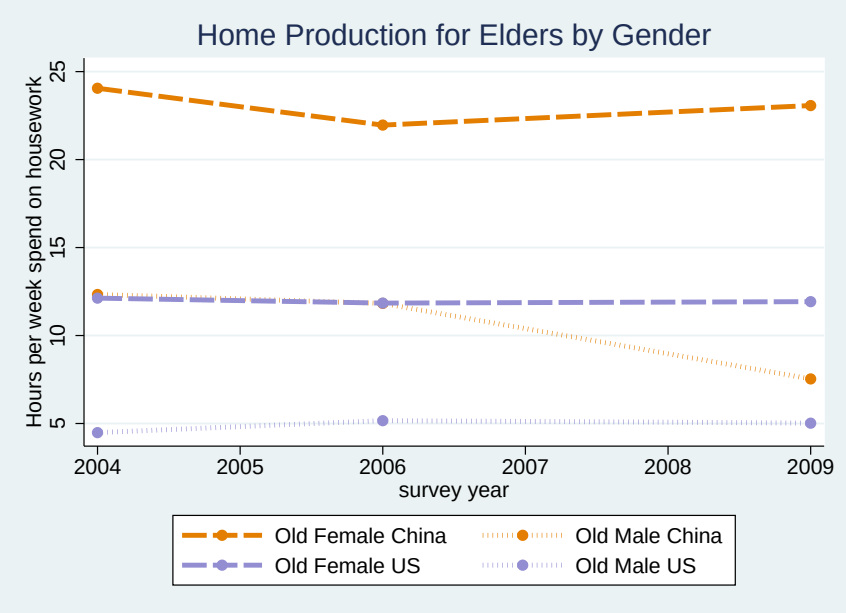
This suggests that there may be interactions in the allocation of time among family members. An individual's home production time can be affected by the presence of his or her old parents in the household. For example, it is possible that living with parents in China significantly reduces the burden of home production on the young adult individual, increasing his or her labor supply. This hypothesis is supported by the recent study of Maurer-Fazio et al. (2011), who find that coresidency with older adults increases prime-aged women's labor force participation rates in urban China. Previous works on home production have typically ignored this issue and estimated only individual models of time allocation. The home production model I will discuss below allows interactions between young adults and retired relatives.

While the role of retired individuals in the home production of Chinese households is still very important, this situation is rapidly changing. Given the expected increase in the elderly share of China's population, it is generally acknowledged that the current pension fund system is not sustainable (World Bank 1997). As the Chinese population ages, increases in the statutory retirement age will soon be put into practice. With the new policy, we would expect home production hours to decline more rapidly for old people, especially for old women. More home work has to be outsourced into the market, and these changes will create consumer demand for a wide variety of household services.

Finally it is interesting to note that in the US the gap in home production between young and old is stable or shrinking, but it is widening in China. Even though average home production in China has dropped in recent years, the speed of this change has been very different for the old and the young. Young Chinese are "catching up" with young Americans at a very fast rate, especially after 2006. On the other hand, the decline in home production hours of old Chinese has proceeded at a moderate rate. The next figure will shed more light on the cause of the relatively sluggish adjustment in home production hours of Chinese elderly people.

D. A Large and Growing Gender Gap among Elderly People in China

Figure 3: Home Production among Elderly People by Gender

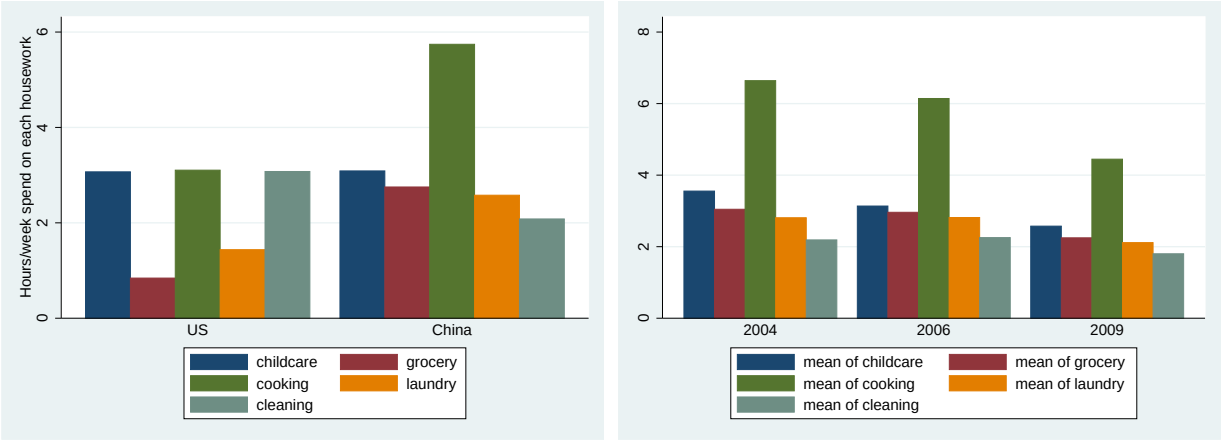


If we analyze the home production hours of elderly people by gender, the facts are more provoking (see Figure 3). Old females in both US and China on average do more home work than old males (the same pattern also holds for working-age males and females). This gender gap in home work can be attributed to culture (the different social roles that males and females play in the society) as well as to the existence of a gender gap in wages. If women face lower wages in the market, they may have incentive to allocate relatively more time to home work. This effect is also taken into account in the home production model described below.

A very striking fact is that despite a decreasing trend of average home production hours for old people in China, the home production hours for old women have not changed much from 2004 to 2009. Thus the drop in home production of old males is the main determinant of the overall decreasing time spent on housework by elderly people. As a result, there is an increasing gender gap in home work among older individuals, with important implications in terms of equality and welfare.

E. Home Production by Category

Figure 4: Home Production by Category



(a) Comparison between US and China

(b) Change of Home Production by Category for China

Figure 4 shows how home work hours are allocated to different categories of home production. Panel (a) plots home production hours averaged across individuals and year in the period 2004-2009 by category for both US and China. Panel (b) shows how home production hours of Chinese individuals have changed from 2004 to 2009 in different categories . From Panel (a) we can see that the only category in which Americans spend more time than Chinese people is in house cleaning. In all the other four categories Chinese spend more time per week than Americans on average. Among these five categories, Chinese individuals spend more than double the time of Americans on grocery (purple bar) and cooking (green bar), and much more time in doing laundry (orange bar). Cultural and economic differences between US and China can explain these patterns. For instance, lower relative prices of market substitutes of home production or better home production technologies could lead to the observed patterns. However, the change is on the way. Looking at the category level of home production over time for China (Panel (b)), there is a downward trend in time spent in all the five home production categories from 2004 to 2009. This is also consistent with the recent service sector development in China (dining service growth, etc...).

Panel (a) shows a similar amount of time spent by US and Chinese individuals on childcare. However, the time American individuals spend on childcare may be overstated for two reasons. Firstly, childcare in the Chinese dataset is defined as weekly hours spending on taking care of household children that are below 6 years old. However, due to survey data constraints, for the American data we can only get the weekly hours spending on taking care for own household chil-

dren under 13 years old (while the youngest child is below 6 years old). Secondly, based on the survey data, the average number of children for a US household is around 2 while for Chinese households is only 1. Similarly, the average American household size is 3 while the average Chinese household size is around 2. This may also explain why Americans spend more time in house cleaning at the individual level.

F. Home Production in China and US: Individual Characteristics and Time Trend

Table 6: Regression Results

Home Hours	CHNS	ATUS
Age	0.295***	0.645***
	(5.71)	(25.82)
Age^2	-0.004***	-0.008***
	(-7.21)	(-30.92)
Retired	6.350***	5.153***
	(13.41)	(23.30)
Female	11.270***	9.675***
	(26.55)	(40.05)
Urban	-0.973**	0.191
	(-3.13)	(1.05)
t	-0.229**	0.0444
	(-2.79)	(0.82)
Male $\times$ t	-0.730***	0.113
	(-6.10)	(1.45)
Earnings	-0.369***	-0.115***
	(-3.87)	(-3.83)
Constant	6.354***	-5.694***
	(5.12)	(-9.84)
N	14827	40049

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 5: Age Profile for US and China

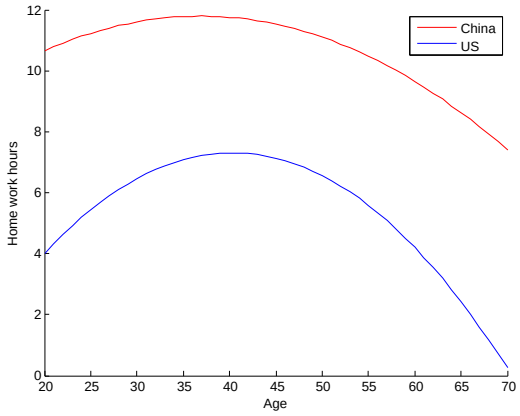


Table 6 summarizes how some key variables are related to home production in U.S. and China. The regression results use the CHNS[4] and the ATUS survey information at the individual level and are consistent with the graphical results above. The left hand side variable is home production hours per week as defined earlier. The regression results show similar pattern for both dataset but differ in magnitude. The effect of age on home production time for both countries follows a reversed U-shape pattern as shown in Figure 5. For both countries, home production peaks at around 40 years on average. Before 40 years there is a positive relation between age and home production, while after 40 years the relation turns negative. The shape of the age profile however is different between US and China: as an individual becomes older, the drop in home hours in China is much slower than the drop in US. Retired is a dummy for the individual's retirement status. The CHNS regression result shows that a retired individual tends to work around 6 hours more per week at home than a non-retired individual while the differential impact of retirment is around 5 hours in the ATUS data. Urban is a dummy equal to 1 if the individual belongs to urban type of household registration and equal to 0 if the individual belongs to a rural type of household registration[5]. On average, individuals from urban households in the CHNS work 1 hour less per week at home than individuals from rural households. The variable t is years since 2004. There is an overall decreasing trend of home production through time in CHNS: Chinese people on average work at home half hour less per week with each additional year from 2004 to 2009[6]. This general

[4]The coefficients reported here are pooled-OLS estimators. Random effect model estimates for CHNS are very similar to these ones. Education is dropped since the coeffiecient is insignificant after adding earnings as an explanatory variable.

[5]For ATUS, urban represents living in metropolitan area.

[6]This can be shown from a regression with year-fixed effect and without year-gender interaction.

trend is likely to reflect some changes in the macroeconomy, such as a decline in market prices of household services. In the table I allow for a different trend for females and males. Female is a dummy variable equal to one if the individual is a woman. Male$\times$ t is an interaction term for addressing both gender and time effects. The estimation results demonstrate a significant effect of gender on the hours of housework. From 2004 to 2009, home production hours per week for male individuals decrease around 1 hour every year, while the weekly home production hours for female individuals only decrease 13 mins every year. Thus, the gap in home production time between women and men increases over time: women spend 11 home production hours per week more than men in 2004. However, in 2006 this number reaches roughly 12.3 hours per week, and further rises to around 14.75 hours per week in 2009[7]. Finally, earnings are negatively related to home production in both dataset: if weekly income increases by around 30 dollars, weekly home production hours in CHNS fall by around 20 mins while in ATUS only fall by 1 min.

4 The Value of Home Production

In the past four decades, there have been many attempts to measure home production within a national accounting framework (for a survey see Hawrylyshyn (2012)). This literature has developed and applied a standard methodology. In order to simplify the discussion I introduce some notation that I will expand later. Consider an individual with market wage W. Let H and f_H respectively be the hours of home production and the home marginal product of the individual. Let X_H be home production output and X_M some close substitute for home production available in the market. Let p be the market price of the good and W_X the market wage paid to labor for producing X_M. The monetary value of the individual's home production, V, is ideally given by $V = pX_H$. However, X_H is not observable (or very difficult to measure) and p may be difficult to compute as well. Thus the literature has usually proceeded by valuing the inputs to home production, namely H. There are essentially two standard methods of evaluating the productive services rendered by family members at home: (a) evaluating time inputs at the market cost, and (b) evaluating time inputs at their opportunity costs. In the next two subsections I will describe the two methods and how to apply them to the CHNS data. Then I will discuss some of the limitations of these methods and introduce a structural method based on estimation of the home production function.

[7]The estimates of the coefficients on urban, t, and Male$\times$ t from the ATUS dataset are not significant, implying that there is no significant change in home production over time since 2004, nor a significant change in the gender gap over time.

4.1 The Market Cost Method

With the market cost method, the individual's hours of home work are evaluated at the observed (nominal) wage in the markets for services that are substitutes to home work:

$$V^{MC} = H \cdot W_X \tag{1}$$

I calculate W_X as the average nominal wage of workers working in the household service sectors. First I extract a subsample of 871 observations who work in the household service sector based on their primary occupation from the individual questionnaire[8], then I compute the mean wages of household service workers across years and provinces, and finally assign them to home hours to obtain the home output value. I illustrate the result of this valuation method in section 5 (see table 9).

4.2 The Opportunity Cost Method

With the opportunity cost method, the individual's hours of home work are evaluated at her marginal opportunity cost, given by her own net wage:

$$V^{OC} = H \cdot W \tag{2}$$

The underlying argument, founded for example in Becker (1965)'s seminal paper, is that the optimal choice of home work hours requires the nominal marginal product at home ($p \cdot f_H$) to be equal to the market wage: $p \cdot f_H = W$. Thus $V \simeq p \cdot f_H \cdot H = W \cdot H$.

As discussed in the literature, this method cannot be directly applied to individuals who work at home but not in the market (such as retired people). There are several different ways to impute a notional wage to individuals that are not employed, as discussed in Sharpe and Abdelghany (1997). Here I will use one of the most popular methods, based on Heckman's (1979) procedure to correct for selectivity bias.

This procedure involves two steps. I regress the probability of an individual working in the market, measured by $Work \equiv 1 - Retired$, on a number of control variables and two identifying variables, namely age and age squared. These two variables are assumed to affect the probability of participation in the labor market, but are assumed not to influence wages. I estimate the following

[8]These observatioins are identified as service workers, which include housekeeper, cook, waiter, doorkeeper, hairdresser, counter salesperson, launderer and child care worker)

Probit model:

$$Pr[Work = 1] = a_0 + a_1 edu + a_2 urban + a_3 female + a_4 married + a_5 t + a_6 age + a_7 age^2 \quad (3)$$

where education is an index, urban is a dummy variable that equals one if the individual holds an urban registration and zero otherwise and t controls for the year. In the second step, I estimate the following wage equation:

$$log(W) = b_0 + b_1 edu + b_2 urban + b_3 female + b_4 married + b_5 t + b_6 \hat{\lambda} \quad (4)$$

where $\hat{\lambda}$ is the estimated inverse of the Mills ratio generated by the Probit equation. The results of this two-step estimation are presented in Table 7.

Finally, it is possible to use the estimates of equation 4 to impute a notional wage for retired individuals, given their personal characteristics. Given this notional wage, W, and the individual home production hours, H, the individual's value of home production can be computed using the opportunity cost method as $V^{OC} = H \cdot W$. I apply the opportunity cost method to both working and retired individuals and illustrate the results in section 5 (see Table 9).

Table 7: Two-Stage Heckman's Estimation of Wage Equation

	(1) log(w)
log(w)	
Edu	0.044***
	(18.59)
Urban	0.317***
	(9.73)
Female	-0.272***
	(-12.72)
Married	0.156***
	(5.18)
t	0.121***
	(23.92)
Constant	-0.046
	(-0.45)
select	
Age	0.086***
	(12.46)
Age^2	-0.001***
	(-18.67)
Edu	0.037***
	(16.91)
Urban	1.005***
	(34.25)
Female	-0.316***
	(-12.11)
Married	-0.050
	(-1.13)
t	0.054***
	(8.92)
Constant	-2.517***
	(-16.68)
Mills	
λ	0.205***
	(5.36)
N	14822

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.3 Structural method

While the market cost and opportunity cost methods are standard in the valuation literature, here I present a third methodology based on the theory of home production that is more consistent with basic economic principles. The two standard methods of valuing home work suffer from a number

of limitations. First, both methods will underestimate the true value of home production if there are diminishing returns to home work. This fact has been overlooked in the accounting literature, but was pointed out in a passage of Gronau 1977 (p. 1122):

> "the product of the average wage rate and the number of hours worked at home therefore understates the value of home production to the extent that diminishing marginal productivity prevails. This imputation does not account for the rent (i.e., the producer's surplus) accruing to a person who is self-employed in his own home".

Similarly, standard valuation methods fail to capture the value of potential complementarities among the household members' home production hours (joint rents). More importantly, these methods do not allow a direct treatment of technology and capital (e.g. electrical appliances). The structural approach I present below, based on a modeling of the home production function, deals with all these issues. Finally, the structural approach provides a way to evaluate the contribution of non-employed individuals more precisely than the imputation methods used in opportunity cost valuation.

I describe a simple home production model, similar in many respects to standard models in the literature, such as Gronau (1977, 1980) and Graham and Green (1984). Gronau (1977, 1980) constructs a model for a married woman where the husband's decision is exogenous. It is a model of one individual who allocates time among market work, home production and leisure. The model assumes that home time produces a good that is a perfect substitute for a composite good that may be purchased on the market. Gronau tests his model's predictions by using data from the 1972 panel of the Michigan Study of Income Dynamics. Graham and Green (1984) extend the Gronau model to a two wage-earner household and allow home production and leisure to overlap to some degree. Their focus is on the estimation of the household consumption technology that consists of a Cobb-Douglas function and a "jointness" function. They estimate an equation for the home production time for married women using data from the Panel Study of Income Dynamics for 1976 and provide estimates for the value of home production.

The main difference of my model from previous works is that I allow some members of the household not to participate in the labor market. This extension makes it possible to take into account the role of retired inviduals, which is very important as the data suggest. I try to keep other aspects of the model as simple as possible.

As an illustration, I consider a household with three members: wife, husband and an old relative that is retired. The model can be easily extended to include more complicated household

structures and in the estimation I will allow an arbitrary number of working and non-working household members. I assume there is no joint use of time for work at home and leisure and that working at home and working in the market are perfect substitutes. I use a unitary model of the household, where the members maximize household utility. Household utility is given by:

$$U(C, L_h, L_w, L_o) \tag{5}$$

where C, L_h, L_w and L_o are household's consumption, leisure of the husband, the wife and the elder relative respectively.

Total consumption of household services (C) can be obtained from the market or produced at home:

$$C = X_M + X_H \tag{6}$$

where X_M represents goods purchased in the market and X_H represents goods produced at home (measured in the same units as market-purchased goods). Clearly, here I focus on market and household products that are perfect substitutes in consumption.

Home production is described by the following technology:

$$X_H = f(H_h, H_w, H_o) \tag{7}$$

where H_h, H_w and H_o represent the time spent in home production by the three members. This production function is twice continuously differentiable with positive first derivatives and is strictly concave. For simplicity, I drop the use of market-purchased intermediate inputs in this formulation[9].

The household faces a budget constraint:

$$pX_M = W_h N_h + W_w N_w + v \tag{8}$$

where v is nonlabor income (including the retirement income of the elder relative) net of expenditure on other goods. W_h and W_w are hourly wages, and N_h and N_w are hours of work of the husband and wife respectively.

[9]Graham and Green include a market-purchased intermediate inputs, and they consider the possibility that the human capital of the household members may be more suited to market work than to home production.

In addition, each household member faces a time allocation constraint:

$$L_i + H_i + N_i = T, \quad i = h, w, o \tag{9}$$

where T equals total time and $N_o \equiv 0$.

The economic problem of the household is to choose an allocation of time that maximizes utility subject to the available technology, the household budget constraint and each member's time constraint:

$$\max U(C, L_h, L_w, L_o)$$
$$\text{s.t. (6), (7), (8), (9)}$$

The choice of the household can be described by the following first order conditions[10]:

$$p \cdot f_i = W_i \quad i = h, w \tag{10}$$

$$p \cdot f_o = W_i \frac{U_o}{U_i} \quad i = h, w \tag{11}$$

where $U_i \equiv \frac{\partial U}{\partial L_i}$ is the marginal utility of individual i's leisure time and $f_i \equiv \partial f / \partial H_i$ is the marginal product of home production hours of i. Equation (10) is standard in the microeconomic literature on home production. It equates the marginal product at home to the real wage for an individual. All the previous studies have focused on estimating the home production function for individuals who participate in the labor market market and thus have a wage. Time allocation data on individuals who do not have a wage cannot be used to derive a production function if we rely only on estimating equation (10). I point out that it is still possible to estimate the parameters of a home production function for unemployed individuals by using equation (11)[11]. This first order condition equates the marginal product at home of individual o to the wage of individual i corrected by the ratio of marginal utilities of leisure $\frac{U_o}{U_i}$.

I estimate the parameters of the household production function using data from the CHNS sample. I consider only households that have at least one working member, so that equations (10) and (11) can be estimated. Within each household, I drop individuals that are 18 years old or younger, as their time allocation decisions may not be correctly described by the model (schooling

[10]The first orderd conditions are obtained as follows. First I subtitute (6), (7), (8), (9) in the objective function $\mathcal{L} \equiv U(C, L_h, L_w, L_o)$. Then I take the first order derivatives with respect to N_i and H_i and set them equal to zero. For each $i = h, w$, this leads to two equations: $-U_i + U_c \cdot f_i = 0$ and $-U_i + U_c \cdot W_i / p = 0$. For $i = o$, we only have $-U_o + U_c \cdot f_o = 0$.

[11]Equation (11) exploits the fact that marginal utility of total consumption U_c is the same for all the household members, since we are using a unitary model of the household. However a similar condition can be obtained also from more general models of the family, such as a bargaining model where consumption allocation is Pareto optimal.

or studying is probably a major time use for these individuals but the model does not include such activities). Instead of using the simple three-member household model introduced above, the estimation allows for a variable household size. Let N be the number of individuals in a family and i the individual index within that household. I choose a specific functional form for the home production function f. I assume home production is described by a constant elasticity of substitution (CES) technology:

$$X_H = A\left[\sum_{i=1}^{N}(E_i H_i^{\gamma})^{\theta}\right]^{\frac{1}{\theta}} \tag{12}$$

Here A is an index of household productivity. The parameter $\theta \in (-\infty; 1] \setminus \{0\}$ is the parameter that measures elasticity of substitution among inputs. When $\theta = 1$ inputs are perfect substitutes, when $\theta \to -\infty$ inputs are perfect complements. The parameter γ captures the diminishing return techonology of non-market production. The inputs of the production function are the "effective" home hours of each household member i, $E_i H_i$. E_i represents a measure of the productivity (or human capital) on an individual level. As Graham and Green I assume human capital is embodied capital and that an individual carries it into all activities—work, leisure and home production.

In order to estimate equation (11), we also need to speficy a functional form for U. For simplicity, I assume that the household utility function takes the standard Cobb-Douglas functional form, with equal shares parameters:

$$U = C^{\delta}\Pi_{i=1}^{N} {L_i}^{\alpha} \tag{13}$$

Then we need to assign a working member j to each non-working member i. To simplify the exposition, I will define the wage of non-working member i as the wage of working member j: $w_i \equiv w_j$.

Finally it is possible to rewrite the first order conditions (10), (11) in a single equation, as follows:

$$w_i = A\left[\sum_{i=1}^{N}(E_i H_i^{\gamma})^{\theta}\right]^{\frac{1}{\theta}-1} E_i^{\theta}\gamma H_i^{\gamma\theta-1}\left[\frac{L_i}{L_j}\right]^{Dummy_i} \tag{14}$$

where

$$Dummy_i = \begin{cases} 0 & \text{if individual } i \text{ works} \\ 1 & \text{if individual } i \text{ does not work} \end{cases} \tag{15}$$

Note that equation (14) reduces to (10) if the individual is working and to (11) if the individual is not working. Equation (14) is the relation I will estimate.

Before estimating (14) it is necessary to specify how A and E_i are determined. Since my production function does not incorporate the household "capital" as an input, I include some of the electrical appliances usage that may affect the household productivity. I consider five dummy variables indicating whether or not the household owns a washing machine (K_1), a refrigerator (K_2), a microwave (K_3), an electric rice cooker (K_4) and an electric pressure cooker (K_5). Then the household productivity index is given by:

$$A = \alpha_0 \exp(\alpha_1 K_1 + \alpha_2 K_2 + \alpha_3 K_3 + \alpha_4 K_4 + \alpha_5 K_5) \tag{16}$$

All these five variables are expected to enter postiviely into the production function ($\alpha_i > 0$) since the usage of electrical appliances are supposed to improve household productivity. I assume that the individual productivity index E_i can be mesaured as a combination of individual $i's$ age, educational attainment and gender:

$$E = \exp(\beta_1 edu + \beta_2 age + \beta_3 gender) \tag{17}$$

Thus the parameters β_1, β_2, and β_3 capture the effect of each of the three elements on individual home productivity respectively.

Estimation of equation (14) requires data on the following variables: the real wage w_i, home production time for each individual in the same household H_i, leisure time for each individual in the same household L_i, education, age and gender of each individual in the household and electrical appliances usage. All these variables except w_i can be obtained directly from the CHNS dataset. H_i is measured as reported weekly hours of home production time and L_i is measured as reported weekly hours spent on leisure.

The real wage w_i serves as the dependent variable in the estimating equation (14). It is the real wage defined as nominal wage (W_i) deflated by an household service sector price index (p). However, a price index for household services cannot be found in public statistics. I overcome

this problem by using the nominal wage W_i as the dependent variable. In this way, the price index is treated as a parameter to be estimated, although it cannot be identified separately from the constant α_0 in the right-hand side of the estimating equation (14). This procedure does not involve any loss of relevant information, since I am not interested in p itself and the purpose of the estimation is to derive the monetary value of home output (pX_H), not its real value.

I estimated equation (14) by non-linear least squares in STATA. Table 7 reports the estimation results. The estimate of θ is highly significant, implying that the CES assumption fits well the actual household production technology. The estimated θ is almost equal to one indicating a high degree of substitutability among the effective home work hours of the household members. The estimate of γ is positive and significantly close to one. Thus the marginal product of each individual is approximately constant . As we expected, all the general household productivity parameters have positive signs except α_2, which is not statistically significant. Usage of microwaves (α_3) and electric rice cookers (α_4) significantly improve household level productivity. Both education (β_1) and age (β_2) have significant positive effect on each individual's productivity at home. Surprisingly, women have lower marginal productivity at home than men (gender is coded as 2 for female and 1 for male), although the coefficient is not significant[12]. Given the characteristics of a household, these estimates can be used to compute the nominal value of home production as:

$$V^{\text{structural}} = p\alpha_0 e^{(\alpha_1 K_1+\alpha_2 K_2+\alpha_3 K_3+\alpha_4 K_4+\alpha_5 K_5)} \left[\sum_{i=1}^{N} (e^{(\beta_1 edu_i+\beta_2 age_i+\beta_3 gender_i)} H_i^{\gamma})^{\theta} \right]^{\frac{1}{\theta}} \tag{18}$$

I illustrate the result of this valuation method in the next section (see Table 9).

[12]The negative sign may come from the inability of the model to capture the gaps between male and female in both home hours and market wages. From (14), if there is a gap between male and female in wages, in order to equate the condition with an inverse gap in home hours, the model has to yield a lower female home productivity. If we restrict our sample only to the retired individuals, to whom I assign the wage of the matched working individual in the family, the estimate of β_3 is both positive and significant, at around 0.979.

Table 8: Estimation Results

	(1)
	w
θ	0.964***
	(32.86)
α_0	1.453***
	(4.58)
α_1	0.248**
	(2.61)
α_2	0.033
	(0.42)
α_3	0.269***
	(5.45)
α_4	0.214*
	(2.25)
α_5	-0.030
	(-0.67)
β_1	0.034***
	(7.83)
β_2	0.009***
	(5.20)
β_3	-0.094
	(-1.91)
γ	1.015***
	(35.39)
N	4567

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5 Forecasting Changes in Household Demand

In this section I will use the valuation methods to estimate the value of home production for a typical Chinese household and forecast the potential changes in household demand for market substitutes for home production.

I consider a family composed by an employed male, an employed female, a retired male and a retired female. The four household members are denoted by wm, wf, rm, and rf respectively. When the valuation method requires information on the individual, I use the average value of the relevant characteristic within the household member type: for example, $education_{wm}$ will be the mean education level among male individuals who work. The market cost method does not require data on each individual (beside home prouction hours) as it uses a common wage for all individuals, W_x, as discussed above. The actual value of W_x is reported in Table 9. The op-

portunity cost method uses the actual wage of each working individual and the imputed wage for retired individuals, according to the methodology illustrated above. The wages for the four household member types employed in the opportunity cost valuation procedure are reported in Table 9. The structural method also requires information at the household and individual level. The index of household productivity, A, is computed in the following way: first I use the estimates of $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ to compute the value of A for each household in the CHNS dataset, then I take the average of the A terms. Similarly, the individual level productivity terms, E_{wm}, E_{wf}, E_{rm}, and E_{rf} are computed using the average age and education of each type of individual $i \in \{wm, wf, rm, rf\}$ in the CHNS sample. Actual values of the household and individual productivity indexes are reported in Table 9.

Table 9: Details of Different Evaluation Methods

Market Cost:	W_x=4.865
Opportunity Cost:	W_{wm}=10.295 W_{wf}=7.282 W_{rm}=7.754 W_{rf}=5.089
Structural Method:	A= 2.193 E_{wm}=2.860 E_{wf}=2.280 E_{rm}=3.543 E_{rf}=2.744
Structural Method with Technological Change:	A=3.027*

*All the E terms are the same as the structural method

In the baseline model, I assign to household member $i \in \{wm, wf, rm, rf\}$ a value of H_i equal to the average of the weekly home production hours across type i individuals in the CHNS sample[13]. Then I compute the monetary value of weekly home production for this stylized household. Table 10 collects the results of this exercise. The estimated nominal value of weekly home production for this household is around 319 Yuan (or 50 Dollars at the current exchange rate) using market cost method, and 451 Yuan (or 70 Dollars) using the opportunity cost method, and 433 Yuan (or 68 Dollars) using the structural method.

Finally I use the three methods to quantify the change in consumer expenditure that may derive from the evolution of home production in China. It is important to stress the underlying

[13]This treatment is the same for all methods in the baseline scenario.

hypothesis: I assume that, as home work hours change, the total value of household consumption is constant, so that a reduction in home production translates into an increase in demand for market substitutes. While this assumption is clearly restrictive, it helps to focus on a specific channel through which private demand may increase. Even though changes in home work hours are likely to be correlated with many other changes in the economy, the effects on private demand could always be decomposed into an overall change in households' consumption target and a reallocation between home and market. Here I focus on the latter. Moreover, since the overall change in households' consumpion target is likely to be positive in the medium run (i.e. an increase in private consumption) my estimates are unlikely to overstate the potential gains in private demand and rather provide a conservative lower bound.

In the scenario labelled "Convergence", I estimate the level of home production that would obtain if the same Chinese household of the baseline scenario allocated hours to home production as an average American family. Thus, I set H_i ($i \in \{wm, wf, rm, rf\}$) equal to the average of the weekly home production hours across type i individuals in the ATUS sample. The estimation is based on the assumption that the elasticity of substitution, the household level and the individual level productivity terms are all fixed. The results are summarized in table 10[14]. The value of home production is expected to fall by around 157 Yuan per week according to the opportunity cost and structural methods, or by 112 Yuan according to the market cost method. This implies that the evolution of home production time in China can generate an equivalent increase in household expenditure on household services: $p_x \Delta X_M = -p_x \Delta X_H$. The increase in demand is equivalent to 12% of household income using the opportunity cost and structural methods, or to 9% of household income according to the market cost method.

This estimate may overstate the actual potential gain in demand if the difference in Chinese-US home work hours is due to differences in home production technologies instead of differences in real wages. In other words, if the reduction in home work hours is due to the fact that households can spend less time in housework while obtaining the same amount of home production, then the reallocation of consumption to the market may be negligible. In order to account for this possibility, I study another scenario, labelled "Appliances", in which I use the structural model but with a higher level of household productivity (a higher A term). Specifically, I set each one of the elettrical appliances usage dummies K_1, K_2, K_3, K_4, K_5 equal to one (instead of using the current

[14] I compute the nominal value of home production by using the same price index of household services employed in the baseline scenario so that the two scenarios can be compared also in nominal terms.

sample mean of the A index). The resulting value of the household productivity index is reported in table 9 and the "Appliances" scenario in table 10 states the associated effect on home production and demand. Accounting for this extreme form of technological change, as home work hours converge to US levels, the weekly home production value drops by only 54 Yuan, generating an increase in demand equivalent to 4% of household income.

Finally, I consider two more scenarios: convergence to US gender gap (keep men's home hours constant while dropping women's home hours to eliminate the difference in China-US gender gap), and convergence to US retirement gap (keep young people's home hours constant while changing retired people's home hours to reach US retirement gap). The results, summarized in table 10, suggest that reducing the gender gap in home production can generate an increase in household demand of around 2% of current average income and reducing the retirement gap can lead to an increase in household demand of around 3% of current average income.

Table 10: Forecasting changes in consumption: methods and scenarios

Methods		Scenarios				
		Current	Convergence	Appliances	US Gender Gap	US Retired Gap
Market Cost	V	319.22	207.37	-	298.35	290.82
	ΔC	-	111.85	-	20.87	28.4
	$\Delta C/I$	-	8.68%	-	1.62%	2.20%
Opp. Cost	V	450.67	293.33	-	422.45	407.25
	ΔC	-	157.34	-	28.22	43.42
	$\Delta C/I$	-	12.21%	-	2.19%	3.37%
Structural	V	433.05	274.65	379.16	407.64	383.82
	ΔC	-	158.4	53.89	25.41	49.23
	$\Delta C/I$	-	12.29%	4.18%	1.97%	3.82%

6 Conclusion

In this paper I have analyzed recent trends in Chinese households' unpaid work time and consumption. First, I have provided a clear comparison of household time allocation between China and the U.S. The evidence suggests that in the past decade Chinese households have witnessed a process of convergence towards US levels in unpaid work time. However, this convergence is far from complete and it is particularly uneven, as important groups of the population, namely women and younger retirees, still spend significant amount of time on unpaid household work.

Then I have studied the implications of these trends for the evolution of consumer demand in China. As regards the methodology of the paper, I have used a structural household model

that provides several advantages over more standard accounting methods, such as explicitly taking into consideration the contribution of retired household members and of electrical appliances. The results of this study show that the value of home production that an average Chinese household generate is around 68 dollars a week, which is about 3300 dollars on an annual basis. As the Chinese market economy expands, there will be more incentives for Chinese households to substitute market activity for home production. The potential increase in household consumption I estimate is significant, and equivalent to around 12% of current average household income in the main scenario I consider, but I also present a number of alternative scenarios with more qualified conclusions.

Such increase in household demand would play a significant role in driving the Chinese economy toward a more consumption-based and more balanced growth. While there is evidence of trends in this direction, the transition will probably require active policies, from facilitating the labor market participation of women and elderly people who are still productive, to guaranteeing competition and lower prices in the market for household services.

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