Marketization in a Heterogeneous Skill Economy*

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Abstract

The surge in marketization – the purchase of services commonly produced at home from the market – in the US has been attributed to decreases in the marginal cost of marketable services through increased productivity. In this paper, I show that low-skill labor is the largest input to the production of these personal services, and thus low-skill wage movements contribute to marginal cost declines. To illustrate the role that the rising skill premium has played in marketization, I build a model to study the economic forces that shape households' resource allocation in a heterogeneous skill economy. In contrast to the findings in the representative household models, my quantitative exercise shows that changes in the wage structure, rather than a larger growth of productivity of the market service sector relative to the home sector, are the predominant driver of marketization. Thus, the forces that change the skill premium can entirely account for trends in marketization. This new mechanism suggests that policies and labor market institutions responsible for the trajectory of the skill premium can also affect the extent of marketization.

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1 Introduction

Economists have long recognized the critical role of reallocation between the home sector and the market sector in shaping economic fluctuations and long-term growth[1]. The process where households purchase services commonly produced at home from the market is defined as *marketization* by Freeman & Schettkat (2005). This reallocation is relevant to economic outcomes because of the large substitutability between the output of home production and personal services. Previous research on marketization typically focuses on representative households and, as a result, concludes that marketization is all driven by the increase in productivity of the personal service sector relative to the home sector[2].

In this paper, I examine the role of Skill-Biased Technological Change (SBTC) in explaining the marketization of the home production sector. The key observation that workers providing personal services have low education attainments suggests that the price of personal services could be affected by the wage change of the low-skilled workers. Given the real wage decline of the low-skilled workers from 1980 to 2019 in the US, it makes one wonder how the recent change of the supply and demand of skill interacts with marketization?

The analysis in this paper proceeds in three steps. First, using Census and the American Community Surveys, I document that the personal service sector has the highest share of hours of low-skilled workers compared to other sectors. Using time diaries, I document that both high and low-skilled households spend less time on home production from 1980 to 2019. Using expenditure diaries, I find that both the high and low-skilled households experience an increase in the expenditure share for home production substitutes. Second, I build a quantitative heterogeneous agent model with high-skilled and low-skilled households to study how different productivity changes affect marketization trends through relative prices. Third, I use the calibrated model to match the aggregate change in skill premium, home production time, and expenditure share on personal services from 1980 to 2019. The quantitative exercise sug-

[1] See Benhabib et al. (1991), Greenwood & Hercowitz (1991), McGrattan et al. (1997) as starting points for business cycles; Becker (1965), Greenwood et al. (2005), Greenwood et al. (2021) for long-term growth

[2] One exception is Ngai & Petrongolo (2017) which studies marketization by genders.

gests that a relative increase of productivity in the market sector over the home sector is *not* necessary to match the aggregate trends in a heterogeneous skill economy. Instead, the opposite trajectories of market opportunities for the high-skilled and low-skilled virtually account for all the aggregate trends. This project links the change of skill premium to the level of marketization, which is particularly relevant to re-think the service sector size difference between the US and Europe as Europe did not experience as large a change in the skill premium as the US on the past four decades.

Empirical facts that low-skilled households display similar qualitative patterns on marketization as high-skilled go against the standard intuition suggested by a representative household economy. In a representative household economy, marketization is explained through a decline in the cost of market service relative to the opportunity cost of home production. However, given the wage stagnation of the low-skilled from 1980 to 2019, the intuition drawn from a representative household economy suggests that the low-skilled would show less than the high-skilled or no marketization pattern, which is not the case empirically. A heterogeneous skill economy is a promising setup to speak to this tension as it allows me to introduce changes to the wage structure. The framework is also helpful in evaluating the general-equilibrium implication of low-skilled wages if the productivity of personal service grows faster than the productivity of the home sector.

The modeling exercise suggests that the underlying forces that shape wage structure by skills also affect the relative prices among market goods, market services, and home production. On the one hand, a decrease in market opportunities for low-skilled workers reduces the price of personal services. As a result, the service bundle gets cheaper relative to goods, prompting both types to spend less time on home production to work more. On the other hand, an increase in market opportunities for high-skilled workers due to higher marginal productivity makes market services relatively more expensive. Hence, both types can spend more of their income on market service. Therefore, it is crucial to leverage on the change of skill premium to quantify how the underlying technological change can also speak to marketization in a heterogeneous

skill economy.

In Section 2, I use the Census, the American Time Use Survey and the Consumer Expenditure Survey to establish three stylized facts on marketization. First, I find that more than 80% of the personal service sector's labor input is from low-skilled labor. This fraction is the largest compared to the manufacturing and the other service sector. Second, for the aggregate, from 1980 – 2019, the hour's ratio between home and market work has declined, while the expenditure share on home production substitutes has gone up. Third, I look at the same measures but split people by skill. I find that the aggregate trend holds for both skill groups, and I see a slightly larger change of hours for the high-skilled compared to the low-skilled.

Motivated by these findings, Section 3 builds a model to study marketization with households of two skill groups. I then discuss how relative price movements could give rise to different trends in home production time and the expenditure share, and one *does not* imply the other. In particular, a higher wage is associated with a larger share of market personal service expenditure while holding the price of goods and market services constant. A lower price of market-produced services corresponds to less time on home production, holding wages and the price of goods constant. These results suggest that changes in wages and prices have distinct implications on marketization outcomes. To generate a realistic prediction, one needs to match both changes in prices and wages.

Section 4 consists of two parts. I first show the results of a few numerical comparative statics to illustrate how technical change affects marketization through relative price movements. This step yields two results: first, I confirm that a relative productivity increase of market services relative to home will give rise to marketization in this heterogeneous skill economy. Second, I discover that a joint change in the skill will also give rise to marketization in this economy. I also exploit the model prediction through a change in the supply of skill in the economy and find that the result conflicts with the data, suggesting that one cannot abstract away from the change in supply to explain marketization trends, and a representative economy fails to capture that. I then use this model to account for aggregate changes from 1980 – 2019 to assess which force

matters more quantitatively. Conditional on matching the aggregate, my finding is in stark contrast with the results from a representative household economy: most of the marketization is captured through the significant change of wage structure, whereas the relative productivity change between home and market is quantitatively negative.

Related Literature

This paper contributes to three strands of literature. First, I relate to the body of work that studies the cause of marketization. I extend previous models by adding a role for skills; hence, both wage and productivity affect the price of market services. My paper is particularly relevant to the theory presented in Rogerson (2008) and Ngai & Pissarides (2008). I make two main contributions. First, I confirm that an increase in market productivity relative to home would give rise to marketization by reducing the relative price in a heterogeneous economy. Second, I provide a new mechanism for marketization in a heterogeneous skill economy. It suggests that a change in wage structure can also explain marketization.

Second, my work relates to the literature studying the rise of skill premium to the size of the service sector (Buera & Kaboski (2012), Buera et al. (2022)). Early literature discussing the increase in skill premium includes Katz & Murphy (1992), Bound & Johnson (1992), Manning (2004). I link marketization to the change of skill premium, and I argue that both the increase in market opportunities for the skilled and the decrease in market opportunities for the unskilled are essential to explain marketization (Mazzolari & Ragusa (2013), Cerina et al. (2021)).

Third, I also speak to an extensive literature on time use in macroeconomics. I extend the empirical analysis to 2019 using the existing method. The utilization of time surveys has become more prevalent in the literature thanks to the earlier work in Aguiar & Hurst (2007*b*), Ramey & Francis (2009). Fang & Zhu (2017) jointly estimate home productivity and the elasticity between market goods and home hours using a similar model.

The rest of the paper is structured as follows. Section 2 uses time use and expenditure survey to highlight that the time spent on home production has been declining, and the ex-

penditure share on market service has been growing for both the high-skilled and low-skilled workers from 1980 to 2019. Section 3 develops a parsimonious model that incorporates two skilled groups and allows households to outsource their home production to the market. Section 4 presents the calibrated result and discusses the main exercise. Section 5 concludes.

2 Empirical Facts

In this section, I document three sets of facts. I start by reviewing the wage evolution between the high-skilled and the low-skilled from 1980 to 2019, and reporting the sectoral labor supply composition by skills. I find that more than 80% of the personal service sector's labor input is from the low-skilled workers, a fraction higher than the manufacturing and other services sectors. This suggests that the real wage decline of the low-skilled workers should transmit to the marginal cost of the personal service, hence results in a lower price. I then reporting the aggregate decline in home production and increase in expenditure share on personal services. I conclude this section by showing that both trends have been observed for households with different educational attainments. The magnitudes of both level change and percentage change are comparable across skills. This suggests that the adaption of market substitutes for home production is not just limited to households that experience a growing opportunity costs of time.

2.1 Data Descriptions

In this section, I briefly describe the three datasets I use in this paper. Time-use facts are based on the four major time-use surveys. Expenditure facts are from the diary portion of the Consumer Expenditure Surveys. Facts related to the skill premium and sectoral labor composition are drawn from Census and the American Community Survey.

2.1.1 American Time Use Survey

To document facts on the evolution of time allocation, I use the four major time-use surveys extensively studied in Aguiar et al. (2012) and other literature. They are the 1975 - 1976 Time Use in Economics and Social Accounts, the Americans' Use of Time in 1985, the National Human Activity Pattern Survey from 1992 - 1994, and the American Time Use Survey (ATUS) from 2003 onwards. The ATUS has been sponsored by the Bureau of Labor Statistics and conducted by the U.S. Census Bureau starting from Jan 2003. Each respondent is asked to recall their activities starting at 4 a.m. the previous day and ending at 4 a.m. on the interview day. I infer the respondents' education attainments' from their CPS response. I refer readers to Aguiar & Hurst (2007*b*) for a comprehensive overview of the older datasets.

One challenge specific to this paper is to have a consistent estimate of childcare and adult care hours from the data from 1975 to 2019. First, the surveys before 2003 do not contain information on whether care time is spent with someone within the family or someone outside. Second, the later surveys use slightly different rules for categorizing activities relative to the earlier surveys. For example, the activity "feed kids" involves meal preparation and childcare. The 1975 survey would code 1/2 of the time to "meal preparation" and 1/2 to "baby care" if the child is four years old or less. The activity would be coded entirely to "meal preparation" if the child is older than four years old. However, this will be coded entirely to "Caring for and Helping Household Children/Physical care" under childcare using rules listed in ATUS coding rules after 2003.

To address this issue, I first calculate the ratio of care time spent with household members and the total care time $\left(\frac{\text{household childcare + household adult care}}{\text{total childcare and adult care}}\right)$ for each demographic cell post-2003. I then use a linear trend to approximate this ratio for surveys prior to 2003 for each cell and take the average. Since I can observe the total care time in the early surveys, the extrapolated ratios allow me to estimate care time spent with household members for the earlier surveys. I choose ratios to extrapolate in order to avoid potential multiplicative measurement errors.

2.1.2 Consumption Expenditure Survey

To document facts on the spending patterns on personal services, I use the weekly diary portion of the Consumer Expenditure Surveys (CEX) from 1990 to 2019 since it covers small and frequent purchases of personal services that are highly substitutable to home production. Due to data availability, I focus my analysis on the period from 1990 to 2019. Unlike the interview portion, the diary portion relies less on the respondent's recall since the data collection period is much shorter. At the beginning of the 2-week collection period, the reference person would report the demographic features of their household and receive the daily expenditure record for the unit to record their expenditures for the week. At the end of each week, the interviewer collects the diary and reviews the entries. On average, less than 5% of the surveyed households report only one week of expenditure. I limit the sample to households with reference persons aged 25 through 55 and neither students nor retirees. I use the reference person's education level to denote the consumer unit's education attainment. The harmonization process is identical to the process described in section 2.1.1.

One caveat to address before combining results from time-use and expenditure surveys is the difference in survey units. Responses from the time-use surveys are on individual levels, whereas responses from the expenditure surveys are on household levels. Under the assumption that family sizes scale up all expenditures through the same linear relationship, I use the household-level expenditure share to approximate the individual expenditure share.

2.1.3 Census and the American Community Survey (ACS)

To document the evolution of wage structure and sectoral labor composition, I use the 5% decennial Census for 1980, 1990, and 2000 and the American Community Survey (ACS) for 2007 and 2019, both provided by Ruggles et al. (2022). I limit the sample to individuals aged 25 to 55 in the labor force who worked in nonfarm sectors last year for more than 30 hours per week. I identify the high-skilled workers as those with at least four years of college, while low-skilled workers are those with less than four years of college. I remove self-employed workers

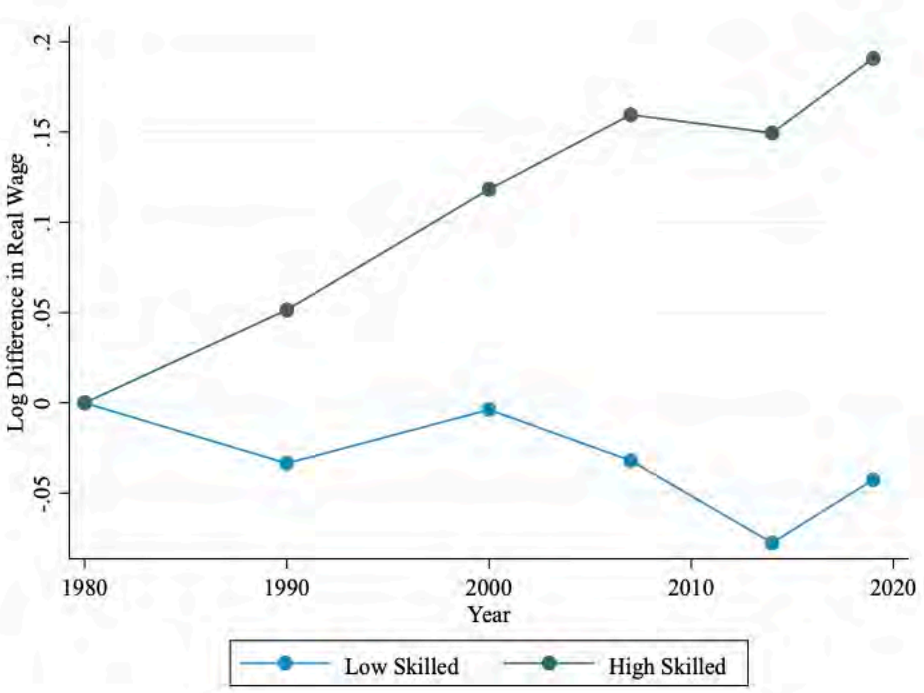
and unpaid family workers from my earning sample. Top-coded incomes are imputed to 150% of the top code. Wages are computed by dividing incomes by the product of weekly hours of work times weeks of work[3]. For those missing hours or weeks, wages are imputed using occupations and education information. I focus on real wages in my analysis which is deflated by the personal consumption expenditure price index published by the Bureau of Economics Analysis. I use the original population weights *perwt* to construct the labor supply weight *lswt*. It is calculated as the product of *perwt*, hours of work, and weeks of work, each normalized by 35 hours per week and 50 weeks of work. I use the information on occupations and education levels to impute labor supply weights for those who miss working hours or weeks.

2.2 Skill Premium and Sectoral Skill Composition

In this section, I review the evolution of the skill premium from 1980 - 2019 and then document the skill composition of the personal service sector. Figure 1 plots mean log real wage changes by skills from 1980 to 2019. Consistent with works like Autor (2019), this graph suggests that the real wage for low-skilled workers remains stagnant for the recent three decades. The widening of the skill premium is entirely driven by the increase in real wages of the high-skilled workers.

The low-skilled workers are the majority in the personal service sector. I focus on three sectors: personal service, manufacturing, and other services. To identify industries in the personal service sector which range from urban transportation to residential care facilities, I rely on the industry code *ind1990* in both CENSUS and ACS. Table A2 lists all industries under the personal service sector in details. To demonstrate that it is mainly the low-skilled labor that provides personal services, I compute the share of hours of the low-skilled workers within a given sector across years. Figure 2 shows the result. It suggests that personal service sector has the largest share of hours from the low-skilled compared to manufacturing and other services.

[3]The Census from 1980 to 2000, ACS 2007 and 2019 asked the exact number of weeks that respondents worked for, but responses on weeks worked are only available in intervals for the 2015 ACS. Therefore, I took the mean of each interval as an approximation.



Note: Figure plots the time series of the mean log wage from 1980 to 2019, using data on individuals aged 25 to 55 in the labor force working in nonfarm sectors for more than 30 hours per week. The data are sorted into demographic-education-experience groups of two sexes, whether white or no, whether foreign-born or not, two education categories (≥ 16 years of education, and below), and four potential experience categories (0–9, 10–19, 20–29, and 30–39 years). Log weekly wages of full-time, full-year workers are regressed in each year separately on dummy variables for sex, two education categories, a quartic in experience, white or other race, and foreign-born dummies. The mean log wage in a given year is the predicted log wage from these regressions evaluated for native-born white males at the yearly-mean experience level.

Figure 1: Wage Evolution from 1980 to 2019

This finding is consistent across all years and Figure 4 shows the results for each year.

2.3 Aggregate Marketization Facts

In this section, I present evidence that households increasingly substitute home production for their market substitutes over the last few decades. The evidence presented here is twofold. First, I show that the time spent on nonmarket work has declined at a faster speed compared to market work from 1975 to 2019. Second, I show that the expenditure share of personal services has increased steadily from 1990 to 2019. These two pieces of evidence have been discussed in previous work, but I include them here for completeness.

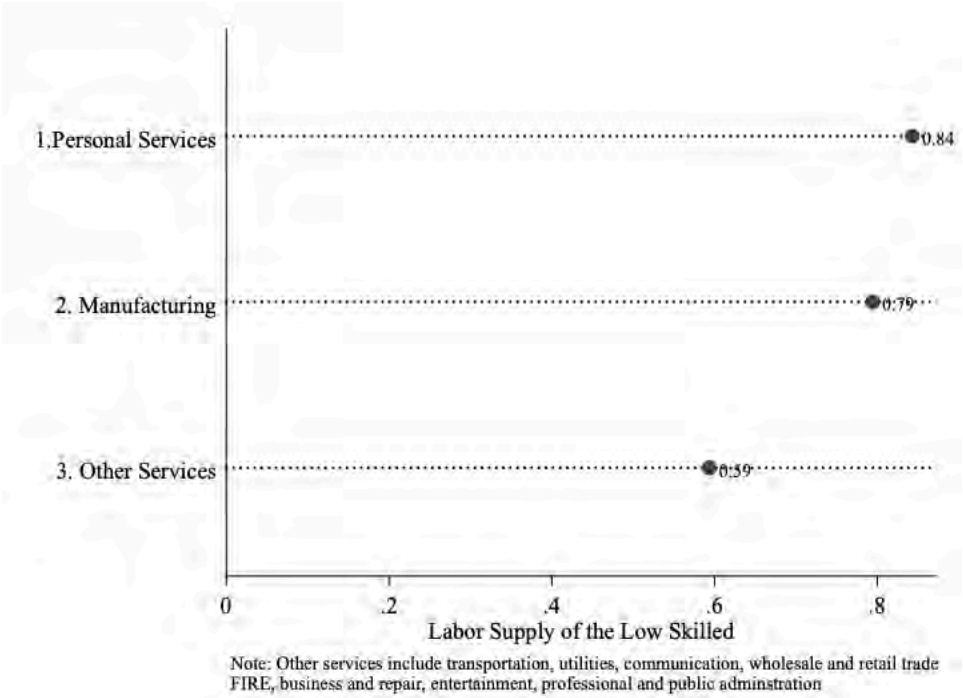


Figure 2: Skill Compositions by Sectors

2.3.1 Change in Time Use Trend

I start by defining activities relevant to these three categories in Table 1. I consider two main measures related to home production. The first is the "Narrow nonmarket work" which includes meal preparation, housework, home maintenance, outdoor cleaning, vehicle repair, gardening, pet care[4], and obtaining good and services. This measure corresponds to the "Total nonmarket work" in Table 1 of Aguiar & Hurst (2007*b*). The second measure include the first measure, plus time spent on personal care, childcare and adult care. For the data before 2003, I extrapolate the time spent on childcare and adult care using the procedure described in section 2.1.1. To show the comparison between my result and the ones in Aguiar & Hurst (2007*b*), table A3 report raw estimates.

The nonmarket work time has declined faster than market work time. In Figure 3, I show the log point difference for narrow nonmarket work and market work from 1975 to 2019. The time spent on "narrow nonmarket work" sees a decline of 20 log points, much larger than the decline

[4]In Table A3 and 5, I refer these as "benchmark activities"

Activity Summary	Activities
Narrow Homework	
Meal Preparation	Preparation, presentation and clean-up
Housework	Interior cleaning, laundry, sewing and storing
Home Maintenance	Interior and exterior maintenance; vehicle care and maintenance and travel related
Garden and pet	Lawn, garden, pet care and travel related
Obtaining things	Grocery shopping, hiring service workers
Broad Homework = Narrow Homework + Below	
Personal Care	Grooming, putting on nail polish, etc
Basic Childcare	Physical care; organization and planning; Attending children's event; activities related to children's health and travel related.
Childcare with Education purpose	Reading and talking with children; attending activities related to children's education and travel related.
Play with Child	Playing, arts and crafts
Adult Care	Caring and helping adults.
Market Work	
Work travel	Travel related to work
Work core	Work at main job and other income-generating activities
Work related	Attending events with coworkers and clients
Leisure	
Socializing, Relaxing, and Telephone Calls	Hanging out with family and friends; TV time; Attending shows
Exercise, sports	Participating and attending sport events
Mail	Responding to household mail and email

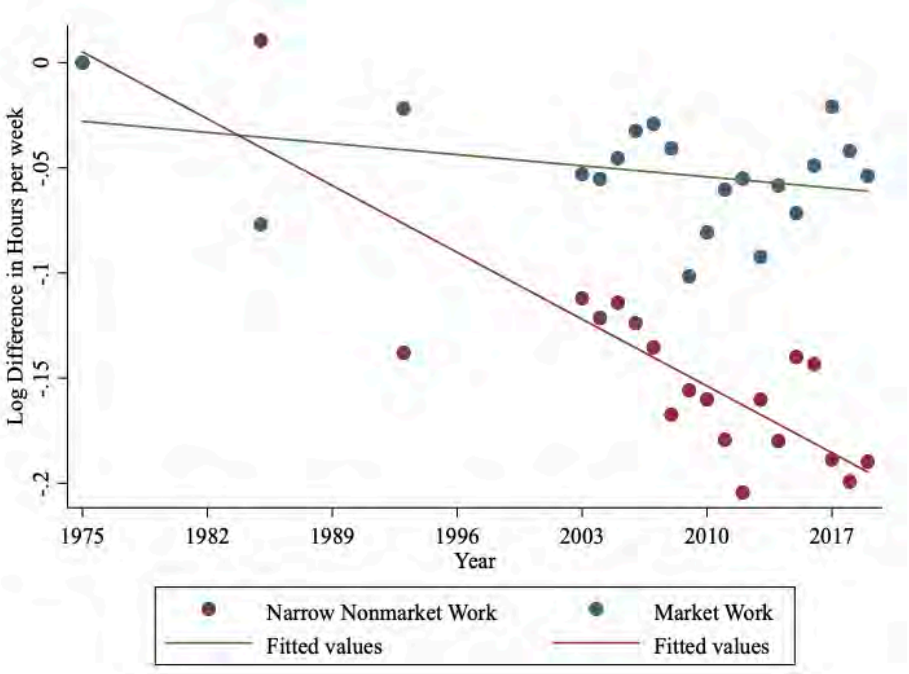
Note: The definition of Market work is identical to the "Total market work" definition in Aguiar & Hurst (2007*b*) which includes travel related to work and attending events with coworker and clients. My leisure measure only include a subset of the "leisure measure 1" in Aguiar & Hurst (2007*b*): Beside socializing and exercise, they also include time spent on gardening, animal, and pet care.

Table 1: Time-Spent Activities Description

of market work of 5 log points. In Table 2, I report the time ratio between nonmarket work and market work. This ratio is of particular interest since marketization primarily influences the time allocation between these two discretionary time uses. The ratio between the narrow measure of homework and market work has declined by 5 percentage points, and the ratio between the broad measure and market work has declined by 3 percentage points.

2.3.2 Change in Expenditure Share Trend

In this subsection, I examine the change in the expenditure share on personal services from 1990 to 2019. I identify personal service expenditures by constructing a crosswalk between



Note: Figure reports the average time spent on different categories. Narrow nonmarket work includes home production and obtaining good and services.The numbers reported are weighted average by relevant (composition-adjusted) cell means. I limit my sample to respondents aged 25 through 55 who are neither students nor retiree and whose response time add up to 1440 minutes. The data are sorted into 16 demographic cells of two sexes, four age bins (25-30, 31-40, 41-50, 51-55) and kid status (yes or no). The time-consistent weights are constructed in a same procedure as Katz & Murphy (1992) and Aguiar & Hurst (2007*b*). For each survey, weights are adjusted to address the issue of uneven days of sampling.

Figure 3: Time Spent on Nonmarket and Market Work: 1975 - 2019

home production activities and expenditure categories. Table 3 summarizes this crosswalk. I then consider two main categories: benchmark expenditure, and total personal care. Benchmark expenditure corresponds to the narrow measure of home work, and expenditure on total personal care corresponds to the broad measure including childcare and adult care. I then use a linear trend to approximate the yearly weighted-average expenditure share, and report this linear estimation below.

From 1990 to 2019, there has been a 2.4 percentage points increase in the expenditure share on personal service. In Table 4, I report the aggregate expenditure share on personal service in 1990, 2019 and its change. On average, households spend 12.3% of their weekly budget on acquiring the benchmark personal services in 1990, 14% for the total personal service including care. This number goes up by 2.9 percentage points from 1990 to 2019, and 2.4 percentage points once including care. Interestingly, there isn't much change on weekly expenditure share on childcare and adult care unlike the results from the time use survey. This is because costs

	1975-85	2017-19	Change
$\frac{\text{Narrow Nonmarket Work}}{\text{Total Work (excl. care)}}$	0.37	0.32	-0.05
$\frac{\text{Leisure}}{\text{Total Work (excl. care)}}$	0.59	0.58	-0.01
$\frac{\text{Broad Nonmarket Work}}{\text{Total Work (incl. care)}}$	0.48	0.44	-0.03
$\frac{\text{Leisure}}{\text{Total Work (incl. care)}}$	0.49	0.48	-0.01

Note: Table reports ratios of time spent on different categories. Data are pooled for the 1975-1985 and 2017–2019 periods

Table 2: Time Allocation Among Nonmarket Work, Market Work and Leisure: Ratios

like daycare occur monthly or every three months, less than the weekly/bi-weekly frequency. Hence they are not recorded in the diary portion of the survey.

2.4 Marketization Facts by Skills

In this section, I investigate the degree of marketization by skills. The decline of home production time is observed for both the high skilled and the low skilled. The increase of the expenditure share on personal services is observed for both as well. Both pieces of evidence suggest that acquiring home production substitutes from the market is common for households facing different opportunity costs of time.

2.4.1 Change in Time Use Trend

From 1975 to 2019, time spent on home production decline for both skill groups. Table 5 reports the change of time spent on home production by skills. The high-skilled has seen a larger decline in the narrow measure of homework in terms of level and percentage, but they also experience a larger increase in time spent on childcare and adult care. Nevertheless, both skill groups have seen a similar percentage decline independent of the categories. Under the narrow measure, the high-skilled has seen a 18% of decline and the low-skilled has seen a 16% decline. Under the broad measure, the high-skilled has seen a 6% decline and the low-skilled has seen a 10% decline. In terms of market work, the high-skilled sees almost no change in

Expenditure Categories	Time Use Activities
Food and Drinks Away from Home	Meal Preparations
Pet Services	Pet care
Shoe repair and alteration of apparel	Housework
Housekeeping services	
Apparel Laundry	
Maintenance of Property	Garden care and home maintenance
Reupholstering, furniture repair services	
Care in convalescent or nursing home	Adult Care
Babysitting and child care	Childcare

Table 3: Home Production Activities and their Corresponding Personal Service Expenditure Categories

Weekly Expenditure Share	1990	2003	2019	Difference 2019 - 1990
Benchmark Expenditure	0.122	0.136	0.153	0.030
Total Personal Service	0.138	0.151	0.167	0.028

Table 4: Expenditure Share on Home Production Substitute: 1990 - 2019

market work but the low-skilled experience a slight decline. I also report leisure measured in definition and population from Aguiar & Hurst (2007*b*) and find that the low-skilled experience less change in leisure time compared to the high-skilled.

I report the trend for the ratio of nonmarket time to market time by skill in table 6. Similar to the aggregate trend, nonmarket work declines at a faster rate than market work. The decrease for the high-skilled individuals is almost twice as large as for the low-skilled, partially because they didn't experience much decline in market work time. Under the narrow homework measure, the high-skilled have seen a 16% decline, whereas the low-skilled have seen a 7% decline. Under the broad homework measure, the high-skilled have seen a 8% decline and the low-skilled have seen a 4% decline.

I detail steps on how I transform these moments to targets for the quantitative exercise in the later section. Although there are some sizable fluctuations in leisure time from 1975 to 2019, I abstract from them to isolate the economics intuition of marketization. I focus on the time allocation within the total work time that consists of market and nonmarket work. To adjust the targets, I calculate the average aggregate leisure fraction $\left(\frac{\text{leisure}}{\text{leisure + work + homework}}\right)$ from 1975 to 2019 and use it as the leisure target for all households in my model. I then use the ratio $\left(\frac{\text{time spent on homework}}{\text{time spent on market work}}\right)$ presented in Table 2 and 6 to generate ratios for the aggregates and the two different skill groups. The results for the different homework measures are reported in Table 7 and 8 respectively. This exercise essentially tries to normalize the targets in order to focus on the tradeoff between market time and nonmarket time for households with heterogeneous education attainment while having a reasonable leisure target.

2.4.2 Change in Expenditure Trend by Skill

From 1990 to 2019, the increase in expenditure share of personal service is common for households with different education attainments. I calculated the numbers reported in Table 9 the same as the aggregate, using linear approximation for each skill group to avoid potential yearly anomaly. The unskilled has seen a 2.8 percentage point increase on benchmark expenditure, slightly larger than the 2.6 percentage point increase of the skilled. The skilled spends a larger share of their weekly expenditure on childcare and adult care. For the total personal service, the skilled experiences a larger increase of 2.7 percentage point in expenditure share comparing to the 2.3 percentage point of the unskilled.

To summarize, in this section I have established that the decline in home production time and the increase in expenditure share on personal services goes hand in hand since 1980. Both trends are observed for households with different education attainments. Evidence presented in this section suggests that marketization is common across households of different level of skilled.

(Hours per week)	1975	2003	2019	Level Change 2019 - 1975	Percentage Change 2019 - 1975
Unskilled					
(1) Benchmark Activities	13.93	13.42	12.72	-1.22	-0.09
(2) Obtaining Things	4.66	4.89	4.15	-0.51	-0.11
(3) Personal Care	7.13	4.77	4.94	-2.19	-0.31
(4) Childcare + Adult care	3.00	5.31	5.65	2.65	0.88
Narrow Nonmarket Work ((1)+(2))	18.60	18.31	16.87	-1.73	-0.09
Broad Nonmarket Work ((1)+(2)+(3)+(4))	28.72	28.39	27.46	-1.26	-0.04
Market Work	35.46	32.80	34.10	-1.36	-0.04
Leisure	33.93	33.24	31.43	-2.50	-0.07
Leisure (Aguiar & Hurst)	34.55	36.35	35.44	0.89	0.03
Skilled					
(1) Benchmark Activities	13.26	11.75	11.65	-1.61	-0.12
(2) Obtaining Things	5.28	5.98	5.35	0.07	0.01
(3) Personal Care	7.35	4.98	5.09	-2.26	-0.31
(4) Childcare + Adult care	2.97	6.75	7.24	4.27	1.44
Narrow Nonmarket Work ((1)+(2))	18.53	17.73	17.00	-1.54	-0.08
Broad Nonmarket Work ((1)+(2)+(3)+(4))	28.85	29.46	29.32	0.47	0.02
Market Work	37.42	37.70	36.22	-1.20	-0.03
Leisure	29.20	28.52	28.15	-1.05	-0.04
Leisure (Aguiar & Hurst)	32.86	31.26	31.25	-1.61	-0.05

Note: Table reports time spent on different categories from 1975 to 2019. The numbers reported are weighted average by relevant (composition-adjusted) cell means. I use the individual education attainment and categorize the high-skilled as those whose education attainment exceeds 16 years, and the remaining individuals are low-skilled. I limit my sample to respondents aged 25 through 55 who are neither students nor retiree and whose response time add up to 1440 minutes. The data are sorted into 16 demographic cells of two sexes, four age bins (25-30, 31-40, 41-50, 51-55) and kid status (yes or no). The time-consistent weights are constructed in a same procedure as Katz & Murphy (1992) and Aguiar & Hurst (2007*b*). For each survey, weights are adjusted to address the issue of uneven days of sampling.

Table 5: Time Allocation Among Nonmarket Work, Market Work and Leisure by Skills: Levels

		1975-85	2017-19	Change
$\frac{\text{Narrow Nonmarket Work}}{\text{Total Work (excl. care)}}$	Unskilled	0.37	0.34	-0.03
	Skilled	0.36	0.30	-0.06
$\frac{\text{Leisure}}{\text{Total Work (excl. care)}}$	Unskilled	0.60	0.63	0.04
	Skilled	0.55	0.51	-0.04
$\frac{\text{Broad Nonmarket Work}}{\text{Total Work (incl. care)}}$	Unskilled	0.47	0.45	-0.02
	Skilled	0.47	0.43	-0.04
$\frac{\text{Leisure}}{\text{Total Work (incl. care)}}$	Unskilled	0.50	0.52	0.03
	Skilled	0.45	0.42	-0.04

Note: Table reports ratios of time spent on different categories. Data are pooled for the 1975-1985 and 2017–2019 periods

Table 6: Time Allocation Among Nonmarket Work, Market Work and Leisure by Skills: Ratios

		1980	2003	2019	Level Change 2019 - 1980	Percentage Change 2019 - 1980
$\frac{\text{Work}}{\text{Leisure + Total Work}}$	Aggregate	0.396	0.409	0.418	0.022	0.055
	Skilled	0.408	0.424	0.437	0.029	0.072
	Unskilled	0.394	0.400	0.405	0.011	0.029
$\frac{\text{Nonmarket}}{\text{Leisure + Total Work}}$	Aggregate	0.226	0.214	0.205	-0.022	-0.096
	Skilled	0.215	0.198	0.186	-0.029	-0.137
	Unskilled	0.229	0.223	0.218	-0.011	-0.049

Table 7: Adjusted Time Fraction using Narrow Homework Measure

		1980	2003	2019	Level Change 2019 - 1980	Percentage Change 2019 - 1980
$\frac{\text{Work}}{\text{Leisure + Total Work}}$	Aggregate	0.354	0.362	0.369	0.015	0.042
	Skilled	0.363	0.373	0.381	0.018	0.049
	Unskilled	0.352	0.356	0.359	0.007	0.020
$\frac{\text{Nonmarket}}{\text{Leisure + Total Work}}$	Aggregate	0.312	0.304	0.297	-0.015	-0.048
	Skilled	0.303	0.293	0.285	-0.018	-0.059
	Unskilled	0.314	0.310	0.307	-0.007	-0.023

Table 8: Adjusted Time Fraction using Broad Homework Measure

Weekly Expenditure Share	1990	2003	2019	Difference 2019 - 1990
Unskilled				
Benchmark Expenditure	0.114	0.127	0.143	0.028
Total Personal Service	0.129	0.140	0.153	0.023
Skilled				
Benchmark Expenditure	0.141	0.153	0.168	0.026
Total Personal Service	0.161	0.173	0.189	0.027

Table 9: Expenditure Share on Home Production Substitute by Skill Level: 1990 - 2019

3 The Model

The evidence presented in the previous section highlights two empirical facts: First, the past few decades have observed a decline in home production time and an increase in the expenditure share on personal services. Second, both trends are common for the skilled and unskilled. Any models with heterogeneous agents facing different wages should have a mechanism to account for the disaggregate in addition to matching the aggregate trends.

The model presented in this section is essentially a heterogeneous agent version of the representative agent economy studied in Rogerson (2008). There are two types of households - the high skilled (H) and the low skilled (L).

There are two types of commodities in the consumption bundle: a general good (g) and personal services (s). Households can acquire personal service through either home production or the market, and the general good is only available through the market.

The model is static, since no capital is involved in the production, and time subscripts are omitted.

3.1 Households

There is a unit mass of households of two types: low skilled (L) and high skilled (H). The fraction of the low skilled is f_L, and the fraction of the high skilled is f_H with $f_L + f_H = 1$. Each household i has utility over composite consumption c_i and leisure $(1 - h_i)$ given by:

$$U(c_i, h_i) = \log c_i + \varphi \log(1 - h_i) \tag{1}$$

where h_i is the sum of time spent in market work plus home work ($h_i = h_{iw} + h_{id}$), $i \in \{L, H\}$.

The composite consumption is a nested CES:

$$c_i = \left[\alpha s_i^{\frac{\epsilon-1}{\epsilon}} + (1-\alpha) g_i^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}} \tag{2}$$

where g_i is the consumption of a general consumption good and s_i is the consumption of personal services. The parameter ϵ represents the elasticity of substitution between the general goods and the composite of personal service. In the quantitative analysis, ϵ will be less than 1, implying that the two consumptions are complements. Personal services s_i is a CES aggregator over market purchased personal services (s_{im}) and home produced personal services (s_{id}).

$$s_i = \left[\psi s_{id}^{\frac{\sigma-1}{\sigma}} + (1-\psi) s_{im}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{3}$$

The parameter σ represents the elasticity of substitution between home and market produced personal services. σ will be greater than 1 in the quantitative exercise, implying that these two are substitutes.

Home production s_{id} is produced by

$$s_{id} = A_{S_d} h_{id} \tag{4}$$

where A_{S_d} is the productivity of home production. Prices for g and s_m are given by p_g and p_s.

Given market wages (w_H, w_L) and market price (p_g, p_s), each household chooses consumption $\{s_i, g_i\}$ and time allocation $\{h_{id}, h_{iw}\}$ to maximize the utility function (1) subject to (2) - (3) and the budget constraint (5):

$$p_g g_i + p_s s_{im} \leq y_i \tag{5}$$

where

$$y_i = \begin{cases} w_L h_{iw} & \text{Low skilled} \\ w_H h_{iw} & \text{High skilled} \end{cases} \tag{6}$$

3.2 Production

Production of the general good uses high skilled and low skilled labor. For simplicity, I assume that the personal services market production function uses only low skilled labor. The two production functions are:

$$S_m = A_{S_m} N_{SL} \tag{7}$$

$$G = \left[\eta (A_{GH} N_{GH})^{\frac{\xi-1}{\xi}} + (1-\eta)(A_{GL} N_{GL})^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}} \tag{8}$$

where N_{GL} is the total hours of low skilled labor in sector G, N_{SL} is the total hours of low skilled labor in sector S_m, and N_{GH} is total hours of high skilled labor in sector G.

Given that the production function exhibits constant return to scale, I will assume that a representative firm operates in each sector.

3.3 Competitive Equilibrium

A competitive equilibrium is defined by unit wages (w_L, w_H), prices (p_g, p_s), consumption $\{g_i, s_i\}_{i\in\{S,U\}}$, and time allocation $\{h_{iw}, h_{id}\}_{i\in\{S,U\}}$ such that:

(i) the representative firms maximize profits, subject to production functions (7), (8); and households maximize utility (1), subject to (5);

(ii) given the optimal choices of firms and households, unit wages and prices clear the market in each sector and the labor market for each occupation:
Market Produced Personal Service:

$$S = (1-f_H)s_m^L + f_H s_m^S$$

Good:

$$G = (1 - f_H)g^L + f_H g^S$$

Labor Market:

$$N_{GL} + N_{SL} = (1 - f_H)h_w^L$$

$$N_{GH} = f_H h_w^H$$

As it is always the case, one price can be normalized to be 1. In what follows, I normalize the price of the good p_g to be 1. However, I still include it in some expressions when useful to the exposition to remind the reader that prices are relative.

3.4 Time Allocation and Expenditure Share

The nested CES structure in household's preference gives rise to the price index $\tilde{p}_s$ of the personal service bundle:

$$\tilde{p}_s = \left[\psi^\sigma p_{ih}^{1-\sigma} + (1-\psi)^\sigma p_s^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{9}$$

where p_{ih} denotes the opportunity cost of time of doing home production:

$$p_{ih} = \frac{w_i}{A_{S_d}}$$

In the following discussion, I set $A_{S_d} = 1$ so I can use wage and opportunity cost of doing home production interchangeably. One can solve for the home production time h_{id} and the

expenditure share of the market personal service Ω_i:

$$h_{id} = \frac{1}{1+\varphi}\left[\frac{\alpha^{\epsilon}\left(\frac{\tilde{p}_s}{p_g}\right)^{1-\epsilon}}{\alpha^{\epsilon}\left(\frac{\tilde{p}_s}{p_g}\right)^{1-\epsilon}+(1-\alpha)^{\epsilon}}\right]\left[\frac{\psi^{\sigma}}{(1-\psi)^{\sigma}\left(\frac{p_s}{w_i}\right)^{1-\sigma}+\psi^{\sigma}}\right] \tag{10}$$

Equation 10 illustrates that the amount of time people spend on home production is determined through two relative price movements, $\frac{\tilde{p}_s}{p_g}$ and $\frac{p_s}{w_i}$, with two elasticities ϵ and σ determining the directions on how the relative prices affect h_{id}. The second bracket illustrates how home production time is determined through the relative price $\frac{p_s}{w_i}$ *within the service bundle*. The substitutability ($\sigma > 1$) suggests that a lower price of market services relative to wage will decrease home production time while holding $\frac{\tilde{p}_s}{p_g}$ fixed. The first bracket shows how home production time is affected through price ratio of the service bundle relative to good $\frac{\tilde{p}_s}{p_g}$ *across the service bundle and good*. The complementarity ($\epsilon < 1$) suggests that a decrease of the service bundle relative to good will also decrease home production time while holding the $\frac{p_s}{w_i}$ fixed. The intuition is that as the service bundle gets cheaper relative to goods, the consumer would reduce the overall service demanded. Although the value-added share of home production in service is constant, the quantity of home production still reduces.

$$\Omega_i = 1 - \frac{(1-\alpha)^{\epsilon}}{\alpha^{\epsilon}\left(\frac{\tilde{p}_s}{p_g}\right)^{1-\epsilon}\frac{(1-\psi)^{\sigma}\left(\frac{p_s}{w_i}\right)^{1-\sigma}}{(1-\psi)^{\sigma}\left(\frac{p_s}{w_i}\right)^{1-\sigma}+\psi^{\sigma}}+(1-\alpha)^{\epsilon}} \tag{11}$$

$$= \frac{\alpha^{\epsilon}\left(\frac{\tilde{p}_s}{p_g}\right)^{1-\epsilon}}{\alpha^{\epsilon}\left(\frac{\tilde{p}_s}{p_g}\right)^{1-\epsilon}+(1-\alpha)^{\epsilon}} - \frac{h_{id}}{h_{iw}}\frac{(1-\alpha)^{\epsilon}}{\alpha^{\epsilon}\left(\frac{\tilde{p}_s}{p_g}\right)^{1-\epsilon}+(1-\alpha)^{\epsilon}} \tag{12}$$

Similarly, equation 12 also suggests that the same two relative prices are critical to think about the dynamics of the expenditure share Ω_i. In particular, holding $\frac{\tilde{p}_s}{p_g}$ constant, a lower price of market services relative to wage will increase the expenditure share; holding $\frac{p_s}{w_i}$ constant, a decrease of the service bundle relative to good will lead to an decrease in expenditure share

on home production substitute. The intuition is similar to the case for h_{id}: a cheaper service bundle relative to good will increase the demand of good due to the complementarity, hence reduces the expenditure share of the market service.

Therefore, it will be mistaken to think that a decrease in h_{id} automatically implies an increase in Ω_i. In the simplified case where $\frac{\tilde{p}_s}{p_g}$ is held constant, only a decrease in $\frac{p_s}{w_i}$ leads to the desired opposite movement of h_{id} and Ω_i which is consistent with the marketization. However, price movements are more complicated in a general equilibrium setting. Note that $\tilde{p}_s$ is determined by p_s and w_i jointly. Therefore, not only the price ratio $\frac{p_s}{w_i}$ between market and home matters, the *level* (relative to p_G) also matters. In the following propositions, I characterize how changes in prices will affect these decision rules.

Proposition 1. *Holding the good price p_g and wage w_i to be constant, a lower price of market produced personal service corresponds to a lower home production time. Namely, $\frac{\partial h_{id}}{\partial p_s} > 0$*

Proof. Take the partial derivative of the two factors of h_{id} separately. See A.3 in appendix for details. □

Proposition 1 is intuitive by analyzing each part in equation 10. Holding w_i constant, a lower price of market produced personal service p_s reduces the price ratio $\frac{p_s}{w_i}$ and moves hours away from home to market because $\sigma > 1$. At the same time, it also lowers the price of the personal service bundle $\tilde{p}_s = w_i \left[\psi^\sigma + (1-\psi)^\sigma \left(\frac{p_s}{w_i}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$. Therefore, hours move away from personal services since $\epsilon < 1$.

In general, it is not possible to characterize the relationship between home production hours and wage ($\frac{\partial h_{id}}{\partial w_i}$) as clear as proposition 1. A higher wage would encourage a household to move hours away from home by reducing $\frac{p_s}{w_i}$ ($\sigma > 1$). However, the personal service price index $\tilde{p}_s = p_s \left[\psi^\sigma \left(\frac{w_i}{p_s}\right)^{1-\sigma} + (1-\psi)^\sigma\right]^{\frac{1}{1-\sigma}}$ increases and it encourages them to move hours to home ($\epsilon < 1$). This illustrates the point that even though one may know the change of relative price between home and market for personal services, it is not sufficient to understand the change of home production hours[5]. This mechanism confirms the insights provided in Ngai & Pissarides

[5]In a special case where wage w_i and market price p_s grow by the same proportion, the change of home hours

(2008), where in their setup the marketization force moves hours from home to market, and the structural change force moves hours to the sector whose output grew relatively more expensive.

Similarly, the expenditure share for the market produced personal services is determined by the cost of doing home production p_{ih} and the cost of market produced personal service p_s.

Proposition 2. *Holding p_g and p_s constant, a higher wage is associated with a larger share of market personal service expenditure. Namely, $\frac{\partial \Omega_i}{\partial w_i} > 0$*

Proof. Take partial derivative and use the chain rule. See A.3 in appendix for details. □

The result in proposition 2 highlights two layers of reallocations associated with higher wages, each governed by the elasticities ϵ and σ. First, a larger relative price $\tilde{p}_s$ would result in a larger relative demand in favor of the personal service. This is because $\epsilon < 1$ in household's preference: since personal service and good are complements to each other, relative demand of c_{iP} is higher for the households facing a higher relative price $\tilde{p}_s$.

The second layer occurs within the personal services bundle. The opportunity cost of time of doing home production p_{ih} is higher for the higher wage households. Since $\sigma > 1$: market home service and home production are substitutes. Households facing a higher home production cost would shift their demand in favor of market service within the personal service bundle.

Proposition 3. *Holding the good price and wage to be constant, there exists a $r^\star$ such that when $r = \frac{p_s}{p_{ih}} < r^\star$, $\frac{\partial \Omega_i}{\partial p_s} > 0$ and when $r > r^\star$, $\frac{\partial \Omega_i}{\partial p_s} < 0$. In particular, $r^\star \to 0$ when $\epsilon \to 1$ or $\psi \to 1$ or $\sigma >> 1$.*

Proof. Take partial derivative and use the chain rule. See A.3 in appendix for details. □

can be determined by whether wage w_i goes up or not. In my model, workers in the bottom occupation fall into this special case.

4 Quantitative Analysis

4.1 Calibrations

The model has eight parameters to be determined, including one demographic share, three elasticities and four relative weights. The demographic parameter is the mass of the low skilled f_L. The three elasticities ϵ, σ, ξ describe the substitutability among good, services and home production and substitutability between high skilled and low skilled labor. The four parameters on relative weights $\alpha_P, \psi, \varphi, \eta$ appear in preference function and production function. Table 10 lists all the parameter values and I will describe them below.

Three parameters are taken from the literature. I consider people with educational attainment above 16 years to be the high skilled following the definition in Katz & Murphy (1992). I consider the rest to be the low skilled, and pin down the mass of low skilled M_U using the 1980 Census 5% as the benchmark. I set ξ to be 1.4 following[6] Katz & Murphy (1992) . I set ϵ to be 0.3 following the range (0,0.3] given by Ngai & Pissarides (2008). I specify $\sigma = 4$ following Aguiar & Hurst (2007*a*) and Fang & Zhu (2017).

The remaining parameters are calibrated using moments drawn from the Census, ATUS and the CEX either directly or indirectly. The skill premium is the regression coefficient on education while regressing log wages on observables such as experience, gender, foreign born status and race. The expenditure share at the 1980 economy is obtained through an extrapolation procedure that I infer using the yearly growth rate implied by the 1990 - 2019 data on the broad expenditure share measure presented in Table 9. The time measures are obtained through Table 8. I present calibration results using the broad homework measure for the time and expenditure share targets below. The results using the narrow homework measure are available in appendix A.4.2.

I report the matching between the model and data in Table 11. Overall, the model is able to match the targets well. Moreover, the model does relatively a good job in matching the

[6]The sensitivity analysis on ξ is available in appendix A.4.3

	A. Aggregate		
M_U	Mass of Unskilled	0.773	1980 Census
	B. Elasticity		
ϵ	Generic and Domestic Service	0.3	Ngai & Pissarides (2008)
σ	Home and Market	4	Aguiar & Hurst (2007*a*)
ξ	Skilled and Unskilled	1.4	Katz & Murphy (1992)
	C. Relative weights		
α	Weight on personal service bundle	0.719	Internally calibrated
ψ	Weight on home produced personal service	0.638	Internally calibrated
φ	Weight on leisure	0.496	Internally calibrated
η	Weight on H-type labor	0.425	Internally calibrated

Table 10: Model Parameters

untargeted moments. In particular, it is able to match disaggregate moments on time, despite four out of five targets reflecting the aggregate values. Even though the model overshoots the expenditure share ratio by skill groups, it is able to reflect the qualitative feature (Ω^S/Ω^U) in the data.

4.2 Numerical Comparative Static Exercise

In this section, I conduct numerical comparative statics exercises where I change the sectoral productivity levels one at a time to study how they yield different implications on marketization through the change of relative prices. Since the economy is homothetic, a level change of productivity across all sectors would lead to the same allocation as a normalized productivity change with one productivity normalized to 1. Therefore, essentially there are three productivities of interests: the productivity of the low skill workers in the good sector A_{GL}, the productivity of the high skill workers in the good sector A_{GH}, and the productivity of low skill workers in the market produced service A_{S_m} with the home sector productivity normalized to

Moments	Model	Targets	Sources
$\log \frac{w_S}{w_U}$: Skill premium in 1980	0.362	0.362	1980 Census 5%
Ω: Aggregate expenditure share	0.129	0.129	CEX extrapolated
M_U: Mass of the unskilled	0.773	0.773	1980 Census 5%
$\mathcal{H}_l$: Aggregate leisure fraction	0.332	0.332	ATUS extrapolated
$\mathcal{H}_m$: Aggregate market work fraction	0.354	0.354	ATUS extrapolated
Untargeted Moments			
Ω^S/Ω^U: Expenditure share ratio by skill	2.586	1.250	CEX extrapolated
h_m^S/h_h^S: Total work allocation of the skilled	1.254	1.191	ATUS extrapolated
h_m^U/h_h^U: Total work allocation of the unskilled	1.094	1.118	ATUS extrapolated
h_m^S/h_m^U: Market work ratio by skill	1.065	1.030	ATUS extrapolated

Table 11: Moments Matching

1 ($A_{S_d} = 1$). In this section, I perturb each parameter by 10% of their calibrated benchmark values while keeping the rest at their benchmark values reported in Table 10. In addition, I also show the results when I change fraction of the high skilled population f_H to its 2019 level since one cannot abstract away from the change of relative skill supply. Table 12 summarizes the parameter values that I am changing.

Three findings are established in this exercise. First, I confirm that in this heterogeneous skill economy, an increase in the productivity of market services relative to home services ($A_{S_m} \uparrow$) can generate the marketization trend. Second, I argue that a *simultaneous* change in productivity can also generate the aggregate marketization trend. Neither a decrease in market opportunities for the low skilled $A_{GL} \downarrow$ nor an increase in market opportunities for the high skilled $A_{GH} \uparrow$ alone gives the full marketization trend. However, combining both forces can account for the full set of changes. Third, I show that a pure increase in the relative supply of skills has distinct impacts on the marketization outcomes. The fact that these results are opposite to the data suggests one cannot abstract away from the change in skill supply in order to explain marketization trends.

	Benchmark	10% perturbation
	A. Change A_{Pm}	
A_{Pm}	1	1.1000
	B. Change A_{GU}	
A_{GU}	1	0.9000
	C. Change f_S	
f_S	0.2271	0.4128
	D. Change A_{GS}	
A_{GS}	1	1.1000

Table 12: Individual Parameter to Change

In the following discussion, I provide intuition on how different productivity changes affect the time allocation and expenditure share decision by skill through changes in relative prices. Table 13 reports the log change of prices, wages, and level change of the time allocation $\frac{h_d}{h_w}$ and expenditure share Ω. Recall that $\tilde{p}$ denotes the personal service bundle price by skills and the price of the good is the numeraire. Therefore, all prices reported in this table are relative to the price of good in the economy.

Panel A reports the result where I increase the market produced personal service productivity A_{S_m}. This is the driving force of marketization in a representative agent economy, and Panel A in Table 13 suggests that it remains true in a heterogeneous skill economy. As the market gets more productive at producing personal services, it has two direct effects in this heterogeneous skill economy: first, the relative price of market produced personal services p_s goes down by 8.5%; second, the unit wage of the low skilled w_L goes up by 1.5%. Together, they make up to the 10% increase in A_{S_m}. In a representative household economy, the entire increase in A_{S_m} is fully translated to decrease in p_s.

The high skilled and the low skilled face different price changes on service bundle $\tilde{p}_s$. $\tilde{p}_s$ depends on both p_s and $\left(\frac{w_i}{p_s}\right)$. For the low skilled, the increase in $\frac{w_i}{p_s}$ is 10%, dominating the decrease of p_s of 8.5%. Therefore $\Delta\tilde{p}^L > 0$. For the high skilled, the increase in $\left(\frac{w_i}{p_s}\right)$ is around

Δw_L	Δw_H	Δp_s	$\Delta \tilde{p}_L$	$\Delta \tilde{p}_H$	$\Delta \frac{h_d^H}{h_w^H}$	$\Delta \frac{h_d^L}{h_w^L}$	$\Delta \Omega^H$	$\Delta \Omega^L$
A. Increase A_{S_m} by 10%								
0.015	-0.026	-0.085	0.004	-0.041	-0.076	-0.052	0.020	0.026
B. Decrease A_{GL} by 10%								
-0.073	-0.048	-0.073	-0.073	-0.054	-0.047	-0.041	0.003	-0.004
C. Increase A_{GH} by 10%								
0.031	0.046	0.031	0.031	0.042	0.003	0.018	0.012	0.002
D. Decrease A_{GL} and increase A_{GH} both by 10%								
-0.044	-0.004	-0.044	-0.044	-0.014	-0.046	-0.025	0.015	-0.003
E. Increase f_H to 2019 level								
0.207	-0.329	0.207	0.207	-0.259	0.219	0.127	-0.182	0.013
Data								
					-0.077	-0.033	0.037	0.031

Table 13: Numerical Comparative Statics

5%, less than the decrease of p_s of 8.5%. Therefore $\Delta \tilde{p}^H < 0$. In a representative economy, $\tilde{p}$ monotonically decreases with respect to A_{S_m}, holding everything else fixed.

Hours are pinned down by two different forces due to the nested preference, namely the home-market force and the service-good force. The home-market force is pinned down by $\frac{w}{p_s}$. An increase in price ratio between wage and market personal service move hours away from home since home and market personal service are close substitutes. The service-good force is pinned down by $\tilde{p}$. A smaller price ratio between the personal service bundle and good moves hour away from home since they are relatively complement. For the high skilled, both forces shift hour away from home. For the low skilled, the first force shifts hour away from home but the second force counteracts against it. Therefore, $\frac{h_d}{h_w}$ declines more for the high skilled than the low skilled.

The expenditures share are also determined by the exact two forces that pin down the home production hours. An increase in the price ratio between wage and market personal service

moves up the expenditure share on market personal service, and an increase in the price ratio between the personal service bundle and good increases expenditure share on market personal service as well. For the low skilled, both forces increase the expenditure share. For the high skilled, the first force increases the expenditure share yet the second force counteracts it. Therefore, Ω increases more for the low skilled than the high skilled, despite of a larger decrease of home-market work ratio for the high skilled.

Panel B shows the result where the low skill experiences worse market opportunities due to a decrease of A_{GL} of 10%. The result shows that a decrease in market opportunity for the low skilled generates the right shape of time allocation. The direct effect of a decrease in A_{GL} is a drop of the wage of the low skilled w_L of 7.6%. This makes the market produced personal service cheaper by lowering down its price through equilibrium condition where marginal revenue equals to marginal cost $p_s A_{S_m} = w_L$. Therefore, the low skilled only faces the relative price decrease of the personal service bundle $\tilde{p}^L$ and no change in the home-market allocation within personal service. This results in a decrease in both home-market time ratio $\frac{h_d}{h_w}$ and expenditure share Ω.

For the high skilled in Panel B, their wage w_H declines by 5% as well since their marginal productivity decreases. But it doesn't decline as much as p_s so the price ratio between home and market service actually slightly goes up by 2%. Therefore, the home-market force moves hour away from home, and increases expenditure share. Given that the market price goes down by 7.6%, the price of service bundle for the high skilled $\tilde{p}^H$ decreases by 5.7% which suggests that the service bundle is getting relatively cheaper comparing to good. The good-service force also moves hour away from home, while reducing expenditure share. This results in a decrease in home-market time ratio, and a net increase of expenditure share.

Panel C shows the result following an increase of market opportunities of the high skilled modeled by an increase of A_{GH} of 10%. The result in Panel C suggests that an increase of A_{GH} can generate the right shape of expenditure share. The direct effect of an increase in A_{GH} is an increase of the wage of the high skilled w_H of 4.3%. At the same time, it also increases

the marginal productivity of the low skilled, hence w_L increases by 3%. This results in a more expensive market service $p_s \uparrow$. The price index for the services bundle for the low skill $\tilde{p}^L$ goes up by the same magnitude as p_s, yet the index for the high skill $\tilde{p}^H$ goes up more since their wage increases more than the market service.

For the low skilled in Panel C, they only face the relative price increase of the personal services bundle $\tilde{p}^L$. Therefore both the home-market time ratio $\frac{h_d}{h_w}$ and expenditure share Ω go up. For the high skilled in panel C, home production gets relatively more expensive than market services. The home-market force moves hours away from home, and increases the expenditure share for services. However, since $\tilde{p}^H$ increases, the good-service force moves hour to home, and increases the expenditure share. Therefore, it results in smaller net increase in home production and a larger increase in expenditure share, comparing to the low skilled.

In Panel D, I report the results associated with a simultaneous change of a decrease in A_{GL} and an increase in A_{GH} of 10%. Results in Panel D are essentially a summation of Panel B and Panel C. The results are able to generate the aggregate marketization trend, with a correct pattern on the time allocation by skills and the change of expenditure share of the high skilled. It suggests that both a decrease in A_{GH} and an increase in A_{GH} are critical to generate the correct marketization trend.

Panel E reports results following from an increase in f_H. This is to reflect the increase in relative supply of skill from 1980 to 2019. The prediction for the high skilled is far off from the data, suggesting that the change of the relative supply has nontrivial effect on the understanding of marketization, and hence cannot be neglected. A relative increase of f_H brings down the wage of the high skilled by 33%, and makes the good to be relatively more abundant in the economy. Therefore, personal services become relatively scarce and p_s increases by 21%. The decline of $\frac{w_H}{p_s}$ of 53% dominates the change of p_s of 21%, hence the service bundle price $\tilde{p}^H$ for the high skilled decline. The home-market force moves hours to home, and reduces the expenditure share on services. The good-service force moves hour away from home, and also reduces the expenditure share. Hence there is a significant decrease of expenditure of -18%,

Moments	Targets	Full Model
$\Delta\pi$: Change of skill premium	0.212	0.211
$\Delta\frac{\mathcal{H}_h}{\mathcal{H}_w}$: Change of aggregate home-market hour ratio	-0.070	-0.070
$\Delta\Omega$: Change of aggregate expenditure share	0.038	0.038

Table 14: Accounting for Changes from 1980 - 2019: Aggregate Matching

and a net increase in home-market work ratio due to the strong home-market force.

4.3 Accounting for Changes from 1980 - 2019

After establishing that there are two mechanisms that can explain marketization in this heterogeneous skill economy while holding the relative supply of skilled to be constant, I use the model to account for changes in marketization observed from 1980 - 2019. The goal is to assess the quantitative importance of these two mechanisms on explaining the data, while I treat the change of the supply of skill to be exogenous. My finding suggests that the change of supply and demand of skill does not only account for the change of skill premium, it also generates the marketization trends. I then compare my results with results in a representative economy where the marketization facts are accounted entirely by a relative productivity increase of market service sector to home. The comparison suggests that in an economy with skill heterogeneity, one *does not* need a positive growth in the productivity of the market service sector relative to the home sector in order to match the marketization facts. The takeaway from this exercise is that the change of wage structure could be another force that shapes our understanding of the causes of marketization.

The full exercise in this section aims to match the change of relative supply of skill, the change in skill premium, the aggregate decrease of home-market ratio, and the aggregate increase of expenditure share by changing the composition of the high skilled f_H, the market service productivity A_{S_m}, and the factor-specific productivity in the good sector A_{GL}, A_{GH}. Table 15 lists the calibrated values. These changes of productivities are able to match the targets

Parameter Values		Annual Growth Rate
New Productivities		
A_{GL}^{new}	0.102	-5.54%
A_{GH}^{new}	6.527	4.80%
$A_{S_m}^{new}$	0.906	-0.25%
Demographics		
f_H^{new}	0.413	1.51%

Table 15: Accounting for Changes from 1980 - 2019: Parameters Values

well. Table 14 reports the matching of the percentage change of the skill premium, the percentage point change of the aggregate home-market hour ratio and the aggregate expenditure share. In order to interpret the scale of these numbers, I transform them to annual growth rates: the A_{GL}^{new} of 0.102 implies a decline rate of 5.5% annually from 1980 to 2019; the A_{GH}^{new} of 6.527 implies an annual growth rate of 4.8%; and the $A_{S_m}^{new}$ of 0.906 implies a decline rate of 0.25% yearly. At the same time, there is a steady increase of the supply of the high skilled by 1.5% annually.

It's important to provide interpretation on these numbers particularly given their signs and magnitudes. I interpret the decline of the low-skilled workers in the good sector as the reduced-form displacement effect in Acemoglu & Restrepo (2019). As low-skilled workers get replaced by robots, they face a decrease in market opportunities. Therefore, they take on jobs in marketized sectors at a much lower wage, reducing the price of market service. Given the recent debate on the substitutability of high-skilled and low-skilled, I perform a similar analysis using a larger ξ value suggested in Bils et al. (2022). Table A17 shows the result. The magnitudes for ΔA_{GL} and ΔA_{GH} are much smaller, yet it still generates a negative change of A_{S_m}

Results in Table 15 suggest that a large change in the wage structure, due to increasing market opportunities for the high skilled and a decreasing market opportunities for the low skilled,

Δw_L	Δw_H	Δp_s	$\Delta \tilde{p}_L$	$\Delta \tilde{p}_H$	$\Delta \frac{h_d^H}{h_w^H}$	$\Delta \frac{h_d^L}{h_w^L}$	$\Delta \Omega^H$	$\Delta \Omega^L$
Full Model								
-0.103	0.108	-0.005	-0.095	0.078	-0.090	-0.014	0.060	-0.025
Data								
					-0.077	-0.033	0.037	0.031

Table 16: Accounting for Changes from 1980 - 2019: Disaggregate Matching

is needed to match the aggregate pattern in this heterogeneous skill economy. These results are in stark contrast to the representative household economy. To illustrate the difference, I first calibrate a representative household economy in section A.4.1 using aggregate targets from Table 11. I then report results on implied productivities and matchings from a similar exercise in Table A7 and Table A6 where I target the aggregate decrease of home-market ratio and the aggregate increase of expenditure share. In the representative household economy, marketization is generated by a larger growth of the market service sector relative to home[7]. However, the sign flips in my setting, suggesting that the wage structure change virtually accounts for the aggregate changes we see in the data once studied in a heterogeneous skill economy.

I exploit the matching of the model by looking at the predictions on the disaggregate measure, and it does relatively well on these dimensions. I report these results in Table 16. My model can give a reasonable match to three out of the four measures. It does overshoot actions of the high skilled.

[7] My result in Table A7 suggests that A_G grows slower than A_{S_m} over time comparing to the numbers in Rogerson (2008). There are two caveats behind this difference. First of all, a faster A_G growth over A_{S_m} is not a necessary condition to match the qualitative feature of the reallocation out of the good sector. I report the decrease of labor supply ratio between good and service in Table A6 which suggests that labor are shifting away from the good sector even when A_G grows slower than A_{S_m}. This is because the relative price increase between service bundle and good is the key to match the labor reallocation, conditional on growth of A_{S_m} relative to home which is pinned down through a shrinking time on home sector. As long as good is getting relatively more expensive than the service price bundle, it can deliver the correct labor reallocation results pattern. Second, we have different calibration strategy. In particular, they take the productivity from the data and use it to calibrate the preference parameter, whereas my process is the opposite.

5 Conclusions

In this paper, I presented a new theory and evidence of the mechanism of marketization. In particular, I link the change in wage structure to marketization and examine how the change in supply and demand of skills affects the understanding of marketization. My finding shows that this change alone can account for the aggregate marketization change in the US from 1980 to 2019. Furthermore, it suggests that the change in wage structure also speaks to the formation of marketization.

This paper also re-opens a discussion on why Europe has seen a smaller service sector than the US despite catching up to the technology frontier. Earlier work like Rogerson (2006), Rogerson (2008), Ohanian et al. (2008), McDaniel (2011) focuses on the tax scheme difference between the US and Europe. However, this paper suggests that the skill premium difference can also help rationalize the size difference in the service sector. Recent work by Doepke & Gaetani (2020) suggests that institutions such as employment protection program could account for the gap in skill premium between Germany and the US. Future work could investigate how the different trajectories of skill premium can quantitatively explain the distinct marketization trend between these two places.

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A Appendices

A.1 Data Appendix

A.1.1 ATUS & CEX Crosswalk

Household Activities (ATUS)	Household Expenditures (CEX)
Interior/Exterior Cleaning	Maintenance of property
Laundry	Apparel laundry and dry cleaning
Food preparation, presentation and clean up	Meals and drinks away from home
Lawn, garden, and houseplant care	Gardening, lawn care and pet service
Interior arrangement, decoration	Housekeeping services
Exterior repair, improvement & decoration	Garbage, trash collection
Sewing, repairing & maintaining textiles	Alteration, tailoring of apparel, and shoe repairing
Caring for & helping household children	Babysitting and child care
Caring for & helping household adults	Care in convalescent or nursing home

Table A1: Crosswalk between Activities in Time-Use Survey and Expenditure Items in CEX

A.1.2 Industries Included under the Personal Service Sector

ind1990	Industry Descriptions
401	Bus service and urban transit
402	Taxicab service
641	Eating and drinking places
761	Private households
771	Laundry, cleaning, and garment services
772	Beauty shops
780	Barber shops
782	Shoe repair shops
790	Dressmaking shops
862	Child day care services
863	Family child care homes
870	Residential care facilities, without nursing

Table A2: Personal Service Industries

A.2 Empirical Facts Appendix

A.2.1 Additional Facts on Sectoral Skill Composition

In Figure 4, I examine the sectoral share of hours from the low-skilled for 1980, 2000 and 2019. The personal service sector has been consistently the one with the highest share of hours from the low-skilled workers.

A.2.2 Additional Facts on Time Use

From 1980 - 2019, the total nonmarket time measured by the narrow measure has declined by 18% and 11% for the broad measure. In Table A3, I report weekly hours, level change, and percentage change. During the period I focus on, time spent on homework has declined

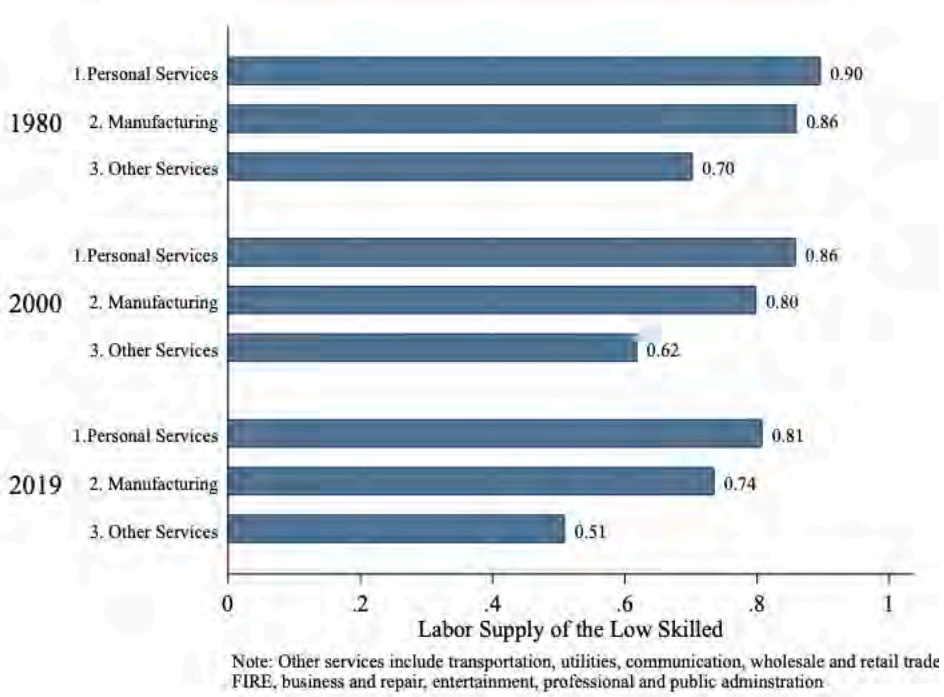

Figure 4: Skill Compositions by Industries: by Years

except for childcare and adult care. The magnitudes reported on nonmarket homework and market work time from 1975 to 2003 are consistent with results in Aguiar & Hurst (2007*b*). However, I observe a decreasing trend in leisure, unlike their results. This is due to both sample selection and leisure definition. They focus on individuals aged 21 - 65 and include time spent on gardening and pet care in their leisure time. I report the point estimates on leisure where I focus on the same definition and population as Aguiar & Hurst (2007*b*) in the last column of Table A3. The results are in line with their findings.

(Hours per week)	1975	2003	2019	Level Change 2019 - 1975	Percentage Change 2019 - 1975
Home Production Categories					
(1) Benchmark Activities	13.91	12.92	12.11	-1.80	-0.13
(2) Obtaining Things	4.93	5.27	4.60	-0.32	-0.07
(3) Personal Care	7.24	4.82	4.99	-2.25	-0.31
(4) Childcare + Adult care	3.08	5.84	6.32	3.24	1.05
Narrow Nonmarket Work ((1)+(2))	18.84	18.19	16.71	-2.13	-0.11
Broad Nonmarket Work ((1)+(2)+(3)+(4))	29.15	28.84	28.01	-1.14	-0.04
Market Work	35.60	34.18	35.28	-0.32	-0.01
Leisure	32.93	31.75	30.17	-2.76	-0.08
Leisure (Aguiar & Hurst)	34.27	34.95	33.90	-0.38	-0.01

Table A3: Time Allocation Among Nonmarket Work, Market Work and Leisure: Levels

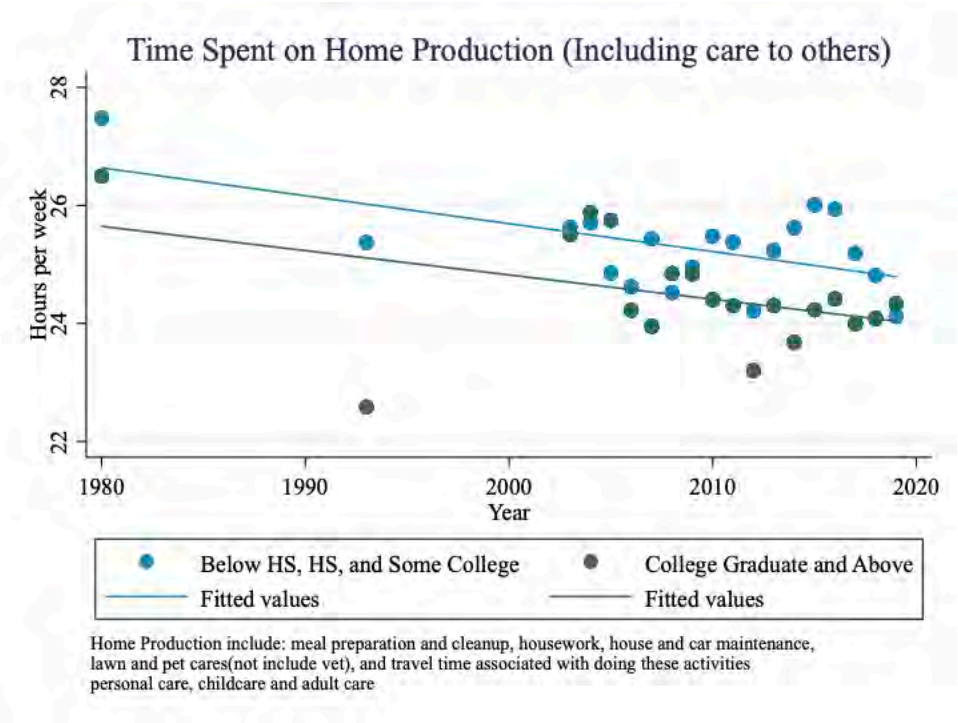

Figure 5: Time Use Trend on Home Production Activities by Skill Level (Including Care): 1980 - 2019

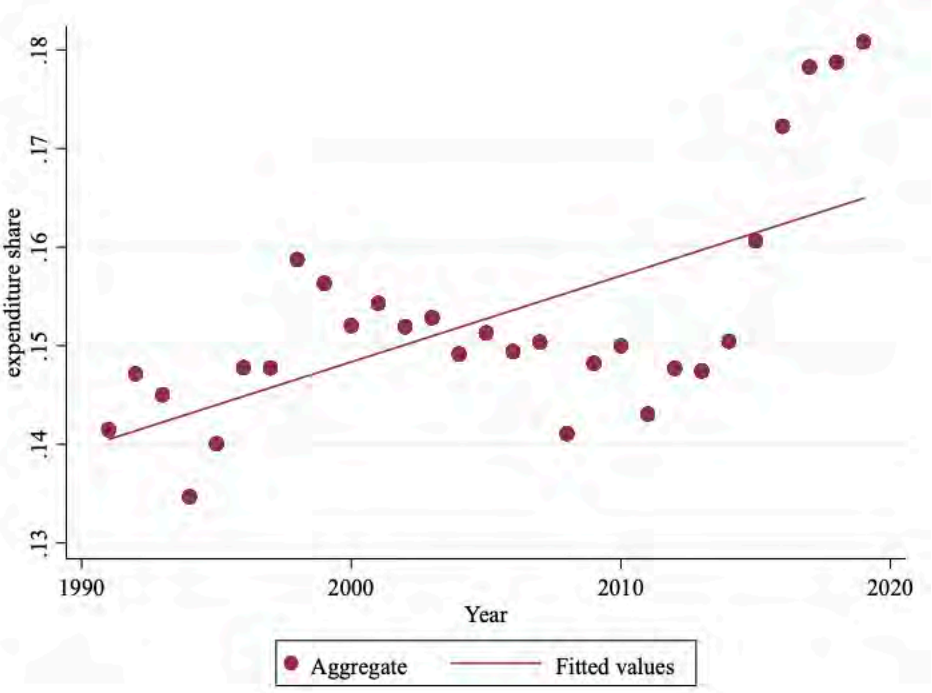

Figure 6: Expenditure Share on Home Production Substitute (Including Care): 1990 - 2019

A.3 Model Appendix

Proof of proposition 1

Proof. Equation 10 shows the analytic form of the home hours. It consists of two parts Λ_1, Λ_2 that are relevant for the analysis. Namely:

$$\Lambda_1 = \frac{\alpha_P^{\epsilon}(p_{iP}^{\star})^{1-\epsilon}}{\alpha_P^{\epsilon}(p_{iP}^{\star})^{1-\epsilon} + (1-\alpha_P)^{\epsilon}(p_G)^{1-\epsilon}} = 1 - \frac{(1-\alpha_P)^{\epsilon}(p_G)^{1-\epsilon}}{\alpha_P^{\epsilon}(p_{iP}^{\star})^{1-\epsilon} + (1-\alpha_P)^{\epsilon}(p_G)^{1-\epsilon}}$$

$$\Lambda_2 = \frac{\psi_i^{\sigma} p_{ih}^{1-\sigma}}{(1-\psi_i)^{\sigma} p_{P_m}^{1-\sigma} + \psi_i^{\sigma} p_{ih}^{1-\sigma}}$$

Since $\Lambda_1, \Lambda_2 > 0$, it is equivalent to show that

$$\frac{\partial \Lambda_1}{\partial p_{Pm}} > 0 \qquad \frac{\partial \Lambda_2}{\partial p_{Pm}} > 0$$

Note that $\frac{\partial \Lambda_2}{\partial p_{Pm}} > 0$ since $\sigma > 1$. Moreover, $\frac{\partial \Lambda_1}{\partial p^{\star}_{iP}} > 0$ since $\epsilon < 1$.

$$\frac{\partial p^{\star}_{iP}}{\partial p_{Pm}} = (p^{\star}_{iP})^{\sigma}(1-\psi_i)^{\sigma} p_{Pm}^{-\sigma} > 0$$

By chain rule, we have $\frac{\partial \Lambda_1}{\partial p_{Pm}} = \frac{\partial \Lambda_1}{\partial p^{\star}_{iP}} \frac{\partial p^{\star}_{iP}}{\partial p_{Pm}} > 0$ □

Proof of proposition 2

Proof. Equation 12 shows the analytic form of the expenditure share on market produced personal service. For composition purpose, I denote the expenditure share as Ω_i below. To show proposition 2, it is equivalent to show

$$\frac{\partial \Omega_i}{\partial w_i} > 0$$

Apply the chain rule, we have:

$$\frac{\partial \Omega_i}{\partial w_i} = \frac{\partial \Omega_i}{\partial p^{\star}_{iP}} \frac{\partial p^{\star}_{iP}}{\partial w_i} = \frac{\partial \Omega_i}{\partial p^{\star}_{iP}} \frac{\partial p^{\star}_{iP}}{\partial p_{ih}} \frac{\partial p_{ih}}{\partial w_i}$$

Take the partial derivative, we have

$$\frac{\partial \Omega_i}{\partial p^{\star}_{iP}} = \frac{(1-\alpha_P)^{\epsilon} p_G^{1-\epsilon}}{\left[\alpha_P^{\epsilon}(p^{\star}_{iP})^{\sigma-\epsilon}(1-\psi_i)^{\sigma} p_{P_m}^{1-\sigma} + (1-\alpha_P)^{\epsilon} p_G^{1-\epsilon}\right]^2} \alpha_P^{\epsilon}(1-\psi_i)^{\sigma} p_{P_m}^{1-\sigma}(\sigma-\epsilon)(p^{\star}_{iP})^{\sigma-\epsilon-1} > 0$$

since $\epsilon < 1 < \sigma$, $0 < \alpha, \psi_i < 1$

$$\frac{\partial p^{\star}_{iP}}{\partial p_{ih}} = (p^{\star}_{iP})^{\sigma} \psi_i^{\sigma} p_{ih}^{-\sigma} > 0$$

$$\frac{\partial p_{ih}}{\partial w_i} = \frac{1}{A_h} > 0$$

□

Proof of proposition 3

Proof. Notice that it is equivalent to determine the sign of $\frac{\partial \tilde{\Omega}}{\partial p_{Pm}}$ where

$$\tilde{\Omega} = \alpha_P^{\epsilon}(p_{iP}^{\star})^{1-\epsilon}\left[1 - \frac{\psi_i^{\sigma} p_{ih}^{1-\sigma}}{\psi_i^{\sigma} p_{ih}^{1-\sigma} + (1-\psi_i)^{\sigma} p_{Pm}^{1-\sigma}}\right]$$

$$\frac{\partial \tilde{\Omega}}{\partial p_{Pm}} = \alpha_P^{\epsilon}\left[(1-\epsilon)\frac{\partial p_{iP}^{\star}}{\partial p_{Pm}}(p_{iP}^{\star})^{-\epsilon} - \psi_i^{\sigma} p_{ih}^{1-\sigma}(\sigma-\epsilon)\frac{\partial p_{iP}^{\star}}{\partial p_{Pm}}(p_{iP}^{\star})^{\sigma-\epsilon-1}\right] \tag{13}$$

$$= \underbrace{\alpha_P^{\epsilon}(p_{iP}^{\star})^{-\epsilon}\frac{\partial p_{iP}^{\star}}{\partial p_{Pm}}}_{>0}\left[(1-\epsilon) - (\sigma-\epsilon)\frac{\psi_i^{\sigma} p_{ih}^{1-\sigma}}{\psi_i^{\sigma} p_{ih}^{1-\sigma} + (1-\psi_i)^{\sigma} p_{Pm}^{1-\sigma}}\right] \tag{14}$$

Equation (14) < 0 if and only if

$$(1-\epsilon) < (\sigma-\epsilon)\frac{\psi_i^{\sigma} p_{ih}^{1-\sigma}}{\psi_i^{\sigma} p_{ih}^{1-\sigma} + (1-\psi_i)^{\sigma} p_{Pm}^{1-\sigma}}$$

Denote $r \equiv \frac{p_{Pm}}{p_{ih}}$ and solve the inequality above, one can get:

$$r > \left(\frac{1-\psi_i}{\psi_i}\right)^{-\frac{\sigma}{1-\sigma}}\left(\frac{\sigma-1}{1-\epsilon}\right)^{\frac{1}{1-\sigma}}$$

Denote $r^{\star} = \left(\frac{1-\psi_i}{\psi_i}\right)^{\frac{\sigma}{\sigma-1}}\left(\frac{1-\epsilon}{\sigma-1}\right)^{\frac{1}{\sigma-1}}$. $r^{\star} \to 0$ if one of the following conditions met: 1) $\psi_i \to 1$; 2) $\epsilon \to 1$; 3) $\sigma \to \infty$

Therefore $\frac{\partial \Omega}{\partial p_{Pm}} > 0$ when $r < r^{\star}$; $\frac{\partial \Omega}{\partial p_{Pm}} < 0$ when $r > r^{\star}$ □

A.4 Quantitative Exercise Appendix

A.4.1 A representative economy

In this section, I outline the model in a representative economy setting (identical to Rogerson (2008)) with calibration to 1980 benchmark and accounting for the change from 1980 to 2019. The household decision is identical to those in Section 3. The production in much simpler as

outlined in the following.

$$S_m = A_{S_m} N_S \tag{15}$$

$$G = A_G N_G \tag{16}$$

The market clearing condition requires:

$$N_S + N_G = h_w \tag{17}$$

$$g = G \tag{18}$$

$$s = S_m \tag{19}$$

The model only has five parameters to be calibrated, including two elasticities ϵ, σ and three preference parameters α, ψ, φ. Similar to section 4.1, I set ϵ to be 0.3 and σ to be 4 following Ngai & Pissarides (2007) and Aguiar & Hurst (2007*b*) respectively.

	A. Elasticity		
ϵ	Generic and Domestic Service	0.3	Ngai & Pissarides (2008)
σ	Home and Market	4	Aguiar & Hurst (2007*a*)
	B. Relative weights		
α	Weight on personal service bundle	0.293	Internally calibrated
ψ	Weight on home produced personal service	0.618	Internally calibrated
φ	Weight on leisure	0.496	Internally calibrated

Table A4: Model Parameters

Moments	Model	Targets	Sources
Ω: Aggregate expenditure share	0.129	0.129	CEX extrapolated
$\mathcal{H}_l$: Aggregate leisure fraction	0.332	0.332	ATUS extrapolated
$\mathcal{H}_m$: Aggregate market work fraction	0.354	0.354	ATUS extrapolated

Table A5: Moments Matching

Table A7 and Table A6 report the productivity changes needed to match the change of aggregate home-market ratio and aggregate expenditure share and the matching.

Moments	Targets	Full Model
$\Delta\frac{\mathcal{H}_h}{\mathcal{H}_w}$: Change of aggregate home-market hour ratio	-0.070	-0.070
$\Delta\Omega$: Change of aggregate expenditure share	0.038	0.038
$\Delta\frac{N_G}{N_S}$: Change of Sectoral Labor Allocation (untarget)		-1.764

Table A6: Accounting for Changes from 1980 - 2019: Aggregate Match

Productivities	Values	Annual Growth Rate
A_G^{new}	1.035	0.09%
$A_{S_m}^{new}$	1.120	0.28%

Table A7: Accounting for Changes from 1980 - 2019: Parameters Values

A.4.2 Calibration and full exercise with targets not including care

All targets (time and expenditure share) reported in this section do not include child care and adult care.

	A. Aggregate		
M_U	Mass of Unskilled	0.7729	1980 Census
	B. Elasticity		
ϵ	Generic and Domestic Service	0.3	Ngai & Pissarides (2008)
σ	Home and Market	4	Aguiar & Hurst (2007*a*)
ξ	Skilled and Unskilled	1.4	Katz & Murphy (1992)
	C. Relative weights		
α	Weight on personal service bundle	0.7192	Internally calibrated
ψ	Weight on home produced personal service	0.6380	Internally calibrated
φ	Weight on leisure	0.4960	Internally calibrated
η	Weight on H-type labor	0.4246	Internally calibrated

Table A8: Model Parameters

Moments	Model	Targets	Sources
$\log \frac{w_S}{w_U}$: Skill premium in 1980	0.3622	0.3622	1980 Census 5%
Ω: Aggregate Expenditure share	0.1122	0.1122	CEX extrapolated
M_U: Mass of the unskilled	0.7729	0.7729	1980 Census 5%
$\mathcal{H}_l$: Aggregate leisure fraction	0.3744	0.3744	ATUS extrapolated
$\mathcal{H}_m$: Aggregate market work fraction	0.3971	0.3971	ATUS extrapolated
Untargeted Moments			
Ω^S/Ω^U: Expenditure share ratio by skill	2.5217	1.2639	CEX extrapolated
h_m^S/h_h^S: Total work allocation of the skilled	1.9704	1.8784	ATUS extrapolated
h_m^U/h_h^U: Total work allocation of the unskilled	1.6761	1.7072	ATUS extrapolated
h_m^S/h_m^U: Market work ratio by skill	1.0591	1.0349	ATUS extrapolated

Table A9: Moments Matching

Δw_U	Δw_S	Δp_{Pm}	$\Delta p_U^\star$	$\Delta p_S^\star$	Δh_h^S	Δh_h^U	$\Delta \Omega^S$	$\Delta \Omega^U$
A. Increase A_{Pm} by 10%								
0.0119	-0.0218	-0.0881	-0.0021	-0.0426	-0.0782	-0.0429	0.0182	0.0218
B. Increase f_S by 10%								
0.0790	-0.1391	0.0790	0.0790	-0.0886	0.1187	0.0314	-0.0788	0.0043
C. Increase f_S to 2019 level								
0.2056	-0.3391	0.2056	0.2056	-0.2495	0.1737	0.0801	-0.1563	0.0117
D. Decrease A_{GU} by 10%								
-0.0735	-0.0480	-0.0735	-0.0735	-0.0557	-0.0437	-0.0299	0.0024	-0.0039
E. Increase A_{GS} by 10%								
0.0299	0.0460	0.0299	0.0299	0.0412	0.0006	0.0119	0.0106	0.0016
F. Increase all market productivities by 10%								
0.1122	0.0692	0.0122	0.0982	0.0515	-0.0345	-0.0031	0.0267	0.0286
Data								
					-0.1315	-0.0447	0.0349	0.0381

Table A10: Moments Matching

Table A12 shows the targets I chose to discipline the parameters in Table A11. I chose the change of average expenditure share on the marketized personal service as one indicator on how the that particular sector changes over time. The overall takeaway is consistent with the one in the main section.

Parameter Values	
A_{GM}^{new}	0.1130
A_{GT}^{new}	6.5091
A_{Pm}^{new}	0.9508

Table A11: Comparative Static: Parameters Values

Moments	Model	Targets
$\Delta\pi$	0.2108	0.2120
$\Delta\mathcal{H}_h$	-0.0881	-0.0879
$\Delta\Omega$	0.0408	0.0407

Table A12: Comparative Static: Targets

Δw_U	Δw_S	Δp_{Pm}	$\Delta p^{\star}_U$	$\Delta p^{\star}_S$	Δh^S_h	Δh^U_h	$\Delta \Omega^S$	$\Delta \Omega^U$
A. Only A_{GS}								
0.9485	0.7306	0.9485	0.9485	0.7811	0.4008	0.3265	0.0075	0.0668
B. A_{GS} and A_{GM}								
-0.0973	0.0907	-0.0973	-0.0973	0.0239	-0.1918	-0.0397	0.0700	-0.0051
C. A_{GS} and A_{Pm}								
0.9352	0.7413	0.9868	0.9411	0.7965	0.4192	0.3421	-0.0022	0.0496
D. Full Model								
-0.1147	0.0976	-0.0631	-0.1088	0.0420	-0.1515	-0.0267	0.0629	-0.0149
					Data			
					-0.1315	-0.0447	0.0349	0.0381

Table A13: Comparative Static: Decision Rule

A.4.3 Calibration and full exercise with $\xi = 4$

In this section, I present results on calibration, the numerical comparative statics and the final exercise with $\xi = 4$ suggested by Bils et al. (2022). All targets (time and expenditure share) reported in this section includes child care and adult care.

The key message from the exercise remains unchanged as suggested in A17. Although the magnitude of A_{GL} and A_{GH} changes, the change of A_{S_m} is virtually identical as Table 15.

	A. Aggregate		
M_U	Mass of Unskilled	0.773	1980 Census
	B. Elasticity		
ϵ	Generic and Domestic Service	0.3	Ngai & Pissarides (2008)
σ	Home and Market	4	Aguiar & Hurst (2007*a*)
ξ	Skilled and Unskilled	4.0	Bils et al. (2022)
	C. Relative weights		
α	Weight on personal service bundle	0.744	Internally calibrated
ψ	Weight on home produced personal service	0.639	Internally calibrated
φ	Weight on leisure	0.496	Internally calibrated
η	Weight on H-type labor	0.532	Internally calibrated

Table A14: Model Parameters

Moments	Model	Targets	Sources
$\log \frac{w_S}{w_U}$: Skill premium in 1980	0.362	0.362	1980 Census 5%
Ω: Aggregate expenditure share	0.128	0.129	CEX extrapolated
M_U: Mass of the unskilled	0.773	0.773	1980 Census 5%
$\mathcal{H}_l$: Aggregate leisure fraction	0.332	0.332	ATUS extrapolated
$\mathcal{H}_m$: Aggregate market work fraction	0.354	0.354	ATUS extrapolated
Untargeted Moments			
Ω^S/Ω^U: Expenditure share ratio by skill	2.591	1.250	CEX extrapolated
h_m^S/h_h^S: Total work allocation of the skilled	1.246	1.191	ATUS extrapolated
h_m^U/h_h^U: Total work allocation of the unskilled	1.089	1.118	ATUS extrapolated
h_m^S/h_m^U: Market work ratio by skill	1.064	1.030	ATUS extrapolated

Table A15: Moments Matching

Δw_L	Δw_H	Δp_s	$\Delta \tilde{p}_H$	$\Delta \tilde{p}_L$	$\Delta \frac{h_d^H}{h_w^H}$	$\Delta \frac{h_d^L}{h_w^L}$	$\Delta \Omega^H$	$\Delta \Omega^L$
A. Increase A_{S_m} by 10%								
0.007	-0.012	-0.093	-0.004	-0.033	-0.095	-0.056	0.030	0.025
B. Decrease A_{GL} by 10%								
-0.087	-0.022	-0.087	-0.087	-0.038	-0.081	-0.049	0.023	-0.005
C. Increase A_{GH} by 10%								
0.015	0.075	0.015	0.015	0.060	-0.038	0.009	0.034	0.001
D. Decrease A_{GL} and increase A_{GH} both by 10%								
-0.075	0.052	-0.075	-0.075	0.018	-0.125	-0.043	0.057	-0.004
E. Increase f_H to 2019 level								
0.093	-0.119	0.093	0.093	-0.081	0.152	0.055	-0.091	0.006
Data								
					-0.077	-0.033	0.037	0.031

Table A16: Moments Matching

Parameter Values		Annual Growth Rate
New Productivities		
A_{GL}^{new}	0.674	-0.98%
A_{GH}^{new}	1.412	0.87%
$A_{S_m}^{new}$	0.905	-0.25%
Demographics		
f_H^{new}	0.413	1.51%

Table A17: Accounting for Changes from 1980 - 2019: Parameters Values

Moments	Model	Targets
$\Delta\pi$: Change of skill premium	0.213	0.212
$\Delta\frac{\mathcal{H}_h}{\mathcal{H}_w}$: Change of aggregate home-market hour ratio	-0.070	-0.070
$\Delta\Omega$: Change of aggregate expenditure share	0.038	0.038

Table A18: Accounting for Changes from 1980 - 2019: Aggregate Match

Δw_L	Δw_H	Δp_s	$\Delta\tilde{p}_L$	$\Delta\tilde{p}_H$	$\Delta\frac{h_d^H}{h_w^H}$	$\Delta\frac{h_d^L}{h_w^L}$	$\Delta\Omega^H$	$\Delta\Omega^L$
Full Model								
-0.104	0.109	-0.004	-0.096	0.079	-0.089	-0.014	0.060	-0.025
Data								
					-0.077	-0.033	0.037	0.031

Table A19: Accounting for Changes from 1980 - 2019: Disaggregate Matching