Richer and Busier? The Facts, Causes and Consequences of Labor Supply in China*

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Abstract

We document the trend in time allocation in China from 2008 to 2020. Market hours per person increase by 3 to 6 hours per week in the urban area but decrease by 4 hours in the rural area, and both changes are mainly driven by the intensive margin. Chinese on average spend much less time on core housework but allocate more time to child care compared with a decade ago. For salary workers, the increase in market hours is broad-based across age, education attainment, gender, sector, and income percentile. Puzzling, even though wage rate and market hours are strongly negatively correlated in cross sections, a substantial rise in market hours is accompanied by a 60-percent increase in wage rate over time. To reconcile this tension, we build a quantitative life cycle heterogeneous agent incomplete market model with home production and pay-as-you-go pension transfer to conduct an accounting. Quantitatively, we find rising income uncertainty, changing demographic structures, and capital augmenting productivity growth in home production contribute to explaining rising market hours. The calibrated model can recover the observed empirical trend in market hours, non-market hours, and the correlation between market hours and wage rate reasonably well.

Key Words: market hours, endogenous labor supply, income uncertainty, public pension.

JEL code: D15, E21, E24, J22, J31, O11.

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1 Introduction

> Three-hour shifts or a fifteen-hour week may put off the problem for a great while. For three hours a day is quite enough to satisfy the old Adam in most of us!
>
> *John Maynard Keynes, 1930*
> *Economic Possibilities for our Grandchildren*

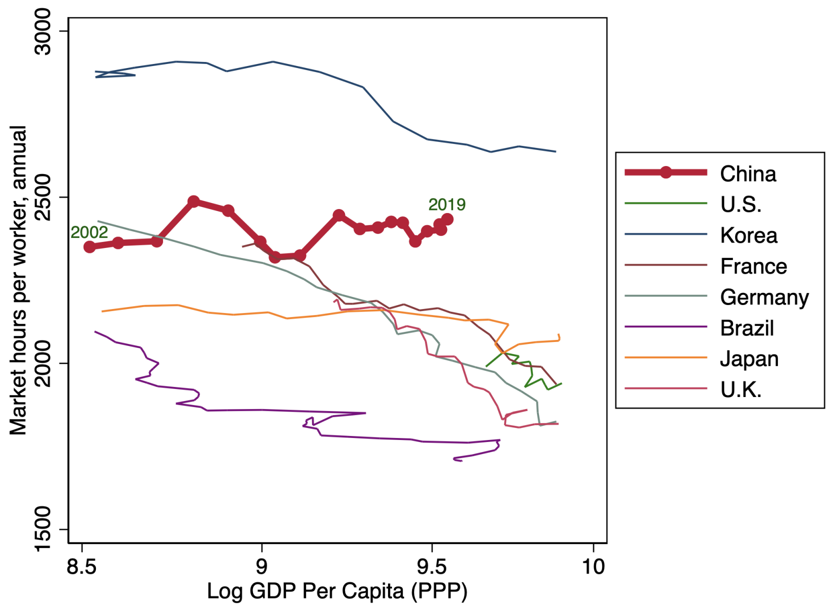
> I personally think that 996 is a huge blessing. How do you achieve the success you want without paying extra effort and time?
>
> *Jack Ma, 2019*
> *In an interview as CEO of Alibaba*

Working hours and leisure are crucial in determining welfare level in economic growth beyond GDP or consumption level (Jones and Klenow, 2016). Recent studies have documented that high-income countries work less than low-income countries (Bick et al., 2018), and aggregate hours worked decrease in income levels within advanced economies (Boppart and Krusell, 2020). China has experienced forty-year rapid economic growth, but less is known about the secular trend in hours and leisure. Most of the growth accounting assumes labor supply is inelastic. Do Chinese work for fewer hours and enjoy a higher welfare growth rate than just looking at consumption? Or do Chinese work for longer hours and henceforth the estimated TFP and welfare growth is upward-biased if not considering the varying labor supply margin? And what explains the changing pattern in time allocation? We try to answer those questions.

In this paper, we study the secular trend in time allocation within China in the last decade. We document a novel and robust empirical finding: Market hours have become much longer in the urban area as China has become richer in the past decade. This fact is opposite to what is observed in many other economies. In Figure 1, we plot market hours per worker versus GDP per capita for a set of selected major economies.[1] Market hours per worker gradually decline in all the major economies when their national income levels increase at the same development stage, except for China. For China, market hours increase

[1]The data for countries except China is taken from Penn world table and the data for China is *average market hours for urban employees*, the only related statistics released by National Bureau of Statistics. The CDP per capita in the horizontal axis is PPP adjusted.

Figure 1: Market Hours Per Worker Across Countries



Notes: This figure plots the sequences of the average annual market hours per worker corresponding to the logarithm of GDP per capita in different countries.
Data source: Penn World Table 10.0, OECD database, and National Bureau of Statistics (China).

with GDP growth, if anything happens. We consolidate this finding by utilizing the Chinese Time Use Survey (CTUS), the best possible data to study time allocation and just becoming available in China, and the China Family Panel Studies (CFPS), a nationally representative longitudinal survey.

In the first part of the paper, we lay out the main empirical finding that working hours have increased significantly in China in the 2010s for urban, non-agriculture workers. Using the Chinese Time Use Survey in 2008 and 2018, we segment time allocation exclusively into five broad categories: time spent in market hours, time spent in housework, time spent in child care, time spent in education, and leisure. Urban and rural samples have significantly different secular patterns. For the urban sample, We find that market hours per person increased by 6.6 hours per week for males and 2.9 hours per week for females. The increase in market hours is jointly compensated by a decline in core housework and leisure[2] while time spent on childcare rises rapidly. For the rural sample, market hours per person declined by 4 and 4.2 hours per week for males and females, respectively. Leisure increases by around 3.2

[2]Leisure is strictly decreasing if we take child care as a separate category. The trend in leisure will be ambiguous if we take some portion of child care as leisure.

hours per week for males and 3.6 hours per week for females in rural areas. The inequality in terms of leisure is shrinking between rural and urban areas.

We then study the sources of observed dynamics in market hours along extensive-margin and intensive-margin. We calculate the employment rate as the extensive-margin measure and the average market hours per worker among employed as the intensive-margin measure. Overall, the increase in market hours per person in urban area is mainly driven by the changes in the intensive margin. There is a modest increase in the employment rate among urban males (2.1 percent) and a modest decline among urban females (0.9 percent). Weekly market hours per worker increase by 5.6 and 3.7 hours. For the rural sample, the decline in market hours per person is driven by both intensive and extensive margins. One interesting finding is that agricultural workers worked much less in 2018 than in 2008, which drives the difference between rural and urban samples. The time allocation for agriculture workers is understudied in the literature due to a lack of data.

We investigate further heterogeneity related to this fact using the China Family Panel Studies (CFPS). As a comprehensive and longitudinal survey, CFPS allows us to measure working hours, wage rates, and various demographic characteristics. Using CFPS, we first find market hours per worker increased by around 3 hours from 2010 to 2020, a similar magnitude as we find using the CTUS. Then, we find that the substantial increase in market hours is broad-based in all groups. It holds across people by age, gender, education, sector, and childbearing. We also use CFPS to document the relationship between individual-level hours and wages. We find a negative relationship between hours and wages. Low-wage workers work more than their high-wage counterparts. However, the hours-wage elasticity is exceptionally stable from 2010 to 2020. These facts suggest that the increasing working hours are unlikely to be explained by different compositions of the population or the change in individual-level hours-wage elasticity.

To reconcile the tension between rises in both hourly wage rate and market hours among urban wage workers, we build a quantitative life cycle heterogeneous agent incomplete market model featuring endogenous labor supply, home production, and pay-as-you-go pension plan to account for underlying factors behind the puzzle. The model is a natural extension of Aiyagari (1994) and Huggett (1996) with the Beckerian model of household production Becker (1965).

First, we consider a rising wage uncertainty to explain why Chinese workers work longer although they are richer. We first document that wage inequality has risen sharply in China in the past decade, using the individual wage data from CFPS. By investigating wage residual dynamics from CFPS data, we find rising wage inequality is mainly attributed to an increase in initial wage dispersion and variance in persistent shocks. The increase in initial dispersion potentially captures deterministic profiles like growing college premiums, occupation premiums, and regional inequality. The increase in the variance of persistent shocks implies individuals are facing higher uninsurable income uncertainty. Ex-ante, higher inequality and uncertainty imply a higher density of individuals hitting borrowing limits in the steady state, delivering a stronger precautionary saving motive. Ex-post, when borrowing constraint binds, endogenous labor supply becomes the only way to provide insurance. Both channels encourage higher hours.

The second set of factors we consider is the changing age structures as a combination of birth and death rates decline. The expected worsening working-age population ratio can change consumption, saving, and labor supply decisions in a simultaneous way. As the pension system is Pay-as-you-go, a decline in the replacement ratio of pension benefits is expected. Therefore, individuals have to work longer as the extensive margin, retirement age, is relatively inelastic in China. While relatively poor agents rely more on pension benefits, they have to adjust their policy functions more aggressively, leading to a decline in the correlation between wages and hours.

Motivated by the fact that non-market hours have declined sharply, the third factor we explore is the substitution between market and non-market hours. As the market goods used in home production and non-market hours are substitutes for producing home goods, growth in wage rate and capital augmenting productivity growth increases the comparative advantage of market hours over non-market hours in home production.

With the model calibrated to the Chinese economy, we find that an increase in TFP would generate lower total hours per worker and a higher correlation between total hours and wages, as the income effect dominates when we choose relative risk aversion bigger than 1. Rising initial dispersion, the variance of persistent shocks, and changing birth and death rates all contribute to an increase in the average total hours as the model predicts. A TFP growth as well as an increase in capital augmenting productivity in producing home goods shifts up the ratio of market hours to non market hours. When we combine the three moving factors, the model can replicate the dynamics in both market and non-market hours reasonably well. The model also successfully reproduces a modest decline in the correlation between market hours and wages. This is because agents with low productivity will be more sensitive to the three factors we analyze above.

Related Literature

This paper is related to several strands of literature. First, our paper relates to empirical documentation of secular trends in time allocation. Boppart and Krusell (2020) documents that across a set of advanced countries and historically, hours fall steadily. The evidence on the US counts from the classical book-length reference Ghez and Becker (1975) to a systematic retrospect accounting by Aguiar and Hurst (2007) and McGrattan et al. (2004). The US evidence is different from most advanced economies since the market hours is relatively stable as the economy grows, partially driven by an increase in the labor force participation rate for female. One exception is that leisure is also growing in these economies, which is the other side of the coin due to a drop in non-market hours. By looking at the secular trend in time allocation in China, this paper shows a unique trend that market hours increase as leisure decreases.

Second, our paper relates to the literature explaining differentials in hours across countries and over time, mainly motivated by the difference between the US and Western Europe. For example, Prescott (2004), Ohanian et al. (2008), and Rogerson (2010) argue that differentials in labor income taxes explain variations in market hours. We find that in our sample period, labor income tax is low for most workers and does not change by much in China.[3] Additionally, Rogerson (2006) suggests the role of government receipts to GDP ratio, and Alesina et al. (2005) suggests that labor-market regulations motivated by culture matter for labor supply.

Thirdly, our research relates to the literature regarding income uncertainty and its implications on labor supply. It is well documented in previous studies that income uncertainty has been rising in the US since 1980 and the rising part mostly comes from transitory shocks (Moffitt and Gottschalk, 1994) (Heathcote et al., 2010a). Since transitory shocks are highly insurable, a rise in variance of transitory shocks does not transfer to consumption inequality (Krueger and Perri, 2006) or aggregate hours. For example, Pijoan-Mas (2006) finds households make ample use of endogenous labor supply as a consumption smoothing mechanism, individuals work for much longer hours compared with a complete market scenario. Santaeulalia-Llopis and Zheng (2018) and Chamon et al. (2013) use the China Health and Nutrition Survey to estimate the income process and find a rising earning uncertainty from 1989 to 2009. We contribute to the literature by showing rising income uncertainty is also important in explaining the secular trend in market hours.

[3] For a reference, we plot the average tax rate and the marginal tax rate of personal income between 2010 and 2020 in Figure A1 in the appendix. Using the CFPS sample, we find the mean of real average labor income tax rate workers face is consistently below 2 percent from 2010 to 2020.

Finally, our research contributes to our understanding of the role of home production in macroeconomics. Though most of macroeconomic models get abstract from home production. Benhabib et al. (1991) and Greenwood and Hercowitz (1991) show that real business cycle models with explicit household production sectors perform better than the standard real business cycle model. Our paper highlights that a model with explicit home production also helps to explain the secular trend of total and market hours better.

The rest of this paper is organized as follows. Section 2 introduces the data sources and measurement. Section 3 establishes stylized facts in time allocation and rising working hours in China, while section 4 discusses potential driving factors empirically. Section 5 presents the theoretical model and section 6 shows the calibration results. Section 7 conducts quantitative estimation. Section 8 concludes.

2 Data

We are interested in whether and how Chinese people change their time allocation between market work and other activities, and what explains the change in working hours. To empirically investigate these questions, we mainly use two nationally representative surveys in China: the Chinese Time Use Survey and the China Family Panel Studies. We describe the data source as well as measurement in detail below.

Chinese Time Use Survey We utilize the Chinese Time Use Survey (CTUS) at the individual level to document the time allocation across different activities for Chinese people. The CTUS is conducted by the National Bureau of Statistics and has been implemented twice: the first time in May 2008 and the second time in April 2018. The two rounds of CTUS are repeated cross-sectional and intended to be nationally representative.[4] One key advantage of using CTUS is that it is based on 24-hour diaries where respondents report the activities from the previous day in detailed time intervals.[5] Each activity is assigned to a specific category in the CTUS's set classification scheme.[6]

[4]The 2008 wave surveyed around 45,000 individuals aged 15-74 from 18,000 households covering 10 provinces. These provinces include Beijing, Hebei, Heilongjiang, Zhejiang, Anhui, Henan, Guangdong, Sichuan, Yunnan, and Gansu. The 2018 wave included around 60,000 individuals at ages 15+ from 20,000 households living in the same 10 provinces.

[5]For each household, the CTUS collects their 24-hour diaries on two days, a workday and a weekend day. For how to determine the two days more specifically, the CTUS first assigns any continuous week in the survey month, or continuous 7 days, for each household, and then chooses a day from Monday to Friday in this week as the workday and chooses Saturday or Sunday in this week as the weekend day.

[6]For example, there are 114 detailed time-use subcategories falling into 10 categories in the TUS 2008.

We segment the time allocation of each individual into five broad time-use categories: market hours, home production, child care, education, and leisure. We construct the categories to be mutually exclusive and to sum to the individuals' entire time endowment (168 hours per week).[7] These categories are based on the response for the primary time-use activity. Market hours measure all time spent on full-time jobs, part-time jobs, apprenticeships or internships, job searches, work-related training, and family production and business activities. Home production includes any time spent on meal preparation and cleanup, doing laundry, ironing, dusting, vacuuming, indoor household cleaning, shopping/obtaining goods and services, and taking care of adult families. Child care measures all time spent by the individual caring for, educating, or playing with their children. Travel time associated with each activity is embedded in the total time spent on the activity.

We measure hours per person as the average hours spent among all persons aged 15-74.[8] In addition, the CTUS allows us to construct employment rates and hours worked per worker according to respondents' employment status and market hours. The employment rate is the fraction of adults who report being employed. The hours worked per worker are the average market hours among all those who are employed. One caveat worth noting is that CTUS is only cross-sectional containing two periods without any information on wages. So we resort to another longitudinal household survey collected in a similar period as CTUS.

China Family Panel Studies We retrieve individual-level working hours and wages from the 2010-2020 waves of the China Family Panel Studies (CFPS). The CFPS is carried out by Peking University every two years and is a nearly nationwide, comprehensive, longitudinal household survey conducted in mainland China.[9] In each round of the survey, the CFPS identifies each respondent to be employed (as a salaried worker, agricultural worker, or self-employed), unemployed, or exited the labor market according to their self-reported employment status. For those employed, CFPS contains a *job module* to survey their working hours and income for each job they worked in the past 12 months.

We only focus on salaried employees using CFPS due to two major reasons. First, there

[7] We calculate the "daily average" time allocation for each individual by adding up the working day time multiplied by 5/7 and the weekend day time multiplied by 2/7. The "weekly average" time allocation for each individual is the "daily average" time multiplied by 7.

[8] We limit the analysis sample to respondents aged 15-74 to ensure comparability between CTUS 2008 and 2018 since the CTUS 2008 only surveyed individuals in this age group.

[9] In 2010, the CFPS implemented the baseline survey covering around 57,000 individuals in 20,000 households from 25 provinces (excluding Tibet, Xinjiang, Qinghai, Ningxia, Inner Mongolia, and Hainan). In subsequent waves, the CFPS followed up with all the family members from the baseline sample. The successful tracking rates at the individual level between any two rounds of the survey were above 80%.

are large measurement errors regarding the self-reported working hours of farmers and self-employed. Not like the Time Use Survey which is based on 24-hour diaries to record each activity, the CFPS does not require individuals to report the time allocated to other kinds of activities such as entertainment or housework, except working hours in a reference period.[10] In this case, farmers and self-employed intend to assign the time when they are working and also have other activities to working time, and thus overestimate the working time due to the flexibility of their jobs. Second, we observe individual earnings only for those who are currently employed as salaried employees. The income from agriculture or self-employment is regarded as family income in the CFPS. It is challenging to assign these incomes to each family member according to the share of time they have worked.

For salaried employees in CFPS, we calculate their actual hours worked in all jobs in the last week or in a reference week.[11] We also construct individual wages for non-agricultural salaried workers with no self-employed income.[12] In particular, we calculate the annual income for each salaried worker including wages, bonuses, cash benefits, and in-kind subsidies, and excluding tax and insurance fees from all jobs. We obtain the hourly wage rate via the annual income divided by the annual hours worked.[13] Via providing the six-round panel data on individual-level labor incomes, the CFPS allows us to estimate the income process.

3 Empirical Facts

In this section, we first document that average hours worked increased in the last decade and take a look at both the extensive margin and intensive margin. We then show that the increasing working hours is not driven by different compositions of the population. Last,

[10]For example, the CFPS asked respondents how many hours per week on average they worked in the last 12 months.

[11]Instead of asking the hours worked in a reference week, CFPS 2010 and 2012 surveyed respondents on the average number of months worked last year, the average number of days worked per working month, and the average number of hours worked per working day. In this case, we calculate the annual hours worked by the product of the above three measures. We obtain monthly hours worked by dividing annual hours by 10.7 and weekly hours worked by dividing monthly hours by 4.34.

[12]The share of salaried workers who have agricultural income or self-employed income is 5.85% in 2010, 26.65% in 2012, 12.33% in 2014, 22.79% in 2016, 9.64% in 2018, and 7.31% in 2020.

[13]In CFPS 2016, salaried workers who didn't change their primary jobs between 2014 and 2016 were not surveyed on the work module due to some technical mistakes in the questionnaire design. So we can't observe the working hours for around one-third of the salaried employee sample (N=4,901/11,460). We impute their working hours by taking the average working hours in 2014 and 2018, if they were still in the CFPS 2018 sample and keep the same primary job of 2014 in 2018. This imputation adds around 1,811 observations in 2016.

we show a not-increasing negative individual-level hours-wage elasticity, which suggests that the substitution effect might not play a dominant role in explaining the increasing hours.

3.1 Aggregate Hours Worked

We begin our analysis by comparing hours per person allocated to different categories between 2008 and 2018. Before this assessment, it's worth noting that the composition effect could confound our findings. The first is the age composition effect. One example is population aging, where people in 2018 are on average older than those in 2008, and older people tend to work less; then an observation of increasing working hours from 2008 to 2018 could be underestimated due to the age composition effect. The second composition effect comes from education, where individuals are more educated in 2018 than in 2008 and people with higher education tend to work longer hours. This could overestimate the increase in working hours, if so. To account for the composition effects by age and by education, we divide individuals in the CTUS into 12 age groups and 6 education groups.[14] We calculate the population weight for 72 demographic groups in 2008 using the CTUS 2008 sample size, and then obtain weighted average hours in 2018 by summing the product between the raw average hours in 2018 in each demographic group and population weight in 2008 for this demographic group.

Table 1 reports time allocation per person by area and gender between 2008 and 2018. Several findings emerge. First, there are huge rural/urban differences in hours allocated to various activities. For example, rural individuals have longer market hours than urban individuals. Urban males on average worked 18.7 hours per week less than rural males in 2008 and 8.1 hours per week less in 2018 than their rural counterparts. Rural females worked 7.3 hours per week more than urban females in 2008 and 5.2 hours per week more in 2018. Regarding child care, rural males spent less time than urban males, while rural females spent similar time as their urban peers. In addition, rural individuals on average spent less time on education and enjoyed less leisure than urban individuals for both genders.

Second, for urban individuals, we observe an increase in market hours. The average market hours per person among urban males were 33.0 hours per week in 2008 and increased to 39.6 hours per week in 2018. The average market hours per person among urban females increased from 25.0 to 27.9 hours per week from 2008 to 2018. Regarding the economic

[14] The 12 age groups are 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, and 70-74. The 6 education groups include no schooling or below the primary school, primary school completed, middle school completed, high school completed, tertiary school completed, and college and above.

significance, the 6.6 (urban male) and 2.9 (urban female) higher weekly hours in 2018 correspond to 20 and 11.6 percent longer working time than in 2008. The increase in market hours among urban people is accompanied by a decline in home production and a decline in leisure. From 2008 to 2018, the average hours spent on home production decreased by 3.3 hours per week for urban males. Urban females experienced a much larger decline in hours spent on housework, from 23.6 hours per week to 17.3 hours per week, or a 6.3-hour decrease. Both urban males and urban females enjoyed a little less leisure between 2008 and 2018. The time spent on child care increased among urban individuals, from 2.1 hours per week to 4.0 hours per week for urban males, and from 4.0 weekly hours to 8.7 weekly hours for urban females. Females on average spend more time on both housework and child care than males.

Third, for rural individuals, market hours per person decreased by 5 hours per week for males and decreased by 4.2 for females. With the decline of market hours by rural individuals and the increase by their urban counterparts, the rural-urban gap in market hours has converged from 2008 to 2018. The decreasing working hours occurred with a slight decrease in time spent on housework, an increase in time spent on taking care of children, and an increase in leisure time. The only exception is that rural males spend 0.2 hours per week more on home production. While urban peers enjoyed less leisure in the decade, their rural counterparts consumed more leisure. The leisure time per week increased from 105.0 hours to 108.2 hours for rural males, and from 100.8 hours to 104.4 hours for urban females between 2008 and 2018.

Table 1: Time Allocation by Area and Gender: Hours Per Person

	Urban male		Urban female		Rural male		Rural female	
	2008	2018	2008	2018	2008	2018	2008	2018
Market hours	33.0	39.6	25.0	27.9	51.7	47.7	37.3	33.1
Non-market hours								
Home production	10.7	7.4	23.6	17.3	6.9	7.1	22.5	19.2
Child care	2.1	4.0	4.0	8.7	1.2	1.6	4.4	7.9
Education	4.7	4.7	4.2	4.3	3.2	3.4	3.0	3.4
Leisure	117.0	112.8	111.2	109.8	105.0	108.2	100.8	104.4
Total	168	168	168	168	168	168	168	168

Notes: This table reports the average weekly hours spent on each broad-use category of activities. The rural-urban definition is based on where the individual lives at the time of the survey. The sample includes all individuals aged 15-74. All means are calculated using fixed demographic weights in 2008: 12 age groups $\times$ 6 education groups.
Data source: The Chinese Time Use Survey 2008 and 2018.

3.2 Extensive Margin vs. Intensive Margin

Differences in hours worked per person are shaped by two margins: the extensive margin – differences in employment rates, and the intensive margin – differences in average hours per worker. To investigate what explains the change in hours worked per person, we decompose market hours per person into the above-mentioned extensive margin and intensive margin.

Table 2 reports the average employment rates and hours per worker in 2008 and 2018. We highlight the following findings. First, there are great rural/urban differences and also gender differences in both years. For instance, urban individuals have a lower probability of being employed than rural peers for both genders. Urban employees worked less than rural employees, except for urban female employees in 2018 who worked longer time than rural female employees. No matter in rural areas or in urban areas, males are more likely to be employed, and male employees work much longer than females.

Second, for urban adults, we observe a slight increase in employment rate among males and a moderate decrease among females. Between 2008 and 2018, the employment rate increased from 69.5% to 71.6% for males while this declined from 55.3% to 54.4% for females. Along the intensive margin, urban employees experienced an increase in working time from

2008 to 2018 for both genders. Market hours per worker increased from 43.0 hours to 48.6 hours per week for males, and from 39.0 hours to 42.7 hours per week for females. The differences in hours per worker account for almost 76.5% (15.3%/20%) increase in hours worked per person for males and 81.8% (9.5%/11.6%) for females. Therefore, the increase in market hours per person is mainly driven by intensive margin for urban individuals, i.e., the increase in hours worked among employees.

Third, for rural adults, the proportion of being employed dropped for both males and females. The employment rate decreased by 3.3 percent for males and 6.5 percent for females. On the other hand, rural workers worked around 4.6 fewer hours per week in 2018 than in 2008, for both males and females. Thus, the decline in hours worked per person is driven by the decrease along both the intensive and the extensive margins. As the main puzzle is for urban individuals along the intensive margin, we mainly focus on wage workers from now on.

Table 2: Employment Rate and Hours Per Worker by Area and Gender

	Urban male		Urban female		Rural male		Rural female	
	2008	2018	2008	2018	2008	2018	2008	2018
Employment rate, %	69.5	71.6	55.3	54.4	89.9	86.6	82.0	75.5
Market hours per worker	43.0	48.6	39.0	42.7	55.6	50.9	42.4	38.8

Notes: This table reports the employment rate (the fraction of adults who report being employed) and average weekly hours worked per worker among employed. The rural-urban definition is based on where the individual lives at the time of the survey. The sample includes all individuals aged 15-74. All means are calculated using fixed demographic weights in 2008: 12 age groups $\times$ 6 education groups.
Data source: Chinese Time Use Survey 2008 and 2018.

3.3 Hours Worked for Different Demographic Groups

So far we document that aggregate hours worked increased in the last decade in China. In this subsection, we explore further heterogeneity related to this fact by leveraging CFPS data, which contains comprehensive demographic and social-economic characteristics. As introduced in Section 2, we focus on salaried employees using CFPS data from now on. Overall, we find that the increase in aggregate hours worked is prevalent across all demographic groups, such as age, gender, education, sector, and childbearing. These findings suggest that the increase in aggregate hours worked is not likely driven by different compositions of the population.

Age Table 3 first reports the average hours per worker by age groups between 2010 and 2020. In each year, the hours worked per worker decreases with age. Young people on average work more hours per week than older cohorts. Across different years, all age groups experienced an increase in hours worked per worker during the ten years from 2010 to 2020. The increase in hours worked per worker is especially larger for prime-age workers: roughly 4-6 hours per week for wage employees at their prime ages (16-55) from 2010 to 2020.

Gender The second heterogeneity turns to gender. Again, female workers work fewer hours per week than their male peers in all years. For example, in 2010, females average worked 49.3 hours per week while males worked 51.7 hours per week. The average hours per worker increased for both male and female workers between 2010 and 2020. In 2020, females worked 52.4 hours per week – 3.1 hours higher than in 2010; while males averaged 57.4 hours per week – 5.7 hours higher than in 2010. The magnitudes of increase in hours worked for both genders are similar to what we find using the CTUS in Table 2.[15]

Education To investigate the heterogeneity by education, we define four education groups: those educated with (i) at most primary school, (ii) middle school, (iii) high school, and (iv) at least college. Low-educated workers work more than their high-educated peers, but all education groups experienced an increase in working hours. Among individuals in the lowest education group, the average hours worked per week was 57.1 in 2010 compared to 60.6 in 2020. The difference between ten years amounts to 3.5 hours for the lowest education group. For individuals with middle school and high school, these two education groups experience a similar magnitude of increase in hours worked per week: 53.6 to 59.5 and 48.6 to 54.3. For the highest education group with at least college, the average hours per worker is 4.4 higher per week in 2020 compared to 2010.

Sector We obtain the industry information for each worker based on their primary job. We then compute the average hours per worker among employees working in two industries (manufacturing and services). Both manufacturing workers and service workers work longer hours than before. Between 2010 and 2018, the weekly working hours increased from 53.5 to 57.8 for manufacturing workers and increased from 49.0 to 54.2 for services workers.

[15]In Table 2, market hours per worker increased by 6.6 hours per week for urban male employees and increased by 3.7 hours per week for urban female employees.

Childbearing The last demographic composition we consider is childbearing, which is related to a pronounced demographic phenomenon in recent years in China – a rapid decline in the birth rate. If the share of adults in the population who are willing to give birth to a child decreases and their working hours are higher than their counterparts who spend more time on childbearing, then the increase in aggregate hours is driven mostly by the increase in the share of adults who have no child or don't need to childbearing. We group individuals by their gender, whether they had at least one child, and the age of their youngest child if they had ever given birth to any children before. For males and females with and without children, working hours have become longer for all of them ten years later since 2010. The magnitudes of increases in working hours for those who need childbearing or do not need are similar. This suggests that the increase in aggregate hours worked is unlikely to be associated with the fact that more young people choose no childbearing.

Table 3: Hours Per Worker: Heterogeneity

	2010	2012	2014	2016	2018	2020
Age						
16-25	54.5	55.2	57.1	61.5	60.1	59.5
26-35	50.2	50.8	53.5	55.4	54.9	55.3
36-45	50.7	52.1	53.6	53.3	55.1	55.2
46-55	48.9	50.7	52.5	51.7	54.6	55
56-65	50.7	47.3	51.1	51.6	53.4	50.1
Gender						
Male	51.7	53.2	55.2	56.0	57.1	57.4
Female	49.3	50.2	52.0	53.9	53.1	52.4
Education						
Primary and below	57.1	56.5	58.9	60.8	60.2	60.6
Middle school	53.6	54.9	56.7	58.2	59.3	59.5
High school	48.6	50.0	51.3	53.6	54.3	54.3
College and above	44.4	45.1	46.6	48.3	48.9	48.8
Sector						
Manufacturing	53.3	54.0	56.4	56.9	57.8	–
Services	49.0	50.2	52.5	54.2	54.2	–
Childbearing						
Female without child	51.4	51.2	52.2	56.0	53.8	52.1
Female with child at ages 0-6	48.7	50.8	52.9	54.8	51.8	51.9
Female with child at ages 7-12	49.8	49.7	52.7	54.1	54.1	53.7
Female with child at ages 13-18	48.9	49.9	50.2	51.4	53.5	53.8
Male without child	52.2	54.3	55.3	58.1	58.6	58.5
Male with child at ages 0-6	53.3	54.7	56.9	57.5	58.0	58.2
Male with child at ages 7-12	52.0	52.9	55.6	56.4	58.6	58.9
Male with child at ages 13-18	51.5	53.5	53.2	54.5	56.3	58.5

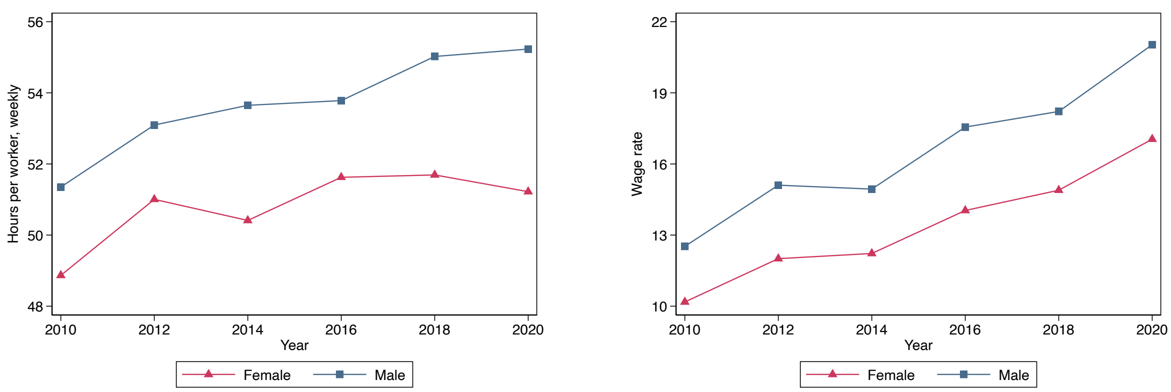
Notes: This table reports the average weekly hours worked per worker. The sample includes all salaried employees at ages 15+, and without farm or self-employment income. Industry information in 2020 is not publicly available. The age of the child is the age of the youngest child if the individual has two or more children.
Data source: CFPS 2010-2020.

3.4 Hours and Wages

In this section, we utilize individual-level wage data to study the relationship between hours and wages across sections and over time.

Figure 2 plots the trend in hours per worker and the trend in wage rate from 2010 to 2020. Within the sample of paid employees we focus on, we observe a rising trend in hours per worker for both male workers and female workers in Figure 2(a). Figure 2(b) shows the level of the wage rate for the same group of wage workers used in 2(a). The wage rate has experienced a surge coincident with the increasing working hours. Between 2010 and 2020, the average wage rate rose roughly 60% while market hours per worker increased around 6%. This is different from what happened in many developed countries, where increasing income levels come with declining working hours. One popular explanation for decreasing working hours in developed countries is the income effect, which assumes that people would work less if they received a higher income. However, we find that Chinese workers choose to work longer time even though they can earn a higher wage rate. This result implies that at the aggregate level, the other channels might be more important in explaining the longer working time in China, instead of the income effect.

Figure 2: Hours Per Worker and Wage Rate, 2010-2020



(a) Hours Per Worker

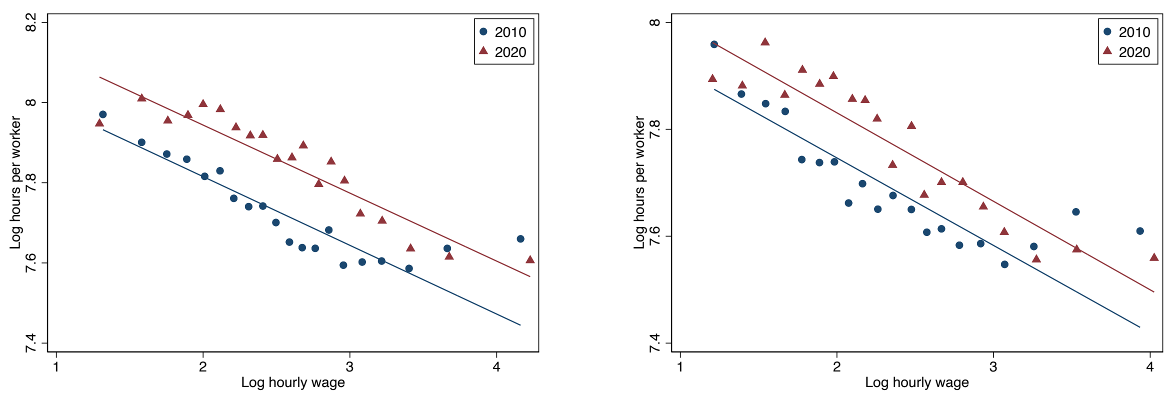
(b) Wage Rate

Notes: This figure plots the trend in hours per worker in Panel A and the trend in wage rate in Panel B. The wage rate is calculated by the total salary income divided by the total working hours during the same reference period. The sample is restricted to full-time workers (work at least 1200 hours per year) at prime ages (16-65).
Data source: CFPS 2010-2020.

We turn to the individual-level variations and ask whether the positive market hours-income relationship at the aggregate level over time is accounted for mostly by the individual elasticity. Figure 3 shows the bin scatter plots of log market hours per worker versus log wage rate in 2010 and 2020. From the cross-sectional perspective, market hours per worker are declining in the individual wage. Employees who earn a higher wage rate work fewer market hours, which points to a dominant role for preferences of income effects rather than substitution effects at the individual level. We run regressions in Table A1 and find that the hours-wage elasticity is significantly negative. This is consistent with the evidence from the majority of countries in the world where Bick et al. (2018) found a decreasing relationship between hours per worker and the individual wage.

However, when we compare the individual-level hours-wage elasticity in 2010 and 2020, we find that it remains largely unchanged instead of being flatter or even positive. Via eyeballing check, the two fitted lines of log working hours against log hourly wage in 2010 and 2020 are almost parallel to each other. The fact holds true when we estimate the elasticity by year as shown in Table A1. This suggests that the increase in aggregate market hours worked is not a result of a flatter individual hours-wage elasticity, and indicates some other aggregate time-varying features that lead to higher hours. We discuss these possible forces resulting in longer market hours in the context of China in the next section.

Figure 3: Correlation of Hour and Wages: 2010 vs. 2020



(a) Male Sample

(b) Female Sample

Notes: This figure shows the binscatter plot of log hours versus log hourly wage using individual-level observations. To construct the binscatter plot, we divide log hourly wage into 20 equal-sized bins and plot the means of log hours in 2010 and 2020 within each bin. The solid line stands for the slope estimated using OLS regression on the 20 points. The sample is restricted to full-time workers (work at least 1200 hours per year) at prime ages (16-65).
Data source: CFPS 2010 and 2020.

4 Why Hours Still Increase While Wages Grow?

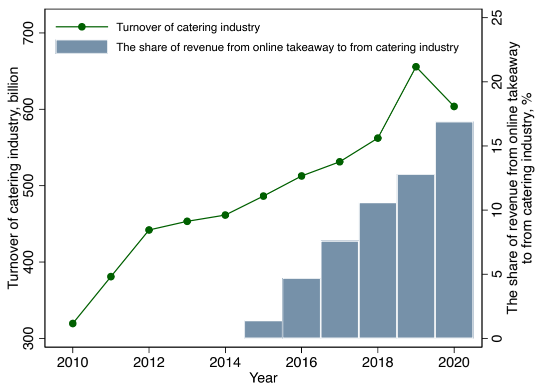
Thus far, we have shown that the average market hours worked have increased in China despite the concurrent growth of the wage rate. This increasing trend of market hours is unlikely to be driven by the composition of different demographic groups while market hours and wage rate are negatively correlated in cross sections, suggesting the dominance of income effect. In this section, we discuss potential time-varying factors that might explain why Chinese workers have higher market hours than before.

Substituting Non-Market Hours with Market Hours Though market hours have been rising sharply from 2008 to 2018, non market hours contracts almost at the same magnitude. Factors are required to explain this phenomenon shift in the structure of labor supply. This shift can be decomposed into two layers. First, households start to use market goods to substitute for home goods. For example, home away from from can substitute food at home. As depicted in Panel A in Figure 4, turnover of catering industry in China has been increasing by more than 100 percent from 2010 to 2019.

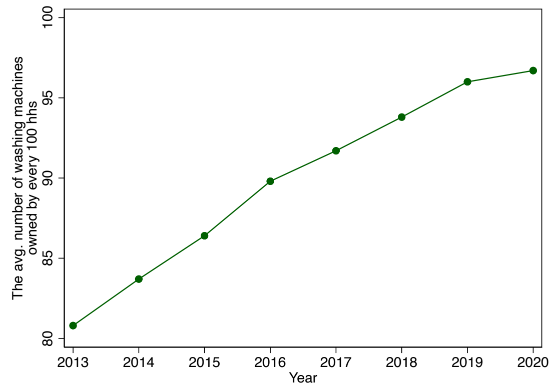
Secondly, home capital starts to substitute non-market hours in the production of home goods. For instance, even though dining out becomes relatively cheaper, people would still prefer to have food at home sometimes as they are not perfect substitutes. To have food at home, one increasingly popular choice is ordering food delivery service. Panel A in Figure 4 shows share of online takeout in the catering industry grows from nothing to over 15 percent from 2014 to 2020. Panel B in Figure 4 also displays the universal usage of washing machine is accomplished within the same period. The expenditure on food delivery service or purchasing washing machine, can be viewed as expenditure on home capital to produce home goods.

Intuitively, a higher wage rate implies a higher shadow cost of non market hours and relatively cheaper market goods. It is optimal for household to substitute market goods for non market goods and substitute home capital for non market hours by allocating more time to market job if the two pairs are substitutes. Meanwhile, the price of home capital might become even cheaper relative to market good due to a productivity growth in producing home capital. This margin delivers additional inventive to substitute home capital for non market hours.

Figure 4: The Decline of Non-Market Hours: Food Production and Washing Machine



(a) Share of Online Takeout in Catering Industry



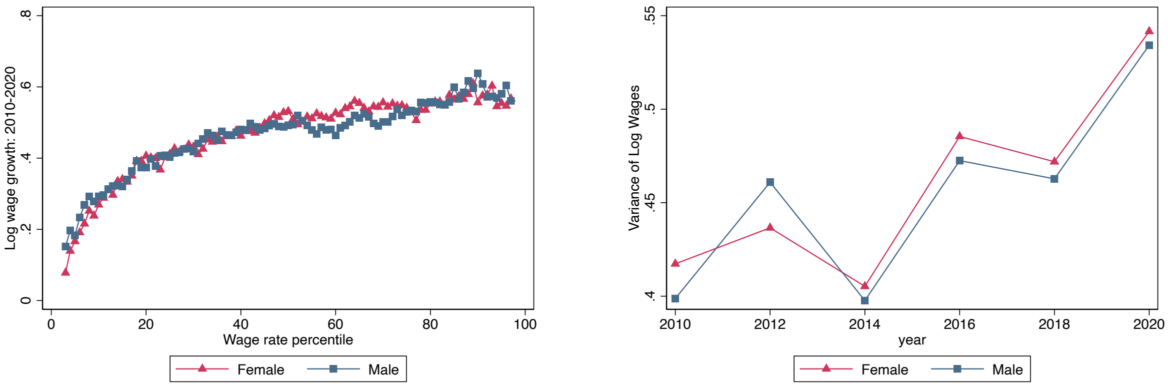
(b) Numbers of Washing Machine Per 100 hhs.

Notes: This figure shows the trend of turnover of the catering industry and the share of the revenue from online takeaway to from the catering industry in Panel A, and the trend of the average number of washing machines per 100 households in China
Data source: the turnover of the catering industry and the number of washing machines are from the National Bureau of Statistics, and the share of online takeaway is from The State Information Center.

Rising Wage Inequality and Uncertainty The second aggregate factor is wage inequality and income uncertainty. Rising income uncertainty might contribute to longer working hours via precautionary saving motives. Then a higher income uncertainty would induce people to save more by decreasing their consumption and increasing their labor supply.

Wage inequality in China has been rising in the last decade. Panel A in Figure 5 displays the wage growth between 2010 and 2020 by income percentile. We find that higher wage growth is achieved among those who have earned a high wage before. This demonstrates a rising wage inequality in the last ten years. Panel B further plots the variance of the log wage rate over time. For both genders, the variance of the log wage rate has been escalating, suggesting a growing wage inequality over time. To examine what contributes to the increasing wage inequality, we decompose the variances into deterministic and stochastic components in section 6. We estimate the income process by utilizing the individual-level panel data on wage residuals from CFPS. It allows us to estimate the contributions from persistent shocks and transitory shocks in explaining the rising inequality.

Figure 5: Wage Inequality Between 2010 and 2020



(a) Wage Growth By Income Percentile

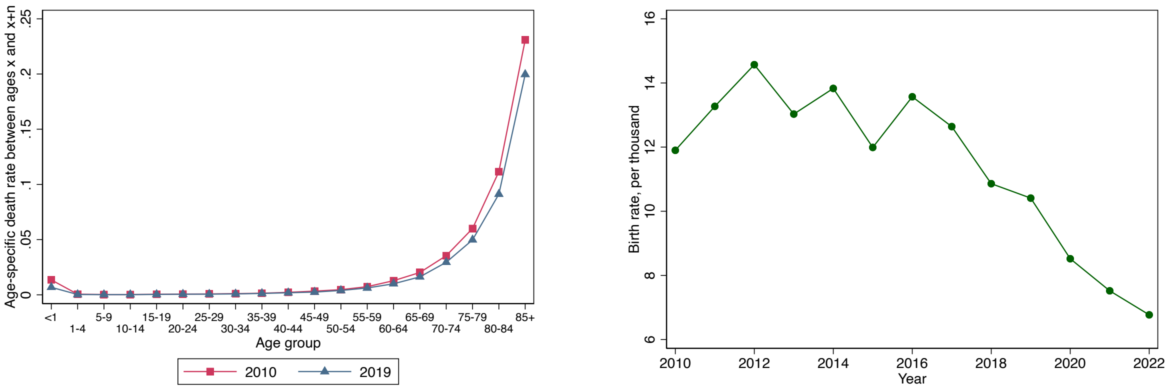
(b) Variance of Log (Wage) over Time

Notes: This figure shows the wage inequality by income percentile and age. Panel A plots the average wage rate growth between 2010 and 2020 by wage rate percentiles. We divide hourly wage into 100 equal-sized groups and obtain the median wage rate within each group in 2010 and 2020. The y-axis is the log difference of each group's median hourly wage rate. Panel B plots the variance of log individual wage rates in 2010 and 2020 by gender. The sample is restricted to full-time workers (work at least 1200 hours per year) at prime ages (16-65).
Data source: CFPS 2010 and 2020.

Aging and Public Pension The third change in institutional factors is the demographic changes. The age structure of the total population and life expectancy could affect individual decisions on working hours. An aging population and a decreasing number of newborn babies today together suggest a rise in the dependency ratio in the future. In other words, with the pay-as-you-go public pension system, fewer people working can support the dependent population in coming times. Additionally, with a prolonged life expectancy, people living in the present period are aware that they need to save more now for their future use in older ages. These demographic changes combined could be likely to explain why Chinese workers work longer now.

China is experiencing such demographic changes rapidly. Panel A of Figure 6 plots the age-specific death rate in 2010 and 2019. All age groups experienced a drop in death rate from 2010 to 2019. Furthermore, older cohorts saw a larger drop in death rate than younger cohorts at prime-working ages. Panel B shows the trend of birth rate since 2010. China's birth rate has been declining for years since the 2010s. Scrapping the one-child policy in 2016 only temporarily increase the birth rate to a very limited extent, largely leaving behind what people expected before. The combination of a decreasing birth rate and age specific death rate means that there will be fewer young workers in the labor market in the future times. We will plug in parameters that capture this demographics shift in our quantitative model and investigate to what extent this relating to dynamics in labor supply moments we want to match.

Figure 6: Age-specific Death Rate and Birth Rate



(a) Death Rate

(b) Birth Rate

Notes: This figure plots the age-specific death rate in Panel A, and birth rate in Panel B. Data source: birth rate data from National Bureau of Statistics, death rate data from World Health Organization (WHO).

5 Model

The economies we investigate are extensions of Huggett (1996) with endogenous labor supply. The main characterization follows Heathcote et al. (2010b). Time is discrete and infinite. We first introduce demographics, production and preferences. Next, we describe households' problems, firm's problem and government policies. Finally, we define the steady state equilibrium in our economy.

5.1 Demographics

The economy is populated by a continuum of individuals and there is no aggregate uncertainty. We consider overlapping generation model, where age is indexed by j, $j \in \mathcal{J} \equiv \{1, 2, ..., J\}$. Individuals live a maximum of J periods and face an probability s_j of surviving up to j conditional on surviving up to $j-1$. Population is growing at an exogenous rate n. Let μ_j be the density of population with age j:

$$\mu_j = \frac{s_j}{1+n}\mu_{j-1}$$

In an economy with constant population growth rate and age specific survival rate, age structure is stationary so we normalize aggregate population density to be one.

$$\sum_{j=1}^{J} \mu_j = 1$$

Individuals enter into labor market at age $j = 1$ and work for J^w periods. They retire from $J^w + 1$ starting receive pension and die with probability of 1 at age $j = J$. The retirement age is exogenous.

5.2 Production

Final good is produced by a representative firm who use aggregate capital K and aggregate market labor as inputs H with Cobb-Douglas technology:

$$Y = AK^{\alpha}H^{1-\alpha}$$

A is total factor productivity and α is capital share. Each period capital K depreciates at rate δ. Final good can be used for market goods consumption, investment and government expenditure. We normalize the price of final good to be one.

Final good can also be used to produce home capital K_h according to a linear technology:

$$K_h = A_h Y_h$$

where Y_h is the market good input and A_h is the productivity in producing home capital. We assume the depreciation rate of home capital is 1[16]. We assume the market for producing home capital is competitive and the implied price for home capital is $1/A_h$

5.3 Preferences

Following MaCurdy (1981), the period utility function is:

$$u(c, h) = \frac{c^{1-\gamma}}{1-\gamma} - \psi \frac{h^{1+\sigma}}{1+\sigma}$$

[16]The household problem can be easily rewritten to allow depreciation in home capital as long as there is no adjustment cost in home capital.

where $c \geq 0$ is final consumption and $h \in [0, 1]$ is the sum of market hours and non-market hours:

$$h = n_h + n_m$$

γ is the relative risk aversion and inverse of inter-temporal elasticity of substitution. σ is inverse of Frisch elasticity of labor supply, measuring elasticity of hours worked to the changes in wage rate, given a constant marginal utility of consumption.

We follow McGrattan et al. (1997) to characterize the preferences on home production. Final consumption is an aggregate over market goods c_m and home goods c_h where ω_2 is the weight on market goods and ξ_2 is the elasticity of substitution between market goods and home goods.

$$c = [\omega_2 c_m^{1-\frac{1}{\xi_2}} + (1-\omega_2) c_h^{1-\frac{1}{\xi_2}}]^{\frac{1}{1-\frac{1}{\xi_2}}}$$

Home goods is an aggregate over home capital k_h and non market hours n_h. ω_1 is the weight on home capital and ξ_1 is the elasticity of substitution between home capital and non market hours.

$$c_h = [\omega_1 k_h^{1-\frac{1}{\xi_1}} + (1-\omega_1) n_h^{1-\frac{1}{\xi_1}}]^{\frac{1}{1-\frac{1}{\xi_1}}}$$

. Let us define the expenditure on home capital as d, $d = k_h/A_h$ and we can rewrite c_h as:

$$c_h = [\omega_1 (A_h d)^{1-\frac{1}{\xi_1}} + (1-\omega_1) n_h^{1-\frac{1}{\xi_1}}]^{\frac{1}{1-\frac{1}{\xi_1}}}$$

5.4 Households' Problem

Agents are born with identical preference at age $j = 1$:

$$\mathbb{E}[\sum_{j=1}^{J} \beta^j (\prod_{m=1}^{m=j} s_m) u(c_j, n_j)] \tag{1}$$

Agent's efficiency units per hour of market work (or individual labor productivity) depends on age(experience) and an idiosyncratic component labor productivity y_{ij} that follows the following stochastic process. Therefore, the hourly wage for an individual i of age j is:

$$p_{ij} = \underbrace{w}_{\text{common wage rate}} \times \underbrace{\exp[L(j) + y_{ij}]}_{\text{individual i's efficiency unit}} \times \underbrace{\frac{1}{\int_{\mathcal{S}} \exp[y_{ij}] d\lambda}}_{\text{normalization term}} \tag{2}$$

The normalization term aims to keep the expected level of idiosyncratic component being constant. Then, any changes in the stochastic process of y will not shift the aggregate labor productivity. Following income process estimation literature, We model y_{ij} as the sum of two orthogonal components: a persistent component $z_{ij} \in \mathcal{Z}$ and a transitory component $\varepsilon_{ij} \in \mathcal{E}$. The initial value of persistent component z_{i1} is drawn from a initial dispersion that describes the labor productivity differentials when individuals enter into the labor market.

$$y_{ij} = z_{ij} + \varepsilon_{ij}$$

$$z_{ij} = \rho z_{i,j-1} + \eta_{ij} \tag{3}$$

$$\varepsilon_{ij} \sim N(0, \sigma_\varepsilon^2), \qquad \eta_{ij} \sim N(0, \sigma_\eta^2), \qquad z_{i1} \sim N(0, \sigma_z^2)$$

To face idiosyncratic income risks, the financial market is incomplete. Agents can only save or borrow in a risk free asset. Let $a \in \mathcal{A} = [\underline{a}, \infty]$ denotes the asset position where $\underline{a}$ is the exogenous borrowing limit. The net return on risk free asset is r and we assume there is no wealth tax given paying wealth tax is rare in our sample in China. Additionally, we assume that asset of agents who die will be distributed proportionally to asset holdings within the same cohort for simplicity. Therefore, the total return of risk free asset is $(1+r)/s_j$. Agents can also insure themselves with endogenous labor supply and earnings $p(w, z, j, \varepsilon)h$ is subject to tax rate τ^p. Notice that this tax refers pension fund payment which is used to finance pension expenditures. As is discussed before, the average labor income tax rate individuals face are very low in China and labor income tax is not a main source of government income. As a result, we do not model additional labor income tax in our model. Then we describe the agents' problem for working age individuals with age $j \in \{1, 2, .., J^w\}$ in recursive form:

$$V(a, z, j, \varepsilon) = \max_{c_m, a', n_h, n_m, d} u(c, h) + \beta s_{j+1} \mathbb{E}[V(a', z', j+1, \varepsilon' | z)] \qquad s.t. \tag{4}$$

$$c_m + a' + d = \frac{1+r}{s_j} a + (1 - \tau^p) p(w, z, j, \varepsilon) n_m$$

$$a' \geq \underline{a}, c \geq 0, h \in [0, 1]$$

For individuals with age $j \in \{J^w + 1, .., J\}$, they are restricted staying way from labor market. A fixed amount pension comes from social security fund b will be provided in each period. Though we still keep their productivity component variables in state variables for consistency, policy functions will only depend on (a, j).

$$V(a,z,j,\varepsilon) = \max_{c,a',n_h,d} u(c,h) + \beta s_{j+1}\mathbb{E}[V(a',z',j+1,\varepsilon'|z)] \qquad s.t. \tag{5}$$

$$c + a' + d = \frac{1+r}{s_j}a + b$$

$$a' \geq \underline{a}, c \geq 0, h = 0$$

5.5 Firm's Problem

There exists a representative firm who use aggregate capital and labor to produce final good. Firm's output is subject to a value added tax τ^f, motivated by the fact that value added tax is the largest single tax funding resource of the government in China. Given prices $\{w, r\}$ and tax rate, firms choose input to maximize profit.

$$\max_{K,H}(1-\tau^f)AK^\alpha H^{1-\alpha} - wH - (r+\delta)K \tag{6}$$

The optimality conditions are:

$$w = (1-\alpha)(1-\tau^f)AK^\alpha H^{-\alpha}, \quad r+\delta = \alpha(1-\tau^f)AK^{\alpha-1}H^{1-\alpha} \tag{7}$$

5.6 Government

Government has two independent budgets to balance. Pension system is Pay-as-you-go. A system in which retirement benefits are financed by contributions levied from current workers, as opposed to a funded system in which contributions are invested to pay for future benefits. Let τ^b be the replacement rate which measures the ratio of pension benefit to average labor earning for working age population. The pension system budget is:

$$\tau^p wH = b\sum_{j=j^w+1}^{J}\mu_j = \tau^b \frac{wH}{\sum_{j=1}^{J^w}\mu_j}\sum_{j=j^w+1}^{J}\mu_j \tag{8}$$

Government expenditure is financed by value added tax.

$$\tau^f AK^\alpha H^{1-\alpha} = G \tag{9}$$

5.7 Competitive Equilibrium

Now we describe the steady state recursive competitive equilibrium. The state space is denoted by $\mathcal{S} \equiv \mathcal{J} \times \mathcal{A} \times \mathcal{E} \times \mathcal{Z}$. Let $\Sigma_{\mathcal{S}}$ be the sigma algebra on $\mathcal{S}$ and $(\mathcal{S}, \Sigma_{\mathcal{S}})$ the corresponding measurable space. Denote the stationary distribution as λ.

A competitive equilibrium is a value function $V(s)$; decision rules $c(s), a'(s), h(s)$; firm choices H, K; prices r, w, tax rates τ^p, τ^f, retirement benefit b government expenditure G and and measures of agents λ, such that:

1. Given prices, retirement benefit and tax rates, the policy functions $c(s), a'(s), n_m(s), n_h(s), d$ solve the household's problem (4), (5) for working periods and retirement periods while $V(s)$ is the associated value function.

2. Given prices, the firm chooses optimally its capital K and its labor H, equation (7) is satisfied.

3. Labor market clears.
$$H = \int_{\mathcal{S}} n_m(s) d\lambda$$

4. Capital market clears. Government budget balances.
$$K(1+n) = \int_{\mathcal{S}} a'(s) d\lambda$$

5. Goods market clears
$$AK^{\alpha}H^{1-\alpha} = \int_{\mathcal{S}} c_m(s) d\lambda + (1+n)K - (1-\delta)K + G + \int_{\mathcal{S}} d(s) d\lambda$$

6. The government budget is balanced, equation (8), (9) are satisfied.

7. The invariant distribution λ is consistent with household decision rules. For all $s \in \mathcal{S}$ and $\mathbb{S} \in \Sigma_{\mathcal{S}}$, the invariant probability measure λ satisfies
$$\lambda(\mathbb{S}) = \int_{\mathcal{S}} Q(s, \mathbb{S}) d\lambda$$
while the transition function $Q(s, \mathbb{S})$ is defined as:
$$Q(s, \mathbb{S}) = I\{j+1 \in \mathbb{J}\} I\{a(s) \in \mathbb{A}\} Pr(\varepsilon \in \mathbb{E}) \sum_{z' \in \mathbb{Z}} \pi(z', z)$$

6 Calibration to the Chinese Economy

With the quantitative model we describe the last section, we now turn to calibrate it. The main target of our quantitative model is to reproduce rising market hours from 2010 to 2020 and conduct an accounting exercise to find what factors contribute to this phenomenon and by how much. The calibration exercises are conducted in three stages. In the first stage, we try to determine the value of externally calibrated parameters, including income process estimation. In the second stage, we try to choose a set of internally calibrated parameters including elasticity of between market goods and home goods as well as elasticity of substitution between home capital and non market hours to match a set of selected steady state moments in 2010. In the third stage, we choose time-varying internally calibrated parameters, the productivity growth in producing final good and home capital, to match some moments in 2020.

6.1 First-Stage Calibration

6.1.1 Externally Calibrated Parameters

Table 6 summarizes the choices of externally calibrated parameters. We choose relative risk aversion to be 1.5, in the middle of the range that micro estimations suggest Attanasio (1999). This choice implies that income effect dominates substitution effect, in line with the long run evidence documented by Boppart and Krusell (2020). The choice of relative risk aversion governs the elasticity of average market hours on total factor productivity. We choose Frisch elasticity of labor supply to be 1. Though the number is greater than some of the early micro estimation surveyed by Blundell and MaCurdy (1999), it is consistent with compensated elasticities at macro level Keane and Rogerson (2015). Indeed, the financial frictions in our model implies why micro estimate might be subject to downward bias. We choose length of life cycle to be 70, reflecting individuals enter into labor market at age 20 and exit at age 90. Statutory retirement age varies by gender and occupation type in China. The statutory retirement age is 60 for male, 55 for female administration and research staff and 50 for female manufacturing staff. We choose the length of working periods to be 40 as an upper bound. Age is the only demographics heterogeneity we consider in our model, we estimate experience profile from the regression we compute hourly wage rate dynamics. We choose pension tax rate to be 20% that corresponds to employer contribution in China's pension system. All employer contributions shall be deposited into social pooling fund as social security transfers and it is consistent our model set up. Notice that the model is isomorphic no matter this tax is imposed on employer or employee. Since all employee contributions shall be deposited into his/her individual account, we omit this tool because it is perfect substitute of individual saving in our model. We assume no borrowing is possible and set asset holding lower bound to be 0. α is chosen to match the capital share and we borrow estimation of depreciation rate in China from Herd (2020).

The age specific survival rates we plug in two steady states come from WTO database as shown in Panel A of Figure 6. Though one-child policy was lifted in the beginning of 2016, the birth rate has been experiencing a dramatic decline starting from 2016. This quick shift in population growth rate is largely unexpected as most people believe the abolish of one child policy can boost the birth rate for a longer period. Though the changing population growth rate will not affect the age structure and dependent ratio instantaneously, but the effect on pension system is fully anticipated. Forward looking households will adjust their consumption, saving and labor supply instantaneously. We assume that households form expectations on birth rate growth rate as the average of birth rate growth rate from the last ten years. Under this belief, population growth rate in the birth cohort to be zero in the 2010 steady state and -0.03 in the 2020 steady state. Productivity in producing final goods in 2010 and productivity in producing home capital good are normalized to be 1 in 2010 steady state.[17]

[17] A_h is not identifiable among ω_1 and ω_2.

Table 4: Summary of Externally Calibrated Parameters

Parameters	Description/Sources	Value
Invariant Parameters:		
γ	Micro-estimates of intertemporal elasticity of substitution	1.5
σ	Micro-estimates of elasticity of labor supply	1
J	Length of life cycle age 20-90	70
J^w	Length of working periods age 20-60	40
$L(j)$	Experience profile from equation	Equation 10
τ^p	Basic old-age insurance public fund tax rate	0.2
$\underline{a}$	No borrowing	0
α	Capital share	0.4
δ	Capital depreciation rate	0.05
ρ	Permanent shock	1
τ_f	Government expenditure to GDP ratio	0.25
A^{2010}	Normalization	1
A_h^{2010}	Normalization	1
Variant Parameters:		
$\sigma_{\varepsilon,2010}/\sigma_{\varepsilon,2020}$	Wage rate residuals dynamics from CFPS	0.155/ 0.143
$\sigma_{\eta,2010}/\sigma_{\eta,2020}$	Wage rate residuals dynamics from CFPS	0.0076/0.0182
$\sigma_{z,2010}/\sigma_{z,2020}$	Wage rate residuals dynamics from CFPS	0.1628/0.2400
$s_{j,2010}/s_{j,2020}$	Age specific survival rate	Figure 6 Panel A
n_{2010}/n_{2020}	Growth rate in birth rate	0/-0.03

6.1.2 *Income Process Estimation*

We utilize residuals in hourly wage rate dynamics from CFPS data estimating income process estimation that follows the model in the previous section. We restrict our sample to full-time workers who work at least 1200 hours per year at ages 20-60. Since labor force participation rate for female is high in China, the selection is not very strong. Hence, we do not restrict our sample only to male sample and our estimation can cover the whole population. Let $w_{i,j,t}$ be the hourly wage rate for individual i, at age j and year t. We get residuals by regressing $w_{i,j,t}$ on a time dummy and and a cubic polynomial in potential experience (age minus years of education minus six) $L(j)$.

$$ln(w_{i,j,t}) = \beta_t^0 + L(j) + y_{i,j,t} \tag{10}$$

The specification is consistent with equation (2) where we describe how the hourly wage at individual level is determined.Then we are going to take residuals by period and education groups to estimate different sets of parameters including variance of transitory shocks, the variance of permanent shocks and variance of the initial distribution of permanent component. I follow the procedure of Heathcote et al. (2010a) in estimating income process. Note that the variance of permanent and transitory shocks is time-variant but we assume they do not depend on age profile. Intuitively, covariances give the same component between two periods, namely permanent component. The variance of residuals gives the sum of the variance of permanent component and a transitory component. Identification is achieved by the following two sets of identities.

$$var(y_{it}) - cov(y_{i,t+2}, y_{i,t}) = \sigma^2_{\varepsilon t}$$

$$var(y_{it}) - cov(y_{it}, y_{i,t-2}) = \sigma^2_{\varepsilon t} + \sigma^2_{\eta,t-1} + \sigma^2_{\eta,t-2}$$

Variance of initial dispersion is computed as the variance of log wage in age $j = 22$ minus estimated variance of transitory shocks.

$$\sigma^2_{zt} = var(y_{i,j=22,t}) - \sigma^2_{\varepsilon t}$$

Table 5 presents the estimation results. From 2010 to 2010, there is an increasing trend in variance of permanent shocks and variance of initial distribution. The trend in variance of transitory shocks is less obvious with a spike in 2012. Indeed, if we consider there exists a measurement error that follows mean zero variance σ^2_e normal distribution and is independent of transitory shocks. The number we estimate here is a sum of variance of transitory shocks and measurement errors. Hence, the main conclusion we draw from this income process estimation is rising wage rate inequality is mainly driven by increases in variance of persistent shocks and initial distribution. We do not model the micro foundation of initial dispersion, neither in structural model nor statistical model. But the idea is it potentially covers deterministic features like education premium, gender gap and geographic differentials. A rise in initial dispersion likely represents a rise in skill premium and compensation differentials across regions. To set parameters in the two steady states we consider, we take the average of the two earliest estimated values as parameters we plug in "2010 steady state" and the average of the two latest estimation values in each column as parameters we plug in "2020 steady state".

Table 5: Income Process Estimation

	(1) σ_η^2	(2) σ_ε^2	(3) σ_z^2
2010		0.125	0.1886
		(0.0123)	
2012	0.0066	0.185	0.1478
	(0.0034)	(0.0145)	
2014	0.0086	0.147	0.2016
	(0.0044)	(0.0103)	
2016	0.0265	0.149	0.2177
	(0.0078)	(0.0085)	
2018	0.0171	0.118	0.2435
	(0.0040)	(0.0078)	
2020	0.0193	0.168	0.2364
	(0.0061)	(0.0132)	

Notes: In this table, I tabulate the estimation results for income process using CFPS sample from 2010 to 2020. Bootstrap standard error in parentheses.

6.2 Second and Third Stage Calibration

In the second stage, we jointly estimate the six parameters left in matching moments in 2010 steady state. The model is complex and non-linear, and there does not exists precise one to one mapping that discipline the model outcomes. However, we choose a selected set of moments to match, regulating the parameterization in intuitive ways. Within the production of home goods, higher weight on home capital implies a higher share of expenditure on home capital relative to the expenditure on market goods. The static choice between non market hours and expenditure on home capital is given by the following first order conditions:

$$(1-\omega_1)n_h^{-\frac{1}{\xi_1}} = p(w,z,j,\varepsilon)\omega_1 A_h^{1-\frac{1}{\xi_1}} d^{-\frac{1}{\xi_1}} \tag{11}$$

Given $\xi_1 > 1$, home capital and non market hours are substitute, a higher wage rate or higher productivity in producing home capital implies a higher expenditure on home capital to non market hours ratio while the sensitivity is governed by ξ_1. Similarly, a higher weight on market goods implies a higher share of market hours in total hours. Agents with higher wage tends to consume a higher share of market goods while the sensitivity is affected by ξ_2. Our estimation results of weights and elasticities of substitution in home production are generally in line wit McGrattan et al. (1997) and Dotsey et al. (2014).

Disuitility of labor affects total hours and discounting factor influences interest rate and wealth to income ratio or capital to output ratio for the whole economy.

Table 6: Summary of Internally Calibrated Parameters

Parameters	Description/Moments to Match	Value	Relative Moments
Second-Stage			
ω_1	Weight on home capital	0.55	Average d/c_m
ξ_1	Sub. betw. n_h and k_h	1.52	Elas. of n_h to wage rate
ω_2	Weight on market goods	0.48	Average n_m/n_h
ξ_2	Sub. betw. market and home goods	2.16	Elas. of n_m/n_h to wage rate
ψ	Disutility of labor	4.29	Average total hours
β	Discounting factor	0.987	Average wealth to income ratio
Third-Stage			
A^{2020}	Productivity in producing final goods 2020	1.42	Change in wage rate
A_h^{2020}	Productivity in producing home capital 2020	1.45	Change in average n_m/n_h

In the third stage, we try to estimate the productivity growth in producing final good as well as home capital. The direct impact of productivity growth in producing final goods is reflected in the wage rate per efficiency unit. The indirect impact is household tend to use market hours to substitute non market hours as shown in equation 11. On the other hand, productivity growth in producing home capital also encourage households to substitute market hours for non market hours. In the calibration, we first choose A^{2020} to match the growth in wage rate from 2010 to 2020 and then choose A_h^{2000} to recover the change in n_m/n_m which is not fully explained by A^{2020}.

7 Quantitative Results

With the calibrated model, we now turn to compute model outcomes in two steady states and see if the time-variant parameters and associated channels can explain the four main moments in labor supply we are interested in: the sharply rising markets hours, the sharply declining non market hours, the flat total hours and the modestly declining negative cross section correlation between hourly wage rate and market hours across individuals. The first three empirical moments are computed using urban sample in Chinese Time Use Survey while the fourth moment is computed by CFPS. As the model does not contain child care, we restrict non-market hours to core housework.[18]. With respect to model simulated moments, we restrict simulated data to agents with age 20-74 for the first three moments to be consistent with empirical moments. For the fourth moment, we restrict simulated data to agents with working age 20-60.

Table 7: Model Outcomes

	h	n_m	n_h	$Corr_{p,n_m}$
Panel A: Model versus Data				
2010 Data	0.411	0.258	0.153	-0.384
2010 Model	0.411	0.258	0.153	-0.313
2020 Data	0.411	0.301	0.110	-0.418
	(0.0%)	(16.7%)	(-28.1%)	
2020 Model	0.402	0.296	0.106	-0.349
	(-2.2%)	(14.7%)	(-30.7%)	
Panel B: Model Partial effect				
TFP	0.364	0.235	0.129	-0.249
	(-11.5%)	(-8.9%)	(-15.7%)	
Productivity in home capital	0.393	0.282	0.111	-0.341
	(-3.9%)	(9.3%)	(-28.1%)	
Income Process	0.431	0.270	0.161	-0.344
	(4.9%)	(4.4%)	(5.2%)	
Demographics	0.448	0.283	0.165	-0.347
	(8.3%)	(9.7%)	(7.8%)	

Notes: Panel A reports empirical moments in two years and model simulated moments in two steady states separately. Panel B reports the partial effect of model generated moments through changing parameters from 2010 steady state, respectively.

From 2008 to 2018, weekly market hours per person increases from 29.0 to 33.8 hours in Chinese Time Use survey. The market hours per worker also increases the similar magnitude in our core CFPS sample. Interestingly, there is a same amount of rise in non market hours and the total hours do not change. The correlation between hourly wage rate and market hours drops around -0.034. From panel A in Table 7, not surprisingly, our quantitative

[18] We assume that total available time is 112 hours per week. From table 1, we define empirical market hours as market hours/112, empirical non market hours as home production/112, leisure is defined by (112-market hours-home production)/112

model in 2010 matches moments in hours well since they are targeted moments. The model generates a negative correlation between market hours and wage rates across individuals. The level of the correlation between market hours and wages is untargeted moment in our calibration so we do not quite hit it. The success of our model can be examined by the performance to match data in 2020 since they are not targeted. Our model slightly undershoots total hours but replicates the diverging trend between market and non market hours reasonably well. Meanwhile, the model successfully generates a a modest decline in correlation between wages and hours as the data suggests.

To examine how much shift is led by which variant factors, we start with 2010 model parameters and only change one class of parameters to see the partial effect as presented in Panel B. The TFP growth lead to a 11.5% drop in total hours since income effect dominates. As households substitute market hours for non market hours, non market hours experience a larger decline relative to market hours. TFP growth also generates an increase in correlation between wages and market hours holding all else equal. This is consistent with cross country evidence documented by Bick et al. (2018).

Secondly, a productivity growth in producing home capital delivers a contacting total hours due to positive income effect. As home capital becomes relatively cheaper, substitution effect on market hours overweighs income effect and market hours expands. Substitution effect and income effect are in the same direction for non market hours. This is the key channel to recover a diverged trend between market and non market hours.

Thirdly, we just modify the parameters in income process estimation to see a partial effect. Overall, rising initial dispersion and larger variance of persistent shocks lead to higher hours and stronger negative correlation between market hours and wage rates. An increase in initial dispersion expands the wage inequality directly. The existence of incomplete market implies a more unequal economy is associated with a larger density of households hit by borrowing constraint in steady state. Individuals who hit the borrowing constraint are not Euler equation consumers and fail to smooth consumption. The inefficient low level of consumption would be associated with inefficient high level of market and non market hours implied by intratemporal substitution between consumption and leisure. An increase in variance of permanent shocks would first increase ex post wage inequality and it first inherits all the effects of a higher initial dispersion. Furthermore, larger income uncertainty pushes up precautionary savings and reduce consumption as well as leisure. The magnitude of idiosyncratic shocks affects the correlation between market hours and wages in an intuitive way. If the shock is fully insurable and is independent of marginal utility of consumption, only substitution effect stands out. Workers work more when wages are high and less when wages are low. On the other hand, if the shock is uninsurable, the shock will affect the marginal utility of consumption and therefore income effect may dominate, depending on the strength between income and substitution effect and the pass through from shocks to consumption. In our exercises, the main action in an increase in variance of permanent shocks which is highly uninsurable Blundell et al. (2008). Hence, the correlation between wages and hours goes down in response to the change in idiosyncratic wage process.

Finally, the combination of decline in death rate and birth rate implies a worsening working population to whole population ratio. In our exercise, we assume pension contribution rate to be constant and therefore pension replacement ratio is endogenous. An aging population structure implies a lower pension replacement ratio in an expected way. Individuals have to build up savings because expected life expectancy is growing and expected transfer is declining. Since poor people rely more on pension transfer, the decline in birth rate hurts the magnitude of social insurance endogenously by lowering the volume of transfer. Therefore, poor households have to work for even longer and this makes the correlation between wages and market hours smaller.

To conclude, not surprisingly, our model shows that a pure TFP growth would lead to lower market hours and non market hours as well as higher correlation between market hours and wages as suggested by cross country evidence. However, all the mechanism we propose in section 4, growing productivity in producing home capital, rising uninsurable risks as well as aging, contributing to reconcile the tension between rising hourly wage rate and rising market hours as a puzzling empirical finding in urban China given income effect dominates in the long run. Our quantitative model is only able to speak to the trend in the urban area. In the rural area, the income process could be very different from urban salary workers. Additionally, agriculture workers do not contribute to pension fund and will not link the changing demographics structures to social security benefit. In contrast, people in the rural area get large transfer in 2020 compared with 2010. Agriculture workers stated to get pure transfer as social pensions starting from 2009[19] and Huang and Zhang (2021) find the welfare gain form this program is substantial. The trend of time allocation in rural area is likely to be explained by a preference with subsistence level, an increase in TFP and a higher net transfer.

[19]The pilot program started in 2009 and the program covered the whole country in 2014.

8 Conclusion

We conclude by answering the questions we ask in the first paragraph in section 1. Time allocation does shift dramatically in China in just ten years but the direction and magnitude depends on where one lives. Urban workers experience an increase in markets hours by around 3 to 6 hours per week accompanied with 60 percent growth in average wage rate in the same period. Even though the trend in total hours is dampened by a substantial contract in non market hours, the total hours are far from a declining trend. On the other hand, rural, agriculture workers' life become relatively easier with lower market hours and higher leisure. The secular trend of market hours for urban workers is very different from empirical evidence in other economies at the same development stage, creating a difficulty to rationalize the phenomenon that market hours and wage rates grow at the same time but they are negatively correlated cross sections. To reconcile this conflict, we build a heterogeneous agent life cycle model with incomplete market and home production to conduct an accounting exercise. we find rising productivity in producing home capital, income uncertainty and worsening expected working population ratio generate significant impact on market hours as predicted by our calibrated quantitative model. The quantitative model successfully replicates the empirical observations across market hours, non markets and correlation between market hours and wage rates.

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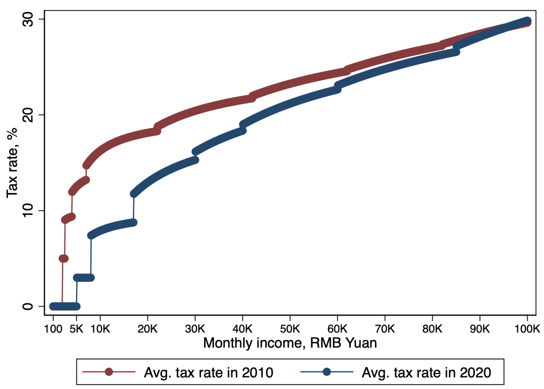
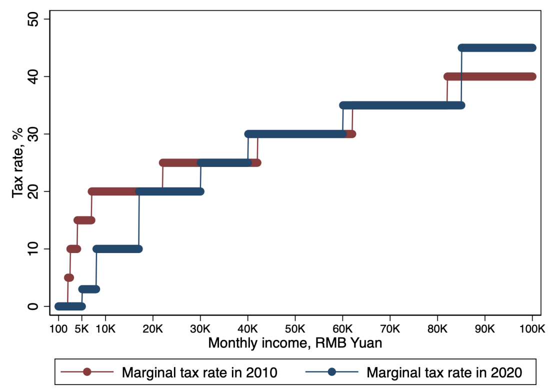
Appendix on Richer and Busier? The Facts, Causes and Consequences of Labor Supply in China



(c) Average Tax Rate



(d) Marginal Tax Rate

Figure A1: Tax Rate, 2010 vs. 2020

Notes: We plot these two figures according to two versions of the Personal Income Tax Law in China revised in 2007 and 2018. The law files can be found in the following link: https://law.pkulaw.com/falv/71ad23cd41c523c2bdfb.html.

Table A1: Elasticity of Hours to Individual Income

	Dependent variable: ln(hours per worker)					
	2010	2012	2014	2016	2018	2020
Panel A. All Gender						
ln(hourly wage)	-0.161^a	-0.170^a	-0.166^a	-0.187^a	-0.177^a	-0.163^a
	(0.006)	(0.006)	(0.005)	(0.006)	(0.004)	(0.004)
R^2	0.151	0.158	0.162	0.207	0.192	0.189
Observations	4,588	4,614	6,771	4,786	7,470	6,615
Panel B. Male						
ln(hourly wage)	-0.175^a	-0.184^a	-0.190^a	-0.194^a	-0.197^a	-0.181^a
	(0.008)	(0.009)	(0.006)	(0.008)	(0.006)	(0.006)
R^2	0.165	0.182	0.208	0.228	0.233	0.230
Observations	2,827	2,706	4,107	2,761	4,398	3,876
Panel C. Female						
ln(hourly wage)	-0.165^a	-0.177^a	-0.170^a	-0.211^a	-0.184^a	-0.172^a
	(0.009)	(0.010)	(0.008)	(0.009)	(0.006)	(0.006)
R^2	0.170	0.168	0.173	0.240	0.209	0.212
Observations	1,761	1,908	2,664	2,025	3,072	2,739

Notes: This table reports the estimated OLS coefficients of equation **??** by regressing individual-level log hours on log wage rate. The estimation equation is

$$\log(h_i) = \alpha + \beta \log(w_i) + \delta_1 age_i + \delta_2 age_i^2 + \epsilon_i$$

where i is for individual and w is the individual wage. The sample is restricted to full-time salaried employees (who work at least 1200 hours per year) at prime ages (16-65). The dependent variable is the logarithm of individual hours worked per worker. Age and age squared are controlled in all regressions. Standard errors in parentheses are robustly clustered. ^{c} $p < 0.10$, ^{b} $p < 0.05$, ^{a} $p < 0.01$.