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

Qing Huang [1] Lintong Li [2]

[1]Renmin University of China

[2]Princeton University

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Motivation

- Final consumption is a composite of consumption good and time (Becker, 1965). As we become richer, how do we change the ways of allocating our time?

- Existing evidence.
  - Hours fall steadily in advanced economies in the past 150 years (Boppart and Krusell, 2020).
  - High-income countries work less than low-income countries (Bick et al., 2018).

> 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*

Motivation

- Much less is known about China's secular trend in hours and leisure, after 40 years of rapid growth.

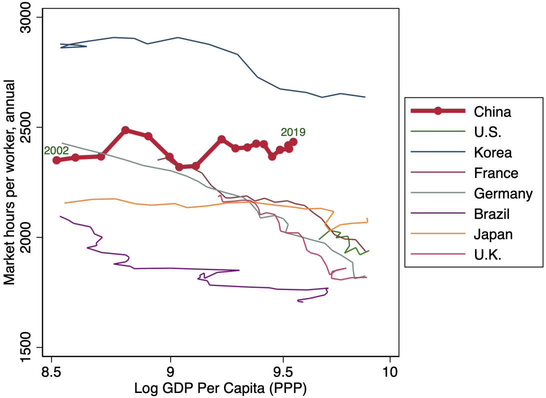

Figure: Market Hours Per Worker Across Countries

> 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*

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, and National Bureau of Statistics (China).

This Paper Studies The Secular Trend in Time Allocation Within China

- Do Chinese work for longer hours as China becomes richer? Who work for longer hours?
- How about non-market hours and leisure?
- What drives these changing patterns in time allocation?

Preview of Findings

Utilize Chinese Time Use Survey 2008 and 2018, China Family Panel Studies 2010-2020,

- **The secular trend in time allocation among Chinese**.
  - Urban: market hours $\uparrow$(3-6 hours a week), home production $\downarrow$, child care $\uparrow$, leisure $\downarrow$.
  - Rural: market hours $\downarrow$, home production $\downarrow$, child care $\uparrow$, leisure $\uparrow$.
- Among wage workers, from 2010 to 2020:
  - a rise in both wage rate ($\sim 60\%$) and market hours ($\sim 6\%$)
  - At any given time, Corr(market hours, wage rate)< 0
  - $$\frac{d(\text{Corr(market hours, wage rate)})}{dt} \leq 0$$
- **A quantitative heterogeneous agent model**: life cycle, incomplete market, home production, Pay-as-you-go pension system.
  - TFP growth $\rightarrow$ market hours $\downarrow$; non market hours $\downarrow\downarrow$
  - Capital augmenting productivity growth in home production $\rightarrow$ market hours $\uparrow$; non market hours $\downarrow$
  - Rising income uncertainty and change in demographics structure $\rightarrow$ market and non market hours$\uparrow$
  - Successfully recover trend in market hours, non market hours and correlation between market hours and wage rate.

Data

Data

- **Chinese Time Use Survey 2008 and 2018.**
  - Conducted by the National Bureau of Statistics in May 2008 and April 2018, repeated cross-section.
  - National representative: 37,000 individuals in 2008, 48,000 individuals in 2018 from 10 provinces.
  - Advantage: Based on 24-h diaries, detailed time-use categories: market hours, home production, child care, education, and leisure.
- **China Family Panel Studies 2010-2020.**
  - Carried out by Peking University every two years.
  - Nationwide representative and longitudinal household survey, around 30,000 adults each round.
  - Advantage: can estimate income process, focus on employees who report working hours, labor income.

Empirical Facts

Hours Per Person

Table: Time Allocation by Area and Gender

	All male		All female		Urban male		Urban female		Rural male		Rural female	
	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018
Market hours	42.0	43.3	30.7	30.6	33.0	39.6	25.0	27.9	51.7	47.7	37.3	33.1
Non-market hours												
Home production	8.9	7.2	23.1	18.2	10.7	7.4	23.6	17.3	6.9	7.1	22.5	19.2
Child care	1.7	2.8	4.2	8.3	2.1	4.0	4.0	8.7	1.2	1.6	4.4	7.9
Education	4.0	4.0	3.6	3.9	4.7	4.7	4.2	4.3	3.2	3.4	3.0	3.4
Leisure	111.4	110.7	106.4	107.0	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	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 at ages 15-74. All means are calculated using fixed demographic weights: 12 age groups $\times$ 6 education groups
Data source: Chinese Time Use Survey 2008 and 2018.

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Extensive vs. Intensive Margin

Table: Employment Rate and Hours Per Worker

	All male		All female		Urban male		Urban female		Rural male		Rural female	
	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018	2008	2018
Employment rate, %	79.3	78.8	67.7	63.3	69.5	71.6	55.3	54.4	89.9	86.6	82.0	75.5
Market hours per worker	49.9	50.8	40.9	40.7	43.0	48.6	39.0	42.7	55.6	50.9	42.4	38.8

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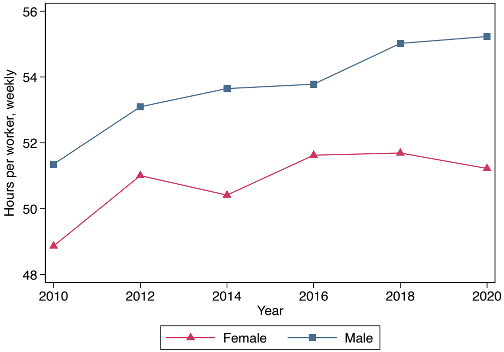
Data source: Chinese Time Use Survey 2008 and 2018.

- Urban: mainly driven by intensive margin
- Rural: driven by both intensive and extensive margin

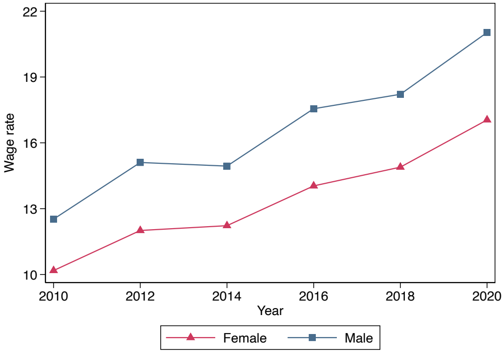
The main puzzle is for urban area, intensive margin. From now on, We mainly focus on wage workers.

Market Hours Using CFPS: Heterogeneity and Composition

Increasing Working Hours Coincide With Growing Wages



Hours Per Worker



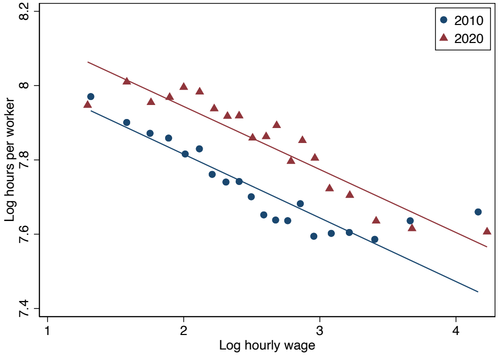
Wage Rate

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

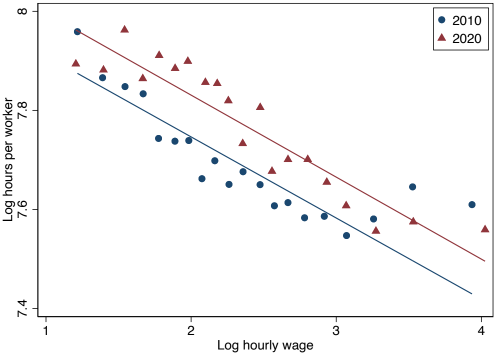
Substitution Effect Dominates? Probably No

What is the puzzle?

- Cross sections: market hours and wage rates are negatively correlated
- Over time: An increase in market hours is associated with an increase in wage rate



Male Sample

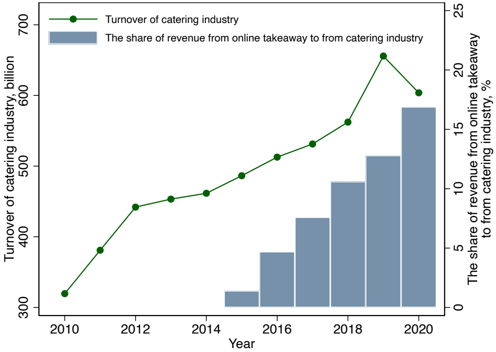


Female Sample

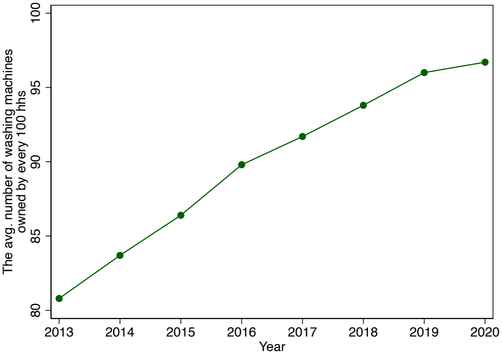
Figure: Correlation of Hour and Wages: 2010 vs. 2020

Why Market Hours Still Increase While Wages Grow?

Substituting Non-Market Hours with Market Hours



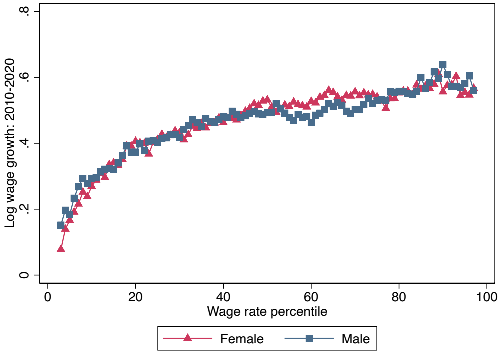
Share of Online Takeout in Catering Industry



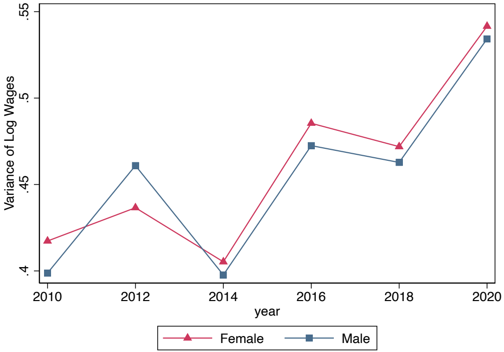
Numbers of Washing Machine Per 100 hhs.

- Market goods substitute for home goods
- Home capital substitutes for non market hours

Rising Wage Inequality and Uncertainty



Wage Rate Growth By Wage Rate Percentile

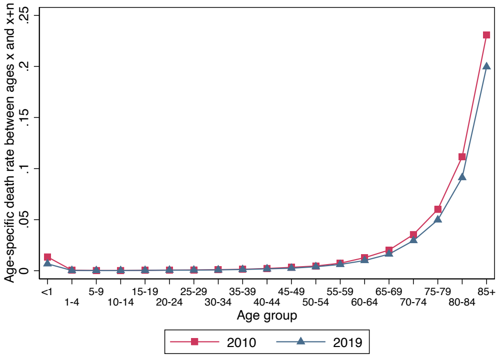


Variance of Log (Wage) over Time

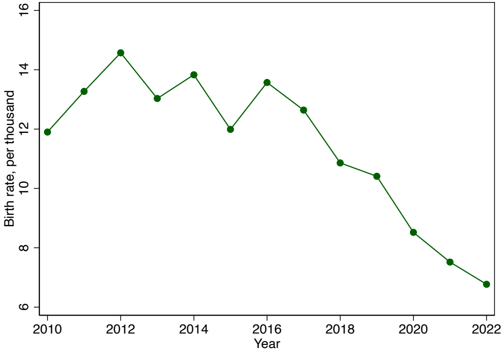
Figure: Wage Inequality Between 2010 and 2020

Decompose the rise in wage inequality into initial dispersion, variance of persistent shocks and variance of transitory shocks.

Aging and Replacement Ratio



Death Rate



Birth Rate

Figure: Age-specific Death Rate and Birth Rate

Model

Preliminaries

A model speak to (urban)wage workers with no extensive margin. An extension of Huggett (1996) with home production. Following (Heathcote et al., 2010).

- Time is discrete and infinite. No aggregate uncertainty.
- The economy is populated by a continuum of overlapping generation individuals with age 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:

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

- 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 $j=J$.

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:

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

- 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.

Preferences

The period utility function is:

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

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

$$h = n_h + n_m$$

Final consumption is an aggregate over market goods c_m and home goods c_h.

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

Home goods is an aggregate over home capital k_h and non market hours n_h.

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

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

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

Household Problem: Labor Productivity

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:

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

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.

$$\begin{gathered} y_{ij} = z_{ij} + \varepsilon_{ij} \\ z_{ij} = \rho z_{i,j-1} + \eta_{ij} \\ \varepsilon_{ij} \sim N(0, \sigma_\varepsilon^2), \quad \eta_{ij} \sim N(0, \sigma_\eta^2), \quad z_{i1} \sim N(0, \sigma_z^2) \end{gathered} \tag{3}$$

Bellman Equations

Working age individuals with age $j \in \{1, 2, .., J^w\}$, borrow and save in one period risk free asset. τ^p is public pension fund contribution rate:

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

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

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

For individuals with age $j \in \{J^w + 1, .., J\}$, they get retired A fixed amount pension comes from social security fund b will be provided in each period.

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

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

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

Firms and Government

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. 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:

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

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.

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

Definition of Recursive Competitive Equilibrium

The state space is denoted by $\mathcal{S} \equiv \mathcal{J} \times \mathcal{A} \times \mathcal{E} \times \mathcal{Z}$. 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: $Q(s, \mathbb{S}) = I\{j+1 \in \mathbb{J}\} I\{a(s) \in \mathbb{A}\} Pr(\varepsilon \in \mathbb{E}) \sum_{z' \in \mathbb{Z}} \pi(z', z)$

Calibration and Quantification

Road Map

Calibration

- Externally calibrated parameters
- Time-invariant internally calibrated parameters to match a group of moments in 2010
- Time-varying internally calibrated parameters to match a group of moments in 2020

Main Exercises: compute model simulated moments in two steady states.

- market hours
- non market hours
- correlation between market hours and wage rates

Examine aggregate performance and partial effect from various mechanisms.
Target to match dynamics of two moments

- Average market hours per worker
- Correlation between market hours and wage rates

First-Stage Calibration

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 **??** Panel A
n_{2010}/n_{2020}	Growth rate in birth rate	0/-0.03

Income Process Estimation: Method

We utilize residuals in hourly wage rate dynamics from CFPS data estimating income process estimation that follows the model. 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).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.

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

Income Process Estimation: Results

	(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: We tabulate the estimation results for income process using CFPS sample from 2010 to 2020. Bootstrap standard error in parentheses.

- Variance of persistent shocks increases
- Initial dispersion increases

Second and Third Stage Calibration

Table: 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

Quantitative Results

	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 (0.0%)	0.301 (16.7%)	0.110 (-28.1%)	-0.418
2020 Model	0.402 (-2.2%)	0.296 (14.7%)	0.106 (-30.7%)	-0.349
Panel B: Model Partial effect				
TFP	0.364 (-11.5%)	0.235 (-8.9%)	0.129 (-15.7%)	-0.249
Productivity in home capital	0.393 (-3.9%)	0.282 (9.3%)	0.111 (-28.1%)	-0.341
Income Process	0.431 (4.9%)	0.270 (4.4%)	0.161 (5.2%)	-0.344
Demographics	0.448 (8.3%)	0.283 (9.7%)	0.165 (7.8%)	-0.347

Conclusion

Conclusion

- We document the secular trend of time allocation among Chinese.
- We find a rise in both wage rate and market hours among wage workers, which is hard to reconcile.
- We build a quantitative HA model to explain the increase in average market hours.
  - TFP growth leads to lower total hours
  - Capital augmenting productivity growth shifts up ratio of market to non market hours
  - Rising income uncertainty and demographic changes increase total hours
  - Successfully recover observed trend

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