The Evolution of Income and Wealth Inequality in China

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INTRODUCTION
Inequality among Countries

Data Source: Piketty, Yang, and Zucman (2019).
Inequality among Countries

Data Source: Piketty, Yang, and Zucman (2019).
Rural Urban Income Gap

Data Source: Piketty, Yang, and Zucman (2019).
What We Do

- Explain the evolution of income and wealth inequality in China from 1990 to 2015.
- Quantify the impact of:
  1. Rural-urban migration
  2. Growth of the private sector (economic reforms early 1990s)
- Project the income and wealth inequality, and study the effects of conceived labor market and financial market reforms on the evolution of inequality.
What We Find

- Rural-urban migration has alleviated the increase in inequality by narrowing the rural-urban income gap.
- The emergence and growth of the private sector is both a fundamental engine of growth and the key driving force behind the increasing inequality.
- Our quantitative exercise suggests that income concentration will keep increasing until the 2050s.
- Implementing reforms in labor market and financial markets could result in a significant decrease in income and wealth concentration.
Related literature I

- **Income**: Storesletten et al. (2004), Piketty et al. (2014), Haskel et al. (2012), Aghion et al. (2019)

- **Wealth**: De Nardi et al. (2016), Quadrini (2000), Cagetti and De Nardi (2008), Castaneda et al. (2003), Krusell and Smith (1998)

- **Transition**: Xavier et al. (2016), Jones and Kim (2018), Hubmer et al. (2019)
Related literature II

- **Data**: Piketty et al. (2019), Luo et al. (2018)
- **Aging population**: Zhong (2010)
- **Housing price**: Knight et al. (2017, 2018)
- **Rural urban gap**: Yang (1999)
- **Human capital gap**: Heckman and Yi (2012)
- **Labor mobility restriction**: Whalley and Zhang (2009)
- **Uninsurable Permanent Income Shocks**: Ding and He (2018)
Institutional Features and Empirical Evidence
## Rural and Urban

<table>
<thead>
<tr>
<th>Name</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban</strong></td>
<td>City jurisdiction and city without district, residents committee and other areas connected to the actual construction of the city and the city government.</td>
</tr>
<tr>
<td><strong>Town</strong></td>
<td>County people’s government resident and other towns outside the city, residents committee and other areas connected to the actual construction of the county government. Mining areas, development zones, research institutes, universities, and other special areas with permanent population of more than 3,000 people and farms and forest farms.</td>
</tr>
<tr>
<td><strong>Rural</strong></td>
<td>Areas except city and town.</td>
</tr>
</tbody>
</table>

**Table:** Division of City, Town, and Rural in Statistics (NBS 2008)
Population Dynamics of Different Groups

![Population Trend of Different Groups 20+](image)
Aging Population

**fertility and mortality rates**

- **fertility rate**
- **male**
- **female**

**old dependent ratio 60-90 / 21-59**

- **rural no migration**
- **urban no migration**
- **rural**
- **urban**
## Institutional Features and Empirical Evidence

### Private and Non-Private Sectors

<table>
<thead>
<tr>
<th>Name</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Privately Owned Firms</td>
</tr>
<tr>
<td></td>
<td>Collective-Owned Enterprises</td>
</tr>
<tr>
<td></td>
<td>Jointly-Owned Enterprises</td>
</tr>
<tr>
<td></td>
<td>Firms with Founds from HMT</td>
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<tr>
<td></td>
<td>Foreign Funded Firms</td>
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<tr>
<td></td>
<td>Self-Employed</td>
</tr>
<tr>
<td><strong>Non-Private</strong></td>
<td>State-Owned Entreprises</td>
</tr>
<tr>
<td></td>
<td>Share-Holding Corporations Ltd</td>
</tr>
</tbody>
</table>

**Table:** Private Sector and Non-Private Sectors in Urban China
Financial Constraint in Private Sector

Labor Market Segmentation

Education Level of urban natives and rural-urban migrants (2007)

Wages in Non-Privately Owned, Privately Owned and Migrants
Model
Model

Technology

Rural sector uses labor to produce agricultural goods:

\[ F_{A,t}(N_{A,t}) = A_t \chi_t N_{A,t} \]

Urban sector:

- Firm \( F \) (non-private sector) is financially integrated, has access to credit and hires urban workers

\[ F_{F,t}(K_{F,t}, N_{F,t}) = K_{F,t}^{\alpha_F} (A_t N_{F,t})^{1-\alpha_F} \]

- Firm \( I \) (private sector) is privately owned, faces tight financial constraints and hires rural migrants. Defined later.
Urban Natives

Born with zero asset and choose career path with commitment.

\[ V_{U,t} = \max \{ V_{F,t}, \ V_{E,t} \} \]

- **Worker.** Works in the non-private firms.
- **Entrepreneur.** Works in the non-private firms until age \( J_e \), and then runs the private firms with accumulated savings and bank loan.
Urban Natives

\[ V_{F,t}(a,j,\epsilon_{F,t}) = \max_{c_a,c_n} \left\{ u_F(c_a,c_n) + \beta \phi_{U,j} E V_{F,t+1}(a',j+1,\epsilon'_{F,t}) \right\} \]

\[
\begin{align*}
pc_a + c_n + a' & = (1+r_t)(a + TR_{F,t}) + \epsilon_{F,t} \omega_{F,j} w_{F,t} & \text{for } j=1 \ldots J_r - 1 \\
\text{s.t.} & \\
pc_a + c_n + a' & = (1+r_t)(a + TR_{F,t}) & \text{for } j=J_r \ldots J \\
\end{align*}
\]

\[ a' \geq 0, \quad c_a \geq \bar{c}_a, \quad c_n \geq 0 \]
Urban Natives

\[ V_{E,t}(a,j,\epsilon_{F,t},\xi_t) = \max_{c_a,c_n} \left\{ u_F(c_a,c_n) + \beta \phi_{U,j} E V_{E,t+1}(a',j+1,\epsilon'_{F,t},\xi'_{t}) \right\} \]

\[
\begin{align*}
\begin{cases}
p_t c_a + c_n + a' &= (1+r_t)(a + TR_{E,t}) + \epsilon_{F,t} \omega_{F,j} \omega_{F,t} \\
\text{s.t.} & \\
p_t c_a + c_n + a' &= \pi(a + TR_{E,t},\xi_t, \text{loan}, n) + a + TR_{E,t} \\
\end{cases}
\end{align*}
\]

for \( j = 1 \ldots J_e - 1 \)

for \( j = J_e \ldots J \)

\[ a' \geq 0, \quad c_a \geq \bar{c}_a, \quad c_n \geq 0 \]
Private Firm

\[ \pi(a + TR_{E,t}, \xi_t) = \max_{\text{loan}, n} \{ k_{l,t}^{\alpha_l} ((\xi_t A_t)^{\frac{1-\alpha_l}{\theta}} n_{l,t})^\theta - \delta k_{l,t} - w_{l,t} n_l - \tilde{r}_t \text{loan} \} \]

\[ k_{l,t} = a + TR_{E,t} + \text{loan} \]

\[ (1 + \tilde{r}_t) \text{loan} \leq \eta [ k_{l,t}^{\alpha_l} ((\xi_t A_t)^{\frac{1-\alpha_l}{\theta}} n_{l,t})^\theta + (1 - \delta) k_{l,t} - w_{l,t} n_l ] \]

\[ 0 < \alpha_l + \theta < 1 \]

\[ \tilde{r}_t = \begin{cases} r_t & \text{if } \text{loan} \leq 0 \\ r_t + spd_t & \text{if } \text{loan} > 0 \end{cases} \]
Rural Residents

Rural residents work on the rural sector. Abstract from the migration decision, computed directly from data.

$$V_{R,t}(a,j,\varepsilon_{R,t}) = \max_{c_a,c_n} \left\{ u_R(c_a,c_n) + \beta \phi_{R,j} \left[ (1-\kappa_{t,j}) EV_{R,t+1}(a',j+1,\varepsilon'_{R,t}) + \kappa_{t,j} EV_{I,t+1}(a',j+1,\varepsilon'_{I,t}) \right] \right\}$$

s.t.  $p_t c_a + c_n + a' = (1+r_t)(a+TR_{R,t}) + \varepsilon_{R,t} \omega_{R,j} w_{R,t}$

$$a' \geq 0, \quad c_a \geq \bar{c}_a, \quad c_n \geq 0$$
Rural Urban Migrants

Migrants move to urban with asset accumulated from rural and work in the private sector.

\[ V_{l,t}(a_j, \varepsilon_{l,t}) = \max_{c_a, c_n} \left\{ u_l(c_a, c_n) + \beta \phi_{l,j} EV_{l,t+1}(a'_{j+1}, \varepsilon'_{l,t}) \right\} \]

\[
\begin{aligned}
& p_t c_a + c_n + a' = (1 + r_t)(a + TR_{l,t}) + \varepsilon_{l,t} \omega_{l,j} w_{l,t} & \text{for } j = 1 \ldots J_r - 1 \\
& s.t. \\
& p_t c_a + c_n + a' = (1 + r_t)(a + TR_{l,t}) & \text{for } j = J_r \ldots J \\
& a' \geq 0, \ c_a \geq \bar{c}_a, \ c_n \geq 0
\end{aligned}
\]
Labor Markets

\[ N_A = \sum_{a,j,\varepsilon_r} X_r(a,j,\varepsilon_r) \]

\[ N_F = \sum_{a,j,\varepsilon_F} X_F(a,j,\varepsilon_F) + \sum_{a,1:j_{E-1},\varepsilon_F} X_E(a,j,\varepsilon_F) \]

\[ \sum_{a,j,\xi} n_I(a,j,\varepsilon_F,\xi) X_e(a,j,\varepsilon_F,\xi) = \sum_{a,j,\varepsilon_I} X_I(a,j,\varepsilon_I) + \sum_{a,j,p,\varepsilon_I} X_{If}(a,j,p,\varepsilon_I) \]
Capital Market

\[
\sum_{a,j,\xi} \text{loan}_t(a,j,\xi)X_{E,t}(a,j,\xi | j \geq j_E) = \\
+ K_{F,t} + \sum_{a,j,\xi_F} \text{a}_{F,t}(a,j,\xi_F)X_{F,t}(a,j,\xi_F) \\
+ \sum_{a,j,\xi_R} \text{a}_{R,t}(a,j,\xi_R)X_{R,t}(a,j,\xi_R) \\
+ \sum_{a,j,\xi_E} \text{a}_{E,t}(a,j,\xi_E,\xi)X_{E,t}(a,j < j_E,\xi_E,\xi) \\
+ \sum_{a,j,\xi_I} \text{a}_{I,t}(a,j,\xi_I)X_{I,t}(a,j,\xi_I)
\]
Equilibrium

- Given demographic trends, prices and bequests, individuals solve utility maximization problem.
- Prices clear goods, labor and capital markets.
Calibration
Age profiles

Age Profiles in Urban Sector

Age Profile in Rural Sector
Let the residual log income $y_t$ be composed of a persistent component and a transitory component

$$y_t = z_t + \nu_t$$

where the persistent component:

$$z_t = \rho z_{t-1} + \eta_t$$

with $\nu_t \sim N(0, \sigma^2_{\nu,t})$, and $\eta_t \sim N(0, \sigma^2_{\eta,t})$, both i.i.d and serially uncorrelated.
# Idiosyncratic Productivity Shocks

<table>
<thead>
<tr>
<th>persistent shocks $\sigma^2_{\tau,t}$</th>
<th>Rural</th>
<th>Non-Private</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-2000</td>
<td>0.257</td>
<td>0.128</td>
<td>0.171</td>
</tr>
<tr>
<td>2004-9</td>
<td>0.250</td>
<td>0.064</td>
<td>0.282</td>
</tr>
<tr>
<td>2011-5</td>
<td>0.191</td>
<td>0.031</td>
<td>0.115</td>
</tr>
<tr>
<td>transitory shocks $\sigma^2_{v,t}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989-2000</td>
<td>0.313</td>
<td>0.056</td>
<td>0.432</td>
</tr>
<tr>
<td>2004-9</td>
<td>0.441</td>
<td>0.083</td>
<td>0.268</td>
</tr>
<tr>
<td>2011-15</td>
<td>0.326</td>
<td>0.109</td>
<td>0.235</td>
</tr>
<tr>
<td>persistent parameter $\rho$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.848</td>
<td>0.821</td>
<td>0.946</td>
</tr>
</tbody>
</table>

**Table:** Worker’s Idiosyncratic Shocks
### Idiosyncratic Productivity Shocks

<table>
<thead>
<tr>
<th></th>
<th>Private Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>persistent shock $\sigma^2_{\tau,t}$</td>
<td>0.164</td>
</tr>
<tr>
<td>transitory shock $\sigma^2_{v,t}$</td>
<td>0.732</td>
</tr>
<tr>
<td>persistent parameter $\rho$</td>
<td>0.544</td>
</tr>
</tbody>
</table>

**Table:** Productivity Shocks in the Private Sector
# Parameters determined outside model

<table>
<thead>
<tr>
<th>para.</th>
<th>value</th>
<th>definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$J$</td>
<td>70</td>
<td>maximum age 90</td>
</tr>
<tr>
<td>$J_e$</td>
<td>21</td>
<td>age to run the private firm 40</td>
</tr>
<tr>
<td>$E_{bound}$</td>
<td>0.05</td>
<td>fraction of population with idea and entrepreneur skill (NBS)</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.24</td>
<td>fraction of consumption for agriculture good (CHNS)</td>
</tr>
<tr>
<td>$\alpha_F$</td>
<td>0.5</td>
<td>capital income share 50% (Bai et al. 2006)</td>
</tr>
<tr>
<td>$\alpha_I$ &amp; $\theta$</td>
<td>0.4</td>
<td>capital income share 50% and residuals 20% (NBS)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.1</td>
<td>10 percents depreciation rate (Bai et al. 2006)</td>
</tr>
<tr>
<td>$spd$</td>
<td>0.026</td>
<td>avg. difference between loans and deposits rates 1990-2019 (IMF)</td>
</tr>
</tbody>
</table>

**Table:** Parameters determined outside model
### Parameter determined within the equilibrium

<table>
<thead>
<tr>
<th>para.</th>
<th>value</th>
<th>target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{c}_a$</td>
<td>1.537</td>
<td>rural GDP share is 38% in 1989</td>
</tr>
<tr>
<td>$\chi$</td>
<td>0.810</td>
<td>relative price is normalized to 1</td>
</tr>
<tr>
<td>$\text{disp}$</td>
<td>2.956</td>
<td>real interest rate is 0.025 in 1989</td>
</tr>
<tr>
<td>$\xi$</td>
<td>6.750</td>
<td>avg. wage ratio is 0.606, 2008/2015</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.448</td>
<td>avg. 10% asset financed by loan, 1994/2002</td>
</tr>
<tr>
<td>$g$</td>
<td>0.057</td>
<td>avg. 9% annual GDP growth, 1999/2019</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.951</td>
<td>avg. capital-output ratio 2.20, 1992 – 2007</td>
</tr>
</tbody>
</table>

**Table:** Parameters determined within the equilibrium
## Initial Steady State

<table>
<thead>
<tr>
<th></th>
<th>Income</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top 10%</td>
<td>Middle 40%</td>
<td>Bottom 50%</td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>0.307</td>
<td>0.469</td>
<td>0.224</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>0.240</td>
<td>0.483</td>
<td>0.277</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Wealth</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Top 10%</td>
<td>Middle 40%</td>
<td>Bottom 50%</td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>0.412</td>
<td>0.507</td>
<td>0.081</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Urban-Rural Income per Capita Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>2.310</td>
</tr>
<tr>
<td>Model</td>
<td>2.110</td>
</tr>
</tbody>
</table>

**Table:** Model Validation–Initial Steady State
Transition

**Figure:** Model Validation–Transition
Transition

**Figure**: Model Validation—Transition
Transition

**Figure:** Model Validation—Transition
Results

Transition-Rural v.s. Urban

Rural Income Inequality v.s PYZ

Urban Income Inequality v.s PYZ
Projection
The future of inequality in China (1989-2058)
The future of inequality in China (1989-2058)
Counterfactual
No migration and no private economy
No migration and no private economy
No migration and no private economy
No private economy
No private economy
No private economy
Labor Market Reforms
Labor Market Reforms

Income

Income Inequality, BM

Income Inequality, L=0.1

Income Inequality, L=0.3

Income Inequality, L=0.5
Financial Market Reforms
Income Inequality, BM

Income Inequality, η=0.6

Income Inequality, η=0.8

Income Inequality, η=1.0
Wealth

Wealth Inequality, BM

Wealth Inequality, $\eta=0.6$

Wealth Inequality, $\eta=0.8$

Wealth Inequality, $\eta=1.0$
Income and wealth shares in reforms.
Income share
Wealth share
Income share

Income Share Different Groups, $\eta=0.6$

Income Share Different Groups, $\eta=0.8$

Income Share Different Groups, $\eta=1.0$
Wealth share
THANK YOU!