The Rise of Service Sector and the Drop in Fertility

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Academia Sinica

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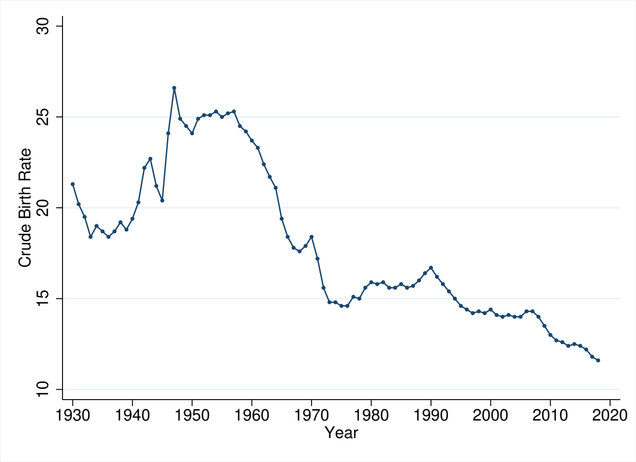
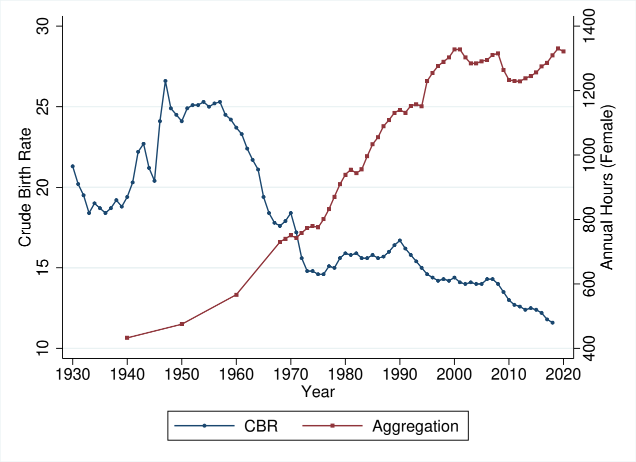
Introduction

Introduction

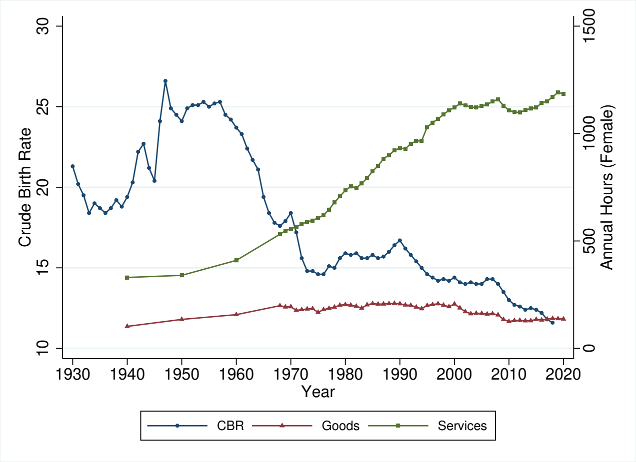
- Birth Rate in the U.S. declining



- Birth Rate in the U.S. declining with female hours



- Birth Rate in the U.S. declining with sectoral female hours



Introduction

- Birth Rate is
  - declining in the U.S.
  - negatively correlated with average female working hours
  - which is driven by the increase in service sector
- Understanding service sector is important to understand female's opportunity cost

Introduction

- Question:
  - What cause expansion in the service sector
  - Why such expansion correlated with fertility rate
- Answer:
  - Female in service (cognitive skills)
  - Opportunity cost (income versus substitution)

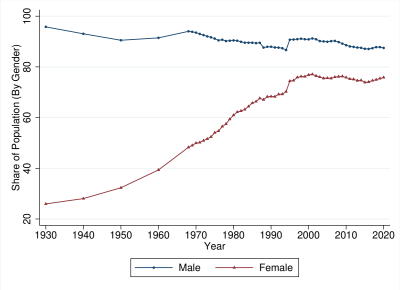
Introduction

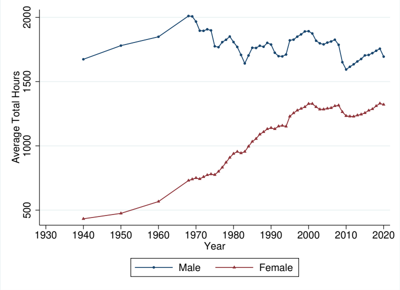
- What I did?
  - Empirical trends on gender hours, wage and natality
  - A theoretical model of household occupation and fertility choice
- What I found?
  - A model assuming female with CA in service sector explains these facts
- Intuition:
  - When the productivity growth is faster in goods sector leads to expansion in service sector (complements)
  - Female has comparative advantage in service sector rise in employment and wage
  - Higher opportunity cost for having baby and fertility declined
- What I will do:
  - Introduce home production sector
  - Add capital to the model

Empirical Facts

Empirical Facts

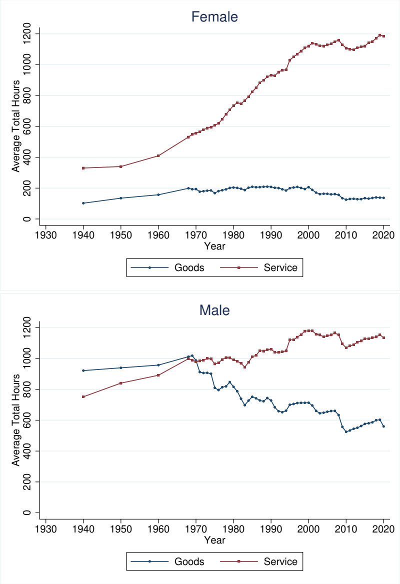
- Working female increasing; male constant Decomposition





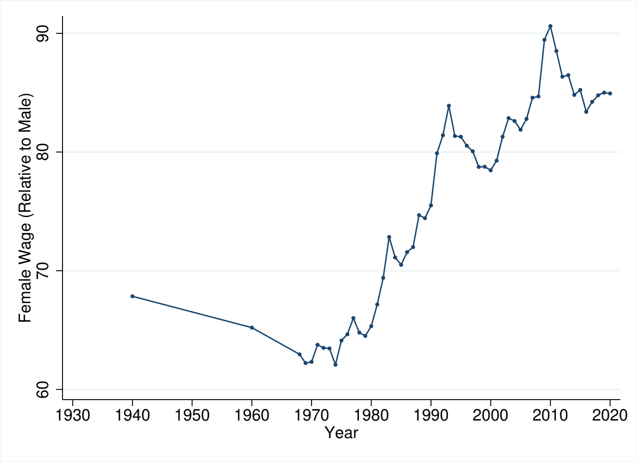
Empirical Facts

- Working female increasing driven by service sector



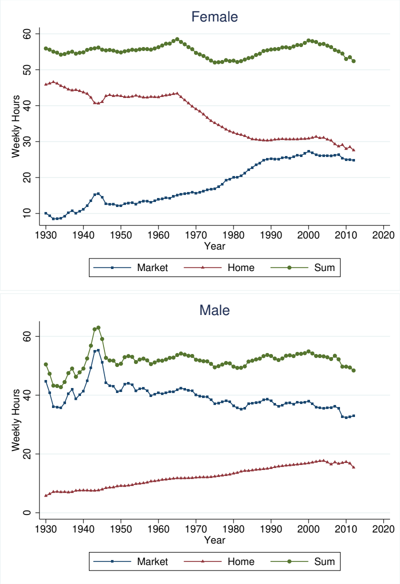
Empirical Facts

- Wage premium



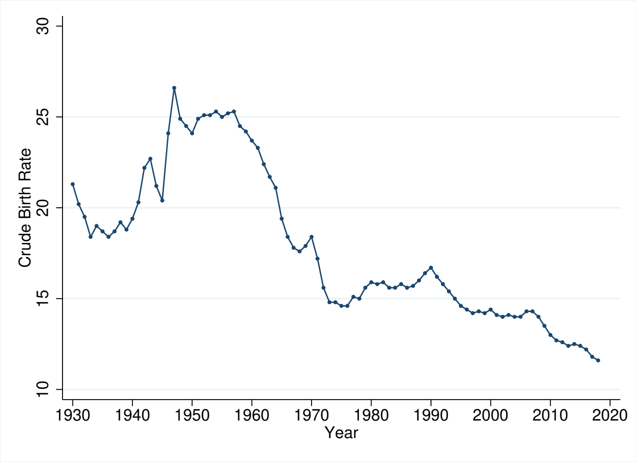
Empirical Facts

- Change in the Household Division of Time



Empirical Facts

- Fertility declines except during the baby boom period



Empirical Facts

- Remark:
  - Large increase in female labor participation
  - Driven by the rise of service sector
  - Female wage increase relative to male
  - Change of family time division
  - Drop in fertility rate

Model

Model – Firm

- Representative Firms in each sector $j = g, s$ have the following technology:

$$Y_j = A_j L_j$$

where

$$L_j = \left[\xi_j L_{fj}^{\frac{\eta-1}{\eta}} + (1 - \xi_j) L_{mj}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

- Assumptions:
  1. $\xi_s > \xi_g$ (comparative advantage) Discussion
  2. $\gamma_g \equiv \frac{\dot{A}_g}{A_g} > \frac{\dot{A}_s}{A_s} \equiv \gamma_s$ (productivity growth, BEA: $\gamma_g - \gamma_s = 1.2\%$)
  3. labor mobility

Model – Household

- Household consists of one male and female:

$$U(c_g, c_s, L_l, n) = \ln c + \varphi \ln L_l + \psi \ln n$$

where

$$c = \left[\omega c_g^{\frac{\epsilon-1}{\epsilon}} + (1-\omega) c_s^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}$$

$$L_l = \left[\xi_l L_{fl}^{\frac{\eta_l-1}{\eta_l}} + (1-\xi_l) L_{ml}^{\frac{\eta_l-1}{\eta_l}}\right]^{\frac{\eta_l}{\eta_l-1}}$$

subject to

$$p_g c_g + p_s c_s = w_m(1 - L_{ml}) + w_f(1 - L_{fl} - \tau n)$$

- Assumptions:
  1. $\epsilon < 1$ substitutability between goods (Herrendorf, Rogerson and Valentinyi, 2013)
  2. $\eta_l < 1$ substitutability between leisure

Model – Equilibrium

- All households maximize utility subject to constraint
- All firms maximize profit
- Markets clear
  - Consumption Market $c_j = Y_j$
  - Labor Market $L_{ms} + L_{mg} = 1 - L_{ml}$
  - Female Labor Market $L_{fs} + L_{fg} = 1 - L_{fl} - \tau n$

Model – Expanding Service Sector

- Define $E_{sg} = \frac{p_s c_s}{p_g c_g}$
- The price ratio is determined by using the free mobility assumption:

$$p_s A_s \xi_s \left(\frac{L_s}{L_{fs}} \right)^{\frac{1}{\eta}} = p_g A_g \xi_g \left(\frac{L_g}{L_{fg}} \right)^{\frac{1}{\eta}}$$

- Notice that by using the definition of the production function

$$\frac{L_j}{L_{fj}} = \xi_j^{\frac{\eta}{\eta-1}} \left[1 + \left(\frac{\xi_j}{1-\xi_j} \right)^{-\eta} \left(\frac{w_f}{w_m} \right)^{\eta-1} \right]^{\frac{\eta}{\eta-1}}$$

- With FOC from the household side

$$E_{sg} = \left(\frac{A_g}{A_s} \right)^{1-\epsilon} \left(\frac{\xi_g}{\xi_s} \right)^{\frac{\eta(1-\epsilon)}{\eta-1}} \left(\frac{1-\omega}{\omega} \right)^{\epsilon} \left[\frac{1 + \left(\frac{\xi_g}{1-\xi_g} \right)^{-\eta} \left(\frac{w_f}{w_m} \right)^{\eta-1}}{1 + \left(\frac{\xi_s}{1-\xi_s} \right)^{-\eta} \left(\frac{w_f}{w_m} \right)^{\eta-1}} \right]^{1-\epsilon}$$

Model – Expanding Service Sector

$$E_{sg} \propto \left(\frac{A_g}{A_s}\right)^{1-\epsilon}$$

- Notice that if $(\gamma_g - \gamma_s)(1-\epsilon) > 0$, the relative expenditure on service sector increases
- Intuition:
  - $1 > \epsilon$ low substitutability
    $\rightarrow$ want to consume similar amount
    $\rightarrow$ more resources devoted to the service sector (which is relatively more expensive) Numerical Example

Model – Rising Female Wage

- Relative Female wage proportional to the size of the service sector

$$s \equiv \frac{L_{ms} + L_{fs}}{L_{ms} + L_{fs} + L_{mg} + L_{fg}}$$

$$s = \frac{\left[1 + \left(\frac{\zeta_s}{1-\zeta_s}\right)^{-\eta} \left(\frac{w_f}{w_m}\right)^{\eta}\right] \left[1 - \frac{N_m}{N_f} \left(\frac{\zeta_s}{1-\zeta_s}\right)^{\eta} \left(\frac{w_f}{w_m}\right)^{-\eta}\right]}{\left(1 + \frac{N_m}{N_f}\right) \left[1 - \frac{\zeta_s(1-\zeta_g)}{\zeta_g(1-\zeta_s)}\right]}$$

where N_i is the total work supply of gender i

- Abstract from leisure, $N_i = 1$, $\frac{d\frac{w_f}{w_m}}{ds} > 0$
- In GE, the change in wage ratio also affect the value of N_i

Model – Rising Child-rearing Cost

- Notice that the child-rearing cost in the model is τw_f
- Increase in w_f brings two effects:
  - Income effect: increase the number of children
  - Substitution effect: reduce the number of children
  - Presence of non-labor income $w_m(1 - L_{ml})$, income effect dominates
  - Intuition: the % increase in income small when compared to % increase in cost (linear in w_f)
- As τ is constant, it suffice to show that w_f increases
- Opportunity cost story:
  - Female's time gets more valuable
    $\rightarrow$ the opportunity cost of children increases
    $\rightarrow$ less child birth

Simulation Result

- The technological progress with $\gamma_g > \gamma_s$

$$E_{sg} \propto \left(\frac{A_g}{A_s}\right)^{1-\epsilon}$$

A_s	A_g	Service Sector	Female Employment	Gender Premium	Fertility
1	1	0.909	0.749	0.600	2.827
2	3	0.928	0.751	0.608	2.808
3	6	0.944	0.752	0.614	2.793

- Interpretation:
  - When $\gamma_g > \gamma_s$ leads to expansion in service sector
  - Female has CA in service sector rise in employment and wage
  - Higher opportunity cost for having babies and fertility declined

Exogenous Feature

- "Female specific" technological Progress

$$L_s = \left[\xi_s L_{fs}^{\frac{\eta-1}{\eta}} + (1-\xi_s) L_{ms}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

A_s	A_g	ζ_s	Female Employment	Gender Premium	Fertility
1	1	0.6	0.749	0.600	2.827
1	1	0.7	0.767	0.856	2.415
1	1	0.8	0.779	0.983	2.093

- This is sometimes interpreted as the decrease in female discrimination:

$$w_f = A_s \zeta_s \left(\frac{L_f}{L_{sf}}\right)^{\frac{1}{\eta}} = A_s (1-\pi) \bar{\zeta}_s \left(\frac{L_f}{L_{sf}}\right)^{\frac{1}{\eta}}$$

Future Plan

- Adding Capital
  - Bequest Motive (heterogeneous agents) Vs. Exogenous Capital?
  - Does capital substitute away routine job (goods sector) consistent with the following production (with $\eta > \mu$)?

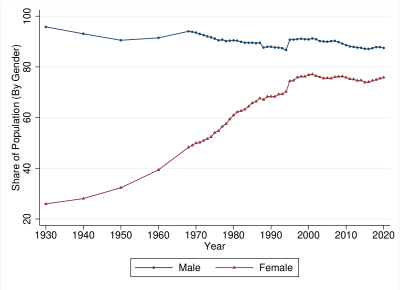
$$Y_j = A_j \left[\zeta_j \left(\theta L_{jf}^{\frac{\mu-1}{\mu}} + (1-\theta) K_j^{\frac{\mu-1}{\mu}} \right)^{\frac{\mu(\eta-1)}{(\mu-1)\eta}} + (1-\zeta_j) L_{jm}^{\frac{\mu-1}{\mu}} \right]^{\frac{\eta}{\eta-1}}$$

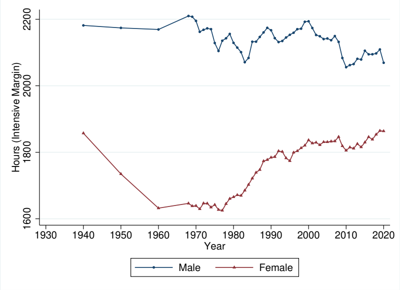
  - If so, $\frac{\partial \frac{w_f}{w_m}}{\partial K} > 0$
- Adding Home Production Sector
  - Greenwood et al. (2005) highlights the importance of home production
  - Leisure Time, Home Production and Fertility Cost
  - $\tau = \tau(L_l)$ where $\tau' < 0$
- Accounting Exercise

Thank you!

Empirical Facts

- Working Female Increasing Back





Empirical Facts

- Consider total resource x (\$10) and utility is in $U = min(c_1, c_2)$
- Originally (c_1, c_2) have the same technology that convert 1 unit of resource into 1 unit of consumption:

$$c_i = x$$

- Optimal allocation $(c_1, c_2) = (5, 5)$
- Assume that now $c_1 = x$ and $c_2 = 3x$ and now $(c_1, c_2) = (7.5, 2.5)$
- Assume that $U = c_1 + c_2$ and $(c_1, c_2) = (0, 10)$

Back

Female Comparative Advantage

- Male has comparative advantage in physical strength
- Female has comparative advantage in communication and interpersonal skills
- Borghans, Bas ter Weel and Weinberg (2008, 2014): the use of interpersonal skills accelerated after 1970s

Back