Structural transformation and U-shaped female employment

Rachel L. Ngai (LSE and CEPR)
Claudia Olivetti (Dartmouth College and NBER)
Barbara Petrongolo (U Oxford and CEPR)

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Background and motivation

► All high-income countries witnessed a rise in female employment since WW2
► But not a universal phenomenon
  ► female employment has been falling during other time windows and/or in other countries
► This paper aims to understand various phases in the evolution of female employment through the lens of structural transformation
  ► labour reallocation across agriculture, manufacturing and services
  ► with focus on unpaid family work
Female employment around the world

Sample: women aged 25+; groups according to GNI pc. Source: WDI & ILO
Female employment and economic development

LFP = 4.6 - 1.04logGDP + 0.063(logGDP)^2

Female employment and structural transformation

Our approach

- Build consistent measure of female employment for the US over 1860-2010; intensive and extensive margins
  - Data on persons employed from Census; correction for unpaid family work and under-reporting
  - Information on hours per employed pre-1940 from various sources (time use surveys, census of manufacturing, state-level sources)
  - Post-1940 information on hours from US census

- Unified framework for understanding U-shaped evolution of female employment
  - **modernization** within agriculture: decline in family farms and rise in modern agriculture
  - **structural transformation** across agriculture, manufacturing and services
  - **marketization** within services: from home production to market services
Related work

- U-shape idea has been pioneered in early work by Sinha (1965), Boserup (1970), Durand (1975), Goldin (1986)
  - based on technology adoption in agriculture, income effects, urbanization, etc.
  - Goldin (1995) shows U-shape on a cross-section of countries in 1980s
  - Goldin (1990): female participation likely decreasing from late 19th–early 20th century, based on a revision of the 1890 Census statistics so as to include undercounted occupations.

  - framework and quantitative evaluation for recent decades
Data
Employment definition and measurement

- ILO definition of employment covers work for pay, profit or family gain in cash or kind
  - in particular it covers unpaid (contributing) family workers
  - relatives who assist without pay in a family-operated income-producing enterprises such as a farm, store, handicraft industry (Durand, 1975)

- ILO definition well established, but measurement is not consistent over time and in country-level sources

- U.S Census: pre-1940 gainful employment; measure of unpaid family work not entirely consistent post-1940

- Key difficulty: identifying unpaid family work (mostly female) when this was more widespread
Importance of Unpaid Family Work

- Measure of employment: female employment and structural transformation

- Comparison of female employment, gender gaps, structural transformation and productivity across time and countries:
  - Productivity: GDP includes value-added of family business
  - Pre-mature de-industrialization in developing countries

- Unpaid family work v.s. home production (treated differently in time-use and GDP)
  - skills and networks
  - income-generating, female bargaining power in the family
  - gender norms (Boserup 1970, Alesina Giuliano and Nunn 2013)
Female employment in the US Census

Notes: Women aged 18-64.
Unpaid family work in agriculture

Ruggles (2015): importance of family enterprise in 19th century, through to mid-20th century. ▶ Family economies

▶ “production was carried out by families”;
▶ 1890, about 40% of US population lived on farm; “all family members that were old enough contributed to farm production.”
▶ Nonfarm family business: shoemakers, tailors, boarding etc.

Undercount of women in agriculture (Smuts, 1960)
▶ about 4m white married women on farm
  ▶ census reported about 23k in agricultural occupations.
▶ 1950: about 14% population on farm
  ▶ nearly 200k as unpaid family labourers
Ruggles (2015) adjustment for unpaid work

- Assign to labour force women on farms, whose head of household is farmer, whether or not they report an occupation

- Method extended to non-farm families in which the head is self employed
(Adjusted) female employment in the US Census

Notes: Women aged 18-64.
Hours

- Bodycount only captures extensive margin of employment.
- But intensive margin highly relevant as hours per employed vary widely over time and across genders and sectors.

- **Weekly hours fell substantially for all non-farm employees** (Costa, 2000)
  - 1880s: 10 hours per day, 6 days a week;
  - 1940: 8 hours per day, 5 days a week
  - Post 1940: further reductions via paid holidays, etc.

- **Unpaid hours on family farm shorter than paid hours in agriculture** (Surveys of farmers; Time-use studies).
  - 1870: Farm labourers worked 10-14h per day, 6 days a week; 44/40 weeks a year for men/women
  - 1920s: Housewives on farm spent 10h per week in unpaid agricultural work; up to 15h in spring/summer
Hours: Sources

- **Historical Statistics of the United States, 1860-1930**
  - good coverage for manufacturing; by gender from 1914

- **Historical Labor Statistics Project, 1874-WWI**
  - (University of California)
  - reports published by 20+ State Bureaus that gathered sectoral labor statistics
  - cover all 3 sectors, but very thin on agriculture
  - micro data, 13.4k men and 5.2k women in total, 1890-1894

- **Women Working project, 20s and 30s**
  - (Harvard University Library’s Open Collections Program)
  - 4,000+ studies, but little info on men

- **1940–: US Census**
Hours: Further elaborations

▶ **Services**
  - Interpolate 1890-1920; impose same trend as manufacturing pre-1920

▶ **Agriculture**

▶ **Unpaid work in family farms**
  - Purcell Act Time-Diary Studies of Homemakers: Housewives on farm spent 10h per week in unpaid agricultural work; up to 15h in spring/summer
Female hours (extensive & intensive margins)

![Graph showing female hours across different census years for agriculture, manufacturing, services, and total.

- Agriculture: Green line, decreasing trend from 1850 to 1970, then stabilizing.
- Manufacturing: Blue line, generally increasing from 1850 to 1950, then fluctuating.
- Services: Orange line, gradually increasing from 1850.
- Total: Red line, overall trend showing the cumulative effect of agriculture, manufacturing, and services.

Census years range from 1850 to 2010.]
Men and women aged 18-64. Source: Ramey and Francis (2009)
Summary of historical evidence

- U-shaped female employment and structural transformation
  - decline associated with declining agriculture
  - rise associated with rising services

- Important role of unpaid family work during 19th century

- Women over-represented in both family farms and service sector

- Total work rather stable for men and women
  - dominant margin of substitution is across different sectors of work: agriculture (paid and unpaid), manufacturing, services and home production
Model
The model economy: Building blocks

- **Households** derive utility from consumption of agriculture, manufacturing and service output
  - gross complements in utility
  - subsistence requirement on agricultural consumption

- 3 market sectors: **agriculture, manufacturing, services**
  - productivity growth: agr, man > serv
  - female intensity: serv > agr, man

- **Family farm** and **home production** sector:
  - Family farms produce close substitutes to market agriculture, sold to the market; → labour input is part of employment.
  - Home production produces close substitutes to market services; for own use.
  - Both have slower productivity growth than corresponding market sectors.
Market firms

- Production function for the representative market firm:

\[ Y_j = A_j N_j, \quad N_j = \left[ \xi_j \frac{l_{fj}^{\eta-1}}{\eta} + (1 - \xi_j) \frac{l_{mj}^{\eta-1}}{\eta} \right]^{\frac{\eta}{\eta-1}} ; \quad j = a, m, s \]

- \( A_j \) is sector-specific productivity, growing at \( \gamma_j \)
- \( \xi_j \) is sector-specific gender weight, capturing comparative advantages

- Competitive labour markets and perfect mobility:

\[ w \equiv \frac{w_f}{w_m} = \frac{\xi_j}{1 - \xi_j} \left( \frac{l_{mj}}{l_{fj}} \right)^{1/\eta} ; \quad j = a, m, s \]
Households (1)

- Utility has 3 consumption arguments: agr, man, serv

\[ U(c_\text{agr}, c_m, c_\text{serv}) = \left[ \omega_a (c_\text{agr} - \bar{c}) \frac{\varepsilon-1}{\varepsilon} + \omega_m c_m^{\varepsilon-1} + \omega_s c_\text{serv}^{\varepsilon-1} \right]^{\varepsilon-1} \]

where \( \varepsilon < 1 \) (poor substitutes) and \( \bar{c} \) is subsistence consumption.

- Services: produced at home or purchased from the market:

\[ c_{\text{serv}} = \left[ \psi c_{\text{serv}}^{\sigma-1} + (1 - \psi) c_{\text{serv}}^{\sigma-1} \right]^{\sigma / (\sigma-1)} \]

where \( \sigma > 1 \) (good substitutes)

- Agricultural goods: purchased from market or family farms:

\[ c_{\text{agr}} = \left[ \psi_n c_n^{\sigma_n-1} + (1 - \psi_n) c_a^{\sigma_n-1} \right]^{\sigma_n / (\sigma_n-1)} \]

where \( \sigma_n > 1 \) (good substitutes)
Households (II)

- Allocate time to market firms, family farms and home production.
- Technology in family farm and home production:

\[ y_j = A_j N_j, \quad N_j = \left[ \xi_j l_{fj}^{\eta} + (1 - \xi_j) l_{mj}^{\eta} \right]^{\eta/\eta-1}; j = n, h \]

- Budget constraint:

\[
\sum_{i=a,n,m,s} p_i c_i \leq w_m (L_m - l_{mh} - l_{mn}) + w_f (L_f - l_{fh} - l_{fn}) + p_n y_n
\]

where home production is for own use while family farm output is sold at market price \( p_n \).
Assumptions

- ILO definition of employment, for each gender $g$:
  \[ l_{gn} + l_{ga} + l_{gm} + l_{gs} \]

- Comparative advantages:
  - $\xi_n > \xi_a$: family farms more intensive in female labour
  - $\xi_s, \xi_h > \xi_a, \xi_m$: service production more intensive in female labour than agriculture and manufacturing.

- Uneven productivity growth
  - $\gamma_a > \gamma_n, \gamma_s > \gamma_h$: productivity growth in market firms benefits from economies of scale
  - $\gamma_a > \gamma_s$: productivity growth is faster in agriculture than services
Labour reallocation

- **Modernization.**
  As output of market agriculture and family farms are good substitutes, faster productivity growth in market agriculture reallocates labour from family to market agriculture

- **Structural transformation.**
  Faster productivity growth in agriculture reallocates labour from agriculture to services:
  - Baumol effect through consumption complementarity
  - Income effect through the subsistence term

- **Marketization.**
  As home and market services are good substitutes, faster productivity growth in market services reallocates labour from home to market services
Stage 1: Fall in agriculture and female employment.

19th century, large agricultural sector

- structural transformation ($\gamma_\bar{a} > \gamma_\bar{s}$, $\bar{c} > 0$) → agriculture shrinks and services expand
- modernization drives decline of family sector compositional change ($\gamma_a > \gamma_n$) → even faster productivity growth in overall agriculture, stronger ST
- marketization weak ($\gamma_s - \gamma_h > 0$ but small),

**ST dominates marketization** → home services expand 
and total employment falls

- Female employment falls via decline in family farms and expansion in home services.
- Bring manufacturing into the picture: stronger female trends
Stage 2: Rise in services and female employment

Starting mid-20th century, overall agriculture sector is small

- modernization nearly complete;
- structural transformation is weaker
- **marketization dominates ST** $\rightarrow$ home service falls and total employment rises
- Female employment rises via decline in home services and expansion of market services
- Bring manufacturing into the picture ($\gamma_m > \gamma_s$): ST implies labor reallocation from manufacturing into services; stronger female trends.

- Due to gender specialization, gender neutral shock such as uneven productivity growth has gender-biased consequences
Equilibrium Allocation

Endogenous variables:

- Gender time allocation into each of five sectors
- Output prices in agriculture (family and market farms), manufacturing, market services.
- Gender wage ratio

The system of equilibrium equations can be reduced to two equations solving for female home share \( l_{fh}/L_f \) and gender wage ratio \( w \)

Female employment is \( 1 - l_{fh}/L_f \).
Key findings

- In cross-country data, female employment declines at early stages of development, and then rises again – in sync with decline in agriculture and rise in services.

- Build a measure of female employment during 1860-2010 in the US; U-shape.

- Develop unified framework to explain these trends.
  
  - *Declining part of U-shape:* faster productivity growth in agriculture implies shrinking agriculture, especially family farms, and declining female employment.
  
  - *Rising part of the U-shape:* slower productivity growth in services (especially home services) implies rising services and declining home production, accompanied by rise in female employment.
Additional slides
Total fertility rate

Live births per woman; groups according to GNI pc. Source: UN
Unpaid family workers as % of employment

Notes: groups according to GNI pc. Source: WDI & ILO.
Transformation of US Families

Figure: Reprint from Ruggles (2015) Figure 4

Sectoral composition of male employment

Notes: Men aged 18-64.
Male hours (per employed person)
Male hours (extensive & intensive margins)

- Agriculture
- Manufacturing
- Services
- Total

Census Year:
- 1850
- 1870
- 1890
- 1910
- 1930
- 1950
- 1970
- 1990
- 2010

Hours:
- 0
- 10
- 20
- 30
- 40
- 50
- 60
Modernization

Optimality condition and market clearing imply

\[
\frac{p_n}{p_a} = \frac{\psi_n}{1 - \psi_n} \left( \frac{Y_a}{Y_n} \right)^{1/\sigma_n}
\]

Expenditure shares \( E_{an} = p_a Y_a / p_n Y_n \):

\[
E_{an} = \left( \frac{A_a}{A_n} \right)^{\sigma_n - 1} \left[ \left( \frac{\xi_n}{\xi_a} \right)^{\eta - 1} \left( \frac{I_n}{I_a} \right)^{1/\eta - 1} \right]^{\sigma_n - 1} \left( \frac{1 - \psi_n}{\psi_n} \right)^{\sigma_n}
\]

where \( I_j = \frac{w_f L_{fj}}{w_f L_{fj} + w_m L_{mj}} \) is female income share

Labour shares

\[
\frac{l_{fa}}{l_{fn}} = \left( \frac{A_a}{A_n} \right)^{\sigma_n - 1} \left( \frac{\xi_a}{\xi_n} \right)^{\sigma_n - 1} \left( \frac{I_n}{I_a} \right)^{\frac{\sigma_n - \eta}{\eta - 1}} \left( \frac{1 - \psi_n}{\psi_n} \right)^{\sigma_n}
\]
Marketization

Expenditure shares

\[ E_{sh} = \left( \frac{A_s}{A_h} \right)^{\sigma-1} \left[ \left( \frac{\xi_h}{\xi_s} \right)^{\frac{\eta}{\eta-1}} \left( \frac{l_h}{l_s} \right)^{\frac{1}{\eta-1}} \right]^{\sigma-1} \left( \frac{1 - \psi}{\psi} \right)^{\sigma} \]

Labour shares

\[ \frac{l_{fs}}{l_{fh}} = \left( \frac{A_s}{A_h} \right)^{\sigma-1} \left( \frac{\xi_s}{\xi_h} \right)^{\sigma-1} \left( \frac{l_h}{l_s} \right)^{\frac{\sigma-\eta}{\eta-1}} \left( \frac{1 - \psi}{\psi} \right)^{\sigma} \]
Structural transformation

▶ Manufacturing vs Services

\[ E_{ms} = \left( \frac{A_m}{A_s} \right)^{\varepsilon-1} \left[ \left( \frac{\xi_s}{\xi_m} \right)^{\eta-1} \left( \frac{I_m}{I_s} \right)^{1/\eta-1} \right]^{1-\varepsilon} \left( \frac{1}{E_{sh}} + 1 \right)^{\frac{\sigma-\varepsilon}{\sigma-1}} B_{ms} \]

▶ Agriculture vs Services

\[ E_{as} = \left( \frac{A_a}{A_s} \right)^{\varepsilon-1} \left[ \left( \frac{\xi_s}{\xi_a} \right)^{\eta-1} \left( \frac{I_a}{I_s} \right)^{1/\eta-1} \right]^{1-\varepsilon} \left( \frac{1}{E_{sh}} + 1 \right)^{\frac{\sigma-\varepsilon}{\sigma-1}} B_{as} \]

where \( M \) reflects modernization within agriculture and \( B_{ij} \) are combinations of preference parameters for goods \( i \) and \( j \).
Female employment and the gender wage ratio

- **Demand equation**: budget constraint and demand for goods/services

\[
\frac{l_{fh}}{L_f} = \frac{l_h(w)}{l(w) \sum_{i=\bar{a},m,s,h} E_{ih}(w)} \left(1 - \frac{\rho(w) \bar{c}}{L_m + wL_f}\right), \quad \rho(w) \equiv \frac{\bar{p}_a}{w_m},
\]

- **Supply equation**: female time constraint and optimal input ratios

\[
\frac{l_{fh}}{L_f} = \frac{l_h(w)}{\sum_{j=a,m,s,h,n} l_j(w) E_{jh}(w)}
\]

- **Equilibrium gender wage ratio** \(w\) solves:

\[
l(w) \sum_{i=\bar{a},m,s,h} E_{ih}(w) = \left[1 - \frac{\rho(w) \bar{c}}{L_m + wL_f}\right] \left[\sum_{j} l_j(w) E_{jh}\right]
\]