Lecture 2: Structural Transformation

Eugenio Proto

February 26, 2009

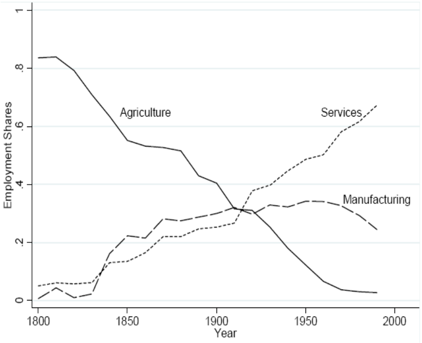


FIGURE 20.1. The share of US employment in agriculture, manufacturing and services, 1800-2000.

- Development always implies a shift of labour force from Agrarian to Manufacturing: *the Kuznets facts*.

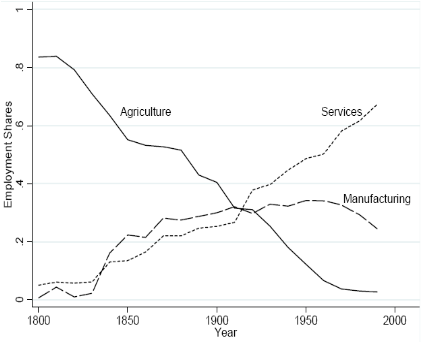


FIGURE 20.1. The share of US employment in agriculture, manufacturing and services, 1800-2000.

- Development always implies a shift of labour force from Agrarian to Manufacturing: *the Kuznets facts*.
- This pattern is common to UK and all industrialized countries

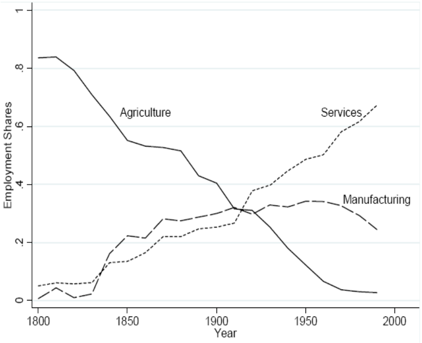


FIGURE 20.1. The share of US employment in agriculture, manufacturing and services, 1800-2000.

- Development always implies a shift of labour force from Agrarian to Manufacturing: *the Kuznets facts*.
- This pattern is common to UK and all industrialized countries
- Consumption of agrarian and manufacturing goods follow the same pattern

Agrarian Productivity and Industrialization (Crafts and Harley 2002)

- Between 1500 and 1800, the French agricultural population fell from 73 to 59 per cent of the total, while agricultural labour productivity was unchanged;

Agrarian Productivity and Industrialization (Crafts and Harley 2002)

- Between 1500 and 1800, the French agricultural population fell from 73 to 59 per cent of the total, while agricultural labour productivity was unchanged;
- in England it fell from 74 to 35 per cent of the total while agricultural labour productivity rose by 43 per cent (Allen 2000).

Agrarian Productivity and Industrialization (Crafts and Harley 2002)

- Between 1500 and 1800, the French agricultural population fell from 73 to 59 per cent of the total, while agricultural labour productivity was unchanged;
- in England it fell from 74 to 35 per cent of the total while agricultural labour productivity rose by 43 per cent (Allen 2000).
- The 1840 English share of agricultural employment was not reached in France and Germany until the 1950s.

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^\infty (c^A(t) - \gamma^A)^\eta c^M(t)^{1-\eta} dt$$

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^\infty (c^A(t) - \gamma^A)^\eta c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^\infty (c^A(t) - \gamma^A)^\eta c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.
  - c^A, c^M : consumptions in the Agrarian and manufacturing

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^\infty (c^A(t) - \gamma^A)^\eta c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.
  - c^A, c^M : consumptions in the Agrarian and manufacturing
- Production

$$Y^M(t) = X(t)F(L^M(t)) \text{ and } Y^A(t) = BG(L^A(t))$$

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^\infty (c^A(t) - \gamma^A)^\eta c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.
  - c^A, c^M : consumptions in the Agrarian and manufacturing

- Production

$$Y^M(t) = X(t)F(L^M(t)) \text{ and } Y^A(t) = BG(L^A(t))$$

  - $X(t) = \kappa Y^M(t)$ learning by doing externalities,

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^{\infty} (c^A(t) - \gamma^A)^{\eta} c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.
  - c^A, c^M : consumptions in the Agrarian and manufacturing

- Production

$$Y^M(t) = X(t)F(L^M(t)) \text{ and } Y^A(t) = BG(L^A(t))$$

  - $X(t) = \kappa Y^M(t)$ learning by doing externalities,
  - Decreasing Return to labor: $F'' < 0$, $G'' < 0$

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^\infty (c^A(t) - \gamma^A)^\eta c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.
  - c^A, c^M : consumptions in the Agrarian and manufacturing

- Production

$$Y^M(t) = X(t)F(L^M(t)) \text{ and } Y^A(t) = BG(L^A(t))$$

  - $X(t) = \kappa Y^M(t)$ learning by doing externalities,
  - Decreasing Return to labor: $F'' < 0$, $G'' < 0$

- Households Budget constraint

$$c^A(t) + p(t)c^M(t) \leq \pi(t) + w(t)$$

Agrarian Productivity and Industrialization (Matsuyama 1992)

- Households preferences

$$\int_0^{\infty} (c^A(t) - \gamma^A)^{\eta} c^M(t)^{1-\eta} dt$$

  - γ^A is the minimum (subsistence) food requirement: Engel's Law.
  - c^A, c^M : consumptions in the Agrarian and manufacturing

- Production

$$Y^M(t) = X(t)F(L^M(t)) \text{ and } Y^A(t) = BG(L^A(t))$$

  - $X(t) = \kappa Y^M(t)$ learning by doing externalities,
  - Decreasing Return to labor:$F'' < 0$, $G'' < 0$

- Households Budget constraint

$$c^A(t) + p(t)c^M(t) \leq \pi(t) + w(t)$$

- Assume $BG(1) > \gamma^M > 0$: Nobody starves

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:
  - $\omega(t) = BG'(L^A(t))$,

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:
  - $\omega(t) = BG'(L^A(t))$,
  - $\omega(t) = p(t)X(t)F'(L^M(t))$,

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:
  - $\omega(t) = BG'(L^A(t))$,
  - $\omega(t) = p(t)X(t)F'(L^M(t))$,
  - No unemployment in equilibrium $L^M(t) = n(t)$, $L^A(t) = 1 - n(t)$.

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:
  - $\omega(t) = BG'(L^A(t))$,
  - $\omega(t) = p(t)X(t)F'(L^M(t))$,
  - No unemployment in equilibrium $L^M(t) = n(t)$, $L^A(t) = 1 - n(t)$.
- General Equilibrium:

$$BG'(1 - n(t)^*) = p(t)^* X(t) F'(n^*(t)) \tag{1}$$

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:
  - $\omega(t) = BG'(L^A(t))$,
  - $\omega(t) = p(t)X(t)F'(L^M(t))$,
  - No unemployment in equilibrium $L^M(t) = n(t)$, $L^A(t) = 1 - n(t)$.
- General Equilibrium:

$$BG'(1 - n(t)^*) = p(t)^* X(t) F'(n^*(t)) \quad (1)$$

- Optimal Consumption (using 1)

$$c^A(t)^* = \gamma^A + \eta p(t) c^M(t)^* / (1 - \eta) \quad (2)$$

Agrarian Productivity and Industrialization (cont'd)

Analysis

- Equilibrium wages:
  - $\omega(t) = BG'(L^A(t))$,
  - $\omega(t) = p(t)X(t)F'(L^M(t))$,
  - No unemployment in equilibrium $L^M(t) = n(t)$, $L^A(t) = 1 - n(t)$.
- General Equilibrium:

$$BG'(1 - n(t)^*) = p(t)^* X(t) F'(n^*(t)) \tag{1}$$

- Optimal Consumption (using 1)

$$c^A(t)^* = \gamma^A + \eta p(t) c^M(t)^* / (1 - \eta) \tag{2}$$

- Equilibrium in the good markets

$$\begin{aligned} X(t)F(n^*(t)) &= c^M(t)^* \\ BG(1 - n^*(t)) &= c^A(t)^* \end{aligned} \tag{3}$$

- Considering expressions (2), (2) and (1), the equilibrium labor allocation is

$$\phi(n(t)^*) = \frac{\gamma^A}{B}$$

- Considering expressions (2), (2) and (1), the equilibrium labor allocation is

$$\phi(n(t)^*) = \frac{\gamma^A}{B}$$

  - with $\phi' < 0$.

Agrarian Productivity and Industrialization (cont'd)

Main result

- Considering expressions (2), (2) and (1), the equilibrium labor allocation is

$$\phi(n(t)^*) = \frac{\gamma^A}{B}$$

  - with $\phi' < 0$.
- n increasing in B (agrarian productivity)

Agrarian Productivity and Industrialization (cont'd)

Main result

- Considering expressions (2), (2) and (1), the equilibrium labor allocation is

$$\phi(n(t)^*) = \frac{\gamma^A}{B}$$

  - with $\phi' < 0$.
- n increasing in B (agrarian productivity)
- **Proposition**: *In the above-described model, the combination of learning-by-doing and Engel's Law generates a unique equilibrium in which the share of employment of manufacturing is constant at* $n \equiv \phi^{-1}(\frac{\gamma^A}{B})$, *and manufacturing output and consumption grow at the rate* $\kappa F(n)$, *which is increasing in agricultural productivity* B.

Agrarian Productivity and Industrialization (cont'd)

- The link of growth to agrarian productivity can provide an explanation for the industrial revolution

Agrarian Productivity and Industrialization (cont'd)

- The link of growth to agrarian productivity can provide an explanation for the industrial revolution
- Can explain the difference in productivity across countries

Agrarian Productivity and Industrialization (cont'd)

- The link of growth to agrarian productivity can provide an explanation for the industrial revolution
- Can explain the difference in productivity across countries
- Proto (2006) provides a different Mechanism based on Contracts in the Agrarian sector as a source of capital accumulation

Other non Balanced Growth model

- Kongsamut, Rebelo and Xie (2001) reconcile Kuznet Facts with the Kaldor fact that the ration labour capital is always constant.

Other non Balanced Growth model

- Kongsamut, Rebelo and Xie (2001) reconcile Kuznet Facts with the Kaldor fact that the ration labour capital is always constant.
  - KRX assume

$$\begin{aligned} Y^A(t) &= B^A F(K^A(t), X(t)L^A(t)) \\ Y^M(t) &= B^M F(K^M(t), X(t)L^M(t)) \\ Y^S(t) &= B^S F(K^S(t), X(t)L^S(t)) \end{aligned}$$

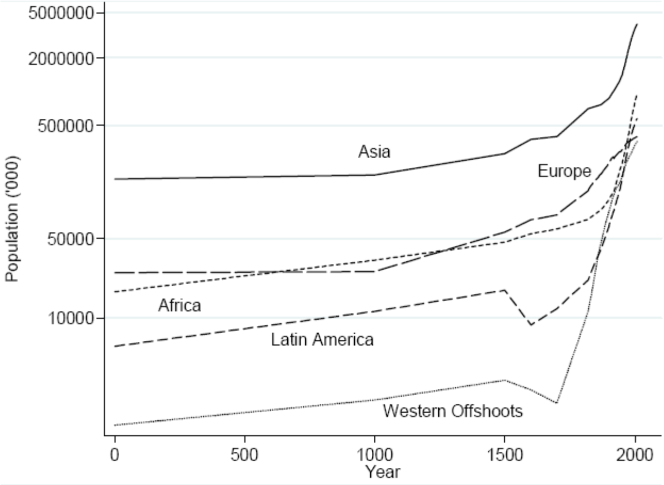
Other non Balanced Growth model

- Kongsamut, Rebelo and Xie (2001) reconcile Kuznet Facts with the Kaldor fact that the ration labour capital is always constant.
    - KRX assume

$$\begin{aligned} Y^A(t) &= B^A F(K^A(t), X(t)L^A(t)) \\ Y^M(t) &= B^M F(K^M(t), X(t)L^M(t)) \\ Y^S(t) &= B^S F(K^S(t), X(t)L^S(t)) \end{aligned}$$

- Baumol's (1967) and Acemoglu and Guerrieri (2008) introduce different production functions

Demographic transition



Demographic transition

- Malthusian Regime: The relationship between income per capita and population growth is positive, no substantial improvement in the living standards

Demographic transition

- Malthusian Regime: The relationship between income per capita and population growth is positive, no substantial improvement in the living standards
- Modem Growth Regime: Negative relationship between economic and demographic growth, increases in the living standards

Demographic transition

- Malthusian Regime: The relationship between income per capita and population growth is positive, no substantial improvement in the living standards
- Modem Growth Regime: Negative relationship between economic and demographic growth, increases in the living standards
- Transition regime: Positive relationship between income and population, but income grows

Theory: Malthusian Growth (cont'd)

The model

- Individuals' Utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}\eta n(t+1)^2)$$

Theory: Malthusian Growth (cont'd)

The model

- Individuals' Utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}\eta n(t+1)^2)$$

  - $y(t+1)$ children' income, $n(t+1)$: number of children

Theory: Malthusian Growth (cont'd)

The model

- Individuals' Utility

$$c^{\alpha}(t)(n(t+1)y(t+1)-\frac{1}{2}\eta n(t+1)^2)$$

  - $y(t+1)$ children' income, $n(t+1)$: number of children
  - η cost to educate each child

Theory: Malthusian Growth (cont'd)

The model

- Individuals' Utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}\eta n(t+1)^2)$$

  - $y(t+1)$ children' income, $n(t+1)$: number of children
  - η cost to educate each child

- Production

$$Y(t) = ZL(t)^{1-\alpha}$$

Theory: Malthusian Growth (cont'd)

The model

- Individuals' Utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}\eta n(t+1)^2)$$

  - $y(t+1)$ children' income, $n(t+1)$: number of children
  - η cost to educate each child

- Production

$$Y(t) = ZL(t)^{1-\alpha}$$

- Demographic expansion

$$L(t+1) = n(t+1)L(t)$$

- Wages

$$w(t+1) = (1-\alpha)L(t+1)^{-\alpha} = y(t+1)$$

- Wages

$$w(t+1) = (1-\alpha)L(t+1)^{-\alpha} = y(t+1)$$

- Optimizing

$$n(t+1) = (1-\alpha)\eta_0^{-1}L(t+1)^{-\alpha}$$

rearranging

$$L(t+1) = (1-\alpha)^{\frac{1}{1+\alpha}}\eta_0^{-\frac{1}{1+\alpha}}L(t)^{\frac{1}{1+\alpha}}$$

Theory: Malthusian Growth (cont'd)

Equilibria

$$
\begin{aligned}
L^* &= (1-\alpha)^{1/\alpha}\eta^{-1/\alpha} \\
c^* &= w^* = (1-\alpha)(L^*)^{-\alpha}
\end{aligned}
$$

Theory: Transition

The model

- Individuals' utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}(\eta_0(1-e(t)) + \eta_1 X(t+1)e(t))n(t+1)^2)$$

- Individuals' utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}(\eta_0(1-e(t)) + \eta_1 X(t+1)e(t))n(t+1)^2)$$

- η_1 : education costs for skilled children

- Individuals' utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}(\eta_0(1-e(t)) + \eta_1 X(t+1)e(t))n(t+1)^2)$$

- η_1 : education costs for skilled children
- Production

$$Y(t) = ZU(t)^{1-\alpha}; Y^M(t) = X(t)S(t)$$

- Individuals' utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}(\eta_0(1-e(t)) + \eta_1 X(t+1)e(t))n(t+1)^2)$$

- η_1 : education costs for skilled children
- Production

$$Y(t) = ZU(t)^{1-\alpha}; Y^M(t) = X(t)S(t)$$

  - $U(t)$: unskilled workers, $S(t)$: skilled workers

Theory: Transition

The model

- Individuals' utility

$$c^{\alpha}(t)(n(t+1)y(t+1) - \frac{1}{2}(\eta_0(1-e(t)) + \eta_1 X(t+1)e(t))n(t+1)^2)$$

- η_1 : education costs for skilled children
- Production

$$Y(t) = ZU(t)^{1-\alpha}; Y^M(t) = X(t)S(t)$$

  - $U(t)$: unskilled workers, $S(t)$: skilled workers
  - Endogenous growth

$$X(t+1) = \kappa S(t)$$

Theory: Transition (cont'd)

- Demographic expansion

$$n(t+1) = \begin{array}{ll} w^U(t+1)\eta_0^{-1} & e(t)=0 \\ \eta_1^{-1} & e(t)=1 \end{array}$$

Theory: Transition (cont'd)

- Demographic expansion

$$n(t+1) = \begin{matrix} w^U(t+1)\eta_0^{-1} & e(t)=0 \\ \eta_1^{-1} & e(t)=1 \end{matrix}$$

  - $\eta_1^{-1} < w^U(t+1)\eta_0^{-1}$:more children in the Malthusian regime if skills are very expensive $(\eta_1 >> \eta_0)$

Theory: Transition (cont'd)

- Demographic expansion

$$n(t+1) = \begin{array}{ll} w^U(t+1)\eta_0^{-1} & e(t)=0 \\ \eta_1^{-1} & e(t)=1 \end{array}$$

  - $\eta_1^{-1} < w^U(t+1)\eta_0^{-1}$:more children in the Malthusian regime if skills are very expensive $(\eta_1 >> \eta_0)$

- Wages:

$$\begin{aligned} w^U(t) &= (1-\alpha)U(t)^{-\alpha} \\ w^S(t) &= X(t) \end{aligned}$$

Theory: Transition (cont'd)

- Compare individuals' utilities:

$$V^U(t) \geq V^S(t)$$

Theory: Transition (cont'd)

- Compare individuals' utilities:

$$V^U(t) \geq V^S(t)$$

  - Malthusian regime if

$$X(0)\eta_1^{-\alpha} < (1-\alpha)(L^*)^{-2\alpha}\eta_0^{-1}.$$

Theory: Transition (cont'd)

- Compare individuals' utilities:

$$V^U(t) \geq V^S(t)$$

  - Malthusian regime if

$$X(0)\eta_1^{-\alpha} < (1-\alpha)(L^*)^{-2\alpha}\eta_0^{-1}.$$

  - Transition if

$$(1-\alpha)(L(1))^{-2\alpha}\eta_0^{-1} > X(0)\eta_1^{-\alpha} > (1-\alpha)(L^*)^{-2\alpha}\eta_0^{-1}$$

Theory: Transition (cont'd)

- Compare individuals' utilities:

$$V^U(t) \geq V^S(t)$$

  - Malthusian regime if

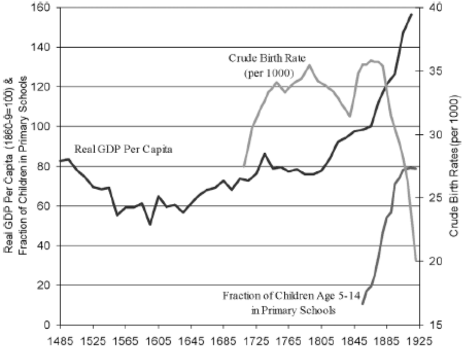
$$X(0)\eta_1^{-\alpha} < (1-\alpha)(L^*)^{-2\alpha}\eta_0^{-1}.$$

  - Transition if

$$(1-\alpha)(L(1))^{-2\alpha}\eta_0^{-1} > X(0)\eta_1^{-\alpha} > (1-\alpha)(L^*)^{-2\alpha}\eta_0^{-1}$$

  - low future wages for children may induce parents to invest in skills

Trade-off Quantity-Quality



igure 41. The sharp rise in the growth rate of real GDP per capita and its association with investment in ducation and fertility decline: England 1485–1920. Sources: Clark (2001), Feinstein (1972), Flora, Kraus and Pfenning (1983), Wrigley and Schofield (1981).

- Black, Devereux and Salvanes (2005), Angrist, Lavy and Schlosser (2006) and Qian (2007), looks at evidence from Norway, Israel and China, but does not find strong support for the quality-quantity

Other explanation for DT

- Social norms

Other explanation for DT

- Social norms
- The large declines in mortality starting in the 19th century,

Other explanation for DT

- Social norms
- The large declines in mortality starting in the 19th century,
- Reduced need for child labor.