

# The U.S. Structural Transformation and Regional Convergence: A Reinterpretation

Caselli and Coleman(2001), JPE

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## OUTLINE

- Joint study of Structural Transformation (ST) & Regional Convergence (RC) in the U.S.
  - ST: Major changes in the sectoral composition of output and employment (Agriculture ↓)
    - Why does ST occur?
  - RC: Southern wage converges to Northern wage
    - How does ST affect RC?

## MOTIVATION

- Goal: Construct a model to match data well

TABLE 1  
STRUCTURAL TRANSFORMATION AND REGIONAL CONVERGENCE IN THE UNITED STATES

	1880	1900	1920	1940	1960	1980
A. Structural Transformation						
Farm share of GDP <sup>1</sup>	.27	.19	.13	.09	.06	.02
Agricultural share of employment <sup>2</sup>	.50	.39	.26	.20	.06	.03
Farm relative price (1967 = 1) <sup>3</sup>	1.20	1.23	1.54	.99	1.10	1.01
Agricultural relative wage <sup>2</sup>	.20	.21	.32	.35	.51	.69
B. Regional Convergence						
South/North relative wage <sup>2</sup>	.41	.44	.59	.60	.78	.90
Midwest/North relative wage <sup>2</sup>	.82	.89	.90	.84	.96	1.00
West/North relative wage <sup>2</sup>	1.28	1.15	1.00	.99	1.03	1.04

<sup>1</sup> Source: *Historical Statistics*, ser. F125, F127; 1998 *Economic Report of the President*, table B-10.

<sup>2</sup> Source: See Sec. II and App. A.

<sup>3</sup> Source: *Historical Statistics*, ser. E25, E135; 1998 *Economic Report of the President*, tables B-60, B-67 (farm relative price equals the wholesale price index for farm goods divided by the consumer price index).

## CONTENT

- ❑ Mechanisms of Structural Transformation
  - Two traditional explanations
  - New explanation
- ❑ Accounting for Regional Convergence
- ❑ Model for Structural Transformation
- ❑ Simulation Result
- ❑ Conclusion and Discussion

## MECHANISMS for ST

### I. Preference-related one: Engel's Law

- Income elasticity of demand for farm goods  $< 1$
- Incorporate Stone-Geary form into utility function

$$u(c_{ft}^i, c_{mt}^i) = \frac{[(c_{ft}^i - \gamma)^\tau (c_{mt}^i)^{1-\tau}]^{1-\sigma}}{1 - \sigma}, \quad 0 < \tau < 1, \sigma \geq 0, \text{ and } \gamma \geq 0$$

### II. Technology-related one: Faster farm TFP growth relative to nonfarm

- Fewer workers needed for the same farm goods

→ Fail w.r.t. the prices (farm goods price and wage)

## MECHANISMS for ST

Mechanism I: Demand for farm products ↓

II: Demand for farm labor ↓

### **III. Sectoral Migration: Supply of farm labor ↓**

- Result of farm-born workers' optimal choice whether to remain in agriculture or join nonagricultural sectors
- If PV of life-time nonfarm wages subtracted by cost of acquiring nonfarm skills exceeds PV of farm wages, join the nonfarm sector
- Long-run decline in the cost of obtaining nonfarm skills (due to transportation tech. ↑, education quality ↑, life expectancy ↑, and school desegregation)

→ Consistent with the increase in farm wages

ST → RC

□ Assume: Two-region model (North and South)

- South : Comparative advantage in farming due to atmospheric and soil conditions

→ Production of farm goods concentrated in the South  
Lower per capita income in the South

□ Mechanisms I-III yield

- **Labor reallocation:** more and more workers out of lower-wage farming into higher-wage manufacturing
- **Increase in relative farm wages** for remaining farm workers

→ Both features lead to RC in average state labor income

# REGIONAL CONVERGENCE

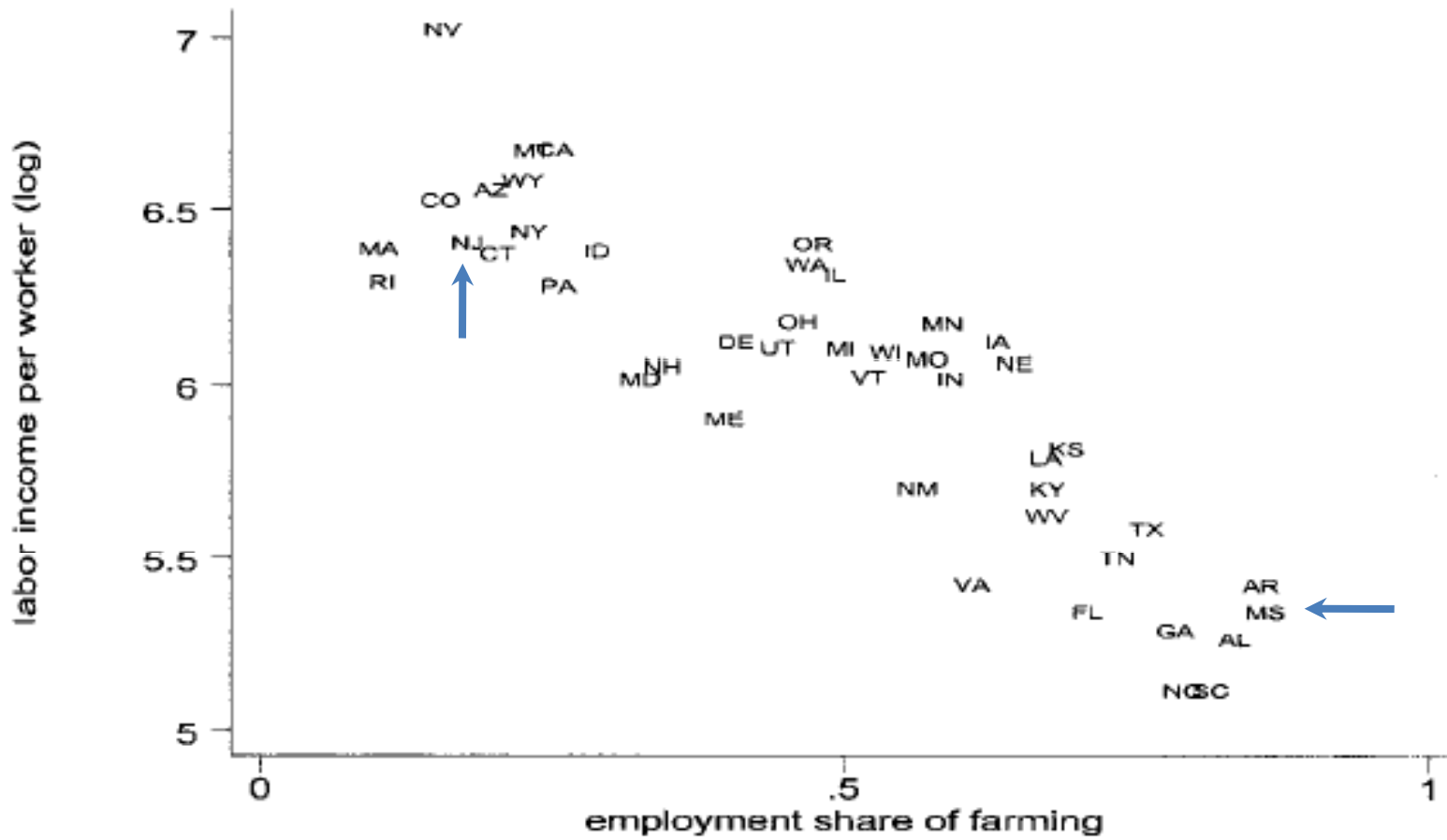


FIG. 1.—Labor income per worker and employment in farming, 1880

Higher farm employment → Lower state labor income (-.87)

# REGIONAL CONVERGENCE

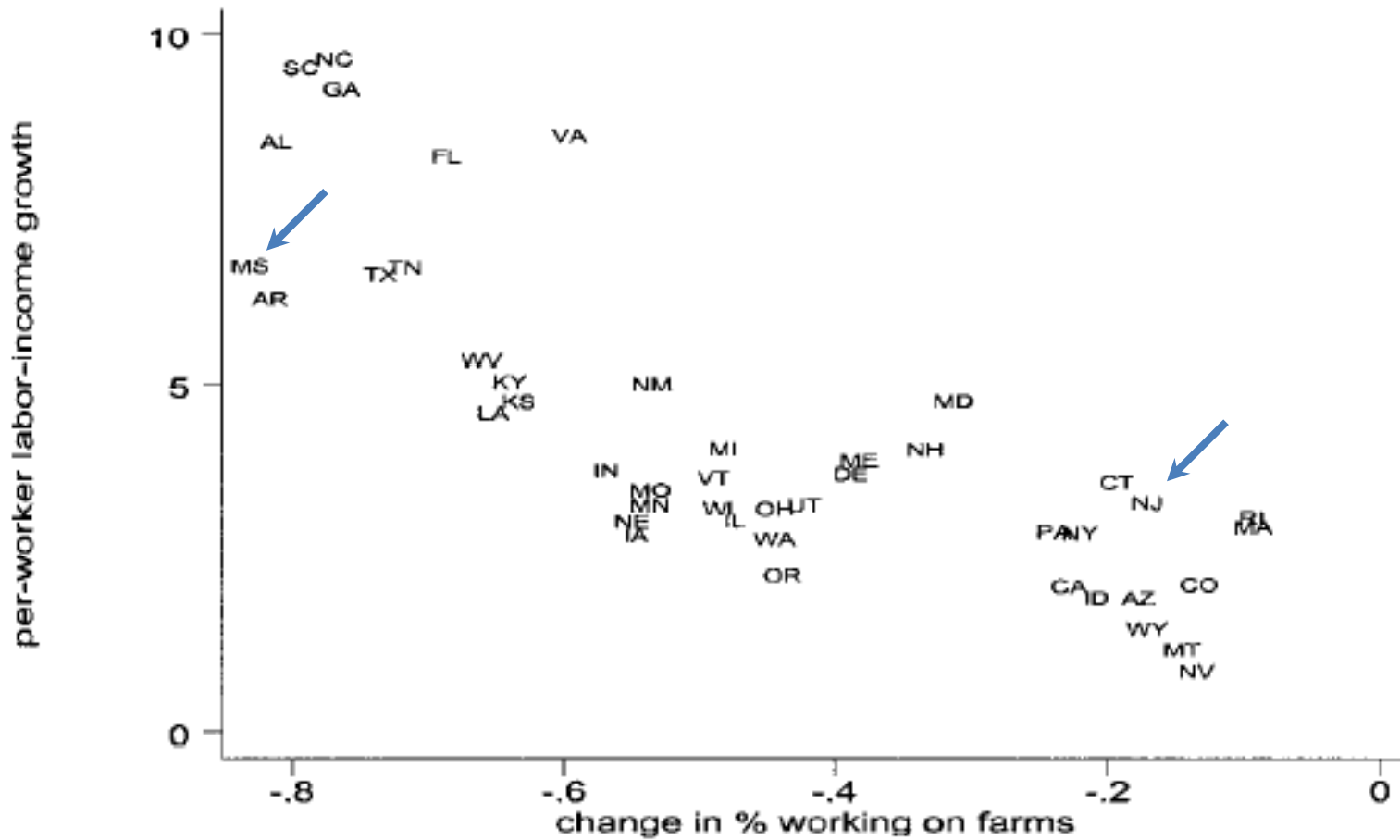


FIG. 2.—Growth and the structural transformation, 1880–1990

Bigger ↓ in farm employment → Higher income growth(-.80)

## ACCOUNTING for RC

□ Decompose convergence of average labor incomes

$$w_t^i = w_{ft}^i L_{ft}^i + w_{mt}^i (1 - L_{ft}^i), \quad i = S, N$$

□ Three channels for convergence  $\left( \frac{w_t^S - w_t^N}{w_t} - \frac{w_{t-1}^S - w_{t-1}^N}{w_{t-1}} \right)$

i) Within-industry wage:  $w_{ft}^S$  to  $w_{ft}^N$ ,  $w_{mt}^S$  to  $w_{mt}^N$

→ Factor price equalization

ii) Labor reallocation:  $L_{ft}^S$  to  $L_{ft}^N$

iii) Between-industry wage:  $w_{ft}$  to  $w_{mt}$

→ Structural transformation

## ACCOUNTING for RC

TABLE 2  
DECOMPOSITION OF CONVERGENCE IN SOUTH TO NORTH INCOME PER WORKER,  
1880–1950

Period	Total (1)	Labor Reallocation (2)	Between Industry (3)	Within Industry (4)
1880–1950	.440	.156	.201	.084
Percentage of total	100	35.5	45.5	19.1
1940–90	.312	.110	.070	.132
Percentage of total	100	35.3	22.4	42.3

SOURCE.—Authors' calculations. Data sources: service income per worker, 1880–1950: Lee et al. (1957), tables L-4, Y8, Y-4; labor income per worker, 1940–90: Ruggles and Sobek (1997).

NOTE.—Col. 1 is the quantity in (2). Col. 2 is the component due to convergence of  $L_{jt}^S$  to  $L_{jt}^N$ . Col. 3 is the component due to convergence of  $w_j$  to  $w_{gr}$ . Col. 4 is the component due to convergence of  $w_j^S$  to  $w_j^N$  and  $w_{gr}^S$  to  $w_{gr}^N$ . See App. B for more details.

→ Structural transformation accounts for 81% or 58% of convergence in South to North income per worker

## TWO-REGION MODEL

### □ Producers' problem

- Production technologies:

$$F_t^i = A_{ft}^i (T_{ft}^i)^{\alpha_T} (L_{ft}^i)^{\alpha_L} (K_{ft}^i)^{1-\alpha_T-\alpha_L}, \quad i = S, N,$$

$$M_t^i = A_{mt}^i (T_{mt}^i)^{\beta_T} (L_{mt}^i)^{\beta_L} (K_{mt}^i)^{1-\beta_T-\beta_L}, \quad i = S, N,$$

- Resource constraints:

$$T_{ft} + T_{mt} = 1$$

$$K_{ft} + K_{mt} = K_t$$

$$L_{mt} + L_{ft} + L_{et} = 1$$

EQ. (1) – (3)

- Market clearing in two sectors:

$$c_{mt} + K_{t+1} = M_t + (1 - \delta)K_t$$

$$c_{ft} = F_t$$

EQ. (4) – (5)

## TWO-REGION MODEL

### □ Producers' problem

- Factor pricing equations:

$$F_1(T_{fv}, L_{fv}, K_{fv}, A_{fv}) = a_v$$

$$F_2(T_{fv}, L_{fv}, K_{fv}, A_{fv}) = w_{fv}$$

$$F_3(T_{fv}, L_{fv}, K_{fv}, A_{fv}) = r_v$$

$$M_1(T_{mt}, L_{mt}, K_{mt}, A_{mt}) = \frac{a_t}{p_t} \quad \text{EQ. (6) – (11)}$$

$$M_2(T_{mt}, L_{mt}, K_{mt}, A_{mt}) = \frac{w_{mt}}{p_t}$$

$$M_3(T_{mt}, L_{mt}, K_{mt}, A_{mt}) = \frac{r_t}{p_t}$$

## TWO-REGION MODEL

### □ Demographic Structure

- Newly born generation of size  $(1-\lambda)$  in each period  
Probability of surviving another period:  $\lambda$

- Either join the F-sector (supply one unit of labor),  
Or devote  $\xi_t \zeta^i$  ( $<1$ ) periods to education and then supply one unit of labor to the M-sector

( $\xi_t$  : costs of acquiring M-skills,  $\zeta^i$  : amounts of time required to acquire M-skills,  $\zeta^i \sim \mu(\zeta^i)$ )

- All individuals with type  $\zeta^i$  will invest in skill acquisition

if  $h_{mt} - \xi_t \zeta^i w_{mt} \geq h_{ft}$

$$\rightarrow \bar{\zeta}_t = \frac{1}{\xi_t} \frac{h_{mt} - h_{ft}}{w_{mt}}$$

## TWO-REGION MODEL

### □ Demographic Structure

- Supply of trainees and newborns to the M sector:

$$l_{et}^0 = \int_0^{\bar{\zeta}_t} \xi_t \zeta^i \mu(\zeta^i) d\zeta^i \quad l_{mt}^0 = \int_0^{\bar{\zeta}_t} (1 - \xi_t \zeta^i) \mu(\zeta^i) d\zeta^i \quad \text{EQ. (12) – (13)}$$

(  $l_{et}^0, l_{mt}^0$  : the fraction of newly born generation's time devoted to training, employment in M-sector)

- Total supply of labor to F, M, and education:

$$L_{ft} = L_{f,t-1} \lambda + l_{ft}^0 (1 - \lambda)$$

$$L_{mt} = (L_{m,t-1} + L_{e,t-1}) \lambda + l_{mt}^0 (1 - \lambda) \quad \text{EQ. (14) – (16)}$$

$$L_{et} = l_{et}^0 (1 - \lambda)$$

## TWO-REGION MODEL

### □ Household's problem

- Utility Maximization with complete markets:

$$\text{Max} \quad \sum_{t=0}^{\infty} \beta^t u(c_{ft}^i, c_{mt}^i) \quad \text{s.t.} \quad \sum_{t=0}^{\infty} q_t (c_{ft}^i + p_t c_{mt}^i) = H_0^i$$

$$\text{,where} \quad u(c_{ft}^i, c_{mt}^i) = \frac{[(c_{ft}^i - \gamma)^\tau (c_{mt}^i)^{1-\tau}]^{1-\sigma}}{1 - \sigma}$$

- Intra- and inter-temporal optimization in consumption:

$$\frac{u_2(c_{ft}, c_{mt})}{u_1(c_{ft}, c_{mt})} = p_t \quad \text{EQ. (17)} \quad \beta \frac{u_1(c_{f,t+1}, c_{m,t+1})}{u_1(c_{ft}, c_{mt})} = \frac{q_{t+1}}{q_t} \quad \text{EQ. (17')}$$

- Capital accumulation: from eq.(17')

$$u_2(c_{ft}, c_{mt}) = \beta u_2(c_{f,t+1}, c_{m,t+1}) [M_3(T_{m,t+1}, L_{m,t+1}, K_{m,t+1}, A_{m,t+1}) + 1 - \delta] \quad \text{EQ. (18)}$$

## TWO-REGION MODEL

### □ Household's problem

- Recursive equations of human capital: from eq.(17')

$$u_1(c_{ft}, c_{mt})h_{mt} = u_1(c_{ft}, c_{mt})w_{mt} + \beta\lambda u_1(c_{f,t+1}, c_{m,t+1})h_{m,t+1} \quad \text{EQ. (19)–(20)}$$

$$u_1(c_{ft}, c_{mt})h_{ft} = u_1(c_{ft}, c_{mt})w_{ft} + \beta\lambda u_1(c_{f,t+1}, c_{m,t+1})h_{f,t+1}$$

$$\left( h_{jt} = \sum_{s=t}^{\infty} \frac{q_s}{q_t} \lambda^{s-t} w_{js}, \quad j = f, m, \text{ the PV of wages in sector } j \right)$$

→ We have 20 eqs. that determine 20 policy functions

These policy functions explain the evolution of

$p_t, a_t, w_{ft}, w_{mt}, r_t, h_{ft}, h_{mt}, T_{ft}, T_{mt}, c_{ft}, c_{mt}, K_{t+1}, K_{ft}, K_{mt}, l_{ft}^0, l_{mt}^0, l_{et}^0, L_{ft}, L_{mt}$  and  $L_{et}$

(The state variables:  $A_{ft}, A_{mt}, \xi_t, K_t, L_{f,t-1}, L_{m,t-1}, L_{e,t-1}$  )

# CALIBRATION

## Parameter values:

PARAMETER VALUES		
Parameter	Value	Description
Both Models		
$\tau$	.01	Utility parameter
$\beta$	.60	Discount factor
$\alpha_T$	.19	Land share in farming
$\alpha_L$	.60	Labor share in farming
$\beta_T$	.06	Land share in manufacturing
$\beta_L$	.60	Labor share in manufacturing
$\delta$	.36	Depreciation rate
$\lambda$	.75	Probability of living another period
$\bar{L}_f$ at $t = 0$	.50	Initial farm labor force
$g_n$	.0840	Nonfarm TFP growth
$g_o$	.1680	Initial farm TFP growth
$\omega$	.75	Land share in South
Model with Constant Education Costs		
$\gamma$	.2205	Utility parameter
$\bar{K}$ at $t = 0$	.0711	Initial capital stock
$\xi_0$ and $\bar{\xi}$	2.0375	Constant education cost parameter
Model with Declining Education Costs		
$\gamma$	.2201	Utility parameter
$\bar{K}$ at $t = 0$	.0712	Initial capital stock
$\xi_0$	1.8977	Initial education cost parameter
$\bar{\xi}$	.1239	Limit of education cost parameter

# SIMULATION

## □ Simulation result:

KEY FEATURES OF THE DATA AND MODEL SIMULATIONS

Variable	Data	Constant Costs	Declining Costs
$(c_f/c)_{1880}$	.31*	.31	.31
$(c_f/c)_{1980}$	.014	.03	.08
$(L_f)_{1880}$	.50*	.50	.50
$(L_f)_{1980}$	.03	.33	.10
$\hat{p}_{1880}/\hat{p}_{1980}$	$\approx 1.0$	.16	1.14
$(w_f/w_m)_{1880}$	.20*	.20	.20
$(w_f/w_m)_{1980}$	.69†	.03	.69
$(w^S/w^N)_{1880}$	.41*	.41	.41
$(w^S/w^N)_{1980}$	.90	.56	.97

\* Models were fit to these values exactly.

† Model with declining education costs was fit to this value exactly.

→ The model with declining costs of acquiring skills better fits the historical experience

## CONCLUSION & DISCUSSION

- The relative wage rate for farm workers has risen whereas their relative supply has fallen because the relative cost of acquiring nonagricultural skills has declined over time
- A Larger share of RC is due to ST out of agriculture than to the removal of interregional obstacles to factor mobility
- Alternatively, if farm workers of different skill levels receive different wages, skill-biased technological change in agriculture raises the average farm wage
- What does this paper suggest about cross-country income differences?