The Depressing Effect of Agricultural Institutions on the Prewar Japanese Economy

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Outline

- Motivation and Context
- Growth Accounting
- Summary and Results
- Model
- Calibration
- Findings
- Alternative Assumptions
- The Barrier
- Conclusion
Motivation

- Why did the Japanese ‘miracle’ happen after WWII and not before?
Motivation

Figure 1: GNP Per Worker, 1885-2000

The Depressing Effect of Agricultural Institutions on the Prewar Japanese Economy
Motivation

- This paper: labour barrier.
- Agricultural employment stayed constant at 14 million.
  - In 50 years agricultural labour share fell from 60% to 40%.
    Slower than any other country (Maddison 1991).
- Wage in agricultural sector was 1/4 of non-agricultural.
- Culturally imposed barrier.
Motivation
This paper’s contribution

- Impose labour barrier in 2 sector growth model.
- This explains prewar stagnation.
- Explore counterfactual: GNP increases by 33%.
Table 1: Growth Accounting

<table>
<thead>
<tr>
<th></th>
<th>per-worker GNP $\frac{Y_t}{N_t}$</th>
<th>TFP factor $TFP_t^{1-\theta}$</th>
<th>capital intensity factor $\left(\frac{K_t}{Y_t}\right)^{\theta^{1-\theta}}$</th>
<th>employment rate $\frac{E_t}{N_t}$</th>
<th>hours worked per worker $h_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1885-1940</td>
<td>2.1%</td>
<td>2.9%</td>
<td>-0.6%</td>
<td>-0.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td>1960-1973</td>
<td>7.2%</td>
<td>7.3%</td>
<td>0.8%</td>
<td>-0.7%</td>
<td>-0.2%</td>
</tr>
</tbody>
</table>

Note: Geometric means. $Y_t = \text{GNP}$, $K_t = \text{capital stock}$, $E_t = \text{employment}$, $N_t = \text{working-age population}$, $h_t = \text{average hours per employed person}$. See (2.1) for the definition of $TFP_t$. $\theta = 1/3$.

- Data from LTES.
- $TFP_t \equiv \frac{Y_t}{K_t^\theta (h_t E_t)^{1-\theta}}$
- $\frac{Y_t}{N_t} = TFP_t^{1-\theta} \left(\frac{K_t}{Y_t}\right)^{\theta^{1-\theta}} \left(\frac{E_t}{N_t}\right) h_t$
Figure 1: GNP Per Worker, 1885-2000
Growth Accounting

Figure 2: Japan’s Overall TFP Factor, 1885-2000
• TFP and GNP grew sharply after WWII.
• Capital intensity increased slightly.
Summary and Results

- Sectoral misallocation hypothesis.
  - Agricultural employment stayed constant at 14 million despite wage gap.
  - Other countries saw quicker decrease in L-share of agriculture (Madison 1991).
  - Post-WWII agricultural employment falls sharply.
Figure 3: Employment in Agriculture, 1885-2003
Figure 4: Agriculture’s Employment Share
View this in the framework of Hansen and Prescott (2002).
- 2 sector growth.
- Impose labour barrier.
- Too much labour tied up in DRS technology.
Main features:
- Sectoral TFP, total labour supply taken as given.
- Sectoral allocation of labour endogenous (but s.t. barrier).
- Sectoral allocation of capital, capital accumulation endogenous.
- Engel’s law: minimum food consumption.
Summary and Results

Figure 5: Sectoral TFPs, 1885-1940 (1885=100)
Figure 6: GNP Per Worker, 1885-1940

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The simulation tracks the data well (by construction).

The counterfactual shows large GNP gains.
- Production efficiency improvement from allocation.
- Capital accumulation boom.
Summary and Results

Figure 7: Capital Stock Per Worker, 1885-1940 (1885=100)
Summary and Results

Removal of labour barrier:
- Increases GNP and TFP.
- Puts TFP onto postwar trend.
- (By construction) doesn’t change labour supply.

These results require that food is nontraded.

Table 2: Level Accounting for 1885-1940, actual vs. counter-factual

<table>
<thead>
<tr>
<th></th>
<th>$\frac{Y_t}{N_t}$</th>
<th>$TFP_t^{1-\theta}$</th>
<th>$\left(\frac{K_t}{Y_t}\right)^{1-\theta}$</th>
<th>$\frac{E_t}{N_t}$</th>
<th>$h_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>geometric mean of $\frac{\text{value without barrier for year } t}{\text{its actual value for year } t}$</td>
<td>1.33</td>
<td>1.24</td>
<td>1.04</td>
<td>1</td>
<td>1.02</td>
</tr>
</tbody>
</table>

Note: See footnote to Table 1 for definition of symbols. Because the counter-factual simulation uses actual $E_t$ and $N_t$, the ratio for the employment rate $\frac{E_t}{N_t}$ is unity by construction.
• Sector 1 is agriculture, 2 is all other.
• Only sector 2 can be invested in capital. Capital has an exogenous transaction cost.
• Agricultural labour share cannot fall below historical level.
- $N_t$ workers, $E_t$ total L supply, $h_{1t}$, $h_{2t}$ hours required in either industry; all given exogenously.

- Choice over which sector to allocate labour to:
  \[ E_{1t} + E_{2t} = E_T. \]

- $E_{1t}$ bounded below by $\bar{E}_{1t} \equiv$ recorded agricultural labour supply.

- $\frac{E_{1t}}{E_t} \equiv s_E \geq \bar{s}_E \equiv \frac{\bar{E}_{1t}}{E_t}$

- $\bar{s}_E$ falls over time as pop. grows
Households allocate labour according to:

\[ s_{Et} = \bar{s}_{Et} \]

\[ = 1 \]

\[ = [\bar{s}_{Et}, 1] \]

- Agricultural sector wages are endogenous; always lower, so \( s_{Et} = \bar{s}_{Et} \) for all \( t \).
Given optimal $s_{E_t}$ HHs choose $\{c_1t, c_2t, k_{t+1}\}$ to maximize utility 

$$\sum_{t=0}^{\infty} \beta^t N_t u(c_1t, c_2t)$$

s.t. budget constraint

$q_t N_t c_1t + N_t c_2t + N_{t+1} k_{t+1} - (1 - \delta_t) N_t k_t = w_1 t h_1 t E_{1t} + w_2 t h_2 t E_{2t} + r_t N_t k_t - \tau_t (r_t - \delta_t) N_t k_t - \pi_t$

yielding FOC:

$$\frac{\partial u(c_1t, c_2t)}{\partial c_{1t}} = \frac{q_t}{\lambda_t} \implies c_{1t} = c_1(q_t, \lambda_t)$$

$$\frac{\partial u(c_1t, c_2t)}{\partial c_{2t}} = \frac{1}{\lambda_t} \implies c_{2t} = c_2(q_t, \lambda_t)$$

$$\lambda_{t+1} = \beta \lambda_t [1 + (1 - \tau_{t+1})(r_{t+1} - \delta_{t+1})]$$

TVC: $\lim_{t \to \infty} \frac{\beta^t \lambda_t^{-1} k_t}{R_1 R_2 \ldots R_t} = 0$
Agricultural production: \( Y_{1t} = TFP_{1t} K_{1t}^{\theta_1} L_{1t}^{\eta} \) where \( \theta_1 + \eta < 1 \)

FOC:
- \( r_t = \theta_1 q_t TFP_{1t} K_{1t}^{\theta_1-1} L_{1t}^{\eta} \)
- \( w_{1t} = \eta q_t TFP_{1t} K_{1t}^{\theta_1} L_{1t}^{\eta-1} \)

Nonagricultural production: \( Y_{2t} = TFP_{2t} K_{2t}^{\theta_2} L_{1t}^{1-\theta_2} \)

FOC:
- \( r_t + \phi = \theta_2 TFP_{2t} (\frac{K_{2t}}{L_{2t}})^{\theta_2-1} \) where \( \phi = \text{cost of financing} \)
- \( w_{2t} = (1 - \theta_2) TFP_{2t} (\frac{K_{2t}}{L_{2t}})^{\theta_2} \)
Market clearing conditions:

- $N_t c_{1t} = Y_{1t}$ food (nontraded)
- $N_t c_{2t} + (N_{t+1} k_{t+1} - (1 - \delta_t) N_t k_t) + G_t = Y_{2t} - \phi k_{2t}$ manufacturing (traded)
- $K_{1t} + K_{2t} = N_t k_t$ capital invested in each industry must add to capital saved
- $L_{1t} = h_{1t} s_{Et} E_t$ labour clearing agriculture
- $L_{2t} = h_{2t} (1 - s_{Et}) E_t$ labour clearing nonagriculture
A competitive equilibrium is a set of prices and quantities \( \{ \lambda_t, q_t, w_{1t}, w_{2t}, r_t, k_{t+1}, k_{1t}, k_{2t}, s_{Et}, L_{1t}, L_{2t} \}_t^{\infty} \) given \( k_0 \) and exogenous \( \{ G_t, E_t, h_{1t}, h_{2t}, TFP_{1t}, TFP_{2t}, \delta_t, \tau_t \}_t^{\infty} \) s.t.

- HH FOCs
- Firm FOCs
- market clearing
The authors reduce the equilibrium conditions to a two-equation detrended dynamic system.

- $x_t \equiv (\tilde{k}_t, \tilde{\lambda}_t); y_t \equiv (s_{kt}, s_{Et}, \tilde{q}_t)$
- $x_{t+1} = f_t(x_t, y_t), y_t = g_t(x_t)$ where $g(.)$ is s.t. L barrier

Show existence of steady state.
Calibration

- Stone-Geary utility \( u(c_1, c_2) = \mu_1 \ln(c_1 - d_1) + \mu_2 \ln(c_2) \) where \( d_1 > 0, \mu_1 + \mu_2 = 1 \)
  - \( \implies c_1(q, \lambda) = d_1 + \mu_1 \frac{\lambda}{q}, c_2(q, \lambda) = \mu_2 \lambda \)

Production functions now allow intermediate inputs:

- \( Y_{1t} = TFP_{1t} K_{1t}^{\theta_1} L_{1t}^{\eta_1} M_{1t}^{\alpha_1} \)
- \( Y_{2t} = TFP_{2t} K_{2t}^{\theta_2} L_{2t}^{\eta_2} M_{1t}^{\alpha_2} \) where \( \theta_2 + \eta_2 + \alpha_2 = 1 \)

Value added:

- value added in sector 1: \( = (1 - \alpha_1) Y_{1t} \)
- value added in sector 2: \( = (1 - \alpha_2) Y_{2t} - \phi K_{2t} \)
Sector 1 is all food products of all kinds. Sector 2 is all other production.

Factor share $\alpha_1$ taken from LTES. $\quad \Rightarrow$ value added $= \text{output} / (1 - \alpha_1)$.

Agricultural factor shares from Yamada and Hayami (1979), adjusted for depreciation using LTES.

Discount rate set to standard value, depreciation calculated from LTES.

Intermediate good share $\alpha_2$ estimated by $\frac{x}{1+x}$ where

$x = \frac{(Y_1 + NM_1 - c_1)q_t}{(1-\alpha_2)Y_2 - \phi K_2}$

Capital share of nonagricultural value added set to $\frac{2}{3}$.

Minimum food consumption set to 90% of recorded consumption in 1885.
<table>
<thead>
<tr>
<th>parameter</th>
<th>calibrated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_1$ (minimum subsistence level for good 1)</td>
<td>90% of per-worker food consumption in 1885</td>
</tr>
<tr>
<td>$\mu_1$ (asymptotic consumption share of good 1)</td>
<td>0.142</td>
</tr>
<tr>
<td>$\mu_2$ (asymptotic consumption share of good 2)</td>
<td>0.858</td>
</tr>
<tr>
<td>$\beta$ (discounting factor)</td>
<td>0.96</td>
</tr>
<tr>
<td>$\theta_1$ (capital share in sector 1 gross output)</td>
<td>0.144</td>
</tr>
<tr>
<td>$\eta$ (labor share in sector 1 gross output)</td>
<td>0.545</td>
</tr>
<tr>
<td>$\alpha_1$ (share of intermediate inputs in sector 1)</td>
<td>0.146</td>
</tr>
<tr>
<td>$\theta_2/(1 - \alpha_2)$ (capital share in sector 2’s value added)</td>
<td>1/3</td>
</tr>
<tr>
<td>$\alpha_2$ (share of intermediate inputs in sector 2)</td>
<td>0.0587</td>
</tr>
<tr>
<td>$\phi$ (proportional intermediation cost)</td>
<td>0.0371</td>
</tr>
<tr>
<td>the exogenous variable</td>
<td>its projection</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>$h_1, h_2$ (hours worked)</td>
<td>$h_{1t} = h_{1,1940} = 59.0$ and $h_{2t} = h_{2,1940} = 62.3$ for $t &gt; 1940$</td>
</tr>
<tr>
<td>$\delta$ (depreciation rate)</td>
<td>$\delta_t = \delta_{1940} = 5.06%$ for $t &gt; 1940$</td>
</tr>
<tr>
<td>$g_1, g_2$ (TFP growth factors for two sectors)</td>
<td>projected growth rates set to their averages for 1885-1940 of $0.96%$ and $1.66%$, respectively. So $g_{1t} = 1.0096$, $g_{2t} = 1.0166$ for $t &gt; 1940$.</td>
</tr>
<tr>
<td>$n$ (growth factor of aggregate employment and working-age population)</td>
<td>set to the geometric mean over 1885-1940 of the growth rate of working-age population of $1.10%$. So $n_t = 1.0110$ for $t &gt; 1940$.</td>
</tr>
<tr>
<td>$\psi$ (government share of sector 2 output)</td>
<td>$\psi_t = \psi_{1940} = 27.4%$ for $t &gt; 1940$</td>
</tr>
<tr>
<td>$\tau$ (tax rate on capital income)</td>
<td>$\tau_t = \tau_{1940} = 47.2%$ for $t &gt; 1940$</td>
</tr>
<tr>
<td>$\bar{E}_1$ (lower bound for sector 1 employment)</td>
<td>$\bar{E}<em>{1t} = \bar{E}</em>{1,1940} = 13.55$ million persons</td>
</tr>
</tbody>
</table>
Findings

Figure 6: GNP Per Worker, 1885-1940
Labour barrier is binding throughout.

Income ratio $\frac{1}{4}$

With the barrier lifted, lower agricultural employment.
  - Even without food imports
  - More efficient to invest capital in agriculture than bodies.
Figure 8: Agriculture’s Share of Employment, 1885-1940

The graph shows the percentage of employment in agriculture from 1885 to 1940. The black line represents the data with a barrier, and the purple line represents the model without a barrier. The data shows a decrease in the share of employment in agriculture over time.
Figure 9: Agriculture’s Share of Capital, 1885-1940
Findings

- Endogenous $q_t$ tracks data well.
- Suggests little food imports even if we allow it (with barrier imposed).
Findings

Figure 10: Relative Price of Food, 1885-1940 (1934-36 in data=1)
Findings

Figure 11: Effect of Labor Barrier on Production Frontier, 1885

- Constrained
- Unconstrained
- Consumption vector in data
- Consumption, with barrier
- Net output, with barrier
- Consumption, without barrier
- Net output, without barrier
Alternative Assumptions

- Lower subsistence food consumption.
- Vary tax policy.
- Allow food to be traded (small open economy).
Figure 12: Effect of Labor Barrier on Production Frontier, 1885, Small Open Economy
Figure 13: How Children were Indoctrinated
Labour barrier can explain low GNP/worker and TFP growth in prewar Japan.

Counterfactual: could have been much higher without barrier.

Response to criticism:
- Lack of mech. of rice production. But then we shouldn’t see wage disparity; also, traditionally labour and capital are substitutable in agriculture.
- Barrier=city infrastructure?