Total Factor Productivity in Thai Agriculture: Measurement and Determinants

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1. Introduction

- TFP in Thai Agriculture: Findings from previous studies
  - TFP growth was relatively high in Thai agricultural sector
    - Over recent decades, TFP has accounted for between one fifth and three fifth of total output growth
  - Growth Accounting is the commonly used method
  - Number of studies investigating TFP determinants is limited
1. Introduction (2)

Objectives and scope of this study

- To measure TFP in Thai agriculture
  - Focus on crop and livestock sectors
- To investigate factors affecting TFP in Thai agriculture
  - Account for all potential causes of TFP growth
- Period of study: 1970-2006
1. Introduction (3)

❖ Research questions:

1. TFP Measurement
   - To what extent TFP have contributed to agricultural growth?

2. TFP Determinants
   - What are causes of TFP?
   - Does agricultural research contribute to TFP growth?
2. TFP Measurement

- **Method**
  - Growth Accounting
  - **Reasons:**
    - Aggregate-level study
    - Data availability: Time series
    - Comparable with previous Thai studies
    - Underlying assumptions are applicable with Thai agriculture context
TFP growth (TFPG) is a residual of output growth that cannot be explained by growth in conventional inputs.
2. TFP Measurement (2)

**Growth Accounting**

- **TFPG** = Output (Q) growth – Input growth weighted by factor income shares (S)
- 3 conventional inputs: labor (L), land (N), capital (K)

\[
TFPG_t = \ln TFP_t - \ln TFP_{t-1} \\
= (\ln Q_t - \ln Q_{t-1}) - \frac{1}{2}(S_{Lt} + S_{Lt-1})(\ln L_t - \ln L_{t-1}) \\
- \frac{1}{2}(S_{Nt} + S_{Nt-1})(\ln N_t - \ln N_{t-1}) - \frac{1}{2}(S_{Kt} + S_{Kt-1})(\ln K_t - \ln K_{t-1})
\]
Factor Input Adjustment:

- **Labor quality: age, sex, education**
  - Using quality-adjusted index developed by Thailand Development Research Institute (TDRI) to adjust number of workers
  - The index incorporates the changing composition of labor in terms of age, sex and education

- **Land quality: irrigation**
  - Using proportion of irrigated areas to adjust stock of crop land area to reflect multiple cropping
2. TFP Measurement: Data

(annual data: 1970-2006)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>Ag GDP at 1988 prices (value added)</td>
<td>National Accounts, NESDB</td>
</tr>
<tr>
<td>Labor</td>
<td>Number of workers age 15 and above</td>
<td>Labor Force Survey, NSO</td>
</tr>
<tr>
<td>Land</td>
<td>Land used in agriculture</td>
<td>Office of AgEcon</td>
</tr>
<tr>
<td>Capital</td>
<td>Net capital stock at 1988 prices</td>
<td>National Accounts, NESDB</td>
</tr>
<tr>
<td>Wage</td>
<td>Yearly wage of all workers</td>
<td>Labor Force Survey, NSO and TDRI</td>
</tr>
<tr>
<td>Land rent</td>
<td>Actual and imputed rent</td>
<td>NESDB</td>
</tr>
</tbody>
</table>
Investigating factors affecting TFP is largely a matter of empirical study.

The TFP determinants model incorporates factors affecting the residual TFP or the non-conventional inputs such as agricultural research, extension services, and other economic and non-economic factors.
3. TFP Determinants (2)

Key Factors Determining TFP Growth in Thai Agriculture

- **Technical Change**
  - Ag research
  - Ag extension

- **Efficiency Gains**
  - Infrastructure
  - Resource reallocation

- **Economies of Scale**
  - Trade openness

- **Natural/Case-specific factors**
  - Rainfall
  - Flood/Drought
  - Epidemics
  - Commodity boom
3. TFP Determinants (3)

TFP Determinant Model

\[ TFP = f(R^p, E, R^f, I, RR, TO, W, D^c) \]

where  
- TFP = total factor productivity,
- \( R^p \) = real public agricultural research expenditure,
- \( E \) = real public agricultural extension expenditure,
- \( R^f \) = international agricultural research spillovers,
- \( I \) = infrastructure (rural roads and irrigation),
- \( RR \) = resource reallocation,
- \( TO \) = trade openness,
- \( W \) = weather or climate factor,
- \( D^c \) = case-specific dummy variable comprising:
  - \( D^{boom} \) = dummy variable capturing the world agricultural commodity boom from 1972-1974,
  - \( D^{bird} \) = dummy variable capturing the Avian Influenza outbreak took place in 2004.
3. TFP Determinants (4)

- Estimation method: ECM (Hendry, 1995)
  - Variables are a mixture of I(0) and I(1)
  - Minimize spurious relationships while retaining long-run information without restricting lag structure
    - Included variables are in both level and rate-of-change terms
    - capturing both SR and LR information
  - Dynamic and flexible form of lags
    - no need to pre-specify length and shape of lags
### 3. TFP Determinants: Data

List of potential factors affecting TFP in Thai agriculture

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public R&amp;D</td>
<td>Real agricultural research budget expenditure</td>
<td>Bureau of budget</td>
</tr>
<tr>
<td>Extension</td>
<td>Real agricultural extension budget expenditure</td>
<td>Bureau of budget</td>
</tr>
<tr>
<td>Foreign R&amp;D spillovers</td>
<td>CGIAR funding to IRRI, CIAT, CIMMYT in USD</td>
<td>CGIAR financial reports,</td>
</tr>
<tr>
<td></td>
<td>Livestock breeders imports</td>
<td>Office of Ag Econ</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Proportion of irrigated area</td>
<td>Office of Ag Econ</td>
</tr>
</tbody>
</table>
## 3. TFP Determinants: Data

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>Amount of rainfall in millimeter</td>
<td>Office of Ag Economics (OAE)</td>
</tr>
<tr>
<td>Weather (drought or flooding)</td>
<td>Ratio of rice harvested to rice planted area</td>
<td>OAE</td>
</tr>
<tr>
<td>Resource reallocation</td>
<td>Non-crops and non-rice employment shares</td>
<td>OAE, National Statistical Office</td>
</tr>
<tr>
<td>Trade openness</td>
<td>Import and export share in agricultural output</td>
<td>OAE</td>
</tr>
<tr>
<td>Ag commodity boom</td>
<td>Dummy = 1 for year 1972-1974</td>
<td></td>
</tr>
<tr>
<td>Bird Flu</td>
<td>Dummy = 1 from year 2004</td>
<td></td>
</tr>
</tbody>
</table>
4. Results: TFP Measure

- TFP makes an important contribution to agricultural growth in Thailand during 1970-2006

- TFP has been the second most important source of output growth in both crop and livestock sectors

- The results are comparable with previous study (Poapongsakorn, 2006)
4. Results

- Crop TFP increases at an average rate of 0.68% per year, accounting for 20.82% of crop output growth.
4. Results

- Livestock TFP grows at an average rate of 0.67% per year, accounting for 17.49% of livestock output growth.
### 4. Results: TFP Determinants in crop sector

<table>
<thead>
<tr>
<th>Dependent Variable: $\Delta \ln TFP_{t}^{\text{crop}}$</th>
<th>Estimated coefficients (t-ratios)</th>
<th>Long-run elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-1.056 (-6.460)***</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln R^p_{t-3}$</td>
<td>0.155 (4.423)***</td>
<td></td>
</tr>
<tr>
<td>$\Delta \ln E_{t-1}$</td>
<td>0.137 (3.665)***</td>
<td></td>
</tr>
<tr>
<td>$\ln R^p_{t-3}$</td>
<td>0.059 (1.876)*</td>
<td>0.067 (2.117)**</td>
</tr>
<tr>
<td>$\ln R^f_{t-1}$</td>
<td>0.092 (2.955)***</td>
<td>0.105 (3.045)***</td>
</tr>
<tr>
<td>$\ln I_{\text{roads}}_{t-1}$</td>
<td>0.033 (1.977)**</td>
<td>0.038 (1.962)**</td>
</tr>
<tr>
<td>$D^{\text{boom}}$</td>
<td>0.127 (3.104)***</td>
<td>0.145 (3.189)***</td>
</tr>
<tr>
<td>$\ln TFP_{t-1}$</td>
<td>-0.873 (-6.664)***</td>
<td></td>
</tr>
</tbody>
</table>

N = 34, Adj.R² = 0.69, F = 11.31
* = 10%, **=5%, ***=1% level of significance
### 4. Results: TFP Determinants in livestock sector

**Dependent Variable:** \( \Delta \ln TFP_{t, livestock} \)

<table>
<thead>
<tr>
<th></th>
<th>Estimated coefficients (t-ratios)</th>
<th>Long-run elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>0.386 (2.246)**</td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln R^f_t )</td>
<td>0.012 (0.517)</td>
<td></td>
</tr>
<tr>
<td>( \Delta \ln E_{t-1} )</td>
<td>0.119 (1.728)*</td>
<td></td>
</tr>
<tr>
<td>( \ln R^p_{t-3} )</td>
<td>0.128 (2.074)**</td>
<td>0.173 (2.111)**</td>
</tr>
<tr>
<td>( \ln E_{t-1} )</td>
<td>-0.089 (-1.590)</td>
<td>-0.121 (-1.578)</td>
</tr>
<tr>
<td>( \ln R^f_{t-1} )</td>
<td>-0.003 (-0.168)</td>
<td>-0.004 (-0.167)</td>
</tr>
<tr>
<td>( D^{bird} )</td>
<td>-0.165 (-2.720)**</td>
<td>-0.224 (-2.593)**</td>
</tr>
<tr>
<td>( \ln TFP_{t-1} )</td>
<td>-0.739 (-5.510)**</td>
<td></td>
</tr>
</tbody>
</table>

\( N = 35, \text{ Adj.} R^2 = 0.50, F = 5.93 \)

* = 10%, **=5%, ***=1% level of significance
5. Conclusion

- This paper provides empirical evidence on TFP estimates and their determinants in Thai agriculture.

- The findings confirm TFP makes important contribution to agricultural growth in Thailand during 1970-2006.

- Major factors affecting TFP are the public investment in agricultural research, international research spillovers, rural roads and case-specific factors.
Thank You!