“Regional Innovation Policy in Taiwan and South Korea: Impact of Science Parks on Firm-Productivity”

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Ohio State University, February 19, 2016
Motivation

- Policy objective of science parks: support regional economic growth through cooperation among universities, small and medium enterprises (SMEs), and large firms

- Due to level of state-sponsored support, important to evaluate economic effectiveness of this policy instrument

- Literature on evaluation of science parks has typically been cluster-specific, and evidence on firm profitability, firm-survival rates is mixed (Salvador and Rolfo, 2011)

- Little analysis of regional-innovation support policies for East Asia
Development Models: Taiwan vs. South Korea

- Taiwan and South Korea have both successfully followed model of export-oriented industrialization (Amsden, 1989)

- Key difference in focus:
  - Taiwan - SMEs and integration into global production networks
  - South Korea - large conglomerates in order to take advantage of capital-intensity and scale economies

- To get around scale problem: analyze and compare total factor productivity (TFP) distribution of firms in science parks
Theoretical Background

- Positive relation between density of economic activity and firm productivity – why?
  - Firms in large cities have high productivity (Rosenthal and Strange, 2004) – an agglomeration effect
  - Larger markets attract more firms, making competition tougher (Melitz and Ottaviano, 2008) – a selection effect
  - Self-selection of high productivity firms into cities (Baldwin and Okubo, 2006; Forslid and Okubo, 2014) – a sorting effect
Model

- Goods produced under monopolistic competition with sunk cost of entry, firms being indexed by unit labor requirement \( h \)
- \( h \) varies across firms based on productivity draw from known cdf \( G(h) \epsilon [0,1] \), common to all regions
- Agglomeration economies introduced by assuming effective labor \( a \) increases with number of firms in region, \( a(N), a'>0, a''<0 \)
- Selection modeled as proportion of firms that fail to survive product market competition in city \( i, S_i \equiv 1-G(h^d_i) \), where \( d \) is cut-off productivity for survival
Hypotheses

Hypothesis 1:

Increase in number of firms in region shifts log productivity distribution rightwards (agglomeration effect)

Hypothesis 2:

Increase in market size raises entry/survival cost, i.e., increases cut-off for unit labor requirement - greater left truncation of log productivity distribution (selection effect)
Methodology – Taiwan Case

- Taiwanese firm-level panel data for 2009-2011 period (EMIS)
- Define three regions: above median population density (large), below median population density (small), and counties housing science parks
- Estimate firms’ total factor productivity (TFP) for each region
- Identify impact of agglomeration and selection on firms’ productivity
- Also account for sorting whereby most productive firms locate in large region(s)
Results-TFP Estimates (Taiwan)

Data:
Firm-level, income statement and balance sheet; industry classification at 3-digit NAICS level

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<td>$\beta_l$</td>
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<td>0.47**</td>
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Regional TFPs

POPULATION DENSITY

TFP-COUNTY MARKETS
### Summary Statistics - Log TFP (Taiwan)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Below median</th>
<th>Science park</th>
<th>Above median</th>
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<tbody>
<tr>
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<td>11.77</td>
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<tr>
<td>IQR</td>
<td>1.23</td>
<td>1.35</td>
<td>1.42</td>
</tr>
</tbody>
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![TFP Distribution for all Industries](image-url)
Inter-Industry Comparison: Technology-Intensive Occupation Levels (Taiwan)

CHEMICAL MANUFACTURING  COMPUTERS AND ELECTRONICS  SCIENTIFIC AND TECHNICAL SERVICES

NAICS 325 Log-TFP Distribution
\[ \text{kernel} = \text{epanechnikov, bandwidth} = 0.1778 \]

NAICS 334 Log-TFP Distribution
\[ \text{kernel} = \text{epanechnikov, bandwidth} = 0.2025 \]

NAICS 541 Log TFP Distribution
\[ \text{kernel} = \text{epanechnikov, bandwidth} = 0.1451 \]
Agglomeration and Selection Variables

- Localization: Henderson et al. (1995) - regional employment share of specific industry (Marshallian specialization)
- Urbanization: Herfindahl index computed as: \[ \sum s_{jrt}^2 \], where \( s \) is employment share of two-digit manufacturing industry \( j \), in region \( r \) at time \( t \) (Jacobian diversification)
- Competition: population density - diseconomies of scale or local demand
- Use median (MED) and 10\(^{th}\) percentile (10 TILE) of productivity distribution to capture rightward-shift (agglomeration) and left-truncation (selection)
Agglomeration vs. Selection (Taiwan)

Agglomeration and Selection in Science Parks (NAICS 334)

<table>
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<tr>
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<th>MED</th>
<th>10-TILE</th>
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<tr>
<td></td>
<td>LOC</td>
<td>URB</td>
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<tr>
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<tr>
<td></td>
<td>(0.077)</td>
<td>(0.106)</td>
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<tr>
<td>AM</td>
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<tr>
<td></td>
<td>(0.268)</td>
<td>(0.351)</td>
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</table>
 Sorting (Taiwan)

- TFP distribution demeaned to remove agglomeration effect
- Region-specific regression used to determine likelihood of firm lying in given percentile of TFP distribution using regional dummy $\beta$
- Positive coefficient on $\beta$ indicates sorting within given percentile, while negative coefficient on $\beta$ indicates dominance of selection effect
- Example: Negative (positive) estimate of $\beta$ at low percentiles implies dominant selection (sorting) effect at lower tail of log-TFP
Sorting (Taiwan)

- Two-sided sorting in science parks, selection in large cities
Results (Taiwan)

Aggregate:

- Firms in large cities have highest level of productivity
- Firms located in science parks usually have intermediate productivity levels (in between large and small cities)
- Some evidence for sorting

Within science parks:

- Firm productivity in science parks depends on technology-intensity of production process
- Agglomeration effects dominates selection
Methodology – South Korean Case

- South Korean firm-level panel data for 2009-2011 period (EMIS)
- Define three regions: above median population density (large), below median population density (small), and cities housing science parks
- Estimate firms’ TFP for each region
- Look at inter-regional TFP distributions for SMEs for South Korea and compare with results for Taiwan
- Examine mean and minimum of TFPs as indicators of rightward shift and left truncation, and compare with results for Taiwan
Results-TFP Estimates (South Korea)

Data:
Firm-level, income statement and balance sheet; industry classification at 3-digit NAICS level

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<tr>
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<tr>
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<td>2.92</td>
<td>5.43</td>
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<tr>
<td>IQR</td>
<td>1.13</td>
<td>1.42</td>
<td>1.62</td>
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</tbody>
</table>

Productivity Distribution-South Korea

- Large City
- Science Park City
- Small City
Inter-Industry Comparison: Technology-Intensive Occupation Levels (South Korea)
Taiwan vs. South Korea: Log-TFP Distributions for SMEs
South Korea-Taiwan Comparison

- For aggregate manufacturing, firms located in large cities have highest mean log-TFP
- Firms in the computer and electronics industry located in cities have highest mean log-TFP
- Firms in the scientific and technical services sector have the highest mean log-TFP when located in science parks
- Support for SMEs appears more effective in Taiwan
- Firms in cities benefit most from agglomeration, but also face highest level of selection
Conclusion

- Differentiate efficient (growth improving) and inefficient (life support) use of science parks
- Efficient use of science parks evident when used to support innovation – notably in sector such as scientific and technical services
- Science park clusters may turn out to be protective shields against competition in some cases such as chemical manufacturing
- Protective environment/tax credits not necessarily sufficient to stimulate growth and development of SMEs