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

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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)

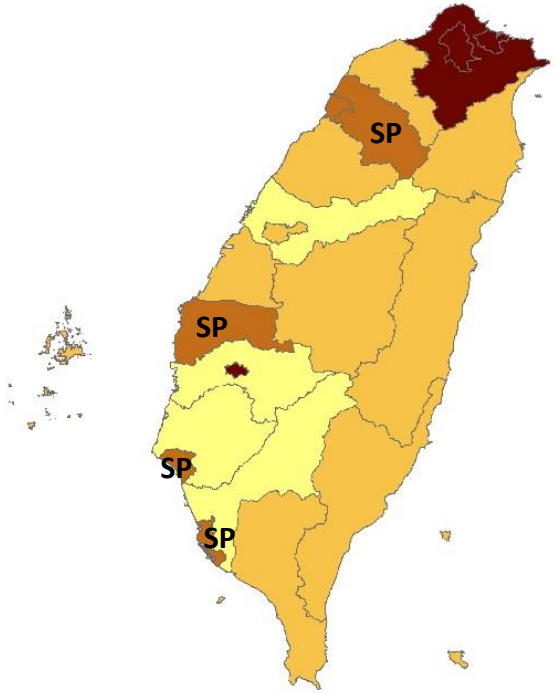
Data:
Firm-level, income statement and balance sheet; industry classification at 3-digit NAICS level

	OLS	IV	OP
β_k	0.37***	0.56***	0.29**
β_l	0.56***	0.21***	0.47**

Regional TFPs

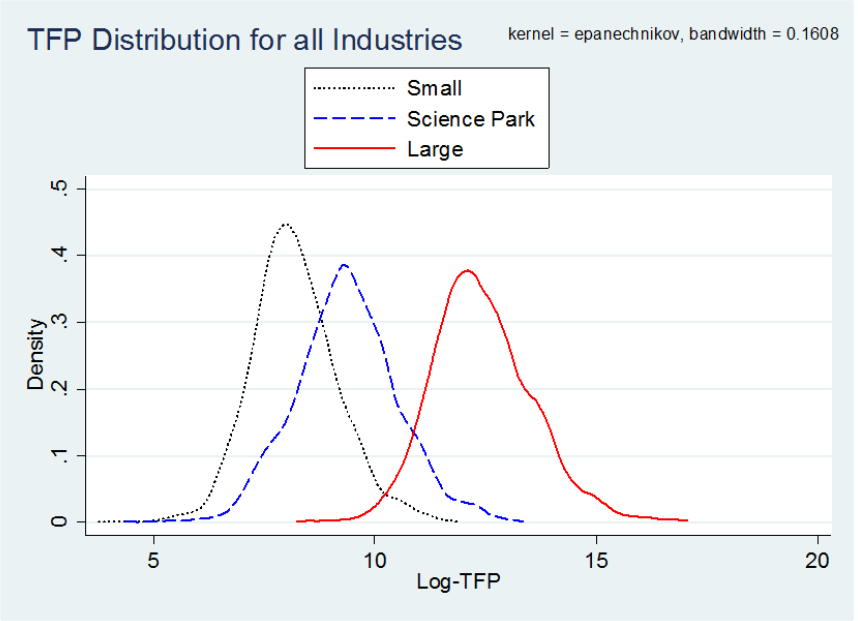
POPULATION DENSITY

TFP-COUNTY MARKETS



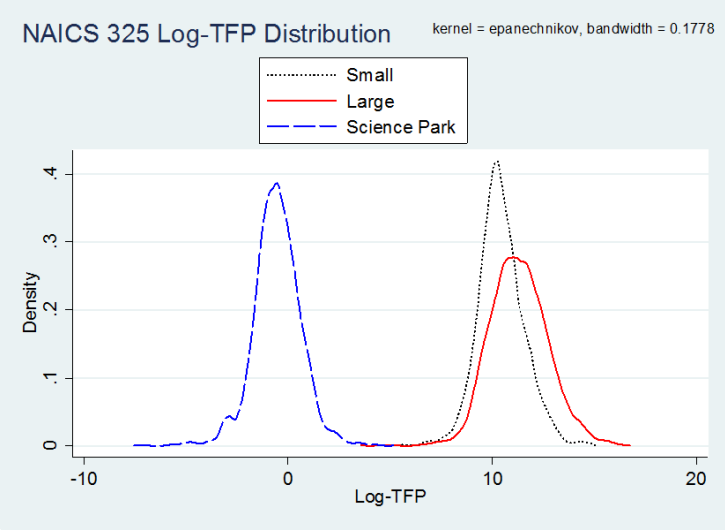
Summary Statistics-Log TFP (Taiwan)

Statistic	Below median	Science park	Above median
N	840	1427	2388
mean	4.107	8.32	11.77
max	8.71	12.10	17.09
min	-2.43	1.00	4.61
IQR	1.23	1.35	1.42

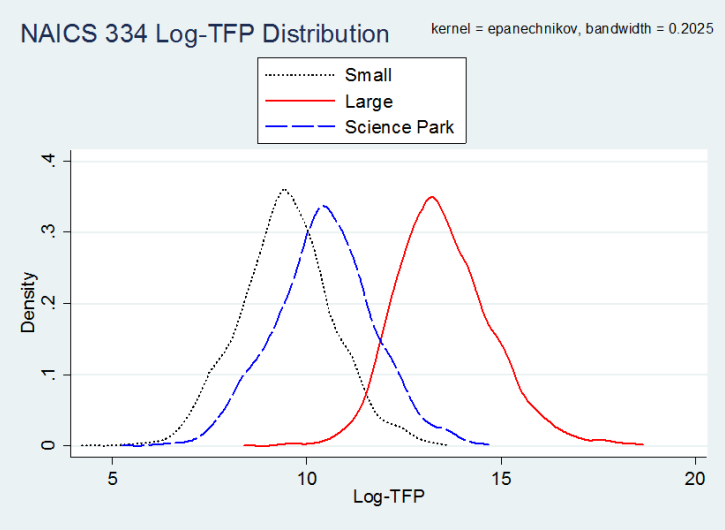


Inter-Industry Comparison: Technology-Intensive Occupation Levels (Taiwan)

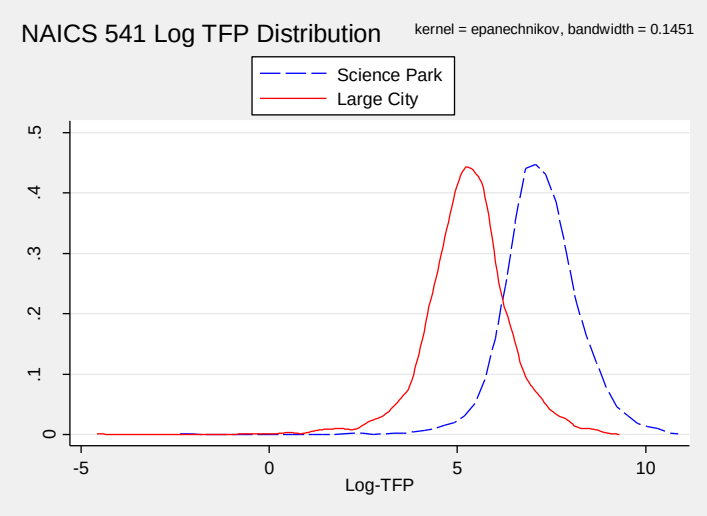
CHEMICAL MANUFACTURING



COMPUTERS AND ELECTRONICS



SCIENTIFIC AND TECHNICAL SERVICES



Agglomeration and Selection Variables

- **Localization: Henderson *et al*. (1995) - regional employment share of specific industry (Marshallian specialization)**
- **Urbanization: Herfindahl index computed as: $\sum_j s_{jrt}^2$, 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 10th percentile (10 TILE) of productivity distribution to capture rightward-shift (agglomeration) and left-truncation (selection)**

Agglomeration vs. Selection (Taiwan)

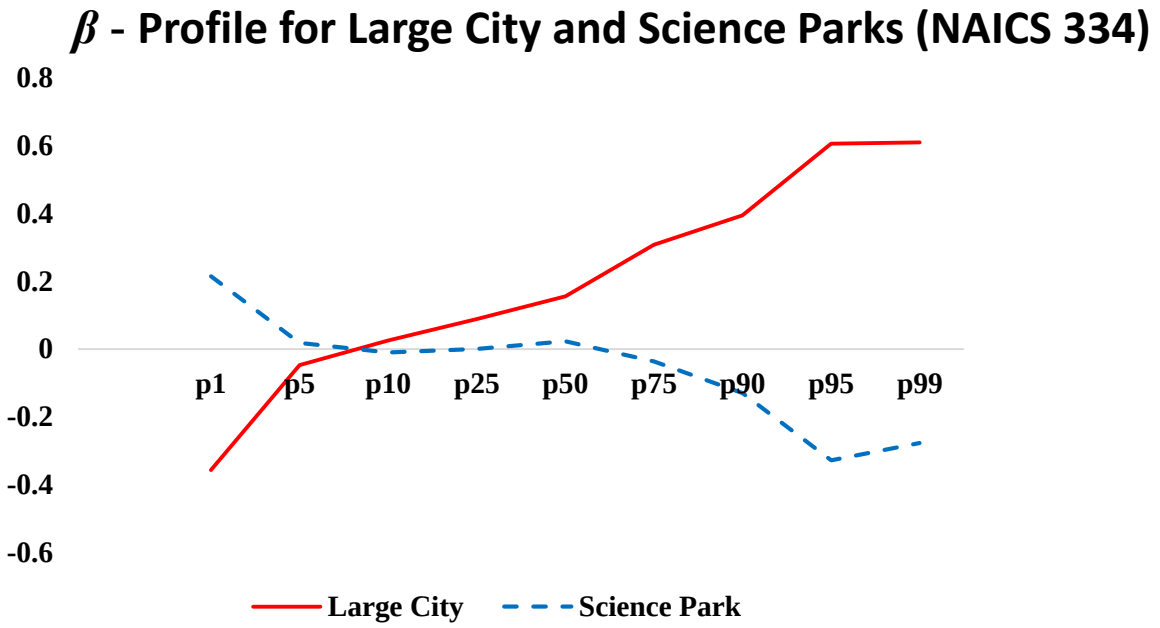
Agglomeration and Selection in Science Parks (NAICS 334)

	MED		10-TILE
	LOC	URB	Selection
SP	0.161***	0.571***	6.08^{-06}***
	(0.077)	(0.106)	(9.61^{-07})
AM	-0.71***	-1.251***	0.0002***
	(0.268)	(0.351)	(0.00001)

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 β
- Positive coefficient on βindicates sorting within given percentile, while negative coefficient on β indicates dominance of selection effect
- Example: Negative (positive) estimate of β 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

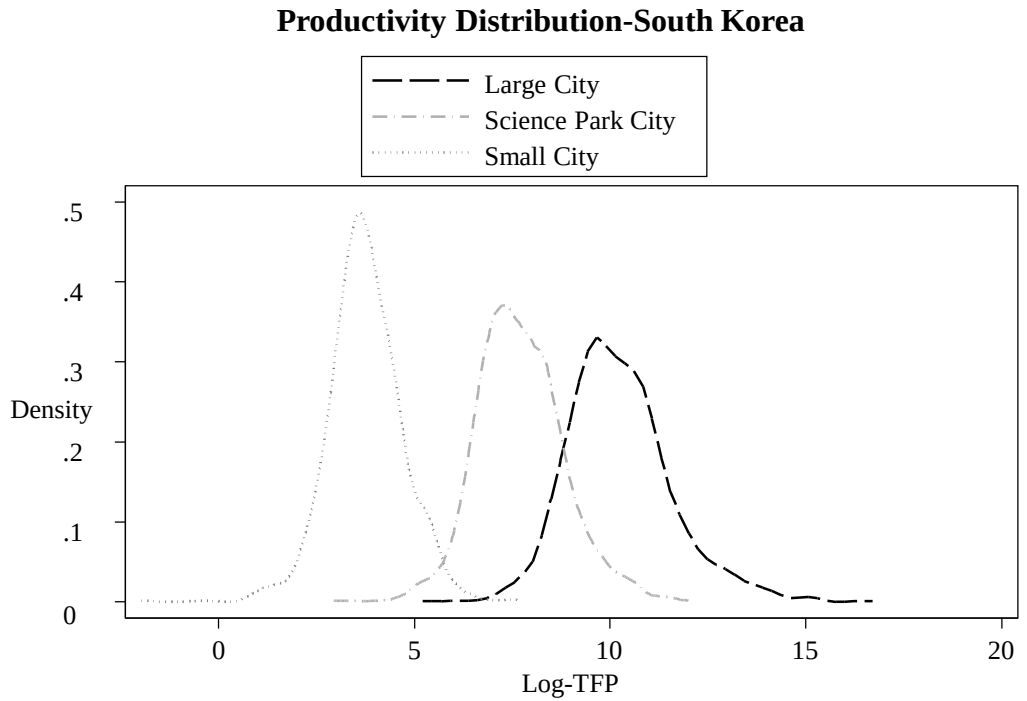
Results-TFP Estimates (South Korea)

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

	OLS	IV	OP
β_k	0.66***	0.56***	0.13**
β_l	0.18***	0.21***	0.39**

Summary Statistics-Log TFP (South Korea)

Statistic	Below median	Science park	Above median
N	981	334	945
mean	3.74	7.70	10.23
max	7.66	12.15	16.47
min	-1.97	2.92	5.43
IQR	1.13	1.42	1.62



Inter-Industry Comparison: Technology-Intensive Occupation Levels (South Korea)

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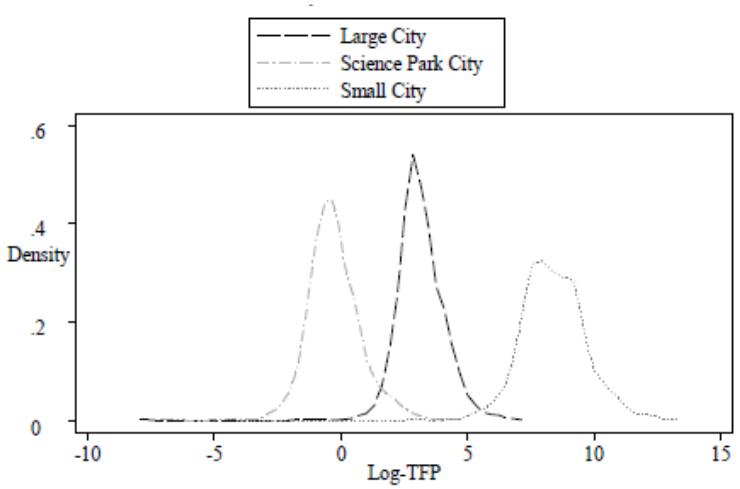

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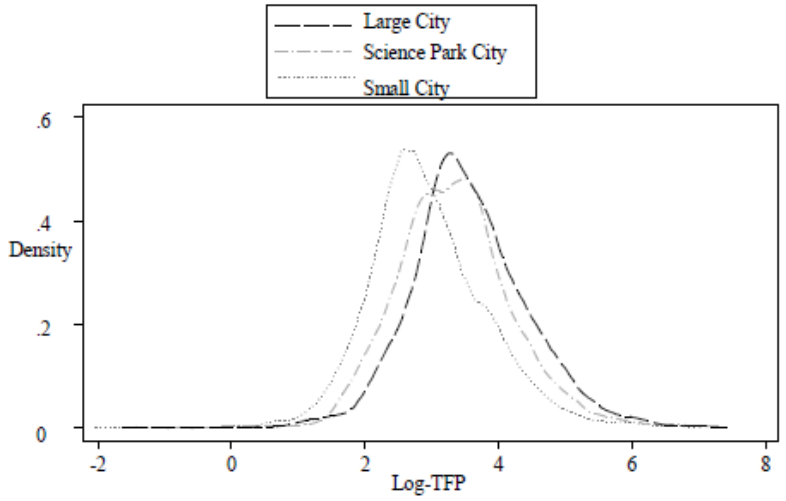

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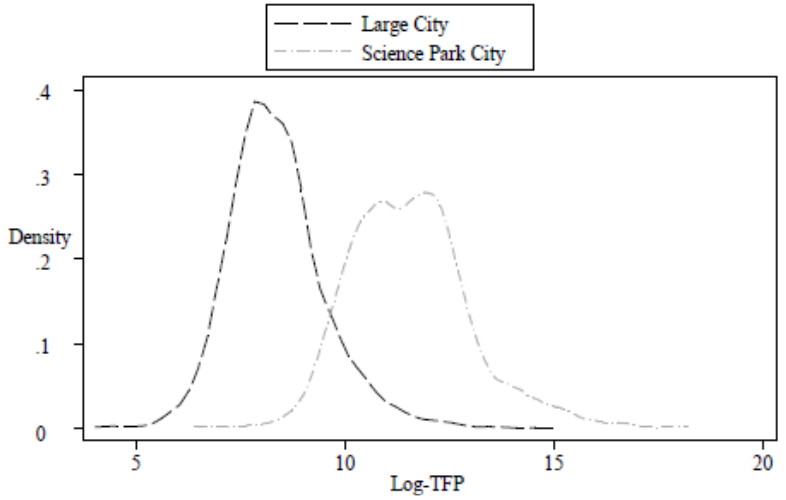
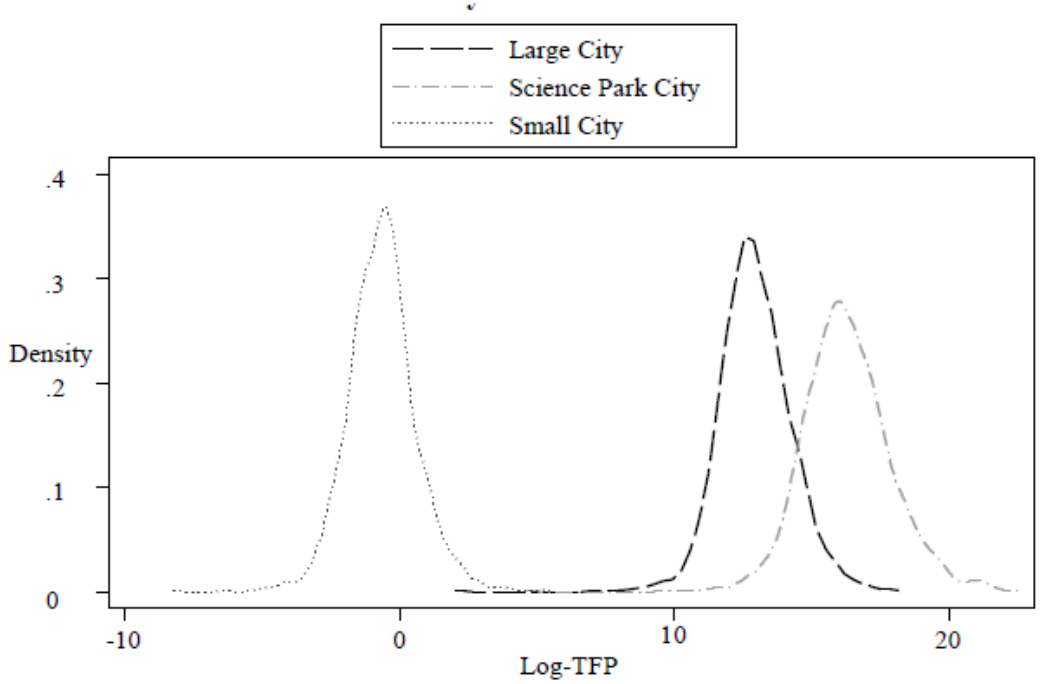
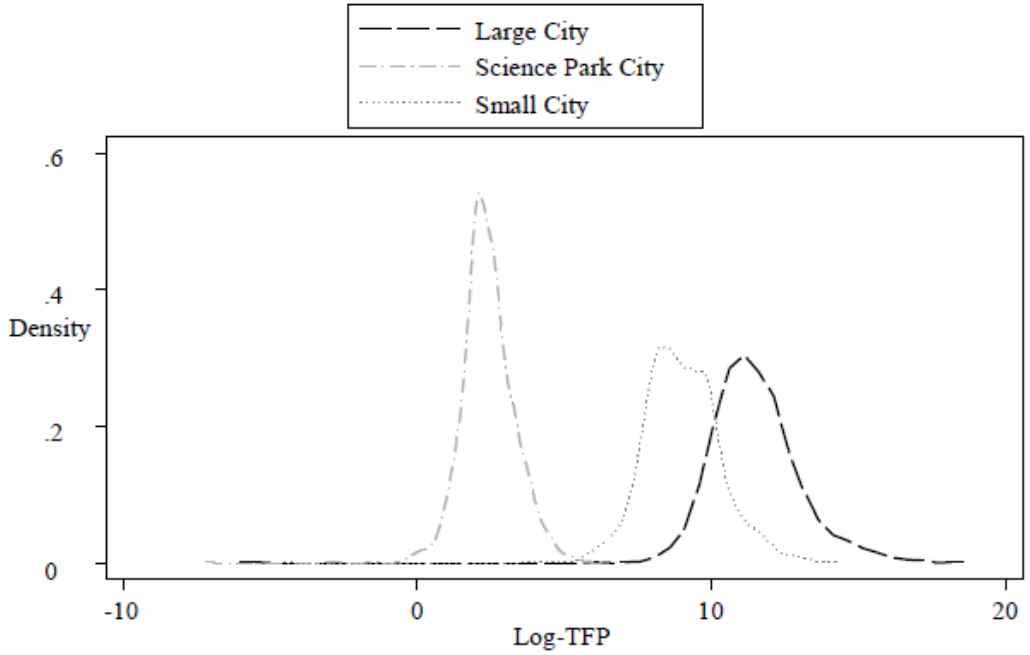


Taiwan vs. South Korea: Log-TFP Distributions for SMEs

TAIWAN



SOUTH KOREA



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**