

Funds for Some, Spills for Others: Explaining the Emergence of Nanotechnology in Chinese Regions

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Nanotechnology as a Technology System: Catch up by seizing the “window of technological opportunities”

- An **emerging technology system** presents a *window of opportunity* for faster catch up (Perez and Soete, 1988)
 - opportunities for successive **improvements across a range of technologies**
 - generates **economy-wide technological externalities** for decades



Geography of spillovers

- Traditional view - **spillovers occur locally**
- **Social & employment network**, not proximity *per se*, is the key for knowledge spillovers (Zucker, et al, 1998; Breschi & Lissoni 2009)
- Spillovers can occur **over a long distance** (Frenken et al. 2010; Tang & Shapira, 2011; Ponds et al, 2009)

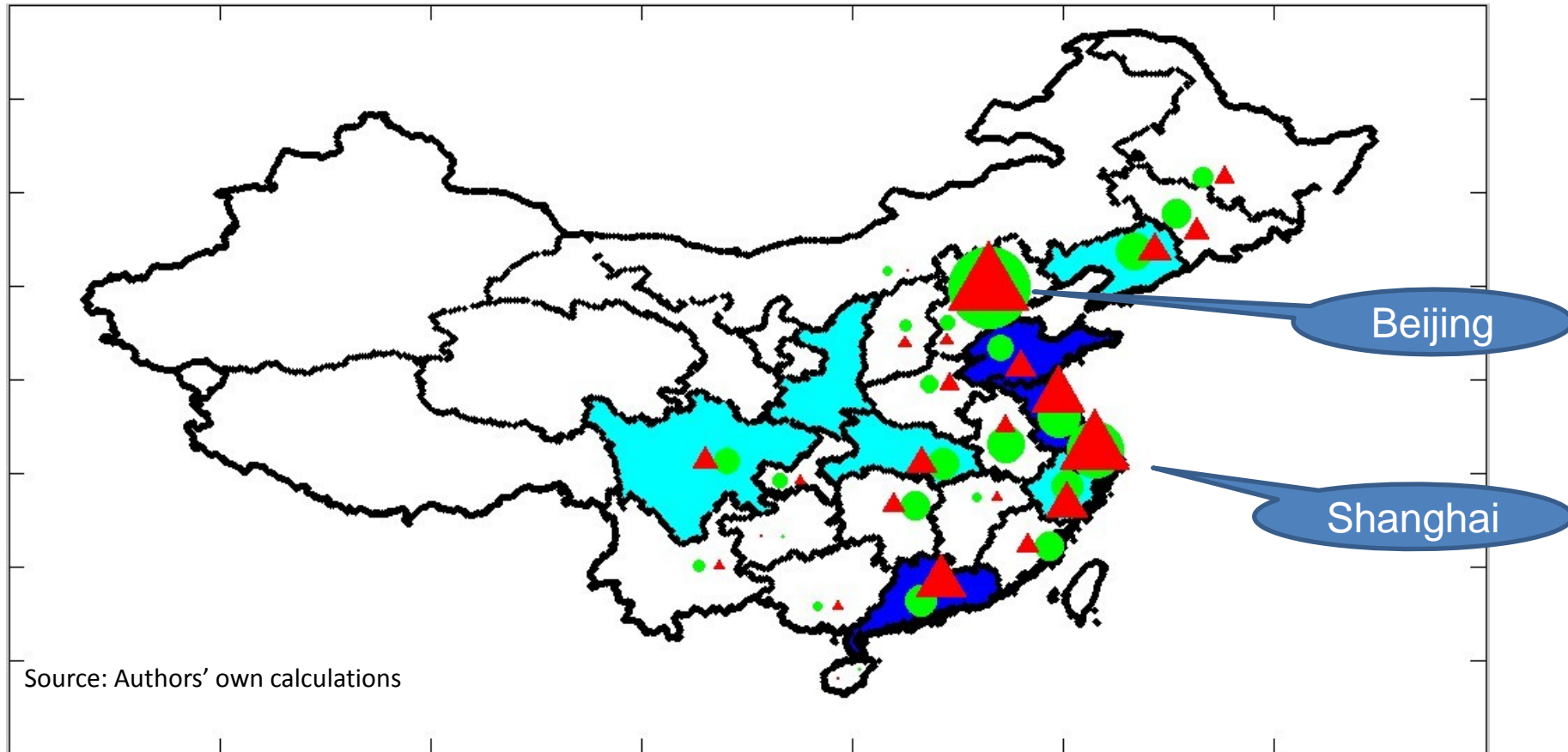


Nano research in China

- National Natural Science Foundation program since 1990, promoting nano research
- Nano publications increased between 1999 and 2010, from 2487 to 23,686
- Nano patent filing increased from 98 in 1999 to 6,000 in 2010



Uneven growth of nanotechnology across regions



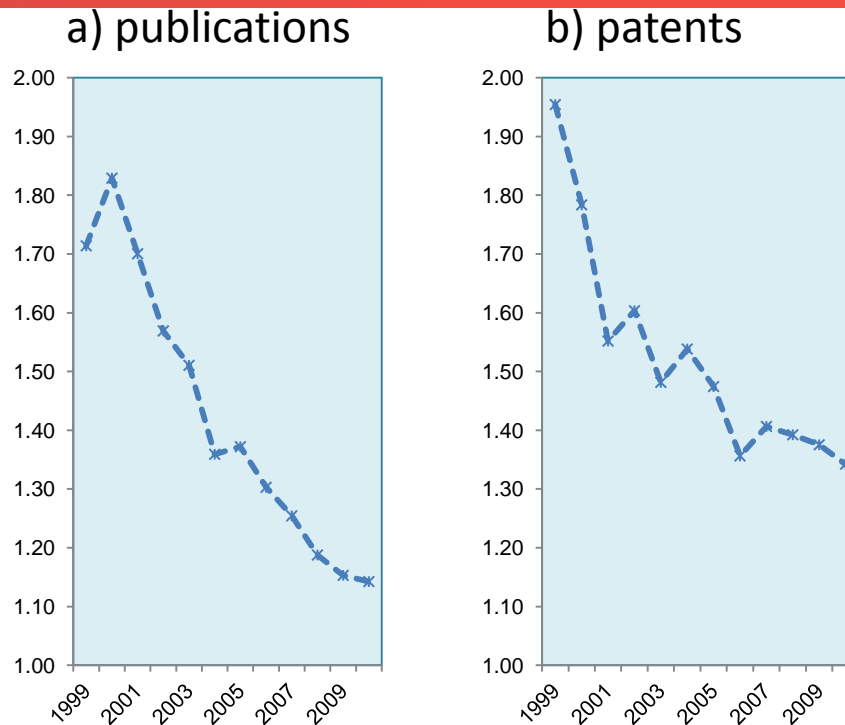
Nano patents: red triangle (the bigger the higher value)

Nano funding: green circle (the bigger the higher value)

R&D expenditure: Blue shades (the darker the higher value)



Coefficient variation of regional nano-publications and nano patents

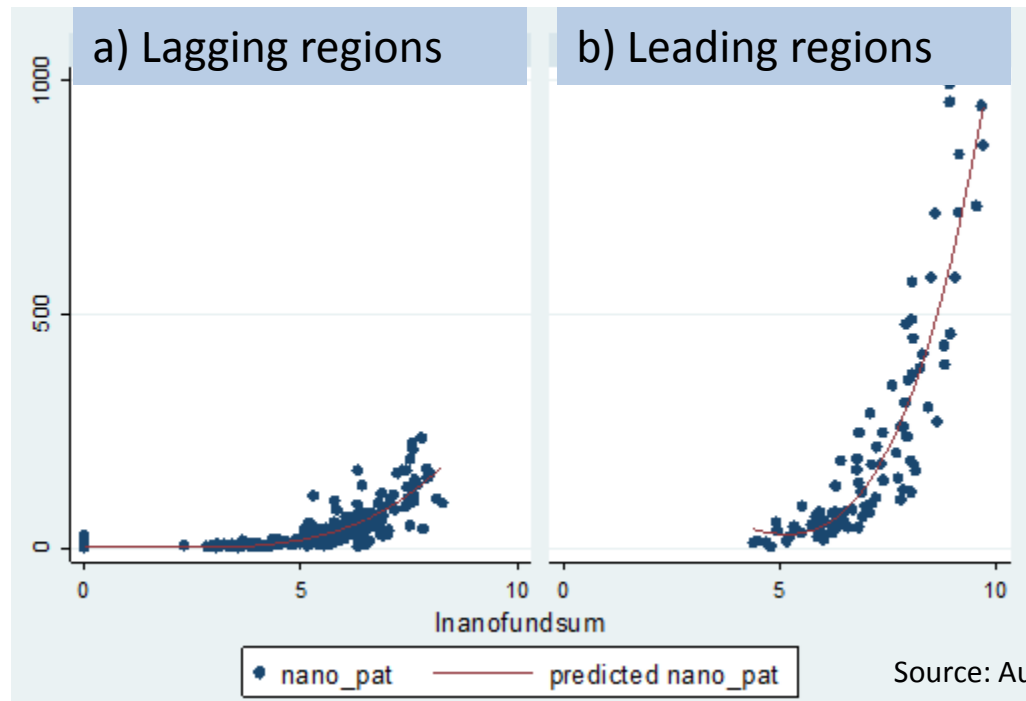


Source: Authors' own calculations

- A few leading regions spearheaded the nanotechnology revolution in China - advanced capabilities plus financing support from the state
- Other, lagging, regions showing increasing dynamism
- What are the drivers of growth in leading and lagging regions?



Nano patent applications and Nano funding



Collaboration intensity

| | 1999-2004 | 2005-2010 |
|------------------------------------|-----------|-----------|
| | (1) | (2) |
| national collaboration | | |
| all regions | 47.7 | 56.8 |
| leading regions | 37.2 | 39.0 |
| lagging regions | 53.6 | 64.8 |
| international collaboration | | |
| all regions | 18.6 | 17.3 |
| leading regions | 21.2 | 20.2 |
| lagging regions | 17.6 | 16.2 |

Source: Authors' own calculations



Key questions

1. To what extent is **nano-funding** the key to the growth of nanotechnology in China?
2. To what extent are **inter-regional knowledge spillovers** important in the growth of nanotechnology?
3. Are the **drivers of nanotechnology growth** different in leading regions compared to in lagging regions? In particular,
 - What is the relative importance of **nano-funding** and **inter-regional spillovers** in leading versus lagging regions?



Key Variables

- **Dependent variable:** **Technological output:** Patent applications at SIPO

Key Explanatory variables

- **FUND_i**: Funding for nanotech research received by region *i*

- **Two collaboration-spillover variables**

- $TECHSPILL_i = \frac{PUB_{ij}}{PUB_j} * PAT_j$ (j=region1- 31, i ≠ j)

- PAT_j patent applications in j in t-1

- $\frac{PUB_{ij}}{PUB_j}$ share of *i* in total publications of *j* in t-1

- $FUNDSPILL_i = \frac{PUB_{ij}}{PUB_j} * FUND_j$ (j=region1- 31, i ≠ j)

- $FUND_j$ nano funding in j in t-1



Key Variables

- Two proximity-spillover variables
- $TECHSPILL_i = w_{ij} * PAT_j$ (j=region1- 31, $i \neq j$)
- $FUNDSPILL_i = w_{ij} * FUND_j$ (j=region1- 31, $i \neq j$)
 - $w_{ij} = w_{ij}^* / \sum_j w_{ij}^*$
 - $w_{ij} = 1/d_{ij}^2$
 - d_{ij} distance between region i and j



Data

- Patent applications - China Patents Full-text Database
 - 30,000 nano patent applications
- Nano funding - National Natural Science Foundation
- Publications-Thomson Reuters Web of Science (WoS)
 - Nano publications 164,000 → collaboration network
 - Total publications → leading vs lagging regions



Econometric Results- Full sample

| | All regions | | |
|--|-------------|----------|----------|
| | (1) | (2) | (3) |
| Key explanatory variables | | | |
| Log of Nano funding | | 0.065* | 0.059 |
| Nanotech spillovers | | | |
| - Collaboration | 0.230*** | 0.201*** | |
| - Proximity | 0.026 | 0.004 | |
| Funding spillovers | | | |
| -Collaboration | | | 0.128** |
| - Proximity | | | 0.127 |
| International collaboration intensity | | | |
| | 0.003 | 0.004 | 0.003 |
| R&D/GDP | | | |
| | 0.153*** | 0.140*** | 0.160*** |
| Non-nano patent/R&D | | | |
| | 0.076 | 0.089 | 0.105* |
| Per capita income | | | |
| | 0.009 | 0.013 | 0.027 |
| Constant | | | |
| | 2.320*** | 2.047*** | 1.225 |
| Observations | | | |
| | 330 | 330 | 330 |
| Number of regions | | | |
| | 30 | 30 | 30 |



Econometric Results- Subsamples

| | Leading regions | | | Lagging regions | | |
|---------------------------------------|-----------------|----------|----------|-----------------|----------|---------|
| | (4) | (5) | (6) | (7) | (8) | (9) |
| Key explanatory variables | | | | | | |
| Log of Nano funding | | 0.292** | 0.258* | | 0.027 | 0.028 |
| Nanotech spillovers | | | | | | |
| - Collaboration | -0.249 | -0.245 | | 0.393*** | 0.378*** | |
| - Proximity | -0.016 | -0.056 | | 0.126 | 0.120 | |
| Funding spillovers | | | | | | |
| -Collaboration | | | -0.304* | | | 0.184** |
| - Proximity | | | 0.078 | | | 0.265 |
| International collaboration intensity | -0.003 | -0.003 | -0.003 | 0.004 | 0.004 | 0.003 |
| R&D/GDP | | | | | | |
| R&D/GDP | 0.246*** | 0.179*** | 0.164*** | 0.010 | 0.010 | 0.101 |
| Non-nano patent/R&D | 0.174** | 0.140* | 0.139* | -0.069 | -0.052 | 0.017 |
| Per capita income | 0.135** | 0.145*** | 0.128** | -0.037 | -0.034 | -0.005 |
| Constant | 4.152*** | 2.093 | 2.405 | 1.759* | 1.632 | 0.521 |
| Observations | 88 | 88 | 88 | 242 | 242 | 242 |
| Number of regions | 8 | 8 | 8 | 22 | 22 | 22 |



Summing up

- State policy played a key role in China's emergence as a global leader in nano technology
- Intensity of inter-regional collaboration is very high in lagging regions, than in leading regions
- Formal scientific network caused spillovers in lagging regions, not in leading regions
- Spatial proximity, between regions, have limited spillover effect



