PUBLIC AND PRIVATE R&D SPILLOVERS AND PRODUCTIVITY AT THE PLANT LEVEL: TECHNOLOGICAL AND GEOGRAPHIC PROXIMITY

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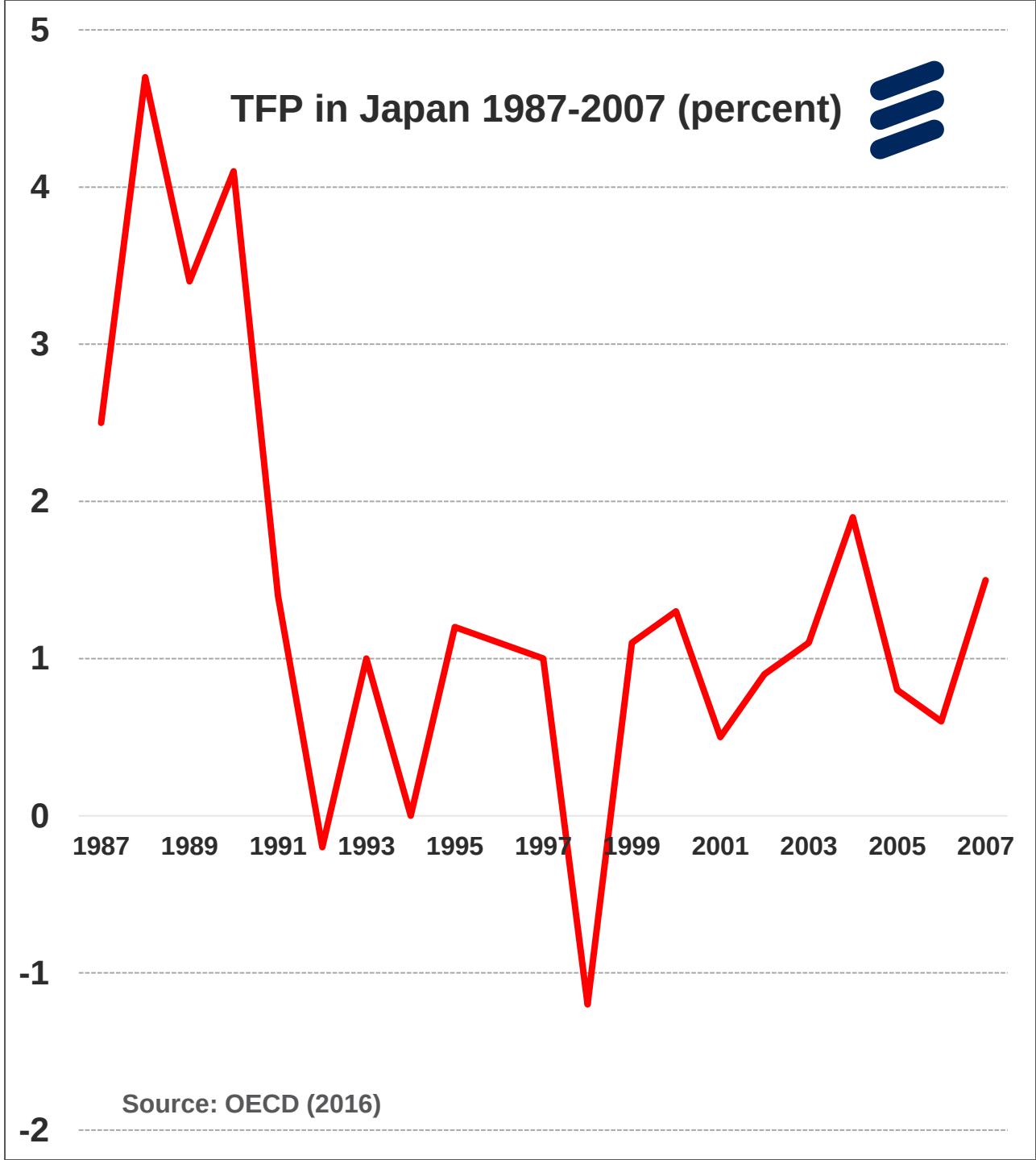
BACKGROUND

- Slowdown in Japanese TFP growth
- One possible explanation: Decline in R&D spillovers
- Extensive literature shows association between R&D and TFP
- Private and public R&D



QUESTIONS

- Are private and public R&D associated with TFP among Japanese manufacturing firms?
- What is the role of technological and geographic proximity?
- To what extent do R&D spillovers contribute to the decline in TFP in Japanese manufacturing?

METHODOLOGY (I)

Augmented production function framework:

$$\ln TFP_{it} = \alpha_R \ln R_{it-1} + \alpha_s \ln S_{it-1} + \alpha_P \ln P_{it-1} + \gamma' X_{it} + \eta_i + \mu_{i,t}$$

TFP is total factor productivity, R is Firm level R&D stock, S is the private R&D stock, P is the public R&D stock, X is a vector of other observable factors (control variables) affecting plant productivity, η is a plant specific fixed effect and μ is a plant year specific efficiency shock.

Assumption: Firm level R&D stocks are available to all the firms' plants

DATA

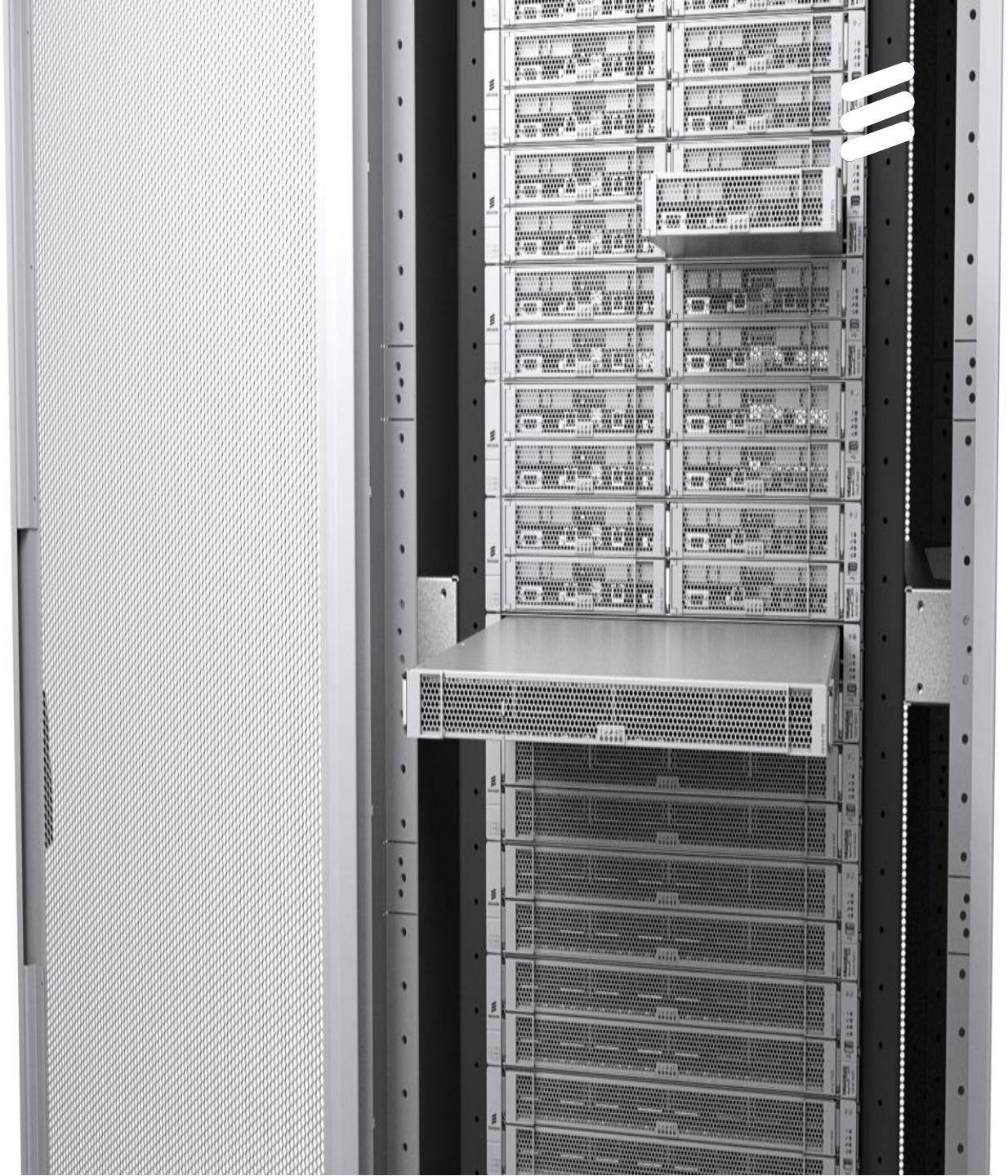
- Manufacturing plant level data 1987–2007

1. Japanese Census of Manufacturers
2. Survey of R&D Activities in Japan

Matching between surveys:

- Unbalanced panel of 19 389 plants for a maximum of 20 years and a minimum of 5 years

- 13 188 firms in 20 different industries



FIRM LEVEL AND PRIVATE R&D STOCK

R&D stock by parent (firm level)

Private R&D stock:

Other firms' R&D assigned to their nearest plants in an industry, weighted by the technological relatedness between the industry of the plants and the industry of the focal plant allowing for geographic decay in the effectiveness of spillovers:

$$S_{ifst}^{tech} = \sum_{f' \neq f} \sum_{s'} K_{f's't} T_{ss'} e^{\tau d_{if's't}}$$

$K_{f's't}$: R&D stock of firm f' in field s' at time t.

$T_{ss'}$: The technological proximity weight derived from patent citation data;

$d_{if's't}$: Minimum geographic distance between plant i and the plant of firm f' in the field s' in year t;

τ: A decay parameter, with $\tau < 0$

PUBLIC R&D

R&D by Universities from R&D Survey – high response rate

Public R&D spillovers:

R&D per science field weighted by its relevance for specific technologies and hence industries

Allowing for decaying effects due to geographic distance (plant-institution)

$$P_{ist} = \sum_{h}\sum_{m} A_{hmt}\tilde{T}_{sm}e^{\theta\tilde{d}_{ih}}$$

A_{hmt}: R&D stock of public institutes in location h for academic field m in year t;

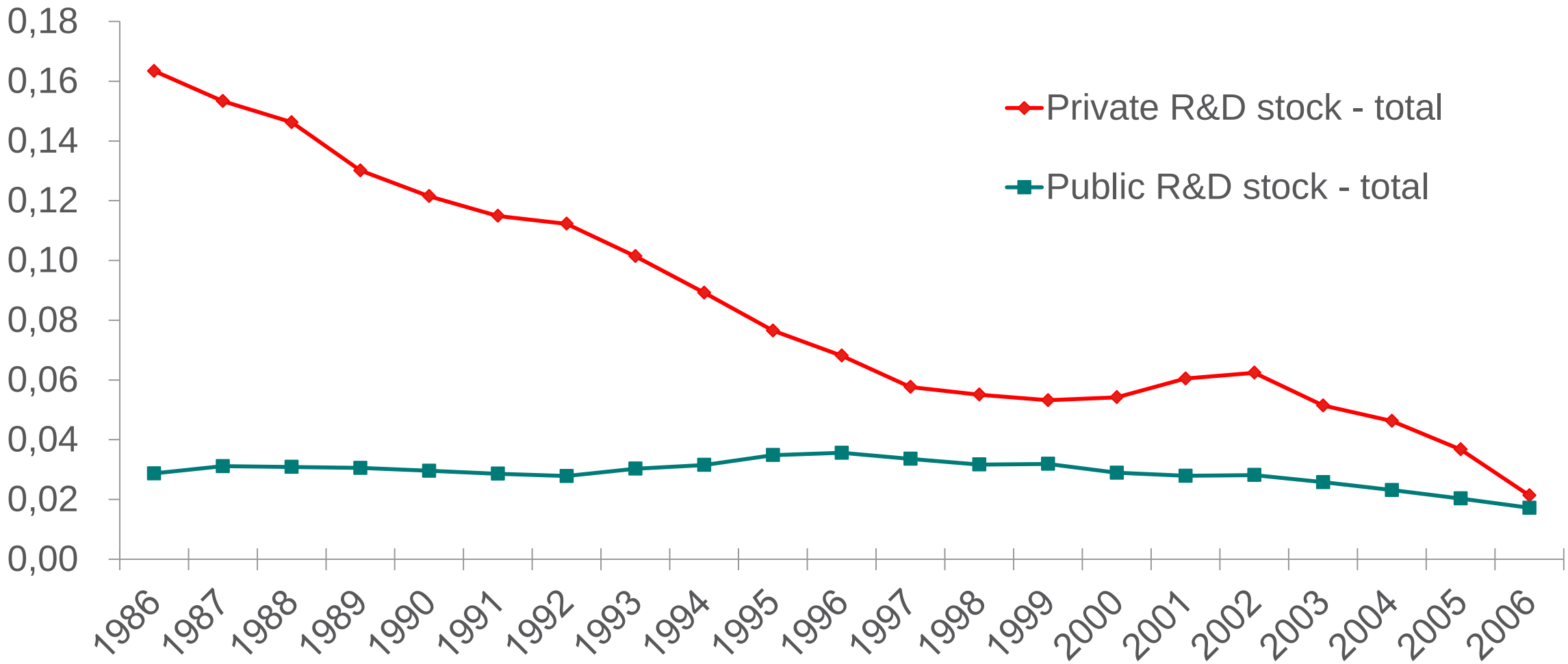
$\tilde{T}_{sm}$: The compound proximity weights between industry/R&D field s and science field m;

$\tilde{d}_{ih}$: Geographic distance between plant i and institution location h;

θ: The geographic decay parameter, $\theta < 0$

GROWTH RATE OF R&D STOCK

(5 YEARS MOVING AVERAGE)



METHOD

- Long difference equation – annual average growth rate during 5 years

- Estimation with nonlinear least squares

- Additional control variables:
  - Plant's relative prior TFP
  - Industry average TFP growth
  - Number of other plants
  - Number of firm employees
  - Number of plant employees
  - Multi-products plant (dummy variable)

RESULTS (I) – R&D PARAMETERS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Parent R&D	0.0331***	0.0097***	0.0097***	0.0096***	0.0096***	0.0096***	0.0096***
Parent R&D stock > 0 (dummy)		0.0050***	0.0050***	0.0050***	0.0050***	0.0050***	0.0034***
Tech-proximate private R&D	0.0583***	0.0600***	0.0582***	0.0392**	0.0346**		0.0347***
All private R&D						0.0775***	
Public R&D			0.0766**	0.0766**	0.0832**	0.0746**	
Public R&D (parent>0)							0.1211***
Public R&D (parent=0)							0.0678*

RESULTS (II) – DISTANCE PARAMETERS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tech-proximate private R&D	–0.0040***	–0.0038***	–0.0040***		–0.0057***		–0.0058***
All private R&D				–0.0018**		–0.0017*	
Public R&D			0.0000	0.0000	0.0000	0.0000	
Public R&D (parent R&D>0)							0.0000
Public R&D (parent R&D=0)							–0.0060

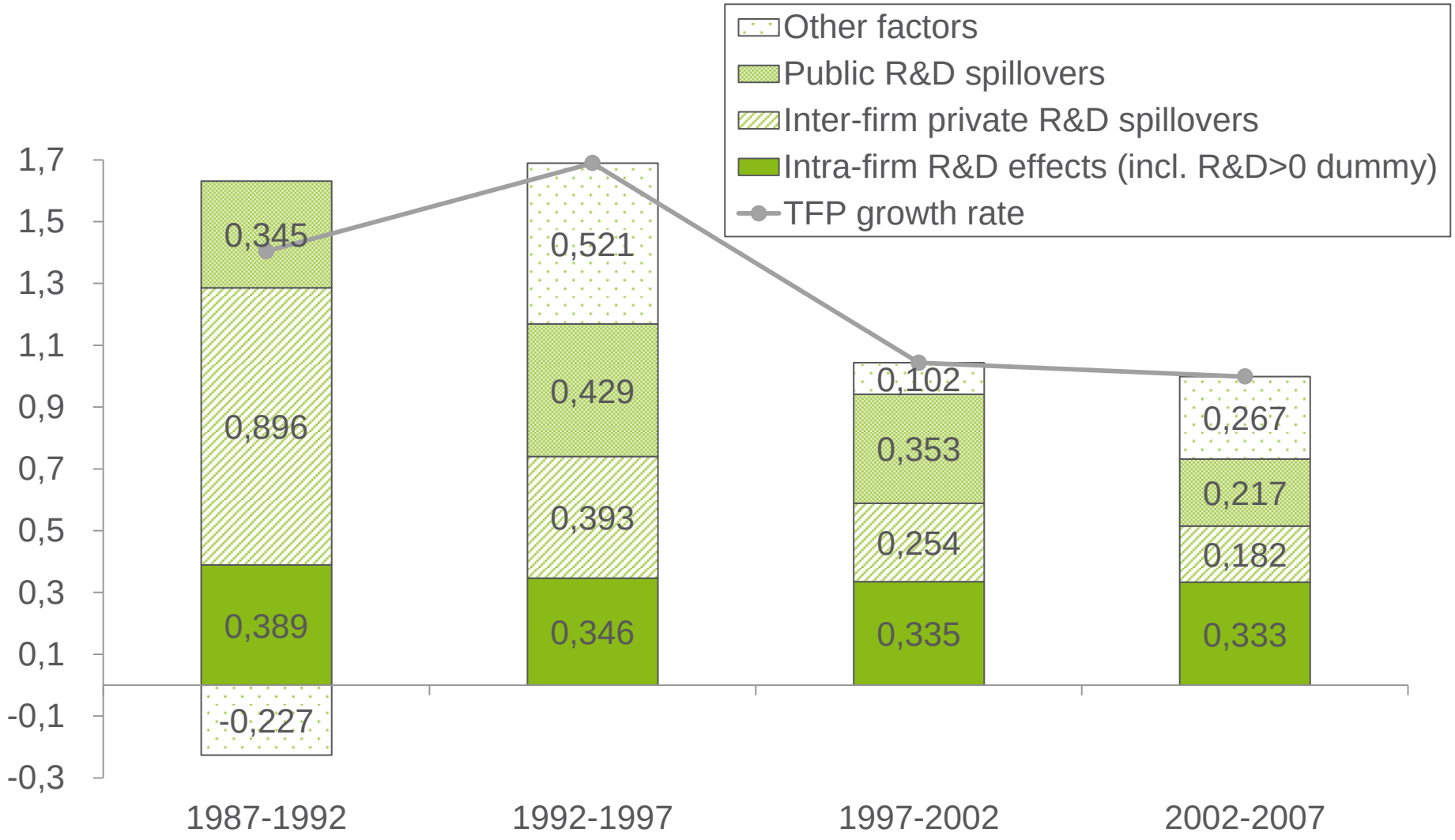
SUMMARY OF RESULTS

- Both public and private R&D are associated with TFP growth
- Technological proximity matters for private and public R&D
- Spillover effects are only attenuated by distance for private R&D

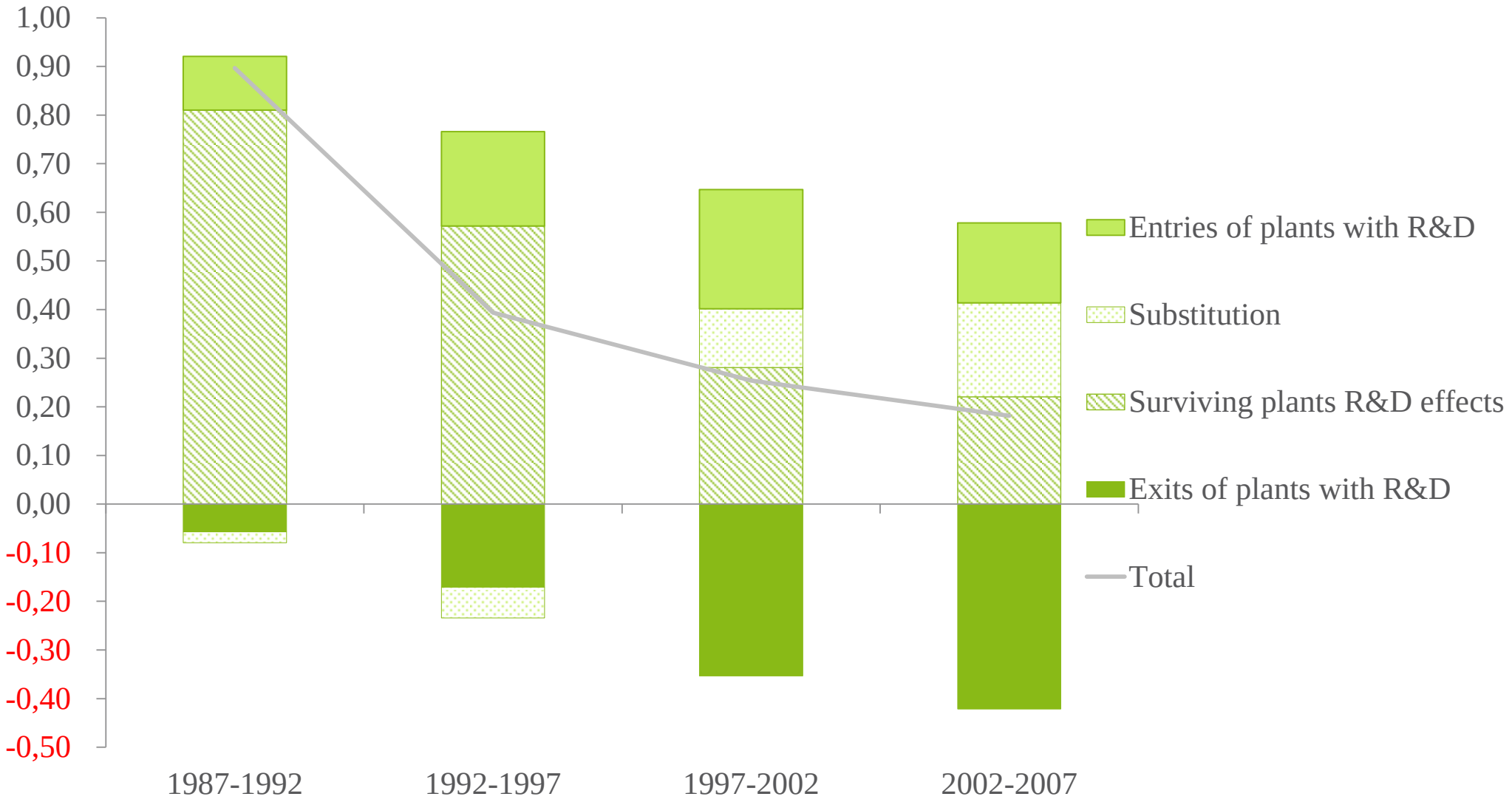
SIMULATION ANALYSIS

- Balanced sample of 4200 plants
- Gross output of each plant as a weight
- Declining inter-firm private R&D spillovers are important for the decline in TFP
- Increasing exit effects and declining R&D stock growth in surviving plants

TFP GROWTH DECOMPOSITION



DECOMPOSITION OF THE INTER-FIRM PRIVATE R&D SPILLOVERS EFFECTS: ENTRY AND EXIT



CONCLUSIONS

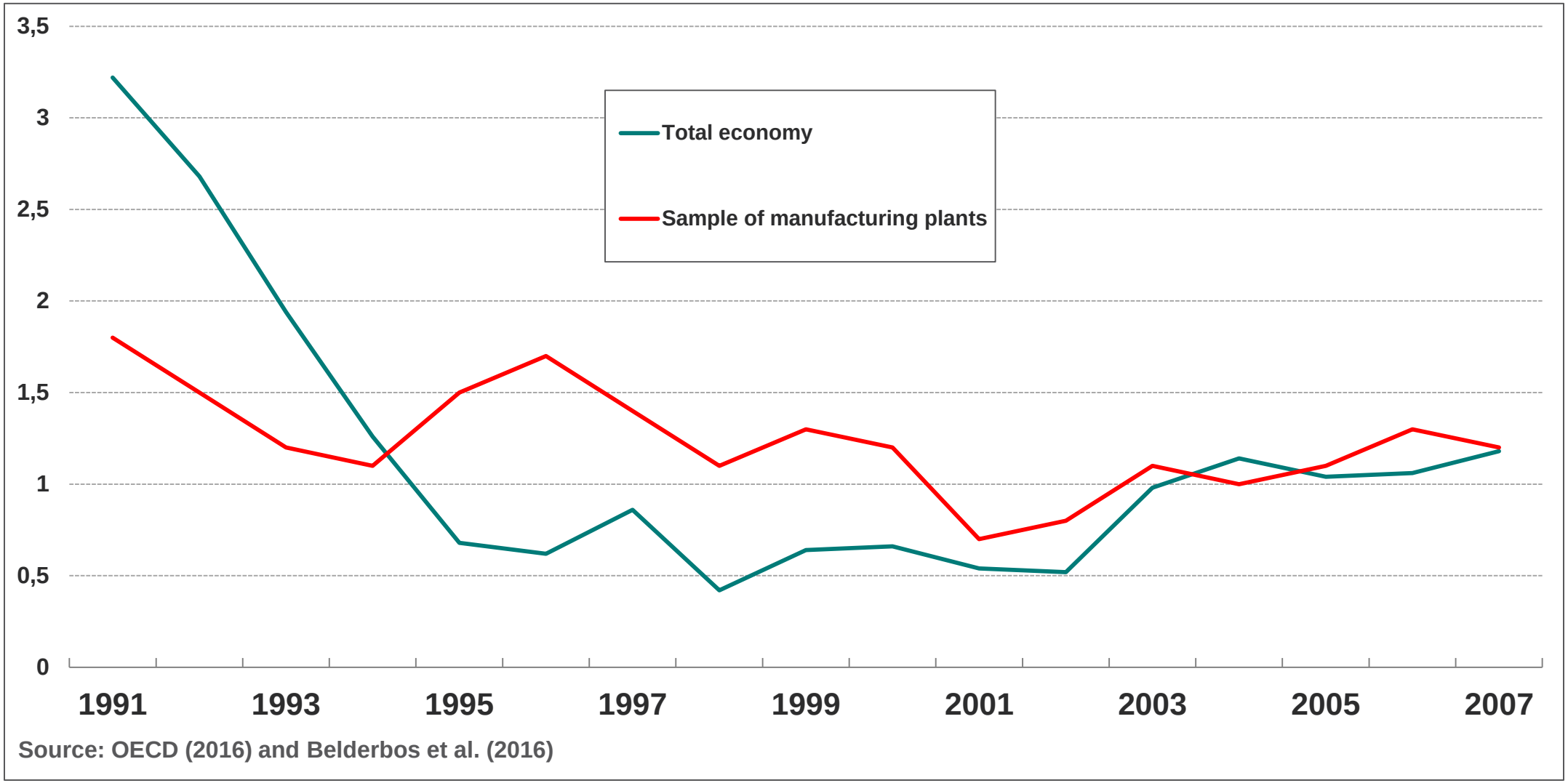
- Technology proximate R&D is positively associated with TFP and attenuated by distance
- Public R&D is also positively associated with TFP, but not attenuated by distance
- Decomposition analysis show that the contribution of private R&D spillovers to TFP growth has declined since the late 1990s
- The decline in Japanese TFP growth can be explained by the exit of relatively productive plants and the declining TFP growth of surviving plants

QUESTIONS (I)

- Why is data only included until 2007?
- What is the effects from R&D performed by Japanese firms abroad?
- Would the effects from distance be decreasing over time? Emergence of cheaper and new communication technologies?
- What is the story for the rest of the economy?

TFP GROWTH IN JAPAN 1991–2007

(5-YEAR MOVING AVERAGE)



Source: OECD (2016) and Belderbos et al. (2016)

QUESTIONS (II)

- How are the results affected if cycles of 5 years are not used?
- What is the effect of industry specific depreciation between 8 and 25 percent? 15 percent for public R&D?
- Could technological proximity measurement be discussed in more detail?

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