Intangible Knowledge Capital and Innovation in China

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Overview

- We focus on intangible knowledge capital (IKC) not embodied in workers (e.g., schooling, training)
  - Produced in China by domestically owned enterprises (DEs) or foreign-invested enterprises (FIEs)
  - Can complement imported intangible capital (e.g. patents)
  - Can complement imported embodied technology (physical capital imported by DEs or FIEs)
- We view IKC as produced through R&D activities and reflected in the R&D stock. (Fraumeni and Okubo,2005; Griliches (numerous); Sveikauskas, 2007)

What about the "Marketplace for Ideas" in China? (Coase and Wang, 2012)

- Does the nascent, but imperfectly enforced, protection of IKC property rights in China threaten long-term growth prospects in China? (Coase, 1960; Stigler, 1989)
- Opening to FDI has enhanced competition, leading to increased R&D and new product development in all ownership sectors (Deng and Jefferson, 2008; Girma, Gong, and Görg, 2009)

What about the "Marketplace for Ideas" in China? (Coase and Wang, 2012)

- At least through the late 1990s, China's R&D performance has become more intense, at least among LME's, although patent elasticities with respect to R&D lag world averages. (Jefferson & Hu, 2003; Hu, Jefferson, & Qian, 2005)
- In the late 1990s, R&D was productive among China's LME's and varied considerably across industries (Hu and Jefferson, 2004)
- As the international productivity gap narrows, China must rely on domestic innovation to sustain its growth (Jefferson, Su, & Hu, 2006)

IS CHINA'S R&D PRODUCTIVE?

- Does either R&D conducted by DE and FIE produce patent applications in China?
- How does R&D (DE and FIE), respectively, relate to China's international trade?
- How does R&D produced by DE and FIE, respectively, relate to TFP and TFP growth in China?
- **DISCLAIMER:** We do not know the lags between specific R&D activities and their effects. We can only search for correlations at this point.

Data

- Our data are of Large and Medium Enterprises and derived from various issues of China Statistical Yearbook of Science and Technology and Statistical Yearbook of China.

What's going on with R&D and innovation?

- A few anecdotes follow, then we overview some basic trends.

THE WALL STREET JOURNAL.
WSJ.com

BUSINESS | Updated April 23, 2012, 2:02 a.m. ET

China Grows Its Dairy Farms With a Global Cattle Drive

By ALEX FRANGOS

Alex Frangos/The Wall Street Journal

Calves at China Modern Dairy's 20,000-head farm in Feidong, Anhui province, were bred from highly productive foreign cows.

FEIDONG, China—In one of the largest transoceanic cattle drives in history, as many as 100,000 heifers from Uruguay, Australia and New Zealand will board multistory cattle-carrying ships this year—bound for China.

The global roundup is a key part of China's effort to satisfy growing domestic demand for milk and remake its dairies after a deadly tainted-milk scandal in 2008 devastated production and caused distrustful consumers to turn to imported milk.

Importing high-tech cows to beef up the dairy industry requires adaptive R&D.

THE WALL STREET JOURNAL.
WSJ.com

AUTOS | Updated April 5, 2012, 9:11 a.m. ET

Ford Plans to Boost Production in China

By NORIHIKO SHIROUZU

BEIJING—Ford Motor Co. unveiled plans Thursday to invest $600 million to turn the inland Chinese city of Chongqing into its major manufacturing center for passenger cars—part of its effort to more than double its China manufacturing capacity and sales to more than 1.3 million vehicles by the end of the decade.

The Dearborn, Mich., auto maker expects to expand overall passenger-car manufacturing capacity there by about 350,000 vehicles to roughly 770,000 vehicles a year by 2014, said Joe Hinrichs, Ford's president for Asia-Pacific and Africa. That would make the Chongqing operations the largest global manufacturing location for Ford outside southeast Michigan, according to the company.

Agence France-Presse/Getty Images

A man pulls a cart past a Ford car on a street in Shanghai. The Dearborn, Mich., auto maker is due to unveil a plan to expand overall passenger-car manufacturing capacity in Chongqing by about 350,000 vehicles to roughly 770,000 vehicles a year by 2014.

Dave Schoch, head of Ford China, joined officials from Chinese partner Chongqing Changan Automobile Co. in Chongqing on Thursday to unveil the strategy. The expansion has already received government approval, a spokesman said.

Coupled with an existing commercial-vehicle assembly plant in the eastern China city of Nanchang and another under construction, Ford and Changan Auto expect to have capacity to produce about 1.3 million vehicles a year by 2014. The companies also produce subcompact Ford Fiesta cars in the eastern city of Nanjing with Japan's Mazda Motor Corp. in a venture that can produce up to 80,000 vehicles a year for Ford, though Ford and Mazda are looking to split the venture into two operations.

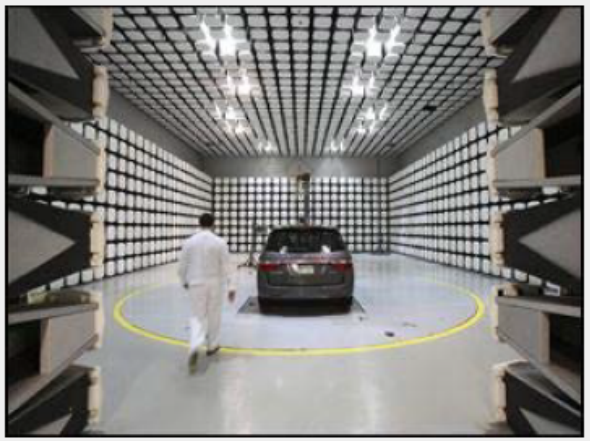
The expansion gives Ford much-needed capacity to help propel sales in China, where it has lagged behind the market's leader like General Motors Co. and Volkswagen AG.

More

Ford will bring patentable technology from US and engage in adaptive R&D in China

Honda opens doors for rare glimpse into Ohio R&D center

BY DAN GEARINO
COLUMBUS DISPATCH



A engineer walks into the radio frequency shielding chamber at Honda Research & Development in Raymond, Ohio.
COLUMBUS DISPATCH/ERIC ALBRECHT
Enlarge

RAYMOND, Ohio -- A mile from a rural highway and past several levels of security is the Honda complex that does some of the heavy lifting -- and much of the heavy thinking -- for the automaker's operations throughout North America.

Unlike the Honda assembly plants in Marysville and East Liberty, Honda R&D Americas in Raymond does not give tours to the public. It keeps such a low profile that even its employee count was once a secret.

That began to change in January, when Honda Motor Co. Inc.'s top executive announced that the Ohio research center would be in charge of developing a new "supercar," the Acura NSX.

The sports car will be built at a yet-to-be announced location in Ohio.

In light of the center's highly publicized role with the NSX and other models, company officials opened its doors to The Dispatch for a rare look inside. (Honda has used the NSX name on several concept cars; it originally stood fo New Sportscar eXperimental.)

The lobby is adorned with 314 plaques representing the patents that Honda obtained based on work at the center.

"It's like a developmental Petri dish," said Frank Paluch, senior vice president of automobile development. "We car try new things."

Automakers tend to do their most-sophisticated research close to their home base, which for Honda is in Japan. Honda is unusual in sending a complicated project so far away.

Sometimes, the home country will engage in innovation R&D in the host country, but it is not typical.

R&D Stock

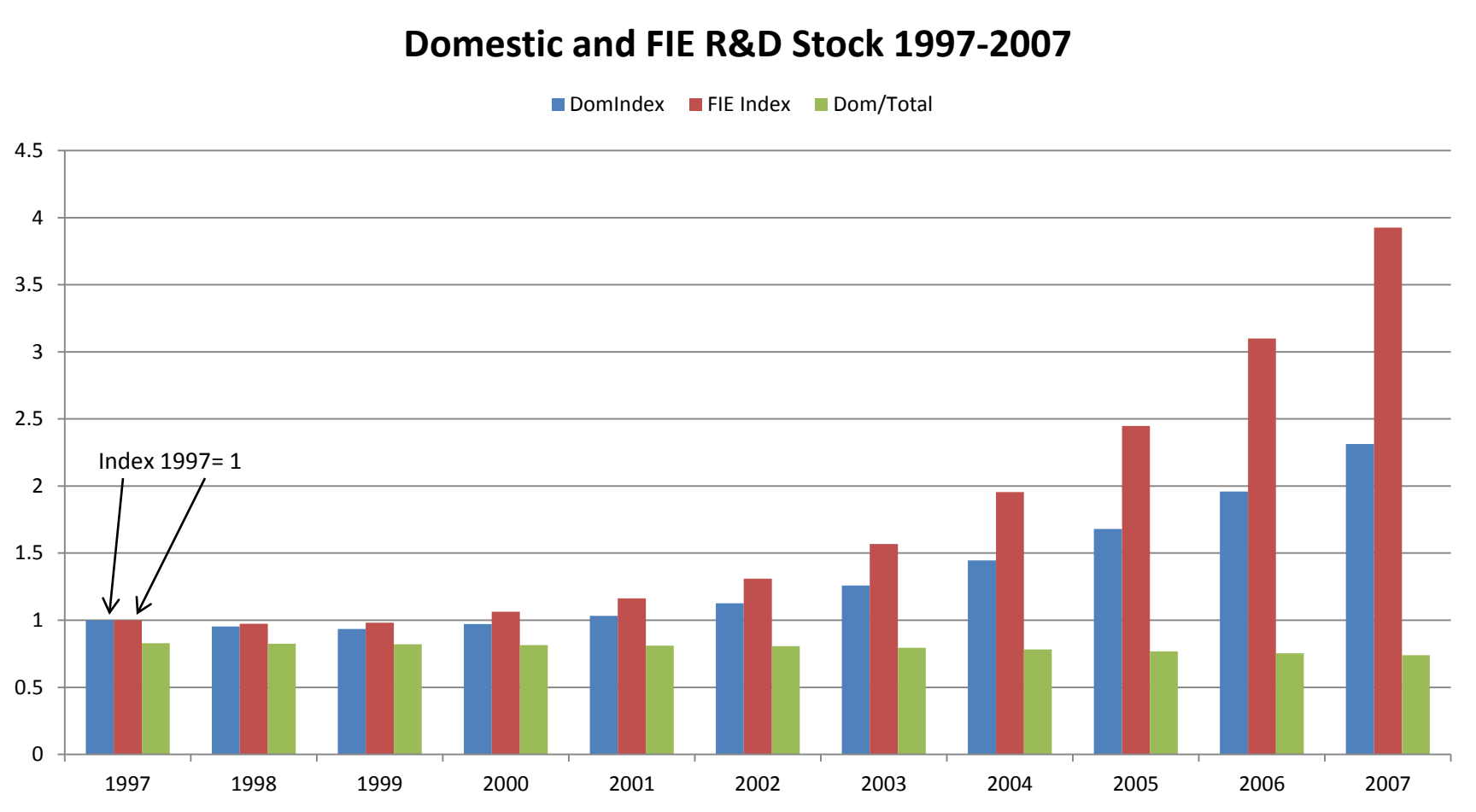
- R&D flows data starting at 1990 (t=0)
- We calculate R&D stock at t=0 as

$$RDstock_0 = 5*RDflow_0$$

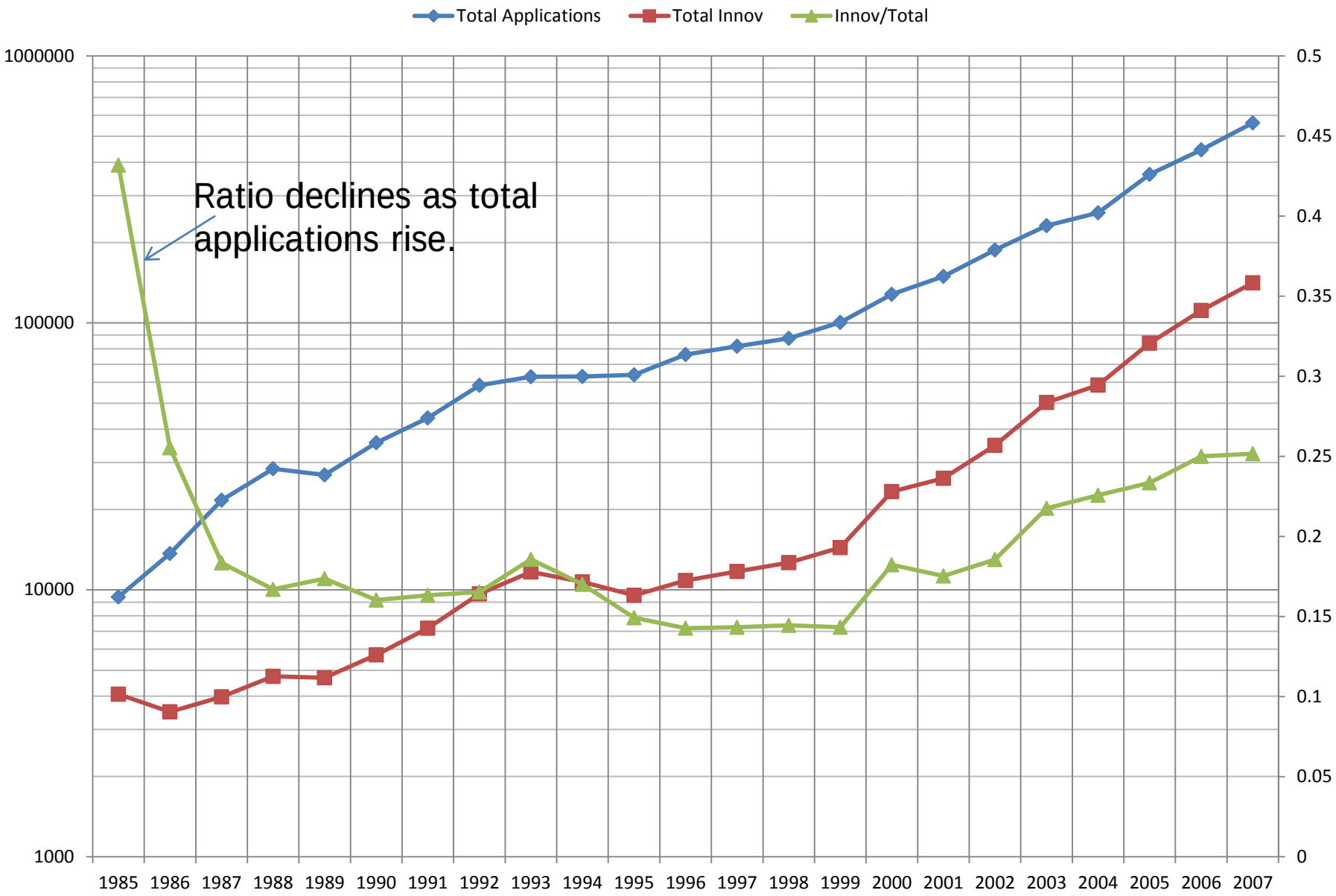
- Following much literature, we use an annual depreciation rate of 15%, although results may be sensitive to this assumption. (B. Hall, 2007)
- It follows that for $t \geq 1$,

$$RDstock_t = RDflow_t + 0.85*RDstock_{t-1}$$

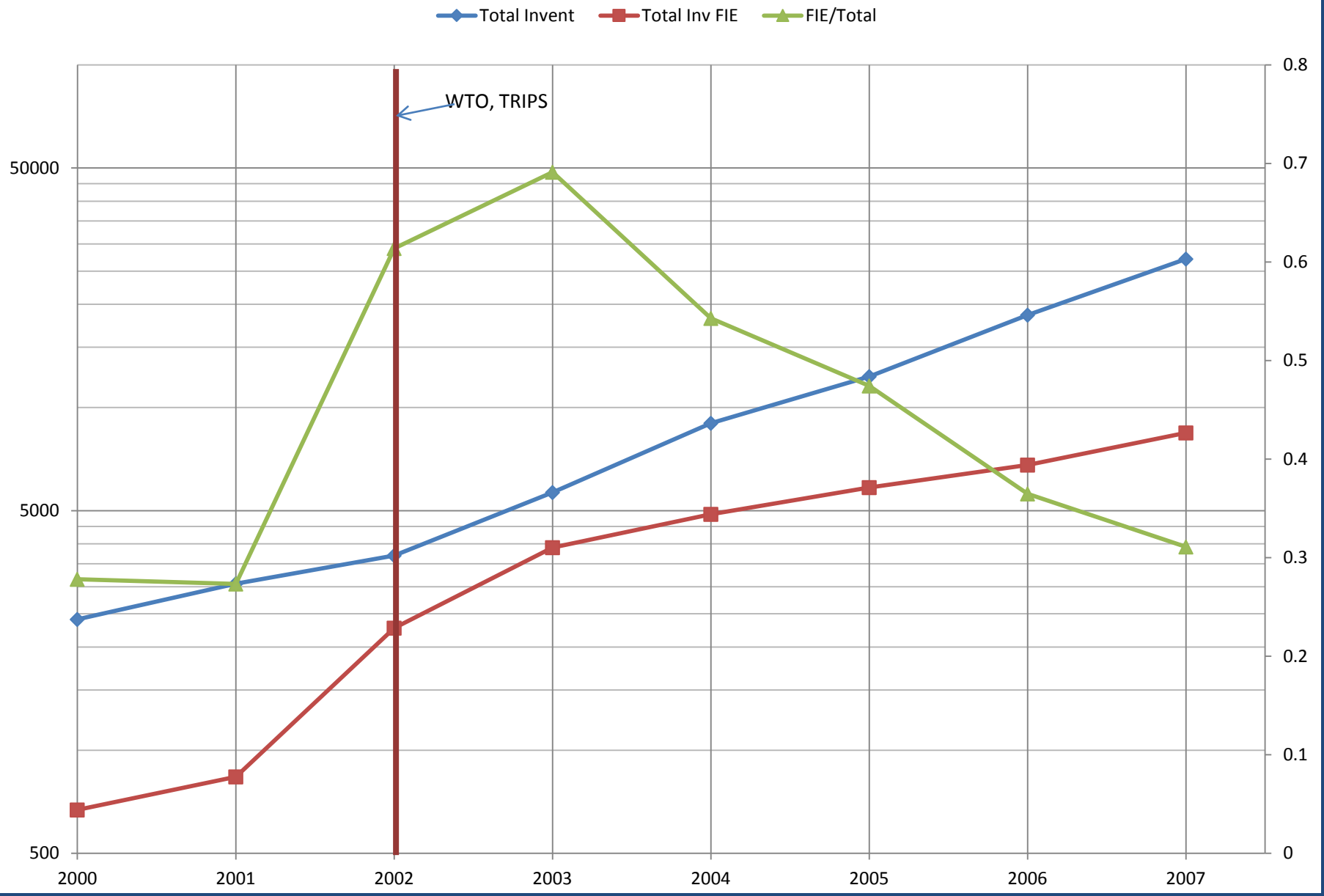
Overview of R&D Stock by Enterprise Ownership



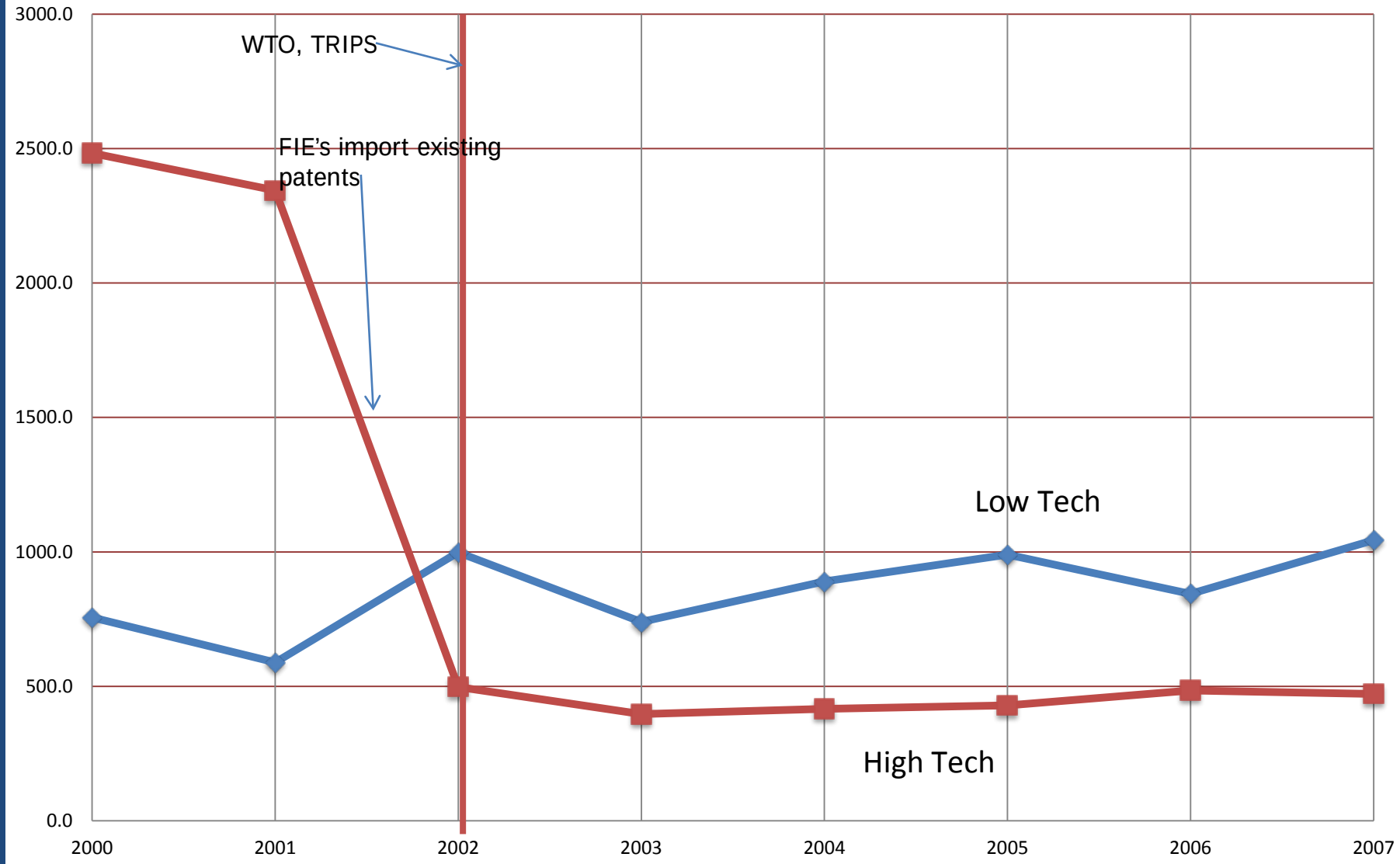
Total and Innovation Patent Applications



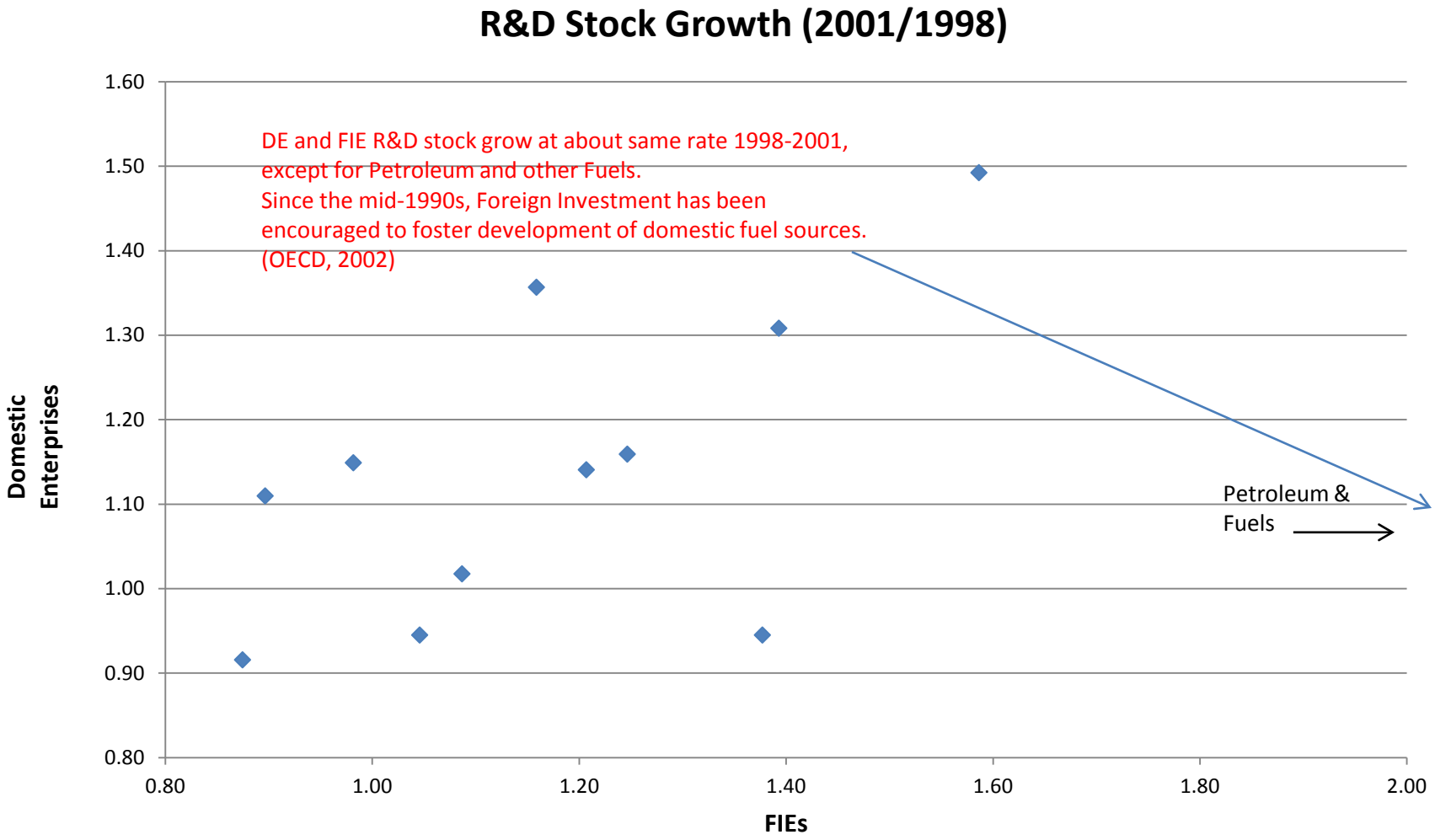
Invention Patent Applications by Ownership



RD Expenditures per Innovation Patent App. by FIEs
(unit: 10,000 Yuan 1990 price)

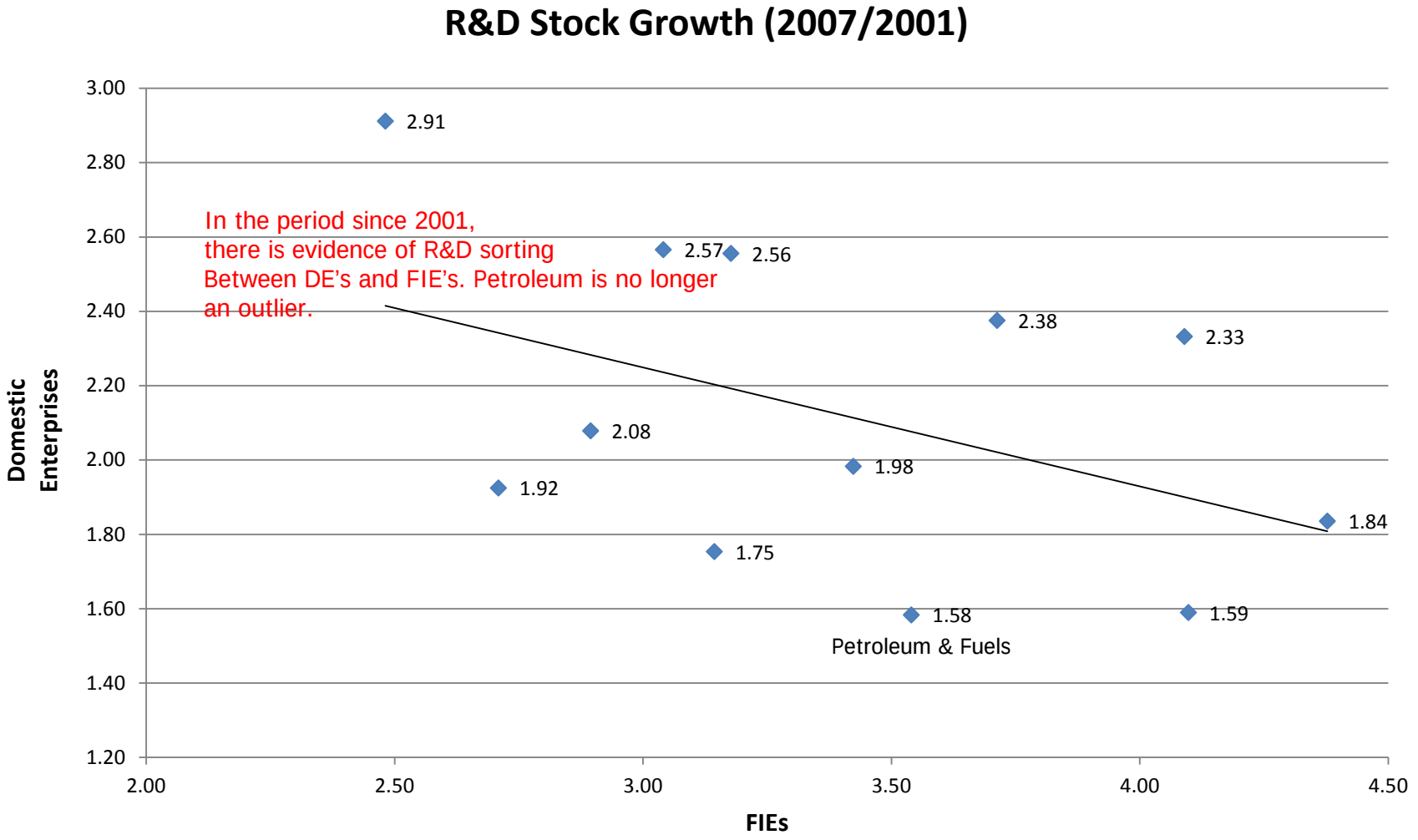


R&D Stock Growth about the same for domestic and FIE's Before 2001 Patent Law



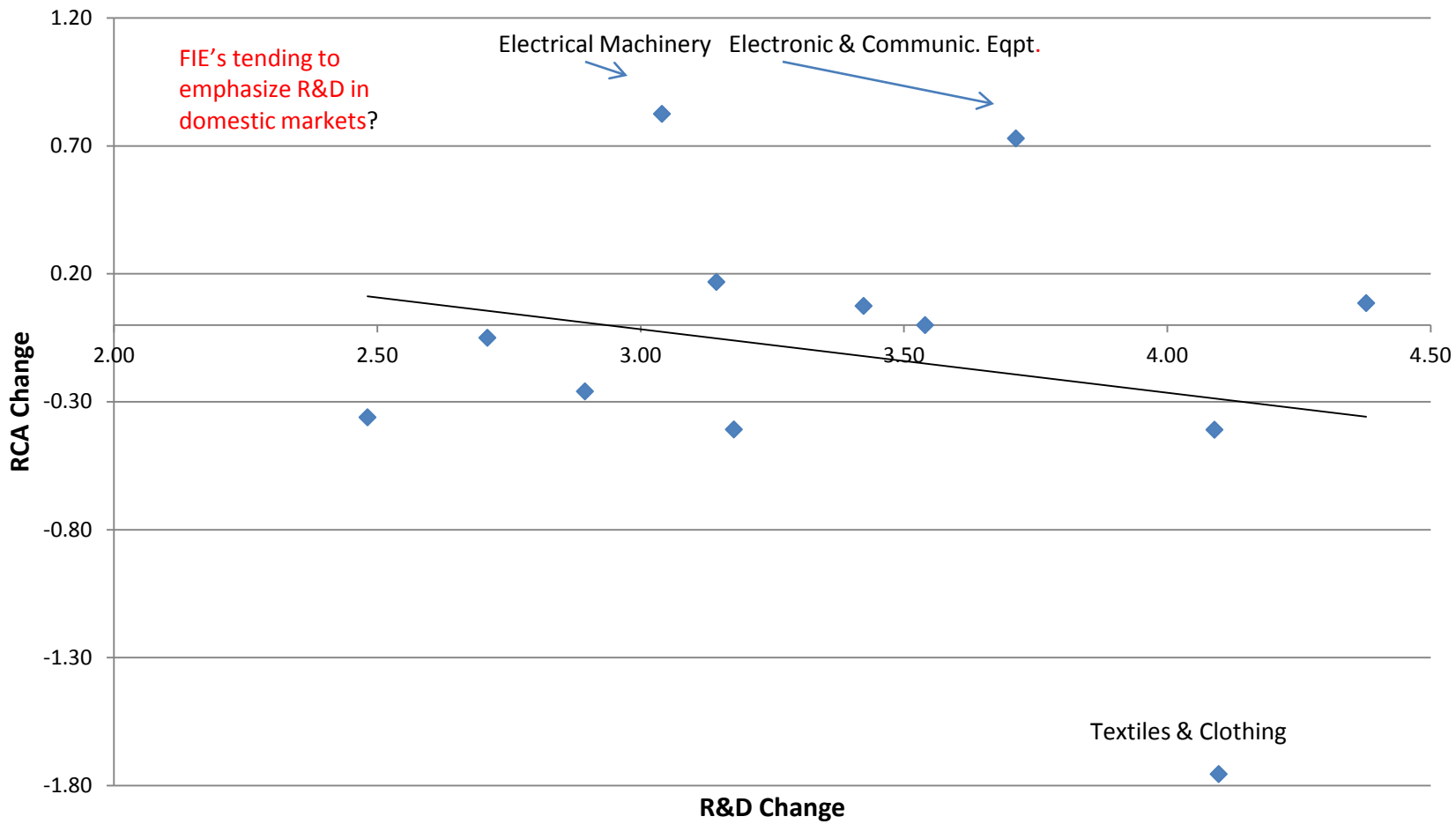
Note: Observations are Industry groups

But after the 2001 Law, the situation reversed.

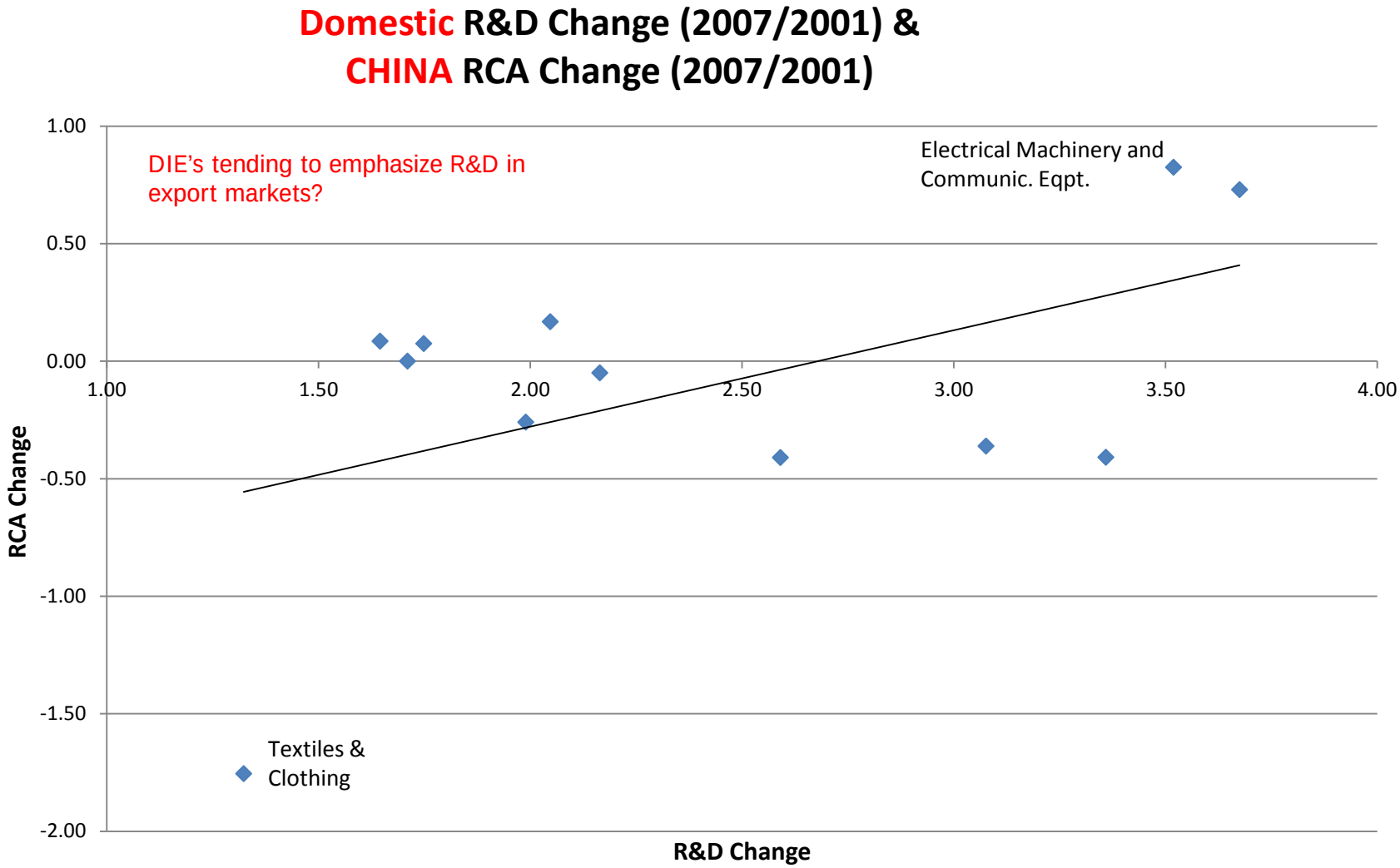


Note: Observations are Industry groups

R&D and Revealed Comparative Advantage (FIE)



R&D and Revealed Comparative Advantage (Domestic)



Formal Tests: Patents

Table 3a

Patents (Negative Binomial Estimator)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	Domestic all Patents		Domestic Invention		FIE all Patents		FIE Invention	
PatentStock (t-1) (Dom or FIE)				-0.044** (0.076) [-.02]				-0.273*** (0.000) [-.08]
R&D Dom (t-1)	0.012* (0.08) [0.04]	0.030*** (0.000) [0.12]	0.031*** (0.000) [0.12]	0.028*** (0.000) [0.11]	0.036*** (0.002) [0.23]		0.025* (0.079) [0.21]	0.016 (0.211) [0.06]
R&D Fie (t-1)	0.003 (0.81) [0.003]		-0.022 (0.11) [-0.03]	-0.006 (0.725) -0.01]	-0.010 (0.66) [-0.02]	0.017 (0.440) [0.04]	0.10 (0.66) [0.02]	0.035 (0.169) [0.06]
Total Labor (t) "Scale effect"	0.23** (0.04) [0.095]	0.040*** (0.000) [0.19]	0.057*** (0.00) [0.09]	0.064*** (0.000) [0.30]	0.002 (0.90) [0.02]	0.012 (0.474) [0.12]	-0.003 (0.88) [-0.03]	0.043** (0.032) [0.40]
Constant	2.66*** (0.00)	0.912*** (0.000)	1.84*** (0.000)	1.81*** (0.000)	1.68*** (0.00)	1.62*** (0.000)	1.55*** (0.000)	1.30*** (0.038)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	203	203	203	203	203	203	203	203

Patent elasticities are quite small in comparison to U.S. and European firms.

FIE patent elasticity is sign. for *domestic* R&D but not for *FIE* R&D, but NOT in col. (8).

Notes: The p-values calculated using robust standard errors are in parentheses (***, **, and * represent significance levels of 1%, 5%, and 10%, respectively). Elasticities evaluated at sample means are in brackets. The years in the sample are 2002-2007. The number of industries in the sample is 29.

Formal Tests: RCA

Table 3c

Dependent Variable: RCA

Variables	(1)	(2)	(3)
RCA(t-1)		0.53***	0.54***
		(0.00)	(0.00)
		[0.54]	[0.55]
R&D Dom (t-1)	0.013*	0.010**	0.033
	(0.052)	(0.01)	(0.22)
	[0.23]	[0.18]	[0.59]
R&D Fie (t-1)	0.004	-0.007**	0.012
	(0.33)	(0.01)	(0.67)
	[0.016]	[-0.18]	[0.05]
R&D Dom (t-2)			-0.031
			(0.33)
			[-0.51]
R&D FIE (t-2)			-0.018
			(0.64)
			[-0.06]
Constant	2.68***	1.31***	1.39***
	(0.00)	(0.00)	(0.00)
Year fixed effect	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Observations	156	156	156
R-square	0.97	0.99	0.99

Notes: The p-values calculated using robust standard errors are in parentheses (***, **, and * represent significance levels of 1%, 5%, and 10%, respectively). Elasticities evaluated at sample means are in brackets. The years in the sample are 2002-2007. The number of industries in the sample is 26.

- Both domestic and FIE R&D appear to be oriented toward increasing exports (col 1) historically,
- but holding lagged RCA constant, we see that FIE R&D is perhaps oriented more toward domestic production while that of domestic R&D more toward exports.
- Consistent with the "reversal" we found in earlier trends.

Formal Tests: TFP

Table 3b

Dependent Variable: LogTFP

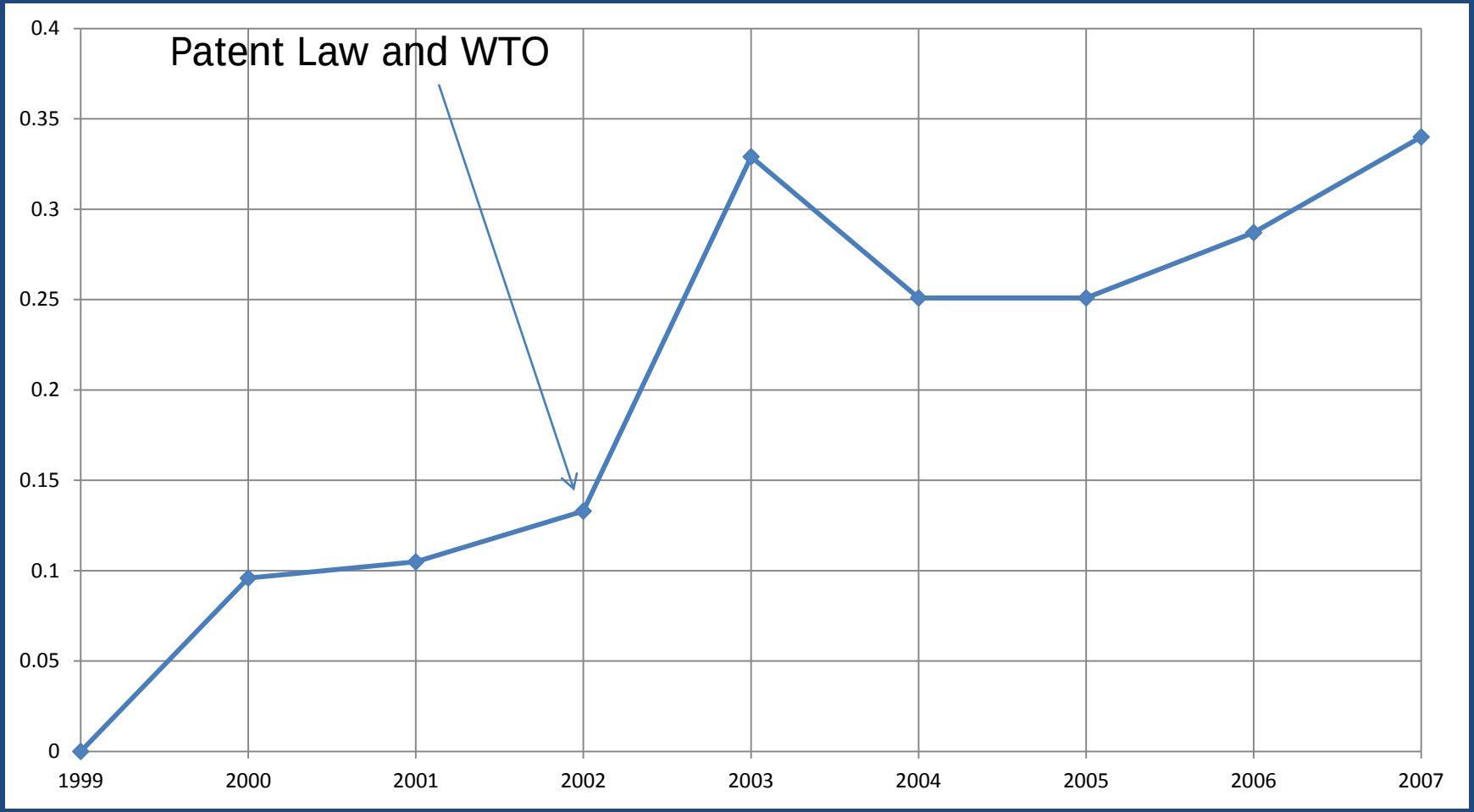
Variables	(1)	(2)	(3)
Log TFP (t-1)		0.71***	0.68***
		(0.00)	(0.00)
R&D Dom (t-1)	0.012***	0.002	0.021***
	(0.001)	(0.074)	(0.010)
	[0.08]	[0.02]	[0.15]
R&D Fie (t-1)	-0.021***	-0.008***	-0.005
	(0.000)	(0.00)	(0.76)
	[-0.04]	[-0.02]	[-0.01]
R&D Dom (t-2)			-0.034**
			(0.011)
			[-0.24]
R&D FIE (t-2)			-0.001
			(0.96)
			[0.001]
Constant	-1.37***	-0.51***	-0.55***
	(0.00)	(0.00)	(0.00)
Year fixed effect	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes
Observations	261	261	261
R-square	0.97	0.98	0.98

Notes: The p-values calculated using robust standard errors are in parentheses (***, **, and * represent significance levels of 1%, 5%, and 10%, respectively). Elasticities evaluated at sample means are in brackets. The years in the sample are 1999-2007. Omitted Year Dummy = 1999. The number of industries in the sample is 29.

R&D elasticities are similar to those estimated by Hu, Jefferson, Qian 1991-95 data for domestic enterprises. Also they are similarly "small" by international standards. Their results for FIEs are mixed. HJQ obtained their estimates directly from the PF.

- Lagged TFP captures omitted variables.
- Col (3) implies that TFP in current period (0) will stagnate unless *Domestic* R&D *flow* is sufficiently large.
- Substituting patent applications for R&D yields insignificant results.
- Why? Patent lag is "long and variable? Low propensity to patent?
- FIE R&D doesn't raise TFP.
- Why? We do not capture possible complementary with new physical capital, which raises K and lowers the TFP "residual", given estimated K elasticity in PF.

Year Fixed Effects from TFP Regression (Column 3)



Conclusions

- Domestic enterprise R&D is productivity enhancing in China, but so far it has had a weak impact on new patents.
- This suggests that the formation of knowledge capital in China has yet to reach the world frontier.
- Foreign IKC imported or developed in China appears aimed at the domestic market.
- Continuation of China's productivity growth at its current pace is likely to depend on incentives for and protection of domestic creativity.

Policy Implications

- Will government get on board or blockade the knowledge train?
  - Enforce IPR;
  - Encourage a Marketplace of Ideas such that foreign-trained scientists are comfortable returning to China; CREATE NEW KNOWLEDGE AS WELL AS FACILITATE TRANSMISSION OF INTERNATIONAL TECHNOLOGY (Keller 2002 & 2009)
  - Be prepared to give up control of Strategic Industries; don't let Sinopec become Pemex