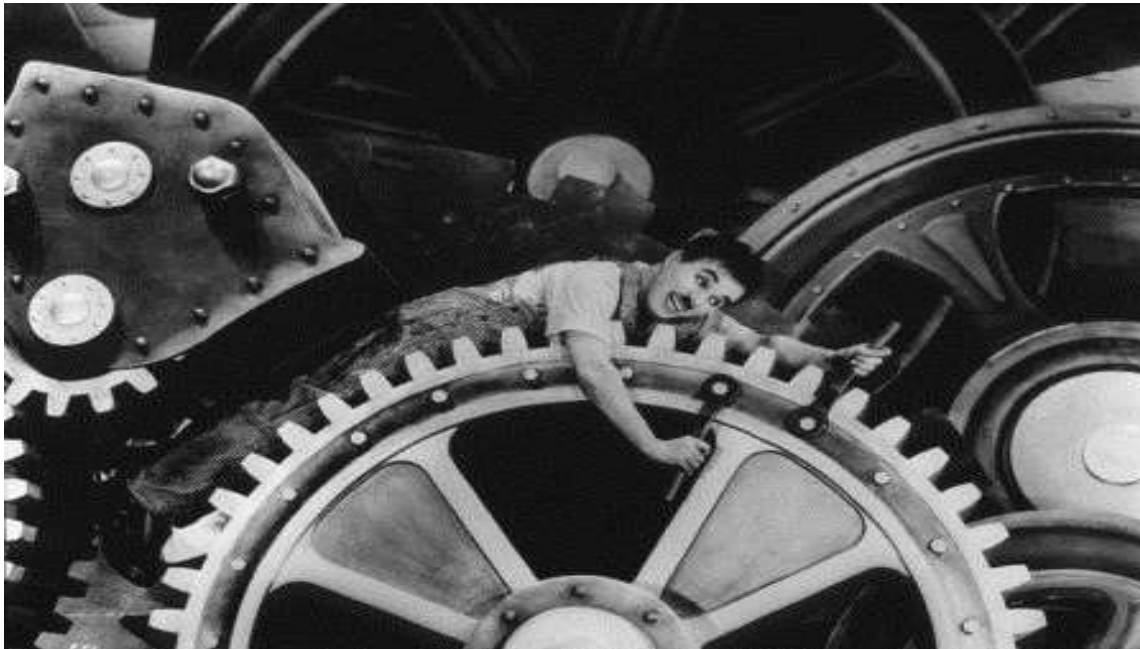


Productivity and Measuring Management

John Van Reenen (LSE, Centre for Economic Performance)

Yrjo Jahnsson Lecture 4



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

CENTRE *for* ECONOMIC
P E R F O R M A N C E

http://www.youtube.com/watch?v=wBl0v_CSqyl&feature=related

Theory ahead of measurement in organizational economics?

- Large theoretical literature on the organization of the firm (e.g. Gibbons & Roberts, 2013, *Handbook*)
- Traditionally much less empirical work because of difficulties in robustly collecting information over large number of firms
 - Consequently, a focus on case studies
 - Case studies useful but hard to generalize from N=1!
- This lecture overview some current organizational data & relates to core theories – e.g. principal agent; knowledge hierarchy; co-ordination, etc.

Overview

- 1. Measuring organization: spans and decentralization**

2. Differences in organization across firms, countries & time

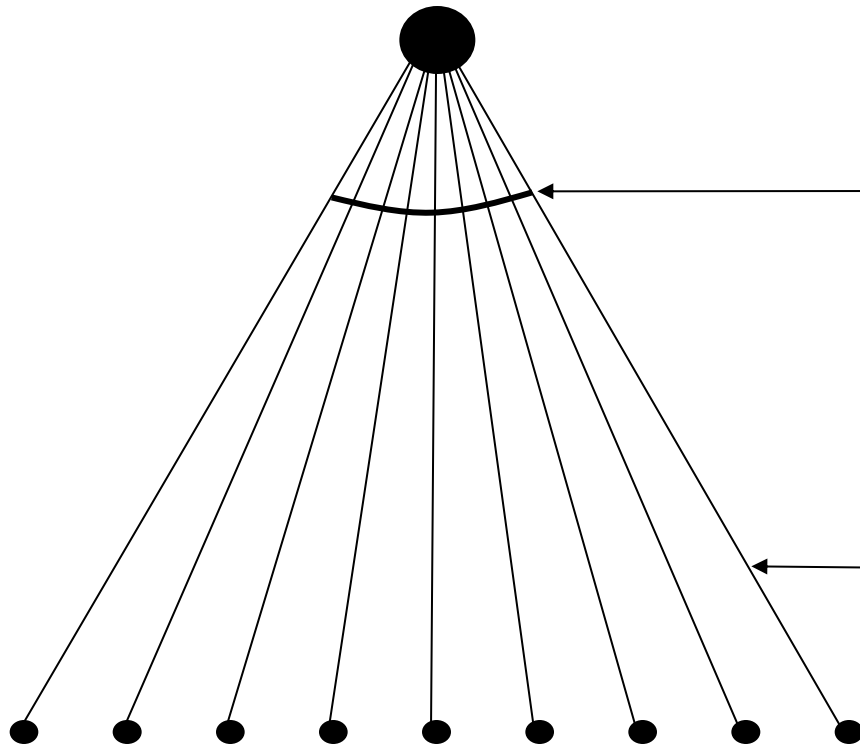
3. Factors affecting firm decentralization

4. Organization and productivity

5. Conclusions

The simple model – organization within a 2-level firm

Manager

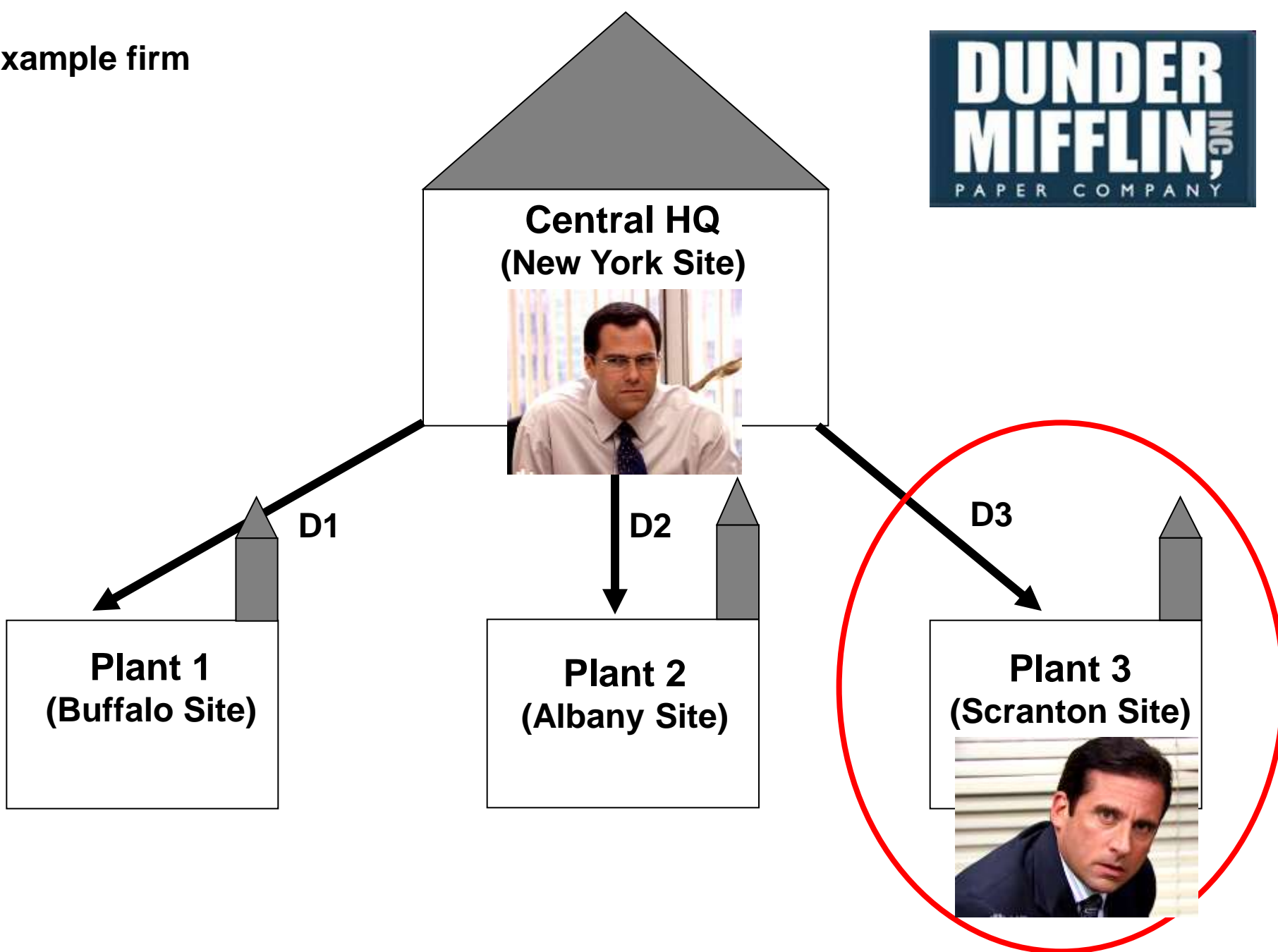


Span of control: the number of workers reporting to the manager

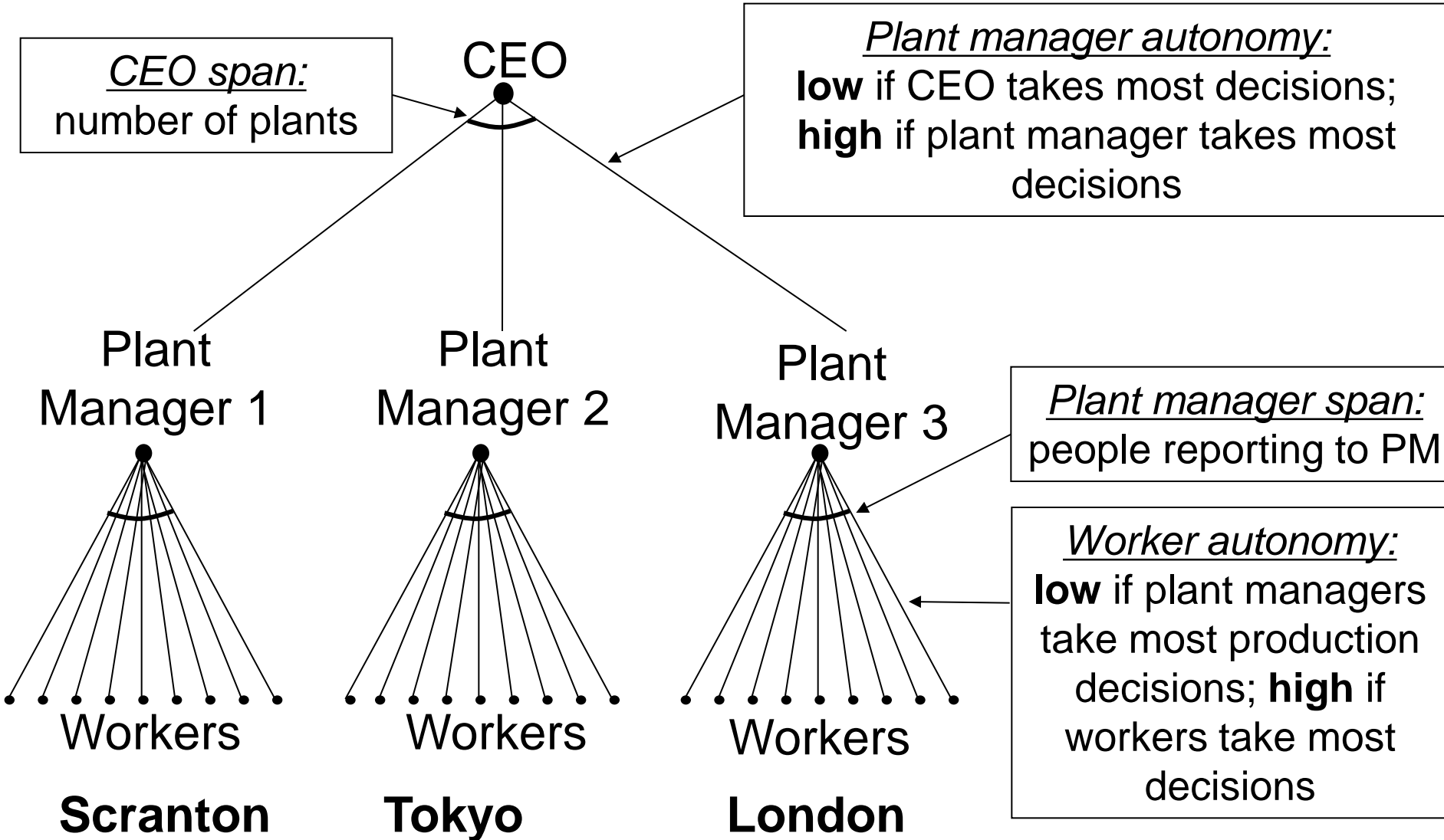
Worker autonomy: **low** if managers take most decisions; **high** if workers take most decisions

Workers

Example firm



A more realistic multi-plant multi-level firm example



Bloom, Sadun & Van Reenen (2012, QJE) collect spans and decentralization data on about 3,600 firms

- 1) **Quantifying**: measure decentralization of hiring, investment, sales and production decisions from CHQ to plant manager
Also collect spans and worker decentralization
- 2) **Truth**: use double blind as in Bloom and Van Reenen (2007)
- 3) **Data**: use various tricks as in Bloom and Van Reenen (2007)
 - Introduced as “Lean-manufacturing” interview, no financials
 - Official Endorsement: Bundesbank, Treasury, RBI , etc.
 - Run by MBA types (loud, assertive & business experience)
- 4) **Sample**: Manufacturing firms with 50 to 5,000 employees

The decentralization survey page

Company Name

WUZHILVYU CHEMICAL & ELECTRIC CO.LTD.

Scoring

1

3

5

To hire a FULL-TIME PERMANENT SHOPFLOOR worker what agreement would your plant need from CHQ?

	▼	No authority - even for replacement hires	Requires sign-off from CHQ based on the business case. Typically agreed (i.e. about 80 or 90% of the time).	Complete authority - it is my decision entirely
--	---	---	---	---

Where are decisions taken on new product introductions - at the plant, at the CHQ or at both?

	▼	All new product introduction decisions taken at the CHQ	New product introductions are jointly determined by the plant and CHQ	All new product introduction decisions take at the plant level
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How much of sales and marketing is carried out at the plant level (rather than at CHQ)?

	▼	None - sales and marketing is all run by CHQ	Sales and marketing decisions are split between the plant and CHQ	The plant runs all sales and marketing
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3. Factors affecting firm decentralization

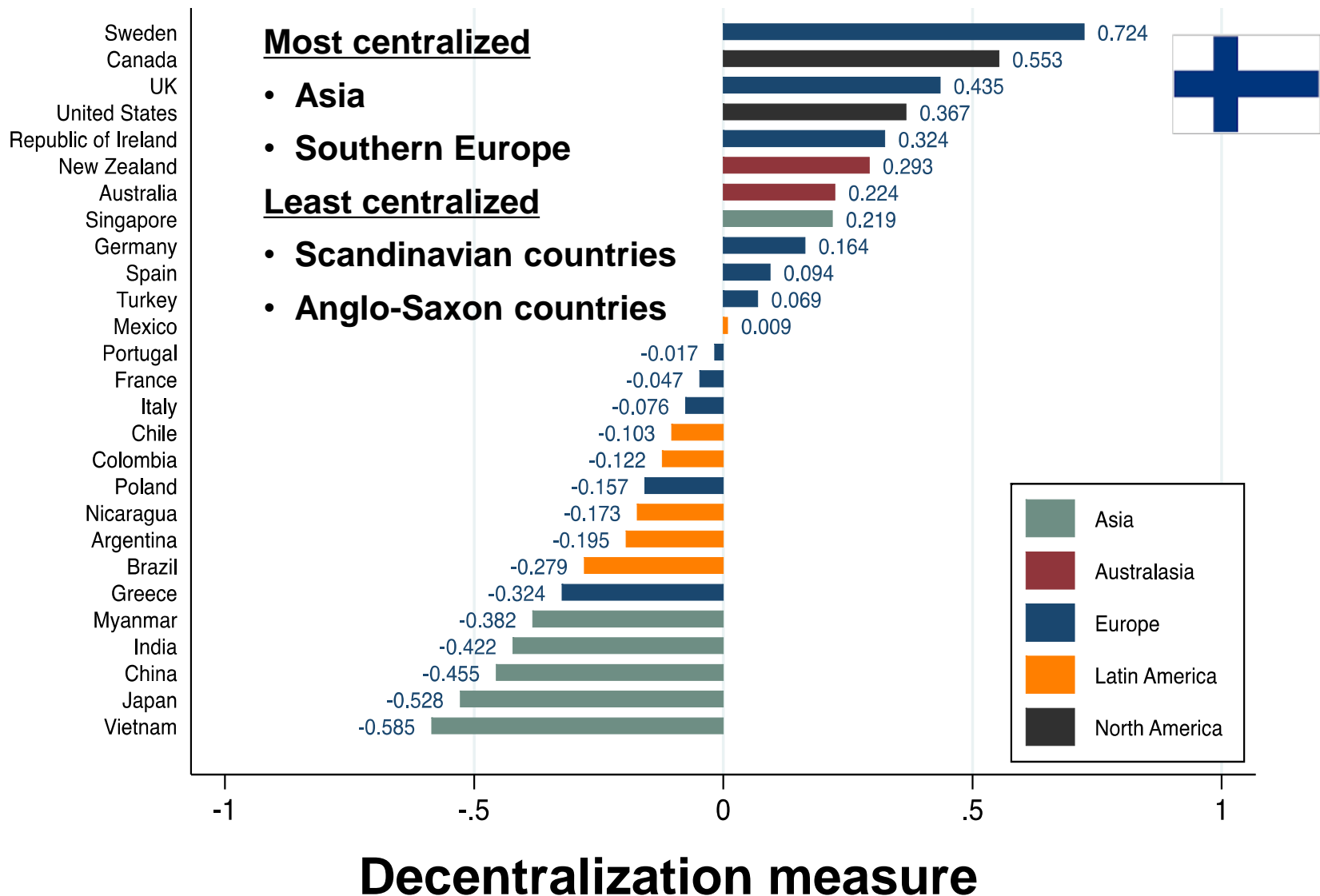
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The Bloom, Sadun and Van Reenen (2012, QJE) empirical decentralization measure

- Main measure averages the z-score (scores normalized to mean 0, standard-deviation 1) of each variable:
 - Hiring senior employees (discrete, 1 to 5)
 - Maximum Capital expenditure (continuous, in \$)
 - Introduction of new products (discrete, 1 to 5)
 - Sales and marketing (discrete, 1 to 5)

Decentralization varies across countries



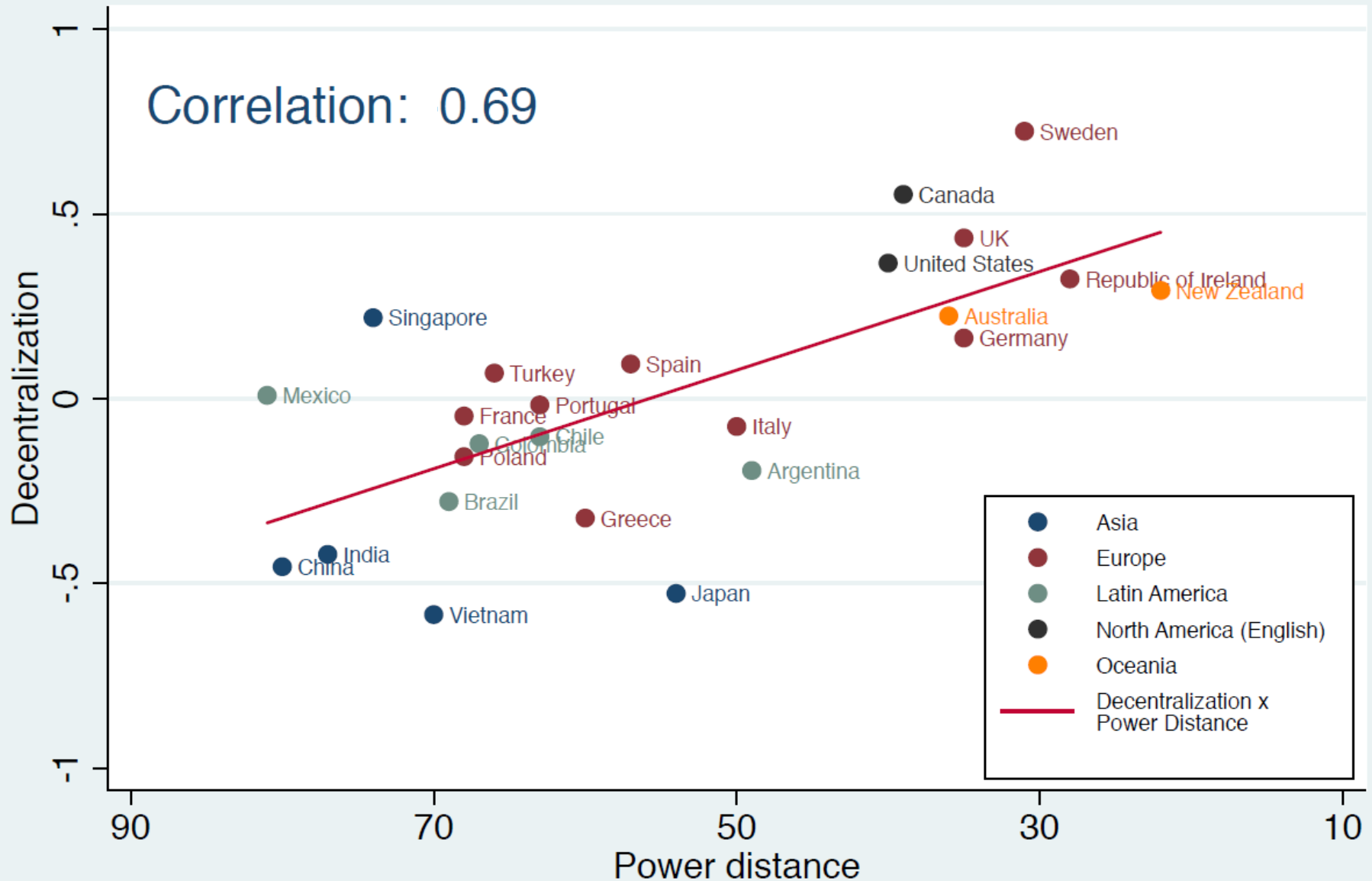
Source: Aghion, Bloom, Lucking, Sadun & Van Reenen (2015)

External validation – country level (1/2)

- Do these cross-country values look sensible?
- Only prior firm decentralization measure to check with we are aware of is Hofstede (1980)
 - Surveyed c.100,000 IBM employees across 50 countries during the 1970s & early 80s
 - Questions on management style (autocratic/paternalistic or consultative) and *preferences* for delegation
 - Combined into *Power Distance* index (1-100), low means limited (preference for) delegation

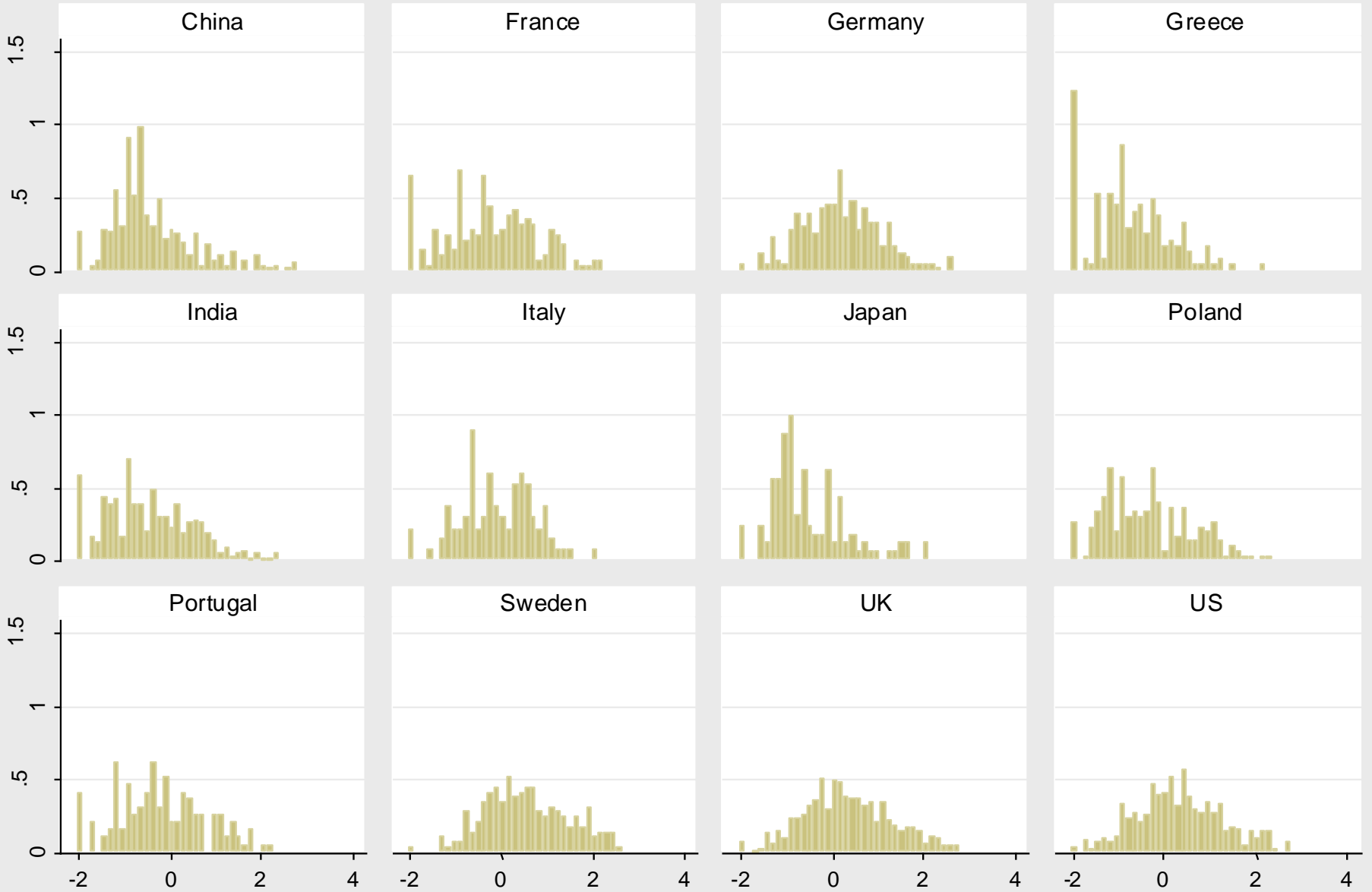


Correlation with Hofstede's power distance



Note: Firms between 50 and 5000. This graph uses the full sample of the World Management Survey. Scale for Hofstede Power-Distance index is reversed.

Decentralization also varies across firms



Decentralization measure (higher number is more decentralized)

Alternative ways to measure organization

1) Analysis of a firm's formal structures

- BSV also ask about **span** (number of direct reports)
- Alternative is to look at a firm's formal organizational structure (“organogram”). Usually case study but Rajan & Wulf (2006) have HR consultancy data across ~300 US firms
- Another possibility is to look at whether firm organized into decentralized profit centers (vs. cost/ revenue centers or centralized; e.g. Acemoglu et al, 2007)

Problem is that real authority different from formal authority

e.g. <http://www.youtube.com/watch?v=5FR>



Alternative ways to measure organization

2) Traditional surveys on formal or real authority

- Black and Lynch (2001, 2004) for US plants (see Bloom & Van Reenen 2011 survey in *Handbook of Labor Economics*)
- Less costly than BSV but harder to probe managers for truth & open to more ambiguity of interpretation.

3) Examination of communication networks

- Surveys (e.g. Boning & Shaw on steel)
- e-mail traffic (Prat, 2010)

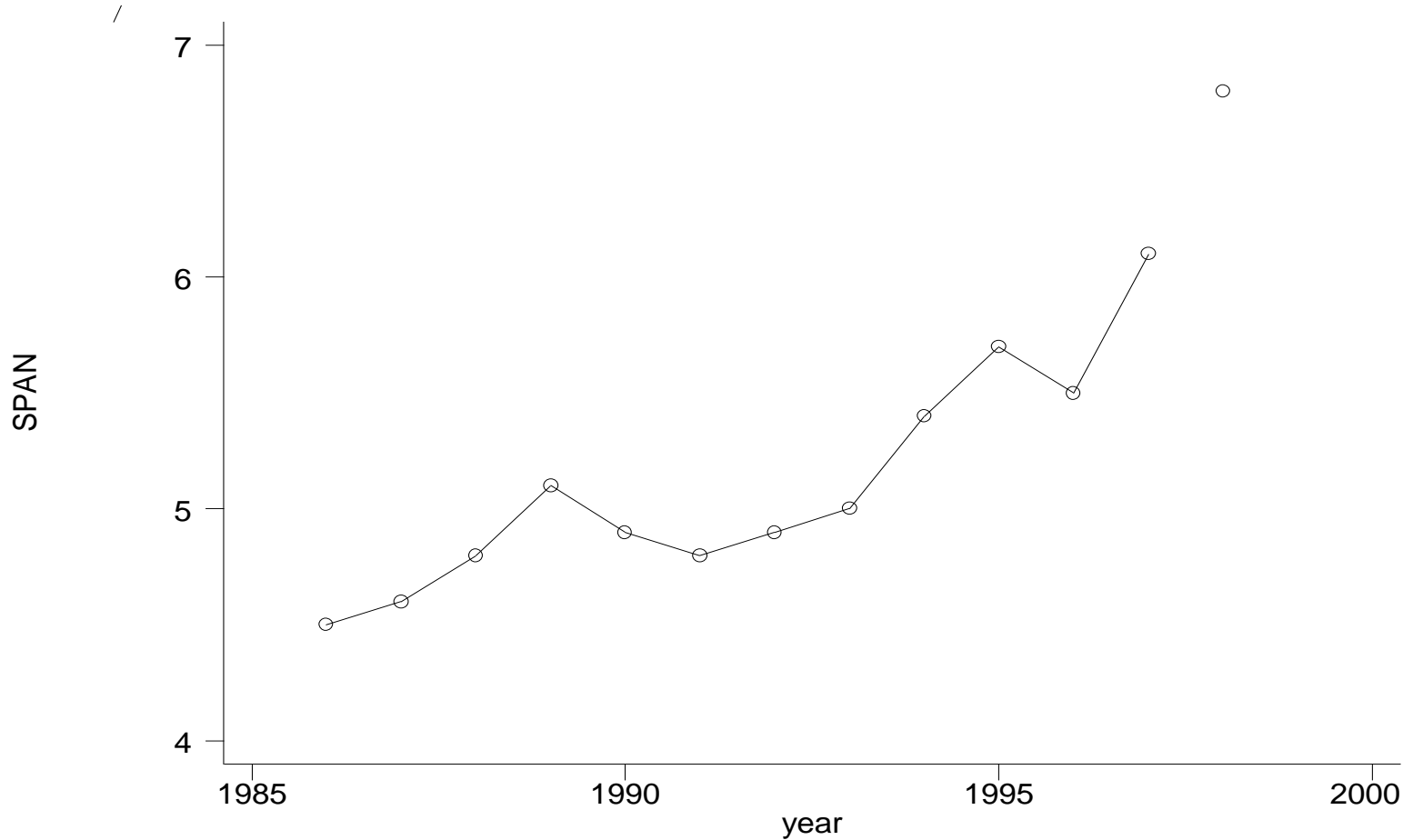
4) Insider Econometrics. “Case study” of a change (e.g. Wu, 2010, on Chinese journalists)

What about changes in decentralization over time?

"Globalization and the arrival of the information economy have rapidly demolished all the old precepts. The management of global companies, which must innovate simultaneously and speed information through horizontal globe-spanning networks, has become a daunting challenge. Old, rigid hierarchies are out"

Business Week, cover story August 21, 2000

Increasing Delaying – positions reporting to CEO



Source: Rajan and Wulf, 2006, 300+ large US corporations

Outline

1. Measuring organization: spans and decentralization
2. Differences in organization across firms, countries & time

3. Factors affecting firm decentralization

- **Technological**
- Economic
- Cultural

4. Organization and productivity
5. Conclusions

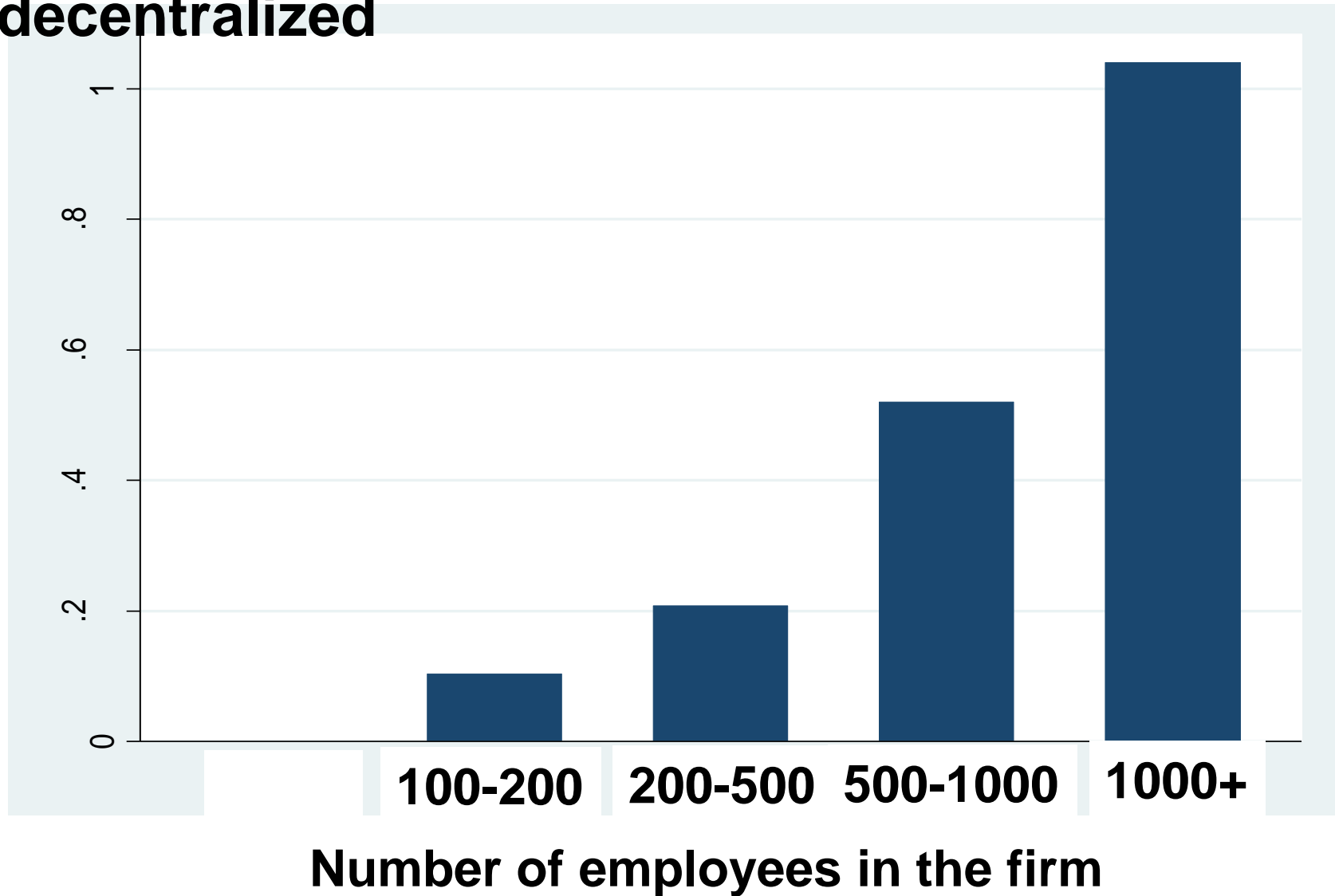
Factors affecting Decentralization

“Driver”	Measure	Association with Decentralization
Technology	Size	Positive
	Volatility	Positive
	IT	Positive
	CT	Negative
Economics	Competition	Positive
	Human Capital	Positive
Culture	Trust	Positive
	Rule of Law	Positive
	Hierarchical Religion	Negative

Factors affecting Decentralization: Technology

- **Complexity**
 - *Example:* Size (Penrose, 1959; Chandler, 1962)
- **Learning**
 - *Example:* Industry volatility/heterogeneity
- **Information & Communication Technology**

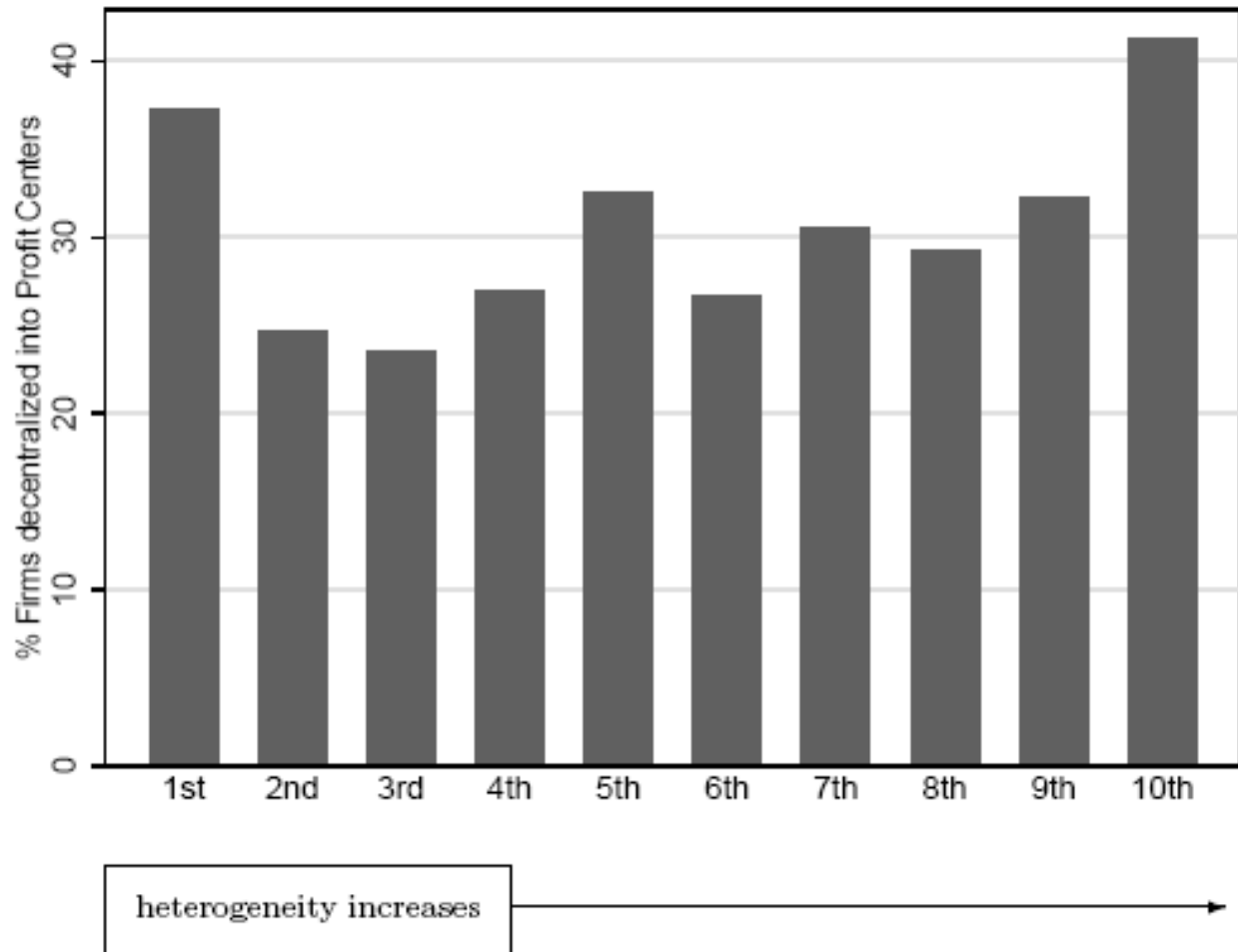
Technology # 1 Complexity: Larger Firms are more decentralized



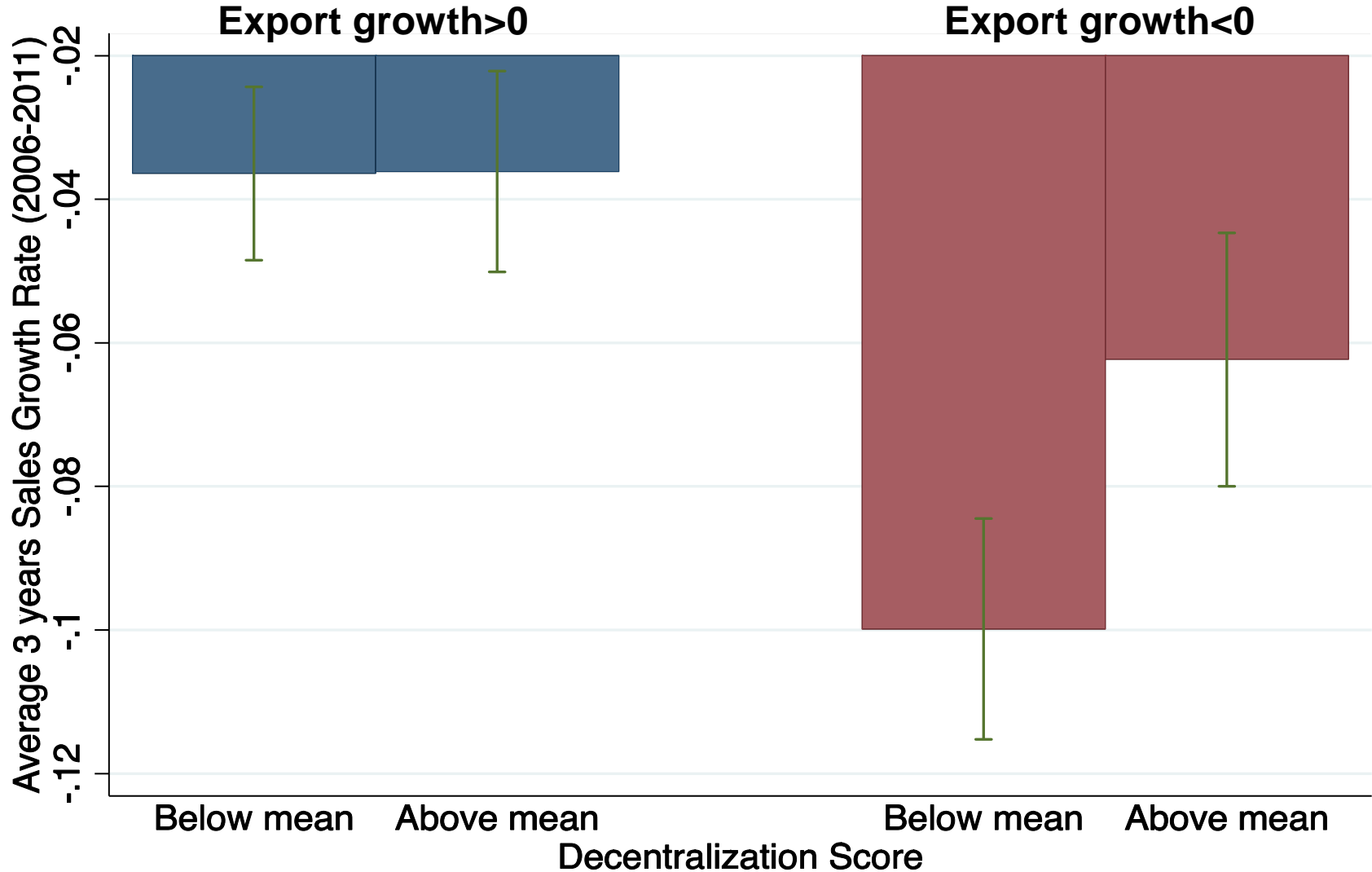
Technology # 2: Volatility

- Acemoglu, Aghion, Lelarge, Van Reenen & Zilibotti (2007, QJE) develop a learning model
- **Firm adopts/develops a new technology**
 - Agent (plant manager) is informed about usefulness of technology (heterogeneous between firms)
 - Principal (CEO) is correctly aligned with owners' incentives
 - Principal learns about likely profits of adoption based on public history of profits from others' use
- **Predictions are that decentralization more likely**
 - Closer to the frontier (less experiments by other firms to learn from)
 - For younger firms (less to learn from past experience)
 - For more **volatile/heterogeneous** industries (because harder to learn from others). Use variance of productivity growth across firms

Learning: Firms who are in more heterogeneous/volatile sectors are more likely to be decentralized into profit centers



Decentralization more valuable in downturns (e.g. when more volatility), decentralized firms “protected” as can respond more rapidly



Change in log firm sales from 2006-2008 to 2009-2011 (10% confidence interval shown).

An Econometric Model (Aghion et al, 2015)

$\Delta \ln Y$, Firm sales (or TFP) growth regressed on decentralization (DEC) & shock

$$\Delta \ln Y_{ijct} = \alpha DEC_{i0} + \beta (DEC_{i0} * SHOCK_{jc}) + \gamma SHOCK_{jc} + \delta x_{i0} + \theta_c + \phi_j + \tau_t + \varepsilon_{icjt}$$

Where:

- i=firm
- j =industry
- c =country
- t=time

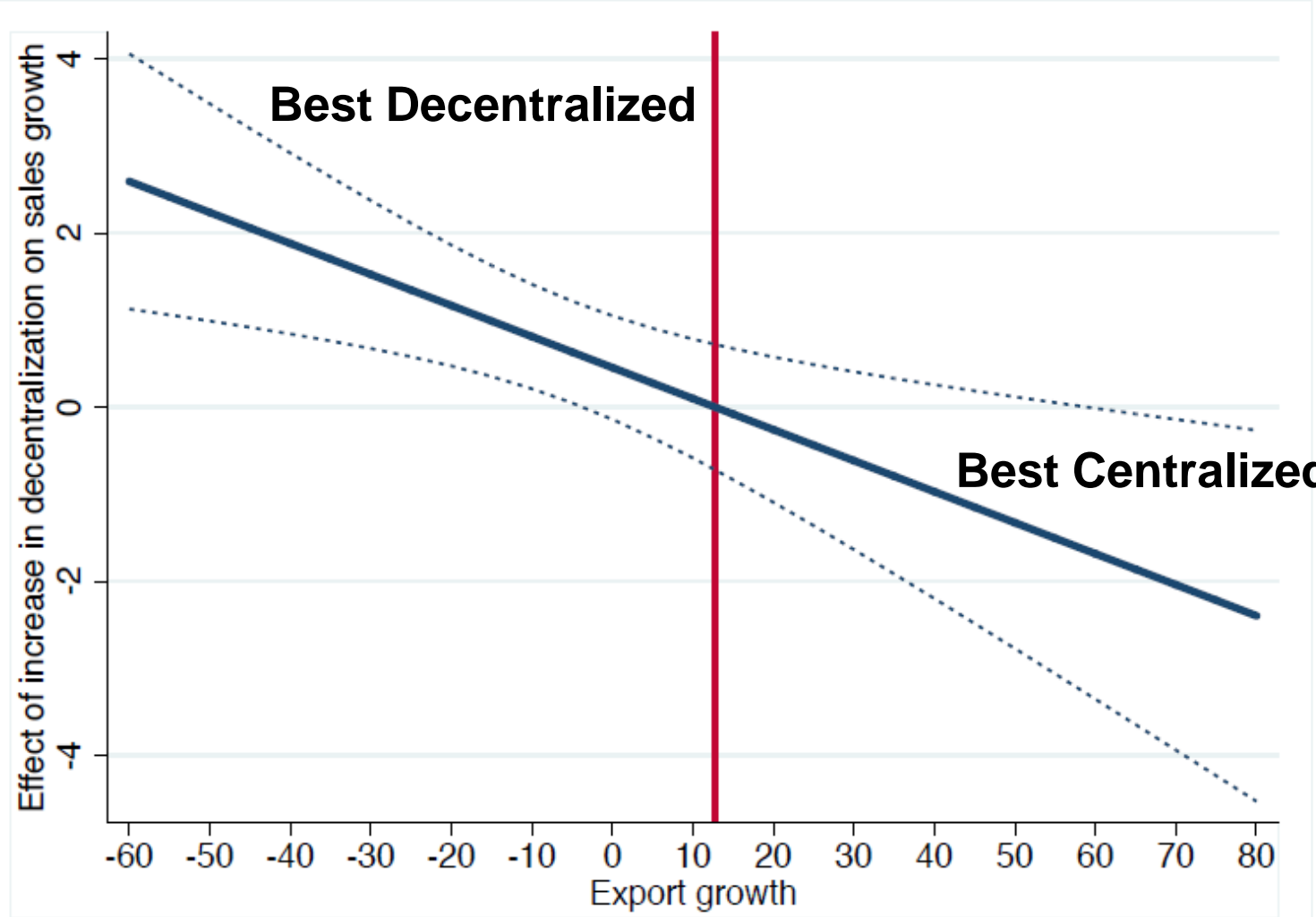
Decentralization attenuated effects of 2008-9 Great Recession

Table 2 - Decentralization and Sales Growth - Main Results

	(1)	(2)	(3)	(4)	(5)
Dependent Variable: Sales Growth (3 years DHS change)					
Decentralization	0.620** (0.302)	0.525* (0.300)	0.118 (0.416)	-0.532 (0.455)	-0.437 (0.541)
EXPORT Growth	0.045* (0.024)	0.039 (0.024)			
Decentralization*EXPORT Growth		-0.035*** (0.012)	-0.037** (0.017)		
Decentralization*SALES Growth				-0.054*** (0.012)	
Decentralization*DURABILITY					0.511*** (0.185)
R-squared	0.227	0.230	0.311	0.314	0.254
Observations	3132	3132	3132	3132	3132
Number of firms	1323	1323	1323	1323	1323
Controls					
Country	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y
Noise	Y	Y	Y	Y	Y
Industry (SIC3)	Y	Y			
Log firm and plant employment			Y	Y	Y
Skills			Y	Y	Y
Industry (SIC3) by Country			Y	Y	
Industry (SIC4)					Y
Cluster	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC3*Cty	SIC4

These coefficients imply on average centralization was “best” before Great Recession, but decentralization was best during

Figure 2 - Effect of increase in decentralization on sales growth (using coefficients from Table 2, col 3)



Technology # 3: Information and Communication Technologies

- Garicano (2000) - Firms as *cognitive hierarchy*: organizations exist to solve problems
- Lower level individual (e.g. Plant manager) solves as many problems as he can, then passes up complex problems to CHQ. CHQ solves but this involves communication cost
- **Information Technologies** (e.g. ERP) help plant managers to solve more problems, lower info acquisition costs.
 - Increases in IT causes decentralization
- **Communication Technologies** (e.g. networks) makes “asking” cheaper
 - Increases in CT cause less decentralization

The Ambassador & the Nurse?



Zhang Qian, Imperial Envoy to
Emporer Wu ~200 years BC



The Ambassador & the Nurse?

- Ambassadors used to be key foreign decision maker, but now downgraded - a glorified export promotion agent?
 - Why? Communication technology means that easier to find out what is going on overseas and tell local diplomats what to do
- Role of nurse used to be very basic, now closer to that of doctor performing many of the more routine medical procedures
 - Information Technology has pushed decisions “down” to nurses(e.g. diagnosis & protocols)
- Bloom, Garicano, Sadun & Van Reenen (2014, MNG Science) test idea using measures of IT & CT separately

Dependent Variable: PLANT MANAGER AUTONOMY

ERP (Enterprise Resource Planning)	0.104*		0.116**
<i>Information technology</i>	(0.054)		(0.054)
NETWORK		-0.098*	-0.110**
<i>Communication technology</i>		(0.053)	(0.053)
ln(Computers/Employee)	-0.041	-0.021	-0.031
	(0.031)	(0.031)	(0.031)

**INFORMATION TECHNOLOGY INCREASES DECENTRALIZATION,
COMMUNICATION TECHNOLOGY DECREASES DECENTRALIZATION,**

Source: Bloom, Garicano, Sadun & Van Reenen (2014)

Notes: OLS, industry & country dummies, 948 firms, noise controls, CEO on-site dummy, size, skills and multinational status. Dependent variable plant manager autonomy z-score. SE clustered by firm.

ENDOGENEITY OF ICT?

- Use distance from SAP's HQ in Waldorf/Hiedelberg (birthplace of most popular SAP) as an instrumental variable for ERP. EU firms only
- Use tele-communication costs (different regulatory regimes) as an instrumental variable for networks
- Strengthens results

Outline

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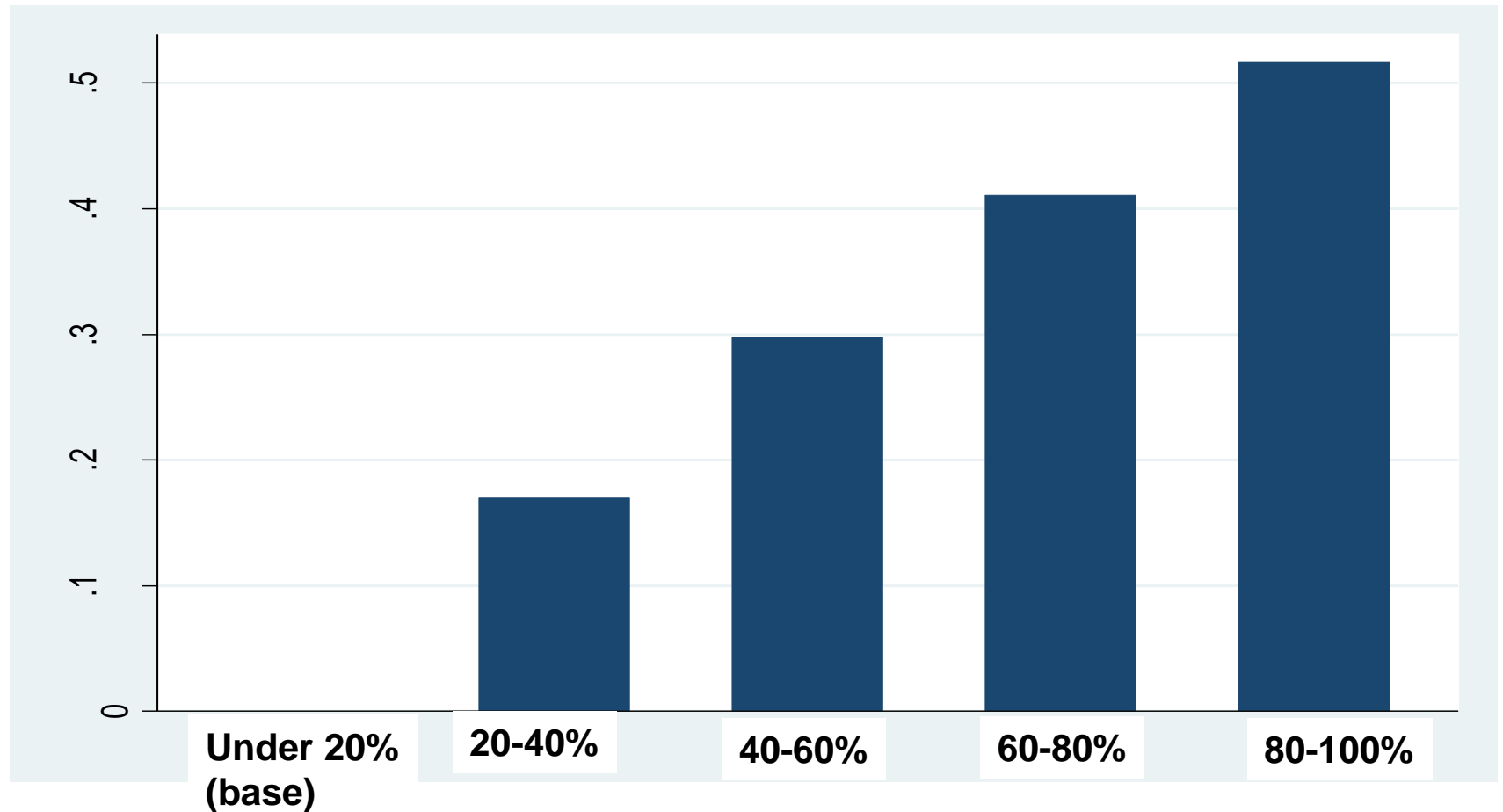
- Technological
- **Economic**
- Cultural

4. Organization and productivity
5. Conclusions

“Skill biased Organizational Change?” Do increases in skill supply increases decentralization?

- Does human capital complement decentralization?
 - From cognitive viewpoint (Garicano, 2000 JPE), less likely to make mistakes
- Fall in IT prices leads to complementary organizational changes (decentralization/delaying) and increased demand for more skilled workers
 - More inequality (e.g. Machin & Van Reenen, 1998 on skill bias of technology)
 - Higher productivity (see later)

Plants with more skilled workers are more decentralized



Proportion of employees with a college degree

Three implications of complementarity between human capital and decentralization

- **Organization equation**
 - Decentralization more likely when supply of human capital increases, e.g. do higher relative prices of skilled workers inhibit decentralization?
- **Skill demand equation**
 - Does decentralization increase demand for more skilled workers?
- **Production or cost function**
 - Positive interactions between skills and organization in the production function
- Caroli & Van Reenen (2001) & Bresnahan, Brynjolfsson and Hitt (2002, QJE) find evidence in favor of all 3 predictions

HIGHER RELATIVE SKILL PRICES REDUCE LIKELIHOOD OF ORGANIZATIONAL CHANGE

TABLE V
DETERMINANTS OF ORGANIZATIONAL CHANGE IN BRITAIN AND FRANCE

	Britain		France	
Mean of dependent variable	.432	.432	.524	.524
	(1)	(2)	(3)	(4)
	<i>OC</i>	<i>OC</i>	<i>OC</i>	<i>OC</i>
Regional relative wage (high-low education)	-0.893	-0.683	-1.122	-1.165
	(0.285)	(0.210)	(0.629)	(0.602)

Source: Caroli & Van Reenen (2001, QJE)

Competition and decentralization – basic theory

- Theory ambiguous
 - Competition may affect information:
 - Improves the value of timely responses to local conditions (e.g. Aghion & Tirole, 1997)
 - But, reduces value of local information as more firms for the principal to learn from (e.g. Acemoglu et al., 2007)
 - Competition may also affect incentives:
 - Lower risk of manager abusing autonomy as incentives more aligned with firm (e.g. Schmidt 1997, Vives 2005)
 - But, less incentive to co-ordinate prices (Alonso et al., 2008)
- Bloom, Sadun & Van Reenen (2010) find net effect of competition positive

Decentralization higher with more competition

Import Penetration	0.131*** (0.050)	0.184*** (0.073)				
1 – Lerner Index			6.537*** (1.176)	2.265*** (1.081)		
Number of competitors					0.134*** (0.036)	0.094** (0.034)
Plant Skills		0.081*** (0.018)		0.090*** (0.016)		0.090*** (0.016)
Ln(Firm Size)		0.076** (0.026)		0.068*** (0.017)		0.066*** (0.018)
Ln(Plant size)		0.119** (0.024)		0.091** (0.022)		0.090** (0.022)
Observations	2,497	2,497	3,587	3,587	3,587	3,587
Country & Ind. dummies	no	yes	no	yes	no	yes
Clustering	Cty * Sic2	Cty * Sic2	Cty * Sic3	Cty * Sic3	Firm	Firm

Notes: Other controls are SIC3 dummies, 12 country dummies, noise controls (interviewer dummies, Interviewee tenure and seniority, etc.), public listing, CEO onsite, plant size, Number of competitors (0=none, 1=between 1 and 4, 2=5 or more (as reported by plant manager)).

Competition increases Decentralization

- The relationship is likely to be **causal**. Guadalupe and Wulf (2010, AEJ)
 - look at Canadian free trade natural experiment
 - Use Rajan & Wulf (2006) panel data of Compustat/Hewitt firms
 - Find that US firms in industries which faced more competition because of fall in tariffs were more likely to delayer/decentralize

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TRUST AND DECENTRALIZATION

- Trust may affect optimal decentralization
 - Agent is less likely to “steal”
 - Facilitate cooperative solutions in repeated game settings: e.g. Baker, Gibbons and Murphy (1999)
 - Proxy the congruence of incentives: e.g. Aghion and Tirole (1997)
- We find evidence of robust positive relationship between trust in region where plant is located and decentralization

MEASURING TRUST

- Measure trust using the World Value Survey, from the question:

“Generally speaking, would you say that most people can be trusted or that you can’t be too careful in dealing with people?”

Trust by region of the country defined as % of people answering “yes” to first part of the trust question

- Experimental studies show this question linked with trust/trusting behavior (Glaeser et al, 2000, Sapienza et al, 2007)
- Used in prior social capital literature: e.g. Knack & Keefer (1997); Guiso, Sapienza, Zingales (2004);

DECENTRALIZATION HIGHER IN AREAS WITH MORE TRUST

Trust (in plant's CHQ region)	1.231*** (0.440)	0.916*** (0.327)	0.596*** (0.219)
Rule of Law		0.580*** (0.071)	
Plant Skills (% college)			0.122*** (0.030)
Firm Size			0.047* (0.025)
Plant Size			0.098*** (0.026)
Observations	3,655	3,655	3,655
Country dummies & other controls	no	no	yes

Notes: Other controls are SIC3 dummies, noise controls (interviewer dummies, Interviewee tenure and seniority, etc.), public listing, CEO onsite, plant size, regional GDP/head, Regional population, Multinational status. Weighted by % of WVS respondents in region in country.

SE clustered by 112 regions.

Source: Bloom, Sadun & Van Reenen (2012)

USE MULTINATIONALS AS A SECOND TEST FOR TRUST

- Could worry about bias due to trust proxying for other country/regional variables
- So look at affiliates of foreign multinationals and investigate whether trust in their home country also matters

USE MULTINATIONALS AS A SECOND TEST FOR IMPORTANCE OF TRUST

- Is there bias due to trust proxying for other country/regional variables
- We look at affiliates of foreign multinationals and investigate whether trust in their home country also matters
 - Can control for region of location dummies
- Also use EuroBarometer survey which asks individuals in all European countries how much they trust people in other countries (inc Japan and US) Bilateral trust
 - Control for region of location & CHQ country of origin
 - IV strategies based on religious & somatic distance

TAB 2: DECENTRALIZATION & TRUST IN MULTINATIONALS

Sample:	CHQ in different region	CHQ in different region	Foreign MNEs OLS	Foreign MNEs OLS	Foreign MNEs IV
Trust (CHQ region)	0.606** (0.270)	0.579** (0.284)	-0.219 (0.471)		
Trust (bilateral from origin cty to location cty)			1.765*** (0.619)	1.669** (0.789)	3.071** (1.253)
Regional of location dummies	No	Yes	No	Yes	Yes
Country CHQ dummies	No	No	No	Yes	Yes
Clustering	Region	Region	CHQ by plant location	CHQ by plant location	CHQ by plant location
Observations	1094	1094	282	282	282

Notes: Controls are country & SIC3 dummies, noise controls (interviewer dummies, Interviewee tenure & seniority, etc.), public listing, CEO onsite, plant size, regional GDP/head, Regional population, multinational status. IV is religious distance

Source: Bloom, Sadun & Van Reenen (2012)

Overview

1. Measuring organization: spans and decentralization
2. Differences in organization across firms, countries & time
3. Factors driving the organization of firms
- 4. Decentralization and productivity**
5. Conclusions

TWO CHANNELS FOR THE IMPACT OF DECENTRALIZATION

- Between firm effect of reallocation
- Within firm effect where decentralization can be a complement for new technologies (as in Acemoglu et al, 2007)

TWO CHANNELS FOR THE IMPACT OF DECENTRALIZATION

Firm size:

Early work on the structure of firms argued that decentralization was critical for large firms, Penrose (1959) & Chandler (1962)

Indeed, see that larger firms are more decentralized

Essential for productivity growth as reallocation - which accounts for $\approx 1/2$ of US TFP growth - needs productive firms to grow

Also important in development as low productivity due to lack of reallocation as “too few” large firms: e.g. Banerjee & Duflo (2004); Hsieh & Klenow (2008); Hsieh & Olken (2014)

Hence, factors driving decentralization – trust, rule of law, competition – also drive growth via facilitating decentralization

TRUST ENABLES FIRMS TO GROW LARGER

Sample:

	All	Foreign MNEs
Trust (CHQ region)	2.270** (0.826)	
Trust (bilateral from origin city to location city)		5.578*** (1.477)
Observations	110	292
Regional controls	Yes	yes
Country dummies	Yes	yes

Notes: Regional controls are GDP per capita, population in the region and % of employees with a degree.

CHANNELS FOR IMPACT OF DECENTRALIZATION

Firm level productivity:

Typically think of decentralization as a control variable – firms choose the right level – so not “right” or “wrong” level

But this level may be hard to change, so can be “right” or “wrong” level in the short-run if situation changes

Good example is IT – huge fall in IT prices, especially since 1995. Garicano (2000) implies optimal form is decentralization but takes time due to adjustment costs

Bresnahan, Brynjolfsson and Hitt (2002, QJE); Bloom, Sadun and Van Reenen (2012, QJE) find strong complementarity between IT and decentralization

SUMMARY OF DECENTRALIZATION LECTURE

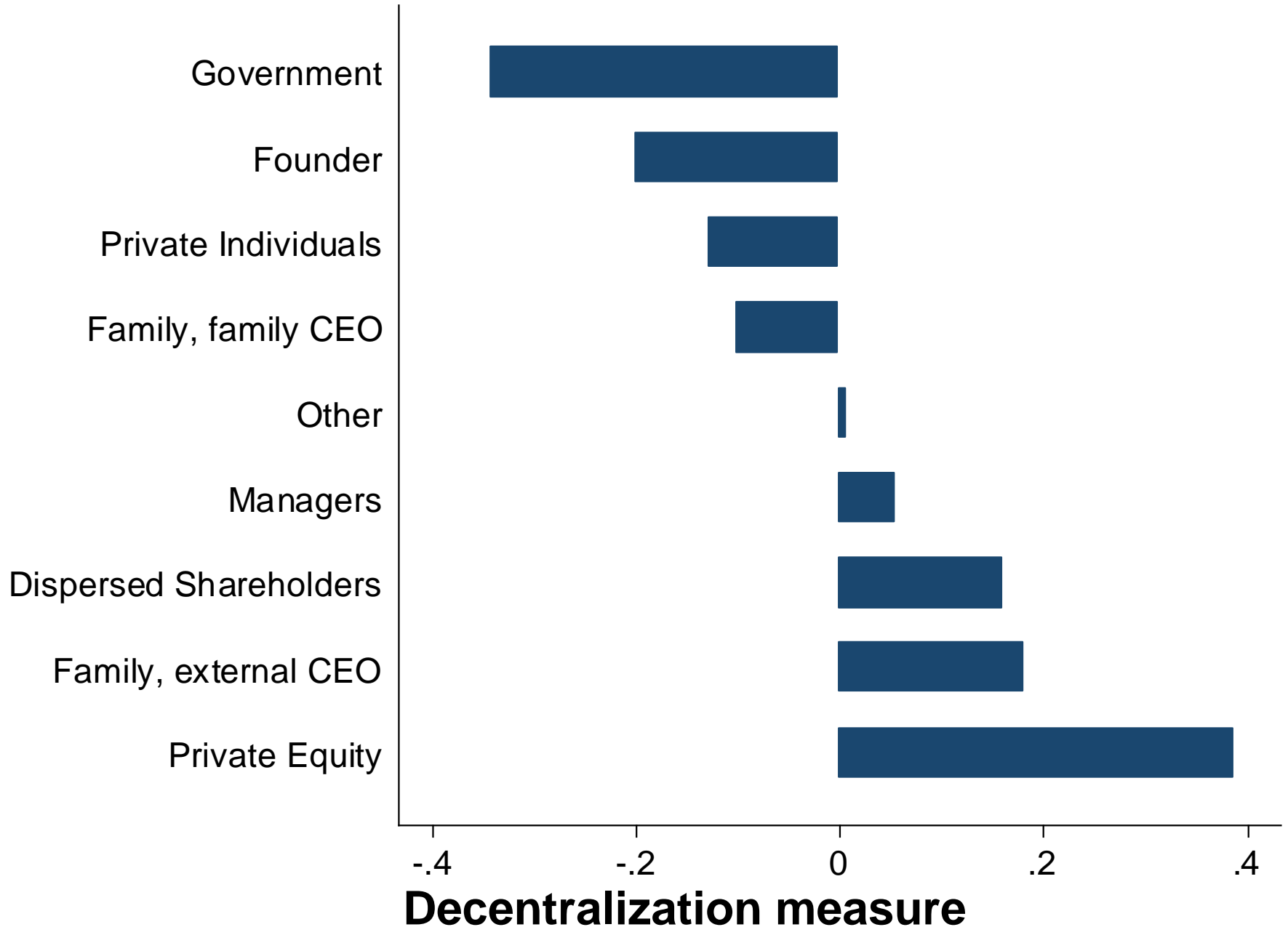
- Decentralization a key organizational trait of firms
- Varies by country – Northern Europe and North America decentralized, Southern Europe and Asian centralized
- Systematically varies by firm – high trust, tough competition, volatility & human capital all positively linked to decentralization
- Important for reallocation: firms need to decentralize to grow, and firm growth required for productivity enhancing reallocation

OVERALL SUMMARY OF 4 LECTURES

- Firm heterogeneity & its causes is a first order economic fact to be addressed
- Internal structure of firms matters for this. Methodological innovations in measuring management & organization
- Management is a form of intangible capital, limited “contingency”, matters a lot for firm & economy wide productivity
- Decentralization is more contingent element of firm organization. Technological, economic & cultural environment matters a lot in whether higher levels are better or worse.
- Start of agenda for new organizational economics

BACK UP

Decentralization also varies across ownership types



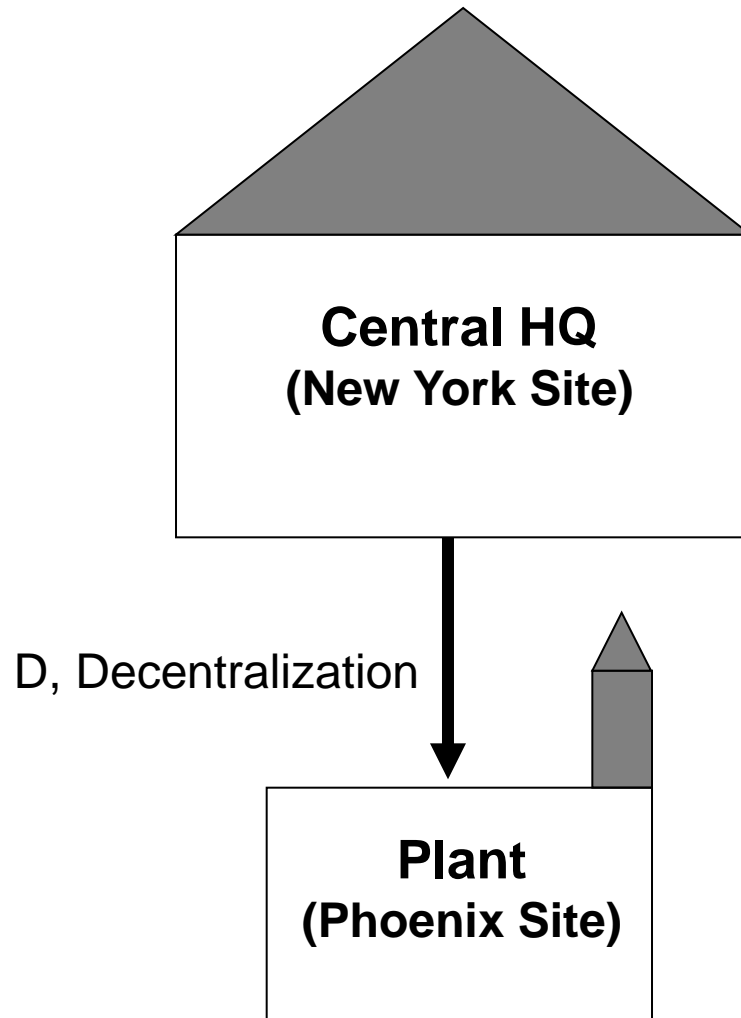
WORKER AUTONOMY & ICT

CADCAM	0.540**		0.535*
<i>Information technology</i>	(0.275)		(0.274)
NETWORK		-0.229	-0.226
<i>Communication technology</i>		(0.178)	(0.180)
ln(Computers/Employee)	-0.004	0.025	0.010
	(0.108)	(0.108)	(0.109)

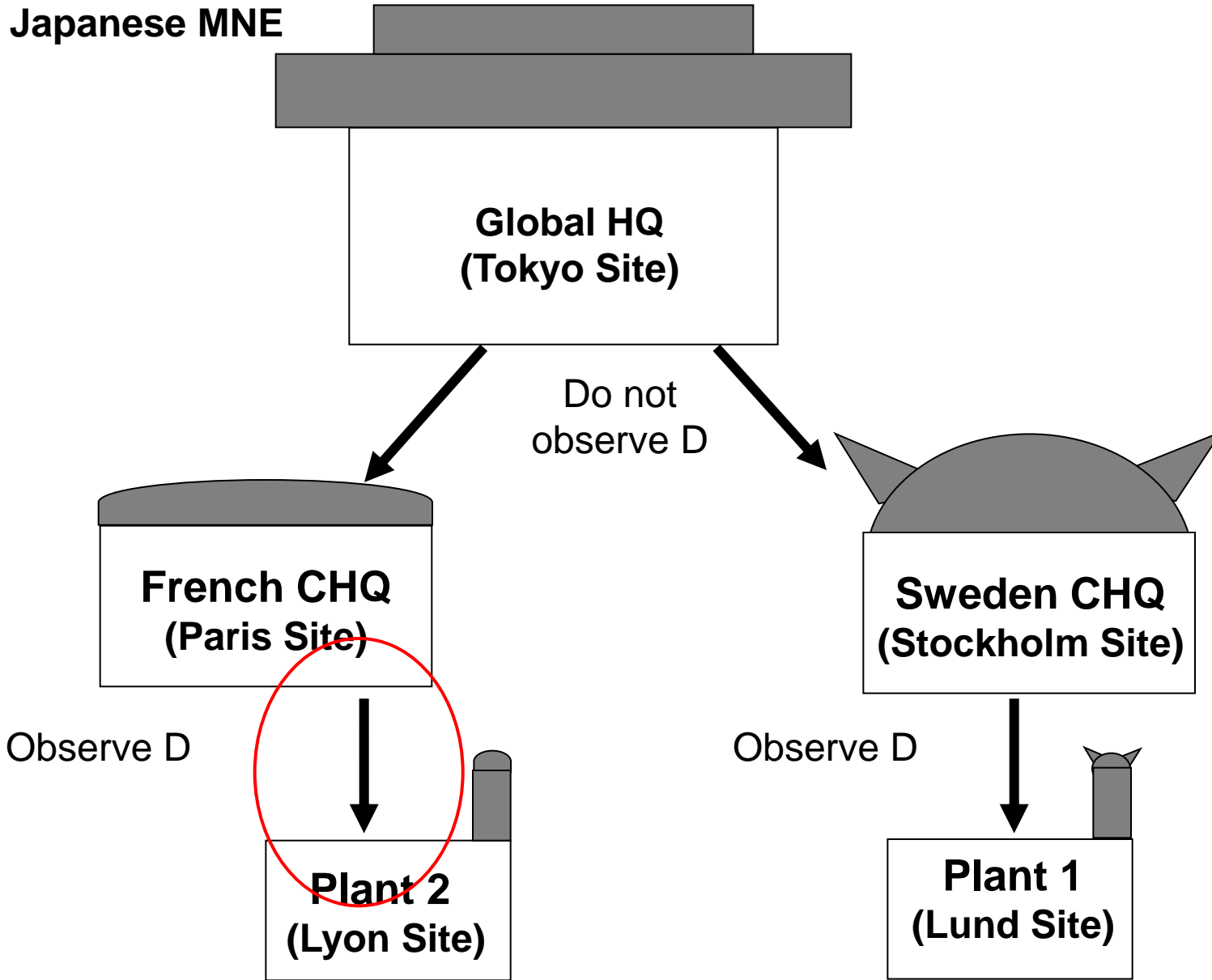
INFORMATION TECHNOLOGY INCREASES DECENTRALIZATION, COMMUNICATION TECHNOLOGY DECREASES DECENTRALIZATION,

Notes: Probit, dependent variable worker more control over production decisions that managers. 687 firms. Same controls as plant manager autonomy equation: industry & country dummies, noise controls, CEO onsite dummy, firm & plant size, domestic MNE.

**Example A:
Domestic Firm
2 Sites, Single Plant**



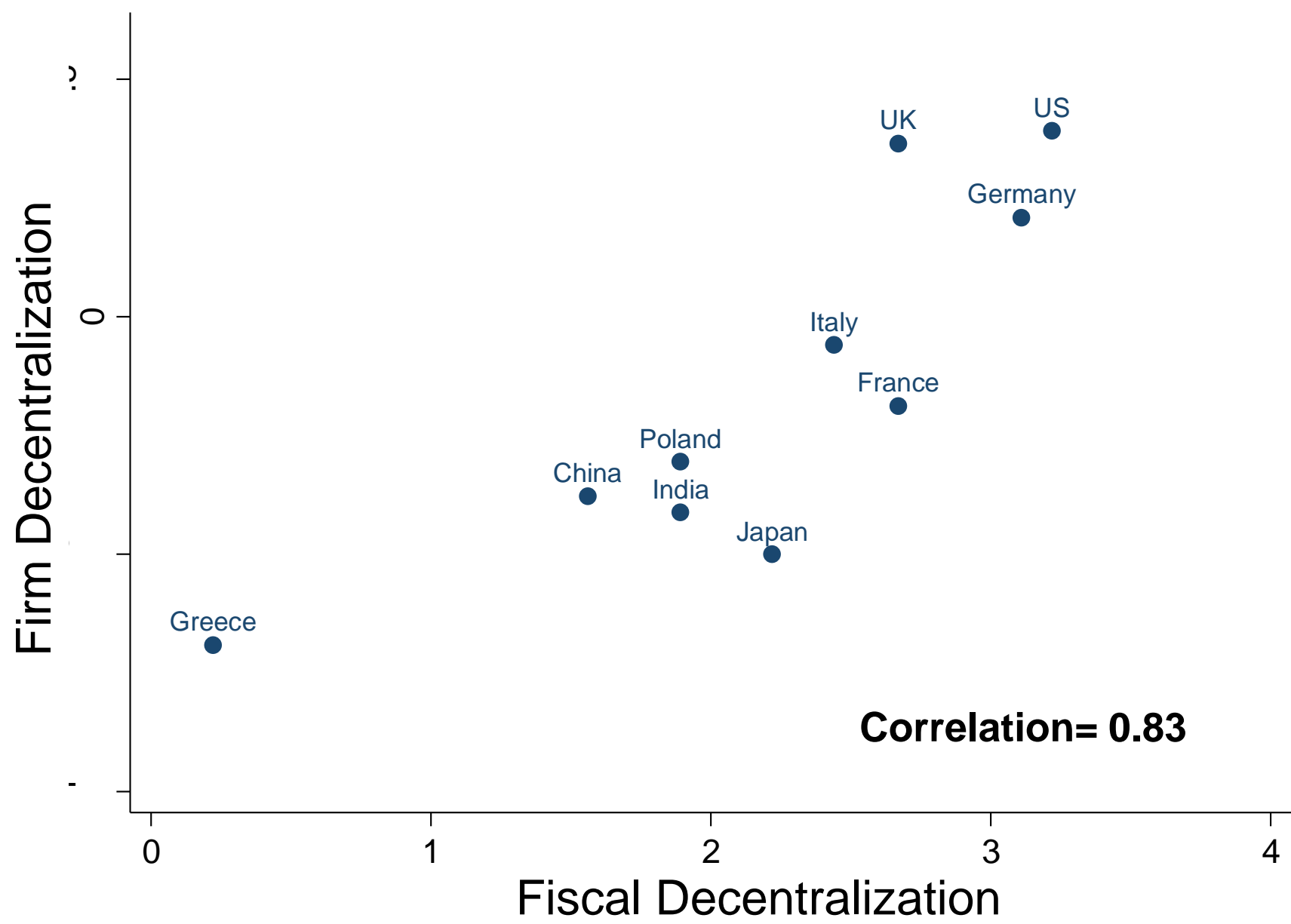
Example D
Japanese MNE



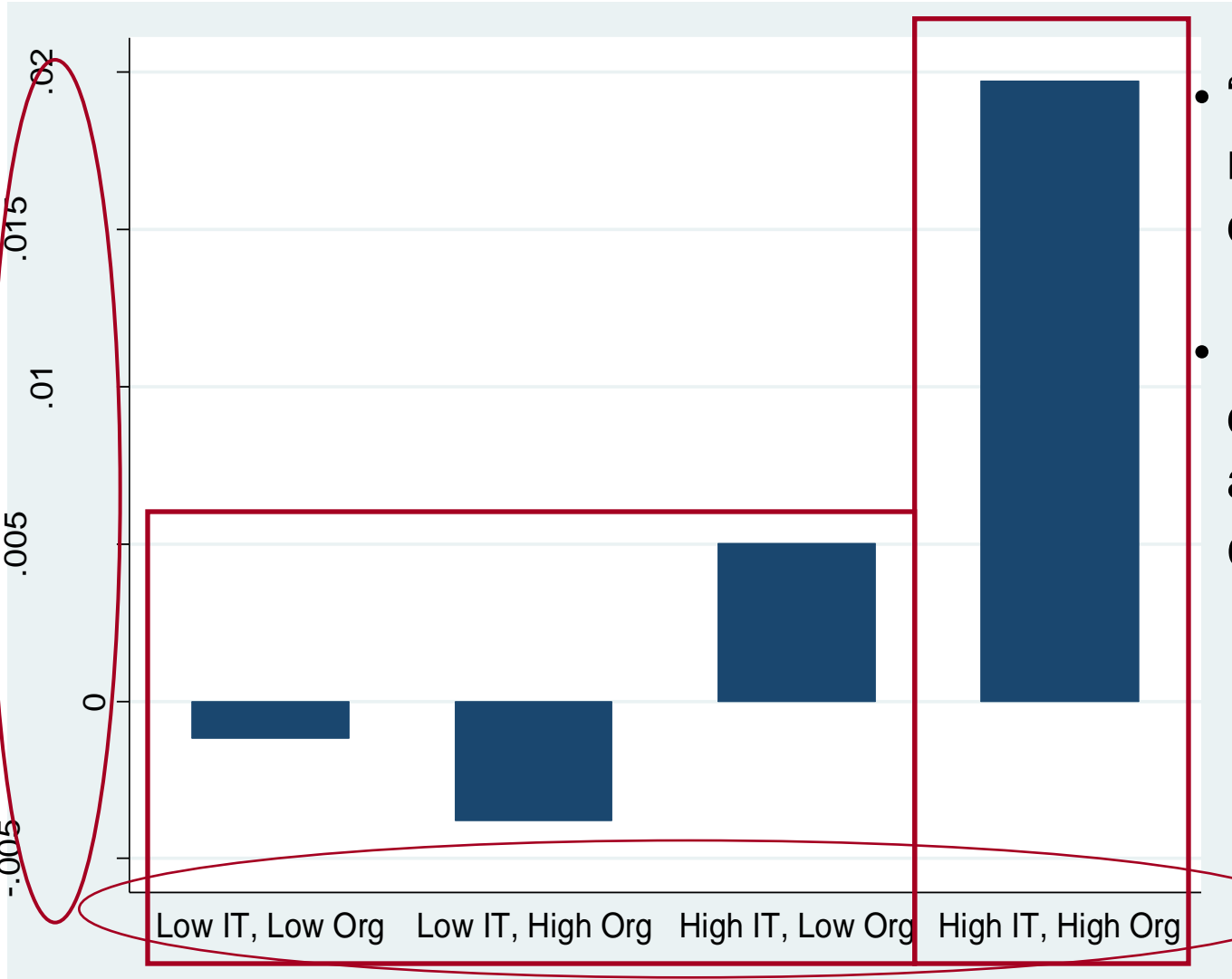
External validation – country level (2/2)

- There is also a cross-country index of Fiscal Decentralization from Arzaghi and Henderson (2005, JPubE)
- Index of Fiscal Decentralization based on 9 factors including:
 - Government structure (e.g. unitary v federal)
 - Local (regional/municipal) democratization & autonomy
 - Local (regional/municipal) control over taxation and spending (education, police, transport etc.)
- Surveyed every country with >10 million people (in 1995)

'Fiscal decentralization' is also correlated with firm decentralization



PRODUCTIVITY GROWTH IMPLICATIONS



- “High Org” = more decentralized
- IT and decentralization appear complementary

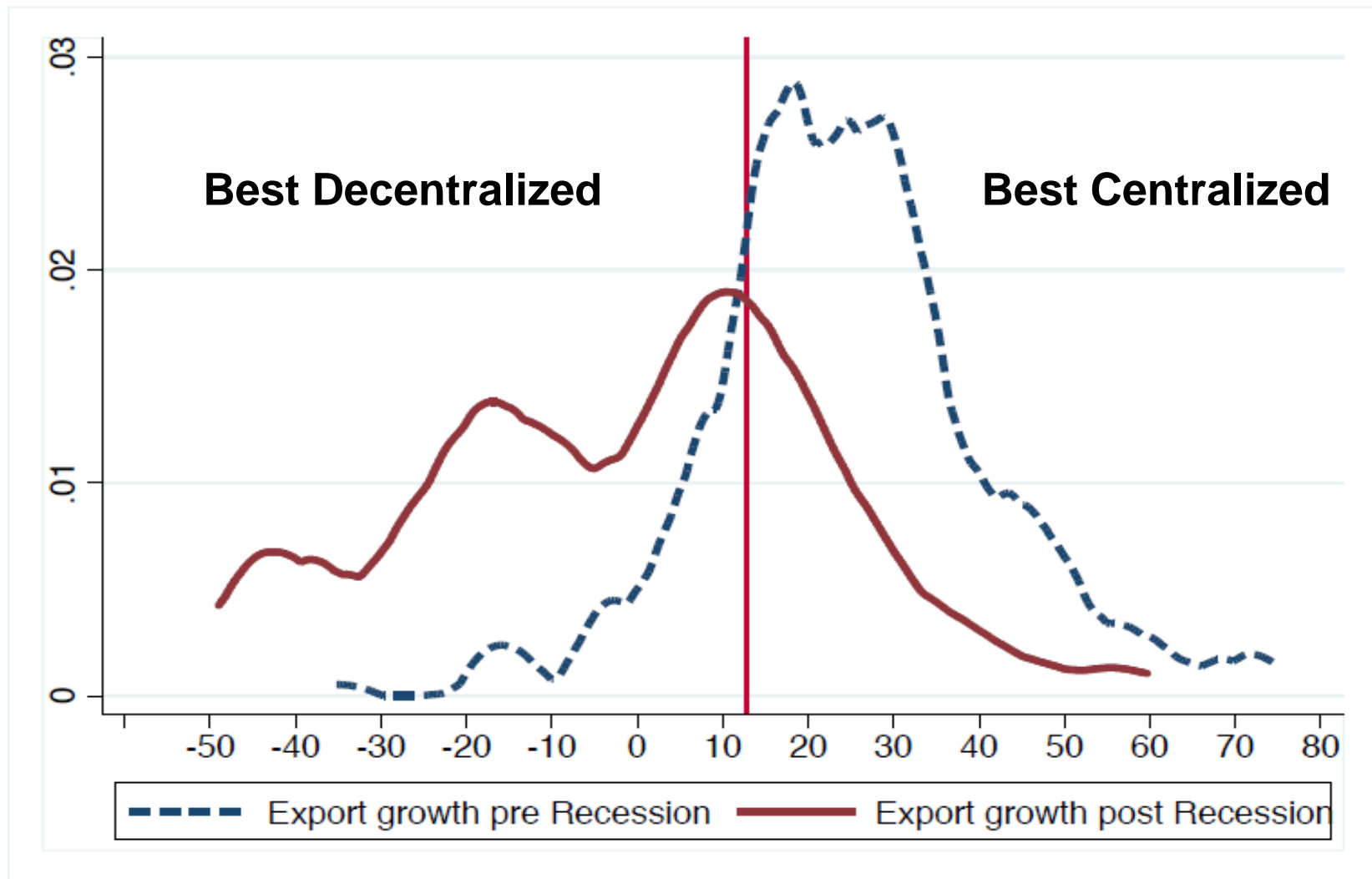
Complexity: Multinationals (even controlling for size) are more decentralized

Dependent variable: Decentralization

Foreign Multinational	0.157*** (0.058)
Firm employment	0.052** (0.022)
Plant employment	0.089*** (0.030)
Plant Skills (% employees with a degree)	0.085*** (0.015)
Observations	3,660
Industry dummies (112)	yes
Country dummies (12)	yes
Other controls (60)	yes

Source: Bloom, Sadun and Van Reenen (2012)

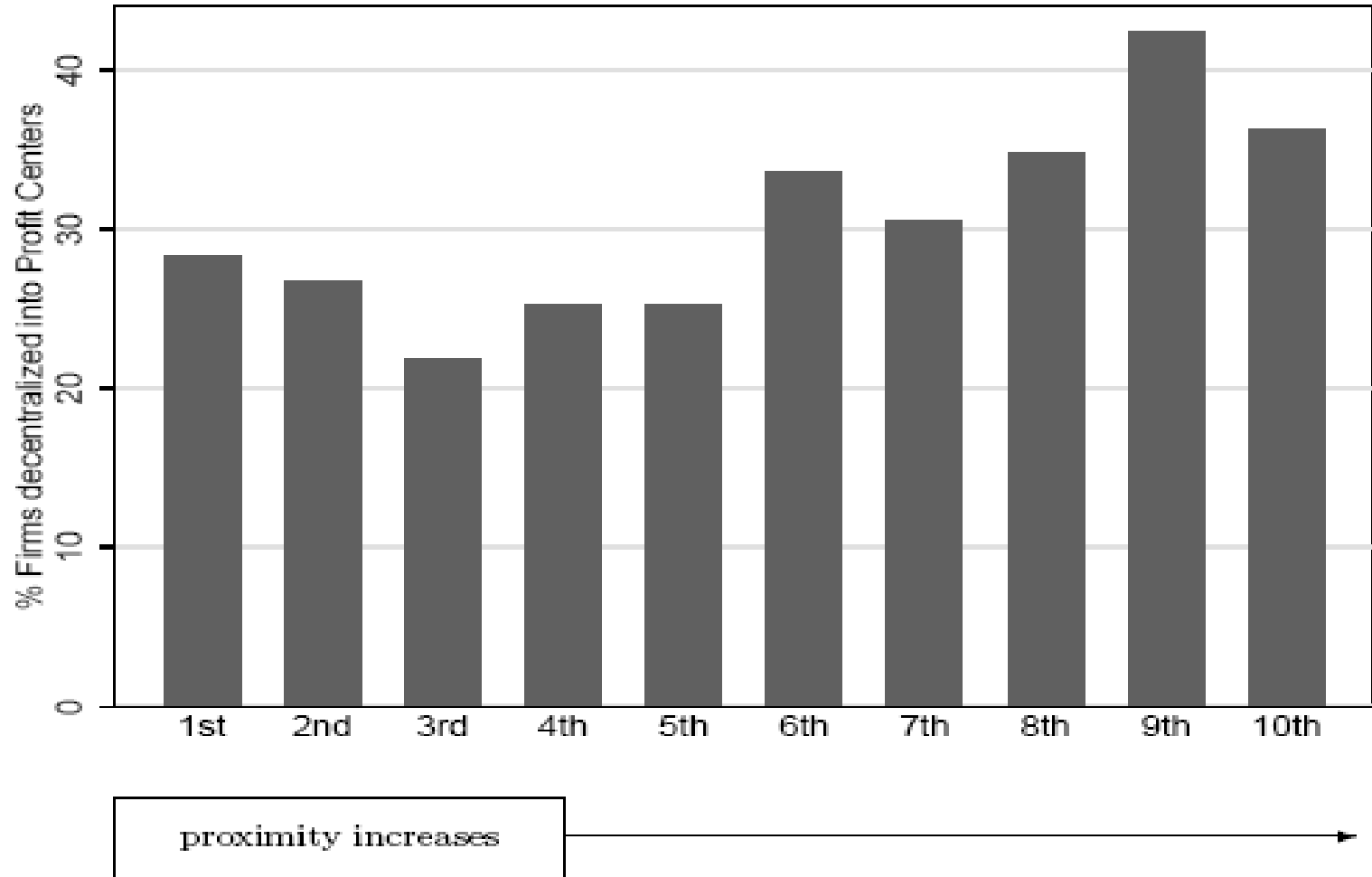
These coefficients imply on average centralization was best before Great Recession, but decentralization was best during



Fraction of firms below 12% export growth before the GR=20%

Fraction of firms below 12% export growth after the GR=70%

Learning: Technologically advanced firms (i.e. close to frontier) likely to be decentralized into profit centers



Learning: Younger firms are more decentralized

Figure 3: Age and decentralization
Decentralization to Profit Centres (COI)

