Ongoing Research at the OECD/WPIA

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OECD Directorate for Science Technology and Industry

Workshop on Intangible Investment, Innovation and Productivity
National Institute of Science and Technology Policy (NISTEP)
Tokyo, 27 January 2012

What drives the dynamics of business growth?

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joint work with **Albert Bravo-Biosca** (Nesta)

and **Carlo Menon** (STI/SPD)

WORK IN PROGRESS - RESULTS ARE NOT FINAL

Motivation: cross-country evidence

Why firm growth?

- Most empirical analysis focuses on entry and exit as driver of creative destruction, resource reallocation and productivity growth
- Not much evidence on post-entry growth performance
- Limited cross-country comparable data points to significant differences in growth after controlling for differences in industrial structure:
  - Bartelsman et al. (2003) → Differences across rich countries in post-entry growth more important than in entry and exit rates.
  - Bravo Biosca (2010) →differences in growth dynamics across countries beyond differences in share of high growth firms in the population
- Haltiwanger, Jarmin, Miranda (2010): who creates jobs?
  - Disproportionate importance of young firms (rather than small)
  - Up or out dynamics (see also Bartelsman et al. 2004 and Aghion, Fally and Scarpetta, 2007)

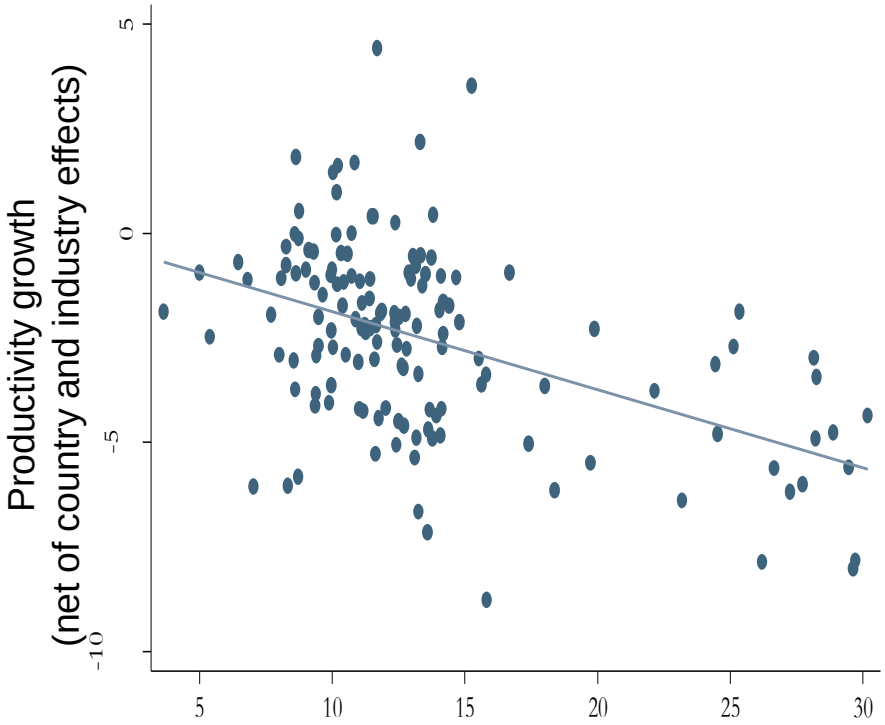
Why does it matter?

- Less experimentation
- Lower reallocation of resources (human and physical capital) towards most productive firms
- Successful innovators less likely to scale up and challenge incumbents
- Lower competitive pressures

→ **Lower productivity growth**

5pp increase in the share of stable firms is associated with 1pp lower annual TFP growth

Both a large share of growing and shrinking firms are associated with higher productivity growth



Source: Bravo-Biosca (forthcoming)

Effect becomes stronger as countries converge to the technology frontier

Drivers of firm employment growth dynamics

Most of the evidence focuses on

- determinants of entry decisions (and exit)
- Drivers of investment decisions, productivity growth and innovation

Exceptions:

Fally and Scarpetta, 2007

- Finance matters most for entry of small firms in sectors that are more dependent upon external finance
  - Sample of developed and developing countries
- Financial development helps post-entry growth
- Stringent EPL affects entry rates but not ex-post entry

Contribution of this work

- Look at firm employment growth
- Looking not only at sectoral averages but at sectoral distributions
- Using harmonised micro-aggregated data

The growth data, as of today…

- Harmonised Micro-aggregated data that describes the distribution of firm growth across several countries:
- **11 countries: Austria, Canada, Denmark, Finland, Italy, the Netherlands, New Zealand, Norway, Spain, the UK and the US**
- Official business register data: "universal" but "confidential"
  - All surviving employer enterprises that are at least 1 year old in the Private sector (ISIC 10-74) for **2002-2005**
- Process: Harmonisation of definitions → manual and code file → data provided by countries → checked for inconsistencies
- Industry breakdown: up to 51 sectors

The indicators

- For each surviving firm (c.a. 6 million), compute average employment growth:
- 11 cells → continuous cdf
- Interpolate between interval bounds
- Allocate to eleven growth intervals:

]-∞;-20[	[-10;-5[	[1;5[	[15;20[
[-20;-15[	[-5;-1[	[5;10[	[20; ∞[
[-15;-10[	[-1;1[	[10;15[	

- For each cell, compute number of firms, average initial/final number of employees, and survival

Methodology

$$y_{ik} = \alpha + X_{ik}\beta + \theta_k + \delta_i + \varepsilon_{ik} \quad \text{with} \quad X_{ik} = q_i n_k$$

- Where i indexes industries, k countries; θ and δ are country and industry fixed effects
- Follow Rajan-Zingales (AER, 1998)
- Look at the differential effect of national level policies (n_k) in industries more likely to be affected by those policies (interactions);
- This allows controlling separately for unobserved country and industry fixed effect.

Regression Analysis

→ Dependent variables:

- share of high growth firms (>20% p.a.)
- share of stable firms (-/+1% p.a.)
- share of shrinking firms (<-1%)
- average employment growth rate over the three year period
- growth rate at different percentiles of the distributions (95th/50th/25th)
- 95th -25th percentile gap
- interquartile range in the employment growth distribution.

Policies analysed

- Regulatory Framework (RF):
  - Administrative barriers and costs to entry
  - Employment Protection Legislation (EPL)
  - Bankruptcy law

Is employment growth in sectors that are more volatile; have more churning more affected by RF?

- Financial development (FD)
  - Stock market capitalization
  - Bank credit
  - Private Bond markets

Is employment growth in sectors that are more dependent of external finance relative more affected by levels of FD?

- R&D policies:
  - R&D fiscal incentives

Is employment growth in sectors that are more R&D intensive relative more affected by supply-push policies?

Look at different point of the growth distribution and the shape of the distribution

Results: Bankruptcy

VARIABLES	(1) Share high growth firms	(2) Share shrinking firms	(3) Average employment growth	(4) p95	(5) p50	(6) p25	(7) iqr	(8) p95-p25
Sh. Job turnover* exemptions	-0.0626	-0.0518	-0.181	-1.407**	0.0481	0.150	-0.352	-2.666***
	(0.0385)	(0.145)	(0.172)	(0.460)	(0.0729)	(0.104)	(0.223)	(0.623)
Observations	180	179	180	174	176	176	176	174
R-squared	0.789	0.651	0.547	0.695	0.554	0.594	0.621	0.671
Sh. Job turnover * composition	0.0400	-0.0885	-0.305	-1.184	0.201*	0.353	-0.807	-3.493*
	(0.0424)	(0.212)	(0.469)	(1.132)	(0.0853)	(0.219)	(0.610)	(1.498)
Observations	180	179	180	174	176	176	176	174
R-squared	0.786	0.651	0.547	0.688	0.558	0.597	0.623	0.664
Sh. job turnover* discharge available	0.0421	0.329***	-0.291	-0.239	-0.157**	-0.349***	0.635	0.646
	(0.0255)	(0.0618)	(0.180)	(0.824)	(0.0454)	(0.0851)	(0.361)	(1.486)
Observations	180	179	180	174	176	176	176	174
R-squared	0.787	0.662	0.551	0.685	0.561	0.605	0.626	0.657

Results: financial development

VARIABLES	(1) Share high growth firms	(2) Share shrinking firms	(3) Average employ ment growth	(4) p95	(5) p50	(6) p25	(7) iqr	(8) p95-p25
Financial Dependence* private bond market capitalization/GDP	3.913**	-4.262	10.31**	69.91***	6.894	-2.348	14.32**	52.71**
	(1.605)	(4.952)	(3.511)	(12.82)	(4.266)	(4.507)	(4.979)	(20.63)
Observations	260	259	264	234	240	240	240	234
R-squared	0.606	0.568	0.421	0.418	0.511	0.627	0.668	0.473

Results: R&D tax subsidies

VARIABLES	(1) Share high growth firms	(2) Share shrinking firms	(3) Average employment growth	(4) p95	(5) p50	(6) p25	(7) iqr	(8) p9525
R&D intensity*RD tax subsidy (LE)	11.71	-114.1***	131.3**	-92.92	64.31***	102.1***	-142.0*	-508.6
	(8.858)	(21.85)	(49.58)	(157.6)	(6.655)	(20.46)	(63.57)	(280.8)
Observations	217	216	221	196	202	202	202	196
R-squared	0.551	0.434	0.321	0.387	0.335	0.590	0.662	0.467
R&D intensity*R&D tax subsidy (SME)	-8.310	-61.25	46.87	-170.8	22.73	50.55	-110.9	-484.4
	(9.266)	(48.23)	(52.29)	(223.8)	(28.28)	(47.37)	(96.65)	(345.3)
Observations	217	216	221	196	202	202	202	196
R-squared	0.550	0.425	0.313	0.388	0.325	0.581	0.661	0.467

Current work

- Additional robustness checks:
  - Instrumental variable estimation
  - Role of particular industries and countries
  - Additional control variables
  - Control for the simultaneous impact of policies
- Focus on role of different policies (e.g. barriers to entry; EPL etc) on the distribution of firm employment growth in R&D intensive sectors

OECD WPIA employment and productivity data collection and analysis project

WPIA: where we are…

- Writing data-construction routine based on questionnaires sent to countries on data availability.

Australia	New Zealand
Belgium	Norway
Canada	Spain
Italy (6)	Sweden
Japan	Switzerland
Luxembourg (2)	United Kingdom
Netherlands	United States

The idea of the questionnaire

- Get info on data availability for a cross-country harmonised micro-aggregated data analysis + comparable microeconometric analysis:
  - Over time
  - Across industries (level of aggregation and coverage)
  - Size threshold
  - Level of analysis: plant vs. enterprises
  - Definition of entry; age and exit
  - Definition of employment
  - Availability of information on turnover
  - Imputations
  - Possible productivity measures

Information on data sources and coverage

- Most countries have Business Registers or Tax Registers (Norway and Sweden)
  - exceptions: Switzerland
- Time coverage is variable: for most countries from late 90s. For Japan, US, Luxemburg, from early 80s'For Australia: 2002/5
- Industry coverage: private (non farm) sector; financial industries only for few countries; Norway manufacturing for plant+service for E
- Caveat: harmonisation of industry classification over time and across countries

Current steps

- The secretariat writing routines:
  - calculate deciles of the employment growth distributions over shorter and longer periods; for different time periods and other characteristics of employment growth distribution;
  - Entry and exit rate and contribution of entry and exit to employment growth;
  - Survival rates;
  - Additional breakdowns for size and age;
  - Estimate employment growth distribution conditional on size at entry
  - Difficulty: endogeneity of size at entry relative to registration threshold
  - Choose a cohort of firms and follow them in the first 5/10 years of their life

Once the data collection is finished

- Look at drivers of firm employment growth dynamics (as done in analysis just discussed)
  - At different deciles of the distribution (this time information on this directly from countries)
  - Share of growing, stable and shrinking firms
  - On entry and exit rates/survival rates and employment contribution of entry and exit
  - Compare drivers of extensive and intensive margins
  - Look at different correlations for different groups of firms in terms of age and size

Comparable microeconometric analysis

- Microeconometric analysis following Haltiwanger, Jarmin and Miranda (2010)
  - Look at who creates job: size vs age
  - Weighted (non parametric regressions) of net employment growth at the firm-level on firm size classes by themselves, on firm age classes by themselves and by firm size and age together - controlling for year and industry effects
- Quantile regression analysis

Productivity analysis

Aim: shed light on the relationship between firm dynamics and productivity growth across countries, quantifying the contribution of within-firm growth and the contribution from entry, exit, and the reallocation of resources across firms.

Focus on the determinants of productivity in:

- Growth – Relationship between firm dynamics, in particular external and internal restructuring, and productivity growth.
- Levels - Role of policies in explaining differences in allocative efficiency across countries (i.e. the extent to which more productive firms have larger market shares).

Measuring patent quality and radicalness: new indicators

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Joint work with Hélène Dernis (OECD) and Marcos de la Torre (EPO)

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Innovation and entrepreneurial firms

New firm formation may help bring innovations to the market.

Tolerance to risk, experience, general and human capital, the importance of barriers to entry and the and scope of the technological opportunity to exploit shape new firm formation.

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Tolerance to risk, experience, general and human capital, the importance of barriers to entry and the and scope of the technological opportunity to exploit shape new firm formation.

New firms more likely to commercialise radical innovation than incumbents (Henderson, 1993; Tushman & Anderson, 1986) because of incumbents':

- established process management practices and organisations may impede change (e.g. 'architectural innovations', Henderson & Clark, 1990);
- 'Rigidity' due to accumulated organisational and technological knowledge (Christensen & Bower, 1996);
- Inability to lead several technological waves (Benner & Tushman, 2002);
- Fear to cannibalise own markets.

Measuring patent quality

The patent based indicators proposed:

- Are based on existing literature;
- Try to capture the technological importance of the invention, its economic value, and the possible impact on subsequent technological developments.
- Rely on information contained in the patent documents:

  -> can be constructed for all patents,

  -> rely on a homogeneous set of information,

  -> comparable across countries and over time.
- Rely on EPO's Worldwide Statistical Database PATSTAT, EPO patents.
- Sectors are defined according to Schmoch (2010).
- Compiled over year & sector cohorts; normalised with respect to max values.

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NOTE: indicators are proxies: no information about e.g. market transactions or real use of the (patented) technology available.

Using different data sources may lead to different results.

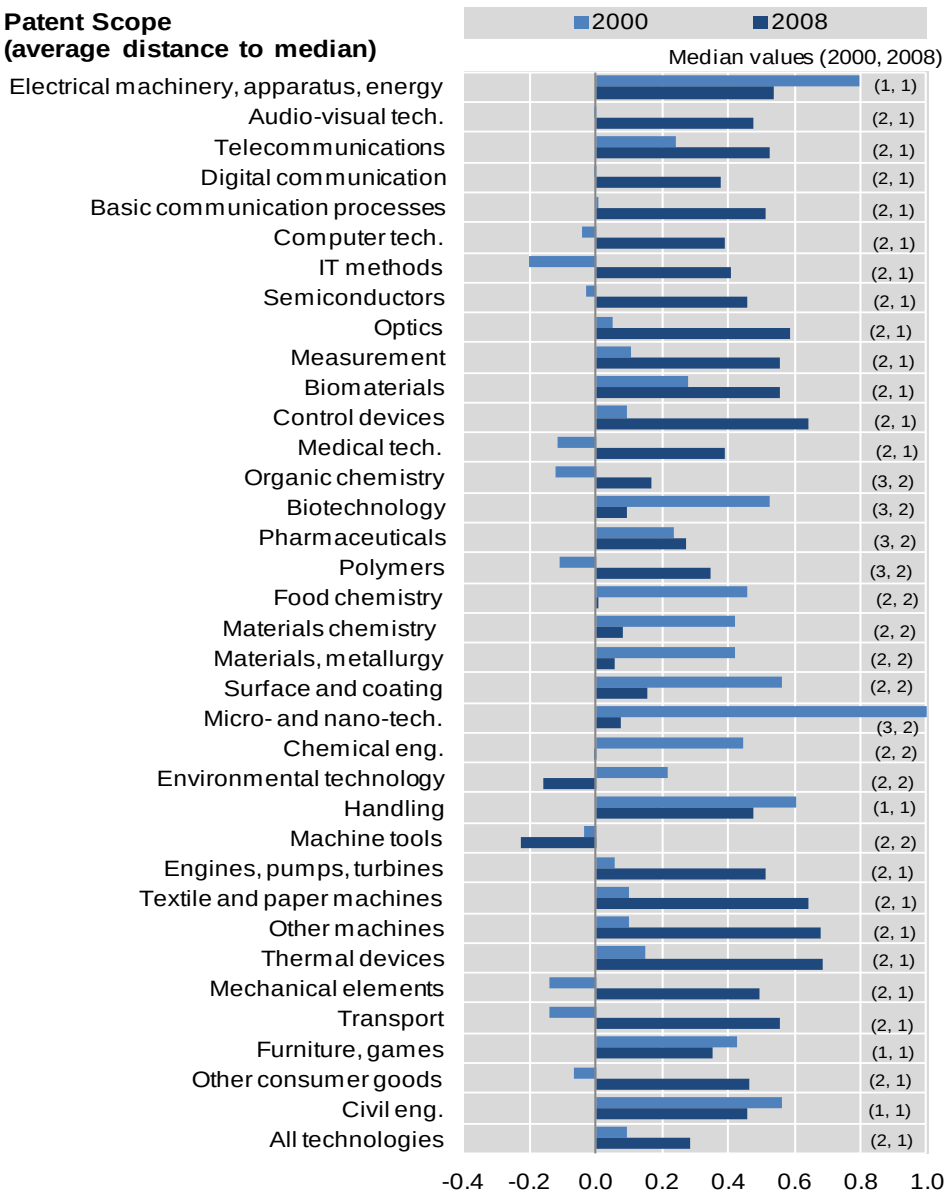
Patent scope

Is associated with the technological and economic value of inventions:

- Patent scope relates to the valuation of a firm; broad patents are more valuable (Lerner, 1994).
- Patents' scope to be used to foster early disclosure of fundamental innovations (Matutes et al., 1996).

<u>Definition</u>: (follows Lerner, 1994).

Number of 4-digit subclasses of the International Patent Classification (IPC) the invention is allocated to. Larger number => broader scope.



Source: OECD, calculations based on PATSTAT, EPO, January 2012.

Number of claims & Patent family size

Claims are associated with the technological and economic value of inventions:

- Determine the technology and aspects protected by law.
- Reflect the expected economic value of a patent (Tong & Davidson, 1994; Lanjouw & Schankerman, 2001, 2004).

Definition: number of claims per patent.

Larger number => more valuable patent.

Families are patents filed in several countries and related to each other by one or several common priorities. Patent family size:

- Is associated to the economic value of patents (Lanjouw et al., , 1998).
- Large international patent families have been found to be particularly valuables (Harhoff et al., 2003).

Definition: number of patent offices at which an invention has been protected by a patent. Larger number => more valuable patent.

Grant lag

The time elapsed between application and grant dates reveals applicants' belief about value of the patent:

- Well-documented patents are approved faster (Harhoff & Wagner, 2009).
- Time to grant depend on effort made by filing party (Régibeau & Rockett, 2010).

Definition:

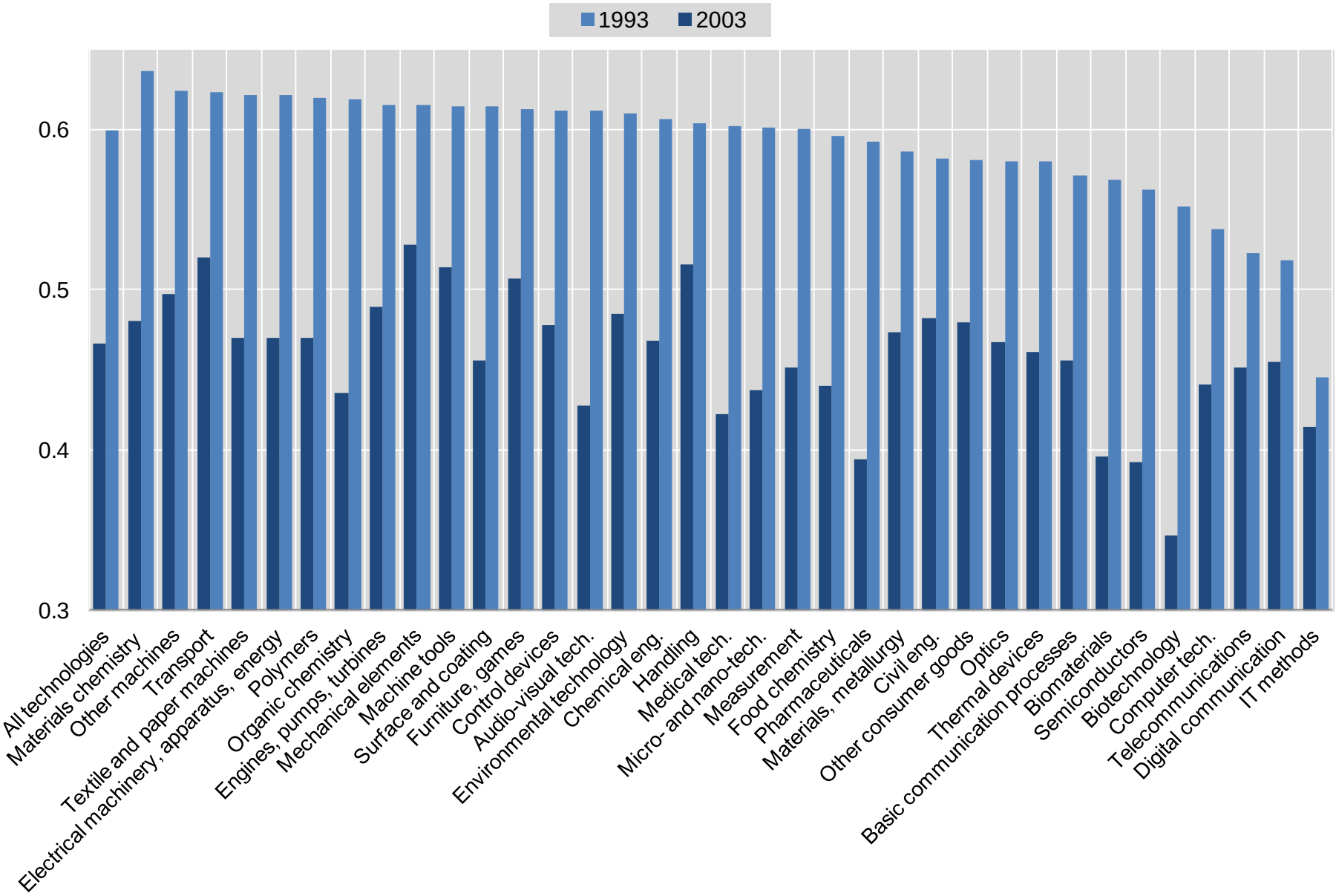
$Grant_{Pi}=1-\Delta t/Max(\Delta t_i)$, where:

Δt is the grant lag (days);

$Max(\Delta t_i)$ the max lag of cohort *i*

Shorter grant lag => more valuable patent.

Grant lag



Source: OECD, calculations based on PATSTAT, EPO, January 2012.

Backward citations & NPL

Patent cited in the patent document. Are used to assess patentability:

- Are positively related to value of patents (Harhoff et al., 2003).

BUT

- May signal inventions of incremental nature (Lanjouw & Schankerman, 2001).

Definition:

Number of patent cited in the patent document. Includes self-citations.

More citations => more valuable patent.

Backward references to Non-Patent Literature (NPL) help assess patentability.

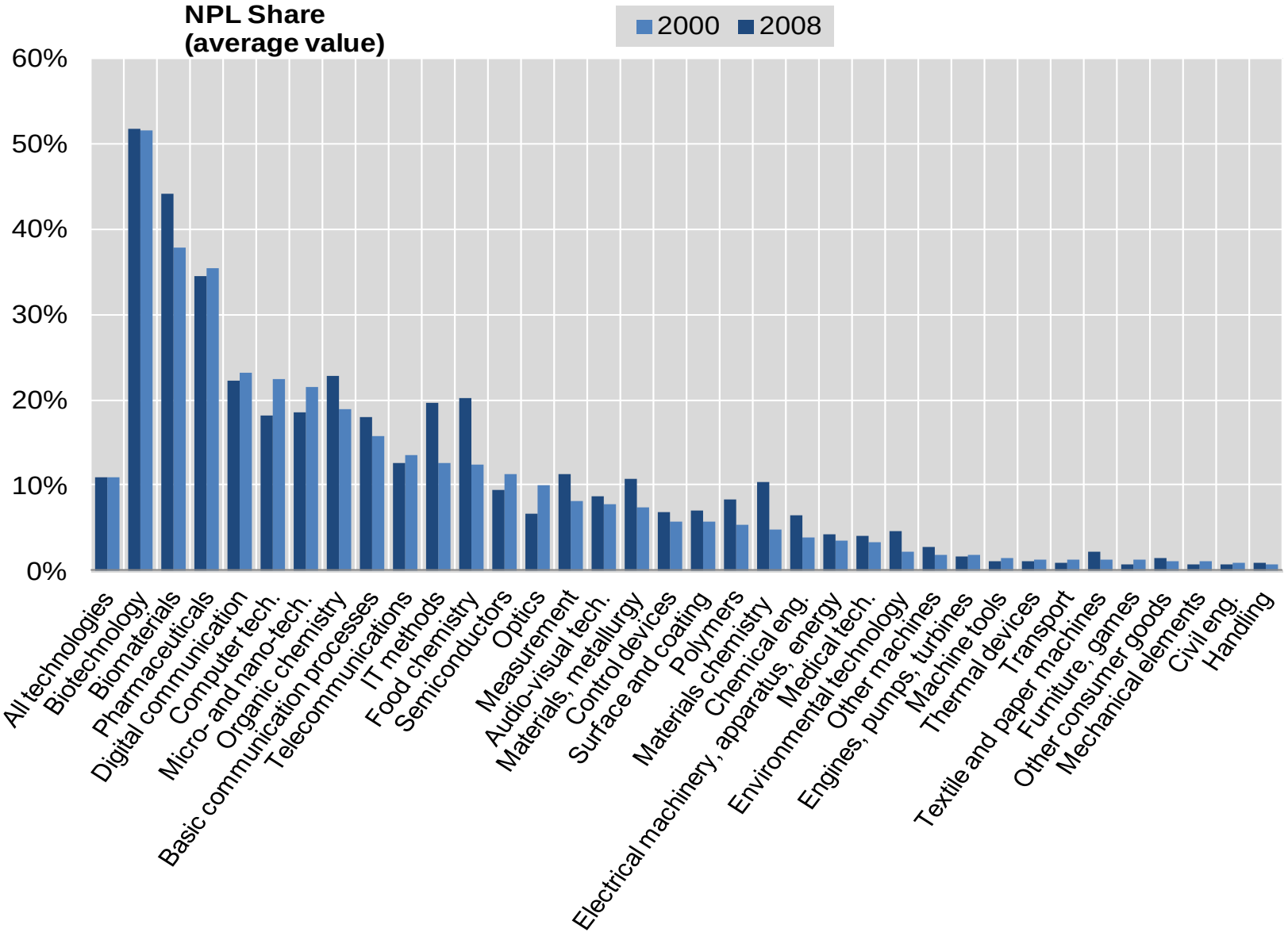
- Reflect closeness to scientific knowledge (Callaert et al., 2006).
- Patents with NPL contain more complex and fundamental knowledge (Cassiman et al., 2008).
- Patents with NPL are of significant higher quality (Branstetter, 2005)

Definition:

Share of NPL citations in a patent document.

More citations => more valuable patent.

NPL



Source: OECD, calculations based on PATSTAT, EPO, January 2012.

Forward citations & Radicalness

Citations received by subsequent patents.

- Mirror technological importance for subsequent developments (e.g. Trajtenberg et al., 1990).
- Include self-citations, as these may be more valuable than external cites (Hall et al., 2005).

Definition:

Number of citations received in 5 year time after publication. Corrected for patent equivalents.

More citations => more valuable patent.

Radicalness difficult to measure.

A radical invention is novel, unique, and impacts on future technology (Dahlin & Behrens, 2005).

Radicalness linked to firm formation and entrepreneurship .

Definition (based on Shane, 2001):

Sum of the weighted CT_j fractional counts of IPC 4-digit codes of patent j cited in patent p that are not allocated to patent p, out of n_p backward citations.

More radicalness => more valuable patent.

Source: OECD, calculations based on PATSTAT, EPO, January 2012.

Breakthrough inventions

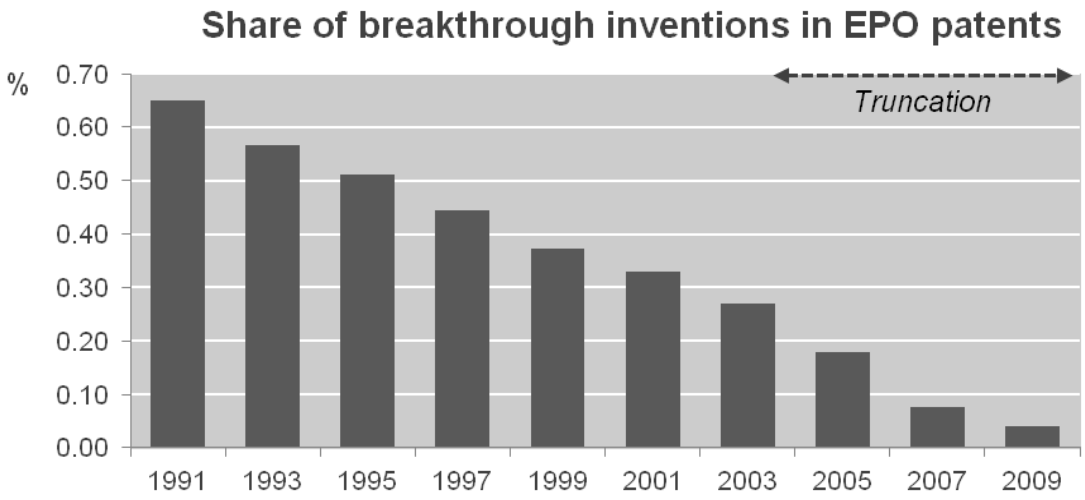
Capture the extent to which inventions serve as basis for future tech developments.

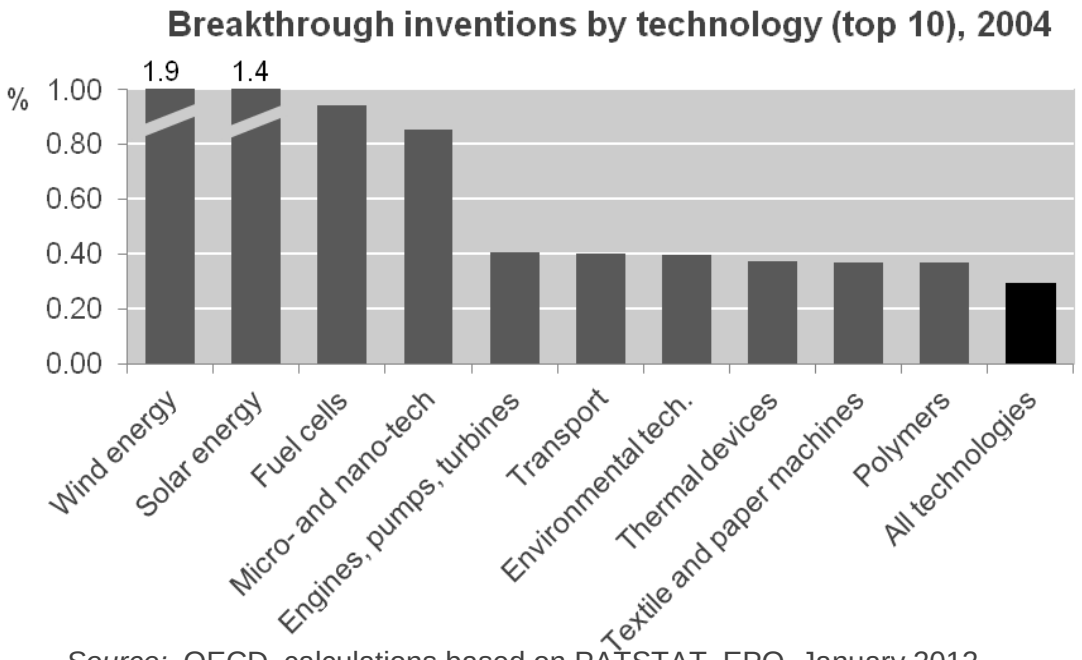
- Are associated with entrepreneurial strategies.
- Patenting grows much more in cities and technologies where breakthrough inventions occur (Kerr, 2010).

Definition (follows Ahuja & Lampert, 2001):

Top 1% cited patents in each cohort (technology field and year). Forward citations counted up to 5 years after publication. Counts corrected for equivalents.

Breakthroughs more valuable.





Source: OECD, calculations based on PATSTAT, EPO, January 2012.

Generality

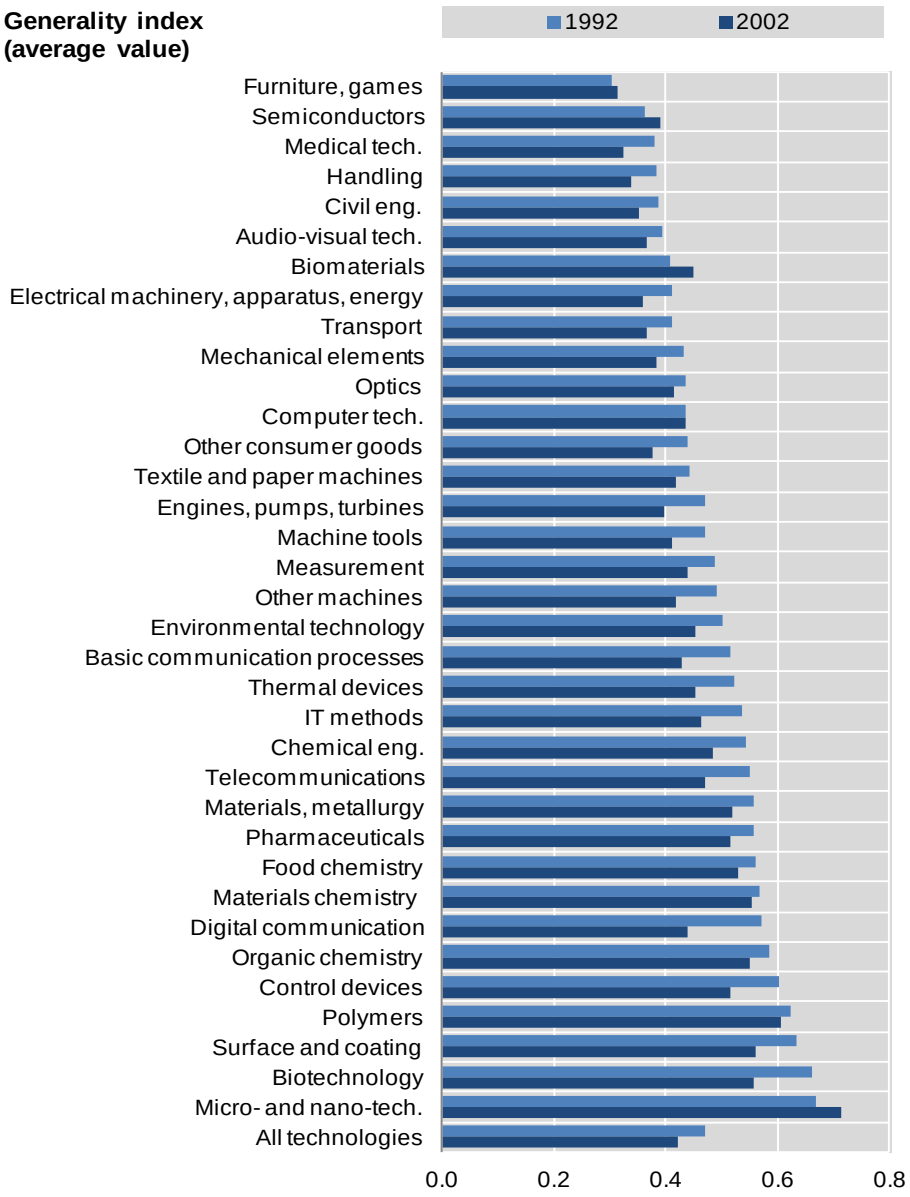
Mirrors number and distribution of forward citations and IPC classes cites belong to.

- Captures importance of patents for later developments, and number of fields where they happen (Bresnahan & Trajtenberg, 1995; Hall et al., 2001). **BUT**
- No difference btw IPC classes (Hall & Trajtenberg, 2004).

<u>Definition</u>: (follows Hall & Trajtenberg, 2004).

Generality$_p$=1-$\Sigma_j S_{pj}^2$, where S_{pj} the share of forward cites to patent p from class j out of n_p 4-digits IPC tech classes.

Higher generality => more valuable patent.



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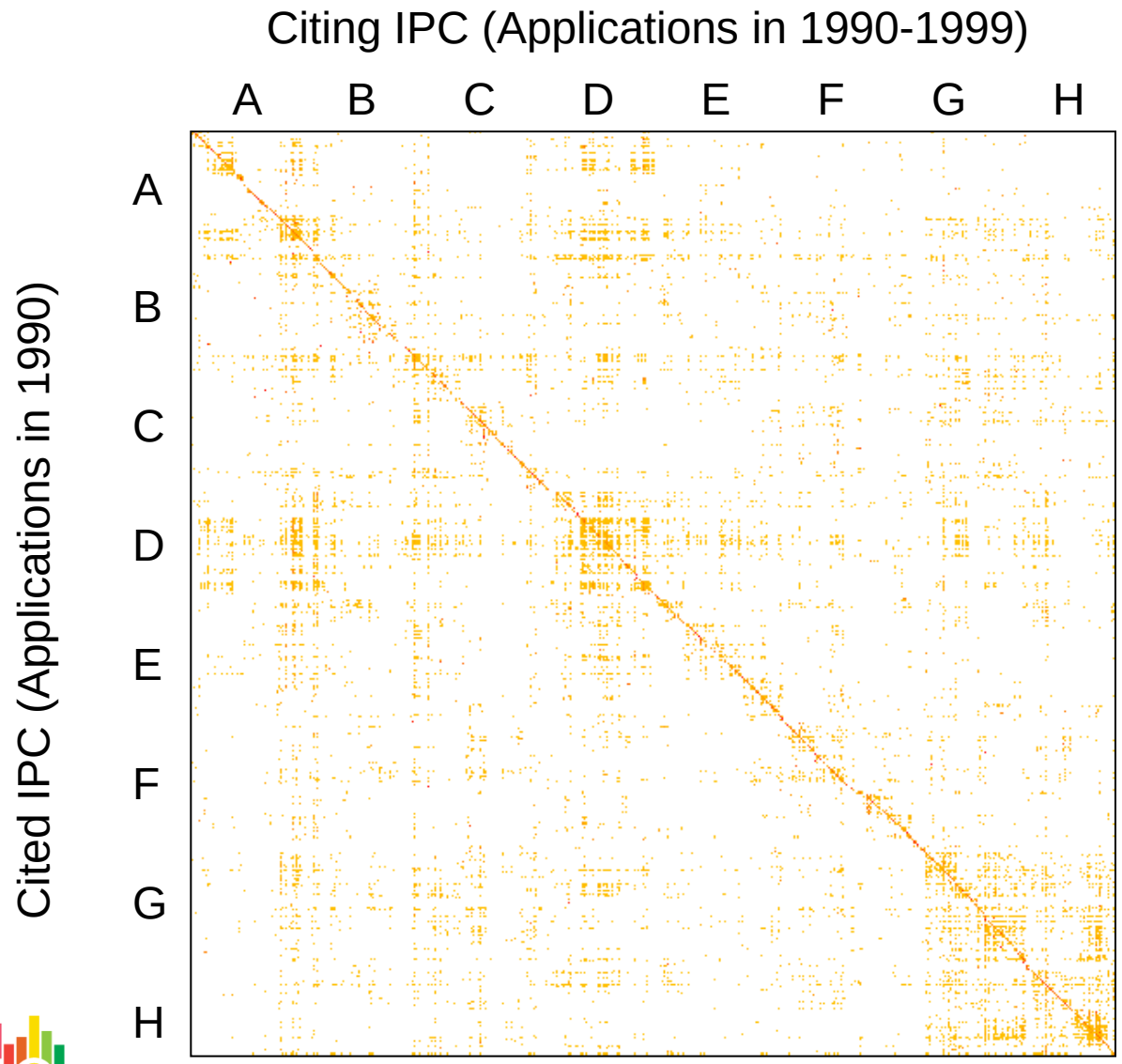
Closeness in the technology space



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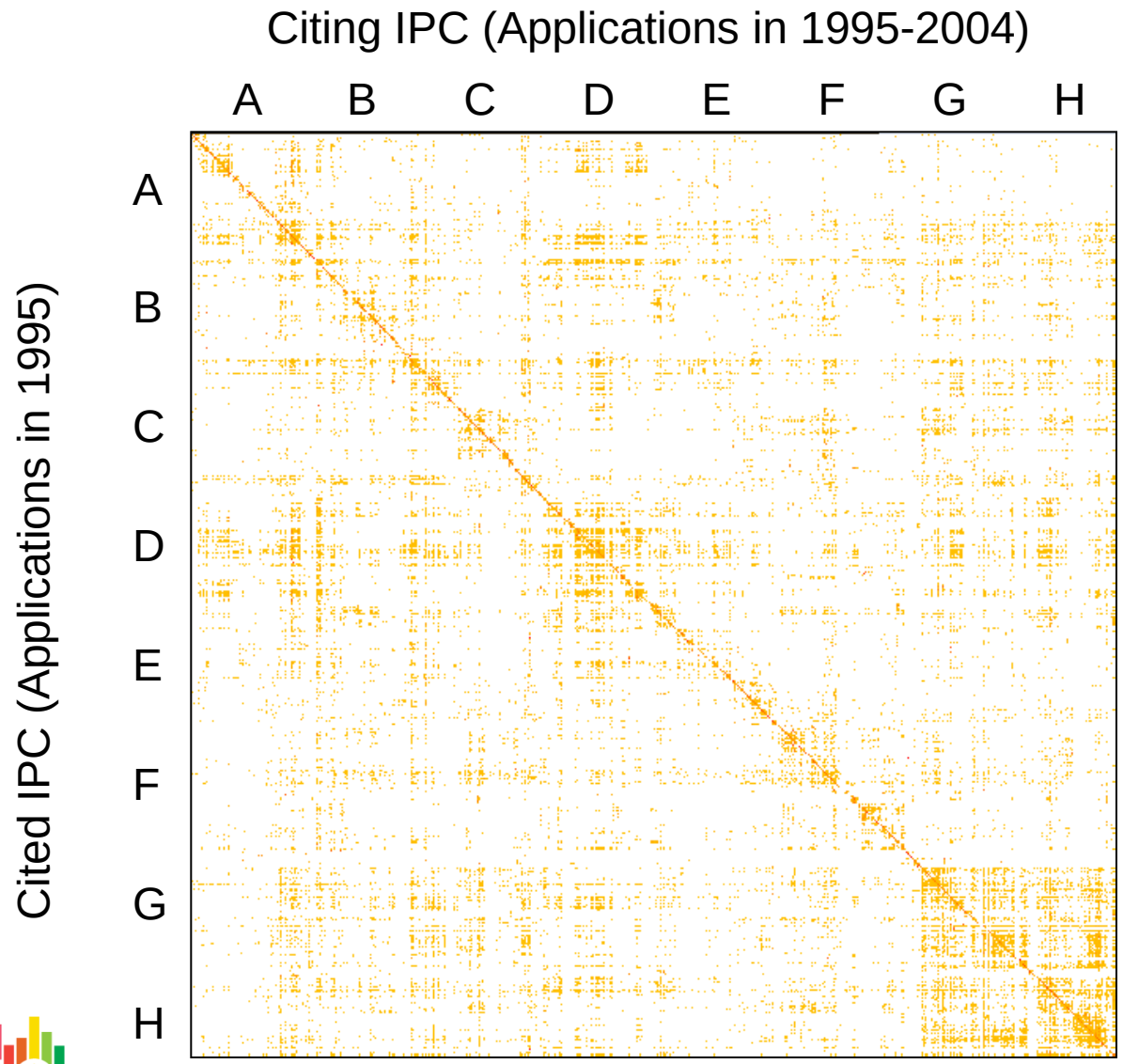

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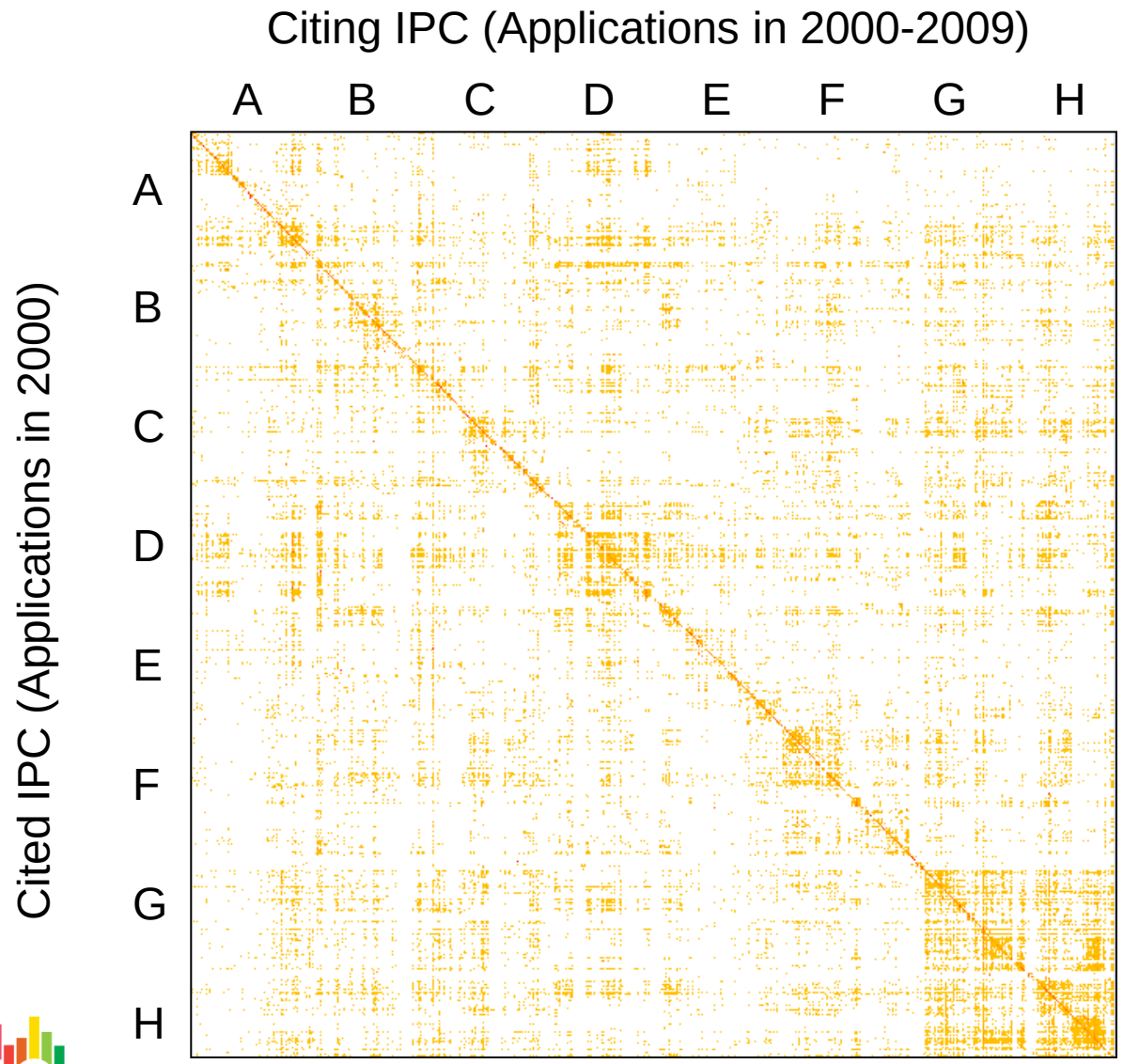

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