

# RISIS



RESEARCH INFRASTRUCTURE FOR SCIENCE  
AND INNOVATION POLICY STUDIES

RISIS #6 Policymakers Session  
3rd December 2020

## INTERNATIONAL PATENTS: THE ROLE OF LARGE MULTINATIONAL FIRMS IN BUILDING COMPETITIVE METROPOLITAN AREAS

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This project is funded by the European Union under Horizon2020 Research and Innovation Programme  
Grant Agreement n° 824091

- What role do large firms play in our innovation systems?
- The geography of large firm innovation
- Which level of analysis: from national to local
- The questions:
  - In which type of territories do large firms invest in R&D?
  - How concentrated or dispersed are these investments?
  - Which firms invest where? (internationalisation)

# Patents a proxy for R&D activities

- Patent is a good indicator of firm innovative capacities (Guellec, D., van Pottelsberghe de la Potterie, 2004, OECD Patent Statistics Manual)
- Patents signal the detection by an economic actor of the potential value of a technical invention
- Easy to access, long time series, rich information (place and date of applications, information on inventors and applicants)
- Addresses of inventors enable the mapping of firm technological activity at geographical level, i.e. the identification of the places where the novelty creation occurred
- Drawbacks: They not necessarily reflect all innovation activity; they account only for codified knowledge creation; biases to consider (IP offices, sectors)



- A database of priority patents applied worldwide by legal organisations (based on Patstat 2017).
- It takes roots in the worldwide patent indicator (de Rassenfosse, Res. Pol., 2013)
- No double counting/application - close to the inventions
- RPD V1 includes the priority patent applications from 2000 to 2014 (complete years) and published between 2002 and 2016

**About 14 M applications of priority patents (39 M inventors)**

2010-2014: 5 117 124 priority patents; 2000-2004: 3 356 364 priority patents

Enriched patent data:

- 🌐 Filling of missing values (additional sources, internal filling) for addresses, IPC, title...
- 🌐 Addition of new type of data:
  - ➔ Classification of applicant type, harmonisation of applicants' names, link with ETER and FIRMREG repositories
  - ➔ Geocoding of addresses and allocation to geographical areas

**Geography - Actor – Technology**

# Selection of priority patents

- Priority patents applied in several countries (higher economical value, reduce national bias)
- Patents applied in main economical zones: US, EU, JP, CN, KR

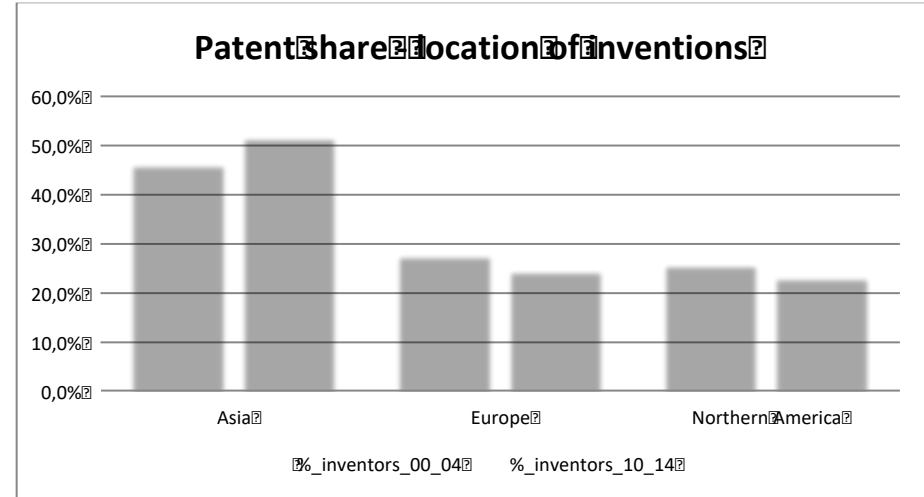
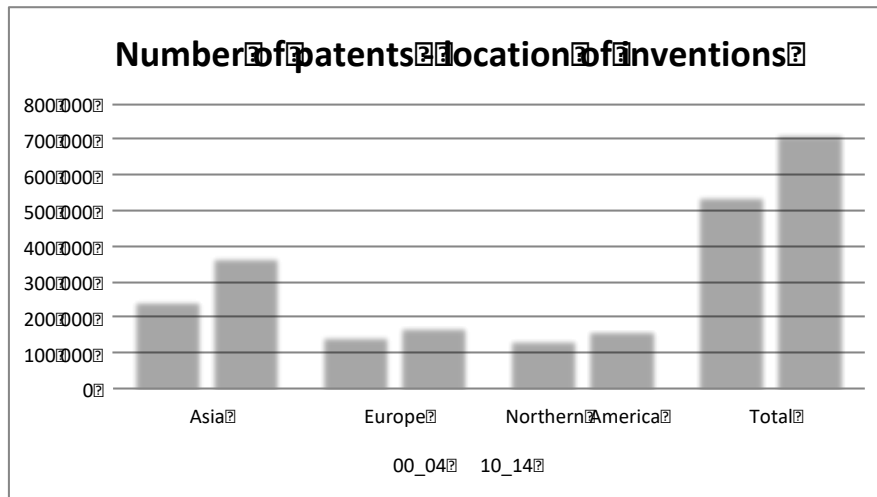
Type of patents	Share
Transnat priority patents	20,2%
2IP5 family priority patents	16,5%
PCT family priority patents	18,5%
Triadic priority patents	5,5%
Priority patents	100,0%

**2IP5 priority patents: patents applied in a least 2 IP5 offices as a marker for internationally valuable technology output of R&D → International Patents**

- 2010-2014: 716 160 Intl. geocoded priority patents
- 2000-2004: 542 492 Intl. geocoded priority patents

# Overview of the geography of inventions

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- Overall increase of International patents (+ 32% in 10 years)
- Asia + Europe + North America: 99% international patents worldwide with Asia > Europe > North America

In 10 years: Patent share of Asia: + 5 pts ; Patent shares in Europe and North America: - 2,5 to - 3 points



- Multinational firms economical key players (added value in 2010 at world level:  $\frac{1}{4}$  of the global GDP (UNCAD 2011))
- Large Multinational Firms (LMF) represent a large source of R&D expenditures:
  - 2005: Top 700 LMF 46% of global R&D expenditures; 69% of all global business R&D (UNCAD 2005)
  - 2018: Top 2500 = 90% of all global business R&D (EU Industrial R&D Investment Scoreboard 2019)

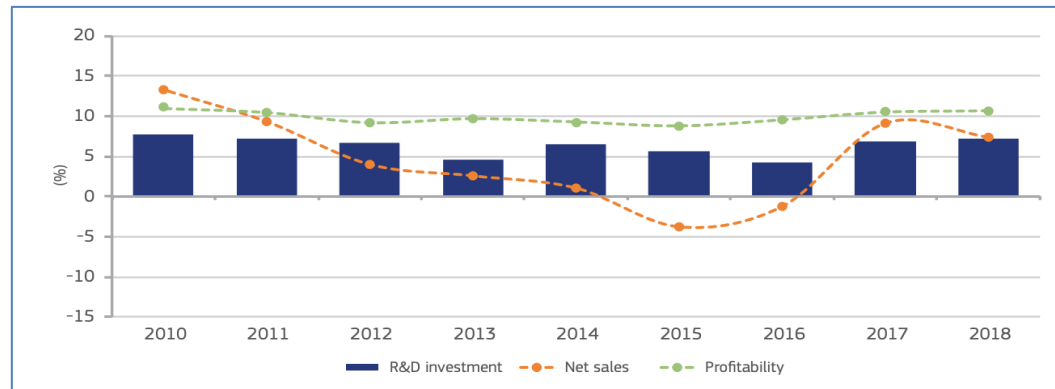


# Large Multinational Firms (LMF)

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- Significant increase of LMF investments in R&D year after year (appr. +5%/year)
- Annual R&D investments increase (%)



- US and Chinese companies increasing sharply their R&D investments (respectively 10.3% and 26.7% in 2018)
- EU companies (4.7%) and Japanese companies (3.9%) following behind

(Source: EU R&D Scoreboard 2019)

# Top LMF R&D performers (RISIS CIB2)



## 2 sources of firms' names:

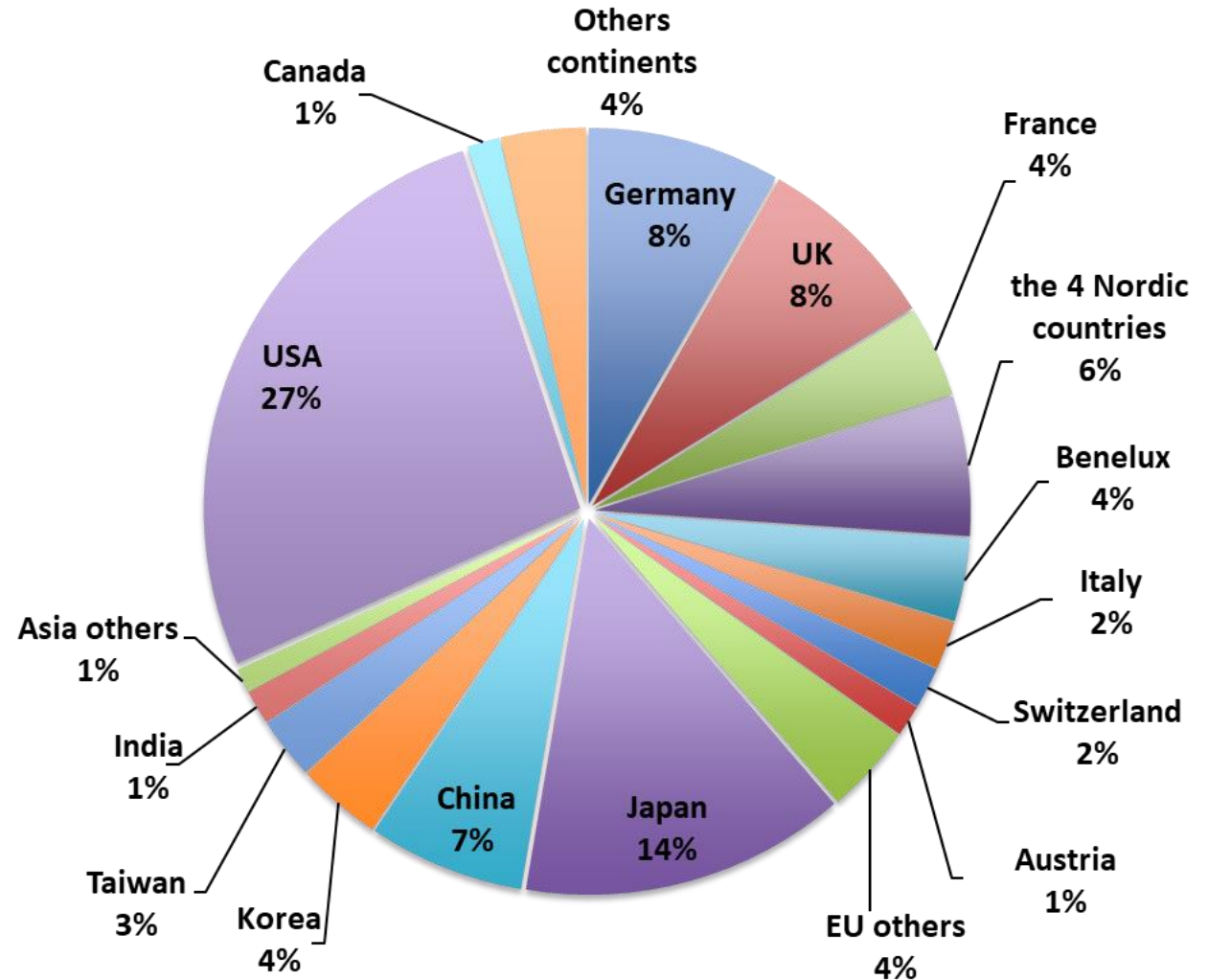
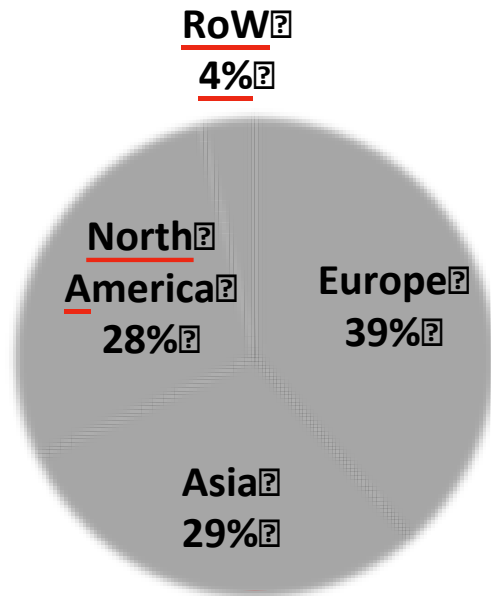
- EU Industrial R&D Investment Scoreboard (editions: 2008-2014)
- Top PCT applicants identified by WIPO (editions: 2008-2014)

Identification of parent company names (GUO or IGUO names)  
using the Orbis database

Identification of LMF perimeter (including subsidiaries with parent  
share >50%)

→ **3993 Large Multinational Firms: the Top R&D performers  
worldwide (nearly 300 000 affiliates)**

# Location of Top LMF R&D performers



# Patent portfolios of Top LMF R&D performers

- Source of patents: RPD (all patents worldwide)

Matching firm names (300 000 names) and patent applicant names (7 Millions names) with PAM (Patent Automatic Matching)

- International patents applied by LMF**
  - **2010-2014: 565 477 patents**
  - **2000-2004: 411 288 patents**

# The core role of LMF inventive activities

LMF/RPD	Worldwide	Asia	Europe	North America
2000-2004	74.7%	84.7%	67.5%	67.7%
2010-2014	77.9%	83.2%	70.1%	76.6%

- LMF: Overwhelming role in invention worldwide (75%)
- Still an increasing trend
- Asia > North America > Europe

# Geography of LMF inventions

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- Location of activities has become an increasingly important determinant of the scope, pattern, form and growth of MNCs (Dunning, Res. Pol., 2009)
- R&D internationalisation of firms was the core of numerous empirical researches
- A dominant view was that globalisation of R&D activities has continued its growth path because companies are increasingly trying to capture knowledge and market opportunities internationally (Moncada-Paternò-Castello et al., Indust. Corp. Change, 2011)
- R&D investment location could better be pictured through a trade-off based on the benefits stemming from the location abroad (assets augmenting motives) and the diverse costs of the R&D activity dispersion (importance of transaction costs)



Our study on LMF R&D internationalisation (Laurens et al. Res. Pol., 2015) showed that R&D is still first home-based and the global R&D internationalisation (23%) is stable

Different regional trends:

- 🌐 EU firms are quite internationalised (30%) - refocused R&D in European countries
- 🌐 US firms are more and more internationalised (17%) - loss of attractiveness of the US as a destination for R&D investments by non-US firms
- 🌐 a rising internationalisation of Asian firm R&D

# Geography of LMF inventions

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- Besides internationalisation, firms strive to outsource R&D activities and to partner
- In an integrated world where barriers (distance and cross border) are lowered, local agglomerations (regions, cities) can emerge because of local comparative advantages (Silicon Valley)
- More uneven or spiky world at a regional level
- Need to study the geography of innovation at a local scale and to move away from administrative boundaries in order to rely only on the internal dynamics of the data studied

**A new set of RISIS tool to analyse location:  
Cortex geo tools**

Source: <https://docs.cortex.net>





- Metropolitan areas (MA) use the concept of Functional Urban Areas (FUA) to identify urban areas. It is based on a core dense space (inhabitants' density) with in addition areas that functionally depend on it (using commuting data). OECD has identified FUA in main OECD countries (Brezzi, 2012; OECD, 2012)
- Following this concept and using additional sources, the Cortext geo tools identify urban areas worldwide (4200 MA). This was made by aggregating locations (addresses, cities...) that are next to a core dense urban centre.
- Outside areas of the highest concentrations of inhabitants, 4428 Non Metropolitan Areas (NMA) are also identified. They are geographic divisions of spaces, based on administrative delineation, left between MA.
- Following OECD, MA and NMA are also classified based on their population. In order to apply this classification to all the areas, metropolitan or non metropolitan, 349,202 cities from GeoNames (GeoNames, 2018) with at least 10 inhabitants have been studied.

# Geography of LMF inventions

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- Large Metropolitan Areas (LMA): population over 1.5 M
- Mid-size Metropolitan Areas (MMA): 100 000 to 1.5 M
- Small Metropolitan Areas (SMA): 50 000 and 100 000
- Non Metropolitan Areas (NMA)

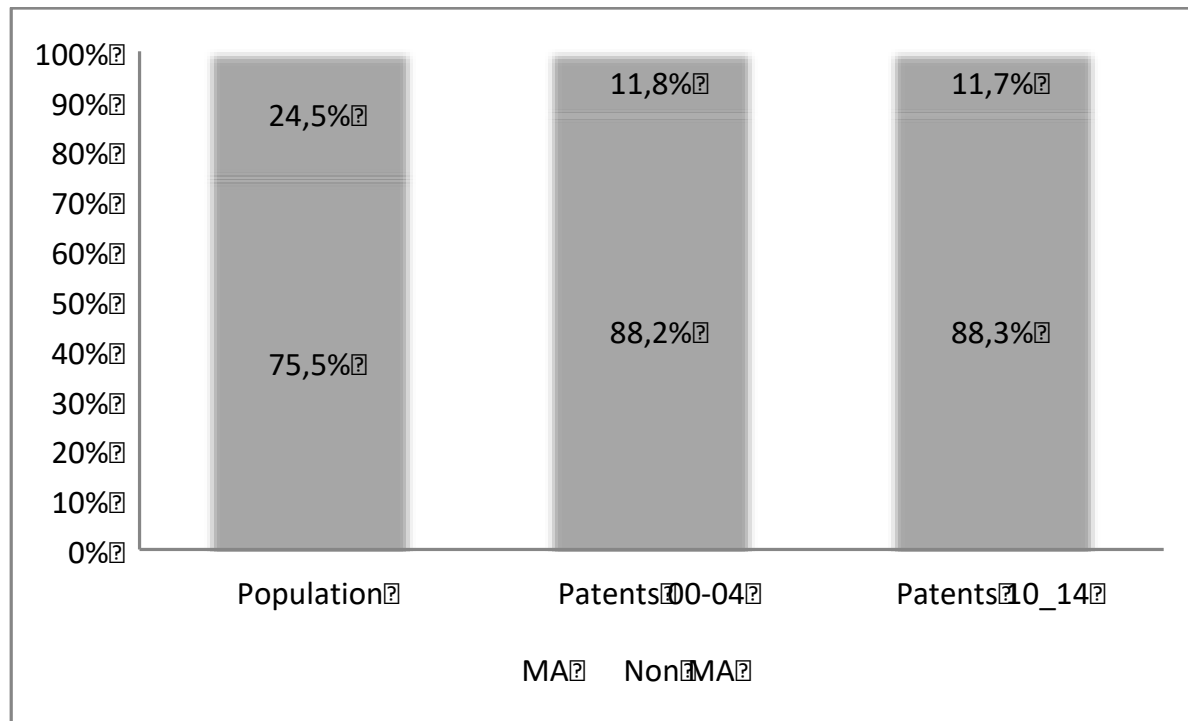
TOTAL	Asia	Europe	Northern America	Total
Large metropolitan area (LMA)	111	40	32	183
Mid-size metropolitan area (MMA)	564	451	137	1152
Small metropolitan area (SMA)	862	639	279	1780
Non metropolitan area (NMA)	1075	1514	63	2652
Total	2612	2644	511	5767

# Geography of LMF inventions

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Projection of the addresses of patent inventors in Areas  
(based on the geocoordinates)



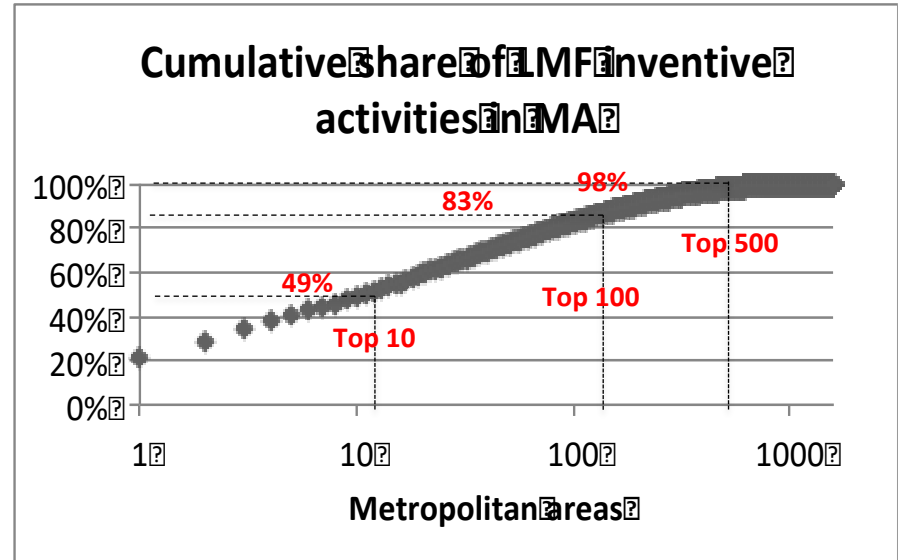
- 🌐 Metropolitan Areas (MA) are where LMF inventive activities first take place

# LMF inventions in MA

Metropolitan Areas	Asia	Europe	Northern America	Total
Total number MA	1537	1130	448	3115
Number of inventive MA (RPD)	618	759	440	1817
Share of inventive MA	<b>40.2%</b>	<b>67.2%</b>	<b>98.2%</b>	<b>58.3%</b>
Number of LMF inventive MA	513	672	433	1618
Share of LMF inventive MA	<b>33.4%</b>	<b>59.5%</b>	<b>96.7%</b>	<b>51.9%</b>

- Overall inventive activities are widespread in MA: 58% of MA are inventive
- Asia < Europe < Northern America
- LMF are present in most inventive MA (absent only in 200 MA, mostly SMA)

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**100 top MA (i.e. 6,2% of Worldwide MA) produce  
82,7% of LMF patents**

# Top 100 inventive MA worldwide

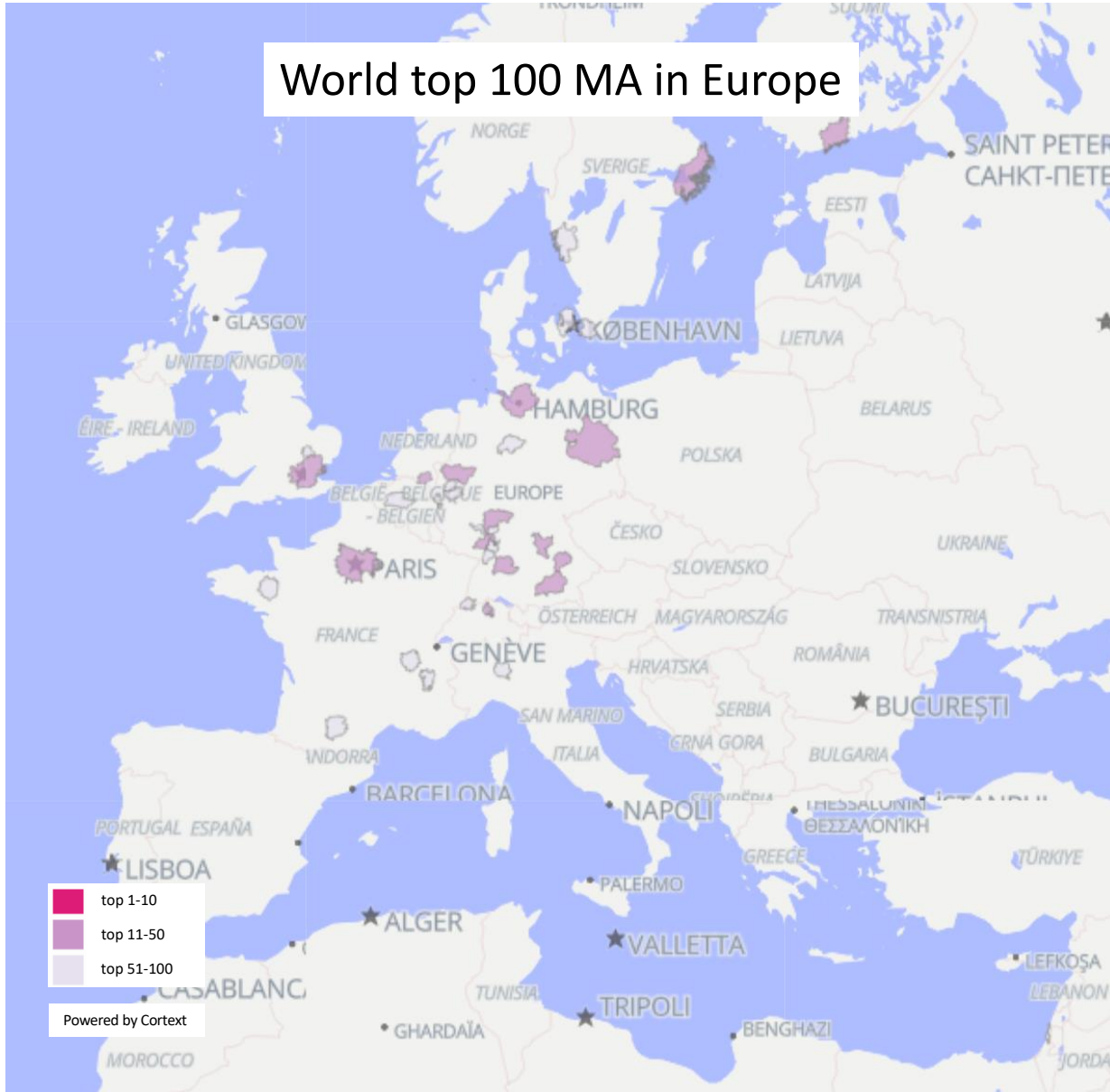
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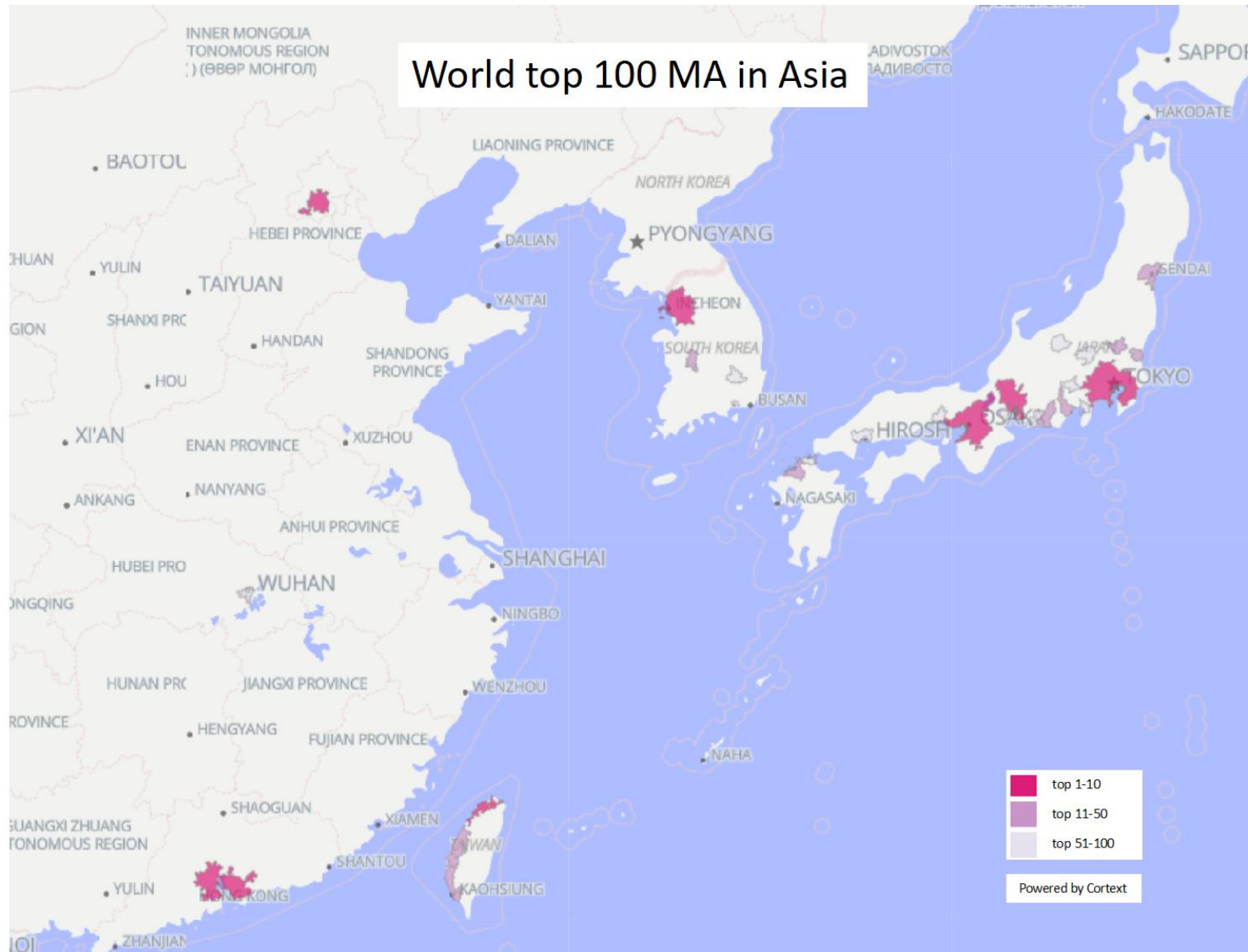
LMF Top 100 MA	Nber LMF patents 2010-2014	Distribution LMF patents 2010-2014	Distribution LMF patents 2000-2004
Asia	261 177	63,3%	60,2%
Europe	63 451	15,4%	19,4%
Northern America	88 062	21,3%	20,4%
Total	412 690	100,0%	100,0%

- Asian MA share is on average 3 times larger than EU or North American MA
- Important decrease of European MA in top 100 MAs over 10 years

## World top 100 MA in Europe

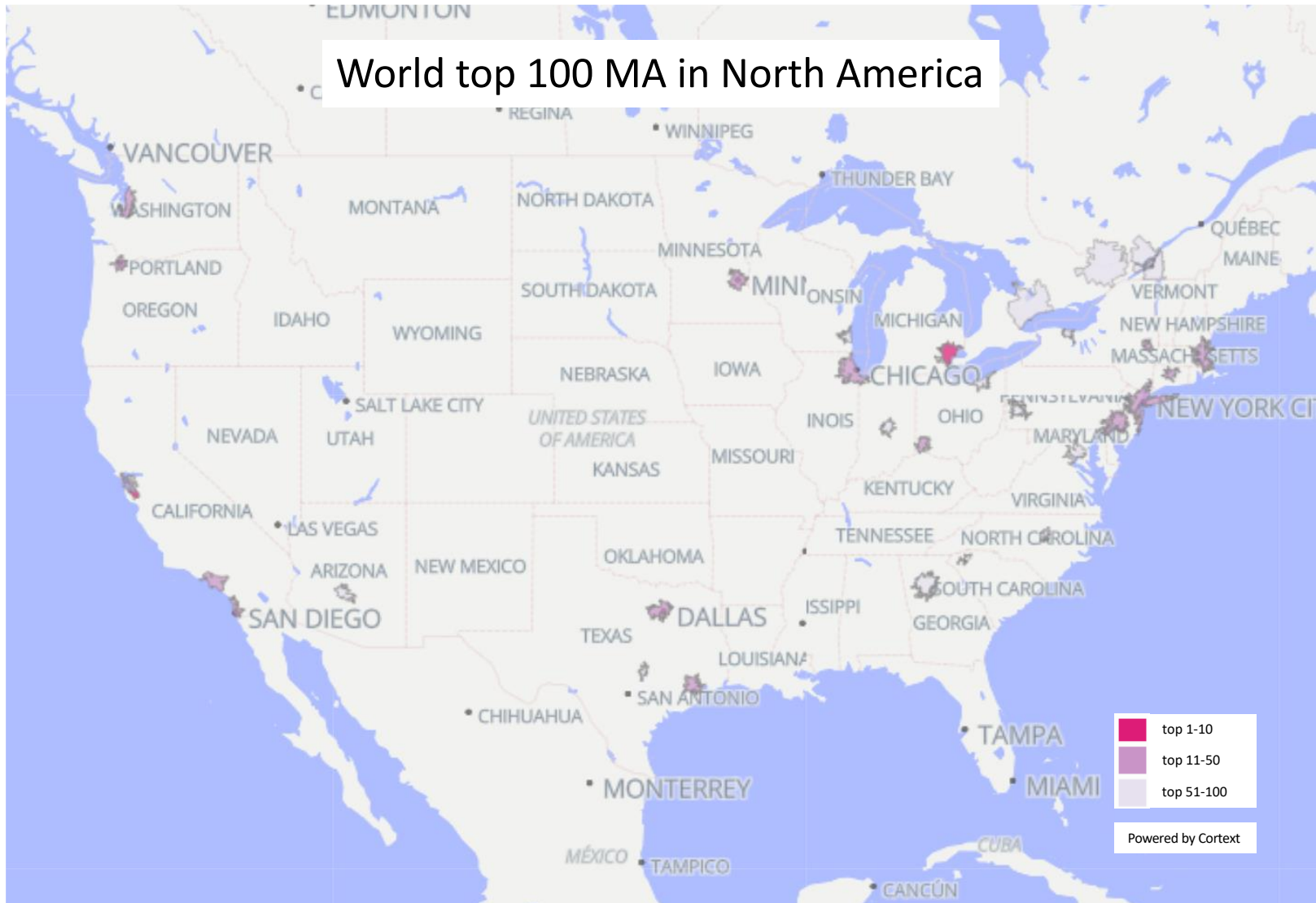


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## World top 100 MA in North America



# Top 100 inventive MA worldwide

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- The top 100 MA worldwide host 82% of LMF activities
- Concentration of LMF activities varies widely across continents:
  - Top 9 Asian MA produce 82% of the Asian patents
  - Top 50 North American MA produce 82% of NA patents
  - Top 105 EU MA produce 82% of EU patents

# Top 100 inventive MA worldwide

Type MA	Nber of LMF patents	Distribution of LMF patents 2010-2014	Distribution of LMF patents 2000-2004	Inventive intensity	Nber of MA	Distribution Nber of MA	Distribution of population
LMA	340 391	<b>82,5%</b>	<b>79,2%</b>	0,98	<b>50</b>	50,0%	90,2%
MMA	70 968	17,2%	20,6%	<b>2,13</b>	<b>49</b>	49,0%	9,8%
SMA	1 331	0,3%	0,1%	ns	1	1,0%	0,0%
Total	412 690	100,0%	100,0%	1,62	100	100,0%	100,0%

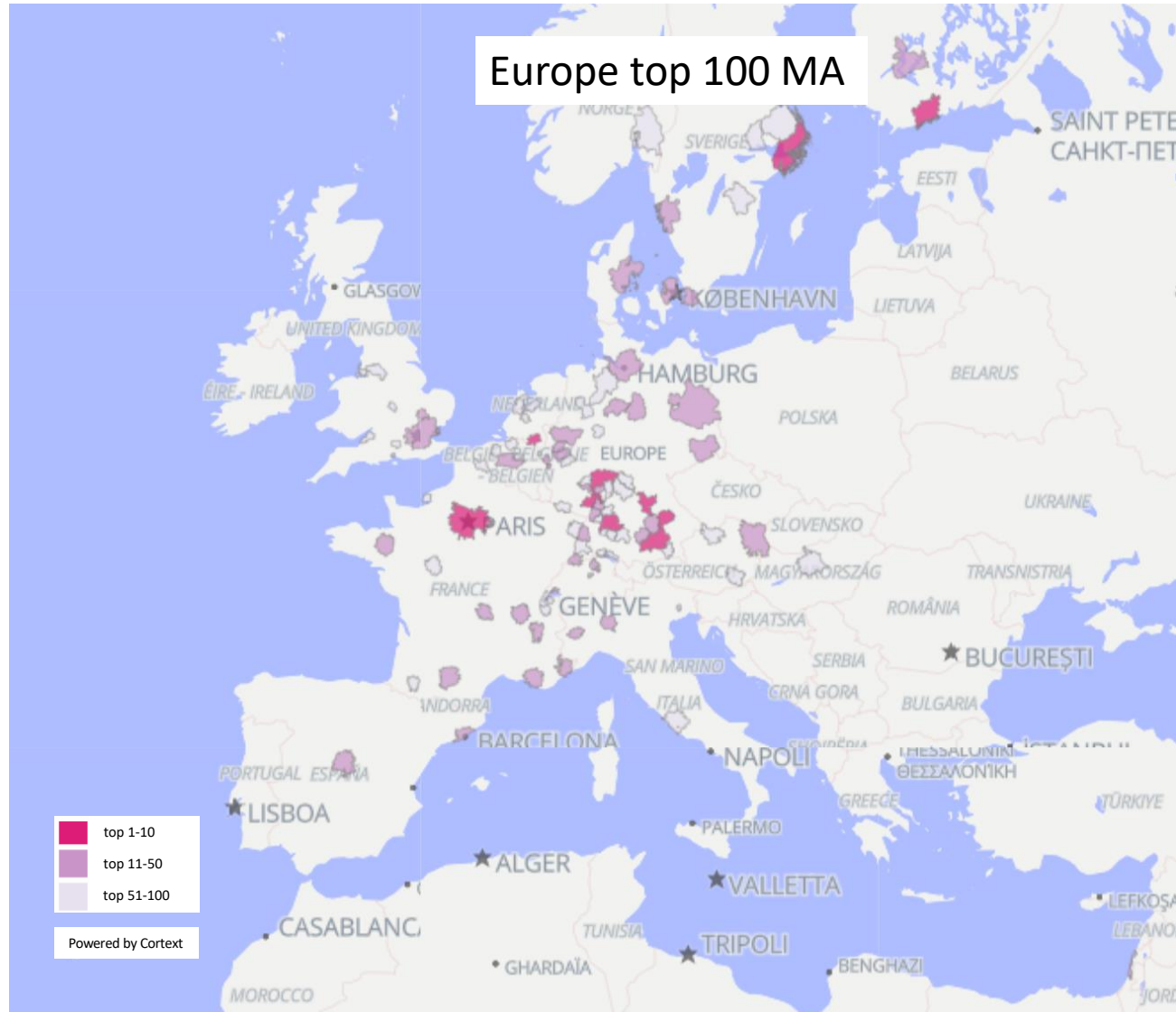
- Top 100 MA: almost exclusively LMA and MMA
- Most of inventive activities in LMA
- Inventive intensity :  $MMA > LMA$

# Top 100 inventive MA in continents



Top 100 MA	Asia				Europe (with UK)				North America			
Type of MA	Nber of MA	LMF of patents	Population	Inventive intensity	Nber of MA	LMF of patents	Population	Inventive intensity	Nber of MA	LMF of patents	Population	Inventive intensity
LMA	46	86.9%	91.6%	0.6	25	45.7%	70.6%	0.37	27	70.3%	77.3%	0.58
MMA	49	13.0%	8.4%	1.04	63	50.4%	27.7%	0.92	54	24.3%	21.1%	0.73
Total	100	100.0%	100.0%	0.64	100	100.0%	100.0%	0.56	100	100.0%	100.0%	0.64
Number of Top 100 MA		273522	429M			87205	156M			107303	167M	
Total MA of continent	1537	99.5%	1022M		1130	81.0%	442M		448	92.3%	237M	

- In Asia and North America, the distribution of patents between LMA and MMA follows the distribution of population in Top 100 MA
- This not true for Europe:
  - LMA and MMA contribute equally to inventions (45 vs 50) while LMA concentrate 70% of the population
  - Inventive intensity in EU MMA >> EU LMA
  - Lower concentration of patent production in top 100 in Europe



# Attractivity of MA for LMF

## Inventive attractivity

- Number of LMF with inventive activity in MA
- Share of LMF with significant inventive activity in MA (>100 patents)

Type of MA	Top 100 worldwide		Top 100 Asia		Top 100 Europe		Top 100 North America	
	LMF		LMF		LMF		LMF	
	with more than 100 patents (Nber)	with more than 100 patents (%)	with more than 100 patents (Nber)	with more than 100 patents (%)	with more than 100 patents (Nber)	with more than 100 patents (%)	with more than 100 patents (Nber)	with more than 100 patents (%)
LMA	128	18.5%	67	22.4%	66	12.1%	101	13.8%
MMA	53	12.7%	33	10.6%	31	9.9%	27	9.0%
SMA	37	10.8%	4	10.0%	16	10.6%	14	9.5%

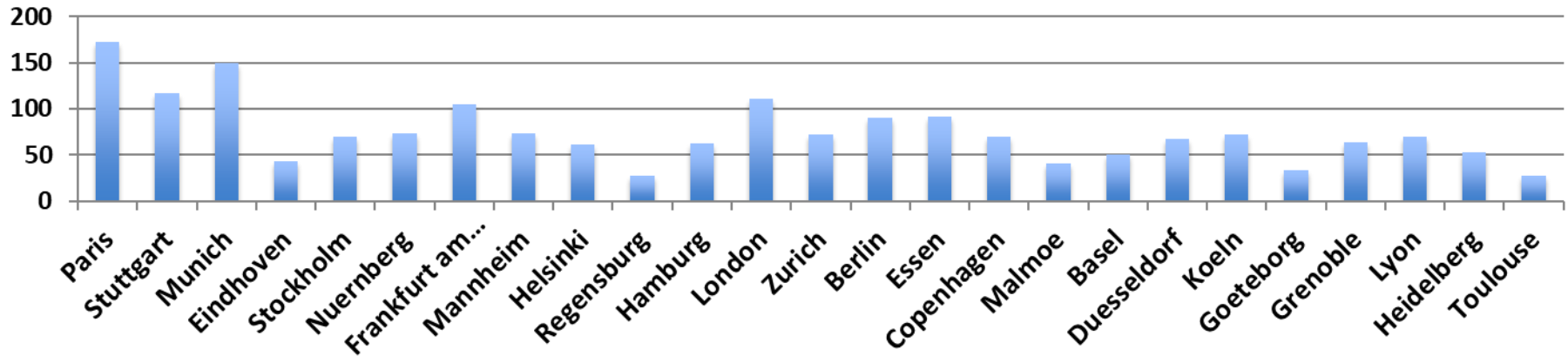
- LMA are the most attractive MA for LMF
- Higher share of highly inventive LMF in LMA
- Attractivity of MA: Asia > North America > Europe

# EU focus: attractiveness of top 25 EU MA

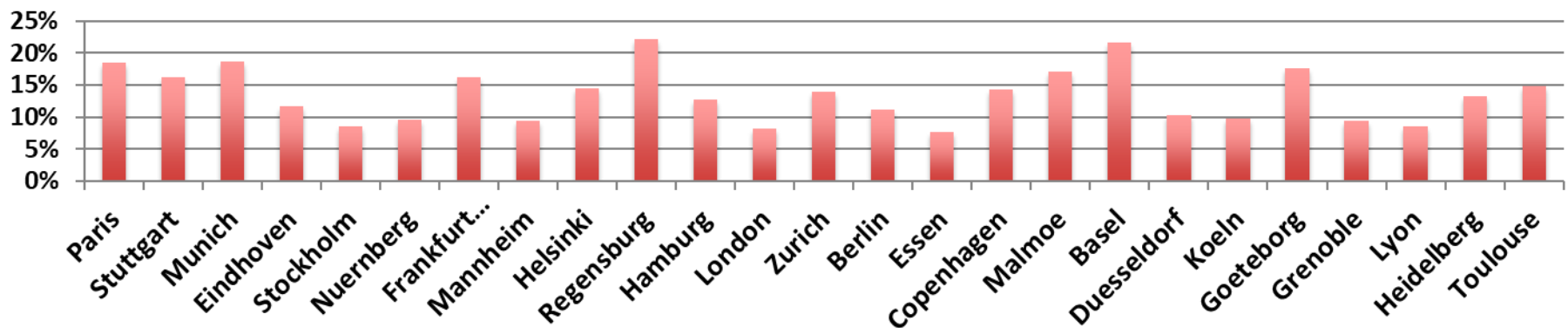
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Number of LMF (>5patents)

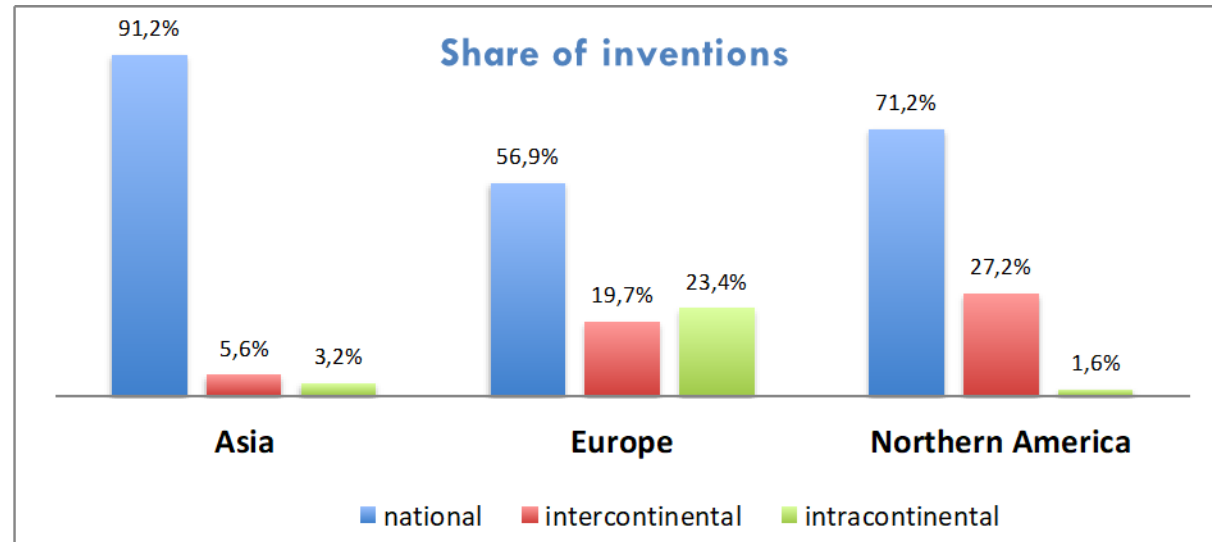


% LMF >100 patents



# Internationalisation of LMF inventions

Home country of LMF (LMF HQ) compared to their invention host country



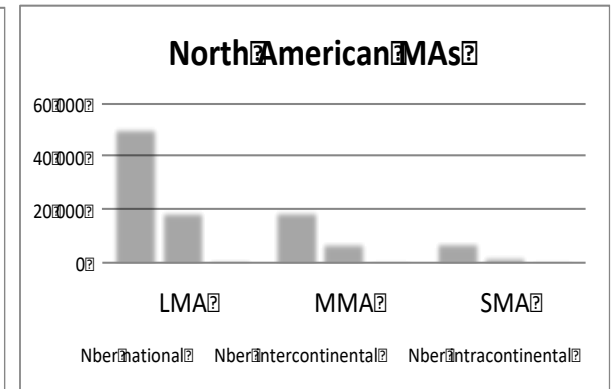
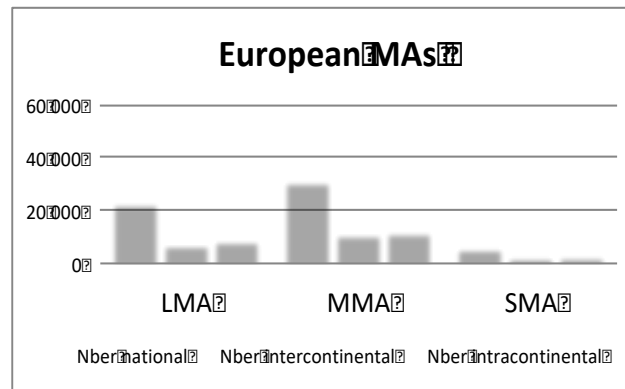
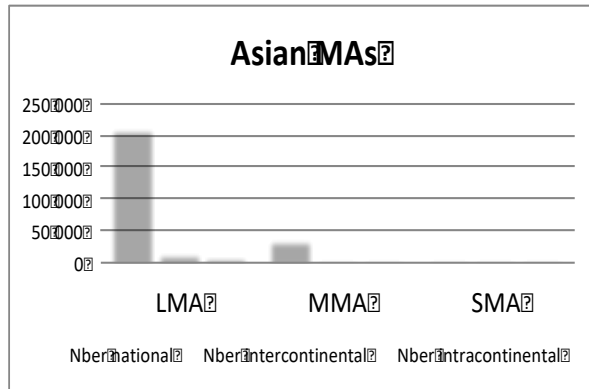
Host locations:

- Asia: invention by national LMF (>90%) - low international attractiveness
- North America: national LMF dominate (70%) but North America attract a significant share of LMF from overseas (25%)
- Europe: Strong international attractiveness: intracontinental and intercontinental attractiveness account respectively for 23% and 20% of LMF inventions



# Internationalisation of LMF inventions

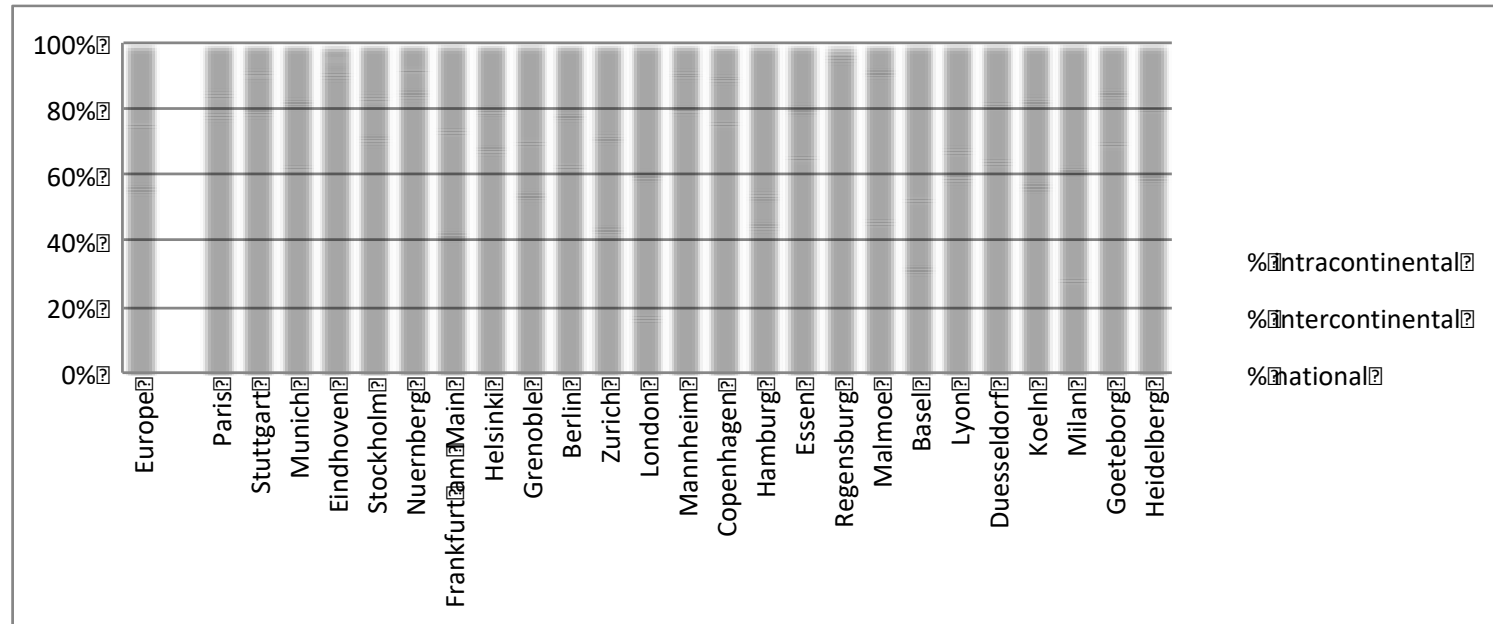
## Number of patents



- Both LMA and MMA attract international LMF
- In Europe inventions of foreign LMF are carried out first in MMAs

# EU focus: origin of LMF inventing in top 25 EU MA

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- Heterogeneity among top 25 EU MA
- Presence of outliers
  - Mostly national firms: Eindhoven, Regensburg
  - Very internationalised MA: London, Basel, Milan, Malmoe

## Four core results:

1. LMF represent 80% of world international patents, confirming the results from financial data
2. LMF are present in more than half Metropolitan Areas of the 3 core continents (Asia, North America and Europe) but the distribution of their activities is highly skewed: 100 MA concentrate more than 80% of LMF inventive activities (Asia > North America > Europe)
3. Distribution of LMF activities follows distribution of population: top LMA concentrate a large share of inventive activities (Asia, North America). Europe behaves differently: MMA matter more.
4. The origin of LMF differs widely in Europe compared to the 2 other continents. The international attractiveness of Europe is high: non national LMF represent around 45% while other European LMF represent 23%. 1 international patent out of 5 comes from non-European LMF. And this figure does not change between small, mid-size and large LMA.

## Next steps

- Diversity of field specialisation of MA
- What lies behind international attractiveness
- Explaining variability of international opening in Europe
- What relation between distributions of population and inventive activities - the role of long term path dependencies
- Relationship between LMF anchoring in MA and MA academic activities

# Policy implications

- Academic developments highlight the key role played by large actors at the territorial level. As ‘anchor tenants’, they are role models, they mobilise in their R&D activities many small high tech firms and they often provide support for international development. Is this point sufficiently taken into account in current innovation policy?
- Should thus revised policies address all types of LMF? Or should they be sector and/or technology focused? If so, should such policies be national, regional or even be developed by MA themselves?
- Do these results open a new dimension in the core debate in Europe between competitiveness and inclusiveness ?
- Does the striking inventive role of non EU firms in Europe warrant a specific attention and dedicated policies?

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