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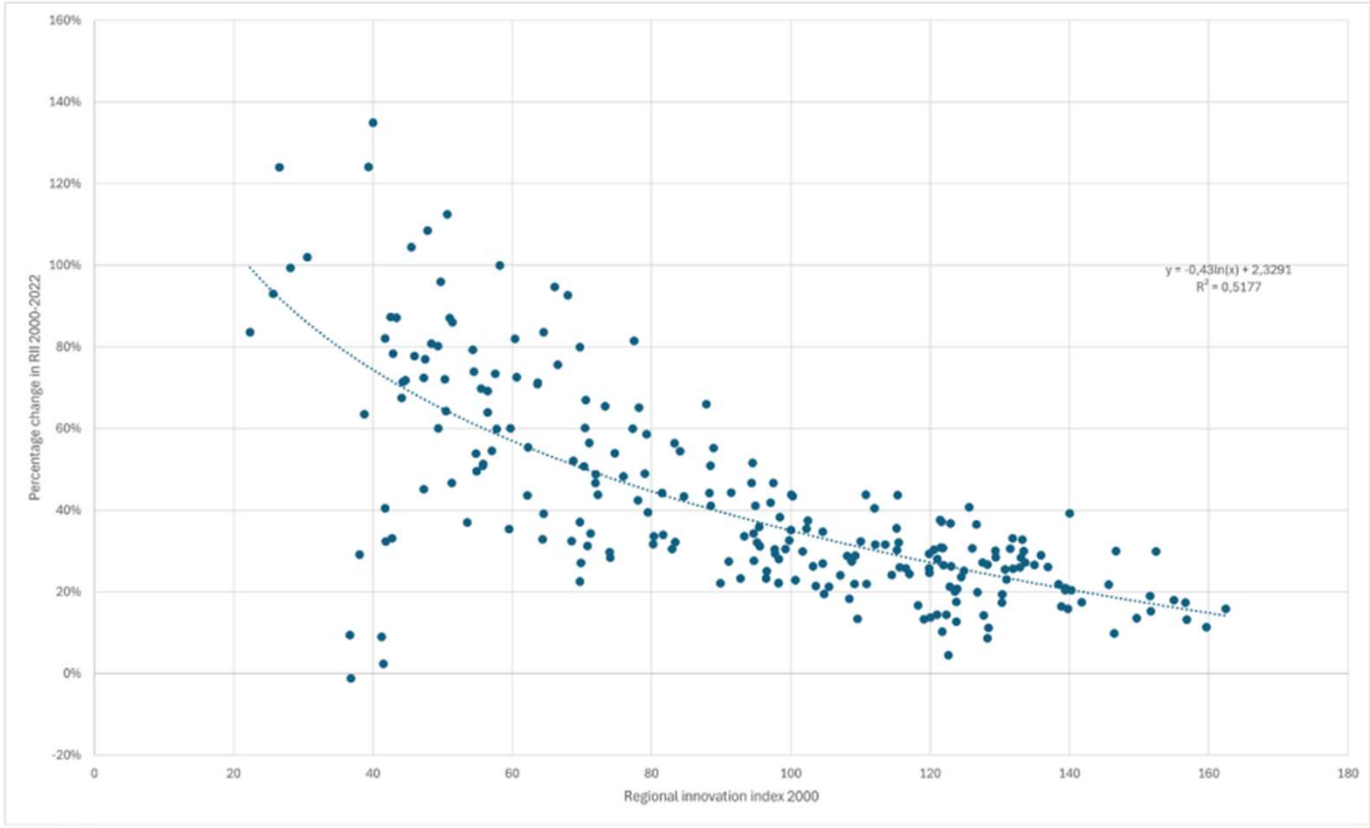
# Innovation in Peripheral Regions: Convergence and connectivity

# Regional innovation in Europe is **converging**

Lowest performing regions are slowly catching up to top performing regions

Figure 5: Convergence in 2000-2022 regional innovation performance

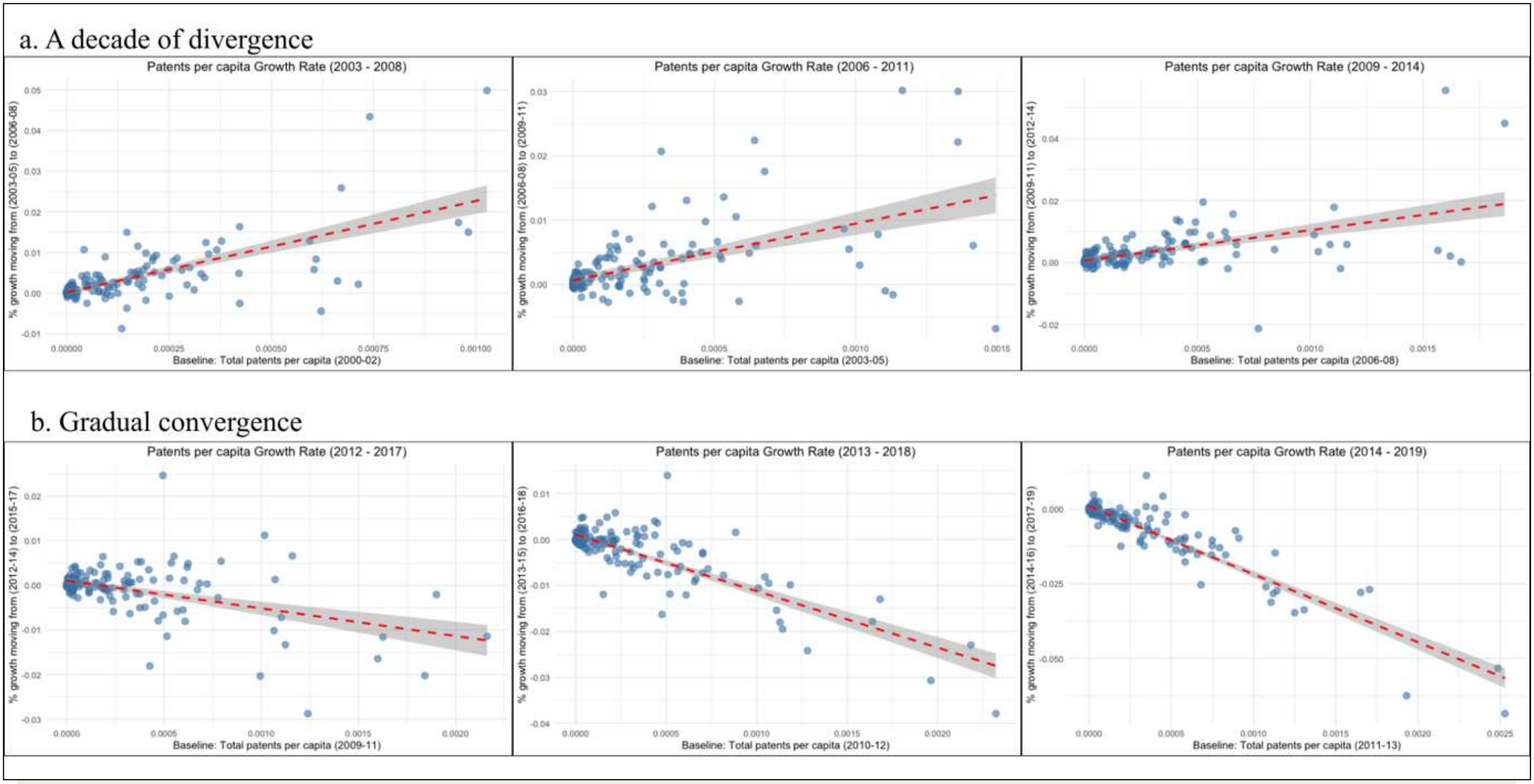



**Regional Innovation Index**

- Patent
- Scientific Publications
- R&D Investments
- Educational Statistics
- Labour productivity
- Exports
- and more…

Regional Innovation Scoreboard - 2025

This is a reversal of the trend in the 2000s:




Source: Kharel, Fitjar and Rodríguez-Pose (2025) – working paper based on data from European Patent Office (EPO)

# Why are innovation levels converging?

Because of public policy to even out disparities created by the market?


*Cohesion Policy has*
- *modernised infrastructure*
- *fostered innovation*
- *helped shape a more dynamic and competitive Europe*
- *driven catch-up growth, particularly in post-2004 Member States*

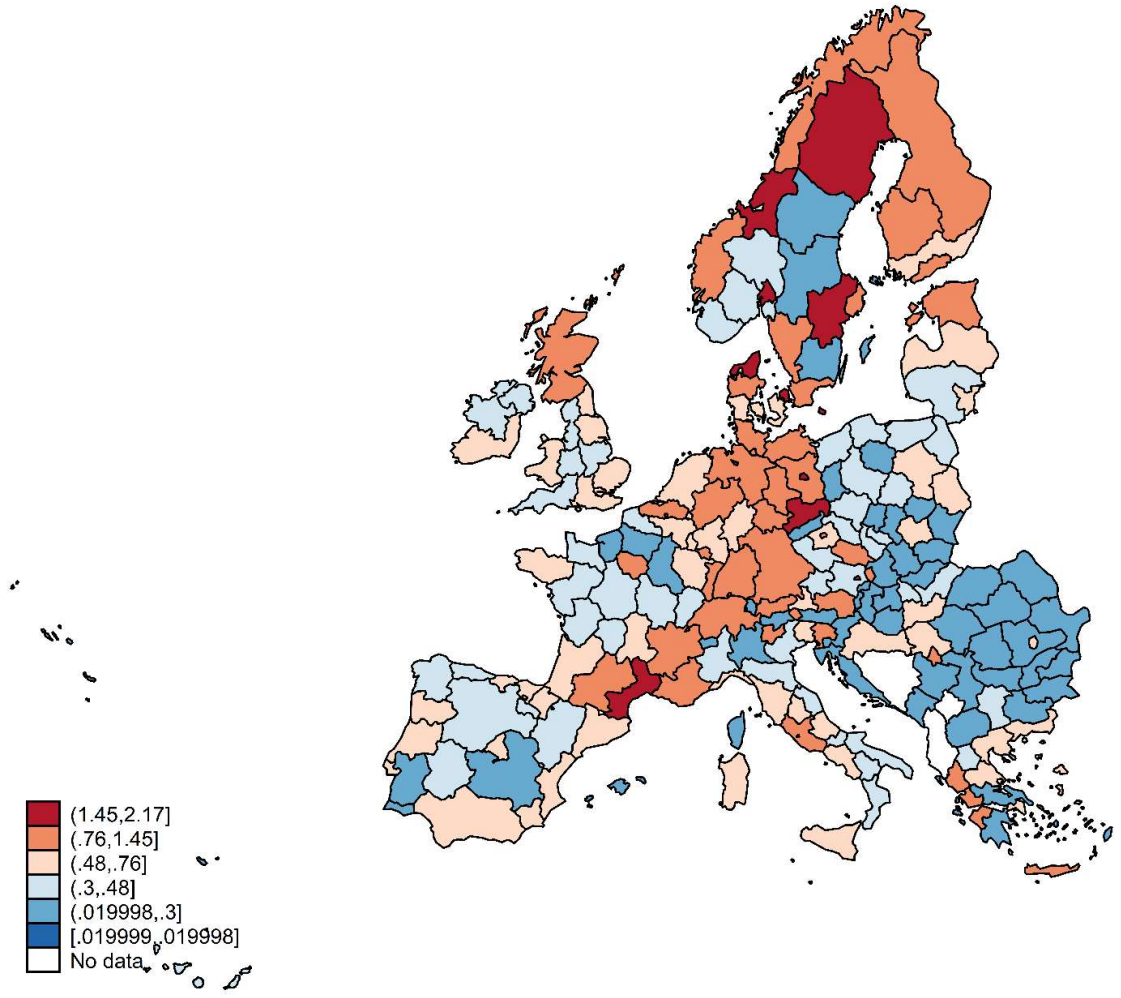
(Rodríguez-Pose, 2025)

… but this partly counteracts the centralising effects of other public policies – not just market-created disparities

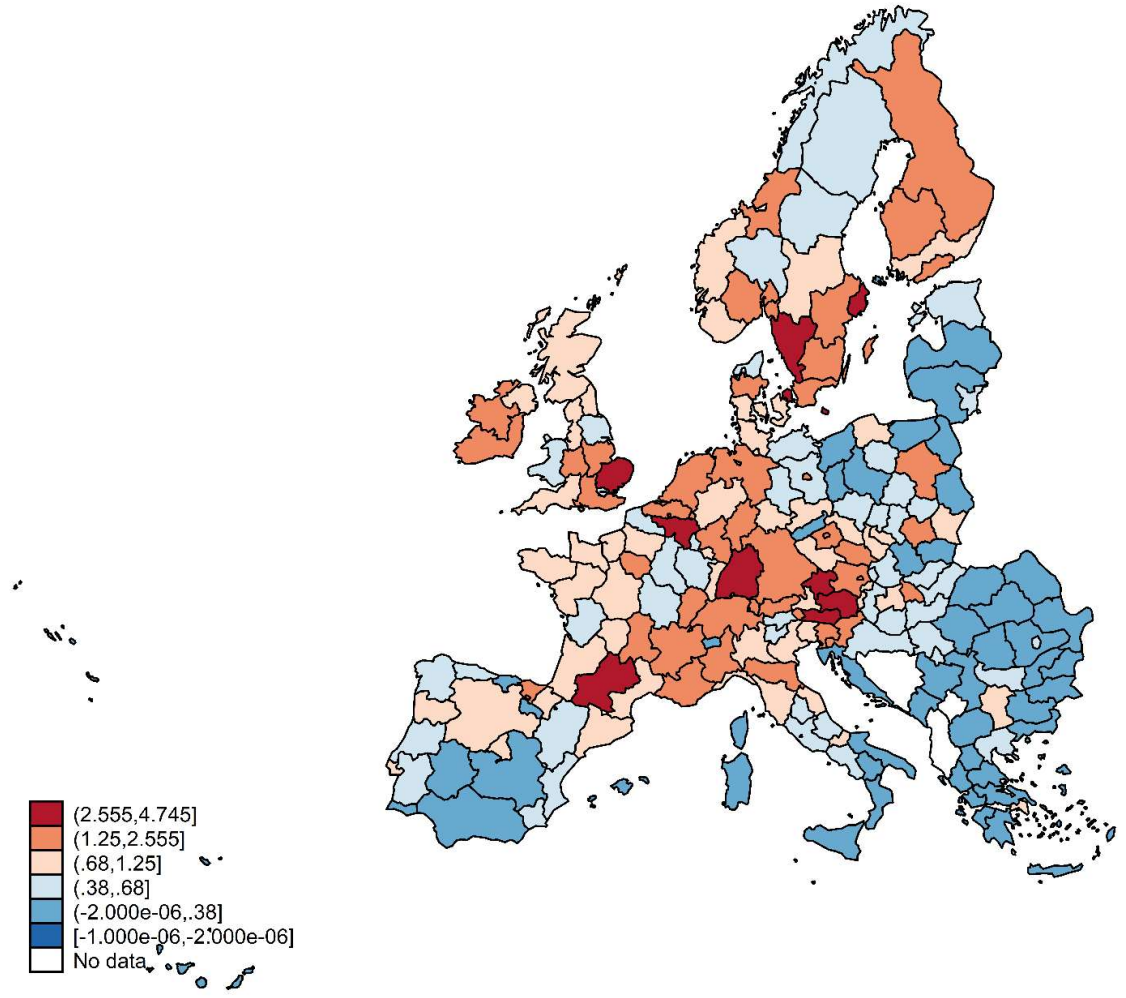
… and these effects may yet become stronger with shifting policy priorities in the years to come

# R&D funding, % of GDP by region, 2018

## Public




## Business




Source: Fitjar RD (2025): Does public R&D funding reinforce regional disparities? *Research Policy* 54:105312

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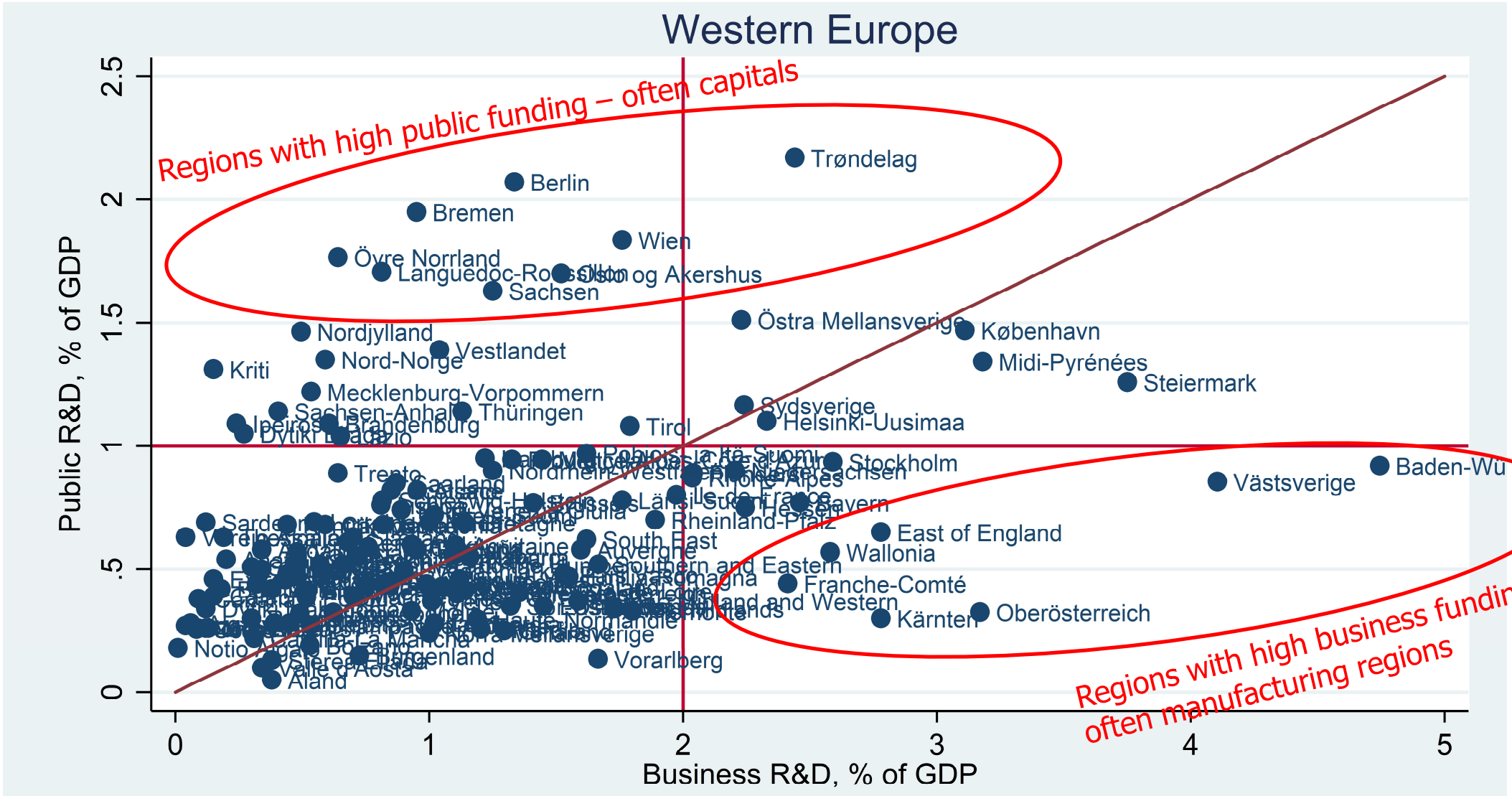
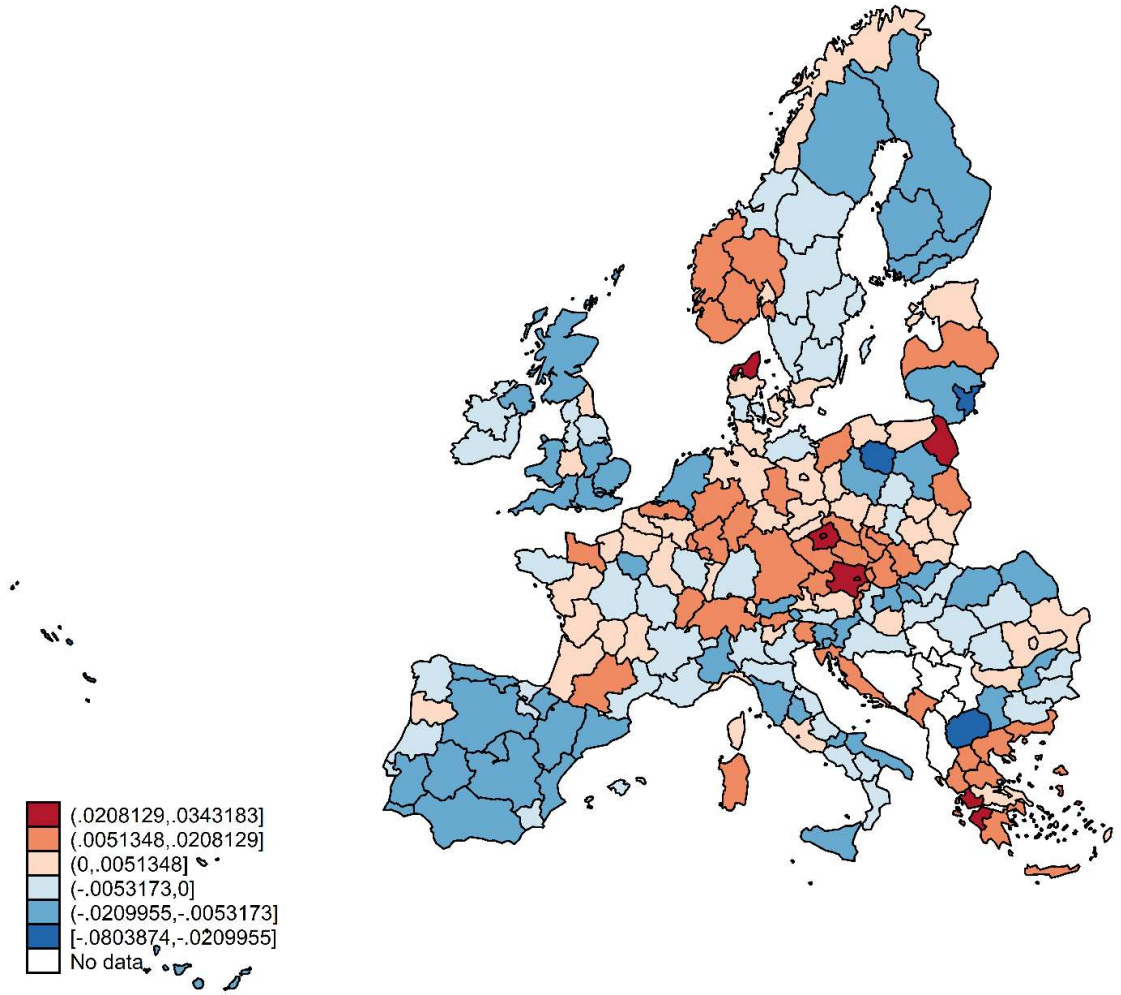
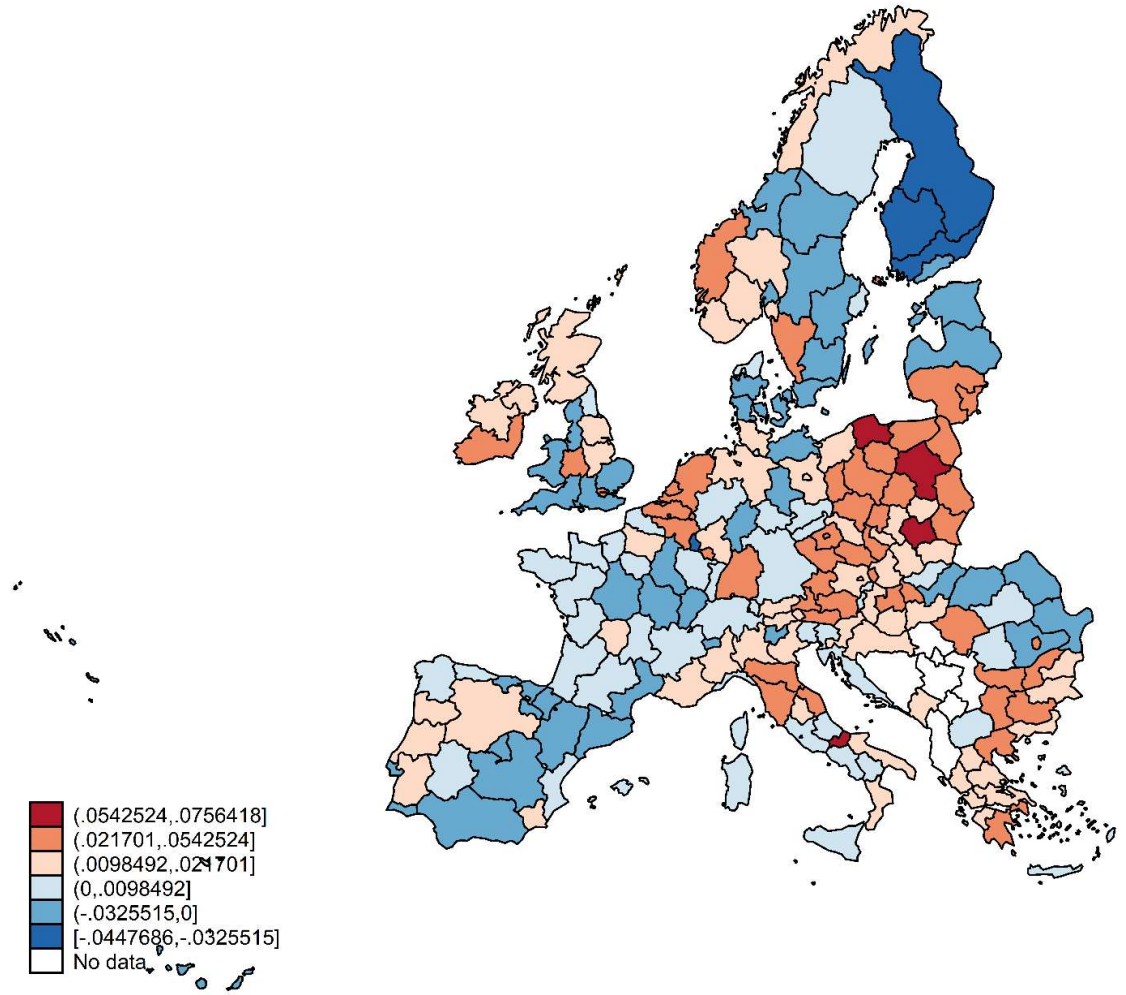

Western Europe
Regions with high public funding – often capitals
Regions with high business funding –
often manufacturing regions
Public R&D, % of GDP
Business R&D, % of GDP
0
.5
1
1.5
2
2.5
0
1
2
3
4
5
Trøndelag
Berlin
Bremen
Wien
Övre Norrland
Languedoc-Roussillon
Oslo og Akershus
Sachsen
Östra Mellansverige
København
Nordjylland
Vestlandet
Midi-Pyrénées
Nord-Norge
Kriti
Steiermark
Mecklenburg-Vorpommern
Sydsverige
Sachsen-Anhalt
Thüringen
Helsinki-Uusimaa
Tirol
Stockholm
Baden-Wü
Trento
Västsverige
Rhône-Alpes
Rheinland-Pfalz
East of England
Wallonia
Franche-Comté
Kärnten
Oberösterreich
Vorarlberg
Aland

# R&D funding as % of GDP, average annual growth 2009-2018

## Public




## Business

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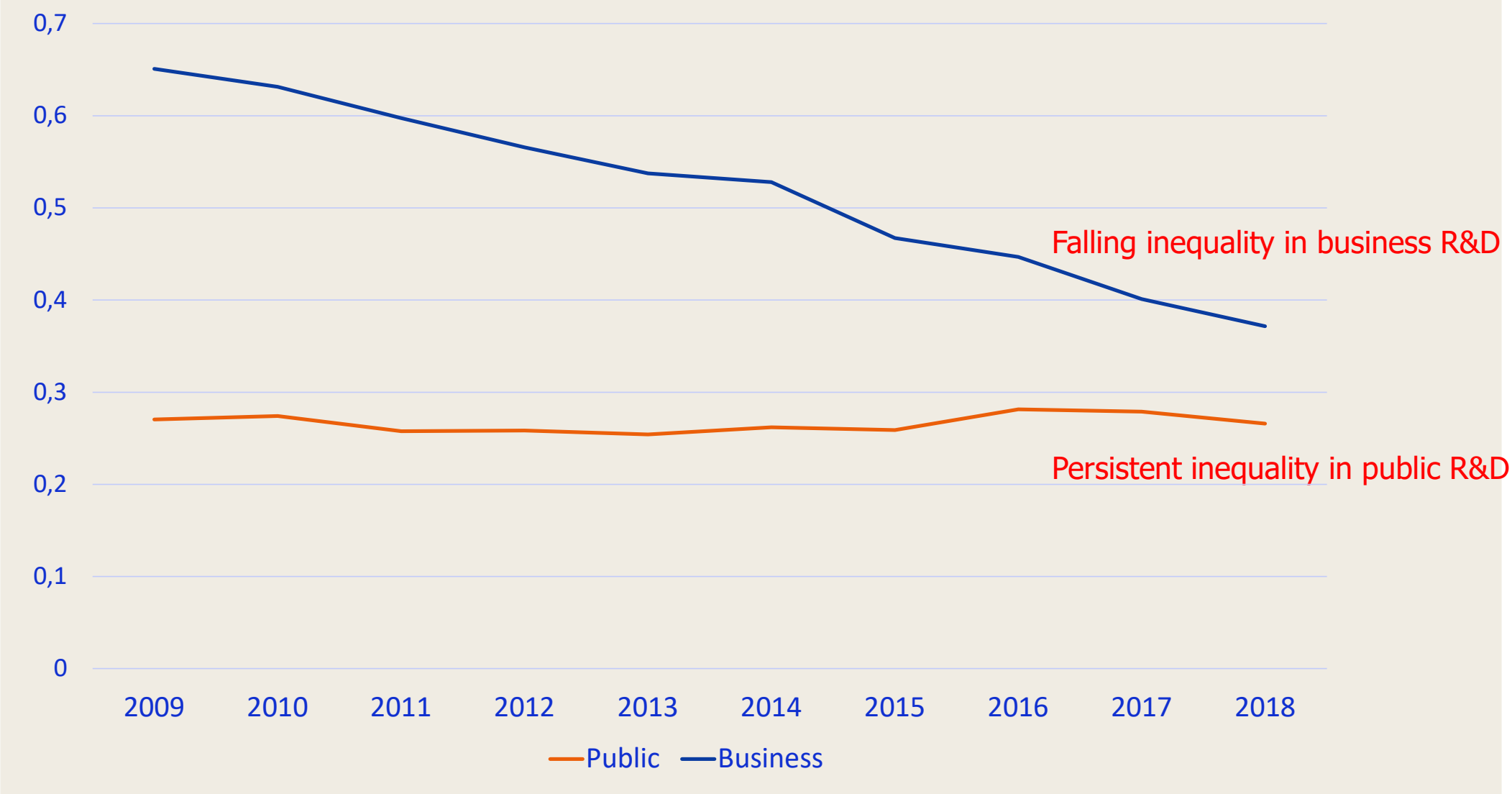
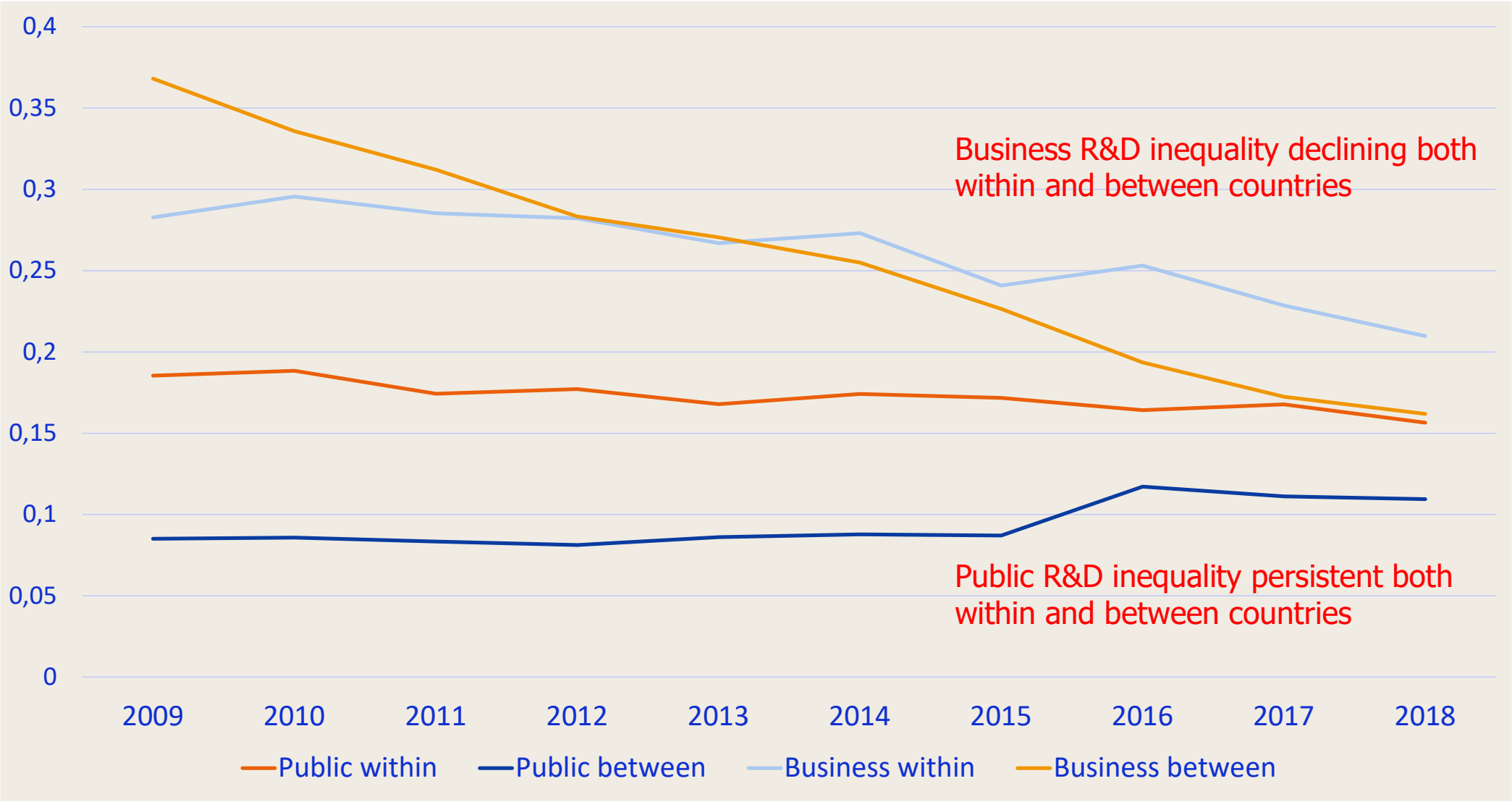

0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Public
Business
Falling inequality in business R&D
Persistent inequality in public R&D


0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Business R&D inequality declining both within and between countries
Public R&D inequality persistent both within and between countries
Public within
Public between
Business within
Business between

# What's Puzzling

Convergence is happening

despite public R&D investments remaining concentrated in core regions

**Do we need to look beyond the region itself?**

Dominant theories emphasize local resources:

- Agglomeration economies
- Local knowledge spillovers

- and typically focuses on core regions

Increasing research on innovation in peripheral regions, emphasizing

- Knowledge spillovers do not require (permanent) geographical proximity
- Other dimensions of proximity are more important
- Temporary proximity may be sufficient
- Firms in peripheral regions need to connect through dedicated knowledge pipelines
- There are benefits to peripheral location: Secrecy, uniqueness, quietness, multiplex interactions, etc.

# Connectivity as a resource for peripheral regions

- Inter-regional linkages and knowledge networks can enhance innovation in less innovative regions *(Eder, 2019; Owen-Smith and Powell, 2004)*

- External knowledge pipelines enable purpose-built interactions among innovation actors in distant locations *(Bathelt et al., 2004)*

- Access to novel ideas and technologies from outside would amplify the value of their existing knowledge *(Feldman and Kogler, 2010)*

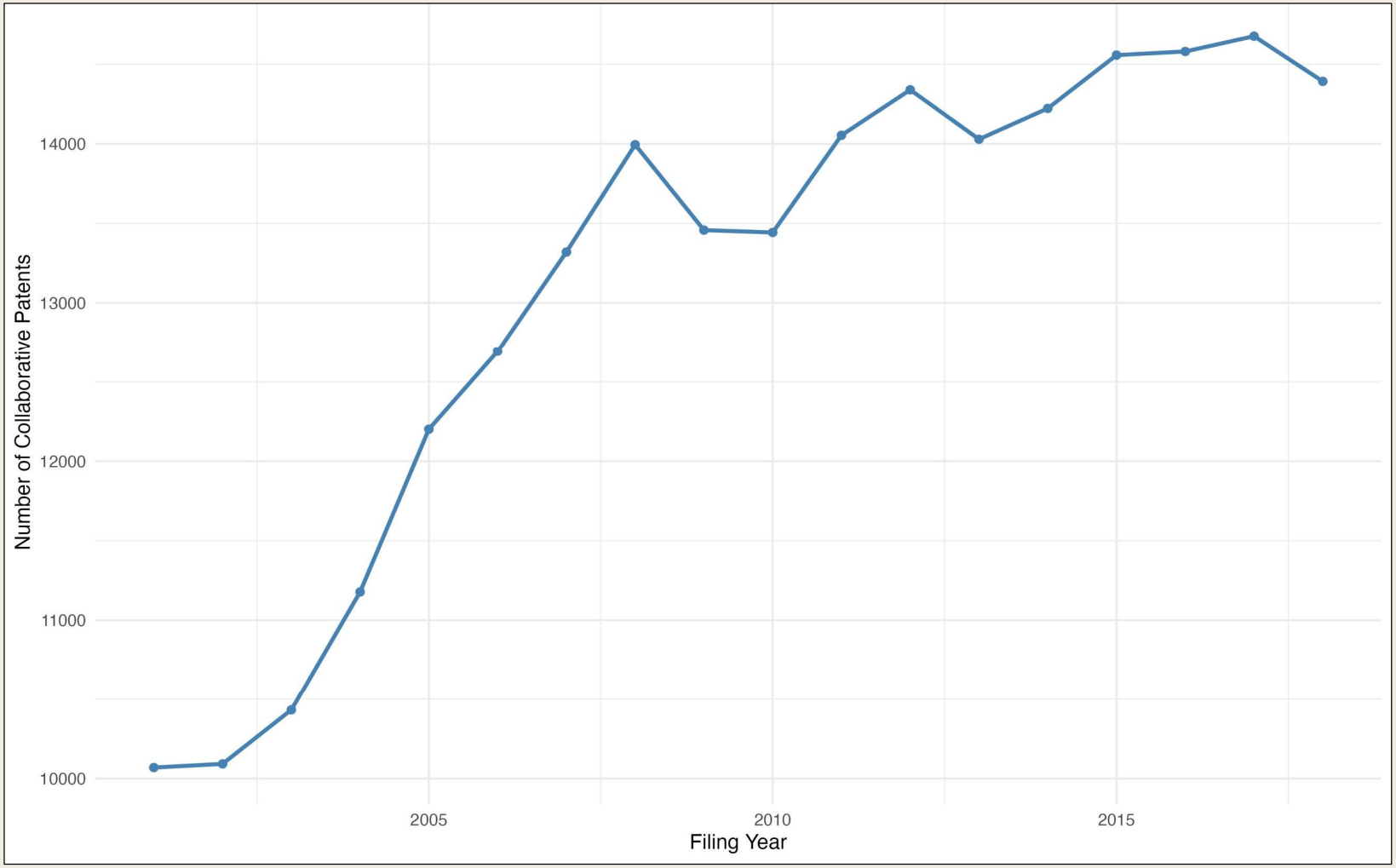
- Less innovative regions can compensate for the absence of geographical proximity among innovation actors *(Boschma, 2005)*

# Connectivity – empirical studies

- **Norway** – Firms engaging in extra-regional collaborations introduce more radical innovations than those relying solely on local partnerships. Collaborations are particularly beneficial in regions with weak innovation infrastructures.
  *Fitjar and Rodríguez-Pose, (2011, 2014, 2020) and Fitjar and Huber (2015)*
- **Sweden** – External and mostly international linkages compensate for a lack of local innovation spillovers
  *Grillitsch and Nilsson (2015) and Dubois (2015)*
- **Austria** – Long-standing nonlocal formal connections to universities, customers and suppliers to ensure inflow of knowledge (*Eder and Trippl, 2019*)
- **Switzerland** – Firms seek external knowledge beyond the region through e.g. international recruitment, clients, universities, and conferences (*Meili and Shearmur, 2019*)
- **Canada** – Most innovative service firms located furthest away from their users (*Shearmur and Doloreux, 2015*).
- **Chile** - Chilean wine cluster *(Giuliani and Bell, 2005)*
- **England** - SMEs in the periphery of England value knowledge networks from within and beyond their region *(Huggins and Johnston, 2009)*
- **Asian lead firms** – technological upgrading and innovation emerging out of Asian lead firms

**Connectivity**, as such, has been studied as a relatively **exogenous mechanism** helping less innovative regions remain innovative and embedded in the knowledge networks.

## *European Patents with Inter-regional Co-inventorship*




*Source: Authors' elaboration based on data from European Patent Office (EPO)*

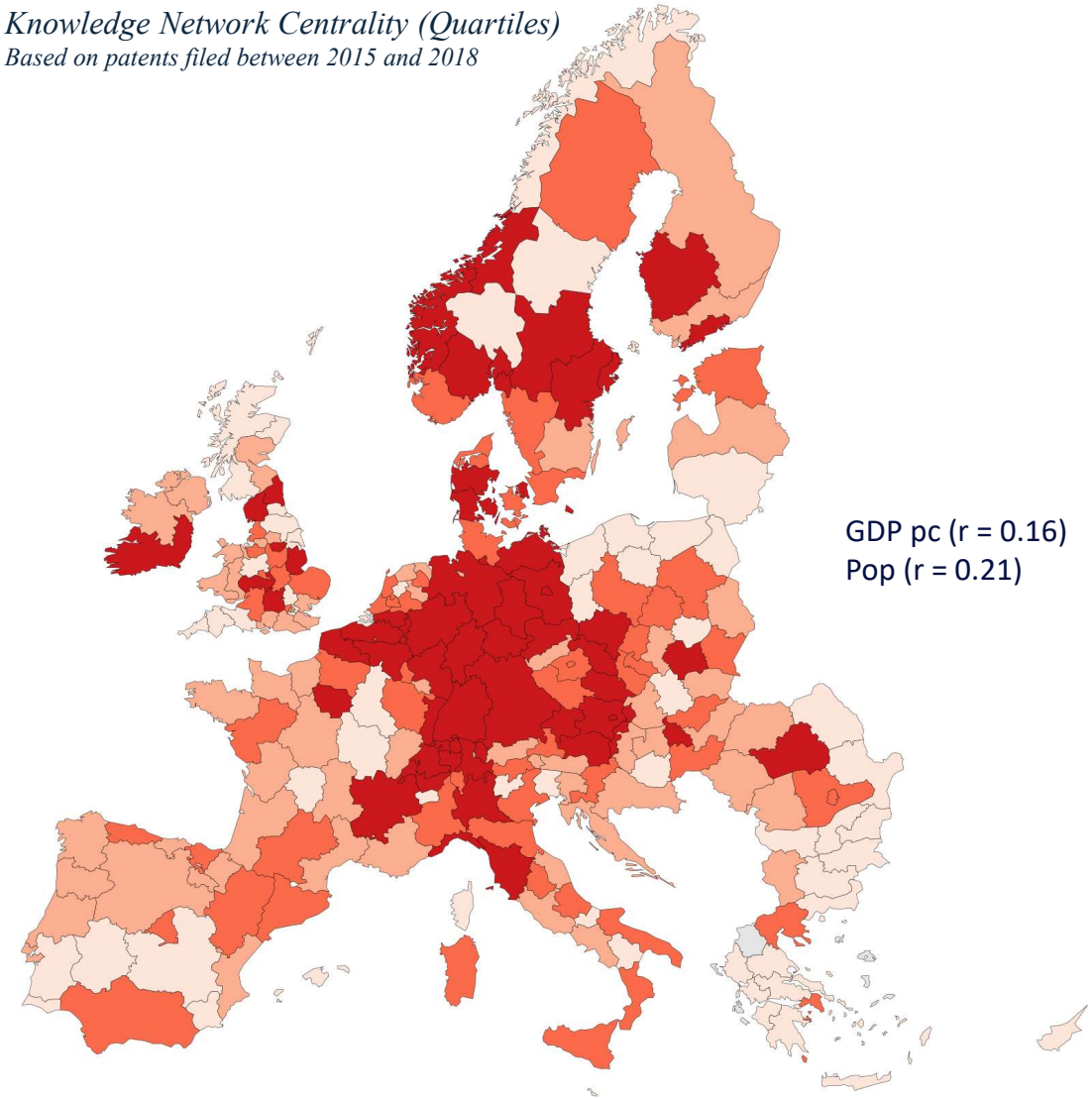
# Connectivity

**In theory:** the extent to which a region is embedded in the global knowledge network

**In practice:**
calculated as the sum of the eigenvector centrality values of externally collaborating patent inventors based in each European region

Resulting in a
**'Knowledge Network Centrality'** indicator

*Knowledge Network Centrality (Quartiles)*
*Based on patents filed between 2015 and 2018*



GDP pc (r = 0.16)
Pop (r = 0.21)

*Source: Network based calculations by the authors based on data from EPO*

More connected regions have higher rates of patent growth

- even if we hold R&D investments constant

**Table 1: R&D and Connectivity for regions in the EU**

| | *Dependent variable:* | | | | |
|---|---|---|---|---|---|
| | Patent Growth (3-year) | | | | |
| | (1) | (2) | (3) | (4) | (5) |
| Baseline Patents(ln) | -7.372*** | -8.924*** | -9.668*** | -11.270*** | -10.914*** |
| | (1.224) | (1.492) | (1.917) | (2.545) | (2.365) |
| Total R&D pc (ln) | | 0.001*** | | 0.001** | 0.003*** |
| | | (0.001) | | (0.001) | (0.001) |
| Connectivity (ln) | | | 0.001** | 0.001** | 0.001** |
| | | | (0.001) | (0.001) | (0.001) |
| Population (ln) | | | | | -0.001* |
| | | | | | (0.0003) |
| Education (%) | | | | | -0.0002 |
| | | | | | (0.0002) |
| GDP pc (ln) | | | | | -0.001 |
| | | | | | (0.002) |
| Manu Emp pc (ln) | | | | | 0.0003 |
| | | | | | (0.001) |
| Constant | 0.011*** | 0.003 | 0.012*** | 0.005** | 0.019 |
| | (0.001) | (0.002) | (0.002) | (0.002) | (0.013) |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Country FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 684 | 684 | 684 | 684 | 684 |
| $R^2$ | 0.237 | 0.247 | 0.248 | 0.259 | 0.266 |
| Adjusted $R^2$ | 0.210 | 0.220 | 0.220 | 0.230 | 0.234 |
| *Note:* | | | | | *p**p***p<0.01 |

**Table 2A: For Regions with above median connectivity**

| | *Dependent variable:* | | |
|---|---|---|---|
| | Patent Growth (3-year) | | |
| | (1) | (2) | (3) |
| Baseline Patents(ln) | -6.939*** | -9.323*** | -9.007*** |
| | (1.246) | (1.838) | (1.982) |
| Total R&D pc (ln) | | 0.003** | 0.004*** |
| | | (0.001) | (0.001) |
| Population (ln) | | | -0.00003 |
| | | | (0.001) |
| Education (%) | | | -0.0002 |
| | | | (0.0002) |
| GDP pc (ln) | | | -0.002 |
| | | | (0.002) |
| Manu Emp pc (ln) | | | 0.0003 |
| | | | (0.001) |
| Constant | 0.012*** | -0.003 | 0.008 |
| | (0.002) | (0.006) | (0.021) |
| Year FE | Yes | Yes | Yes |
| Country FE | Yes | Yes | Yes |
| Observations | 340 | 340 | 340 |
| $R^2$ | 0.336 | 0.349 | 0.356 |
| Adjusted $R^2$ | 0.293 | 0.304 | 0.302 |
| *Note:* | | | *p**p***p<0.01 |

**Table 2B: For Regions with below median connectivity**

| | *Dependent variable:* | | |
|---|---|---|---|
| | Patent Growth (3-year) | | |
| | (1) | (2) | (3) |
| Baseline Patents(ln) | 0.163 | -1.142 | -1.430 |
| | (3.880) | (4.100) | (4.336) |
| Total R&D pc (ln) | | 0.001*** | 0.001* |
| | | (0.0002) | (0.001) |
| Population (ln) | | | -0.0001 |
| | | | (0.0002) |
| Education (%) | | | -0.0001 |
| | | | (0.0001) |
| GDP pc (ln) | | | -0.0005 |
| | | | (0.001) |
| Manu Emp pc (ln) | | | 0.0001 |
| | | | (0.0004) |
| Constant | 0.008*** | 0.006* | 0.011 |
| | (0.003) | (0.003) | (0.008) |
| Year FE | Yes | Yes | Yes |
| Country FE | Yes | Yes | Yes |
| Observations | 344 | 344 | 344 |
| $R^2$ | 0.264 | 0.275 | 0.280 |
| Adjusted $R^2$ | 0.218 | 0.228 | 0.223 |
| *Note:* | | | *p**p***p<0.01 |

R&D investments are more effective in more connected regions

# Can connectivity explain convergence?

- Connectivity is stronger between core regions
  - This is what makes them core regions!
- But connectivity might be more important for peripheral regions
  - Enables access to knowledge sources even from a distance
  - Reduces liability of peripherality
  - Allows smaller regions to "borrow size" from larger ones
- Increased connectivity brings peripheral regions closer to the core – enhancing their capacity for innovation

# Conclusions

- Convergence in patent rates across European regions
  - Less innovative regions are catching up
- This is happening despite continued concentration of public R&D funding in the core regions
  - In contrast, business R&D is being diverted to lagging regions
- Besides R&D investments, connectivity is associated with higher patent growth rates in European regions
- Inter-regional collaboration for innovation increasing
- Many studies of peripheral regions highlight connectivity as a way to overcome challenges of peripheral location
- Overall, connectivity seems to be an important driver of innovation – especially for peripheral regions

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