

# Innovating in peripheries: Comparing North America and Europe

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# Background and motivation (1)

- ❑ **Core areas are decidedly more innovative than peripheral ones**
  - ❑ There are a host of socioeconomic and institutional factors behind this greater dynamism
  - ❑ Innovation in peripheral areas is constrained by unfavourable contexts and geographic isolation
- ❑ **Processes of innovation are contingent on place**
  - ❑ They are shaped by the socioeconomic, institutional and political characteristics of the places in which they occur
  - ❑ No two innovation systems are exactly the same

# Background and motivation (2)

- ❑ Endogenous growth, new economic geography, institutional economics tend to predict an ever increasing concentration of innovation in the core.
- ❑ Peripheries normally considered as innovation-averse
- ❑ **But not all peripheries are the same**
  - ❑ Are all peripheries (cores) the same?
  - ❑ If not why do we tend to recommend similar innovation policies to different cores and peripheries?
  - ❑ Why are peripheries in North America different from those of Europe in Innovation?

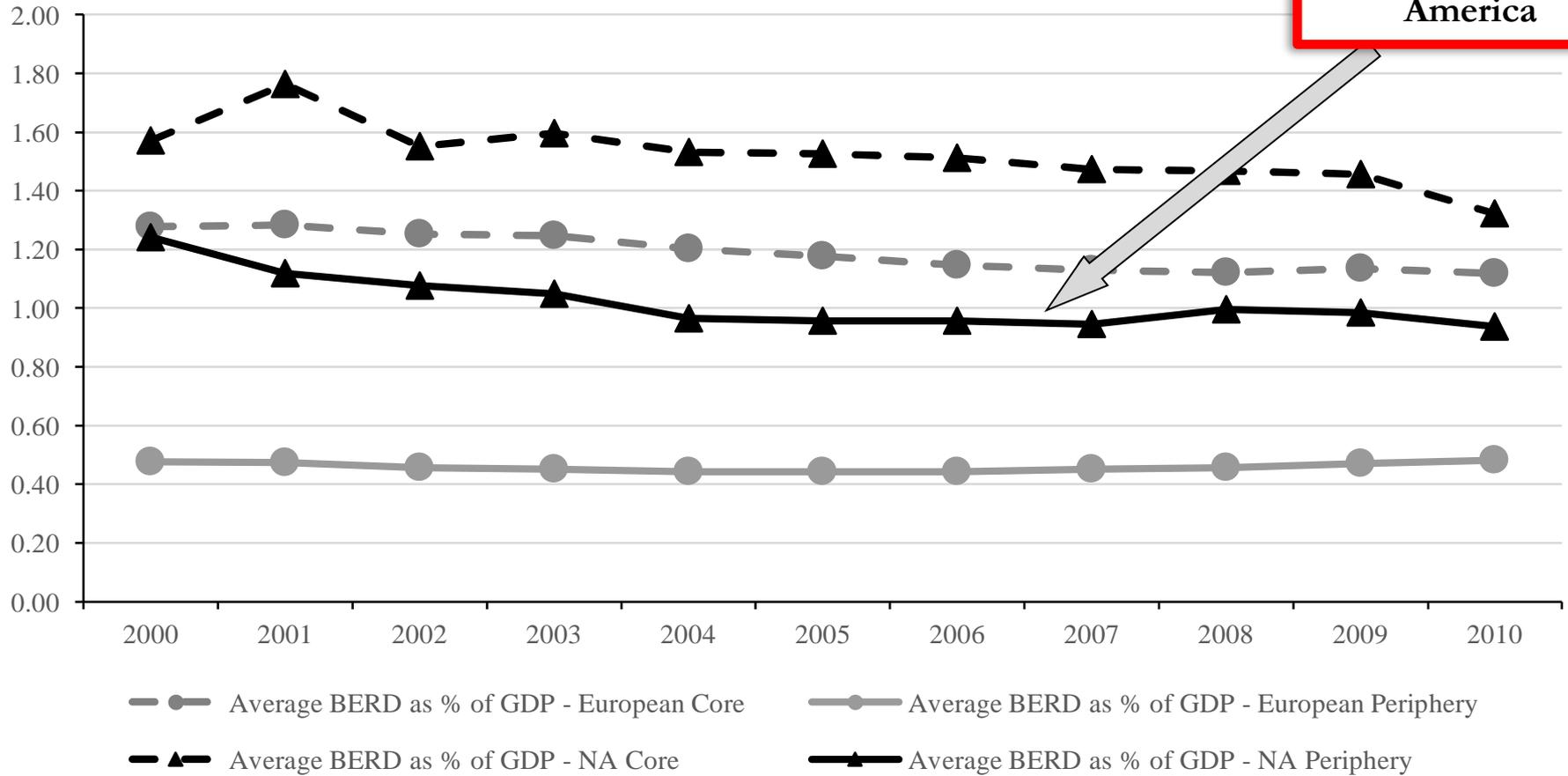
# Research questions

1. Are North American and European peripheries similar in terms of innovation?
2. What are the socioeconomic factors that shape processes of innovation of the periphery of Canada and the United States, and Europe?
3. **How do the factors that govern innovation in the European periphery differ from those of the North American periphery?**

# Empirical approach

- ▣ Macroeconomic investigation of TL2 regions in Canada, US and EU between 2000 and 2010
  - ▣ Canadian provinces, US states and a combination of European NUTS1 and NUTS2 regions
- ▣ Peripherality = > 90% of average GDP per capita

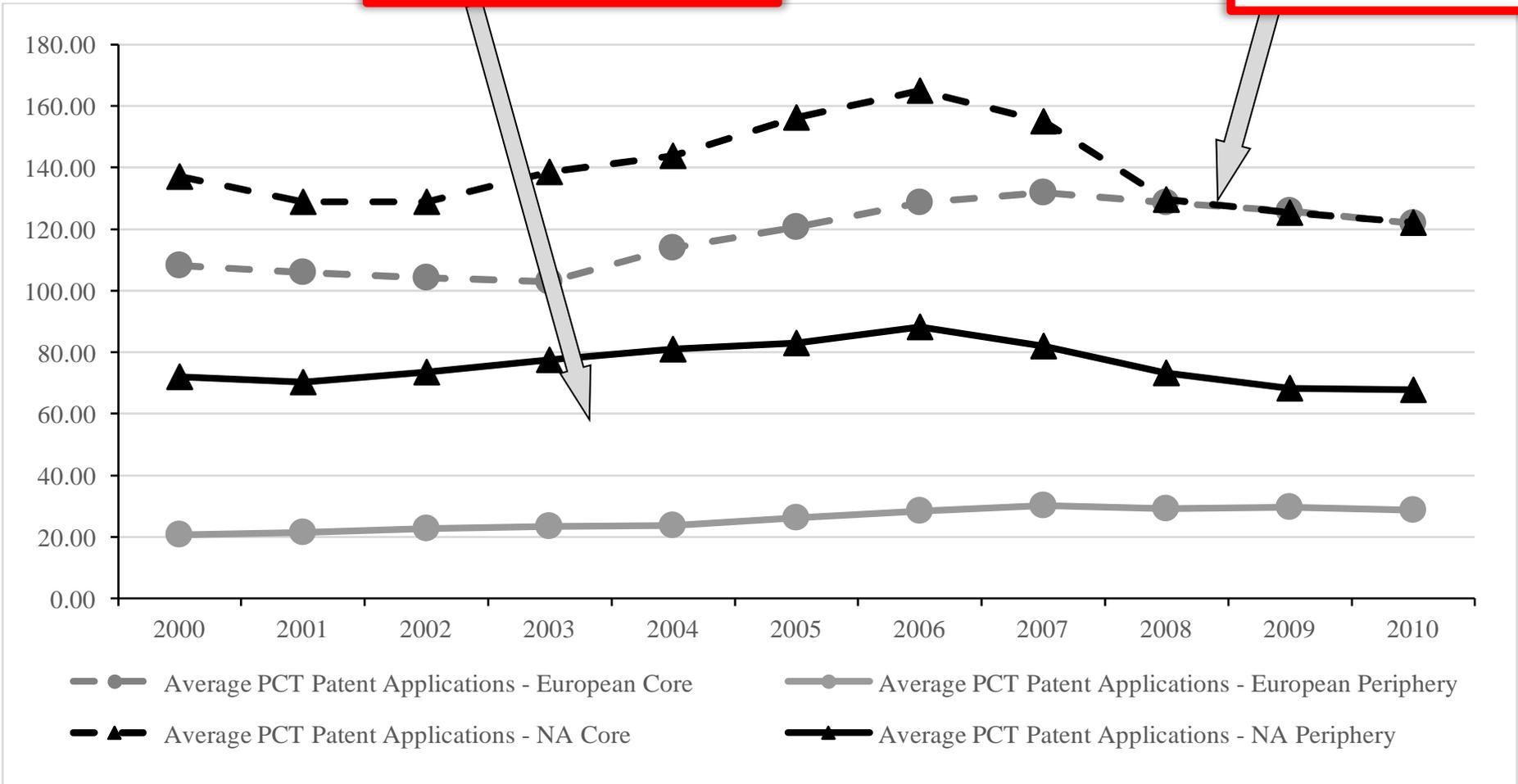
**Greater investment  
in R&D (private  
sector) in North  
America**



*Average regional business enterprise R&D expenditure as a percentage of GDP,  
North American and European core and periphery, 2000-2010*

The gap is in the periphery (2 to 3.5 times more innovative)

No difference in patenting between cores





## Core-Periphery Distinction

Peripheral Regions

Core Regions

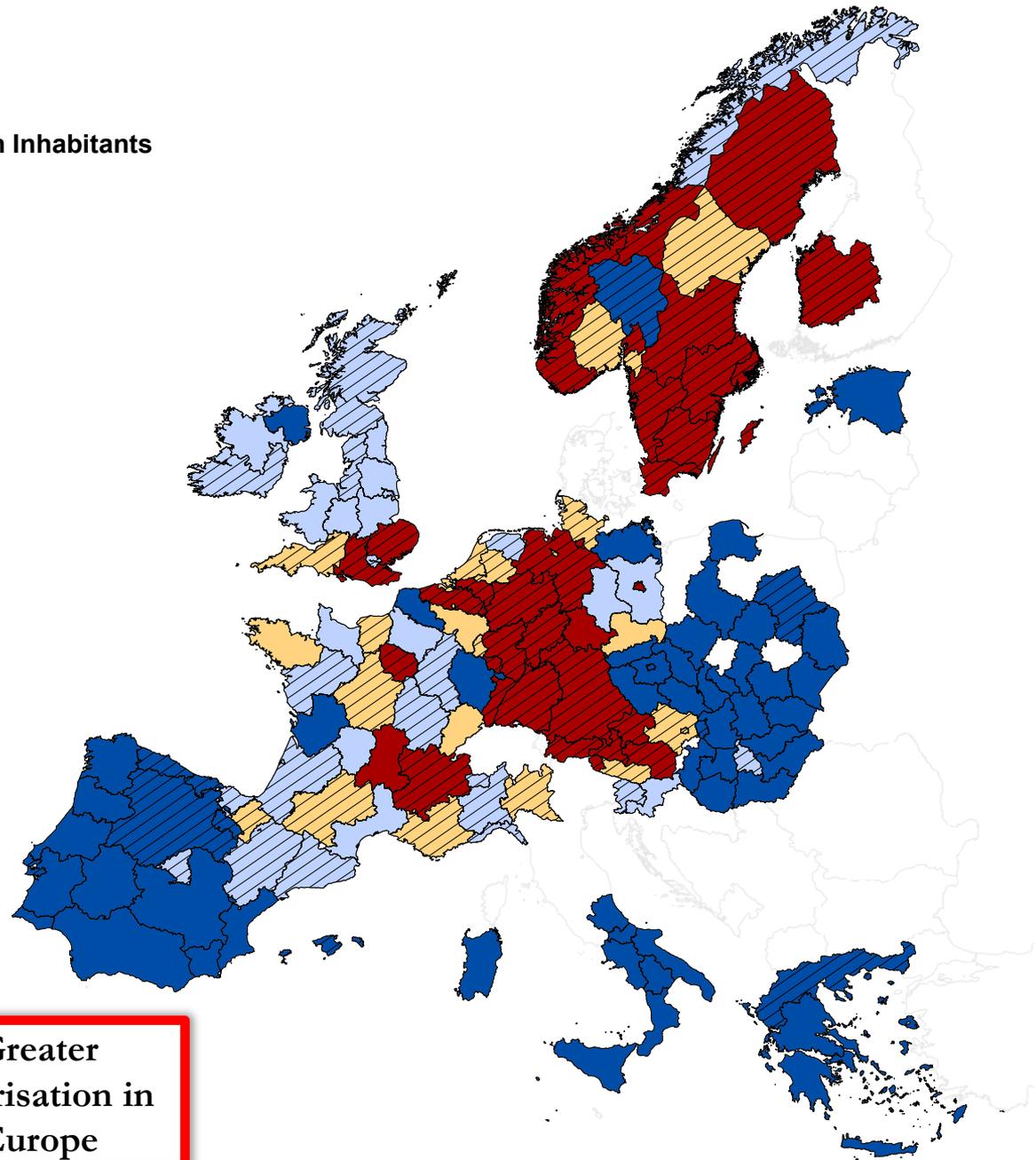
## Regional PCT Patent Applications per Million Inhabitants

Less than 50% European average

50% of European average to European average

European average to 150% of European average

Greater than 150% of European average



Greater  
polarisation in  
Europe

# Model

- Modified knowledge production function:

Regional patenting intensity

Spatially-lagged Regional R&D Expenditure

$$y_{i,t} = \alpha + \beta R\&D_{i,t} + \delta WR\&D_{i,t} + \theta X_{i,t} + \varepsilon_{i,t}$$

Regional R&D Expenditure

Socioeconomic control variables

The diagram illustrates the modified knowledge production function. The equation is  $y_{i,t} = \alpha + \beta R\&D_{i,t} + \delta WR\&D_{i,t} + \theta X_{i,t} + \varepsilon_{i,t}$ . Arrows point from the labels to the corresponding terms in the equation: 'Regional patenting intensity' points to  $y_{i,t}$ ; 'Regional R&D Expenditure' points to  $R\&D_{i,t}$ ; 'Socioeconomic control variables' points to  $X_{i,t}$ ; 'Spatially-lagged Regional R&D Expenditure' points to  $WR\&D_{i,t}$ .

# Independent Variables

|                          |                                    |                                   |
|--------------------------|------------------------------------|-----------------------------------|
| Innovation activities    | Regional Investment in R&D         | Business R&D expenditure          |
|                          |                                    | Higher education R&D expenditure  |
|                          |                                    | Government sector R&D expenditure |
| Socioeconomic conditions | Human capital                      | Tertiary educational attainment   |
|                          | Use of resources                   | Unemployment rate                 |
|                          | Industrial composition             | Employment in industry            |
|                          | Agglomeration of economic activity | Population density                |
|                          | Demographic composition            | % of the population aged 15-24    |

# Spatially-weighted R&D variables

- Two spatially-lagged R&D variables to capture interregional knowledge (R&D) flows
  1. One developed using a first-order contiguity spatial weights matrix ← **shorter-distance knowledge flows**
  1. One developed using an 'inverse distance' spatial weight matrix ← **long-distance knowledge flows**

# North America: Periphery

|  | PCT Patent Applications (ln) |                      |                       |                       |                      |                      |
|--|------------------------------|----------------------|-----------------------|-----------------------|----------------------|----------------------|
|  | (I)                          | (II)                 | (III)                 | (IV)                  | (V)                  | (VI)                 |
| GDP per capita (ln)  | 0.7908<br>(0.5313)           | 0.9184*<br>(0.5425)  | 0.8929<br>(0.6432)    | 0.8615<br>(0.6468)    | 0.7437<br>(0.6327)   | 0.6942<br>(0.6402)   |
| Business enterprise R&D (ln)   | 0.0115<br>(0.0585)           | 0.0245<br>(0.0615)   |                       |                       |                      |                      |
| Higher education R&D (ln)  |                              |                      | 0.1319***<br>(0.0496) | 0.1322***<br>(0.0493) |                      |                      |
| Government sector R&D (ln)   |                              |                      |                       |                       | -0.0424<br>(0.0322)  | -0.0440<br>(0.0329)  |
| Spatially-lagged business enterprise R&D (1st order contiguity) (ln) | 0.3153**<br>(0.1323)         |                      |                       |                       |                      |                      |
| Spatially-lagged business enterprise R&D (inverse distance) (ln)     |                              | 1.3430**<br>(0.6610) |                       |                       |                      |                      |
| Spatially-lagged higher education R&D (1st order contiguity) (ln)    |                              |                      | 0.0667<br>(0.1271)    |                       |                      |                      |
| Spatially-lagged higher education R&D (inverse distance) (ln)        |                              |                      |                       | 0.5474<br>(0.4012)    |                      |                      |
| Spatially-lagged government sector R&D (1st order contiguity) (ln)   |                              |                      |                       |                       | -0.0299<br>(0.0508)  |                      |
| Spatially-lagged government sector R&D (inverse distance) (ln)       |                              |                      |                       |                       |                      | -0.1636<br>(0.1327)  |
| Tertiary educational attainment                                      | 0.0468***<br>(0.0171)        | 0.0429**<br>(0.0179) | 0.0343*<br>(0.0179)   | 0.0326*<br>(0.0180)   | 0.0381**<br>(0.0187) | 0.0374**<br>(0.0191) |
| Unemployment rate  | -0.015<br>(0.0238)           | -0.0194<br>(0.0248)  | -0.0167<br>(0.0261)   | -0.0147<br>(0.0255)   | -0.0108<br>(0.0261)  | -0.0110<br>(0.0257)  |
| Employment in industry   | -0.0248<br>(0.0177)          | -0.0213<br>(0.0191)  | -0.0160<br>(0.0200)   | -0.0168<br>(0.0206)   | -0.0233<br>(0.0198)  | -0.0235<br>(0.0200)  |
| Population density (ln)  | 0.2032**<br>(0.0919)         | 0.1822*<br>(0.1022)  | 0.2052*<br>(0.1109)   | 0.1983*<br>(0.1165)   | 0.1933*<br>(0.1167)  | 0.2040<br>(0.1250)   |
| Percentage of the population aged 16-24                              | 0.0568**<br>(0.0242)         | 0.0747**<br>(0.0295) | 0.0523<br>(0.0321)    | 0.0375<br>(0.0282)    | 0.0511*<br>(0.0305)  | 0.0467*<br>(0.0279)  |
| Constant   | 5.3305<br>(5.3305)           | 5.3135<br>(5.3135)   | 6.3199<br>(6.3199)    | 6.4318<br>(6.4318)    | 6.2804<br>(6.2804)   | 6.3093<br>(6.3093)   |
| Macro-region fixed-effects   | Yes                          | Yes                  | Yes                   | Yes                   | Yes                  | Yes                  |
| Time fixed-effects   | Yes                          | Yes                  | Yes                   | Yes                   | Yes                  | Yes                  |
| Observations   | 297                          | 297                  | 297                   | 297                   | 297                  | 297                  |
| Overall R2   | 0.7826                       | 0.7495               | 0.6866                | 0.6745                | 0.6636               | 0.6563               |

Robust S.E. in parenthesis. \*\*\* indicates significance at 1% level; \*\* indicates significance at 5% level; \* indicates significance at 10% level.

Innovation driven by higher education R&D, in more educated, more dense and younger less developed regions. Extensive role for spillovers

# North America: Core

**Situation  
not  
dissimilar  
from that of  
the  
periphery**

|  | PCT Patent Applications (ln) |                       |                      |                      |                       |                       |
|--|------------------------------|-----------------------|----------------------|----------------------|-----------------------|-----------------------|
|  | (I)                          | (II)                  | (III)                | (IV)                 | (V)                   | (VI)                  |
| GDP per capita (ln)  | -0.1470<br>(0.2152)          | -0.1241<br>(0.2091)   | 0.3234<br>(0.2176)   | 0.2932<br>(0.2129)   | -0.0277<br>(0.2287)   | 0.0024<br>(0.2312)    |
| Business enterprise R&D (ln)   | 0.0883*<br>(0.0519)          | 0.0811<br>(0.0542)    |                      |                      |                       |                       |
| Higher education R&D (ln)  |                              |                       | 0.3687**<br>(0.1816) | 0.3669**<br>(0.1823) |                       |                       |
| Government sector R&D (ln)   |                              |                       |                      |                      | 0.0235<br>(0.0280)    | 0.0250<br>(0.0283)    |
| Spatially-lagged business enterprise R&D (1st order contiguity) (ln) | -0.0153<br>(0.0849)          |                       |                      |                      |                       |                       |
| Spatially-lagged business enterprise R&D (inverse distance) (ln)     |                              | -0.3063<br>(0.2580)   |                      |                      |                       |                       |
| Spatially-lagged higher education R&D (1st order contiguity) (ln)    |                              |                       | -0.4485*<br>(0.2626) |                      |                       |                       |
| Spatially-lagged higher education R&D (inverse distance) (ln)        |                              |                       |                      | -0.0078<br>(0.0909)  |                       |                       |
| Spatially-lagged government sector R&D (1st order contiguity) (ln)   |                              |                       |                      |                      | 0.0178<br>(0.0356)    |                       |
| Spatially-lagged government sector R&D (inverse distance) (ln)       |                              |                       |                      |                      |                       | 0.1607*<br>(0.0878)   |
| Tertiary educational attainment                                      | 0.0427***<br>(0.0146)        | 0.0431***<br>(0.0145) | 0.0357**<br>(0.0153) | 0.0343**<br>(0.0152) | 0.0376***<br>(0.0139) | 0.0367***<br>(0.0137) |
| Unemployment rate  | -0.0321<br>(0.0223)          | -0.0303<br>(0.0218)   | -0.0264<br>(0.0187)  | -0.0299<br>(0.0191)  | -0.0356<br>(0.0223)   | -0.0360*<br>(0.0213)  |
| Employment in industry   | 0.0273<br>(0.0227)           | 0.0264<br>(0.0227)    | 0.0211<br>(0.0237)   | 0.0227<br>(0.0237)   | 0.0224<br>(0.0240)    | 0.0185<br>(0.0230)    |
| Population density (ln)  | 0.2107**<br>(0.0913)         | 0.2145**<br>(0.0948)  | 0.1964*<br>(0.1103)  | 0.1934*<br>(0.1127)  | 0.2077**<br>(0.1020)  | 0.1912*<br>(0.1069)   |
| Percentage of the population aged 16-24                              | -0.0936<br>(0.0652)          | -0.0992<br>(0.0655)   | -0.1026<br>(0.0676)  | -0.0926<br>(0.0706)  | -0.0969<br>(0.0737)   | -0.0950<br>(0.0711)   |
| Constant   | 5.4212**<br>(2.2607)         | 5.3577**<br>(2.2375)  | 1.1897<br>(2.1180)   | 1.2167<br>(2.1907)   | 4.4345*<br>(2.5510)   | 4.3900*<br>(2.6018)   |
| Macro-region fixed-effects   | Yes                          | Yes                   | Yes                  | Yes                  | Yes                   | Yes                   |
| Time fixed-effects   | Yes                          | Yes                   | Yes                  | Yes                  | Yes                   | Yes                   |
| Observations   | 374                          | 374                   | 374                  | 374                  | 374                   | 374                   |
| Overall R2   | 0.6813                       | 0.6743                | 0.5504               | 0.5522               | 0.5941                | 0.5749                |

Robust S.E. in parenthesis. \*\*\* indicates significance at 1% level; \*\* indicates significance at 5% level; \* indicates significance at 10% level.

# Europe: Periphery

|  | PCT Patent Applications (ln) |                        |                        |                        |                        |                        |
|--|------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
|  | (I)                          | (II)                   | (III)                  | (IV)                   | (V)                    | (VI)                   |
| GDP per capita (ln)  | 0.7590**<br>(0.2166)         | 0.6869**<br>(0.2278)   | 0.5432<br>(0.3830)     | 0.5266<br>(0.4122)     | 0.6473*<br>(0.3600)    | 0.6698*<br>(0.3644)    |
| Business enterprise R&D (ln)   | 0.2259***<br>(0.0667)        | 0.2277***<br>(0.0651)  |                        |                        |                        |                        |
| Higher education R&D (ln)  |                              |                        | 0.0927<br>(0.0594)     | 0.1039<br>(0.0637)     |                        |                        |
| Government sector R&D (ln)   |                              |                        |                        |                        | 0.0293<br>(0.0284)     | 0.0263<br>(0.0286)     |
| Spatially-lagged business enterprise R&D (1st order contiguity) (ln) | 0.1100<br>(0.0690)           |                        |                        |                        |                        |                        |
| Spatially-lagged business enterprise R&D (inverse distance) (ln)     |                              | 1.1276**<br>(0.5701)   |                        |                        |                        |                        |
| Spatially-lagged higher education R&D (1st order contiguity) (ln)    |                              |                        | 0.2074**<br>(0.0917)   |                        |                        |                        |
| Spatially-lagged higher education R&D (inverse distance) (ln)        |                              |                        |                        | 1.0965<br>(0.6929)     |                        |                        |
| Spatially-lagged government sector R&D (1st order contiguity) (ln)   |                              |                        |                        |                        | -0.0748<br>(0.0829)    |                        |
| Spatially-lagged government sector R&D (inverse distance) (ln)       |                              |                        |                        |                        |                        | 0.3850*<br>(0.2336)    |
| Tertiary educational attainment                                      | 0.0189*<br>(0.0106)          | 0.0166<br>(0.0111)     | 0.0207*<br>(0.0109)    | 0.0201*<br>(0.0111)    | 0.0205*<br>(0.0105)    | 0.0211**<br>(0.0103)   |
| Unemployment rate  | 0.0045<br>(0.0057)           | 0.0024<br>(0.0061)     | 0.0104<br>(0.0065)     | 0.0091<br>(0.0066)     | 0.0097<br>(0.0065)     | 0.0094<br>(0.0065)     |
| Employment in industry   | 0.0027<br>(0.0046)           | 0.0027<br>(0.0047)     | 0.0090*<br>(0.0049)    | 0.0097*<br>(0.0051)    | 0.0080*<br>(0.0048)    | 0.0086*<br>(0.0049)    |
| Population density (ln)  | 0.2625***<br>(0.0817)        | 0.2603***<br>(0.0799)  | 0.2878***<br>(0.0992)  | 0.3044***<br>(0.1028)  | 0.2782***<br>(0.0999)  | 0.3059***<br>(0.0956)  |
| Percentage of the population aged 16-24                              | -0.1402***<br>(0.0310)       | -0.1373***<br>(0.0297) | -0.1641***<br>(0.0329) | -0.1698***<br>(0.0350) | -0.1724***<br>(0.0355) | -0.1623***<br>(0.0343) |
| Constant   | -3.6854<br>(3.3982)          | -2.9741<br>(3.5828)    | -1.1611<br>(4.0970)    | -0.1333<br>(4.7127)    | -2.3792<br>(3.8212)    | -2.1613<br>(3.9514)    |
| Macro-region fixed-effects   | Yes                          | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Time fixed-effects   | Yes                          | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Observations   | 768                          | 768                    | 757                    | 757                    | 768                    | 768                    |
| Overall R2   | 0.8650                       | 0.8654                 | 0.8432                 | 0.8447                 | 0.8478                 | 0.8478                 |

Robust S.E. in parenthesis. \*\*\* indicates significance at 1% level; \*\* indicates significance at 5% level; \* indicates significance at 10% level.

Innovation driven by business enterprise R&D, in more educated, more dense regions. Young population a barrier for innovation. More limited role for spillovers

# Europe: Core

Relatively similar to the core, with a stronger role for business R&D and skills

|  | PCT Patent Applications (ln) |                        |                        |                        |                        |                        |
|--|------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
|  | (I)                          | (II)                   | (III)                  | (IV)                   | (V)                    | (VI)                   |
| GDP per capita (ln)  | 0.1608<br>(0.1948)           | 0.1712<br>(0.1961)     | -0.0990<br>(0.2400)    | -0.0905<br>(0.2331)    | -0.0908<br>(0.2451)    | -0.0666<br>(0.2407)    |
| Business enterprise R&D (ln)   | 0.2661***<br>(0.0733)        | 0.2693***<br>(0.0754)  |                        |                        |                        |                        |
| Higher education R&D (ln)  |                              |                        | -0.0577<br>(0.0597)    | -0.0594<br>(0.0597)    |                        |                        |
| Government sector R&D (ln)   |                              |                        |                        |                        | 0.0184<br>(0.0382)     | 0.0379<br>(0.0306)     |
| Spatially-lagged business enterprise R&D (1st order contiguity) (ln) | 0.0237<br>(0.0565)           |                        |                        |                        |                        |                        |
| Spatially-lagged business enterprise R&D (inverse distance) (ln)     |                              | 0.5102**<br>(0.2220)   |                        |                        |                        |                        |
| Spatially-lagged higher education R&D (1st order contiguity) (ln)    |                              |                        | -0.0767*<br>(0.0448)   |                        |                        |                        |
| Spatially-lagged higher education R&D (inverse distance) (ln)        |                              |                        |                        | -0.7029<br>(0.4746)    |                        |                        |
| Spatially-lagged government sector R&D (1st order contiguity) (ln)   |                              |                        |                        |                        | 0.0941<br>(0.0850)     |                        |
| Spatially-lagged government sector R&D (inverse distance) (ln)       |                              |                        |                        |                        |                        | 0.8098*<br>(0.4828)    |
| Tertiary educational attainment                                      | 0.0167***<br>(0.0057)        | 0.0166***<br>(0.0057)  | 0.0201***<br>(0.0074)  | 0.0197***<br>(0.0075)  | 0.0162**<br>(0.0067)   | 0.0167**<br>(0.0067)   |
| Unemployment rate  | -0.0157*<br>(0.0082)         | -0.0152*<br>(0.0081)   | -0.0138*<br>(0.0083)   | -0.0137*<br>(0.0083)   | -0.0159*<br>(0.0085)   | -0.0166***<br>(0.0084) |
| Employment in industry   | 0.0076<br>(0.0060)           | 0.0080<br>(0.0057)     | 0.0079<br>(0.0064)     | 0.0085<br>(0.0063)     | 0.0082<br>(0.0065)     | 0.0088<br>(0.0065)     |
| Population density (ln)  | 0.1050*<br>(0.0539)          | 0.1101**<br>(0.0526)   | 0.1630***<br>(0.0561)  | 0.1650***<br>(0.0552)  | 0.1724***<br>(0.0599)  | 0.1517**<br>(0.0611)   |
| Percentage of the population aged 16-24                              | -0.0725***<br>(0.0172)       | -0.0641***<br>(0.0167) | -0.0998***<br>(0.0207) | -0.0996***<br>(0.0202) | -0.1000***<br>(0.0206) | -0.0947***<br>(0.0199) |
| Constant   | 2.9043<br>(1.8711)           | 2.6741<br>(1.8960)     | 5.4932**<br>(2.3235)   | 4.7492**<br>(2.2578)   | 5.8503**<br>(2.3949)   | 6.7221***<br>(2.4804)  |
| Macro-region fixed-effects   | Yes                          | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Time fixed-effects   | Yes                          | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Observations   | 888                          | 888                    | 884                    | 888                    | 888                    | 888                    |
| Overall R2   | 0.8413                       | 0.8412                 | 0.7564                 | 0.7637                 | 0.7588                 | 0.7482                 |

Robust S.E. in parenthesis. \*\*\* indicates significance at 1% level; \*\* indicates significance at 5% level; \* indicates significance at 10% level.

# Comparative axes

- ▣ The research draws comparisons along three axes:
  1. North American core v. periphery
  2. European core v. periphery
  3. **North American periphery v. European periphery**

# The North American core vs. the North American periphery

- ❑ Key similarities:
  - ❑ Returns to higher education R&D expenditure
  - ❑ Importance of human capital and agglomeration
- ❑ Key differences:
  - ❑ Returns to business R&D in the core
  - ❑ Importance of short and long-distance business R&D knowledge flows in the periphery
  - ❑ Importance of demographic composition in the periphery

# The European core vs. the European periphery

- ❑ Key similarities:
  - ❑ Returns to business R&D expenditure
  - ❑ Importance of human capital and agglomeration
  - ❑ Importance of long distance business enterprise R&D knowledge flows
  
- ❑ Key differences:
  - ❑ Importance of higher education R&D knowledge flows in the periphery
  - ❑ Negative coefficient for higher education R&D knowledge flows in the core
  - ❑ Importance of industrial composition in the periphery
  - ❑ Importance of mobilisation of human capital in the core

# The North American periphery vs. the European periphery

- ❑ Key similarities:
  - ❑ Importance of human capital and agglomeration
  - ❑ Importance of interregional R&D knowledge flows
    - ❑ ...but different kinds (and distances)
  
- ❑ Key differences:
  - ❑ Returns to R&D investment
    - ❑ Business R&D in EU
    - ❑ Higher education R&D in NA
  - ❑ Importance of industrial composition in EU
  - ❑ Demographic composition has opposite effect

# Conclusions

1. The set of socioeconomic factors that governs innovation in the European periphery, despite some similarities, differs from that of the North American periphery
  - ▣ Innovation policies pursued in either context must be tailored accordingly
2. Similarly, the socioeconomic factors that govern processes of innovation in core regions differ from those of peripheral regions
3. But greater similarities between core and peripheries in North America and Europe than between North American and European peripheries
  - ▣ North American and European systems of innovation differ significantly
4. Need to tailor policies according to these different conditions
  - ▣ Addressing structural conditions (i.e. human capital) essential for impelling innovation in peripheral regions in EU and NA alike
  - ▣ In both the EU and NA, peripheral regions benefit from the innovative activities of distant (likely core) territories suggesting that the promotion of extra-local connections – “pipelines” – should be integrated into peripheral innovation strategies

# Innovating in peripheries: Comparing North America and Europe

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