

The impact of foreign direct investments on regional innovation

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Outline

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Mechanisms

Empirical strategy

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Background and aims

- ▶ EU **promotes within-EU** flows of cross-borders **investments**
- ▶ **Extra-EU** flows are under the EC's **scrutiny** ⇒ mitigate the negative impacts of FDIs (e.g. EU Merger Regulation, Council Regulation (EC) No 139/2004)
- ▶ **Ambiguous** impact of cross-border (innovative) investment flows on the **innovation** of the **target** region
- ▶ **Existing empirical literature** ⇒ **limited consideration** of the for the **endogeneity** of investment flows

Our **contribution**:

- ▶ Provide **empirical evidence** on the link between innovative **inward FDIs** (both greenfield and brownfield) and **patent applications** for EU NUTS3 **regions** accounting for the **endogeneity** of FDIs
- ▶ Identify relevant **economic mechanisms**

Mechanisms

- ▶ **Knowledge spillovers**
 - ▶ Diffusion of knowledge from foreign MNE to local firms in the recipient region (positive effect)
- ▶ **War for talents**
 - ▶ Especially for GF, the newly created company looks for talented inventors (locally) and creates disruptions to the local labour market (e.g. wage premium to be paid by incumbent local firms) and in the local network of inventors (negative effect)
- ▶ **Direct effects**
 - ▶ Access to the knowledge (and facilities) of the foreign MNE could increase the productivity of inventors (positive effect)

Empirical strategy

- ▶ We **estimate** the following **equation**:

$$Y_{i;t,t+2} = \alpha_i + \beta FDI_{i;t-1,t-3} + X'_{i;t-1}\theta + \tau_t + \varepsilon_{i;t}$$

- ▶ **Endogeneity** concerns
 - ▶ Innovative **FDIs** attracted by **regions** with high **innovation potential** \Rightarrow **reverse causality** (OLS/FE biased upward)
 - ▶ **'Good' local conditions** (e.g. business environment, availability of skills and infrastructure, local policies, etc.): **favour local innovation** and **attract FDIs** \Rightarrow **omitted variable** bias (OLS/FE biased upward)
 - ▶ Omitted variable even **more important** for **greenfield** FDIs than for M&A \Rightarrow decisions about GF consider **local conditions**, decisions about **M&A** consider the **characteristics** of the **target company** (while local conditions could be secondary)

Rationale of the IV

- ▶ **Structural characteristics** of **target regions** as a source of **exogenous variation** in the number of **inward FDI projects**
- ▶ **Frankel and Romer (1999 AER)** and **Ortega and Peri (2014 JIE)** ⇒ value of **import** and **export** given **geographical** and **structural characteristics** via a **gravity model** for bilateral trade flows
- ▶ **Predicted total value** of import and export from the gravity model as an **instrumental variable** for trade in a growth regression ⇒ they keep the **exogenous component** of **trade** patterns
- ▶ **Miguelez and Moreno (2015 RP)**: approach extended to **migrations** of **inventors** across EU regions
- ▶ We consider **dyadic FDI flows** of different kinds and estimate the **predicted inward flow** of FDI given **structural characteristics** from a **gravity** model

Summary of the main results

- ▶ Accounting for the **endogeneity** of FDIs **matters**
- ▶ **No significant** effect on local patenting of **M&A**, **negative** effect of **greenfield** FDIs
- ▶ **Larger** negative impact for **new inventors** than for incumbent ⇒ **disruption** in **local networks**
- ▶ **Opposite** signs for **outward** innovative FDI ⇒ **learning** from doing FDI (more than receiving FDI)
- ▶ Poor **absorptive capacity** worsens the negative effect
- ▶ **Tight local supply** of **talents** implies a more negative effect

Table: Main results

Patent applications (t;t+2, log)	Pooled OLS		Fixed effects		IV fixed effects	
	Region of inventor	Region of applicant	Region of inventor	Region of applicant	Region of inventor	Region of applicant
Inward innovative GF FDI (t-1; t-3 in log)	0.263*** (0.0532)	0.264*** (0.0545)	0.0106 (0.00960)	-0.00108 (0.0135)	-0.649*** (0.170)	-0.538*** (0.142)
Inward innovative BF FDI (t-1; t-3 in log)	0.438*** (0.0487)	0.535*** (0.0617)	-0.00727 (0.00846)	-0.00684 (0.0107)	0.0913 (0.125)	0.0958 (0.121)
Share of industrial GVA (t-1)	3.516*** (0.465)	3.215*** (0.537)	1.639*** (0.548)	1.246* (0.660)	0.689 (0.496)	0.487 (0.468)
Patent specialisation index (t-1)	-3.835*** (0.228)	-4.307*** (0.263)	-0.0472 (0.0799)	-0.190*** (0.0734)	-0.0180 (0.0787)	-0.168** (0.0711)
Population (t-1, in log)	0.308*** (0.0427)	0.407*** (0.0498)	-0.208 (0.401)	0.608 (0.432)	-0.835* (0.466)	0.0650 (0.417)
GDP pc (t-1, log)	0.198 (0.130)	0.217 (0.148)	0.898*** (0.344)	0.932** (0.433)	1.036*** (0.250)	1.043*** (0.283)
3-years growth in GDP pc (t-1)	-0.135 (0.608)	0.106 (0.440)	0.735*** (0.182)	0.831*** (0.190)	0.705*** (0.229)	0.801*** (0.251)
3-years growth in GDP pc (country, t-1)	1.336 (0.954)	-0.283 (0.869)	-1.223*** (0.277)	-0.796** (0.347)	-0.756** (0.309)	-0.406 (0.308)
Corporate tax rate (country, t-1)	0.0688*** (0.00713)	0.0571*** (0.00859)	0.0239*** (0.00312)	0.0210*** (0.00334)	0.0122*** (0.00456)	0.0117*** (0.00403)
F-test of excluded IV in first stage					11.82	11.82
N	9180	9180	9180	9180	9180	9180

Regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included.

Table: Outward FDI

Patent applications in t, t+2 (log)	Region of inventor	Region of inventor	Region of applicant	Region of applicant
Outward innovative GF FDI projects (t-1; t-3, in log)	0.508** (0.226)		0.715** (0.303)	
Outward innovative BF FDI projects (t-1; t-3, in log)		0.238 (0.182)		0.150 (0.185)
F-test of excluded IV in first stage	6.825	6.548	6.825	6.548
N	9180	9180	9180	9180

IV-FE regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included. Additional control variables: share of industrial GVA (t-1), Patent specialisation index (t-1), Population (t-1, in log), GDP per capita (t-1, in log), 3-years growth in GDP per capita (t-1), 3-years growth in GDP per capita (country-level, t-1), Corporate tax rate (country-level, t-1).

Table: Persistent vs new inventors

Patent applications in t, t+2 (log)	Persistent inventors; Region of inventor	New inventors; Region of inventor
Inward innovative GF FDI projects (t-1; t-3 in log)	-0.376** (0.172)	-0.761*** (0.190)
Inward innovative BF FDI projects (t-1; t-3 in log)	0.226** (0.109)	0.0206 (0.144)
F-test of excluded IV in first stage	11.82	11.82
N	9180	9180

FE-IV regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included. Additional control variables: share of industrial GVA (t-1), Patent specialisation index (t-1), Population (t-1, in log), GDP per capita (t-1, in log), 3-years growth in GDP per capita (t-1), 3-years growth in GDP per capita (country-level, t-1), Corporate tax rate (country-level, t-1).

Table: Interaction with GDP per capita dummy

Patent applications in t, t+2 (log)	Region of inventor	Region of inventor	Region of applicant	Region of applicant
Inward innovative GF FDI projects (t-1; t-3, in log)	-0.346** (0.152)		-0.344** (0.135)	
Inward innovative GF FDI projects (t-1; t-3, in log) x low-income dummy	-0.625** (0.269)		-0.363 (0.233)	
Inward innovative BF FDI projects (t-1; t-3, in log)		0.0978 (0.0636)		0.113** (0.0536)
Inward innovative BF FDI projects (t-1; t-3, in log) x low-income dummy		-0.0840 (0.107)		-0.195** (0.0761)
Net effect for low-income regions	-0.971*** (0.349)	0.0138 (0.121)	-0.706** (0.295)	-0.0814 (0.0840)
F-test of excluded IV in first stage	8.930	27.31	8.930	27.31
N	9180	9180	9180	9180

FE-IV regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included. Additional control variables: share of industrial GVA (t-1), Patent specialisation index (t-1), Population (t-1, in log), GDP per capita (t-1, in log), 3-years growth in GDP per capita (t-1), 3-years growth in GDP per capita (country-level, t-1), Corporate tax rate (country-level, t-1), Linear trend for low-income regions.

Table: Interaction with human capital

Patent applications in t, t+2 (log)	Region of inventor	Region of inventor	Region of applicant	Region of applicant
Share LF tertiary educ or science & tech	-0.355** (0.170)	0.221*** (0.0708)	-0.246 (0.151)	0.278*** (0.0929)
Inward innovative GF FDI projects (t-1; t-3, in log)	-1.016*** (0.265)		-0.824*** (0.229)	
Inward innovative GF FDI projects (t-1; t-3, in log) x share LF tertiary educ or science & tech	0.365*** (0.109)		0.284*** (0.0968)	
Inward innovative BF FDI projects (t-1; t-3, in log)		0.149** (0.0600)		0.154** (0.0708)
Inward innovative BF FDI projects (t-1; t-3, in log) x share LF tertiary educ or science & tech		-0.101*** (0.0389)		-0.126*** (0.0424)
Net effect for Q1 of tertiary educ or science & tech	-0.881*** (0.230)	0.111* (0.0574)	-0.719*** (0.199)	0.108 (0.0689)
Net effect for Q3 of tertiary educ or science & tech	-0.783*** (0.206)	0.0839 (0.0577)	-0.642*** (0.178)	0.0739 (0.0698)
F-test of excluded IV in first stage	9.692	24.86	9.692	24.86
N	9135	9135	9135	9135

FE-IV regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included. Additional control variables: share of industrial GVA (t-1), Patent specialisation index (t-1), Population (t-1, in log), GDP per capita (t-1, in log), 3-years growth in GDP per capita (t-1), 3-years growth in GDP per capita (country-level, t-1), Corporate tax rate (country-level, t-1), Linear trend for low-income regions.

Policy implications

- ▶ **Attraction of innovative FDI** not per se **positively** related to **innovation** output, quite the opposite
 - ▶ Policy makers want to attract MNEs for **other benefits** (e.g. local multipliers)
 - ▶ Need to **mitigate** the **negative impact** on **innovation**
- ▶ **Negative** impact of **greenfield** innovative FDI on **innovation** due to:
 - ▶ **Pressures** on **local labour markets** for **talents** ⇒ increase the **local supply of human capital** might **not** be enough
 - ▶ **Failure** to reap the benefits of **knowledge spillovers** ⇒ **develop** local **absorptive capacity**
 - ▶ **New potential inventors** negatively affected ⇒ targeted **programmes** to **compensate** these entrants as **local networks** are **disrupted** by the arrival of the MNE

THANK YOU FOR YOUR ATTENTION

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Data sources

- ▶ **Patent data**
 - ▶ OECD-REGPAT Database
 - ▶ EPO patent applications by priority year and NUTS3 region of the inventor/applicant
- ▶ **Greenfield FDI**
 - ▶ fDI Markets
 - ▶ Number of FDI project by target region
 - ▶ Innovative FDI ⇒ business activities: R&D; Design, Development & Testing
- ▶ **Brownfield FDI (M&A)**
 - ▶ Zephyr-BvD database
 - ▶ Number M&A by target region
 - ▶ Innovative FDI ⇒ target company with active patent portfolio
- ▶ Other **control variables** at the region level (Cambridge Econometrics database) and country-level (regulation/policy)

Figure: Inward FDI flows and patents per capita (level)

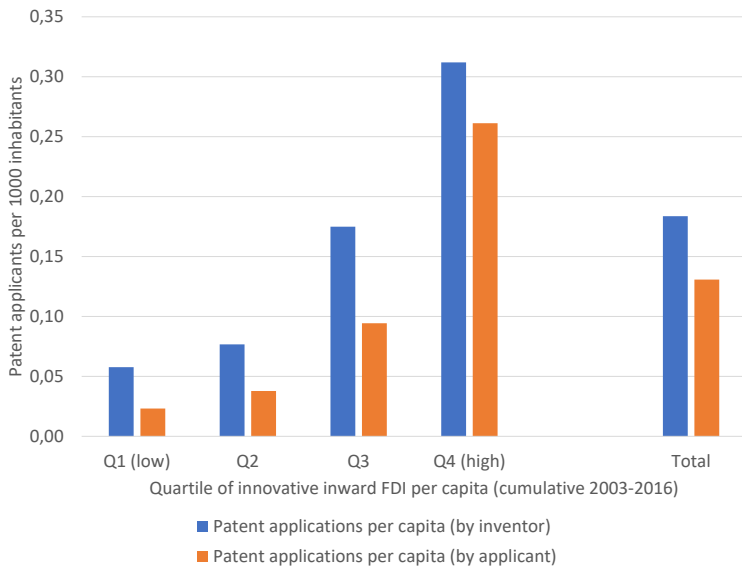
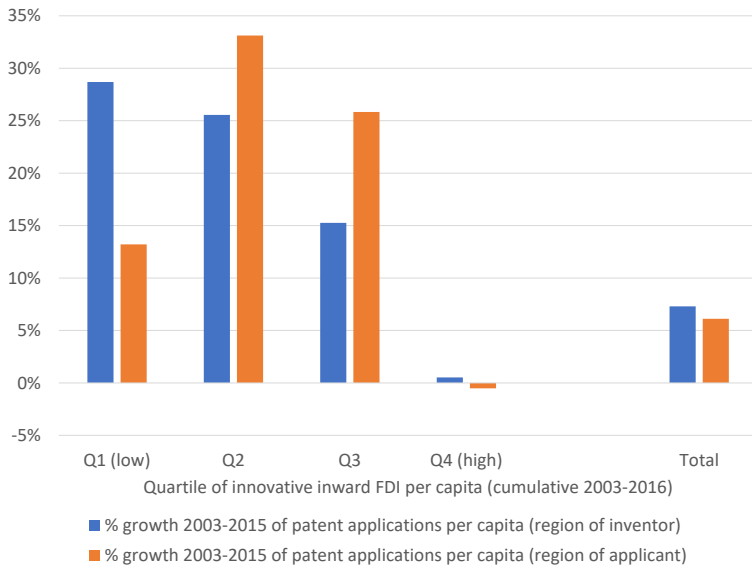


Figure: Inward FDI flows and patents per capita (growth rate)



Details of the IV

- ▶ **Year-by-year cross-sectional gravity equations** (with PPML) of bilateral FDI flows across **EU NUTS3 regions** and between EU NUTS3 regions and **non-EU countries** \Rightarrow gravity equation for year 2005 considers FDI flows for 2003-2005

$$FDI_{ijt} = X_{ij}'\beta_t + V_i'\theta_t + W_j'\gamma_t + \varepsilon_{ijt}$$

- ▶ FDI_{ijt} is the **flow of FDI projects** from country/region j to country/region i in period (3-yrs time window), X_{ij} is a set of **bilateral variables** (contiguity, distance, commonality of language, etc) between region/country i and region/country j , V_i and W_j are, respectively, **characteristics** (area, population in 1995, GDP in 1995) of region/country i and region/country j
- ▶ β_t , θ_t and γ_t are **year-specific elasticities** (or semi-elasticities) of FDI wrt **time-invariant independent variables**
- ▶ $IV_{it} = \sum_j \hat{FDI}_{ijt}$

Table: Gravity regression for 2003-2005 and 2013-2015

	2003-2005		2013-2015	
	Innovative GF inward FDI	Innovative BF inward FDI	Innovative GF inward FDI	Innovative BF inward FDI
Contiguity	11.58*** (3.176)	19.14*** (1.877)	10.37 (6.467)	-9.982*** (1.504)
Common language	1.599*** (0.260)	1.777*** (0.220)	1.603*** (0.168)	1.480*** (0.179)
Time-zone difference	0.228*** (0.0594)	0.314*** (0.0614)	0.281*** (0.0427)	0.178*** (0.0438)
Common religion	-0.916*** (0.331)	-0.633** (0.311)	-1.271*** (0.214)	-0.471** (0.213)
Distance (log)	-0.243*** (0.0922)	-0.579*** (0.0731)	-0.209*** (0.0705)	-0.369*** (0.0686)
Contiguity x Distance (log)	-2.113*** (0.478)	-0.169* (0.100)	-0.922*** (0.215)	2.242*** (0.248)
Area (origin, log)	0.651*** (0.0548)	0.513*** (0.0664)	0.513*** (0.0403)	0.418*** (0.0423)
Area (destination, log)	0.564*** (0.0579)	0.437*** (0.0668)	0.469*** (0.0450)	0.365*** (0.0448)
Contiguity x Area (origin, log)	1.241*** (0.160)	-1.046*** (0.0779)	0.272 (0.806)	-0.965*** (0.136)
Contiguity x Area (destination, log)	-0.00316 (0.275)	-0.608*** (0.0746)	0.139 (0.602)	1.009*** (0.129)
Pop 1995 (origin, log)	-0.757*** (0.257)	-0.618*** (0.169)	-0.126 (0.0912)	-0.561*** (0.113)
Pop 1995 (destination, log)	0.758*** (0.121)	-0.532*** (0.137)	0.417*** (0.0725)	-0.773*** (0.116)
Contiguity x Pop 1995 (origin, log)	1.943*** (0.640)	0.182** (0.0854)	0.463 (0.778)	-0.529*** (0.115)
Contiguity x Pop 1995 (destination, log)	-1.394*** (0.309)	1.174*** (0.172)	-0.735* (0.435)	-0.555*** (0.126)

(continue)

Table: Gravity regression for 2003-2005 and 2013-2015

	2003-2005		2013-2015	
	Innovative GF inward FDI	Innovative BF inward FDI	Innovative GF inward FDI	Innovative BF inward FDI
<i>(continue)</i>				
GDP 1995 (origin, log)	1.771*** (0.220)	1.387*** (0.147)	1.057*** (0.0745)	1.271*** (0.0884)
GDP 1995 (destination, log)	0.0496 (0.0879)	1.245*** (0.116)	0.293*** (0.0623)	1.356*** (0.0979)
Contiguity x GDP 1995 (origin, log)	-1.624*** (0.246)	-0.0288 (0.0551)	-0.799 (0.660)	0.0983** (0.0469)
Contiguity x GDP 1995 (destination, log)	-0.0328 (0.250)	-1.642*** (0.146)	0.0712 (0.249)	0.250*** (0.0641)

Pseudo-poisson maximum likelihood estimator. N=1,597,396. Standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01.

Table: Robustness check: additional policy controls

Patent applications (log) in t, t+2	Region of inventor	Region of applicant
Inward innovative GF FDI projects (t-1; t-3 in log)	-0.719*** (0.177)	-0.618*** (0.155)
Inward innovative BF FDI projects (t-1; t-3 in log)	0.0566 (0.140)	-0.0202 (0.134)
Share of industrial GVA (t-1)	-0.130 (0.627)	-0.539 (0.588)
Patent specialisation index (t-1)	0.0761 (0.0887)	-0.104 (0.0844)
Population (t-1, in log)	0.455 (0.532)	0.769 (0.503)
GDP per capita (t-1, log)	1.198*** (0.216)	1.392*** (0.237)
3-years growth in GDP per capita (t-1)	0.529*** (0.196)	0.955*** (0.204)
3-years growth in GDP per capita (country-level, t-1)	-0.143 (0.445)	-0.189 (0.425)
Corporate tax rate (country-level, t-1)	0.00512 (0.00521)	0.00585 (0.00476)
FDI restriction index (country-level, t-1)	2.688* (1.534)	1.665 (1.506)
Employment Protection Legislation (country-level, t-1)	-0.210** (0.0916)	-0.254*** (0.0869)
Patent legislation index (country-level, t-1)	1.195*** (0.193)	0.823*** (0.185)
F-test of excluded IV in first stage	10.86	10.86
N	7989	7989

FE-IV regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included. Excluded countries (policy indicators not available): BG, EE, HR, HU, LT, LV, RO, SI.

Table: Patent quality indicators

Patent applications (t;t+2, log)	5-yrs forward cits		Patent family size		NPL backward cits	
	Region of inventor	Region of applicant	Region of inventor	Region of applicant	Region of inventor	Region of applicant
Inward innovative GF FDI (t-1; t-3 in log)	-0.947*** (0.229)	-0.923*** (0.242)	-0.792*** (0.206)	-0.655*** (0.181)	-1.034*** (0.279)	-0.622*** (0.204)
Inward innovative BF FDI (t-1; t-3 in log)	-0.230 (0.193)	-0.244 (0.209)	0.104 (0.152)	0.136 (0.150)	0.268 (0.209)	0.106 (0.172)
Share of industrial GVA (t-1)	-0.217 (0.692)	0.391 (0.633)	0.897 (0.647)	1.400** (0.672)	2.723*** (0.891)	0.438 (0.744)
Patent specialisation index (t-1)	0.0399 (0.104)	-0.103 (0.0941)	-0.0714 (0.114)	-0.192* (0.107)	-0.0502 (0.146)	-0.261** (0.115)
Population (t-1, in log)	-1.653** (0.689)	-2.255*** (0.756)	-2.011*** (0.579)	-0.583 (0.561)	-3.132*** (0.738)	0.257 (0.637)
GDP per capita (t-1, log)	1.128*** (0.240)	1.072*** (0.255)	1.030*** (0.268)	1.079*** (0.394)	0.823** (0.374)	0.675* (0.353)
3-years growth in GDP pc (t-1)	0.707*** (0.197)	0.803*** (0.209)	0.763*** (0.249)	1.140*** (0.361)	0.600* (0.351)	0.471 (0.357)
3-years growth in GDP pc (country, t-1)	-0.720* (0.396)	-0.895** (0.398)	-0.897** (0.390)	-0.768* (0.438)	-1.087** (0.522)	-1.078** (0.467)
Corporate tax rate (country, t-1)	0.00593 (0.00668)	0.00539 (0.00704)	0.0111** (0.00558)	0.0116** (0.00511)	0.0243*** (0.00779)	0.0192*** (0.00637)
F-test of excluded IV in first stage	11.82	11.82	11.82	11.82	11.82	11.82
N	9180	9180	9180	9180	9180	9180

IV-FE regressions weighted with average population in 2005-2016. Standard errors clustered by NUTS3 region in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable and the FDI variables have been transformed with inverse hyperbolic sine before taking the log. Year dummies included.