Mobility of Skilled Individuals and Local Innovation Activity

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Motivation

In an open economy migration is an natural process; poses challenges for the host countries but also brings benefits, especially if migrants are highly skilled.

- Innovation and technological progress are main engines of long-run growth, according to endogenous growth theory (Romer 1990, Aghion and Howitt 1992).
- Behind innovation, and a major determinant of growth, is skilled human capital accumulation (Lucas 2009; Gennaioli et al. 2012).
- High-skilled migrants bring advanced, or "upper-tail" human capital (Mokyr 2002, Squicciarini and Voigtländer, 2015) to the host country, they can have a large impact on technology diffusion and productivity growth.

Motivation (cond.)

The mobility of skilled individuals as channel to foster innovation is at the core of the policy agenda at different levels.

- Mobility of highly skilled personnel has become one of the main pillars of the European Research Area (ERA) launched by the Lisbon Agenda back in 2000.
- Cross-border mobility of researchers, scientists is key to develop a 'truly modern and competitive economy' and that member States and the EU must remove barriers to the free movement of knowledge (European Council, 2008).
- Key policy goal for the UK: attract entrepreneurs and researchers and enable companies to recruit skilled employees (UK Department for Business, Innovation and Skills)

Motivation (cond.)

- How far inventors are stretched in space and the knowledge they carry?
  - Are the claims of "death of distance" (Cairncross, 1997), "end of geography" (O' Brien, 1992), and "flatness of the world" (Friedman, 2005) relevant for this class of migrants?
- How important is the role of technological similarity, cultural proximity and institutions?
  - Scant empirical evidence, mainly by the studies of Miguélez et al. (2010) and Miguélez and Moreno (2014).
- Does knowledge that moves along with the inventors shape local innovation activity?
  - Thin and limited to some countries (US, UK) evidence.

Highly Skilled/ 'Star' Migrants: The Inventors

- Specific typology of skilled and innovative individuals: (i) more homogeneous than tertiary educated workers, and (ii) with direct contribution to the innovation process (tertiary graduates' contribution to innovation processes is only 'potential' and possibly delayed in time).
- Important economic contribution:
  - Deeply involved in the production of innovation, which in turn is the main driver of economic growth (Romer, 1988);
  - Important vehicle of knowledge circulation ('knowledge-carriers'); when skilled workers move, their knowledge and skills move with them (Lucas, 1988; Breschi and Lissoni, 2009).

Relevance to the Literature

- Broadly, our paper associates to the literature on the determinants of international migration (Mayda, 2010; Grogger and Hanson, 2011; Beine et al., 2011; Ortega and Peri, 2013; Czaika and Parsons, 2015).
- Our paper speaks most directly to the strand of literature that specifically focuses on invetors' mobility (Miguélez et al., 2010; Miguélez and Moreno, 2014).
- Also relates to a recent literature on the role of migrant inventors in the technological knowledge creation and diffusion:
  - US: Historical evidence (Akcigit et al., 2017a,b) and in recent time periods (Kerr, 2008; Hunt and Gauthier-Loiselle, 2010; Kerr and Lincoln, 2010; Drivas et al., 2016; Breschi et al., 2017).
  - UK: inter-regional mobility, innovation and firms' behavioral heterogeneity in the UK (Gagliardi, 2015).
  - EU regions: regional innovation and spatial effects of mobility (Miguélez and Moreno, 2013a,b).

Purpose

This paper studies what shapes inventors' mobility across space and their impact on local innovation activity. Specifically,

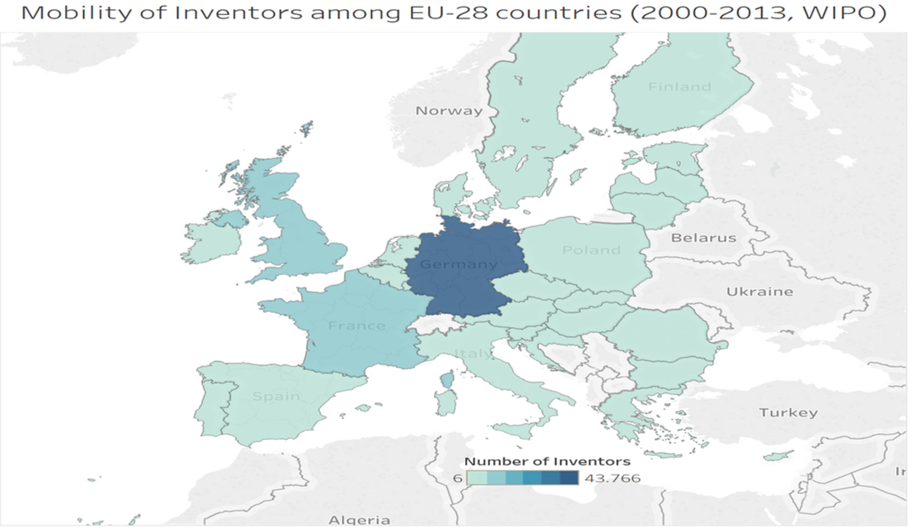
- Patent data are used to track invetors' moves.
- Our empirical (gravity) model is consistent with an underlying micro-founded random utility model (Bertoli and Moraga, 2015) while also accounting for recent innovations, namely a high proportion of zeroes in the dependent variable and multilateral resistance to migration.
- Within the same framework we also analyze, as an exercise, the flows of ordinary, less skilled migrants.
- Finally, we assess the impact of mobility on local innovation using a knowledge production function framework.

Research Questions:

We apply our modeling approach to thirty European countries over the period 2000-2012 with two key questions in mind:

- What shapes the international mobility of inventors?
- What shapes the international mobility of the ordinary, migrants?
- What is the impact of inventor migration flows on local innovation activity?

Inventor-attracting countries (EU28)

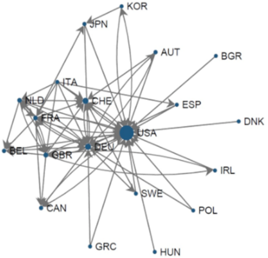


Inventor-attracting countries (OECD)

Figure 1: Inventor Flows

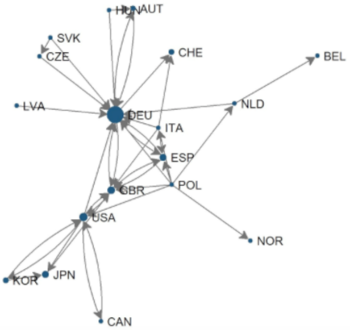
Top (5%) Inventor Flows

Figure 2: Top 5% Inventor Flows



Top Destination Countries	Origin of Largest Flows	Number of Inventors	% out of total
USA		95,735	
	Canada	21,837	22.81%
	UK	17,424	18.20%
	Germany	12,040	12.58%
Germany		22,453	
	Austria	3,169	14.11%
	France	3,074	13.69%
	UK	2,429	10.82%
Switzerland		22,198	
	Germany	9,719	43.78%
	France	3,341	15.05%
	Italy	1,824	8.22%
UK		13,008	
	France	2,372	18.23%
	Germany	1,917	14.74%
	Italy	1,425	10.95%
Nederlands		8,400	
	Germany	2,515	29.94%
	UK	1,633	19.44%
	Italy/France	656	7.81%

Top (5%) Migrant Flows



Top Destination Countries	Origin of Major Flows	Number of immigrants	Share
Germany		3,540,019	
	Poland	1,577,493	44.56%
	Italy	300,308	8.48%
	Hungary	278,914	7.88%
UK		1,313,663	
	Poland	226,361	17.23%
	USA	202,022	15.38%
	Germany	170,656	12.99%
USA		1,183,853	
	Republic of Korea	280,900	23.73%
	Canada	209,969	17.74%
	UK	190,316	16.08%
Spain		962,090	
	UK	300,198	31.31%
	Italy	164,289	17.08%
	Germany	151,954	15.79%
Japan		938,482	
	Republic of Korea	326,161	34.75%
	USA	286,365	30.51%
	UK	79,672	8.49%

Modeling Bilateral Migrant Flows, $\mathrm{F_{ij}}$

The decision of inventors to move is influenced by the comparison between expected utilities of the origin and destination locations (Anderson and van Wincoop, 2003; Helpman et al., 2008; Bertoli and Moraga, 2015).

$$\begin{aligned}
\mathrm{F_{ijt}} &= \beta_{\mathrm{i}} + \beta_{\mathrm{j}} + \beta_1 \mathrm{NeighbouringCountries}\,[> 300\,\mathrm{km}]_{\mathrm{ij}} \\
&+ \beta_2 \mathrm{Distance}\,[< 1,110\,\mathrm{km}]_{\mathrm{ij}} + \beta_3 \mathrm{Distance}\,[1,110 - 1,500\,\mathrm{km}]_{\mathrm{ij}} \\
&+ \beta_4 \mathrm{Distance}\,[> 1,500\,\mathrm{km}]_{\mathrm{ij}} + \beta_5 \mathrm{Density_{it}} + \beta_6 \mathrm{Density_{jt}} \\
&+ \beta_7 \mathrm{Inventors_{it}} + \beta_8 \mathrm{Inventors_{jt}} + \beta_9 \mathrm{Z_{ijt}} + \epsilon_{\mathrm{ijt}} \qquad (1)
\end{aligned}$$

back to the Innovation Production function

Geographic Proximity, GEO

- NeighbouringCountries [>300 km]: 1, if countries do share a common border and their geographical centers are located in a distance of more than 300 km; 0 otherwise.
- Distance [<1,110 Km]: 1, if countries do not share a common border and their geographical centers are located within in a distance of 1,110 km; 0 otherwise.
- Distance [1,110-1,500 Km]: 1, if countries do not share a common border and their geographical centers are located between 1,110 and 1,500 km; 0 otherwise.

Geographic Proximity, GEO (cond.)

- Distance [>1, 500 Km]: 1, if countries do not share a common border and their geographical centers are located within in a distance of 1,110 km; 0 otherwise.

  NOTE: benchmark distance/area: NeighbouringCountries [<300 km]

  -The longest distance between two neighboring countries in our sample: 1,110 km (France and Italy).

  -The longest country-pair distance in our sample is: 11,200 km (Portugal and Japan: and the shortest pair-country distance is: 60 (Slovakia and Austria).

Technological Proximity, TECH

- Technological Effort: Difference in logged average real R&D spending per scientist between two countries, i and j at year t,

  $$\mathrm{TechEffortDistance} = \ln \frac{\mathrm{R\&D_i}}{\mathrm{Scientists_i}} - \ln \frac{\mathrm{R\&D_j}}{\mathrm{Scientists_j}}$$

  (Griffith et al. 2004, Peri, 2005)

- Technological specialization of production sectors similarity: correlation between two countries' patent portfolios with respect to technology fields at year t,

  $$\mathrm{TechSpecializationSimilarity} = \frac{\mathrm{sh_i}' \, \mathrm{sh_j}}{\sqrt{\sum_{s=1}^{8} \mathrm{sh_{is}^2} \sum_{s=1}^{8} \mathrm{sh_{js}^2}}}$$

  (Jaffe, 1986; Hall et al., 2001; Peri, 2005)

Social Proximity, Cultural

- LinguisticSimilarity: dummy of 1 if two countries belong in the same sub-family, 0 otherwise

  six dominant Indo-European subfamilies, i.e., Germanic, Romance, Slavic, Baltic, Celtic and Greek, and one non Indo-European, the Uralic (Estonian, Finnish, and Hungarian)

- ReligionSimilarity: ranges from 0 (no believers in common) to 1 (all believers in common) and for t is equal to:

  $\mathrm{ReligionSimilarity_{ij}} = (\%\mathrm{muslim_i} * \%\mathrm{muslim_j}) + (\%\mathrm{catholic_i} * \%\mathrm{catholic_j}) + (\%\mathrm{orthodox_i} * \%\mathrm{orthodox_j}) + (\%\mathrm{protestant_i} * \%\mathrm{protestant_j}) + (\%\mathrm{hinduism_i} * \%\mathrm{hinduism_j}) + (\%\mathrm{buddhist_i} * \%\mathrm{buddhist_j}) + (\%\mathrm{eastern_i} * \%\mathrm{eastern_j}) + (\%\mathrm{ju}$ $\%\mathrm{judaism_j})$

Other Controls

Levels and modes of innovation as well as the position of a country with respect to the technological frontiers is affected by:

- Institutions - quality of regulations, rule of law, easiness of doing business
  - shape (economic) incentives to invest in technology, physical and human capital and formation of mutual trust (Acemoglu et al., 2005; Caselli and Coleman, 2001) fostering economic and financial growth.
- Knowledge Institutions - human capital (STEM, HRST, public spending on tertiary)
  - input in the innovation process and therefore serves as a complement to technology; facilitates generation and diffusion of new technologies or a more efficient adoption of a given technology (Benhabib and Spiegel, 1994; Romer, 1990) and leading to more economic growth (Aghion et al., 2009).

Other Controls

- Labor Institutions - Employment Protection Legislation (EPL) stringency
  - increase job security and greater enforceability of job contracts and, therefore, could increase worker investment in innovative activity; however, strict labor legislation also increases firms' adjustment costs, which may lead to underinvestment in activities that are likely to require adjustment, including technologically advanced innovation (Griffith and Macartney, 2014).
- Bilateral Trade Intensity
  - acts as conduit of information and may also foster technological partnerships; allows a recipient country to learn from the R&D-, or 'technology'-content embodied in the traded good; increases innovation and knowledge diffusion (Grossman and Helpman, 1991; Eaton and Kortum, 2001; Keller, 2002).

Estimation Approach

Count data models are more suitable in this framework, as the dependent variable is either zero or positive integer.

- Poisson pseudo-maximum likelihood method is a first choice; in presence, however, of over-dispersion produces inefficient estimates (Burger et al., 2009). Therefore, negative binomial estimation is more appropriate.
- Therefore, negative binomial (NB) estimation is more appropriate; however, presence of (excess) zeros in the dependent variable may come from different data generating processes
- The zero-inflated negative binomial (ZINB) model: consists of two parts: (i) the zero-inflated part - a logt model - to determine the probability of whether a particular origin-destination flow will be zero or positive, and (ii) a standard negative binomial (gravity) model to estimate the relationship between the mobility of flows.

Summary Statistics

Proximity	Variable	Obs	Mean	St. Dev.	Min	Max
Inventor Flows	Inventor Flows	11,310	18.071	100.934	0	2,415
Migrant flows	Non − invetor Flows	5,967	2082,281	7074 ,274	0	177,758
Geographic						
	Neighboring Countries [< 300Km]	11,310	0.028	0.164	0	1
	Neighboring Countries [> 300Km]	11,310	0.055	0.228	0	1
	Distance [< 1, 110Km]	11,310	0.225	0.418	0	1
	Distance [1, 110 − 1, 500Km]	11,310	0.156	0.363	0	1
	Distance [> 1, 500Km]	11,310	0.536	0.499	0	1
	Density	11,310	13.614	11.840	0.308	49.930
Inventors	Inventors	11,310	9,308	21,627	3	134

Summary Statistics (cond.)

Proximity	Variable	Obs	Mean	St. Dev.	Min	Max
Technological						
	TechEffortDistance	11,310	0.968	0.779	0.00003	3.569
	TechSpecialisationSimilarity	11,310	0.795	0.150	0.130	0.997
Cultural						
	LinguisticSimilarity	11,310	0.048	0.214	0	1
	ReligionSimilarity	11,310	0.174	0.208	0	0.873
Institutions	Regulation Quality	11310	1.244	0.403	-0.039	2.077
	Rule of Law	11310	1.198	0.583	-0.223	1.999
	Doing Business	7163	82.35	10.58	51.47	97.22
	EPL	9367	2.47	0.587	1	4.1
HumanCapital						
	TertiarySpending	11310	1.341	0.513	0.540	2.71
	STEM	7279	25.810	5.315	2.112	35.2 ă
	HRST	6032	40.888	8.017	21.4	55.4
Bilateral Trade	Trade	11,310	0.0414	0.0860	0.00001	1.428
Innovation Activity	Patents	10,962	39,289.8	104,536	8	542,815

Estimates of International Mobility

- Table 1: International Inventor Flows ▸ here
- Table 2: International Inventor Flows from Most and Less Innovative Countries
- Table 3 International Inventor & Ordinary (Non-inventor) Flows ▸ here
- Table 4 Robustness: Causality/Endogeneity Issues (2SRI, Wooldridge, 2002) ▸ here

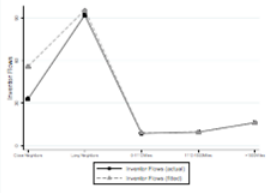
Findings: Geographical Proximity

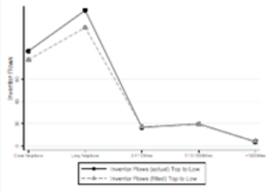
Table: Drop of Knowledge Flows on Crossing Geo Distances to in-300 km Flows

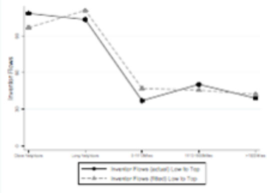
	All Countries	Most Tech to		Less Tech to		22 Countries	
	Invetors	Less	All	Most	All	Invetors	Migrants
Neighboring [> 300Km]	45% ↓	–	–	–	49% ↓	46% ,↓	70% ↓
Distance [$300 - 1,110$Km]	61% ↓	54% ↓	53% ↓	–	63% ↓	63% ↓	78% ↓
Distance [$1,110 - 1,500$Km]	66% ↓	–	–	–	68% ↓	67% ↓	82% ↓
Distance [$> 1,500$Km]	80% ↓	78% ↓	78% ↓	–	70% ↓	85% ↓	92% ↓
lnInvetors(host)	0.85% ↑	0.80% ↑	0.86% ↑	–	0.82% ↑	0.69% ↑	0.12% ↑
lnInvetors(origin)	0.25% ↑	0.45% ↑	–	–	0.16% ↑	0.30% ↑	0.16% ↑

- Gravity emerges almost everywhere, in inventor (less) and non-inventor (more) flows; inventor movers from less tech countries to most tech are the least bounded.
- Invetors' communities at the destination (i.e., job market opportunities and synergies) matter.

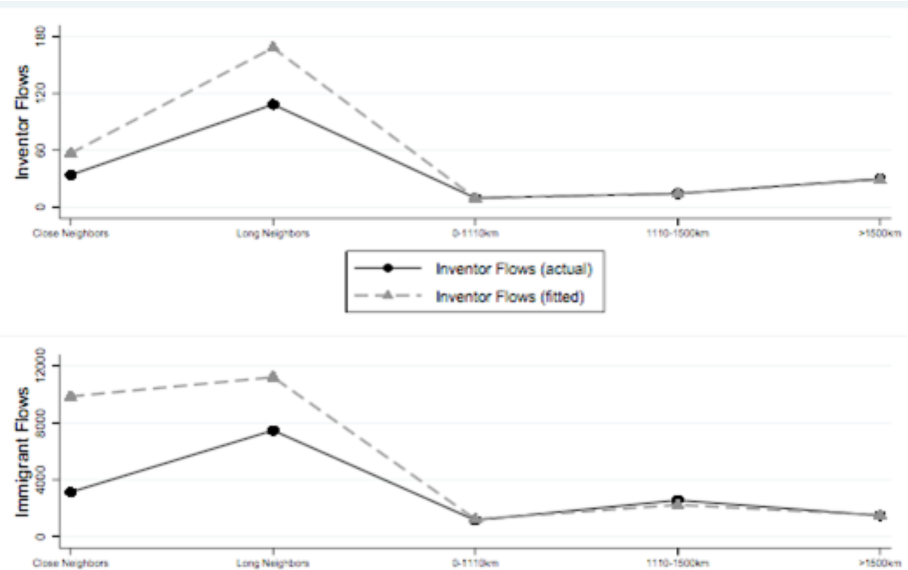
Inventor Flows (various groups)







Inventor vs. Non-Inventor Flows



Findings: Technological and Cultural Proximity

Table: Technological and Cultural Proximities and Controls

	All Countries	Most Tech to		Less Tech to		22 Countries	
	Invetors	Less	All	Most	All	Invetors	Migrants
TechEffortDistance	44% ↑	–	–	–	–	47% ↑	19% ↑
TechSpecialisationSimilarity	70% ↑	418% ↑	250% ↑	287%	70% ↑	60% ↑	–
LinguisticSimilarity	30% ↑	37% ↑	39% ↑	57% ↑	63% ↑	35% ↑	77% ↑
ReligionSimilariry	35% ↑	–	–	–	66% ↑	44% ↑	79% ↑
Institutions(host)	22% ↑	188% ↑	121% ↑	–	–	16% ↑	37% ↑
Institutions(origin)	–	–	–	–	–	–	31% ↓
HumanCapital(host)	–	–	–	64% ↑	–	–	43% ↑
HumanCapital(origin)	–	–	–	–	–	–	–
Trade(host, origin)	39% ↑	–	–	–	77% ↑	25% ↑	–

- Technological proximity (i.e., technological production structure similarity) matters the most; also institutions. Cultural proximities for non-invetors; also institutions and knowledge at home.

Robustness

Table: Additional Institutions: Labor (EPL)

	All Countries	Most Tech to		Less Tech to		22 Countries	
	Invetors	Less	All	Most	All	Invetors	Migrants
EPL(host)	12.17% ↑					7.9% ↑	
EPL(origin)							
Schengen	19% ↑					14% ↑	22% ↑

- Different patterns of innovation specialization could require different types of labour market regulations: incremental innovation (stability & and cooperation) vs. disruptive (loose EPL). Schengen member countries, exchange 14%-22% more migration flows.

Table: Alternative Definitions of Human Capital

	All Countries	Most Tech to		Less Tech to		22 Countries	
	Invetors	Less	All	Most	All	Invetors	Migrants
STEM(host)	12.17% ↑						1.6% ↑
STEM(origin)							
HRST(host)	12.17% ↑					4.6% ↑	4.4% ↑
HRST(origin)						5.6% ↓	–

Economic Impact

- On Local (country) Innovation Production

Innovation Production

$$Q_{it} = (A_{it})^{\beta}(A^{\alpha}_{it})^{\mu} \tag{1}$$

where,

- Q is the innovative output, proxied by the number of patents produced in country i;

- A is own, homegrown knowledge stock, proxied by R&D stock accumulated from past and current R&D investments in country i; and

- A^{α} is the stock of external and accessible (hence the α superscript) to country i knowledge stock, proxied by R&D accumulated in countries other than i at time t.

Innovation Production (cond.)

If knowledge flows manage to perfectly and completely spill over, then A^{α} that reaches country i is simply the summation of all borrowed knowledge that comes from all other countries. In reality, however, the diffusion of knowledge flows across countries may be less than complete:

$$A_{it}^{\alpha} = \sum_{j \neq i} \phi_{ij} A_{jt} \tag{2}$$

where, ϕ_{ij} is the share of knowledge learned in country i.

Substituting equation (2) into equation (1) and by taking logs, equation (1) yields:

$$\ln Q_{it} = \beta \ln A_{it} + \mu \ln \left(\sum_{j \neq i} \phi_{ij} A_{jt} \right) \tag{3}$$

- ϕ is standardized fitted values of F_{ijt} here

Do Inventor Movers Contribute to Local Production of Innovation?

Table: Elasticities of Innovation Function

	All countries (i)	Top 5 Innovative (ii)	All countries (weighted) (iii)
$\ln R\&D_{own}$	0.912***	0.881***	0.889***
	(0.139)	(0.022)	(0.130)
$\ln R\&D_{external}$	0.099***		
	(0.044)		
$\ln R\&D_{externalTop}$		0.140**	
		(0.062)	
$\ln R\&D_{externalRelative}$			0.102*
			(0.059)
Constant	11.10***	8.350***	7.762***
	(0.151)	(0.772)	(0.654)
Observations	349	289	349

All regressions include country and year fixed effects; All regressors are one period lagged; Robust standard errors reported in parentheses; (***), (**), (*): significance at 1%, 5% and 10% level, respectively. [a] All countries were included as senders (origin) of knowledge flows. All countries were included as receivers (destination) of knowledge flows; [b] Only the top 5 innovative countries were included as senders (origin) of knowledge flows. Only the remaining 25 countries were included as receivers (destination) of knowledge flows. The top 5 most innovative countries in our sample are: the US, Japan, Korea, Germany and Canada; [c] All external flows are weighted by $\rho = \left(\frac{\text{Patents}}{\text{R\&D}}\right) / \left(\frac{\text{Patents}}{\text{R\&D}}\right)_{\text{leader}}$.

Findings:

- Overall, our estimates of own R&D elasticity (65%-82%) are in the vicinity of estimates reported in the international spillover literature, and in particular,
  - in the studies of Peri (2005) (60%-80%), Branstetter (2001) (72%), Pakes and Griliches (1980) (61%), Bottazzi and Peri (2007) (78%), among others.
- Our inventor-weighted R&D estimates are about half to those reported in Peri (2005) (40%-50%) and Peri (2005) (40%-50%) - these elasticities, however, refer to citation-weighted external knowledge.
  - Our findings corroborate with those reported in Hunt and Gauthier-Loiselle (2010), Miguélez and Moreno (2013) and Crescenzi and Gagliard (2015) of about 15%-27% increases of patent activity.

Summing up:

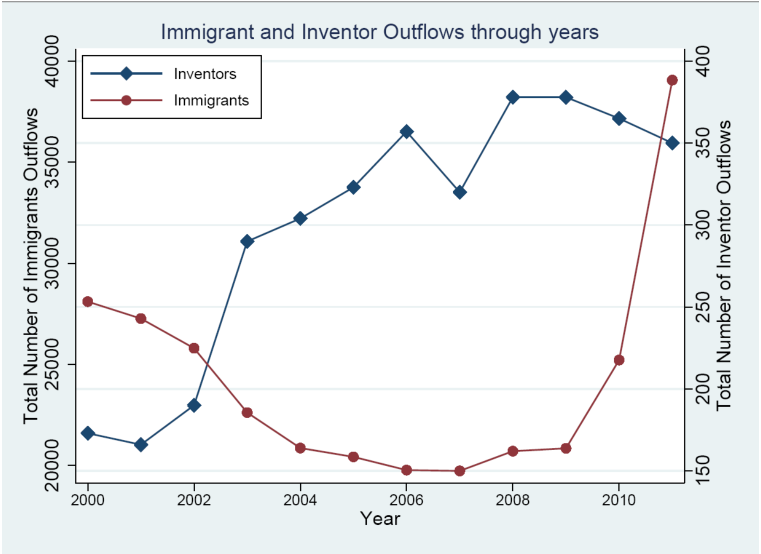
- Proximity matters for migration flows. Gravity emerges everywhere - in the mobility of the highly skilled workers as well as in the ordinary (non-inventor) migrant workers.
- Inventors are less geographically restricted than ordinary immigrants.
- Similarity in technological structure of production between countries is the main driver of inventor moves - especially for inventors from the most innovative countries. Social proximity matters more for the average migrant flows.
- Quality of institutions matter for all types of flows, especially for the most talented.

Summing up:

- Attractive country features for inventor mobility quality of institutions, the size of inventors' community and the trade linkages between origin and host country.
- Finally, knowledge and skills that move with the inventors have a positive impact on local innovation production.

Policy Implications

- Allow knowledge flows - a region will become more integrated and productive to the benefit of all - by:
    - Enhance labor mobility - sectoral and geographical by removing non-compete clause and promote ‘inventor’s visa’
    - Given the important economic contribution, immigration policies could be more welcoming to skilled people (remove barriers and regulatory obstacles, flexible wages & time).
    - Taking a hard line stance on immigration policy, it would potentially threaten a country’s ability to attract the brightest and best migrant innovators and hamper its growth potentials.

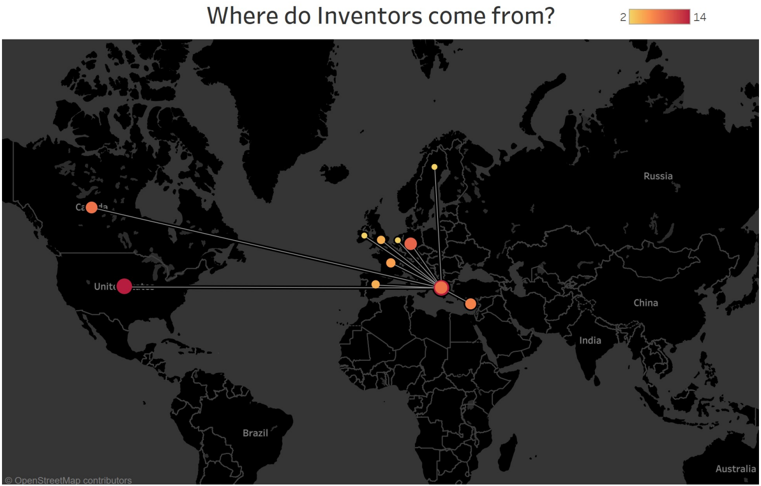

Immigrant and Inventor Outflows through years
Inventors
Immigrants
Total Number of Immigrants Outflows
Total Number of Inventor Outflows
Year
20000
25000
30000
35000
40000
150
200
250
300
350
400
2000
2002
2004
2006
2008
2010

Destinations of Greek Migrants

country	IMMIGRANT OUTFLOWS	country	INVENTOR OUTFLOWS
DEU	180859	USA	1364
GBR	75243	DEU	1018
NLD	17320	GBR	526
USA	11925	CHE	248
BEL	9531	SWE	144

Destinations of Greek Invetors

Origin of Foreign Invetors



How Many Foreign Invetors per year Migrate to Greece?

Table: Inventor Inflows to Greece (2000-2012)

year	Inventor inflows
2000	2
2001	5
2002	4
2003	5
2004	3
2005	8
2006	5
2007	7
2008	4
2009	5
2010	4
2011	5
2012	3

Origin of Foreign Invetors who Migrate to Greece

Table: Inventor Inflows to Greece (2000-2012)

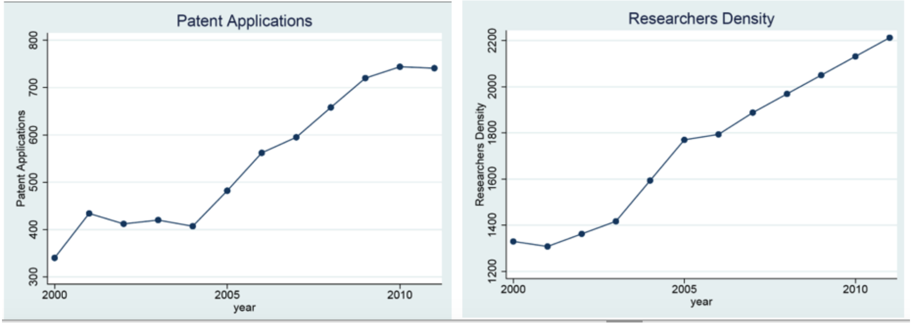
USA	14	BGR	0
DEU	9	CHE	0
CAN	8	CZE	0
CYP	7	EST	0
FRA	5	HRV	0
ESP	4	HUN	0
GBR	4	ITA	0
IRL	2	JPN	0
NLD	2	KOR	0
SWE	2	LVA	0
DNK	1	POL	0
FIN	1	PRT	0
NOR	1	SVK	0
AUT	0	SVN	0
BEL	0		

Greece: Summary Stats (2000-2012)

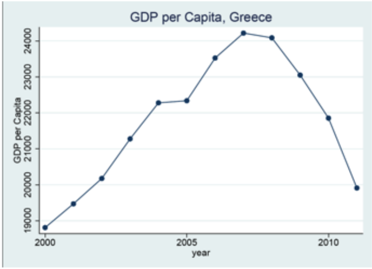
INVENTORS OUTFLOWS	364	10 (18)	27	0	169
MIGRANT OUTFLOWS	364	941 (2082)	3028	0	32660
GDP per capita (2005 PPP)	364	21500 (33,314.43)	1897.26	18,508	24,219
Labor force	364	4,933,097 (22,318.563)	100,959	4,749,778	5,080,556
R&D (% GDP)	364	0.59% (1.98%)	0.052	0.52	0.70
Inventors	364	186.23 (9734.17)	61.22	99	300
Researchers (per mil. of pop)	364	1773.7 (3692.3)	328.73	1308	2232
Patent Applications	364	551.6 (42371.5)	137.93	340	744
Spending on Tertiary (% GDP)	364	1.35% (1.41%)	0.17	1.07	1.5
STEM	290	24.42% (25.81%)	0.45	23.8	25.2
HRST	232	32.025 (40.89%)	1.428	29.5	34.3
Regulatory Quality	364	0.81 (1.25)	0.16	0.40	0.99
Easiness of doing business	261	65.24 (82.35)	7.195	57.45	78.72
Rule of Law	364	0.73 (1.20)	0.14	0.39	0.91
EPL	364	2.86 (2.47)	0.162	2.48	2.93

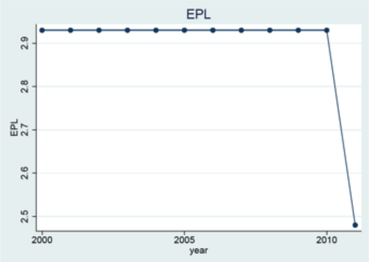
Note: In (orange) the mean of our 30 OECD countries.

Innovation Activity in Greece

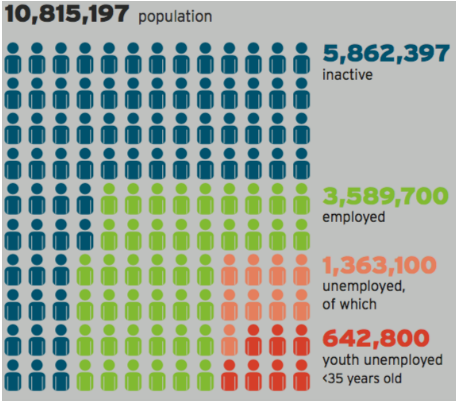


Institutions and Policies in Greece



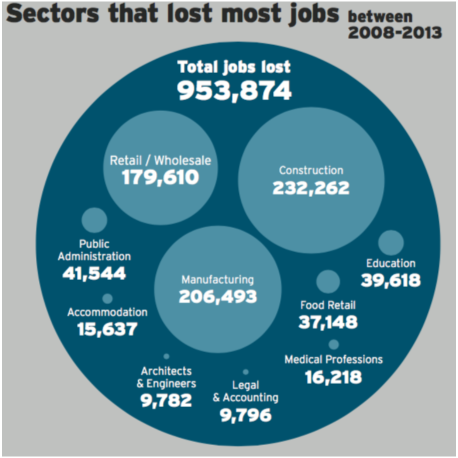


Unemployment



Source: http://endeavor.org

Jobs lost



Source: http://endeavor.org

Exodus of Talents

- During the last 8 years, and as Greek society has been anxiously observing the direct impacts of the economic crisis on its everyday life, a particular phenomenon started to acquire alarming momentum.
- On a macro level, this movement is a clear ‘brain drain’ (200,000 university graduates emigrated over the last 5 years). On a micro level, it is all about pursuing opportunities where they are, i.e., it helps build the extrovert mentality and skills that the Greek labor market has failed to create.
- 673 outstanding researchers/invetors of greek origin received more than 17,000 citations and are listed among the 'most-cited' in the world; only 14% of them reside in Greece.

Turn ‘brain drain’ into ‘brain circulation’

Rather than preventing it, the challenge for the country is three-fold:

- To sustain links to this new generation of international Greeks.
  - Enhance the "ethnic-driven" knowledge flows. Emigrant scientists and engineers may retain social contacts with professional associations and educational institutions in their home countries, and transmit them scientific and technical skills either on a friendly or contractual basis.
- Create an environment for them to return to and implant their acquired skills and mindset, especially in two ‘windows of opportunity’: after 2-3 years of work abroad, and after 8-10 years of work abroad.
- Retain in the country - at all costs - a critical mass of ‘change agents’, i.e., young professionals who are willing to explore local opportunities and become the change ambassadors for tomorrow.

International Inventor Mobility

(ZINB estimates)

	(1)		(2)		(3)		(4)	
	NB	logit	NB	logit	NB	logit	NB	logit
Neighbouring Countries [> 300Km]	-0.615**	18.98***	-0.609**	15.70***	-0.601***	16.27***	-0.595***	11.08***
	(0.247)	(1.986)	(0.242)	(1.098)	(0.215)	(1.145)	(0.205)	(1.771)
Distance [$< 1,110$Km]	-1.469***	2.177	-1.442***	13.87***	-1.089***	14.45***	-0.946***	11.08***
	(0.211)	(1.679)	(0.207)	(1.087)	(0.207)	(1.238)	(0.198)	(1.315)
Distance [$1,110 - 1,500$Km]	-1.670***	4.472	-1.654***	13.74***	-1.253***	14.20***	-1.073***	11.26***
	(0.222)	(5.747)	(0.217)	(1.364)	(0.213)	(1.742)	(0.206)	(1.298)
Distance [$> 1,500$Km]	-2.326***	19.32	-2.277***	15.41***	-1.799***	15.77***	-1.602***	10.15***
	(0.237)	(12.34)	(0.231)	(0.714)	(0.227)	(1.048)	(0.220)	(1.488)
$\text{Density}_{\text{i}}$	-0.037	0.015	-0.044	0.057***	-0.061	0.058***	-0.037	0.039***
	(0.051)	(0.035)	(0.051)	(0.016)	(0.051)	(0.015)	(0.050)	(0.013)
$\text{Density}_{\text{j}}$	-0.075*	-0.156***	-0.076*	-0.080***	-0.080*	-0.074***	-0.084*	-0.092***
	(0.045)	(0.053)	(0.046)	(0.020)	(0.046)	(0.018)	(0.044)	(0.018)
$\text{lnInventors}_{\text{i}}$	0.876***	-0.598***	0.840***	-0.311**	0.821***	-0.332***	0.853***	-0.194
	(0.068)	(0.137)	(0.070)	(0.125)	(0.071)	(0.119)	(0.071)	(0.130)
$\text{lnInventors}_{\text{j}}$	0.177***	-0.893**	0.231***	-0.677***	0.220***	-0.660***	0.250***	-0.414***
	(0.059)	(0.383)	(0.061)	(0.133)	(0.059)	(0.119)	(0.058)	(0.144)
TechEffortDistance			0.403***	-0.622***	0.388**	-0.637***	0.365***	-0.055
			(0.115)	(0.221)	(0.185)	(0.231)	(0.112)	(0.316)
TechSpecialisationSimilarity			0.590**	-7.621***	0.578***	-6.981***	0.531***	-2.774**
			(0.294)	(1.637)	(0.080)	(1.333)	(0.191)	(1.167)
LinguisticSimilarity					0.264***	-12.99***	0.265***	-0.170
					(0.073)	(1.943)	(0.089)	(0.736)
ReligionSimilarity					0.295***	-0.454	0.298***	-0.892
					(0.010)	(1.353)	(0.096)	(0.987)

International Inventor Mobility (ZINB estimates, continued)

	(1)		(2)		(3)		(4)	
	NB	logit	NB	logit	NB	logit	NB	logit
$Trade_{ij}$							0.330**	-19.3**
							(0.155)	(8.415)
$Institutions_i$							0.199*	-2.262***
							(0.111)	(0.489)
$Institutions_j$							0.016	0.416
							(0.110)	(0.669)
$HumanCapital_i$							0.016	0.855**
							(0.114)	(0.392)
$HumanCapital_j$							0.099	-0.056
							(0.115)	(0.458)
Observations	11,310	11,310	11,310	11,310	11,310	11,310	11,310	11,310
Nonzero observations	5,056	5,056	5,056	5,056	5,056	5,056	5,056	5,056
LR test for overdispresion	36,000		35,000		28,000		28,000	
P-value	0.000		0.000		0.000		0.000	
Vuong statistic	3.89		5.93		6.34		8.80	
P-value	0.000		0.000		0.000		0.000	
McFadden"s R^2	0.300		0.303		0.308		0.313	

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International Inventor Mobility from Most and Least innovative Countries (ZINB estimates, continued)

	From Top 5 innovative to		From Less 25 innovative to	
	Less 25	All	Top 5	All
	(1)	(2)	(3)	(4)
Neighboring Countries [$>$ 300Km]	-0.382	-0.114	-0.141	-0.664***
	(0.304)	(0.378)	(0.434)	(0.208)
Distance [$< 1,110$Km]	-0.765***	-0.758**	-0.148	-0.991***
	(0.275)	(0.371)	(0.445)	(0.215)
Distance [$1,110 - 1,500$Km]	-0.945	-0.828	-0.129	-1.145***
	(0.269)	(0.343)	(0.463)	(0.218)
Distance [$> 1,500$Km]	-1.510***	-1.503***	-0.389	-1.207***
	(0.367)	(0.425)	(0.494)	(0.242)
Density_i	-0.055	-0.032	0.652*	0.030
	(0.108)	(0.087)	(0.373)	(0.060)
Density_j	0.389***	-0.421***	-0.067	-0.158***
	(0.102)	(0.152)	(0.086)	(0.057)
lnInventors_i	0.801***	0.858***	0.248	0.820***
	(0.166)	(0.130)	(0.330)	(0.090)
lnInventors_j	-0.445*	-0.283	-0.917	-0.158**
	(0.228)	(0.188)	(0.852)	(0.068)
TechEffortDistance	0.366	0.340	0.193	0.178
	(0.292)	(0.263)	(0.208)	(0.130)
TechSpecialisationSimilarity	1.644**	1.249***	1.352**	0.533*
	(0.743)	(0.656)	(0.575)	(0.304)
LinguisticSimilarity	0.317***	0.328***	0.451***	0.486***
	(0.060)	(0.068)	(0.174)	(0.183)
ReligionSimilarity	0.604	0.544	0.619	0.504***
	(0.724)	(0.964)	(0.693)	(0.111)

International Inventor Mobility from Top and Less innovative Countries (ZINB estimates, continued)

	From Top 5 innovative to		From Low 25 innovative to	
	Less 25	All	Top 5	All
	(1)	(2)	(3)	(4)
Trade_{ij}	0.457	0.432	3.514	0.571***
	(0.342)	(0.423)	(2.298)	(0.190)
Institutions_{i}	1.059***	0.791**	0.933	0.911
	(0.390)	(0.376)	(0.806)	(0.814)
Institutions_{j}	-0.345	-0.125	-0.123	-0.189
	(0.580)	(0.510)	(0.206)	(0.158)
HumanCapital_{i}	0.232	0.222	0.495***	0.174
	(0.201)	(0.188)	(0.143)	(0.136)
HumanCapital_{j}	0.331	0.686	0.160	0.101
	(0.333)	(0.688)	(0.183)	(0.128)
Observations	1,625	1,885	1,625	9,425
Nonzero observations	797	1,056	1,058	4,000
LR test for α	1,708.81	5,558.58	3,907.1	13.000
P-value	0.000	0.000	0.000	0.000
Vuong statistic	4.48	3.34	5.24	6.18
P-value	0.000	0.004	0.000	0.000
McFadden's R^2	0.358	0.331	0.307	0.322

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International Inventor & Ordinary Migrant Mobility (ZINB estimates)

	Inventors (1)		Ordinary Migrants (2)	
	NB	logit	NB	logit
Neighbouring Countries [> 300Km]	-0.612**	1.521	-1.176***	1.815*
	(0.251)	(1.323)	(0.287)	(1.067)
Distance [$< 1,110$Km]	-0.981***	0.178	-1.525***	2.203***
	(0.220)	(1.755)	(0.246)	(0.794)
Distance [$1,110 - 1,500$Km]	-1.116***	1.383	-1.731***	2.190***
	(0.231)	(1.494)	(0.253)	(0.810)
Distance [$> 1,500$Km]	-1.870***	1.229	-2.534***	2.574***
	(0.253)	(1.838)	(0.269)	(0.847)
Density_{i}	-0.059	-0.036**	0.052	-0.027***
	(0.058)	(0.015)	(0.041)	(0.009)
Density_{j}	-0.046	-0.042**	-0.086**	-0.010
	(0.049)	(0.017)	(0.037)	(0.011)
lnInventors_{i}	0.689***	-0.772**	0.123**	- 0.012
	(0.087)	(0.336)	(0.0504)	(0.113)
lnInventors_{j}	0.300***	-0.056	-0.160***	-0.744***
	(0.070)	(0.382)	(0.048)	(0.109)
TechEffortDistance	0.382***	-0.193	0.175**	-0.628***
	(0.138)	(0.537)	(0.082)	(0.226)
TechSpecialisationSimilarity	0.470***	-0.896	0.118	-2.237***
	(0.155)	(1.370)	(0.350)	(0.700)
LinguisticSimilarity	0.302***	0.011	0.569***	-15.81***
	(0.115)	(0.822)	(0.154)	(0.580)

International Inventor & Ordinary Migrant Mobility (ZINB estimates, continued)

	Inventors		Ordinary Migrants	
	(1)		(2)	
	NB	logit	NB	logit
$Trade_{ij}$	0.231**	-60.53	0.377	-9.163***
	(0.113)	(39.16)	(0.893)	(3.171)
$Institutions_i$	0.146**	-3.112***	0.312***	0.330
	(0.063)	(0.589)	(0.008)	(0.379)
$Institutions_j$	-0.173	-1.549**	-0.338***	0.815**
	(0.189)	(0.695)	(0.009)	(0.393)
$HumanCapital_i$	0.212	1.345**	0.355***	1.577***
	(0.135)	(0.624)	(0.099)	(0.268)
$HumanCapital_j$	-0.215	0.253	-0.012	0.0273
	(0.131)	(0.500)	(0.082)	(0.327)
Observations	5,967	5,967	5,967	5,967
Nonzero observations	3,380	3,380	4,500	4,500
LR test for α	19.000		5.300.000	
P-value	0.000		0.000	
Vuong statistic	6.6		36.19	
P-value	0.000		0.000	
McFadden's R^2	0.29		0.125	

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International Inventors' Mobility (Robustness: 2SRI estimates)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Neighbouring Countries [> 300Km]	-0.595***	-0.629***	-0.612***	-0.614***	-0.620***	-0.604***	-0.601***
	(0.205)	(0.194)	(0.194)	(0.195)	(0.214)	(0.201)	(0.201)
Distance [$< 1,110$Km]	-0.946***	-0.927***	-0.935***	-0.950***	-0.946***	-0.946***	-0.944***
	(0.198)	(0.192)	(0.190)	(0.191)	(0.195)	(0.195)	(0.195)
Distance [$1,110 - 1,500$Km]	-1.073***	-1.012***	-1.005***	-1.004***	-1.078***	-1.072***	-1.069***
	(0.206)	(0.199)	(0.198)	(0.199)	(0.206)	(0.203)	(0.203)
Distance [$> 1,500$Km]	-1.602****	-1.483***	-1.490***	-1.494***	-1.602***	-1.598***	-1.598***
	(0.220)	(0.216)	(0.215)	(0.216)	(0.219)	(0.216)	(0.216)
Density_i	-0.037	-0.044	-0.0225	-0.0181	-0.0423	-0.0452	-0.0492
	(0.050)	(0.050)	(0.0517)	(0.0552)	(0.0497)	(0.0499)	(0.0501)
Density_j	-0.084***	-0.121***	-0.133***	-0.0857*	-0.103**	-0.101**	-0.0900**
	(0.044)	(0.046)	(0.0489)	(0.0510)	(0.0435)	(0.0439)	(0.0438)
lnInventors_i	0.853***	0.853***	0.952***	1.041***	0.869***	0.850***	0.852***
	(0.071)	(0.070)	(0.0738)	(0.0837)	(0.111)	(0.0707)	(0.0709)
lnInventors_j	0.250***	0.185***	0.170***	0.218***	0.238***	0.253***	0.246***
	(0.058)	(0.057)	(0.0615)	(0.0673)	(0.0598)	(0.0567)	(0.0568)
TechEffortDistance	0.365***	0.352***	0.359***	0.315**	0.334***	0.363***	0.357***
	(0.112)	(0.107)	(0.103)	(0.108)	(0.108)	(0.103)	(0.109)
TechSpecialisationSimilarity	0.531***	0.535**	0.538**	0.541**	0.533**	0.536**	0.542**
	(0.191)	(0.271)	(0.269)	(0.276)	(0.268)	(0.270)	(0.164)
LinguisticSimilarity	0.265***	0.261***	0.263**	0.258***	0.255***	0.261***	0.262***
	(0.089)	(0.090)	(0.018)	(0.009)	(0.016)	(0.082)	(0.091)
ReligionSimilarity	0.298***	0.281***	0.282***	0.286***	0.271***	0.277***	0.275***
	(0.096)	(0.063)	(0.071)	(0.068)	(0.069)	(0.086)	(0.054)

International Inventors' Mobility (Robustness: 2SRI estimates, continued)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Trade_{ij}	0.330**	0.331**	0.325**	0.333**	0.255**	0.249**	0.235**
	(0.151)	(0.164)	(0.156)	(0.161)	(0.130)	(0.121)	(0.112)
Institutions_{i}	0.199*	0.225**	0.236**	0.286**	0.275**	0.225**	0.272**
	(0.111)	(0.112)	(0.119)	(0.140)	(0.116)	(0.114)	(0.118)
Institutions_{j}	0.016	-0.0656	-0.0644	-0.132	-0.0124	0.00721	-0.0166
	(0.110)	(0.115)	(0.119)	(0.136)	(0.117)	(0.110)	(0.113)
HumanCapital_{i}	0.023	0.111	0.098	0.132	0.049	0.024	0.023
	(0.114)	(0.118)	(0.125)	(0.130)	(0.131)	(0.114)	(0.114)
HumanCapital_{j}	0.099	0.091	0.125	0.121	0.074	0.092	0.107
	(0.115)	(0.115)	(0.118)	(0.121)	(0.111)	(0.112)	(0.113)
Flows_{t-1}		0.001**					
		(0.0004)					
Flows_{t-2}			0.001**				
			(0.0004)				
Flows_{t-3}				0.001**			
				(0.0004)			
Control term					-0.036	-0.126	-0.143
					(0.084)	(0.092)	(0.104)
Observations	11,310	10,440	9,570	8,700	11,310	11,310	11,310
Hansen J statistic					52.876	55.408	57.321
P-value					0.610	0.721	0.743

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