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# Migration, Cultural Diversity and Innovation: A European Perspective



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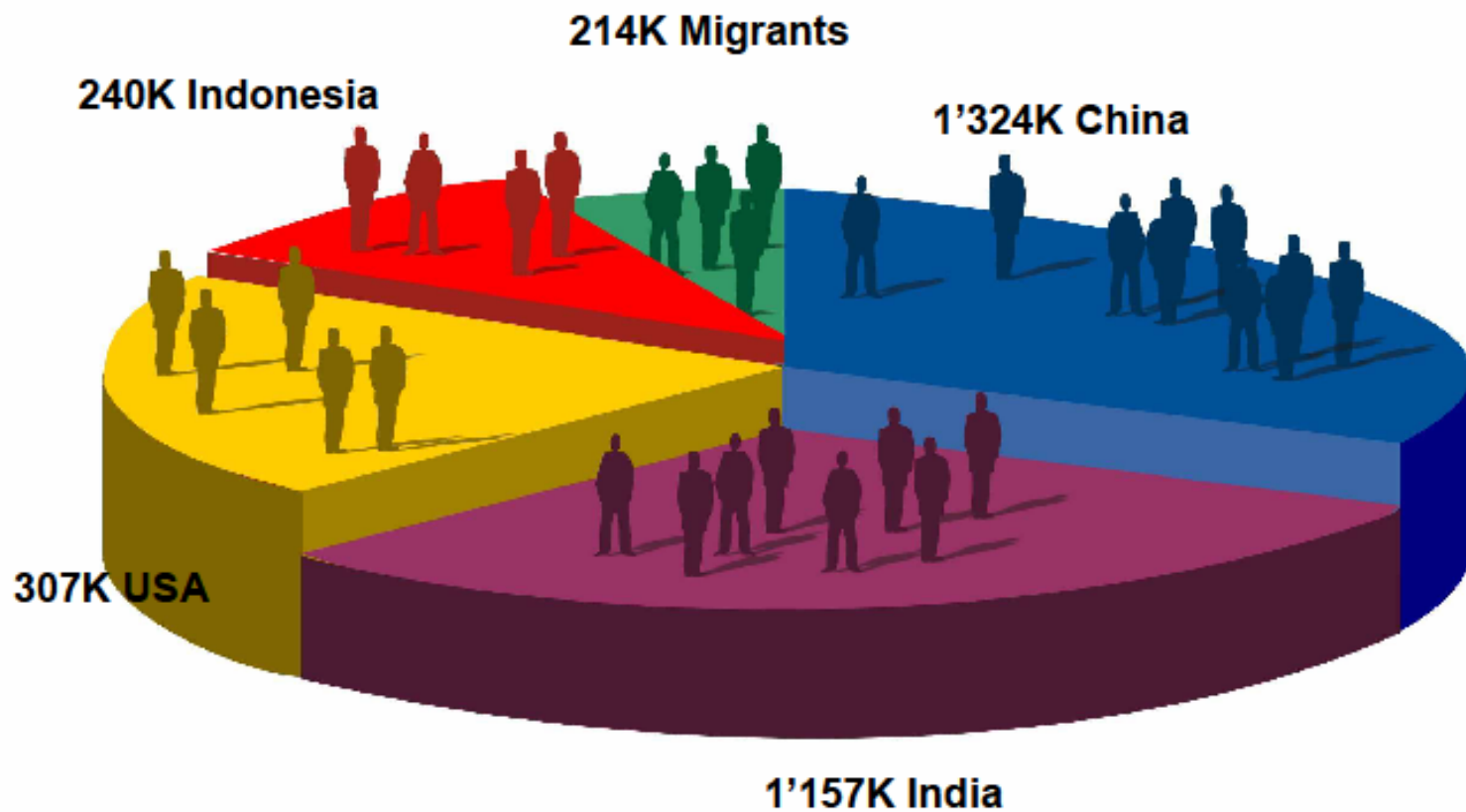
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# Stylized facts



# Objectives

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- We provide one of the novel analyses of the contribution of cultural diversity on **EU innovation**
  - Most of the literature focuses on the USA
  - Few studies in the European context, but only for selected countries
- We consider **two different kinds of innovative activity**
  - Patented knowledge – patent data
  - Basic scientific research - publication statistics
- We apply a standard proxy of cultural diversity (share of foreigners) and we consider skilled foreigners
  - **Innovative** way to **measure skills**-not skills acquired through education but through occupation

# Objectives

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- We test whether the degree of “**brain waste**” influences the innovative capacity
- We indirectly test the relationship between **national migration policies** and innovation
  - We compute an index of tightening entry laws for mostly of the European countries in the period 1995-2007

- Theoretical: Knowledge production function
  - Labour force in the research sector and the available stock of knowledge (Romer, 1990; Aghion and Howitt, 1992; Grossman and Helpman, 1994)
- Empirical: Characteristics of the research labour force input
  - Great advantages arising from the diversity in the research team –micro analysis (Katz and Martin 1997; Younglove-Webb et al, 1999; Stephan and Levin, 2001; Carayol and Mat, 2004)
  - Positive effects of country level diversity and innovation-macro level analysis
    - many for the USA (Stephan and Levin, 2001; Peri, 2007; Chellaraj et al, 2008; Hunt and Gauthier-Loiselle, 2010; Kerr and Lincoln, 2010; Kerr, 2008, 2010; Maskus et al, 2011)
    - only few for the EU (Niebhur, 2010; Ozgen et al., 2011)

### 3. A simple model

$$\dot{A}_i = \bar{\delta} L_i^A$$

$$\dot{A}_i = \rho \left[ A_i^\alpha (D_i^A)^\beta (L_i^A)^\gamma \right]$$

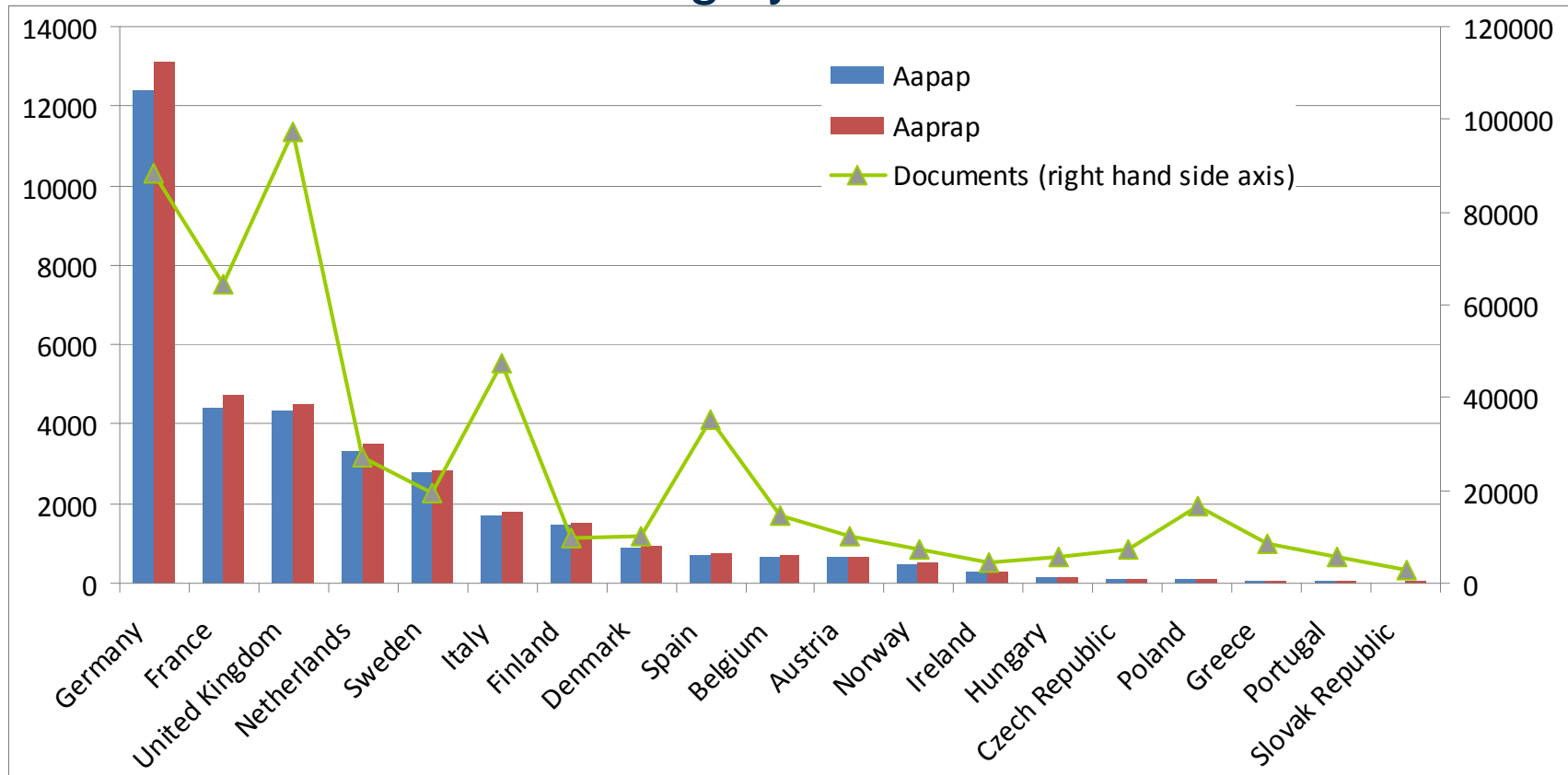
We apply logs to equation (1) and use one year lag for the control variables:

$$\ln(A_{i,t}) = \alpha \ln(R \& D_{i,t-1}) + \beta \ln(D_{i,t-1}) + \gamma \ln(L_{i,t-1}^A) + \mu_t + \mu_i + \varepsilon_{i,t}$$

- Hard to find a proper measure of innovative activity
- **Patents**
  - Linked with the output of the R&D process and inform on a number of blueprints available
  - Their use has been largely validated in an empirical context, both micro and macro
  - However, they do not capture the inventions which are not patented or patentable
  - They are not the best indicator of the general *knowledge* of the countries
- **Published documents**
  - Patents are indicative of innovations with practical applications, while published documents are related to basic knowledge

## Data description: total number of patents and published documents (average)

The two measures are highly correlated:  $\sim 0.81$





## Data description - methodological issues

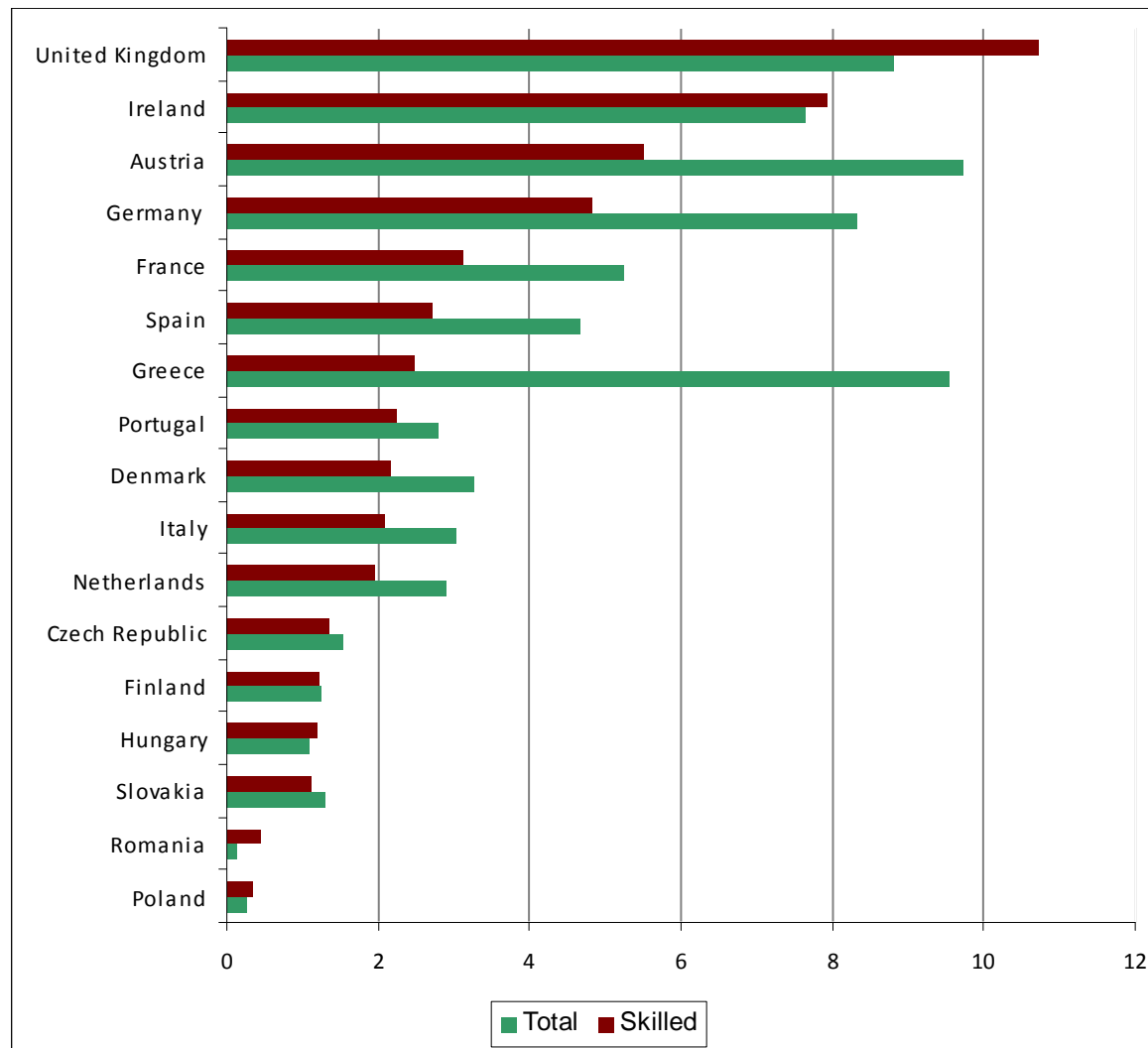
- Cultural diversity (D) is proxied by ethnic diversity
  - Share of foreigners in the total population
- Given the focus on innovation, we consider only diversity in top-skilled occupations
- The appropriate diversity measure is then based on the number of **skilled** foreigners in total skilled labour
- Non-standard dimension to measure skills
  - Literature uses educational attainment (independently to occupation considerations)
  - Here we focus on occupation
  - ISCO-88 occupation classification (ILO)

## Data description - methodological issues

ISCO-88	Low Skilled	Intermediate	High-skilled
1: Legislators, senior officials and managers			X
2: Professionals			X
3: Technician and associate professionals			X
4: Clerks		X	
5: Service workers and shop and market sales workers		X	
6: Skilled agricultural and fishery workers		X	
7: Craft and related trades workers		X	
8: Plant and machinery operators and assemblers		X	
9: Elementary occupations	X		

- The ISCO-88 classification takes into consideration the kind of work performed and the skills embodied in the work
- Occupations are grouped according to the similarity of the skills involved and the formal education required to fulfil the tasks
- Three skill levels are defined:
  - They mirror the length of time a person requires to become fully competent in the performance of the tasks associated with her job

## Data description: percentage of total and skilled foreigners (2001)



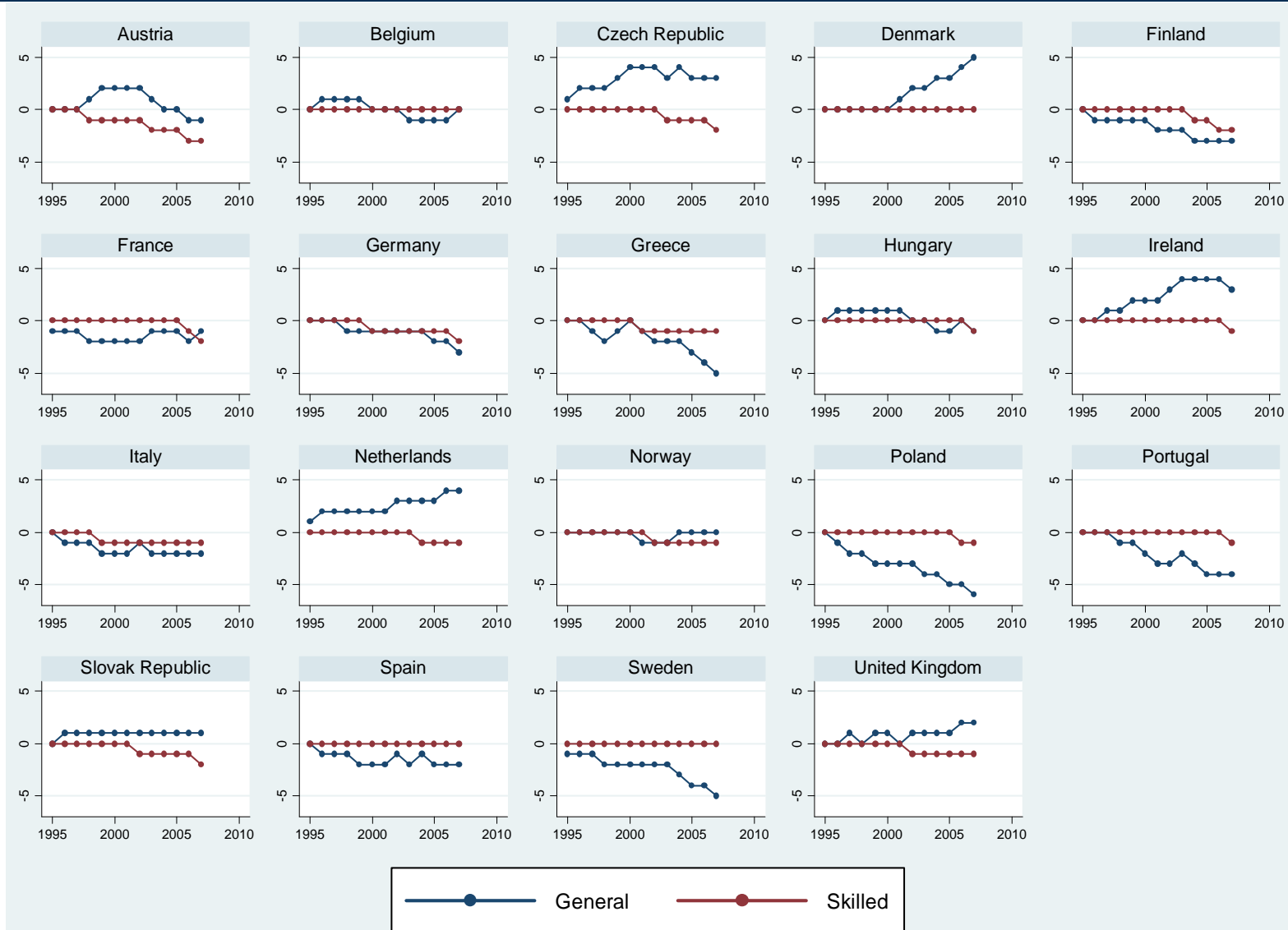
- (L): Number of employees in the technology and knowledge intensive sector
- (A): perpetual inventory method on R&D expenditure
  - Decompose funding into *total, private, public*
- (Sample): 19 European countries over 1995-2008

## 5. Empirical results - OLS

	Patents by application date			Patents by priority date			Publications		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(diversity)	0.112 [0.0689]	0.119* [0.0670]	0.0719 [0.0728]	0.169** [0.0628]	0.177** [0.0616]	0.124* [0.0686]	0.0737 [0.0447]	0.0872* [0.0481]	0.0264 [0.0321]
ln(stock of total R&D)	0.462 [0.308]			0.536 [0.379]			0.518*** [0.169]		
ln(stock of private R&D)		0.408 [0.247]			0.477 [0.294]			0.401*** [0.119]	
ln(stock of public R&D)			0.567* [0.302]			0.647 [0.384]			0.651*** [0.127]
ln(skilled labour force)	0.425** [0.169]	0.406** [0.185]	0.417** [0.173]	0.383 [0.253]	0.360 [0.270]	0.375 [0.246]	0.160 [0.116]	0.149 [0.113]	0.150* [0.0796]
Observations	200	200	200	200	200	200	200	200	200
R-squared	0.824	0.832	0.831	0.768	0.781	0.777	0.924	0.929	0.948
Number of countries	19	19	19	19	19	19	19	19	19

- Correlation between the error term and the diversity variable is  $\neq 0$
- 2SLS technique
  - Two instruments:
    - Imputed share of migrants
    - Index measuring the tightness of national policies
      - General migration law
      - Migration Law directed to attract skilled foreigners

# Empirical results: migration policy variable



# Empirical results - first stage

	ln(diversity)					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Imputed shares)	0.263*** [0.0944]	0.251** [0.0983]	0.237** [0.0982]	0.221** [0.0947]	0.218** [0.0994]	0.199** [0.0991]
Skilled migration law	-0.110** [0.0508]	-0.111** [0.0498]	-0.108** [0.0497]	-0.0984** [0.0497]	-0.0962* [0.0490]	-0.0988** [0.0491]
General migration law	0.0515*** [0.0170]	0.0480*** [0.0169]	0.0484*** [0.0157]			
F-test of excluded instruments	F( 3, 156) = 8.28	F( 3, 156) =7.45	F( 3, 156) =7.51	F( 2, 157) =8.07	F( 2, 157) =7.67	F( 2, 157) =7.15



# Empirical results - 2SLS

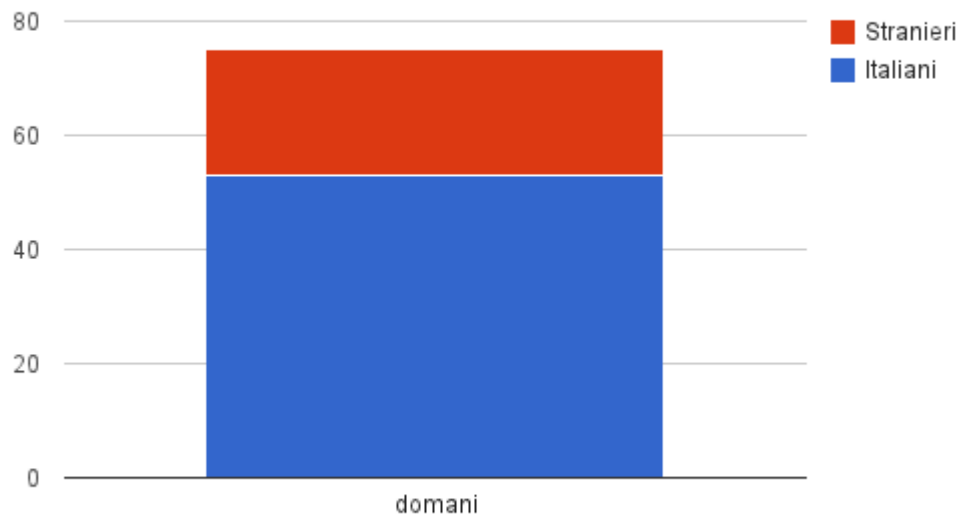
	Patents by application date						Patents by priority date					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln(diversity)	0.533** [0.238]	0.766* [0.431]	0.554** [0.251]	0.726* [0.409]	0.418* [0.213]	0.668 [0.416]	0.692** [0.323]	0.970* [0.563]	0.719** [0.331]	0.919* [0.525]	0.551** [0.279]	0.851 [0.536]
ln(stock of total R&D)	0.368* [0.206]	0.308 [0.249]					0.459* [0.256]	0.387 [0.293]				
ln(stock of private R&D)			0.379** [0.163]	0.362** [0.177]					0.472** [0.205]	0.452** [0.215]		
ln(stock of public R&D)					0.437** [0.199]	0.319 [0.260]					0.540** [0.263]	0.398 [0.311]
ln(skilled labour force)	0.356** [0.165]	0.311 [0.202]	0.306* [0.162]	0.270 [0.193]	0.372** [0.159]	0.333* [0.192]	0.311 [0.315]	0.258 [0.358]	0.249 [0.309]	0.208 [0.342]	0.332 [0.305]	0.285 [0.346]
First stage Instruments:												
Imputed shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
General migration law	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	no
Skilled migration law	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	191	191	191	191	191	191	191	191	191	191	191	191
Number of countries	19	19	19	19	19	19	19	19	19	19	19	19

# 5. Empirical results - 2SLS

	Publications					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(diversity)	0.311*** [0.120]	0.427** [0.207]	0.318*** [0.123]	0.383** [0.190]	0.215** [0.0999]	0.338* [0.184]
ln(stock of total R&D)	0.418*** [0.114]	0.388*** [0.142]				
ln(stock of private R&D)			0.349*** [0.0769]	0.342*** [0.0866]		
ln(stock of public R&D)					0.543*** [0.0968]	0.485*** [0.138]
ln(skilled labour force)	0.163* [0.0976]	0.141 [0.116]	0.134 [0.0881]	0.121 [0.0986]	0.166** [0.0834]	0.147 [0.103]
First stage Instruments:						
Imputed shares	Yes	Yes	Yes	Yes	Yes	Yes
General migration law	Yes	No	Yes	No	Yes	No
Skilled migration law	Yes	Yes	Yes	Yes	Yes	Yes
Observations	191	191	191	191	191	191
Number of countries	19	19	19	19	19	19

# FEEM

Malaga objective !



# Robustness checks - education classification

	Patents by application date			Patents by priority date			Publications		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(diversity)	1.118** [0.473]	1.070** [0.484]	1.089** [0.514]	1.444** [0.702]	1.390** [0.700]	1.404* [0.735]	0.511** [0.232]	0.463** [0.232]	0.407* [0.222]
ln(stock of total R&D)	0.141 [0.274]			0.164 [0.323]			0.317** [0.160]		
ln(stock of private R&D)		0.184 [0.207]			0.210 [0.245]			0.265** [0.114]	
ln(stock of public R&D)			0.134 [0.327]			0.180 [0.389]			0.458*** [0.161]
ln(skilled labour force)	-0.219 [0.413]	-0.212 [0.405]	-0.201 [0.416]	-0.460 [0.706]	-0.452 [0.686]	-0.442 [0.703]	-0.0771 [0.208]	-0.0599 [0.192]	-0.0477 [0.175]
Observations	189	189	189	189	189	189	189	189	189
Number of countries	19	19	19	19	19	19	19	19	19

# Robustness checks - comparison of coefficients

	Patents by application date			Patents by priority date			Publications		
Diversity based on Skill	1.118	1.07	1.089	1.444	1.39	1.404	0.511	0.463	0.407
Diversity based on Education	0.533	0.554	0.418	0.692	0.719	0.551	0.311	0.318	0.215
t-test on difference of coefficients	1.105	0.946	1.206	0.973	0.867	1.085	0.766	0.552	0.789

## Robustness checks - effective allocation

- Labour markets in destination countries may not fully absorb the skill potential of foreigners (brain waste)
  - High education attainments do not guarantee that migrants are employed in high skill occupations
  - Imperfect transferability of skills and imperfect screening of the quality of a foreign educational institution
- We employ a “normative” approach to measure the allocation capacity (education-occupation mismatch)
  - We measure the correspondence between education and qualification levels
- We interact the core diversity variable with the measure of the allocation capacity of the different countries

## Robustness checks - effective allocation

<b>Country</b>	<b>Allocation rates</b>
Slovak Republic	0.93
Poland	0.85
Czech Republic	0.83
Hungary	0.81
Netherlands	0.79
United Kingdom	0.78
Belgium	0.76
Austria	0.75
Norway	0.74
Sweden	0.74
Denmark	0.72
Germany	0.71
France	0.70
Finland	0.69
Ireland	0.68
Portugal	0.67
Spain	0.47
Italy	0.41
Greece	0.31

# Robustness checks - effective allocation

	Patents by application date		Patents by priority date		Publications	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(skilled diversity)	0.528** [0.216]		0.666** [0.300]		0.329*** [0.0854]	
ln(diversity)*allocation rate	0.0565 [0.0811]		0.0894 [0.0844]		0.00742 [0.0252]	
ln(education diversity)		0.927** [0.390]		1.126** [0.485]		0.445*** [0.126]
ln(diversity)* allocation rate		0.0248 [0.0729]		0.0583 [0.0791]		-0.00564 [0.0256]
ln(stock of total R&D)	0.211 [0.193]	0.169 [0.196]	0.284 [0.254]	0.237 [0.213]	0.408*** [0.0824]	0.407*** [0.0833]
ln(skilled labour force)	0.257 [0.227]	-0.246 [0.345]	0.202 [0.368]	-0.416 [0.534]	0.124 [0.0883]	-0.104 [0.113]
Observations	170	170	170	170	170	170
Number of countries	19	19	19	19	19	19



## Robustness checks - long term migrants

	Patents by application date	Patents by priority date	Publications
	(1)	(2)	(3)
ln(diversity)	1.253** [0.610]	1.534** [0.711]	0.468** [0.209]
ln(stock of total R&D)	0.201 [0.310]	0.239 [0.368]	0.500*** [0.132]
ln(skilled labour force)	0.314 [0.302]	0.238 [0.403]	0.120 [0.102]
Observations	189	189	189
Number of countries	19	19	19

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Diversity based on all skilled migrants	0.533	0.692	0.311
Diversity based on long term skilled migrants	1.253	1.534	0.468
t-test on difference of coefficients	-1.100	-1.078	-0.651

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# Robustness checks - two years lag

	Patents by application date			Patents by priority date			Publications		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(diversity)	0.888*** [0.344]	0.914*** [0.347]	0.727** [0.304]	0.981*** [0.371]	0.996*** [0.380]	0.874** [0.376]	0.483*** [0.171]	0.464*** [0.167]	0.380** [0.152]
ln(stock of total R&D)	0.299 [0.250]			0.197 [0.300]			0.330** [0.152]		
ln(stock of private R&D)		0.357* [0.202]			0.268 [0.211]			0.305*** [0.103]	
ln(stock of public R&D)			0.338 [0.260]			0.184 [0.304]			0.432*** [0.132]
ln(skilled labour force)	0.312 [0.318]	0.249 [0.313]	0.351 [0.297]	0.510* [0.263]	0.458* [0.256]	0.540** [0.249]	0.160 [0.144]	0.125 [0.129]	0.183 [0.131]
Observations	173	173	173	173	173	173	173	173	173
Number of countries	19	19	19	19	19	19	19	19	19

# Robustness checks - alternative patent count

	Patents by application date to EPO			Patents by priority date to EPO			Patents by application date to USPTO			Patents by priority date to USPTO		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln(diversity)	0.824** [0.336]	0.843** [0.358]	0.817** [0.365]	0.792** [0.355]	0.805** [0.368]	0.789** [0.389]	1.156** [0.480]	1.197** [0.522]	1.282** [0.609]	0.610 [0.403]	0.600 [0.415]	0.577 [0.449]
ln(stock of total R&D)	-0.0477 [0.259]			-0.0985 [0.294]			-0.582 [0.519]			0.111 [0.401]		
ln(stock of private R&D)		0.0406 [0.177]			0.0184 [0.211]			-0.346 [0.350]			0.0900 [0.265]	
ln(stock of public R&D)			0.0671 [0.294]			0.0404 [0.327]			-0.381 [0.613]			0.363 [0.453]
ln(skilled labour force)	0.475** [0.188]	0.451** [0.193]	0.457** [0.190]	0.463** [0.229]	0.438* [0.234]	0.442** [0.224]	0.613* [0.338]	0.602* [0.354]	0.548 [0.347]	0.278 [0.279]	0.275 [0.278]	0.244 [0.272]
Observations	191	191	191	173	173	173	191	191	191	187	187	187
Number of countries	19	19	19	19	19	19	19	19	19	19	19	19

## Robustness checks - alternative measure of skilled labour

	Publications		
	(1)	(2)	(3)
ln(diversity)	0.321** [0.155]	0.296** [0.150]	0.227* [0.130]
ln(stock of total R&D)	0.426*** [0.122]		
ln(stock of private R&D)		0.359*** [0.0798]	
ln(stock of public R&D)			0.577*** [0.105]
ln(skilled labour force)	0.0740 [0.0999]	0.102 [0.0921]	0.0716 [0.0766]
Observations	188	188	188
Number of countries	19	19	19

## Summary and conclusions

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- Positive and robust effect of diversity on both measures of innovation
- Positive effect independently to the way we measure skills
  - The education-occupation mismatch is eventually small
  - Regardless of where educated migrants are employed, they contribute to the creation of knowledge
- No gains emerge from a better allocation of the human capital of foreigners
- The effect of cultural diversity is unaffected by the duration of stay of foreigners
- Migration entry policies indirectly influence innovation
  - They alter the skill mix of foreigners

# Thanks