The impact of migration, age and skills on innovation in Europe
A study on France, Germany and UK

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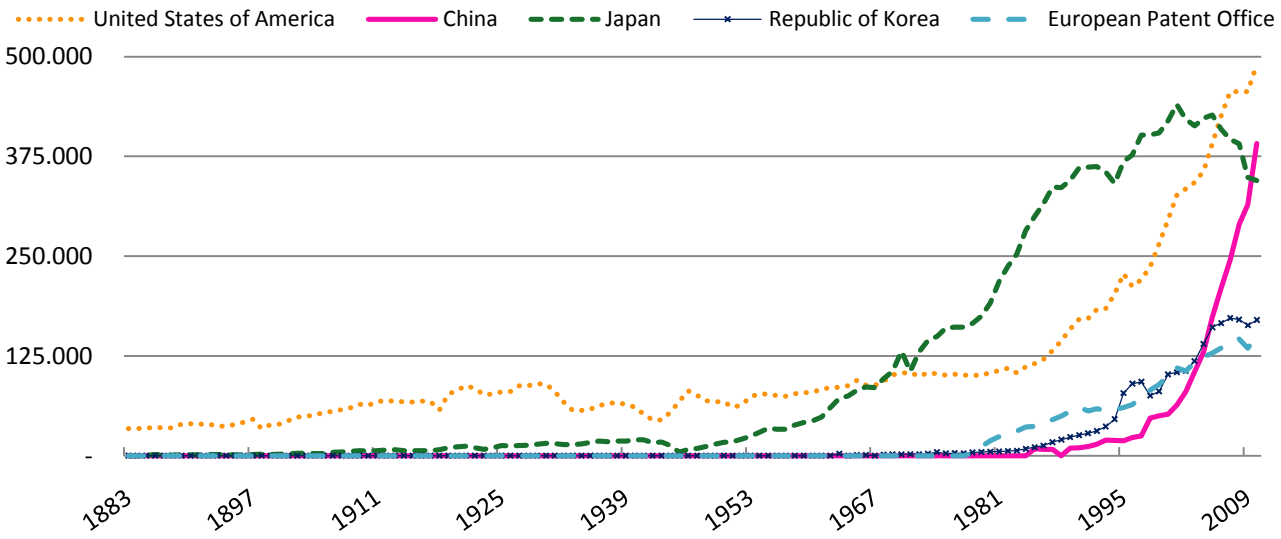
ZEW – SEEK conference
Engines for More and Better Jobs in Europe
25-26 April, 2013
Mannheim, Germany

Background & Motivations

European competitiveness, Europe 2020: *smart, sustainable and inclusive growth.* Innovation and skills

• Innovation and R&D considered as key drivers of growth. Usual problems: difficulties with R&D targets, adverse technological specialization

Figure 1: Trend in patent applications at the top five offices, 1883-2010.



Source: WIPO Statistical Database, October 2011.

Background & Motivations

Human capital related problems: ageing of population, lack of (mobility of) skills

1. Ageing of European labour force (CEDEFOP, 2010): is the increasing average age of the European labour force an obstacle to the growth of productivity and innovation?
2. Lack (of mobility) of skills: is the European labour market able to efficiently allocate its skilled labour force?

In both cases migration can be beneficial for European competitiveness.

However European policies often aim to restrict immigration on claims related to the use of the welfare state, the potential competitive role in the labour market, difficult integration.

Main Hypothesis

We stress the fact that innovative capacity in European countries depends crucially on the quality of human capital and specifically on the following interconnected components :

1. Skills/ education
2. Age
3. Ethnicity

Background literature and research hypotheses

The role of skills:

- Are skill necessary for innovation?
  - Endogenous growth theory and the role of education/human capital (Benhabib and Spiegal, 1994, Mankiw, Romer, and Weil, 1992, Aghion, Boustan, Hoxby, Vandenbussche, 2009)
  - Skill-biased nature of technological change (Acemoglu, 2002, 2003)

The role of age:

- Is there an *age dividend* for innovation? Does it affect differently educated and non-educated workers?
  - Human capital life cycle and continuing vocational training and investment in additional accumulation of human capital (Jones, 2010; Levin, Stephan 1991, Frosch, 2011)

Background literature and research hypotheses

The role of ethnicity:

- Are *skilled* migrants contributing to innovation and growth in Europe?
  - European Commission competitiveness agenda: Blue Card Directive inside the Global Migration Approach
  - Some evidence in US (Peri, 2011; Ortega, Peri, 2011; Hunt and Gauthier-Loiselle, 2010; Kerr and Lincoln 2010) and conflicting evidence in Europe (Ozgen et al. 2011, Cattaneo et al, 2012, Breschi, Lissoni, Tarasconi, 2013)

- Are *low skilled* migrants contributing to growth in Europe?
  - No evidence, only indirect evidence on complementarity with high skilled women's fertility choices (Cortes Tessada, 2011; Baroni Mocetti, 2011; Farré et al, 2011; Romiti Rossi 2011)

The role of the country-level institutional framework :

- Are there different *country migration patterns* that affect innovation activities in Europe?
  - Impact of EU enlargement

The empirical strategy: the model

Endogenous growth model (Romer, 1990) and national innovative capacity (Furman et al. 2002). The rate of technological progress is:

$$\dot{A}_t = \delta(A_t^{\beta} H_t^{\gamma})$$

Complementarity and imperfect substitutability of different labour factors

We expand the model: $$\dot{A}_{it} = \delta(A_{it}^{\beta} RD_{it}^{\gamma} L_{it}^{\varphi} X_{it}^{\omega})$$

And take logs: $$\ln \dot{A}_{it} = \delta + \beta \ln A_{it-1} + \gamma \ln RD_{it-1} + \varphi \ln L_{it-1} + \omega \ln X_{it-1}$$

Variables

$\dot{A}_{it}$: flow of new technologies from country−sector i in year t,

$R\&D_{it}$: R&D expenditures,

L_{it}: employed labour force

- age, skills, country of origin,

A_{it}: accumulated knowledge stock held country−sector i in year t (perpetual inventory method),

X_{it}: trade openness.

Sources of data

- 3 countries, 16 manufacturing industries (NACE), 13 years (1994-2005)
- Patent applications and patent citations counts (4-y impact) at the EPO (Patstat).
- National labour force surveys for UK and FRA
- Microcensus Germany
- STAN –ANBERD Database (sectoral R&D, Value Added, Trade)

Identification strategy

- We use log and estimate elasticities,
- one year lag for all independent variables
- Endogeneity issues
  - Important pull factors

Internal instruments:

Blundell and Bond (1998) GMM-SYSTEM

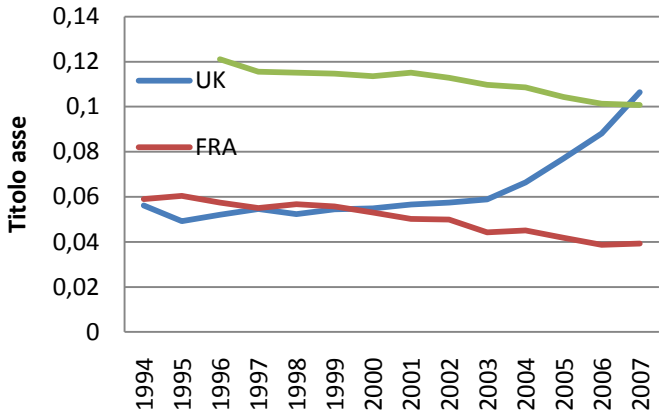
- All labour force variables are considered endogenous

-This works well with large N and small T (as N decreases Hansen test unreliable and large standard errors: use of Roodman (2008) procedure to reduce the number of instruments)

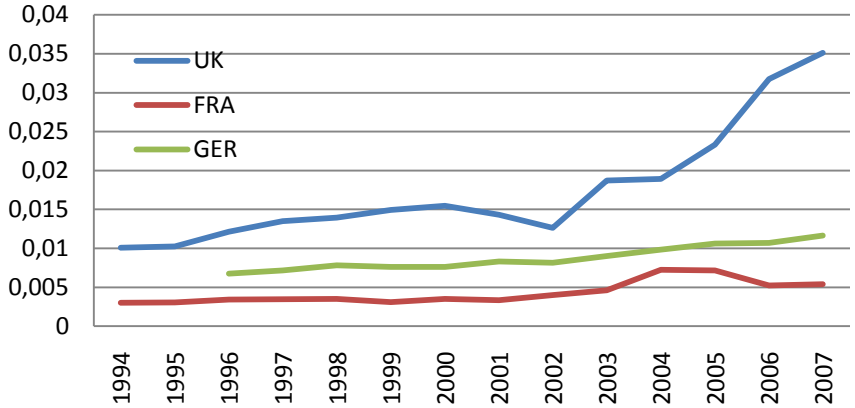
-Possible use of external instruments (Card, 2001) for country regressions

Descriptive statistics

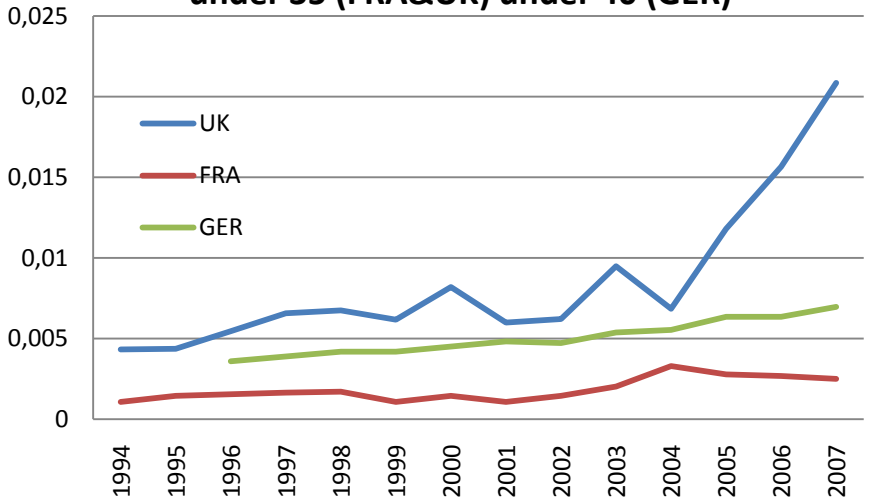
Share of migrants on employment

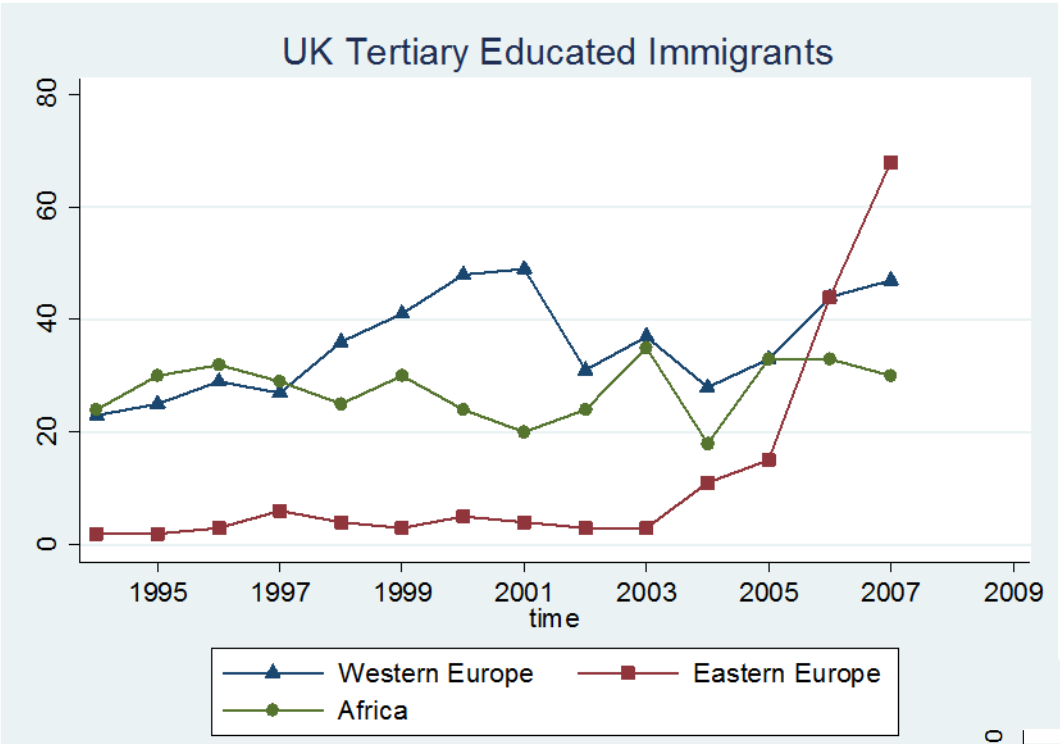


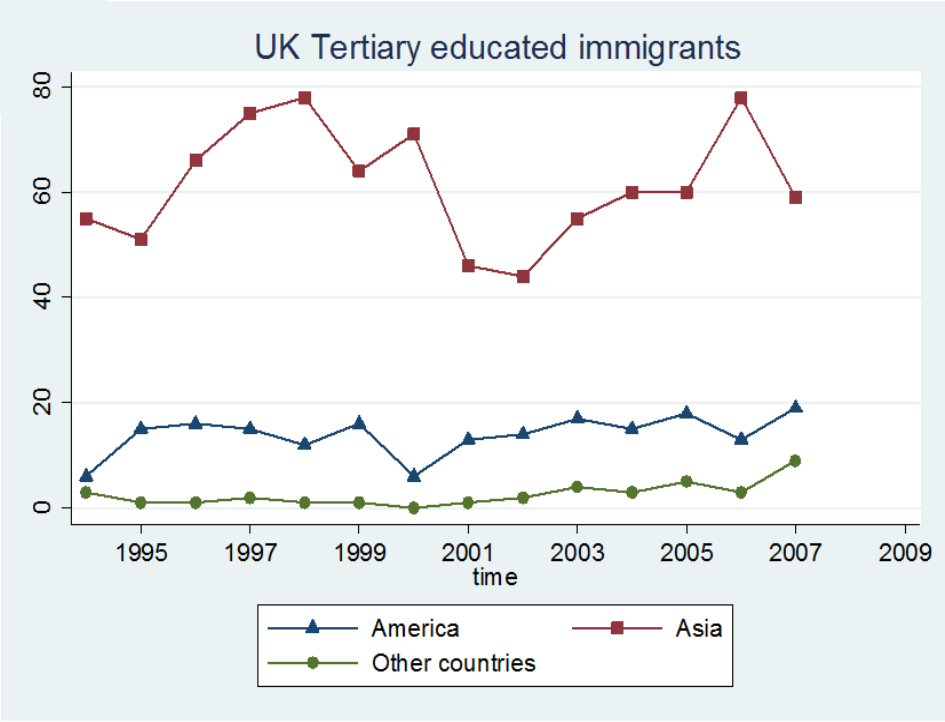
Share of tertiary educated migrants



Share of tertiary educated young migrants under 35 (FRA&UK) under 40 (GER)

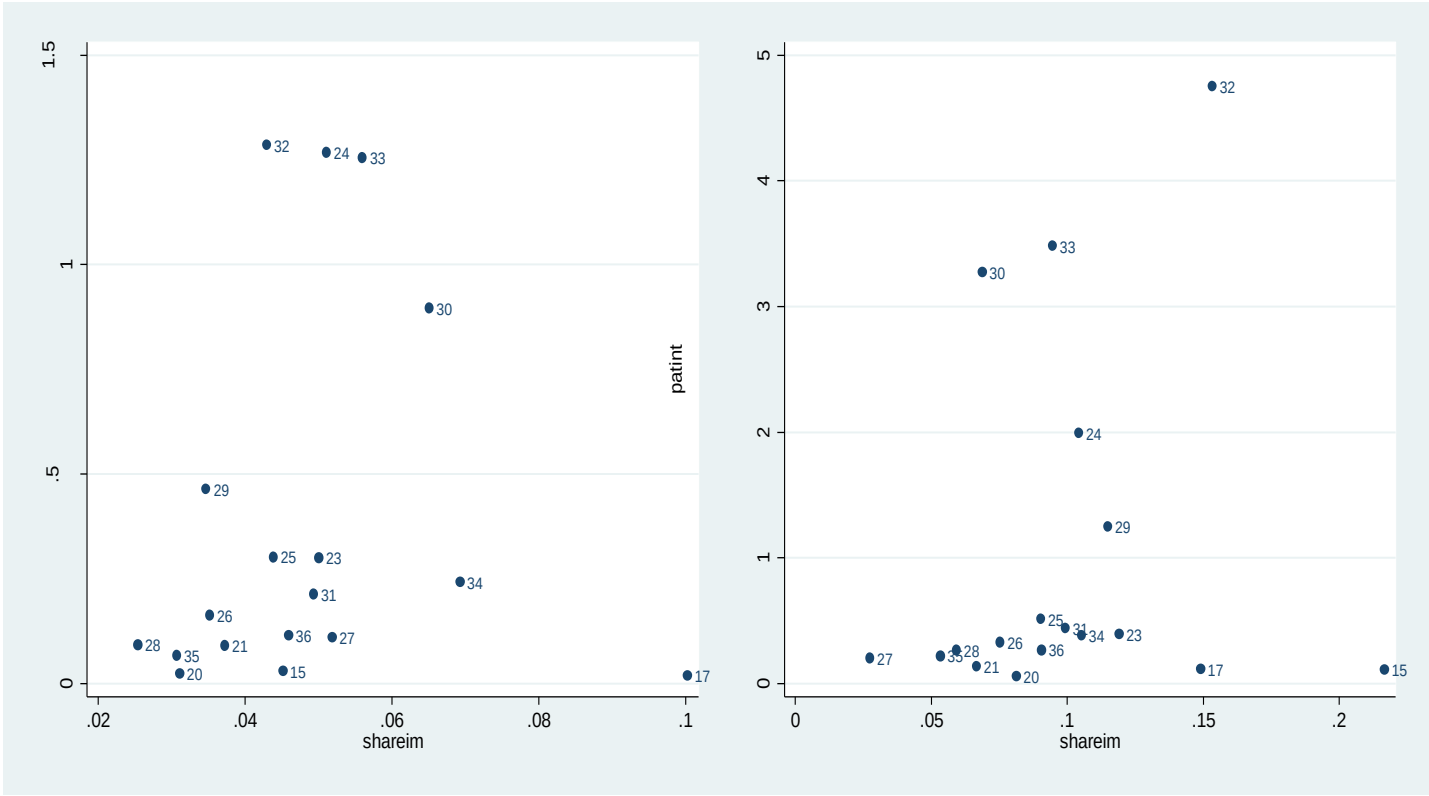



UK Tertiary Educated Immigrants
0
20
40
60
80
1995
1997
1999
2001
2003
2005
2007
2009
time
Western Europe
Eastern Europe
Africa

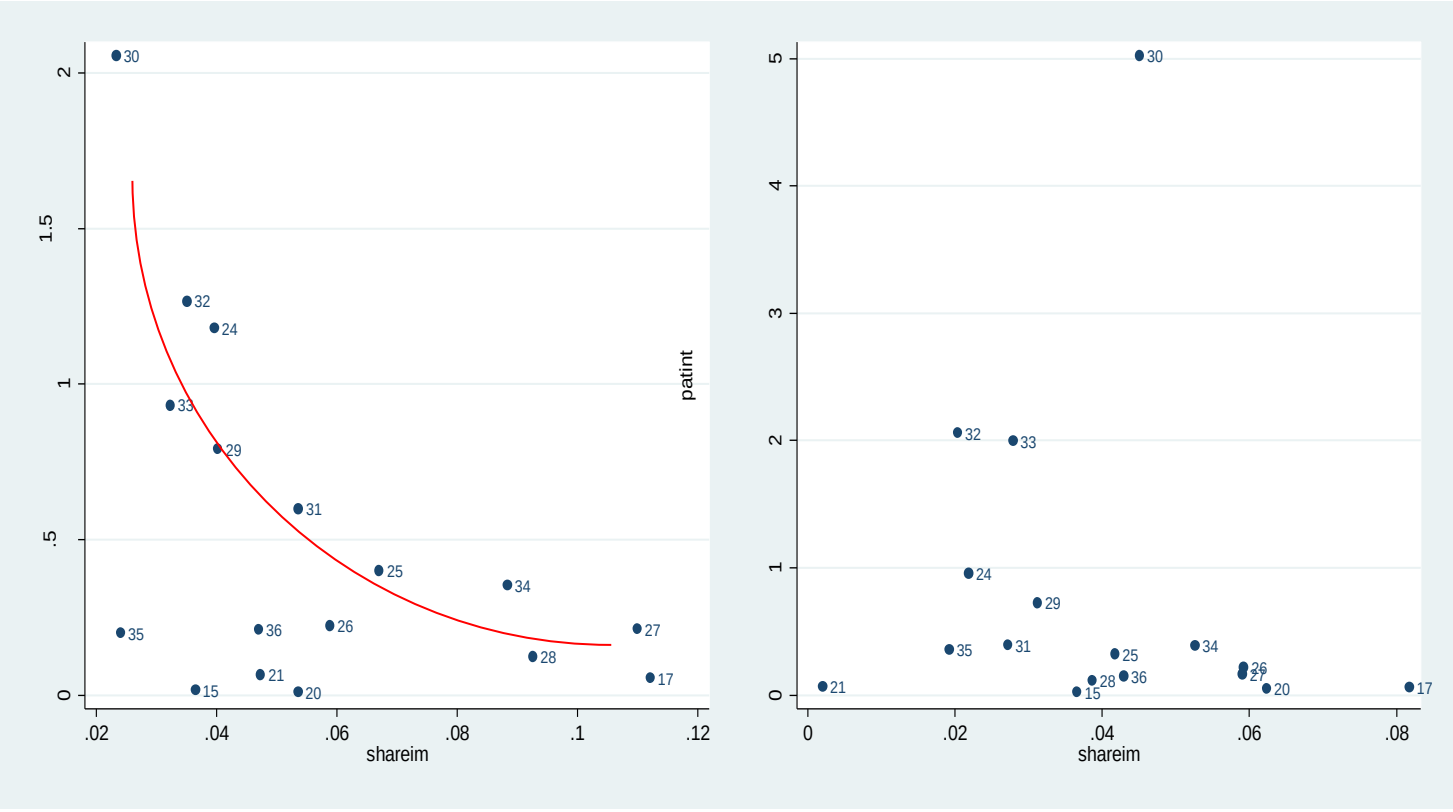

UK Tertiary educated immigrants
0
20
40
60
80
1995
1997
1999
2001
2003
2005
2007
2009
time
America
Asia
Other countries

Different sectoral distributions of the migrant labour force in the three countries

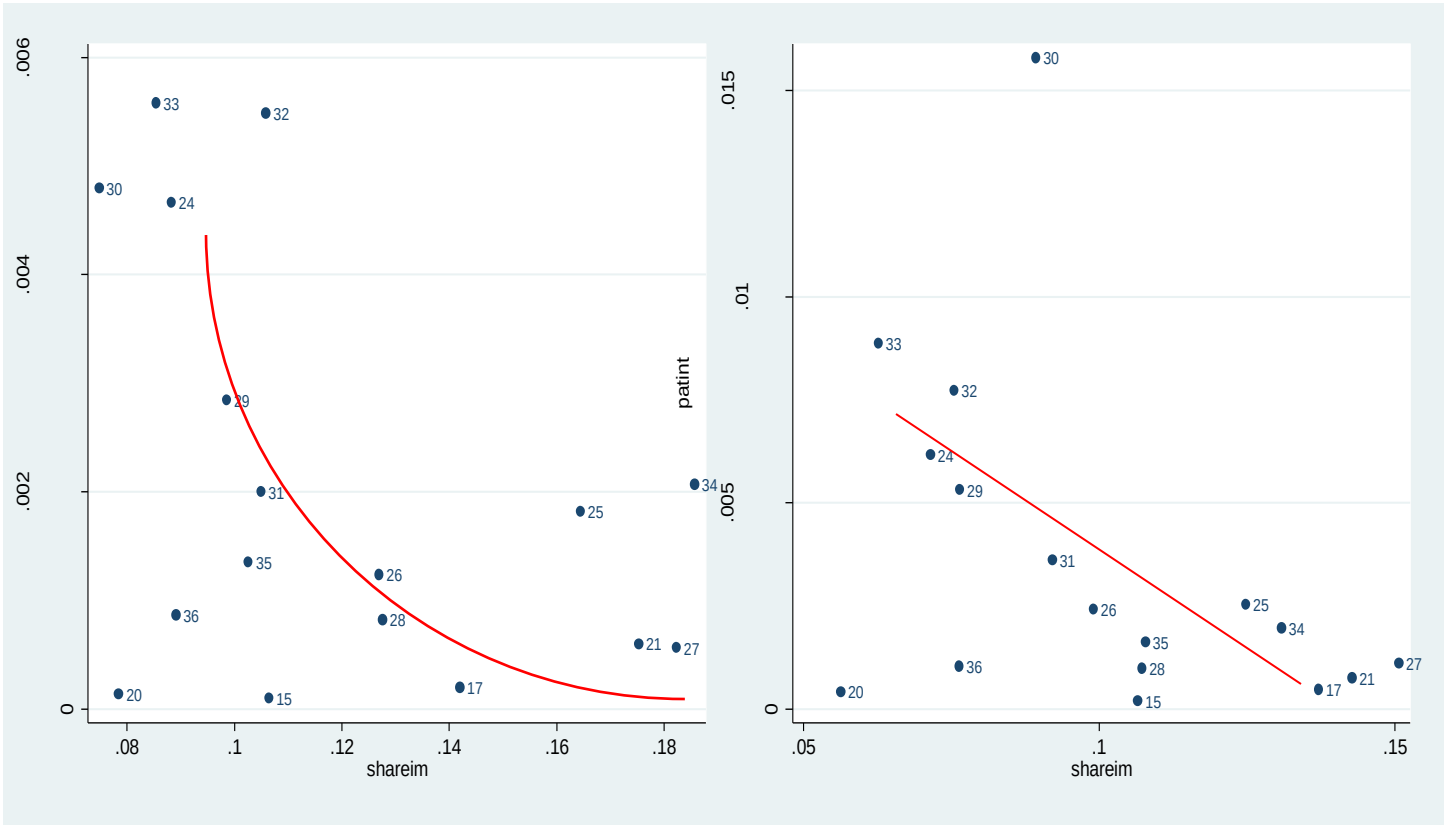
UK – share of migrants on total employment (by sector) in 1994 and 2005 and number of patents per worker (on the y axis)



FRANCE – share of migrants on total employment (by sector) in 1994 and 2005 and number of patents per worker (on the y axis)



GERMANY – share of migrants on total employment (by sector) in 1996 and 2005 and number of patents per worker (on the y axis)



AGE and SKILLS

VARIABLES	(1) OLS logpat	(2) OLS logcit	(3) GMM logpat	(4) GMM logcit	(7) GMM logpat	(8) GMM logcit
L.logRD	0.051	0.292**	0.121***	0.357***	0.075*	0.237***
	(0.056)	(0.122)	(0.043)	(0.086)	(0.039)	(0.081)
L.loga	0.400***	0.102	0.717***	0.793***	0.690***	0.722***
	(0.117)	(0.127)	(0.066)	(0.087)	(0.059)	(0.074)
L.lopen	0.067	-0.379**	0.072***	0.140***	0.087***	0.163***
	(0.081)	(0.187)	(0.027)	(0.048)	(0.028)	(0.051)
L.logn	0.091	-0.150	0.027	-0.465		
	(0.086)	(0.203)	(0.148)	(0.353)		
L.logedu					0.213**	0.421***
					(0.091)	(0.140)
L.lognoedu					-0.049	-0.472*
					(0.110)	(0.282)
L.logage	-0.945	-2.657**	-1.339*	-4.877***	-1.114	-3.327***
	(0.672)	(1.082)	(0.774)	(1.493)	(0.829)	(1.269)
L.logage_edu					0.212	-0.159
					(0.220)	(0.527)
Constant	3.563	11.089**	1.902	13.435*	0.104	6.812
	(3.128)	(4.544)	(3.832)	(8.000)	(3.725)	(5.964)
Observations	485	485	485	485	485	485
Number of id2	47	47	47	47	47	47
R-squared	0.467	0.748				
AR(1)			-3.236	-2.406	-3.482	-2.472
AR(1) p-value			0.001	0.016	0.000	0.013
AR(2)			0.756	0.410	0.598	0.495
AR(2) p-value			0.449	0.682	0.550	0.620
Hansen test			0.254	3.058	2.469	6.543
Hansen test p-value			0.881	0.217	0.650	0.162

AGE, SKILLS and ETHNICITY

VARIABLES	(1) GMM logpat	(2) GMM logcit
L.logRD	0.079*	0.173***
	(0.045)	(0.058)
L.loga	0.690***	0.694***
	(0.058)	(0.083)
L.lopen	0.090***	0.168***
	(0.028)	(0.054)
L.logedu_nat	0.208***	0.457**
	(0.081)	(0.199)
L.lognoedu_nat	-0.171	-0.407
	(0.130)	(0.263)
L.logedu_imm	0.033	0.084*
	(0.021)	(0.043)
L.lognoedu_imm	-0.004	-0.032
	(0.019)	(0.047)
L.logage_nat	-1.505*	-3.698***
	(0.787)	(1.272)
L.logage_edu_nat	0.144	0.162
	(0.253)	(0.612)
L.logage_immi	-0.167	0.303
	(0.119)	(0.379)
L.logage_edu_immi	-0.078	-0.399***
	(0.090)	(0.152)
Constant	3.786	7.606
	(3.954)	(6.185)
Observations	459	459
Number of id	47	47
AR(1) p-value	0.000	0.005
AR(2) p-value	0.527	0.463
Hansen test p-value	0.610	0.163

Results (aggregate)

1. Positive role of education and skills for innovation in European countries

2. Positive (milder) role for education also among migrants

3. Ageing employment is a problem for innovation (negative effect of age on innovation performances among natives)

4. Age dividend for high skilled natives. Young dividend for high skilled migrants

Different country patterns

	UK GMM-SYS		GERMANY GMM-SYS		FRANCE GMM-SYS	
VARIABLES	logpat	logcit	logpat	logcit	logpat	logcit
L.loga	0.902***	0.800***	1.129***	0.951***	0.934***	0.970***
	(0.055)	(0.139)	(0.080)	(0.249)	(0.035)	(0.065)
L.logedu_nat	0.130	0.564**	-0.005	0.568	0.260**	0.616***
	(0.131)	(0.286)	(0.173)	(0.542)	(0.111)	(0.221)
L.lognoedu_nat	0.084	0.295	-0.493**	-0.980*	-0.343**	-0.580**
	(0.176)	(0.345)	(0.250)	(0.515)	(0.156)	(0.256)
L.logedu_imm	0.075**	0.184***	-0.033	-0.079	0.063**	0.128*
	(0.029)	(0.056)	(0.042)	(0.089)	(0.030)	(0.075)
L.lognoedu_imm	-0.055	-0.358***	0.315**	0.381	0.045***	0.045
	(0.037)	(0.115)	(0.124)	(0.262)	(0.015)	(0.032)
L.logage_nat	-1.195	-2.656	-2.350***	-3.370	-0.503	1.957
	(1.060)	(1.953)	(0.784)	(3.022)	(0.907)	(1.886)
L.logage_edu_nat	0.546	0.880	-0.135	1.708	-1.260	-4.633***
	(0.514)	(1.215)	(0.834)	(1.910)	(0.852)	(1.654)
L.logage_immi	0.079	-0.017	-0.044	1.220	-0.298	0.090
	(0.363)	(0.598)	(0.422)	(1.361)	(0.194)	(0.457)
L.logage_edu_immi	-0.081	-0.307*	0.102	-0.651	-0.056	-0.373
	(0.150)	(0.170)	(0.210)	(0.453)	(0.117)	(0.301)
Constant	-1.641	-2.014	6.575	-4.018	6.745***	6.276
	(3.867)	(9.972)	(6.394)	(12.616)	(2.357)	(4.841)
Observations	175	175	144	144	151	151
Number of id2	16	16	16	16	16	16
AR(1) p-value	0.014	0.016	0.063	0.163	0.029	0.074
AR(2) p-value	0.288	0.078	0.515	0.313	0.626	0.511
Hansen test p-value	1.00	1.00	1.00	1.00	1.00	1.00

Summing up

- Important role of skilled labour force.
- Ageing employment is a problem for innovation
- Different country patterns.
  - In UK higher flow of educated immigrant with a positive effects on innovation
  - Positive impact for Germany of low educated immigrants
  - Mixed results in France
  - Age premium for educated natives in UK (but the contrary in France)
  - Younger educated immigrants contribute positively to innovation (less so in Germany)

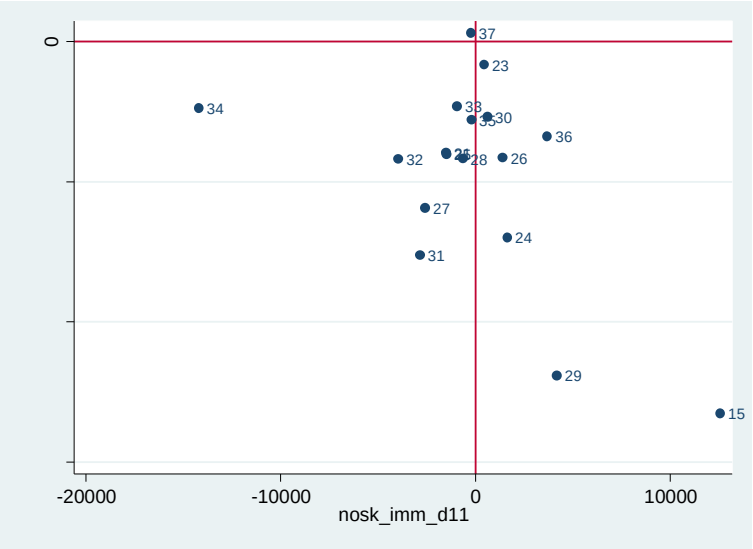
Prospect

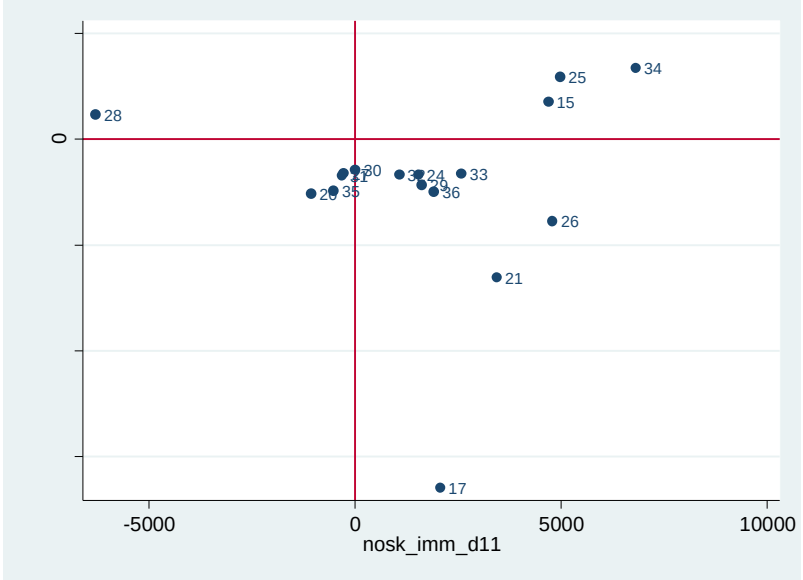
- Why *exactly* these different country patterns occur?
- Use better (external) instruments and countries of origin
- Expanding the database on other EU countries (Italy)

UK

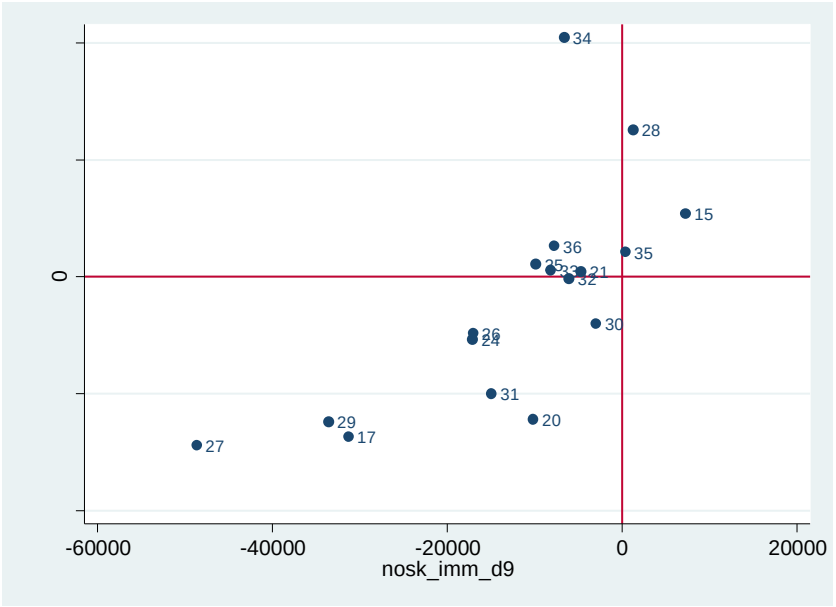
NATIVE AND MIGRANT LOW EDUCATED WORKERS

FRANCE





GERMANY



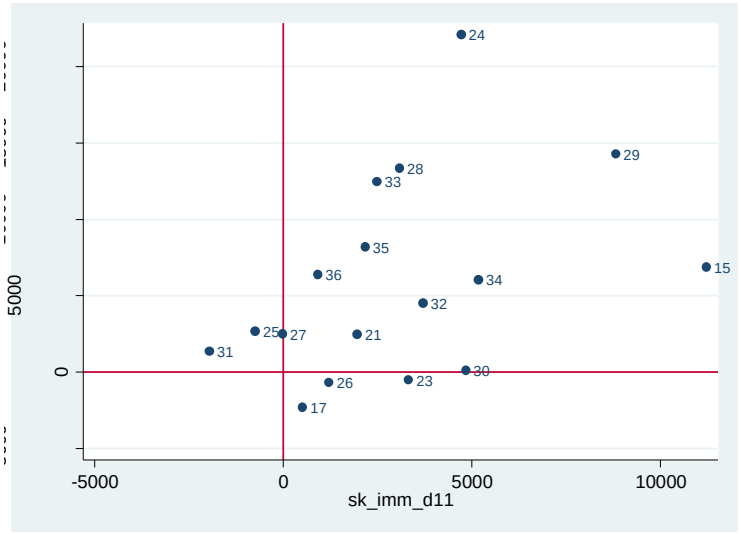
Y axes=difference between non-educated natives in 1994 and 2005

X axes=difference between non-educated migrants in 1994 and 2005

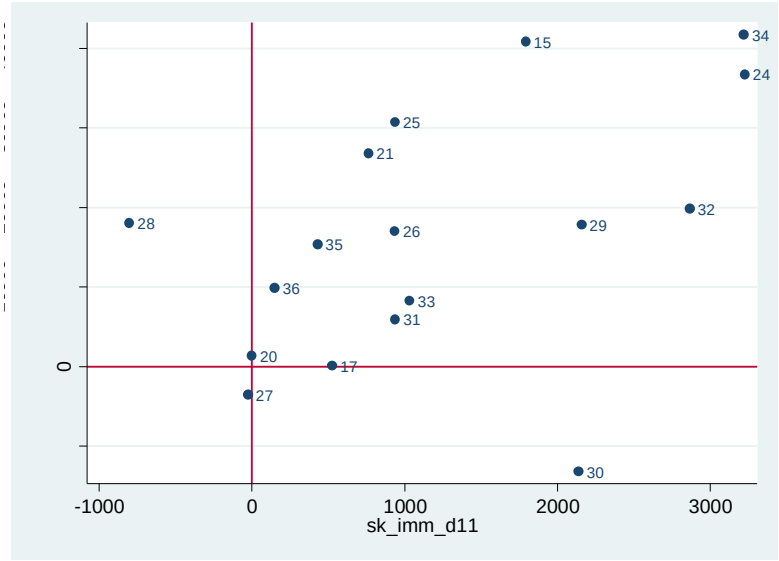
In UK and France low-educated migrants are often substituting low educated natives. In Germany this is never the case

NATIVE AND MIGRANT HIGHLY EDUCATED WORKERS

UK



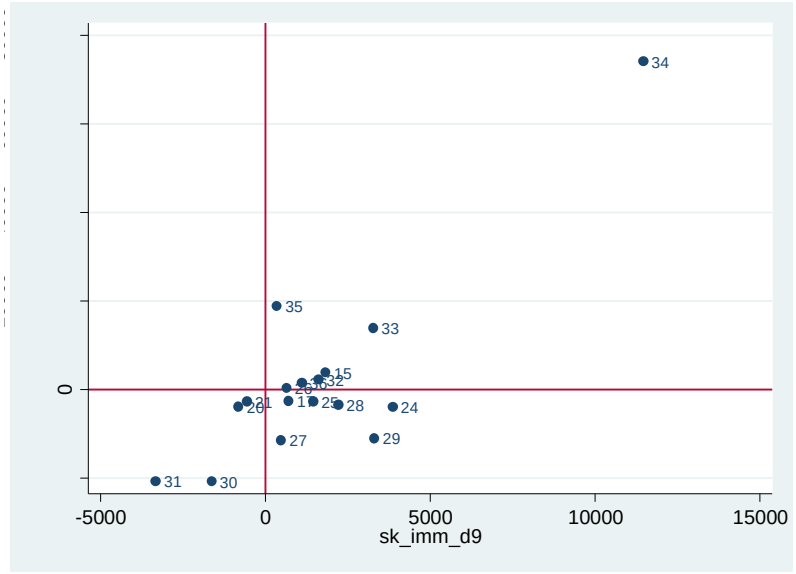
FRANCE



GERMANY

Y axes=difference between highly-educated natives in 1994 and 2005

X axes=difference between highly-educated migrants in 1994 and 2005



In Germany highly-educated migrants are often substituting highly educated natives. In Uk and France this is never the case

	logsk_~m	logsk_~t	lognos~m	lognos~t
logsk_imm	1			
logsk_nat	0.2671	1		
lognosk_imm	0.3289	0.3363	1	
lognosk_nat	0.2172	0.6359	0.8128	1

Looking at the previous graphs we notice that:

- In Germany the share of migrants is high only in low tech sectors, with a little number of patents per worker.

- IN France this is the case only for the 1994 distribution

- In UK there is not a clear relationship between technology intensity and migrants' share.

UK and Germany are two opposite sytems, France is in the middle

- Vienna Institute of Demography, Austrian Academy of Sciences and Institute for Futures Studies, Stockholm, Sweden
- the capacity to absorb technological progress may be higher with a younger age structure and more recent education in the workforce.

- Empirical evidence based on pooled cross-country data over the period 1960-1990 indicates that workers aged 40-49 have a large positive effect on productivity (as measured by the Solow residual). A study based on Japanese industries, however, indicates that the positive effect of educated workers older than 40 on technological progress turned from positive in the 1980s to negative in the 1990s.
- Why?
- Higher rate of technological change and capital-biased *(or skill biased*) technological change during the 1990s may have shifted the productivity peak towards younger ages, opening for the speculation that it may shift again as this slows down with the maturation of ICT technologies

- **age-related productivity declines for individuals is likely to** be age-specific reductions in **cognitive abilities**

- IN austria and sweden: The age-productivity curve shows a **hump-shaped pattern with a peak for mid-life workers in ages 30-49.**
- technology
- differences between industries also modify what we can expect from changing age and education structure in the workforce.

- According to cattaneo et al Germany was the firs tot implement plocicies aimed at increasing skilled immigrants
- France was the last (after 2005), UK didi it before 2005
- Inf rance and uk nosk im substituted nosk natives. In germany instead they had the same dynamics