Innovation and immigration - Insights from a placement policy[*]

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Abstract: We examine the impact of immigration on innovation by exploiting a placement policy for immigrants in Germany. This allows us to overcome the potential bias of endogenous location decisions. Although the majority of inflows was unskilled, we do not find any evidence of a negative impact on innovations. Instead, our panel estimates suggest that immigration had no or even a positive impact on innovations.

Keywords: Innovation, Immigration, Quasi-Experimental Setting.

JEL-Codes: F22, O32, R11.

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1. Introduction

Currently Western European states are experiencing massive inflows of refugees and immigrants from South-Eastern Europe and the Middle East. While anti-immigrant opposition grows, German politicians, like Chancellor Angela Merkel, are trying to promote the economic benefits of immigration. One popular pro-immigration argument used is that immigration can promote economic growth through innovations. Potential channels are knowledge transfer, technology adoption, capital accumulation and cultural diversity.

Although there is a growing literature on the link between immigration and innovation, the empirical evidence on its causal relationship is relatively scarce and the findings are mixed (see e.g. Hunt and Gauthier-Loiselle 2010, Bratti and Conti 2014, Lee 2015). One reason for this is the methodological challenge of endogenous location decisions of immigrants. In principle, immigrants tend to move to those regions that offer favorable economic conditions. These are likely to have disproportional high levels of innovation. Any analysis which does not properly address this endogeneity problem will produce (upward) biased estimates.

In this paper, we overcome the potential bias of endogenous location decisions by exploiting a unique placement policy in Germany which was implemented for immigrants of German origin, so called ethnic Germans, in the nineties of the last century.[1] We make use of this quasi-experimental regional inflows of mostly unskilled immigrants to estimate how regional changes in the concentration of immigrants affected patent applications over time. To the best of our knowledge, this is the first attempt to provide evidence on the link between immigration and innovation by taking advantage of a placement policy.

2. The Immigration of Ethnic Germans

Ethnic German immigrants, also known as *Aussiedler*, are descendants of Germans who migrated to Eastern Europe and Asia in the 18th and 19th century. After expulsion and escape during and after WWII, remigration to Germany was heavily regulated in the

[1] The placement policy was already used to study the impact of immigration on labor market outcomes (Glitz 2012) and crime (Piopiunik and Ruhose 2015).

communist regimes. Towards the end of the Cold War, travel restrictions were removed, causing an enormous migration to Germany. The immigration wave reached its peak in 1990 with nearly 397,000 Aussiedler arriving in Germany (Worbs et al. 2013). The skill structure of ethnic Germans was characterized by a u-shaped pattern. While the majority of Aussiedler were lower skilled, measured by the last occupation held in the home country, the share of skilled migrants (e.g. managers and technical workers) was higher than the share of Aussiedler with medium skills.[2]

Faced with these massive inflows in the early nineties, Germany changed the immigration policy for Aussiedler (Worbs et al. 2013). Among others, the government introduced yearly quotas and imposed restrictions on all ethnic Germans living outside the former Soviet Union. In fact, Aussiedler from the former Soviet Union were the only group allowed continue to immigrate to Germany without testifying that they face serious disadvantages in their host countries due to their German ethnicity. As a consequence, about 95% of all Aussiedler arriving in Germany from 1993 onwards emigrated from the former Soviet Union (Worbs et al. 2013).[3] Most important for our identification strategy was a placement policy implemented in 1989.[4] It allocated arriving Aussiedler to German regions in order to ensure a relatively even regional distribution of ethnic Germans.[5] In the first years, the allocation was not binding, leading many immigrants to leave their assigned regions and predominantly move to urban regions. Seven heavily affected regions released the so-called *Gifhorn Declaration* demanding a more even distribution to spread the financial burden. As a consequence, six out of ten federal states in West Germany changed the law in 1996 and introduced penalties for all those Aussiedler who leave the assigned region.[6]

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[2] Table A1 in the Appendix reports the skill distribution of ethnic German immigrants defined by occupation. The educational attainment of Aussiedler was not registered on arrival in Germany.

[3] Table A2 in the Appendix shows the source countries of ethnic German immigrants between 1993 and 2005.

[4] Assigned Place of Residence Act (*Wohnortzuweisungsgesetz*).

[5] In few cases, allocation was not binding if Aussiedler could prove to have sufficient housing space and a source of permanent income to make a living (Glitz 2012).

[6] Lower Saxony changed the respective law in 1997 and Hesse in 2002, while Bavaria and Rhineland-Palatine not implemented the sanctions. Noncompliance was prosecuted with the loss of most welfare benefits.

The allocation was carried out in three stages. In the first stage, national government authorities specified quotas, based on tax revenues and population size, for each of the sixteen German federal states determining the number of Aussiedler a federal state receives. In the second stage, each state specified quotas, mostly based on population size and space, determining the number of ethnic Germans the state's NUTS-3-regions receive (Glitz 2012). In the third stage, government authorities used the aforementioned quotas to allocate individuals into German regions. Decisions were in most cases based on family ties. The skill level of Aussiedler did not play a role in the allocation process (Glitz 2012). Most important, there was no policy provision which based allocation within federal states on local economic conditions or innovative power.

In the following, we will test whether regional inflows of ethnic Germans were de facto not related to the innovative strength of regions. Doing so, we regress the inflows of Aussiedler in 166 NUTS-3-regions in 1997 on innovation in these regions one year earlier while controlling for regional population size, space, the share of foreigners, unemployment, the skill structure of the population and regional industrial structure one year earlier.

The estimates in Table 1 show that the inflow of ethnic Germans was indeed not correlated with the innovative capacity of regions. In line with the placement policy, we find instead that inflows were positively correlated with population size and space, although the latter relationship is not significant. This strongly supports our identification assumption that the inflow of ethnic Germans was exogenous to the innovative strength of regions. Therefore, the placement policy can be used as a unique quasi-experimental setting for analyzing the impact of immigration on innovations.

Table 1: Placement of ethnic Germans in 1997

Dependent variable: Ethnic German inflows$_{rt}$	
Number of patents$_{rt-1}$	-0.731
	(0.740)
Ln population$_{rt-1}$	363.9***
	(89.47)
Ln space$_{rt-1}$	42.74
	(35.96)
Share of foreigners$_{rt-1}$	-3.646
	(5.459)
Unemployment rate$_{rt-1}$	-5.012
	(9.917)
High-skilled employment$_{rt-1}$	-3.188
	(8.077)
GVA primary$_{rt-1}$	-1.220
	(1.700)
GVA tertiary$_{rt-1}$	-0.451
	(4.353)
Constant	-1,696***
	(449.3)
Observations	166
Adj. R-square	0.693

The table reports coefficients from an OLS regression. Federal state fixed effects are included. Standard errors, clustered at the level of regions, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

3. The Impact of Immigration on Innovation

To investigate the effect of immigration on innovation, we estimate the following panel model:

$$\text{Number of patents}_{rt} = \alpha_0 + \alpha_1 \text{ ethnic German inflow rate}_{rt-1} + \beta X_{rt-1} + I_t + \mu_r + \varepsilon_{rt} \qquad (1)$$

where the number of patent applications in region r in year t is regressed on the ethnic German inflow rate in t-1. The latter measures the number of Aussiedler allocated to a region in relation to its population. Due to the lag structure, our model captures, depending on the exact date of immigration, the impact of ethnic Germans on innovations one or two years after arrival. We run regressions for the period 1996 to 2005 during which Aussiedler were allocated by the described placement policy.[7] X_{rt-1} is a vector of additional explanatory controls. In line with the related literature, it includes among others measures for investments in research and development and local labor market conditions. For a description of variables see Table A3 in the Appendix. I_t is a vector of year fixed effects controlling for potential time trends in innovations. The terms μ_r and ε_{rt} are the region specific and idiosyncratic components of the error term. By including regional fixed effects our model captures any time-invariant differences between regions which matter for innovations.

Table 2: Effect of immigration on innovation, 1996-2005

Dependent variable: Number of $patents_{rt}$	
Ethnic German inflow $rate_{rt-1}$	1.207*
	(0.684)
Ln $population_{rt-1}$	125.9***
	(41.69)
Share of $foreigners_{rt-1}$	-1.465
	(1.836)
GDP per $capita_{rt-1}$	27.91**
	(12.38)
Unemployment $rate_{rt-1}$	-2.158**
	(0.974)
High-Skilled $Employment_{rt-1}$	15.93***
	(4.496)
GVA $primary_{rt-1}$	0.0494
	(0.0826)
GVA $tertiary_{rt-1}$	0.132
	(0.324)
RD_{rt-1}	3.203
	(13.92)
Constant	-803.0***
	(214.4)
Observations	1,553
Regions	175
Adj. R-square (within)	0.401

The table reports coefficients from a panel regression with region fixed effects. Time fixed effects are also included. For a detailed description of variables see Table A1 in the Appendix. Standard errors, clustered at the level of regions, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[7] Regions from Lower Saxony and Hesse are included from 1997, respectively 2002, onwards. Regions that had registration centers or signed the Gifhorn Declaration are excluded.

As shown in Table 2, we find a significant and positive impact of ethnic German inflows on innovations.[8] In other words, a growing inflow of Aussiedler is associated with an increase in the number of patents. With respect to the magnitude of the impact, our results indicate that an increase in the inflow by one Aussiedler per thousand inhabitants, which corresponds to a one standard deviation increase in the inflow rate (see Table A4 in the Appendix), increases the number of patents by approximately 1.2. Given an average of 34 patents per region in a year, the effect is not marginal. This is notable in so far as we measure the total effect of Aussiedler inflows. Based on information on the last occupation in the source country, these were largely low skilled (1996: 57.33%). However, remarkably 19.58% of Aussiedler had worked in high skilled occupations like engineers (see Table A1). This is substantially higher than the corresponding share among natives in Germany at this time (10%) (Glitz 2012), and suggests that the inflow of ethnic Germans increased on average the relative size of the highly skilled workforce in German regions.[9] Moreover, in contrast to other immigrant groups, Aussiedler were very likely to have German language skills prior to immigration and were not facing any labour market restrictions since they received the German passport with immigration. The positive effect found could therefore be driven by an improvement in human capital. In line with previous studies, we further find significantly positive coefficients on population size, GDP per capita and the share of highly skilled employees in a region, while increases in unemployment are associated with lower levels of innovations.

In order to check the stability of our results, we perform a number of additional regressions reported in Table A5 in the Appendix. Controlling for possible knowledge spillovers from universities leaves our main results unaffected. The same holds true when we use the number of patents per thousand inhabitants in a region as our dependent variable. Next, we take a long-term perspective to allow for a potential lag between R&D and patent applications. For this purpose, we look at innovations between 2000 and 2009

[8] We made use of the Im-Pesaran-Shin and the Harris-Tzavalis Tests to ensure that the panel is stationary.

[9] Data on skills of Aussiedler at the level of NUTS-3-regions is not available. According to Glitz (2012), it is very likely that the skill distribution of ethnic German inflows during the time the placement policy was binding was similar across regions.

using five-year lags of all our explanatory variables. The latter choice is motivated by Chellaraj et al. (2008) who point out that the average life-cycle of innovations from the start until patent application is about 5 years. The estimates in column 3 of Table A5 suggest that immigration positively affects innovations also in the long run, whereas the estimated impact is only slightly smaller than the one in the short-run. Finally, adding observations of those regions that signed the Gifhorn Declaration or state specific time trends turns the coefficient of our immigration variable insignificant, although its sign remains positive.

4. Conclusions

This paper contributes to the ongoing controversial debates on the economic implications of immigration by delivering new evidence on the link between immigration and innovation. Our panel estimates do not provide any support for a negative impact of immigration on innovations, although the majority of arriving Aussiedler were unskilled. They instead indicate that the investigated inflows had no or even a positive impact on innovations. This suggests that the positive effect of skilled ethnic Germans outweighed the negative impact of unskilled Aussiedler. Our findings might reflect the particular case of ethnic German immigrants which differed less in terms of culture and language than other immigrants and were with arrival legally treated like German citizens. Further research using placement policies in other countries for immigrants with no connections to the host country could help to test the generality of our findings.

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Appendix

Table A1: Skill distribution of ethnic German immigrants, 1990-2002

Skill level	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Occupation I	24.95	26.51	27.32	28.29	26.99	28.54	28.32	28.92	27.34	27.54	28.38	26.14	24.15
Occupation II	40.09	33.13	30.03	28.09	27.22	30.21	29.01	28.56	31.02	30.33	30.46	31.53	31.92
Occupation III	17.63	20.60	20.93	22.46	24.50	17.36	18.67	18.27	17.94	17.68	18.44	18.70	18.86
Occupation IV	4.83	3.96	3.74	3.79	3.91	4.10	4.43	4.83	4.73	5.52	5.33	4.83	5.20
Occupation V	12.50	15.79	17.98	17.38	17.38	19.79	19.58	19.42	18.97	18.94	17.39	18.81	19.88

The table reports the skill level of ethnic Germans who immigrated to Germany between 1990 and 2002 in percent. Skill groups are defined by occupation: (I) farmers, laborers, and transport workers, (II) operatives, craft workers, (III) service workers, (IV) managers, sales workers, and (V) professional and technical workers. The skill level of Aussiedler was recorded at the national level on arrival and refers to the last occupation held in the home country. Data are available only until 2002. Own calculation using data provided by Albrecht Glitz.

Table A2: Home countries of ethnic German immigrants, 1993-2005

Home country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Former Soviet Union (USSR)	94.73	95.79	96.10	96.87	98.12	98.52	98.74	98.89	98.93	99.09	99.18	99.38	99.65
Armenia	0.01	0.04	0.02	0.01	0.02	0.05	0.06	0.06	0.05	0.10	0.03	0.01	0.03
Azerbaijan	0.02	0.02	0.02	0.01	0.01	0.00	0.03	0.02	0.05	0.03	0.04	0.07	0.10
Estonia	0.13	0.16	0.17	0.19	0.10	0.07	0.11	0.08	0.08	0.09	0.09	0.08	0.09
Georgia	0.23	0.07	0.08	0.07	0.05	0.07	0.05	0.03	0.03	0.04	0.05	0.07	0.06
Kazakhstan	51.76	54.59	53.76	51.83	55.03	49.60	47.08	47.75	46.89	42.28	36.21	33.55	31.55
Kyrgyzstan	5.65	4.87	4.07	4.20	2.98	3.16	2.61	2.42	2.05	2.24	2.80	2.77	2.36
Latvia	0.12	0.12	0.17	0.14	0.09	0.14	0.17	0.19	0.12	0.05	0.06	0.09	0.12
Lithuania	0.08	0.11	0.11	0.17	0.13	0.16	0.15	0.20	0.10	0.19	0.17	0.15	0.08
Moldova	0.52	0.43	0.34	0.25	0.18	0.36	0.39	0.38	0.19	0.49	0.39	0.37	0.37
Russian Federation	30.78	30.73	32.90	35.62	35.01	39.83	43.80	43.38	44.56	48.67	54.06	56.45	59.44
Tajikistan	2.19	1.26	0.84	0.49	0.31	0.20	0.11	0.06	0.06	0.04	0.04	0.05	0.04
Turkmenistan	0.15	0.22	0.27	0.26	0.33	0.35	0.24	0.25	0.19	0.14	0.16	0.28	0.20
Ukraine	1.24	1.41	1.68	1.95	2.35	2.89	2.63	2.90	3.22	3.48	3.72	3.89	3.68
Uzbekistan	1.77	1.69	1.59	1.57	1.40	1.48	1.14	0.96	1.01	0.92	0.98	1.09	0.86
Belarus	0.08	0.06	0.10	0.10	0.12	0.16	0.16	0.20	0.34	0.34	0.37	0.47	0.66
Poland	2.48	1.10	0.77	0.66	0.51	0.47	0.41	0.51	0.63	0.60	0.61	0.47	0.23
Romania	2.65	2.97	2.99	2.41	1.32	0.97	0.81	0.57	0.39	0.28	0.19	0.13	0.11
Former Czech and Slovak Federal Republic (ČSFR)	0.06	0.05	0.03	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.00	0.01	0.01
Former Yugoslavia	0.05	0.08	0.08	0.04	0.03	0.01	0.02	0.00	0.02	0.00	0.01	0.01	0.00
Hungary	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01
Other countries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00

The table reports from which home countries Aussiedler emigrated in percent. Own calculation based on data provided by the German Federal Office of Administration.

Table A3: Description of employed variables

Variable	Definition	Source
Number of patents	Number of PCT patent applications. For the allocation of patents to regions and over time we use the following three criteria: inventors' place of work[a], fractional count, and priority date.	Own calculation on the basis of REGPAT Database, OECD, February 2015 edition
Ethnic German inflows	Total number of ethnic German inflows	Glitz (2012), Piopiunik and Ruhose (2015)
Ethnic German inflow rate	The inflow rate is defined as the number of ethnic German immigrants allocated to a particular region in year t divided by the population of that region in thousand at the end of year t-1.	Own calculation following Piopiunik and Ruhose (2015)
RD	Linear combination of total firms' internal investments in R&D and total R&D-employees in firms' research establishments	Stifterverband[b]
Unemployment rate	Unemployment rate of civil employees in percent	Federal Employment Agency
High-Skilled Employment	Share of employees with a degree in a university or a university of applied sciences in all employees in percent	INKAR online
Population	Population in thousand at December 31st	Destatis
Space	Area in square kilometer	INKAR (2010), Destatis
Share of foreigners	Share of foreigners in the population in percent	INKAR online
GVA primary	Gross value added at basic prices (€, thousands) in the primary sector per worker in the primary sector	INKAR (2010)
GVA tertiary	Gross value added at basic prices (€, thousands) in the tertiary sector per worker in the tertiary sector	INKAR (2010)
GDP per capita	Gross domestic product at current prices (€, thousands) per capita	INKAR (2010)

[a] The address given in the patent document is usually the professional address of the inventor, e.g. the address of the lab at which the inventor works.

[b] Special calculation on request.

Table A4: Descriptive statistics, 1996-2005

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of patents$_{rt}$	1556	34.20634	41.16847	0	322.8865
Number of patents$_{rt-1}$	1556	31.51934	38.7422	0	322.8865
Ethnic German inflows$_{rt}$	1552	279.6057	227.2537	0	1993
Ethnic German inflow rate$_{rt-1}$	1553	1.32547	0.764324	0	6.68243
Population$_{rt-1}$	1556	248.1653	156.7156	50.963	1128.336
Space$_{rt-1}$	1556	807.3606	551.9783	44.88929	2290.867
Share of foreigners$_{rt-1}$	1556	9.295051	4.351146	2.4	26.3
GDP per capita$_{rt-1}$	1556	24.43342	8.005745	12.5	74.4
Unemployment rate$_{rt-1}$	1556	9.808162	2.998588	4	20.9
High-Skilled Employment$_{rt-1}$	1556	6.354242	2.929825	2.7	20.4
GVA primary$_{rt-1}$	1556	25.14679	10.33057	1.7	160.5
GVA tertiary$_{rt-1}$	1556	47.17661	5.209489	36.7	72.5
RD$_{rt-1}$	1556	0.3546107	0.781503	0	9.460106

The table reports the number of observations, means, standard deviations, minimum, and maximum of variables used. In line with the baseline model (see Table 2), we exclude Lower Saxony in 1996 and Hesse in the period 1996-2001. Additionally, regions that signed the Gifhorn Declaration and/or hosted Aussiedler registration centers are excluded. Emden is the only region which received in one year no ethnic German immigrant.

Table A5: Robustness tests and extensions

Dependent variable: See legend.	(1)	(2)	(3)	(4)	(5)
Ethnic German inflow rate$_{rt-1}$	1.230*	0.00403*	1.049*	0.648	0.346
	(0.684)	(0.00211)	(0.593)	(0.718)	(0.629)
Ln population$_{rt-1}$	126.0***	0.295**	98.37***	112.3**	40.18*
	(41.69)	(0.131)	(31.84)	(45.53)	(22.82)
Share of foreigners$_{rt-1}$	-1.499	-0.00500	-2.584	-2.227	-0.190
	(1.845)	(0.00612)	(1.709)	(1.941)	(0.879)
GDP per capita$_{rt-1}$	27.53**	0.0852*	6.703	22.19	14.60
	(12.55)	(0.0477)	(11.00)	(14.05)	(9.469)
Unemployment rate$_{rt-1}$	-2.173**	-0.00609*	-0.789	-0.0659	-1.123*
	(0.976)	(0.00309)	(0.643)	(1.148)	(0.586)
High-Skilled Employment$_{rt-1}$	15.92***	0.0314***	9.527***	13.30***	14.30***
	(4.500)	(0.00932)	(2.157)	(4.531)	(0.908)
GVA primary$_{rt-1}$	0.0497	-9.50e-05	0.0168	0.0354	0.191**
	(0.0828)	(0.000329)	(0.0614)	(0.0830)	(0.0765)
GVA tertiary$_{rt-1}$	0.138	0.00101	0.519*	0.256	-0.229
	(0.325)	(0.00109)	(0.264)	(0.338)	(0.208)
RD$_{rt-1}$	3.130	0.0146	-4.194	-0.205	1.940
	(13.92)	(0.0249)	(6.363)	(12.68)	(1.857)
Students$_{rt-1}$	-0.0442				
	(0.0968)				
Constant	-801.1***	-1.892***	-557.1***	-713.6***	-269.0***
	(213.9)	(0.702)	(167.8)	(231.4)	(102.5)
Observations	1,553	1,553	1,553	1,607	1,553
Regions	175	175	175	181	175
Adj. R-square (within)	0.400	0.367	0.242	0.354	0.925

The table reports coefficients from panel regressions with region and time fixed effects. For a detailed description of variables see Table A1 in the Appendix. In column 1, we expand the baseline model (see Table 2) by including the number of students per thousand inhabitants as an additional control variable. In column 2, we modify the dependent variable using the number of patents per thousand inhabitants in region r and time t. In column 3, we estimate long term effects by using five-year lags of all explanatory variables looking at innovations during the period 2000 to 2009. In column 4, we expand the baseline model by including regions that signed the Gifhorn Declaration. In column 1 to 4, we cluster standard errors at the level of regions. In column 5, we add state-specific time trends using a LSDV model. Standard errors are two way clustered at region and year-by-state level. Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.