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Zusammenfassung / Abstract

The paper examines the impact of immigration on innovation. We exploit an immigrant placement policy which took place during the early nineties in Germany when large numbers of so called ethnic Germans entered the country. This allows us to overcome the potential bias of endogenous location decisions and to estimate how regional inflows of ethnic Germans affected patent applications over time. Although the majority of ethnic German 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.

JEL-Klassifikation / JEL-Classification: F22, O32, R11

Schlagworte / Keywords: Innovation, Immigration, Ethnic Germans, Quasi-experimental setting

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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 and calls for restrictive immigration and asylum policies are getting louder (The Economist 2015), German business leaders and politicians, like Chancellor Angela Merkel, are trying to promote the economic benefits of immigration (The New York Times 2015). 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 for example 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 labor market opportunities like high wages and low unemployment. These regions are likely to be characterized by 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 of immigrants in Germany in the nineties of the last century.[1] During this time, Germany was experiencing large inflows of immigrants of German origin from Eastern Europe and the territory of the former Soviet Union. These immigrants did not have the opportunity to choose their preferred area of settlement, but were instead allocated to regions within Germany. We make use of this quasi-experimental regional inflows of mostly unskilled immigrants to estimate the causal impact of immigration on innovation. In particular, we run panel regressions to analyze how changes in the concentration of ethnic Germans in German regions 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.

[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).

The paper is organized as follows. In Section 2, we describe the immigration of ethnic Germans, the aforementioned placement policy and the data used in the empirical exercise. In Section 3, we present our main results on the impact of immigration on innovations. Section 4 concludes the paper.

2. The immigration of Ethnic Germans

Ethnic German immigrants, also known as *Aussiedler*, are descendants of Germans who migrated to Poland, Romania and other Eastern European and Asian states in the 18th and 19th century. After expulsion and escape between 1944 and 1949, more than 4 million ethnic Germans remained living in Eastern Europe in 1950 (Bade 1993). In the following years, most of them continued to live outside post-war Germany, since remigration to Germany was heavily regulated in the 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 ethnic Germans and their descendants 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, the share of skilled migrants was higher than the share of Aussiedler with medium skills (Glitz 2012).

Faced with these massive inflows in the early nineties, the German government introduced a number of policy changes. In 1990, the government implemented a new admission system requiring ethnic Germans to register in their country of residence (Worbs et al. 2013). In 1993 the government limited the inflows by establishing yearly quotas of about 225,000 immigrants (Glitz 2012). In the same year, a law imposed restrictions on all ethnic Germans living outside the former territory of the 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 percent of all Aussiedler arriving in Germany from 1993 onwards emigrated from the former Soviet Union (Worbs et al. 2013). Most important for the identification strategy of this paper was a placement policy implemented in 1989.[2] It allocated arriving Aussiedler to German regions in order to ensure a relatively even regional distribution of ethnic Germans.[3] This should ensure to distribute the financial burden across regions and facilitate integration of ethnic

[2] Assigned Place of Residence Act (*Wohnortzuweisungsgesetz*).
[3] 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).

Germans. In the first years, the allocation was not binding, leading many immigrants to leave their assigned regions and predominantly move to urban regions (Mammey and Swiaczny 2001). Seven heavily affected regions from Lower Saxony released the so-called *Gifhorn Declaration* demanding a more even distribution of Aussiedler across regions.[4] As a consequence, six out of ten federal states in West Germany changed the law in 1996 and introduced penalties for all those ethnic Germans who leave the assigned region.[5]

The allocation was carried out in three stages. In the first stage, national government authorities specified quotas for each of the sixteen German federal states (the so called *Königsteiner Schlüssel*) determining the number of Aussiedler a federal state receives. These quotas were based on the states' tax revenues and population size. In the second stage, each state specified quotas determining the number of ethnic Germans the state's NUTS-3-regions receive. These quotas were in most cases based on population size and space (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. Additional, but much less important, factors were existing child-care facilities for single parents and the presence of healthcare facilities. 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. We will focus only on regions in those West German federal states which had a binding allocation policy in 1997.[6] Doing so, we regress the inflows of ethnic Germans 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.[7] The data on inflows of ethnic Germans comes from Glitz (2012) and Piopiunik and Ruhose (2015). Data on regional characteristics was collected from various administrative data sources. See Table A1 in the Appendix. Innovation is measured by the number of PCT patent

[4] The *Gifhorn Declaration for the Integration of Ethnic German Immigrants* was signed by Wolfsburg, Salzgitter, Gifhorn, Nienburg/Weser, Cloppenburg, Emsland, and the rural region Osnabrück.
[5] Lower Saxony changed the respective law in 1997 and Hesse in 2002, while Bavaria and Rhineland-Palatine not implemented the sanctions (Glitz 2012). Noncompliance was prosecuted with the loss of most welfare benefits.
[6] We focus on West German regions (excluding Berlin) since data on Aussiedler inflows to East German regions are very fragmentary. Moreover, we exclude the region Aachen from our analysis due to data availability.
[7] The lag structure ensures that our explanatory variables are not already affected by the inflow of ethnic Germans in 1997.

applications in a given region (inventors' place of work, fractional count, priority date). The figures are based on own calculations using the REGPAT Database of the OECD.

The corresponding results are provided in Table 1. The estimates 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.

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 ethnic Germans allocated to a region r in relation to its population. Due to the lag structure, our model captures, depending on the exact date of immigration to Germany, 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.[8] 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, local labor market conditions, the local industry structure and the regional skill composition. For a description of used variables see Table A1 in the Appendix. I_t is a vector of year fixed effects controlling for cyclical effects and 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. Standard errors, clustered at the level of regions, are robust to heteroscedasticity and general forms of serial correlation over time.

[8] Regions from Lower Saxony and Hesse are included from 1997, respectively 2002, onwards. We further exclude regions with registration centers as well as those regions which signed the Gifhorn Declaration since the number of ethnic Germans these seven regions received after 1997 was lower in order to compensate these regions for the disproportionate high burden they had to bear before the placement policy was enacted.

Table 2 presents the corresponding results.[9] We find a significant and positive impact of inflows of ethnic Germans on innovations. In other words, a growing inflow of ethnic Germans 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 A2 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 all ethnic German inflows. Based on information on the last occupation in the source country, these were largely low skilled (approx. 58%). On the other hand, remarkably 19% of Aussiedler had worked in high skilled occupations like mathematicians and engineers (Glitz 2012). This is substantially higher than the corresponding share among natives in Germany during this time (10%), and suggests that the inflow of ethnic Germans increased on average the relative size of the highly skilled workforce in German regions.[10] Moreover, in contrast to other immigrant groups, ethnic Germans 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. As a result, they were allowed to work in any kind of occupation right after arrival. The positive effect found could therefore be driven by an improvement in human capital. In line with the related literature, 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 3. First, we add the number of students relative to thousand inhabitants per region as a control variable in order to capture possible knowledge spillovers from universities. As shown in column 1 of Table 3, our main results are unaffected by adding this additional input factor for innovation. In column 2, we modify our dependent variable by using the number of patents per thousand inhabitants in a region at time t. Once again, we find a positive relationship between inflows of ethnic Germans and innovations. In line with other studies (e.g. Bratti and Conti 2014), we have used so far one period lags of explanatory variables and focused

[9] We made use of the Im-Pesaran-Shin and the Harris-Tzavalis Tests to ensure that the panel is stationary. Test statistics are available from the authors on request.

[10] 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.

on the short-term impact on innovations. Next, we take a long-term perspective. For this purpose, we look at the development of innovations between 2000 and 2009 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 3 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.

In column 4, we include those regions which signed the Gifhorn Declaration in March 1995 and were hit by excessive inflows of ethnic German immigrants before the placement policy became binding.[11] Adding observations of these regions to our sample turns the coefficient of our immigration variable insignificant, although its sign remains positive. Finally, we include federal state specific time trends in our benchmark specification. By this we take into account that time trends in innovations and local placement policies could differ across states. The corresponding regression yields a positive but insignificant coefficient.[12]

4. Conclusions

Currently Europe and the US are characterized by controversial discussions on the economic implications of immigration. This paper contributes to this debate by providing evidence on the link between immigration and innovation. Doing so, we exploit a unique placement policy for immigrants of German origin in West Germany in the nineties of the last century. Since allocation of Aussiedler to regions within Germany was exogenous to local innovations and economic conditions, the framework studied has a quasi-experimental character and solves the well-known problem of endogenous location decisions of immigrants.

Our panel estimates do not provide any support for a negative impact of immigration on innovations, although the majority of arriving Aussiedler were unskilled. Our estimates 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. Moreover, 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

[11] We do not include the rural region of Osnabrück since it not only signed the Gifhorn Declaration, but also hosted a registration center.

[12] In contrast to previous regressions, we use two-way clustered standard errors to allow standard errors to be correlated also within year-by-state cells. For this purpose, we estimated a LSDV model. As a result, the reported adjusted R^2 is much higher than the ones in the previous regressions.

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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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. For a detailed description of variables see Table A1 in the Appendix. 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.

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.

Table 3: 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.

Appendix

Table A1: 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 A2: 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.

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