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# NAMES, DIVERSITY AND INNOVATION

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# Names, diversity and innovation

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**Abstract**

Diversity of a country is often measured by the amount and spread of nationalities that live there. But also within a country, regions vary in their traditions and culture. Cultural homogeneity within communities is mixed up by (internal) migration, that, like international migration, increases diversity of a place. In a novel approach I therefore look at diversity in German municipality associations measured by different family names and investigate the effect it has on the number of generated patents. I show that cultural diversity and openness of a place affect its economic performance positively in terms of innovation also when referring to intra-country differences.

*JEL classification*: O31, R12, Z10, J61, O18

*Keywords*: cultural diversity, innovation, openness, phone book, patents, local level, Germany.

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# Introduction

Family names tell, to some degree, a story about an individual's background. "Foreign" names point to a family immigration history more recently or long ago. "Domestic" names give hints, too, about where a family originally stems from because many names are specific for a region. Furthermore, the distribution of family names displays the degree of diversity in a community quite well. This is because when individuals or families move they also bring their names to a new place. Thus, earlier migration is reflected in the composition of family names to some degree. Migration itself is an important determinant of diversity because it increases the cultural heterogeneity of a place when migrants keep (parts of) their culture. This is illustrated vividly by the example of international migration. Earlier research has shown that diversity, usually measured on an inter-country level by different nationalities, positively affects innovativeness and productivity of an economy. However, within a country cultural disparities also arise. Usually they stem from a different history and tradition of the regions but also have to do with the natural environment and the resulting life-style, economy and more. I hypothesize that not only inter-country differences are relevant for cultural diversity but that also these intra-country, regional disparities advance innovativeness. To measure diversity within a country I make use of the spread of family names and prove my hypothesis by the example of Germany.

The distribution of family names proxies for family distribution (in the male line) in Germany quite well. This is due to the legal situation until 1976 that determined the last name of the husband as the family name. The legal circumstances changed; however, a large majority of couples still choose the husband's last name when they marry (only 3% decided for the wife's but 80% for the husband's name in 1996;[1] Rosar, 2020). How families historically spread across Germany is therefore reflected by their names in a phone book, which I use to account for diversity. A drawback of using a phone book to measure diversity stems from having common names that originated at different places and thus do not necessarily relate to a geographical distribution of the name (compare e.g. "Smith"). Still, many names are peculiar or predominant in a specific region and can account for movements of families. I use this insight and a data set containing all phone book entries from 1996 to determine where in Germany diversity of family names is high or low. For this I use a measure of concentration. I also regard the openness of municipalities throughout the past 100 years by comparing family names at places from the casualty list in World War I and the phone book entries from 1996.

The literature suggests that "interactions between diverse people [...] increases economic performance" (Möhlmann and Bakens, 2015, p. 235). This is based on the idea of Jacobs externalities – spillovers from firm and sector diversity (Jacobs, 1969; proven by Glaeser et al., 1992; Henderson, 1997) and also holds true for cultural diversity. Ottaviano and Peri (2006) provide evidence for this by showing that native workers have higher wages and rents in places where the share of foreign-born people is higher. Focusing on Germany, Niebuhr (2010) looks at a cross-section of German regions to study the effect of cultural diversity of the labour force on patent applications. She confirms that a positive spillover effect outweighs the costs of diversity. However, most

[1] 17% kept their individual last names.

studies focus on the effect of cultural diversity measured solely by nationalities.

I add to the literature by looking at whether diversity from intra-country differences, controlled for by family names, affects economic performance. This micro level has not been investigated yet. In my work I estimate the effect of local diversity at the level of municipality associations, measured by (the change in) family names, on innovativeness, measured by patents. A higher amount of different family names is expected to be connected to a more dynamic composition of the municipality associations throughout history and thus a higher diversity. With this I build on the reasoning that relocation of people induces cultural diversity (Bakens et al., 2015) because culture varies over space and even small alterations, such as within Germany, shape people differently. From these different interacting backgrounds innovation is expected to arise. Additionally, firms in a more diverse environment have the possibility to choose the most capable employees from a larger pool which might also increase innovativeness.

My two hypotheses are:

- More diverse municipalities, in terms of family names, have a higher innovativeness.
- More open municipalities throughout the past 100 years, in terms of a changing pattern of family names, have a higher innovativeness.

The next section gives an overview on the existing work on how cultural diversity, measured at the inter-country level, affects economic performance. I then turn to explaining my empirical method by commenting on the theroretical model, the derived empirical regression, measure of diversity and the data. Next, I explain my estimation and findings and perform some robustness checks before concluding.

## Literature review

According to Jacobs (1969), diversity helps to generate new knowledge by bringing together different proficiencies and exchanging ideas. The idea that diversity produces spillovers and then innovation, originally focuses on how different firms and sectors interact. Jacobs' theory is confirmed by the work of Glaeser et al. (1992) who show that it is rather spillovers from diversity than externalities from competition and specialization within an industry that advance innovation in agglomerations. For this, they relate cities' industry diversity and growth in the USA between 1956 and 1987. Likewise, Henderson (1997) shows for the US-American urban counties between 1977 and 1987 that diversity externalities between industries have a longer lasting effect on employment and seem to be dynamic.

After Jacobs' theory was proven successful with respect to industrial diversity, it also translated to a cultural definition of diversity: Culture determines how we live together and is defined as comprising features that are relatively homogeneous within but vary between groups. These include a common value system, historical traditions, religion and lifestyles (Bakens et al., 2015). Cultural groups are often delimited by geography. Thus, spatial distribution of people correlates with cultural dispersion to some extent. However, this relationship is not set in stone. Migration mixes it up and increases cultural diversity, when people relocate and keep (aspects of) their original culture (Bakens et al., 2015). This happens both on a inter- and intra-country level. The resulting cultural diversity can have a positive or negative effect on innovation and productivity. While heterogeneous workers might have to deal with communication bar-

riers they can also exchange ideas stemming from their different backgrounds, generate knowledge and improve production.

Ottaviano and Peri (2006) provide evidence for a positive effect of cultural diversity on productivity by showing that native workers have higher wages and rents in places where the share of foreign-born is higher. They study 160 metropolitan areas in the USA between 1970-1990 and distinguish between places of birth for cultural diversity. With an IV method they aim to solve the endogeneity that migrants tend to go where industries and cities boom. They use the predicted change in national groups for each of the cities as an instrument, relying on the observation that nationalities tend to flock together. Their results are robust. Looking at a more recent time period Cooke and Kemeny (2017) confirm that diversity of birthplace is responsible for improvements in productivity in the USA between 1991 and 2008. They also show that more complex problem solving is enriched by diversity. Bellini et al. (2013) follow Ottaviano and Peri in their approach and regard how diversity, defined by country of birth, affects productivity in the NUTS3 regions of 12 European countries. They confirm a positive correlation and find further evidence for causation, too. Möhlmann and Bakens (2015) investigate on the same relationship with a two-step method. For firms in the Netherlands they firstly estimate total factor productivity by measuring the deviation to sector productivity. In a second step they investigate whether more diverse firms are more productive. Their results show that a higher share of foreigners in a firm has a negative effect on productivity. Diversity among these employees however is positively correlated to firm performance. The effect vanishes when including firm fixed effects. Ozgen et al. (2014) also look at firm level data from the Netherlands and Germany. They establish a connection between (parental) place of birth of employees and the number of new products in a firm. Their results suggest a modest positive influence of cultural diversity on innovativeness. They also subsume evidence from other studies in Europe, North America and New Zealand extensively. In this they emphasize the positive potential (productivity and innovation) and negative effects (communication barriers) of cultural diversity.

Regarding employers more closely, Nathan and Lee (2013) study 7600 firms in London and compare their cultural diversity with innovation, entrepreneurship and whereto sales are directed. They rely on firm micro data to define diversity as whether owners and partners are migrants or non-(white-)British. The authors find in their regression a small but significant diversity bonus: A higher diversity makes firms more innovative, they reach out better to international markets and migrants are more likely to be entrepreneurs. Evidence for spillovers from cultural diversity is also found in papers dealing with business management (Roberge and van Dick, 2010; Van Beers and Zand, 2014).

Focusing on Germany, Niebuhr (2010) estimated a cross-section of German regions to prove the effect of cultural diversity of the labour force on patent applications. She confirms that a positive spillover effect outweighs the costs of diversity. With respect to the endogeneity problem she argues that migration is often motivated by earlier migration from the same origin and thus uses latitude of region centre and lagged diversity of neighbouring regions as instruments in an IV regression. This approach is similar to Ottaviano and Peri (2006). Brunow and Stockinger (2015) also confirm the effect of cultural diversity on innovation at the firm level in Germany. They account for diversity by different nationalities while their dependent variables reflects different

innovation outcomes (e.g. improvement or introduction of products).

Literature that specifically looks at how openness of societies affects innovation is scarce. However, the reasoning builds on the same theory and effects as for diversity. Moreover, openness and diversity are closely entangled because, expectedly, more open societies become more diverse.

Taken together, the literature emphasizes that cultural diversity has advantages (innovation and productivity) as well as disadvantages (communication barriers) for economic performance. Yet, it shows that more often than not, innovation is positively affected by it. I examine whether this also holds true on the municipality level in Germany. In contrast to existing work, I proxy for (intra-country) diversity by family names and their dispersion over time. A higher amount of different family names is expected to be connected to a more dynamic place. In this I build on the reasoning that relocation of people induces cultural diversity because culture varies over space and even little deviations, such as within Germany, shape people differently. From these differences, innovation is expected to arise. This might be due to people with different background sharing ideas or stems from having a larger pool of capable individuals from which firms can choose.

In the next section I turn to the empirical method.

# Method

## Model and measure of diversity

In order to take potential costs and advantages of diversity for innovativeness into account I rely on the model of Niebuhr (2010) (with a slight deviation). It expects that excessive differences hinder exchange and thus innovation. Advantages on the other hand could arise from diversity via two channels: Firstly, if more diverse people meet, interactions are expected to be more productive and generate new knowledge. Secondly, from having a larger pool of more diverse people firms can choose the most capable employees who then generate more innovation.

The common production function in place $i$ is augmented by the effect of cultural diversity, based on Ottaviano and Peri (2006). Culturally different origins, noted by $o$, increase output for a fixed number of workers. Therefore the product of labour over different origins is used.[2] This implies that not only a higher diversity increases output but additionally, there is a complementarity between employees of different origin. An additional "diverse" employee increases the output of the others because they benefit from her new knowledge. The costs of differences ($\tau$), e.g. communication barriers, on the other hand are an increasing function of diversity ($div$) and thus reduce the advantages of it.

$$Y_i = [1 - \tau(div_i)]^{\alpha} A_i^{1-\alpha} \prod (L_{io})^{\alpha}$$

Whether (dis)advantages of cultural diversity prevail depends on the elasticity of substitution between people with different origins.

The derived basic regression model to determine the overall effect of diversity on innovativeness is

[2] Niebuhr (2010) uses the sum over origins instead.

$$P_i/L_i = \beta + \beta_1 * Div_i + \sum_m (\beta_m * C_{mi}) + \epsilon$$

The equation defines innovativeness as patents per employees and sets it in relation to diversity. Additionally, it controls for other important determinants of innovation ($C$) like sector structure, urbanisation and education level.

To measure diversity I look at (de)concentration of family names. A comparison of the number of different family names with the total number of entries in the phone book in a municipality reveals how diverse a place is in terms of family names. I thus calculate for every place $i$

$$Div_i = names_i/entries_i$$

Most of the literature looking at diversity and innovation also employs a fractionalisation or entropy index (e.g. Herfindahl (Ottaviano and Peri, 2006) or Theil (Niebuhr, 2010)) to account for birthplace diversity. These indices account not only for the number of different groups but additionally for the evenness of distribution of different groups. While this is relevant with respect to nationalities I argue that these measures are not enlightening about diversity with respect to family names. The representation of different nationalities is uneven if only one or two groups prevail while many more are present as (small) minorities. It is even if all nationalities are about equal in size. Both cases reasonably affect economic performance. Family names however define many more and much smaller groups that are usually all "minorities". Because not one or a few groups prevail, evenness is less relevant because usually the distribution is unnoticeable to the individuals.

Furthermore, I make use of the distribution of family names in (approximately) 1890 to see how open places were throughout the past 100 years. For this I compare the development of (de)concentration between 1890 and 1996 and refer to this measure as openness. A positive openness implies a higher diversity in 1996 than in 1890.

## Data

The distribution of names is provided in two maps from CompGen (Verein für Computergenealogie e.V.), which are used to derive diversity measures. The first is based on casualty lists from WWI and proxies for the time about 1890 as it provides birth places of those that died. The second draws from a digitalized phone book that provides the distribution of names in 1996. I match geocoded names[3] with today's municipality boundaries to have time-consistent areas.

Because private phone coverage in East Germany was only really advancing after reunification but had not finished in 1995 (Didczuneit, 2015) I restrict my sample to West Germany where the true distribution of names is expected to be reliably identified. In every place about 18 145 (mean) different family names appear and every name accounts for 2.5 entries on average. Diversity, measured as (de)concentration, has a mean value of 0.4986 names per inhabitant with a standard deviation of 0.9571 and is approximately normally distributed.

[3]The geocoding refers to post code and place name and is thus not entirely but acceptably enough accurate.

As for innovation, patent data is available from Deutsches Patent- und Markenamt. I identify places of innovation from the post codes of the patent inventors and times by the year of the effective European filing date of the innovation. The average number of patents per employee over the years 1995-1999 is 0.007 with a standard deviation of 0.026. The distribution is heavily left skewed.

Data on control variables related to the regional employment structure stems from the Establishment History Panel of IAB (Ganzer et al., 2021). Skill level, share of foreign-born employees, participation of women and age groups are used as controls. For the spatial structure, information on the urban type is gathered from the INKAR database (Bundesinstitut für Bau- Stadt- und Raumforschung (BBSR)).

All variables correlate by less than 50%, thus I expect no problematic multicollinearity.

As the spatial unit I build on municipalities associations ("Gemeindeverbände") because they are more comparable across Germany than the more unevenly sized municipalities but still refer to a fine spatial level.

## Results

I firstly estimate a log-linear OLS. A Poisson GLM regression is additionally used because the dependent variable is strongly negatively skewed but not overdispersed. The selection bias from dropping 0 patents is neglectable because only very few municipality associations have no generated patents during the relevant time span.

Because I estimate a cross-section but have panel data on patents and control variables in the estimations, I use averages of the latter to prevent measurement biases.

Results of the base regressions are found in Table 1 in columns (1) and (2). Both the OLS and the GLM estimation point towards similar interpretations; GLM, however, is less significant for many variables. The OLS estimation has a slightly smaller sample because few regions in Rhineland-Palatinate and Schleswig-Holstein have no patents registered between 1995 and 1999. Both estimations show a positive relation between diversity and innovation but only in the OLS this relationship is highly significant. I can thus confirm my first hypothesis that more diverse municipalities, in terms of family names, have a higher innovativeness. An increase of 10% in the relation between different family names to phone book entries, results in around 20% more patents. A higher number of different names helps to explain a higher number of generated patents. However, there is an endogeneity problem with respect to which factor determines which one. The controls point towards the rather surprising result that less dense areas are more innovative than larger cities. While share of low-skilled employees has a negative effect in both estimations, a positive correlation between high-skilled employees and patents per employees is only confirmed in the OLS. The estimations moreover confirm a strong positive effect of the share of foreign-born employees for innovation and thus affirm the earlier literature.

Columns (3) and (4) of Table 1 additionally control for the influence of the manufacturing sector which is expected to be responsible for a high number of patents. The sample size is severely reduced due to data censoring. Again, a positive relation between diversity and patents per employee is found but this is only significant in the OLS. The effect of the share of manufacturing is insignificant but positive in the OLS

Table 1: Estimation results (1) + (2) diversity, (3) + (4) diversity with manufacturing sector, (5) + (6) openness

| | (1) OLS log(patents/employee) | (2) GLM patents/employee | (3) OLS log(patents/employee) | (4) GLM patents/employee | (5) OLS log(patents/employee) | (6) GLM patents/employee |
|---|---|---|---|---|---|---|
| Diversity | 1.974*** | 0.549 | 4.268** | 0.0516 | | |
| | (0.518) | (0.993) | (2.078) | (1.498) | | |
| Openness | | | | | 1.638*** | 0.102 |
| | | | | | (0.402) | (0.437) |
| Medium-sized cities | 0.225* | 0.451*** | -0.0988 | 0.928* | 0.410*** | 0.531*** |
| | (0.128) | (0.151) | (0.507) | (0.518) | (0.110) | (0.113) |
| (Larger) Small cities | 0.319** | 0.783*** | 0.193 | 1.396** | 0.545*** | 0.890*** |
| | (0.152) | (0.188) | (0.657) | (0.679) | (0.120) | (0.127) |
| Smaller towns | 0.416** | 1.070*** | 0.0198 | 1.862** | 0.681*** | 1.194*** |
| | (0.168) | (0.204) | (0.724) | (0.728) | (0.131) | (0.135) |
| Rural areas | 0.272 | 1.628*** | -0.322 | 2.529*** | 0.610*** | 1.774*** |
| | (0.197) | (0.317) | (0.881) | (0.872) | (0.146) | (0.133) |
| Share foreign | 9.047*** | 4.863** | 5.509 | 2.876 | 9.784*** | 5.231*** |
| | (1.054) | (2.044) | (4.568) | (2.852) | (0.982) | (1.466) |
| Share high-skilled | 3.863*** | -1.877 | 5.651 | -0.174 | 4.213*** | -1.630 |
| | (1.114) | (2.034) | (4.880) | (4.341) | (1.149) | (2.316) |
| Share low-skilled | -3.665*** | -4.505* | -1.403 | 1.357 | -4.515*** | -4.834** |
| | (1.089) | (2.711) | (3.922) | (3.314) | (1.031) | (2.251) |
| Share manufacturing | | | 1.316 | -0.604 | | |
| | | | (1.076) | (0.603) | | |
| Constant | -7.753*** | -5.890*** | -9.355*** | -6.851*** | -7.059*** | -5.721*** |
| | (0.278) | (0.732) | (1.044) | (0.690) | (0.228) | (0.475) |
| $N$ | 3141 | 3162 | 341 | 344 | 3141 | 3162 |
| adj. $R^2$ | 0.077 | | 0.046 | | 0.079 | |

The urban type refers to dummy variables with larger cities as reference category.
Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

and negative in the GLM estimation. However, this might have to do with the limited number of observations.

In the last two columns (5) and (6) of Table 1 the change in diversity over time, defined as openness, is regarded. Again, the effect is positive but only significant in the OLS. The pattern of the controls is also similar to the base estimations on diversity. I thus can affirm my second hypothesis that more open municipalities throughout the past 100 years, in terms of a changing pattern of family names, have a higher innovativeness. This shows that regions that had a higher inflow of migrants, and family names, are generating more patents today. This result, however, might be especially threatened by reverse causality that more innovative regions attracted more people from elsewhere.

## Robustness

In order to prove robustness of the estimations I additionally control for demographic factors of the work force (column (1) of Table 2). The share of women has a positive but insignificant effect on the number of generated patents per employee. Employees between the ages of 20 and 24 years have a negative but again insignificant effect which might have to do with their shorter experience. The results of the base regression are moreover confirmed.

Additionally I check in column (2) of Table 2 whether the effect of diversity on innovation is non-linear. Introducing the square of diversity shows that indeed the relationship has an inverted u-shape. This points towards an optimal degree of diversity for innovation that can be under- or overshot and is in line with Niebuhr (2010).

Because the data on family names does not have a panel structure but patents and controls are available for several years, I estimate a two-step fixed effects model. In a first step I regress all base controls on patents per employee. I use the resulting regression residual for every municipality association as region-fixed effect for innovativeness. In a second step I then prove how the fixed effect relates to the diversity of the places. I find a positive significant correlation between a (from controls) higher unexplained innovativeness and the diversity of family names (Table 3).

Due to commutes between the municipalities, I also test my findings at the level of labour market regions. I find a negative relation between diversity and innovation. This potentially shows that immediate interactions are relevant for diversity affecting innovation.

There is still a strong endogeneity problem to be solved. Additionally, spatial dependencies might be present and should be taken into account.

## Conclusion

By measuring diversity with the distribution of family names in Germany I show that diversity enhances innovation also when defined as intra-country differences. A more diverse family name distribution, in terms of deconcentration or measured as openness by development over time, within a municipality association is associated with a higher number of generated patents. This shows that cultural disparities within a country are relevant to economic outcomes.

Table 2: Estimation results with more control variables and u-shaped

| | (1) OLS log(patents/employee) | (2) OLS log(patents/employee) |
|---|---|---|
| Diversity | 1.807*** | 7.746*** |
| | (0.530) | (2.874) |
| $\text{Diversity}^2$ | | -5.572** |
| | | (2.716) |
| Medium-sized cities | 0.256** | 0.0697 |
| | (0.130) | (0.149) |
| (Larger) Small cities | 0.371** | 0.158 |
| | (0.155) | (0.173) |
| Smaller towns | 0.477*** | 0.254 |
| | (0.172) | (0.186) |
| Rural areas | 0.366* | 0.125 |
| | (0.205) | (0.208) |
| Share foreign | 9.230*** | 9.129*** |
| | (1.084) | (1.055) |
| Share high-skilled | 3.220*** | 3.987*** |
| | (1.119) | (1.123) |
| Share low-skilled | -4.035*** | -3.741*** |
| | (1.106) | (1.093) |
| Share women | 0.560 | |
| | (0.538) | |
| Share 20-29 year olds | -2.099 | |
| | (1.400) | |
| Constant | -7.358*** | -9.044*** |
| | (0.474) | (0.690) |
| $N$ | 3141 | 3141 |
| adj. $R^2$ | 0.078 | 0.078 |

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Estimation results of two-step fixed effects estimation

| | (1)OLS<br>2nd step<br>region fixed effects |
|---|---|
| Diversity | 3.040*** |
| | (0.210) |
| Constant | -1.521*** |
| | (0.107) |
| $N$ | 11255 |
| adj. $R^2$ | 0.018 |

Region fixed effects refer to error terms of municipality associations. They are estimated in a 1st step regression from controls on patents per employees. Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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