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Postal Address:
Institut d'Economia de Barcelona
Facultat d'Economia i Empresa
Universitat de Barcelona
C/ Tinent Coronel Valenzuela, 1-11
(08034) Barcelona, Spain
Tel.: + 34 93 403 46 46
Fax: + 34 93 403 98 32
ieb@ub.edu
http://www.ieb.ub.edu

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ABSTRACT: It has long been argued that economic phenomena are affected by culture. However, the causal effect of cultural ties on economic exchange is difficult to identify, chiefly because cultural ties are endogenous to the current level of economic exchange, and because it is hard to separate *culture* from other influences. In this paper, we address these issues by using a novel measure for cultural identity—historical dialect differences across regions of the same country. We evaluate linguistic micro-data from a unique language survey conducted between 1879 and 1888 in about 45,000 German schools. The recorded geography of dialects comprehensively reflects local cultural differences that have been evolving for centuries and provides an ideal opportunity to isolate cultural costs from other barriers to economic exchange. In a gravity analysis, we then show that cross-regional migration flows in the period 2000–2006 are positively affected by historical dialect similarity, a finding that indicates highly time-persistent cultural borders that impede economic exchange even at a fine geographical scale.

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Oliver Falck
Ifo Institute for Economic Research
Poschingerstr. 5
D-81679 Munich, Germany
Phone: +49 89 9224 1370
Email: falck@ifo.de

Stephan Heblich
Institute of Economics
Kahlaischestr. 10
D-07745 Jena, Germany
Phone: +49 3641 686 733
Email: heblich@econ.mpg.de

Alfred Lameli
Research Centre *Deutscher Sprachatlas*
Hermann-Jacobsohn-Weg 3
D-35032 Marburg, Germany
Phone: +49 6421 28 22 482
Email: lameli@staff.uni-marburg.de

Jens Südekum
Mercator School of Mgmt.
University of Duisburg-Essen
Lotharstraße 65
D-47057 Duisburg,Germany
Phone: +49 203 379 2357
Email: jens.suedekum@uni-due.de

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"It is impossible for an Englishman to open his mouth without making some other Englishman hate or despise him"
(George Bernhard Shaw — Pygmalion, 1916)

1. Introduction

Scholars from various disciplines have long argued that economic phenomena are strongly affected by culture, but quantitative research on the causal effects of cultural ties on economic exchange has started only very recently. *Culture* is not an easily operational concept, however, and is thus difficult to measure. Specifically, proxies for cultural ties: i) are often available only at a high level of aggregation, typically for different countries; ii) may also capture other effects on economic outcomes, such as transaction costs, information barriers, or institutions; iii) do not provide a comprehensive picture of cultural identity, but capture only a single aspect such as religion or ethnicity; and iv) are often endogenous to the level of economic exchange.

We address these problems by using a novel measure for cultural identity—historical local dialects—and analyze how dialect similarity across regions of the same country affects current cross-regional economic exchange, specifically regional migration flows.

From a linguistic point of view, dialects are local variants of the same language. They can vary substantially in terms of pronunciation, vocabulary, or grammar (Crystal, 1987), but despite their peculiarities, dialects are not usually major barriers to communication in the same way that completely different languages are. For example, the dialect spoken in Liverpool ("Scouse") is quite distinct from the English spoken in most parts of the United Kingdom, including the neighboring regions of Chesire and Lancashire. Nevertheless, "Scousers" can still easily engage in conversation with people from other areas of the country. The geography of dialects, therefore, is not a literal communication barrier, but the outcome of a century-long process of linguistic evolution. This is not a new idea; Charles Darwin recognized this phenomenon when he wrote, in his seminal book, *Origin of Species*:

> *If we possessed a perfect pedigree of mankind, a genealogical arrangement of the races of man would afford the best classification of the languages now spoken around the world; and if all extinct languages, and all intermediate and slowly changing dialect, were to be included, such an arrangement would be the only possible one.* (cited after Cavalli-Sforza 2000:167).

Below we provide several examples showing that linguistic patterns—almost like a genome—store information about historical interactions. The examples support Darwin's argument and suggest that dialects provide a unique opportunity to comprehensively portray deep cultural differences at the regional level.

We evaluate micro-data derived from an encompassing language survey conducted by the linguist Georg Wenker between 1879 and 1888. This survey was intended to provide a detailed inquiry into language variation within the newly created German Empire, which was comprised of a large number of formerly autonomous princedoms and kingdoms. The survey includes detailed phonological and grammatical attributes of the languages spoken by pupils in about 45,000 schools across the German Empire, and thus provides a genuine picture of the cultural variation arising from Germany's legacy of sectionalism.[1] Using these data, we construct a dialect similarity matrix for the current 439 German districts (NUTS3 regions), where the characterization of each district's dialect is based on 383 linguistic features having to do with the pronunciation of consonants and vowels as well as with grammar. Based on a gravity model, we then investigate to what extent historical dialect differences affect regional gross migration flows during the period 2000–2006.

Research on internal migration consistently shows that local economic conditions, such as wages, unemployment, housing prices, etc., are key drivers of individual location decisions. Economically prosperous regions tend to experience larger inflows than outflows of population, while backward regions experience net emigration. However, it is also frequently

[1] To this day, the Wenker survey is the most complete documentation ever of a nation's language and has defined standards in the linguistics discipline (for a detailed introduction, see Lameli 2008). Similar data are not available for other countries or languages at a comparable degree of detail.

noted that gross flows are two-directional and typically larger than net flows. That is, the direction of migration is not always from poor to rich places, but also the other way around.[2] Moreover, gross flows are often relatively small, especially in European countries where regional labor mobility is lower than it is in the United States. These observations suggest that migration, even at the regional level, is accompanied by significant costs other than and in addition to the strictly economic ones. In a classic article, Sjaastad (1962) uses the term "psychic costs of migration," which include the costs of leaving "familiar surroundings" and therefore encapsulate cultural differences across regions that affect mobility decisions.

In our gravity model for migration, we control for contemporaneous differences in economic prosperity with source and destination area fixed effects. These fixed effects also capture other unobservable region-specific attributes, and this specification allows for a consistent estimation of region-pair specific impacts such as geographical distance or travel time across regions (Anderson and van Wincoup 2003; Feenstra 2004). Most importantly, our dialect similarity matrix allows us to directly proxy the "psychic mobility costs" and to quantify their effect on regional migration flows.[3]

The central finding of our empirical analysis is that current migration is significantly positively affected by the similarity of the dialects prevalent in the source and destination area in the late 19th century. An individual who decides to migrate today—all else equal—prefers destinations with a dialect similar to that found in the source region more than 120 years ago. Cultural ties across regions are highly persistent over time and affect economic

[2] See, e.g., Hunt (2006) for an analysis of internal migration in Germany. Classical references are Schwartz (1973) and Greenwood (1975). Pissarides and McMaster (1990) analyze net regional migration flows and show that they tend to be directed toward areas with high wages and low unemployment rates.

[3] It is possible to specify a similar gravity model with other types of cross-regional flows as the outcome variable. However, inter-regional data on trade or financial flows are not available at a comparable level of geographical disaggregation. Moreover, we believe that migration flows are at least equally well suited to study the effects of intangible and persistent cultural borders on current economic exchange. Individuals do not migrate very often during a lifetime, even at the regional level. Hence, moving from one region to another is a substantial act, and cultural biases may influence such a decision even more strongly than, say, they would the decision to trade goods or to conduct financial transactions with someone from a different region.

decisions even today. These cultural ties are comprehensively portrayed by dialects; in fact, we show that dialect similarity is not confounded with other types of region-pair-specific congruencies, like a common religious or political history, but instead seems to capture an entirety of historical imprints and otherwise immeasurable aspects of cultural identity.

There is an extensive literature about language and economics that discusses language acquisition by foreigners or the coexistence of domestic and foreign languages within one country.[4] Our focus is different in that we study regional variation of the *same* language. Our findings are thus unlikely to be due to a similar transaction cost mechanism as in Lazear's (1999) model, where individuals can conduct economic transactions only when they speak a common language. Dialect differences matter for internal migration decisions not because people would be literally unable to communicate in other regions, but because they have a preference for living in a culturally familiar environment.[5]

Our study is also related to a recent line of research on the economic effects of cultural similarity at the international level. Guiso *et al.* (2009) show that trade and investment flows across countries are impeded by intangible borders that stem from a lack of bilateral trust. Bilateral trust is explained, inter alia, by cultural differences across countries, which are in turn measured by differences in religious, genetic, and somatic traits. Our study adds to this literature by showing that cultural borders to economic exchange also exist *within* nations and, hence, on a much finer geographical scale. Furthermore, our regional focus allows us to abstract from distortions such as institutions or information barriers, which are difficult to

[4] Important contributions to the literature on language acquisition by immigrants and multilingual countries include Chiswick (1991), Rauch (1999), Rauch and Trindade (2002), Alesina and La Ferrara (2005), and Melitz (2008). Ginsburgh and Weber (2010) comprehensively review the economics of linguistic diversity.

[5] The only other economic study we are aware of that exploits linguistic variation within the same language is Grogger (2010). He finds that black workers in the United States systematically earn lower wages if their speech can be distinctively identified as African-American English. Our focus is different in that we are not interested in labor market discrimination against particular dialects (or sociolects), but in the effects of cultural similarity—as measured by dialect similarity—on economic exchange.

separate from the effect of culture, as those other distortions surely matter more at the international than at the regional level.[6]

Tabellini (2010) studies the interaction of culture and institutions in determining output differences across European regions. Recognizing that contemporaneous cultural values are endogenous to current economic outcomes, he instruments culture with historical regional variables on literacy rates and political institutions. In our study, we directly observe past cultural differences across regions by relying on dialects measured in the 19th century and, therefore, face no comparable simultaneity problem.

We also take into account another possible source of endogeneity, namely, that migration flows may be persistent over time. If this is the case, linguisitic similarity could be the outcome of previous migration flows, rather than a causal influence on current migration. Exploiting the quasi-natural experiment of German Reunification, we analyze whether network effects may have led to persistence in migration flows and, in turn, to dialect assimilation. Furthermore, by focusing on subsamples of regions with similar geological features, we address the possibility that migration flows are driven by persistent omitted factors over the very long run. Our results suggest that it is appropriate to interpret our findings as a causal effect of culture on economic exchange.

The remainder of this paper is organized as follows. In Section 2 we describe our linguistic data and discuss the meaning of dialects, especially in the historical context of our study. Section 3 sets out a simple gravity model for current migration flows that serves as the underlying framework for the empirical analysis. Section 4 presents our baseline results together with various robustness checks. Section 5 concludes.

[6] Cultural and genetic differences are also put in perspective by Desmet *et al.* (2008), who show that countries with more distant gene profiles exhibit stronger differences in cultural values. Spolaore and Wacziarg (2009) find a positive relationship of genetic and current income differences across countries. These papers thus emphasize that genetic similarity stimulates economic exchange via a cultural channel. We obtain a consistent result for linguistic similarity on a much finer spatial scale.

2. Background and data

2.1. Historical background and the measurement of linguistic characteristics

In the centuries following Charlemagne, France, Spain, England, and Habsburg Austria developed into states where power was wielded by a centralized sovereign. In contrast, the Holy Roman Empire became increasingly fragmented. When the Treaty of Westphalia ended the Holy Roman Empire in 1648, what we know as Germany today was comprised of hundreds of sovereign kingdoms, principalities, and dukedoms. This fragmentation continued until the German Empire (*Deutsches Reich*) was established in the late 19th century. When Georg Wenker conducted his language survey shortly after the Empire was established, each of these independent territories had been in existence for several centuries.

Between 1879 and 1888, Wenker asked teachers and pupils in more than 45,000 schools to translate 40 German sentences into their local dialect. These sentences were especially designed to reveal specific dialect characteristics. The survey covered the entire area of the Empire and revealed pronounced differentiation of local languages, since at that time (more so than today) dialects were the people's common everyday speech.

Wenker's surviving material contains millions of phonological and grammatical observations in the form of handwritten protocols of the language characteristics recorded in the individual schools (see Figure 1a for an example). These raw data were integrated by Wenker and collaborators into a linguistic atlas of the German Empire (*Sprachatlas des Deutschen Reichs*). The *Sprachatlas* was developed between 1889 and 1923 and contains more than 1,600 hand-drawn maps showing the detailed geographical distribution of particular language characteristics across the German Empire (see Figure 1b for an example). In an evaluation process that spanned several decades, Ferdinand Wrede, one of Wenker's collaborators, determined the prototypical characteristics most relevant for the

structuring of the German language area.[7] For today's Federal Republic of Germany, 66 variables are relevant, each of which has to do with the pronunciation of consonants and vowels as well as with grammar. An individual map exists for each linguistic attribute.[8]

[Figures 1a and 1b here]

We matched these 66 thematic maps from the *Sprachatlas* with Germany's current administrative classification scheme. The Federal Republic of Germany currently consists of R=439 districts (*Landkreise*); however, the linguistic maps from the *Sprachatlas* do not conform to this classification system. We therefore use GIS (Geographical Information System) technology to juxtapose digitized versions of these linguistic maps and the map of the current administrative districts. We then quantify the dialect of each district in the form of binary variables.

The following example illustrates this approach. One of the linguistic attributes is the German word for *pound*. Depending on the dialect, it is pronounced as "Pfund," "Pund," or "Fund." The corresponding map in the *Sprachatlas* shows the variant "Fund" mostly in the eastern parts of Germany, "Pund" mostly in the northern areas, and "Pfund" mostly in the southern parts. These variants are then transferred into a binary coding of the type: "Fund" = {1 0 0}; "Pund" = {0 1 0}; "Pfund' = {0 0 1}. Comparing the individual linguistic map for the word *pound* and the current administrative map of Germany, we assign one of these codes to each of the 439 districts. This approach is unambiguous when there is no intra-regional variation of this particular language characteristic, i.e., when the entire area of some district *r* exhibited the same pronunciation according to the map in the *Sprachatlas*. Typically this has been the case. However, the spatial distribution of this particular language attribute and the current boundaries of the districts are not in all cases perfectly coincident. If

[7] Wrede combined local extractions of variants to a dialect classification (see Wrede *et al.* 1927–1956, map 56). One advantage of this classification over more recent categorizations of the Wenker data (e.g., Wiesinger 1983b) is that it lends itself quite easily to a mathematical representation of dialects (see below).

[8] All hand-drawn maps are published online as the 'Digitaler Wenker-Atlas' (DiWA), see http://www.diwa.info.

we found intra-regional variation of pronunciation, we then chose the most frequent variant within the district as representative. The entire matching procedure was accompanied by several linguistic plausibility tests and cross-checks with the underlying raw data on the phonetic protocols from the Wenker survey.

Repeating this procedure for all 66 language characteristics, we end up with K=383 binary variables representing the dialect that was spoken in the area of a district in the late 19th century. More formally, the historical dialect of the current district *r* is represented by a vector $\mathbf{i}^r = \{i_1^r, i_2^r, \cdots, i_K^r\}$ of length K=383, where each vector element is a binary variable [0,1]. Using these data, we can then construct a dialect similarity matrix across all *R* regions as follows: consider any two German districts *r* and *s* whose historical dialects are represented by $\mathbf{i}^r = \{i_1^r, i_2^r, \cdots, i_K^r\}$ and $\mathbf{i}^s = \{i_1^s, i_2^s, \cdots, i_K^s\}$, respectively. We use a simple count similarity measure, namely $\ell_{rs} = \mathbf{i}^r \times \mathbf{i}^s$, where $0 \le \ell_{rs} \le K$ for $r \ne s$.[9] The resulting matrix across all regions then has dimension 439×439 with elements ℓ_{rs}.

2.2. What does dialect similarity capture?

Nations are not monolithic linguistically. Typically, there are hundreds of regional dialects within the same language. Such phonological and grammatical variations across space are by no means random, but they are imprints from the past. In this subsection we discuss some examples of our German data. These examples suggest that the geography of dialect similarity as recorded in the 19th century reflects long-term evolutionary processes of region-pair-specific congruencies and past interactions.

[9] As a robustness check we also calculated two different similarity indices. First, Jaccard's (1901) similarity index is computed as follows: Given the two vectors $\mathbf{i}^r$ and $\mathbf{i}^s$ of length K, let M_{11} be the number of vector columns where both $\mathbf{i}^r$ and $\mathbf{i}^s$ have the value 1, M_{10} the number of cases where $\mathbf{i}^r$ has a 1 and $\mathbf{i}^s$ has a 0, M_{01} the number of cases where $\mathbf{i}^r$ has a 0 and $\mathbf{i}^s$ has a 1, and M_{00} the number of cases where both vectors have a 0. The Jaccard similarity index is then defined as $M_{11}/(M_{11}+M_{10}+M_{01})$. Second, Kulczynski's (1927) similarity index is defined as $\frac{1}{2} \cdot [M_{11}/(M_{11}+M_{10}) + M_{11}/(M_{11}+M_{01})]$. Note that the count similarity index is equivalent to M_{11}.

Before turning to these examples, it is worth pointing out that anthropologists have long been aware of the coherence between genetic, cultural, and linguistic evolution. As a thought experiment, albeit an extreme one, consider a number of initially identical populations that became separated from each other at a certain point in time and have henceforth no contact with each other. The genetic profile of each isolated population evolves over time as a result of mutation, natural selection, and genetic drift, and the DNA profiles of any two groups are likely to drift apart due to the random elements of evolution. As forcefully argued in Cavalli-Sforza (2000), the same phenomenon is likely to occur in regard to cultures and languages. Isolated populations, even if initially identical, develop idiosyncratic habits and expressions. After the passage of a certain amount of time, it would be difficult for members of two initially identical groups to even understand each other if they had the chance to meet. In fact, linguistic evolution would be much faster and more drastic than genetic evolution, i.e., language differences across groups would become visible earlier and be clearer than DNA differences in this hypothetical scenario. Next, imagine that our now differentiated populations initiate cross-border contact. This exchange, which may occur through migration, is one major force behind diffusion. The more intensively two populations interact, the more diffusion occurs and the more similar these groups will once more become. Linguistic and cultural diffusion (adaption of words, habits, etc.) would again be faster and more intensive than genetic diffusion, but it would still occur slowly.

In short, as already noted by Charles Darwin (see above), both genes and languages are the product of evolution and are persistent over time.[10] We now turn to some specific examples of linguistic evolution within Germany.

[10] The relationship between and the economic consequences of linguistic, cultural and genetic differences have recently been summarized comprehensively by Ginsburgh and Weber (2010). Further linguistic studies on this relationship include Barbujani *et al.* (1996), Dupanloup de Ceuninck *et al.* (2000), and Manni (in press). For a broader discussion, also see the "*linguistic dynamics approach*" developed in Schmidt (2010).

Our first example illustrates the interrelations between dialects and religious similarities. The map on the left in Figure 2 depicts the regional similarities to the dialect spoken in *Waldshut*, a district located in the southwest of Germany (Baden-Württemberg). The reference point *Waldshut* is marked. Warm colors indicate a high, and cold colors a low, degree of similarity. The map on the right in Figure 2 zooms in on Baden-Württemberg and compares the spatial pattern of dialect similarity with the religious geography of that area.

As is well known, the Reformation of the 16th century resulted in distinct Protestant and Catholic localities in Germany (see also Becker and Woessmann 2009). Protestant areas in the year 1546 are indicated in Figure 2 by a hatching from left to right, whereas the hatching from right to left indicates those areas that were Catholic in 1546 but became Protestant by 1820. Notice that there are only very few such areas, i.e., religious orientation remained remarkably stable over this time span of almost 300 years. This stability is chiefly due to social practice. For example, in earlier times it was uncommon, if not completely unheard of, to marry across religious borders; Protestants marry Protestants, Catholics marry Catholics.[11]

[FIGURE 2 HERE]

The main message conveyed by Figure 2, however, is that the geography of dialect similarity is strikingly similar to religious geography. Waldshut itself was and always remained Catholic, and it can be seen that the dialects of other Catholic districts resemble the one in Waldshut more closely than do the dialects of Protestant districts. This finding aligns itself nicely with the discussion on linguistic evolution. Catholic localities are in closer contact with other Catholic localities; Protestants are more in contact with Protestants. Hence, religious and linguistic similarities co-evolve, and they do so until today (Stoeckle, in press).

[11] This stability is even more remarkable in light of the fact that it was not until after the Peace of Westphalia (1648) that a newly-converted ruler became prohibited from forcing his new religion on his subjects, which had been common practice ever since the Peace of Augsburg in 1555 (see Cantoni 2009). Other factors apart from social practice that might have a stabilizing effect on religious orientation include natural boundaries such as the Black Forest or the Rhine, or national and administrative borders, in this case the border of the archbishopric Freiburg.

Second, language is also reflective of previous migration waves. To illustrate this point, let us consider the example of the *Goslar* district. The map in Figure 3 illustrates the dialect similarity between Goslar (white) and all other German districts.

[FIGURE 3 HERE]

Linguists view the Harz Mountains in Goslar as a *language enclave* in the sense that the dialect spoken there is not similar to dialects spoken in neighboring districts but instead more resembles a dialect spoken about 300 kilometers away in the mountainous *Erzgebirge*, where, in Figure 3, we find an accumulation of warm colors (indicating high similarity). The historical explanation for this phenomenon is the revival of silver mining in the Goslar area between 1520 and 1620, motivating migration to that area by starving miners in Saxony. This 16th-century relationship between the two regions is still visible in dialect data from the late 19th century (also see Wiesinger 1983a), which illustrates the degree of inertia inherent to evolutionary processes.

An important aspect of pre-modern migration is that it was nearly always a social or *mass* phenomenon, and thus much different from current migration, which is strongly based in *individual* economic motives. With very few exceptions, these mass migrations in Germany ended during the 18th century (Wiesinger 1983a). Therefore, at the time Wenker conducted his language survey (1879–1888), roughly one and a half centuries had elapsed without such major perturbations.[12] The local cultures and dialects had thus some time to harden.

Third, geographical distance certainly plays a role in dialect similarity. As seen in Figure 2, the districts adjacent to Waldshut tended to have similar dialects. However, we also find districts relatively close to Waldshut that are less similar than districts that are farther away. This suggests that our dialect data contain information that goes beyond what can be

[12] The last incident known to us that can be classified, albeit rather broadly, as a *mass migration* occurred between 1749 and 1832. Initially, a rather small community of people from the Palatinate decided to immigrate to America, but ended up as settlers in a region near the city of Kleve. The reason for migrating was hunger caused by a poor harvest. Once settled in that area, other families from the Palatinate followed.

explained by mere physical distance, a point made clearly by the Goslar example (Figure 3), where there is virtually no relationship between geographical distance and dialect similarity. Dialect similarity could, however, still reflect the existence of old trading routes, which, by taking advantage of rivers, natural passages, and forts, historically led to more contact between certain regions. And, indeed, the importance of transport routes for the spatial structuring of language attributes is made evident by the example of the so-called *Rheinstaffel*. Klausmann (1990) notes a difference in linguistic development depending on the topological relation of individual locations to the Rhine river, i.e., dialect similarity may also be influenced by ancient transportation networks.

Last, at the time Wenker collected the data, the German Empire had just been created out of formerly independent territories. These territories had previously been in existence for centuries, and thereby also contributed to linguistic evolution. In fact, dialectologists since the 19th century were aware of the congruencies between the areal distribution of historical territories and language (see Haag 1898; Aubin *et al.* 1926; and, more recently, Barbour and Stevenson 1990). One reason for this persistence may be that the territories tended to encourage internal traffic, and discourage, or at least not improve the means for, travel external to their borders. Hence, communication and exchange between territories was somewhat hindered (Bach 1950:81). From an evolutionary perspective, such limitations can lead to a higher degree of dialect similarities among regions that formerly belonged to the same historic territory.

Summing up, these examples suggest that dialect similarity between regions is higher the more intensive was their interaction and exchange in the course of history. The influences that have been discussed, such as common religious and historical political borders, distance and the influences of ancient transportation networks, as well as unique historical events and previous migration waves, all left some long-lasting imprints on the local dialects. Dialect

similarities between regions are correlated with these other types of regional congruency, but are likely to capture other (and less well measurable) aspects of cultural similarity and emotions (see Schifferle 1990). The dialects should therefore be interpreted more broadly as comprehensive measures of local *cultural identity*.

Culture, of course, is not restricted to language, but occurs in many other domains such as art, traditions, habits, etc. However, regional differences within these cultural domains are likely to be reflected in dialect differences, as cultural and linguistic evolution proceeds in parallel. Put differently, as argued in the sociology literature by Brewer (1991) and in the linguistics literature by Chambers and Trudgill (1998), language is the strongest marker of cultural identity. It has the added advantage of being an overt one; people can disguise their true norms and values, but not their regional dialect, which is formed during childhood and is enormously difficult to suppress. Finally, dialects are relatively easily measurable using linguistic techniques.

3. A gravity model of current regional migration

The main aim of this paper is to investigate to what extent historical dialect differences affect current bilateral economic exchange. Specifically, we investigate the effects on cross-regional migration flows. To this aim, we derive a theoretically grounded gravity equation in this section, which serves as the underlying framework for our empirical analysis.

3.1. Current regional migration data

We use data on pair-wise gross migration flows for the 439 German districts averaged over the period 2000–2006 as provided by the German Federal Statistical Office.[13]

[Table 1a and 1b here]

[13] In Germany, every person who changes his or her place of residence is legally required to register at the new residence within at most two weeks (even earlier in some states). The migration data are thus very accurate.

Table 1a provides an overview of these data and points out two basic facts about internal migration flows in Germany. First, across all regional pairs, there has been some gross migration in more than 96% of all cases. That is, migration occurs not only from economically poor to rich regions, but also in the other direction.[14] This suggests that individuals are heterogeneous in their perceptions of different regional characteristics when making location decisions. Second, Table 1a indicates that migration flows in Germany are rather small. The average annual gross migration flow between a pair of regions was seven migrants per 100,000 inhabitants in the district of origin, which implies a total gross emigration rate of only 3% for the typical German district. This low number suggests that the costs of cross-regional migration are substantial.

3.2. The model

Our gravity model for migration precisely features such two-way gross flows which are larger than net flows. It also takes into account that individuals are heterogeneous and face distance-dependent mobility costs should they decide to move.

The model is derived from a simplified version of the economic geography frameworks with locational taste heterogeneity by Murata (2003) and Tabuchi and Thisse (2002). Consider a country that consists of $r = 1, 2, ..., R$ regions and a mass of heterogeneous individuals indexed by *h*. Indirect utility in region *r* is given by

$$V_r^h = u_r + \varepsilon_r^h \qquad (1)$$

The variable u_r denotes the economic level of well-being in region *r*. This includes the local wage level, unemployment rate, price level, etc. This economic level of well-being is the same for all individuals in a region. For our purposes it suffices to think of u_r as being exogenously given. That is, we abstract from market interactions and assume that the

[14] The presence of two-way gross migration flows is not easily reconciled with standard models of regional labor mobility (e.g., Krugman 1991) that predict only one-way migration flows.

regional levels of economic well-being do not respond to the location decisions of the workers. The term ε_r^h is idiosyncratic for individual *h* and region *r*, capturing his or her perception of the attributes and characteristics associated with that particular region.

As shown in Anderson *et al.* (1992:ch. 3), this type of individual taste heterogeneity can be modeled such that the actual matching value between a worker and region is the realization of a random variable. We follow this modeling strategy and assume that ε_r^h is distributed i.i.d. across individuals and regions. Furthermore, we adopt the standard parameterization of a double exponential distribution, $F(x) = \mathbf{Pr}\left(\varepsilon_r^h \le x\right) = \mathbf{exp}[-\mathbf{exp}(-x/\beta - \gamma)]$, where γ ($\approx$0.5572) is the Euler constant and β>0 is a parameter. This distribution has mean zero and variance $\left(\pi^2/6\right)\cdot\beta^2 \approx 1.6449\cdot\beta^2$. The term β, which is positively associated with the variance, is referred to as the *degree of taste heterogeneity*. It is well-established that under this parameterization, the choice probability of some individual *h* to live in region *r* can be calculated as follows (see Murata 2003):

$$P_r = \mathbf{Pr}\left[V_r^h > \max_{j \neq r}\left\{V_j^h\right\}\right] = \frac{\mathbf{exp}\left[u_r/\beta\right]}{\sum_{j=1}^{R}\mathbf{exp}\left[u_j/\beta\right]} \qquad (2)$$

The larger β, the more heterogeneous are the individual attachments to the regions. If $\beta \rightarrow 0$, people make location decisions based only on the economic levels of well-being. We are then back to a model having homogeneous individuals. On the other hand, if β tends to infinity, people choose among the *R* regions with equal probability *(1/R)*. In this case, locational tastes are extremely heterogeneous and the economic levels of well-being have no effect on location decisions.

It is useful to embed this model into a two-period framework. Suppose the individuals are distributed in some given way across regions, and the random variables ε_r^h are drawn in the first period. Individuals then choose the location they most prefer during the second period.

Depending on the realizations of the ε_r^h, this may involve migration to an area with a lower level of economic well-being than in the current source region, as well as parallel gross flows from *r* to *s* and from *s* to *r*.

Specifically, an individual *h* migrates from the initial location *r* to some other region *s* if the overall utility from living in *s*, net of the region-pair-specific mobility costs c_{rs}, exceeds the (net of mobility costs) utility level of all other locations *j*, including the current location *r*. Formally, a move from *r* to *s* takes place if $V_s^h - c_{rs} > \mathbf{max}_{j \neq s}\{V_j^h - c_{rj}\}$, with $c_{rr} = 0$ and $c_{rj} \geq 0$ if $j \neq r$. Using Equation (2), the probability of migrating from *r* to *s* is given by $P_{rs} = \mathbf{exp}\left[(u_s - c_{rs})/\beta\right] \Big/ \sum_{j=1}^{R} \mathbf{exp}\left[(u_j - c_{rj})/\beta\right]$. Aggregating across individuals, the gross migration flow from *r* to *s* is equal to $M_{rs} = P_{rs} \cdot L_r$, where L_r is the population size of the source region. Rearranging $P_{rs} = M_{rs} / L_r$ and taking logs we obtain the following gravity equation: $\mathbf{log}\left(M_{rs}/L_r\right) = (u_s - c_{rs})/\beta - \mathbf{log}\left[\sum_{j=1}^{R} \mathbf{exp}[(u_j - c_{rj})/\beta]\right]$.

The mobility costs are region-pair-specific. We not only include standard pecuniary mobility costs (for moving furniture, finding accommodation, etc.), which are denoted by d_{rs} and will be approximated by physical distances or travel time across regions. We also incorporate, in the spirit of Sjaastad (1962), non-pecuniary costs of migration at the region-pair level, denoted ℓ_{rs}, which capture the psychic costs of moving to a culturally unfamiliar environment. In the empirical analysis, we measure cultural mobility costs by the historical dialect similarity. We assume the following specification: $c_{rs} = a_1 \cdot \mathbf{log}\left[d_{rs}\right] + a_2 \cdot \mathbf{log}\left[\ell_{rs}\right]$. With this specification, we can then rewrite the gravity equation and arrive at our final equation:

$$\mathbf{log}\left(M_{rs}/L_r\right) = D_r + D_s + \alpha_1 \cdot \mathbf{log}\left[d_{rs}\right] + \alpha_2 \cdot \mathbf{log}\left[\ell_{rs}\right] + e_{rs}, \qquad (3)$$

where we add a standard error term e_{rs}. Notice that $D_r = -\mathbf{log}\left[\sum_{j=1}^{R} \mathbf{exp}\left((u_j - c_{rj})/\beta\right)\right]$ varies only at the level of the source region, whereas the term $D_s = u_s/\beta$ varies only at the level of the destination region. These terms will therefore be captured by source and destination area fixed effects in the empirical analysis.[15]

The coefficients of interest are the geographical distance elasticity α_1 and, in particular, the elasticity α_2, which measures the impact of dialect (cultural) similarity on gross migration flows.[16] In table 1b we provide some descriptive statistics for these (linguistic and geographic) distances across German regions.

4. The effect of dialect similarity on regional migration

4.1. Baseline results

We estimate the gravity equation (Equation (3)) by ordinary least squares with origin and destination fixed effects. Table 2 presents the estimation results. Panel a) refers to migrants and populations of all ages, whereas panel b) presents the results when considering only working-age individuals.

[Table 2 here]

The results show that dialect similarity has a positive and highly statistically significant effect on gross regional migration flows. When including only dialect similarity without controlling for geographical distance, as in specification 1, we find a sizable (scaled) elasticity with a value around 2.2. That is, doubling the historical dialect similarity between

[15] Such a specification is standard practice in the gravity literature in international trade (Anderson and van Wincoop 2003). The fixed effects capture all impact variables that vary only at the regional level in our cross-sectional analysis, such as wages and housing prices, as well as time-invariant unobservable regional features. This fixed effects specification also takes into account the problem of interdependent flows in a multi-region economy ("multilateral resistance terms"). As shown by Feenstra (2004), this fixed effects specification allows for a consistent estimation of region-pair-specific impacts such as mobility costs.

[16] Since we have $\alpha_2 = a_2/\beta$, we can identify this elasticity up to the unobservable constant $1/\beta$.

two districts, all else equal, would lead to an increase of the gross migration flows between those regions by more than 220%. This specification thus indicates that there are sizable cultural mobility costs that impede internal migration in Germany. The results are similar for working-age migration (see panel b).

As illustrated by the examples in Section 2, dialect similarity is correlated with geographical distance, which per se is likely to have a negative impact on migration flows. To address this issue we first separately study the impact of geographical distance without considering dialect similarity. In specification 2 we use the linear physical distance between the centers of the source and the destination district as our proxy for pecuniary mobility costs. The results show that doubling the physical distance between two regions, all else equal, drives down gross migration flows by roughly 140–150%. In specification 3 we use an alternative distance measure, namely, the travel time by car between any pair of regions (in minutes), which may better capture the true regional accessibility. The results indicate that the elasticity with respect to travel time (176–178%) is a bit larger than for physical distance, which is intuitive as the latter might not always match the shortest travel distance due to natural barriers like rivers or mountains. When including both measures at the same time (as in specification 4), it turns out that most of the negative impact is captured by physical distances, with travel time having some small additional impact. Altogether, these findings on the detrimental effect of geographical distance on migration flows are consistent with the previous literature on internal migration (see, e.g., Greenwood 1975).

The important question is whether the positive effect of dialect similarity on migration flows prevails once we control for geographical distance. In specification 5 we simultaneously include dialect similarity and both proxies of pecuniary mobility costs. As can be seen, the coefficient α_2 drops substantially compared to column 1, which is due to the correlation of

linguistic and geographical distance. However, even conditional on geographical distance (and origin and destination fixed effects), we find a positive and highly significant effect of dialect similarity on gross migration flows.[17] The estimated elasticity ranges between 18% and 20% and is similar for total and for working-age migration. The standard deviation of our dialect similarity measure is 10.53, which is about 32 percent of the sample mean (see table 1b). Thus, an increase of dialect similarity by one standard deviation (measured at the sample mean) increases gross migration flows between a pair of regions by about 6 percent. This elasticity in column 5 of Table 2 is the benchmark result of our empirical analysis.

Columns 6 and 7 of Table 2 address the robustness of this finding with respect to the estimation method. First, the interpretation of the parameters of log-linear gravity models estimated by linear least squares methods can be misleading in the presence of heteroskedasticity. To overcome this problem, we estimate the gravity equation by means of a Poisson pseudo-maximum-likelihood (PPML) estimator with Eicker-White robust standard errors, as proposed by Santos-Silva and Tenreyro (2006). Second, previous work in the international trade literature suggests that zero flows can pose problems in the estimation of gravity equations (see Disdier and Head 2008; Helpman *et al.* 2008). As shown in Section 3, zero gross migration flows across German districts account for less than 4% of all cases and therefore would appear to be a minor issue. Nevertheless, we tackle this potential problem by employing a two-stage Heckman procedure that uses a non-linear probit equation for selection into migration in the first stage, and then estimates Equation (3) in the second stage.[18] In the PPML estimation (see column 6), the elasticity with respect to dialect similarity is around 11% and thus somewhat lower than in the benchmark specification. The

[17] In the literature on how genetic similarities affect international trade flows, Giuliano *et al.* (2006) argue that there may actually be no such effects once transport costs across countries are properly controlled for. Our estimation in column 5 takes such issues into account because actual travel time across regions can be thought of as an analogue of actual transport costs for goods.

[18] We thus rely on the normality assumption for identification of our second-stage estimates.

two-step Heckman selection model (column 7) yields estimates that are similar to the benchmark. All in all, these results confirm the positive and significant effect of historical dialect similarity on current bilateral migration flows across German regions.

Table 2 additionally shows that our results are also robust with respect to the linguistic similarity index. We replace the simple count index with the similarity index by Jaccard (1901) in column 8, and with the similarity index by Kulczynksi (1927) in column 9, while returning to ordinary least squares estimation.[19] Regardless of which similarity index we use, our results are very similar to the benchmark specification.

In Table 3 we investigate the effect of dialect similarity on migration flows for different types of regional pairs, where local populations may vary systematically in their view of cultural differences. In particular, we divide the 439 German districts into 178 urban and 261 peripheral regions. Since we can observe two-way gross migration flows for each pair of regions, we can create four categories of flows: urban-to-urban (U-U), peripheral-to-peripheral (P-P), urban-to-peripheral (U-P), and peripheral-to-urban (P-U). We then estimate Equation (3) separately for each sample.

[Table 3 here]

Notice that the U-U and P-P samples consist of more homogeneous pairs of regions than the U-P and P-U samples. These four different samples thus permit us to investigate whether the impact of dialect (cultural) similarity on migration decisions is dependent on whether the source and the destination area are heterogeneous or homogeneous, and the distinction of urban and peripheral regions seems to be the most natural division to capture this type of effect heterogeneity. The results in Table 3 suggest that the impact of dialect similarity on migration is rather similar in all cases. It is a bit lower for the P-P group, but we consistently

[19] See footnote 9 for more detail on these indices. Including any of these similarity indices (or the geographical distance measures) in levels instead of logs does not change our qualitative results. We thus consistently use a logarithmic specification, which allows interpreting our coefficients as elasticities.

find a positive and significant impact of cultural similarity for all types of cross-regional migration flows.[20] To further study effect heterogeneity with respect to different types of migration flows, we have dropped all flows where the destination region is a major city with more than 500,000 inhabitants. Those migrations may be mainly motivated by the career concerns of young workers, who temporarily move because human capital investments are easier in big cities (Glaeser 1999; Peri 2002), whereas cultural affinity may play a lesser role in those cases. Furthermore, we have dropped all flows below some minimum distance (50, 100, or 150 km), because individuals do not have to leave their cultural environment over those short distances. We omit the detailed results, but the effect of dialect similarity on migration hardly changes in those additional robustness checks.

Finally, we have conducted some further tests for which we also omit the detailed results. First, we have augmented the benchmark specification with a dummy variable that equals unity if the source and the destination region are not located within the same federal same state (Bundesland). Crossing the border of a federal state may systematically increase pecuniary mobility costs, e.g., because of different regulations and laws applicable to various occupational groups (e.g., for teachers and lawyers). Results show that state borders significantly reduce gross migration flows. The effect of historical dialect similarity hardly changes, however. Second, we have also taken into account the impact of local industry structures on migration. We have augmented the benchmark specification with a dummy variable that equals unity if the source and the destination region have the same dominant 2-digit NACE code industry (in terms of employment). Results show that the similarity of the industry structure between a pair of regions significantly increases gross migration flows, which suggests that industry-specific human capital plays a role for location decisions.

[20] As for the somewhat lower elasticity of dialect similarity in the P-P sample, one should also take into account that zero flows are concentrated within this group. Specifically, although the P-P sample accounts for only 35% of all migration flows, it includes 56.6% of all zero flows.

However, the effect of historical dialect similarity on current migration again hardly changes.

The results reported so far imply that an individual who decides to migrate today, all else equal, will prefer a destination characterized by a dialect similar to the one prevalent in his or her source region more than 120 years ago. How to interpret this finding? We argue that these results point at significant cultural mobility costs, which impede internal migration flows in Germany. That is, our empirical findings indicate that individuals dislike moving to culturally unfamiliar environments, and current cultural differences between German regions are well captured by historical dialect differences. This interpretation rests on two important conditions. First, it requires that dialect differences are a good measure for cultural differences across regions that are persistent over time. Second, it supposes a causal effect of dialect (cultural) differences on migration, rather than a persistence of migration flows that has affected the geography of dialects. We now turn to several extended analyses that specifically address these estimation concerns and shed light on the economic interpretation of our results.

4.2. Omitted region-pair-specific and region-specific characteristics

With respect to the first estimation issue, it should be noted that time persistence of dialect differences per se seems to be a very reasonable supposition. Certainly, there has been some linguistic diffusion during the 20th century, and dialect use is less common today than it was when Georg Wenker collected the linguistic data. One factor behind this diffusion is the migration that has occurred since that time. During the 20th century, migration became an increasingly individual phenomenon, and even if the migration of individuals does not cause perturbations as major as those that resulted from the mass migrations of earlier times, it still

contributes at least something to the local language mix. The ubiquity of modern mass media may be another factor that has facilitated linguistic diffusion.

However, even if these developments led to some assimilation across regions, they have certainly not completely nullified local dialect differences. Although cultural evolution progresses faster than genetic evolution, a period of 120 years is still much too short to erase all regional cultural differences.[21] It is therefore not surprising that linguists frequently note a close correspondence of the geography of dialects as recorded in the Wenker survey, and current linguistic patterns in Germany (see, e.g., Bellmann 1985:213). What is more, dialect differences today may be *absolutely* smaller than they were in the 19th century, but the aforementioned diffusion processes are not markedly region-pair-specific. *Relative* linguistic differences across regions are thus particularly likely to have endured.

If dialect differences are persistent over time, their impact may still be confounded with the effects of other persistent, but omitted, factors that drive contemporary migration and that are also correlated with historical dialect patterns. In that case our estimations would suffer from an omitted variable bias. Notice that our estimate for the dialect similarity elasticity should still be consistent as long as omitted variables are purely region-specific, as the fixed effects should take into account all persistent factors for the source and the destination area. A problem would clearly arise, however, if we omit relevant region-pair-specific variables. We therefore introduce additional region-pair-specific control variables in order to address this estimation concern.

We argued in Section 2 that dialect similarity reveals a spatial pattern that often corresponds to other types of historically determined congruencies between the regions, including religious orientation as illustrated by the Waldshut case. Another possible confounding

[21] The transmission of cultural values across generations and the stability of cultural patterns over time is further studied in Tabellini (2008) and Benabou and Tirole (2006). As example, recall the Waldshut case from Section 2, which illustrated the stability of religious orientation over the period 1546–1820. If one were to draw a map of the religious geography of that area today, one would find a spatial pattern that is still strikingly similar to the one from 1546.

factor is former administrative borders, since we emphasized above that the geography of dialect similarity is also correlated with the borders between the territories out of which the German Empire was created (as noted, e.g., by Barbour and Stevenson 1990). Dialect differences may thus simply capture the persistent effects these regional differences have on current migration flows.

To address this possibility, we control for differences in religious denominations in 1890, roughly the same time at which the linguistic data were collected. We define a dummy variable that equals unity if the majority of the population in the source region had a different religion than those in the destination region in the late 19th century. Furthermore, we include a dummy that equals unity if the current migration flow extends across a historical administrative border. More specifically, we consider the borders of 38 member states and 4 independent cities that were part of the German Confederation at the time of its foundation in 1815. These borders are a good representation of the politically fragmented environment that prevailed until the German Empire was established.

If cultural differences between current German regions are manifested mainly along those religious and political lines, and if dialects simply pick up these persistent effects, we would expect the elasticity of migration with respect to dialect similarity to turn insignificant (or at least to drop substantially) once we include these additional control variables.

[Table 4 here]

In columns 1 and 2 of Table 4 we control for the new variables separately; they are considered jointly in column 3. The results suggest that there is significantly more current migration between regions with historically different religious denominations, while historical administrative borders exert a negative impact on current migration flows. The main insight of Table 4, however, is that the effect of historical dialect similarity hardly changes. These results underline our previous argument that dialect similarity is a well-

suited comprehensive measure of regional cultural similarity. Our linguistic measure does not merely reflect religious or political congruencies that are correlated with the geography of dialects, but seems to capture many more dimensions of cultural similarity across German regions.[22] Thus, although we can never be sure that we have ruled out all possible omitted variables at the region-pair level, our empirical approach seems to come as close as possible to correctly portraying persistent cultural differences across German regions.

4.3 Persistence of migration flows

Turning now to the second estimation concern discussed in Section 4.1, the question remains whether we can interpret our main finding as a *causal* effect of cultural similarity on internal migration. Tabellini (2010) discusses one crucial endogeneity concern, by noting that data for current cultural characteristics (e.g., value survey data) are clearly endogenous to current economic outcomes. Due to the long time lag between the dialect and the contemporary migration data, our estimation certainly does not suffer from this type of simultaneity problem. However, there is still the concern that migration flows may be persistent over time and have, inter alia, shaped the geography of dialects.

One intuition for such a persistence can be network effects and social interactions in migration.[23] In a long-run dynamic perspective, social interactions may result in a clustering of migrants from the same source region at the same destination region. Suppose that at the time Georg Wenker collected the linguistic data (in the late 19th century) there was already a previously established migration connection between particular pairs of regions. Say,

[22] The other time-persistent factors may influence today's regional migration via other channels than cultural identity. In particular, the positive effect of religious differences on migration may capture an enduring prosperity difference between Catholic and Protestant areas, which was recognized early on by Max Weber and studied further by Becker and Woessmann (2009). Moreover, we find that the historical border dummy turns insignificant when we add current administrative borders in the same way as described in Section 4.1. This suggests that current and historical borders overlap, so that the historical borders partly capture the negative impact of Federal State borders on migration that operates via an increase in pecuniary mobility costs.

[23] Network effects in migration are extensively studied both theoretically (Carrington *et al*. 1996) and empirically (e.g., Munshi 2003).

families in some region *r* can draw on an already existing network of social contacts in some other region *s*, as well as vice versa, and these network effects constantly influence migration decisions. This would lead to a correlation of current region-pair-specific migration flows with the flows from 120 years ago and, in turn, even with flows from earlier times. If this is so, the prediction would be that dialect distance slowly disappears between the source and destination regions experiencing high migration exchange. Dialect similarity would then not actually *cause* contemporary migration, but persistent migration would lead to dialect assimilation. Our estimations would then capture a spurious correlation.

To answer the question of whether the positive effect of historical dialect similarity on current migration flows can be attributed to persistent cultural differences rather than persistent migration flows, we can turn to a quasi-natural experiment in German history. From the foundation of the German Democratic Republic (GDR) in 1949 or, at the latest, the construction of the Berlin Wall in 1961, migration flows between East and West Germany were cut off until the German reunification in 1989.[24] In other words, persistent migration networks between East and West German regions that might have caused slow dialect assimilation were exogenously interrupted for a considerable time span between the Wenker survey and our contemporary migration data.

When migration between the East and the West became again possible after 1989, the pre-existing social networks have thus not been in operation for quite a while. To the extent that social networks have no "memory function" comparable to that of dialects, as they are based on personal contacts and interactions (Glaeser *et al.* 2002), we would not expect to see a continuation of the persistence in migration flows across particular pairs of regions that existed prior to the division of Germany. On the other hand, cultural identity, as reflected in

[24] The division and reunification of Germany is used as a quasi-natural experiment by Redding and Sturm (2008), who show that the decline of West German cities near the inner German border can be attributed to the loss of market access to the neighboring East German areas after the division of Germany.

dialect similarity, does have such a memory function, as emphasized in the anthropological literature by Cavalli-Sforza (2000) and others, and is likely to have survived the division.

Put differently, if our baseline findings only reflect the persistence of migration flows, we would expect to find no (or at least substantially lower) effects of dialect similarity on contemporary migration flows within a subsample of migration flows across the inner German border only. By contrast, if we still find a positive effect of dialect similarity on contemporary migration flows for these cases, such would suggest that cultural identity at the regional level really is persistent over time and actually does affect migration decisions.

[Table 5 here]

Table 5 shows the results for the East-West and the West-East subsamples and, indeed, the coefficient of language similarity is still significantly positive and of similar magnitude as in the benchmark specification. These results are thus much more in line with a persistent causal effect of cultural similarity on migration flows, rather than with the opposite causality of persistence in migration flows.

In the last step of the analysis, we investigate another possible source of persistence in migration flows that may have caused the geography of dialects. Specifically, there may be deep regional differences that have persistently driven migration flows over the course of history and, thereby, also linguistic development. In particular, think of first-nature geographical features which have determined the economic prosperity of the regions over the very long run. Salient candidates are indicators of a region's suitability for agriculture and forestry, all of which were major sources of wealth before the Industrial Revolution. As argued by Combes *et al.* (in press), *soil* characteristics can be regarded as a major determinant of local labor demand in an agrarian society. Accordingly, geological indicators for the suitability of the soil for agriculture and forestry should provide a meaningful insight into the distribution of regional wealth before the heyday of industrialization. These soil

characteristics should then be related to ancient migration patterns. As regions with good soil tended to be economically prosperous, they were likely to attract mass migration waves, particularly from areas with bad soil characteristics. A similar point can be made for the *slope* of a region, which is also likely to have influenced agricultural productivity, hence regional prosperity, in former times. Slope may have had another effect on ancient migration patterns – transport routes probably avoided large differences in steepness or ruggedness.

If these very basic geological factors have affected migration waves over the very long run, they could also have influenced the spatial pattern of dialects in Germany. Specifically, the smaller the difference in soil quality and the larger the slope difference between two regions, the lower the probability that local populations interacted very often. This, in turn, may have resulted in less similar dialects between such regions. To the extent that these geological features still affect current regional migration, our estimations may be capturing a spurious correlation between dialect similarity and migration flows.

As argued in Section 4.2, the fixed effects specification of the gravity model should, in principle, take into account this potential problem. Consider a region with very favorable geographical features. The resulting pull effects on migration into that region, which have persistently occurred across time and may still occur today, should be captured in the estimation: The fixed effects should level all actual differences in economic prosperity between the origin and the destination, regardless of whether these differences have their origin in history or are the result of current developments. However, to complement this approach, we again create different subsamples of regions that limit the degree of heterogeneity of the respective source and destination areas. For pairs of regions with similar soil and slope characteristics, we may expect very long-run push and pull effects to matter relatively little. This may have led to few cross-regional contacts and therefore to little dialect assimilation over the very long run. In other words, if we find that dialect similarity

matters for current migration also for these homogeneous pairs of regions, then a long-run persistence of migration flows is unlikely to be reason. Such a finding would rather suggest that we actually capture a causal effect of cultural similarity on migration decisions.

To address this issue, we sort regions into those with "good" soil and those with "bad" soil. Good soil is suitable and imposes no limitations for agriculture, whereas bad soil imposes such limits because the soil is overly gravelly, stony, or lithic.[25] Using this classification scheme, we can create subsamples of regional pairs and separately study migration flows for cases where both the source and the destination area have good soil, where the source has bad but the destination has good soil, etc. A similar approach is adopted to distinguish between regions with different slope characteristics. Slope is measured as the difference between the maximum and minimum elevation in meters within a region. We can then classify "steep" (above average) and "flat" (below average) regions and create appropriate samples of regional pairs. The results of our gravity estimation for these samples of regional pairs are reported in Table 6a and 6b, respectively.

[Tables 6a and 6b here]

As can be seen, the results are qualitatively similar for all the considered samples. That is, even for those cases where source and destination area are relatively homogeneous in their geographical features, we find a positive and significant impact of dialect (cultural) similarity on current gross migration flows (see columns 1 and 2 of Tables 6a and 6b). Results also do not change when we additionally control for the similarity of the industry structure in the source and destination area (see Section 4.1), which is a sensible exercise

[25] We are deeply indebted to Gilles Duranton for providing the data for these indicators (see the Appendix and Combes *et al.* for a more detailed description). To use current indicators of soil quality we need to assume that soil characteristics have not changed during the past centuries, and there are good reasons to believe that this condition is met by our binary distinction between good and bad soil. We also tried a variety of other indicators related to the climate and soil of a region, but this did not crucially affect our empirical results.

since first-nature geographical features may also have influenced industry compositions and thereby have an indirect effect on current migration flows.

Summing up, the results from Table 6 corroborate that our estimation results are not capturing a spurious correlation, but reflect a causal effect of persistent cultural differences on current gross migration flows across German regions.

5. Conclusion

In this paper, we have evaluated detailed linguistic micro-data from the 19th century on the intra-national variation of phonological and grammatical attributes within the German language. We do so since language variation, i.e. dialects, is probably the best measurable indicator of cultural differences that one can come up with. In our empirical analysis we find an economically meaningful effect of historical dialect similarity on current regional migration flows. This finding implies that there are intangible cultural borders within a country that impede economic exchange across its regions. An increase of dialect similarity by one standard deviation (measured at the sample mean) increases gross migration flows between a pair of regions by about 6 percent in the benchmark.

These intangible regional borders in Germany are enormously persistent over time; we have described how they have been developed over centuries, and so they are likely to be there also tomorrow. Even on a low geographical level people seem to be unwilling to move to culturally unfamiliar environments. The average Bavarian will not easily move to Saxony, nor vice versa, unless he or she is compensated by considerably better economic prospects or job opportunities in the other region. The existence of cultural borders thus clearly limits mobility across local labor markets and, thus, the integration of the national labor market.

It is beyond the scope of this paper to discuss whether it is possible, or desirable, to downsize such borders. Policy initiatives in the European Union aiming for a preservation of

regional languages tend to suggest that there is currently no interest in cultural equalization, but rather that linguistic diversity is perceived as valuable for a society. It is thus a natural extension for future research to explore the welfare consequences of cultural differences at a low geographical level in greater detail.

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Table 1a: Descriptive Statistics of Gross Migration Flows, Average 2000–2006

	Mean of M_{rs}/L_r (per 100,000 inhabitants)	Mean of all positive M_{rs}/L_r (per 100,000 inhabitants)	Share of district pairs with $M_{rs}/L_r > 0$
German inhabitants, entire population	7.11	7.35	96.75%
German inhabitants, working-age population (18–65)	8.84	9.21	96.04%

Notes: Means are calculated across 192,282 observations for migration flows from every region r to s ($r \neq s$ and $r=s=439$). The number of positive observations is 186,025 (184,667) for the entire population (working-age population).

Table 1b: Descriptive Statistics of the Similarity and Distance Measures

	Obs.	Mean	Std. Dev.	Min	Max
Dialect Similarity	96,141	32.60	10.53	11	66
Dialect Similarity (Jaccard)	96,141	0.344	0.156	0.091	1
Dialect Similarity (Kulczynski)	96,141	0.494	0.160	0.167	1
Geographical Distance (in kilometers)	96,141	309.69	152.33	1.07	845.32
Travel Distance (in minutes)	96,141	263.33	113.44	8.80	683.31

Notes: Descriptive Statistics are provided for 96,141 pairs of regions r and s ($r \neq s$ and $r=s=439$). See footnote 9 for the definition of the linguistic similarity indices.

Table 2a: Baseline Results—FE-OLS Regressions (All Ages)

	(1) $\ln(M_{rs}/L_r)$ OLS	(2) $\ln(M_{rs}/L_r)$ OLS	(3) $\ln(M_{rs}/L_r)$ OLS	(4) $\ln(M_{rs}/L_r)$ OLS	(5) $\ln(M_{rs}/L_r)$ OLS	(6) (M_{rs}/L_r) Poisson	(7) $\ln(M_{rs}/L_r)$ Heckman	(8) $\ln(M_{rs}/L_r)$ OLS	(9) $\ln(M_{rs}/L_r)$ OLS
Dialect Similarity	2.209*** (0.031)	-	-	-	0.186*** (0.025)	0.118** (0.046)	0.204*** (0.008)	-	-
Dialect Similarity (Jaccard)	-	-	-	-	-	-	-	0.175*** (0.019)	-
Dialect Similarity (Kulczynski)	-	-	-	-	-	-	-	-	0.186*** (0.025)
Geographical Distance	-	-1.493*** (0.012)	-	-1.263*** (0.036)	-1.262*** (0.035)	-1.471*** (0.028)	-1.263*** (0.013)	-1.257*** (0.035)	-1.262*** (0.035)
Travel Distance	-	-	-1.773*** (0.014)	-0.283*** (0.029)	-0.200*** (0.046)	-0.460*** (0.037)	-0.224*** (0.016)	-0.181*** (0.045)	-0.200*** (0.046)
Mills Lambda	-	-	-	-	-	-	0.533*** (0.018)	-	-
R^2	0.558	0.744	0.731	0.744	0.745	-	-	0.745	0.745
Pseudo R^2	-	-	-	-	-	0.196	-	-	-
Cens. Obs.	-	-	-	-	-	-	6,257	-	-
N	186,025	186,025	186,025	186,025	186,025	192,282	192,282	186,025	186,025

Notes: This table reports estimation results with fixed effects for both origin region r and target region s. In Columns (1)–(7) language similarity is measured by a count index, while Column (8) applies Jaccard's similarity index and Column (9) applies Kulczynski's similarity index. Column (6) reports a Poisson regression of geographical distance and language similarity on the number of German migrants from region r to s, M_{rs}, divided by the origin region's number of all inhabitants L_r. Column (7) reports the results from a Heckman selection model. In this specification, a first-stage selection considers the probability of a zero flow of migrants between region r and s. Zero flows drop out except in specifications (6) and (7). Geographical distance, travel time, and dialect similarity are in logs in all specifications. Robust standard errors are reported in parentheses.
**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

Table 2b: Baseline Results—FE-OLS Regressions (Working-Age Population)

	(1) $\ln(M_{rs}/L_r)$ OLS	(2) $\ln(M_{rs}/L_r)$ OLS	(3) $\ln(M_{rs}/L_r)$ OLS	(4) $\ln(M_{rs}/L_r)$ OLS	(5) $\ln(M_{rs}/L_r)$ OLS	(6) (M_{rs}/L_r) Poisson	(7) $\ln(M_{rs}/L_r)$ Heckman	(8) $\ln(M_{rs}/L_r)$ OLS	(9) $\ln(M_{rs}/L_r)$ OLS
Dialect Similarity	2.198*** (0.030)	-	-	-	0.191*** (0.025)	0.156*** (0.039)	0.217*** (0.008)	-	-
Dialect Similarity (Jaccard)	-	-	-	-	-	-	-	0.179*** (0 .019)	-
Dialect Similarity (Kulczynski)	-	-	-	-	-	-	-	-	0.191*** (0.025)
Geographical Distance	-	-1.481*** (0.012)	-	-1.250*** (0.037)	-1.249*** (0.036)	-1.441*** (0.027)	-1.251*** (0.013)	-1.244*** (0)	-1.250*** (0.036)
Travel Distance	-	-	-1.760*** (0.014)	-0.284*** (0.045)	-0.197*** (0.047)	-0.464*** (0.036))	-0.232*** (0.016)	-0.179*** (0.046)	-0.198*** (0.047)
Mills Lambda	-	-	-	-	-	-	0.655*** (0.016)	-	-
R^2	0.573	0.758	0.745	0.758	0.759	-	-	0.759	0.759
Pseudo R^2	-	-	-	-	-	0.200	-	-	-
Cens. Obs.	-	-	-	-	-	-	7,615	-	-
N	184,667	184,667	184,667	184,667	184,667	192,282	192,282	184,667	184,667

Notes: This table reports estimation results with fixed effects for both origin region r and target region s. In Columns (1)–(7) language similarity is measured by a count index, while Column (8) applies Jaccard's similarity index and Column (9) applies Kulczynski's similarity index. Column (6) reports a Poisson regression of geographical distance and language similarity on the number of German working-age migrants from region r to s, M_{rs}, divided by the origin region's number of working-age inhabitants L_r. Column (7) reports the results from a Heckman selection model. In this specification, a first-stage selection considers the probability of a zero flow of migrants between region r and s. Zero flows drop out except in specifications (6) and (7). Geographical distance, travel time, and dialect similarity are in logs in all specifications. Robust standard errors are reported in parentheses.
**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

Table 3: Subsamples: Urban-Periphery (Entire Population)

	(1)	(2)	(3)	(4)
	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$
	UU	PP	*UP*	*PU*
Dialect Similarity	0.180***	0.065*	0.257***	0.208***
	(0.040)	(0.034)	(0.040)	(0.037)
Geographical Distance	-1.632***	-1.211***	-1.037***	-1.049***
	(0.059)	(0.054)	(0.061)	(0.060)
Travel Distance	0.340***	-0.486***	-0.351***	-0.362***
	(0.073)	(0.068)	(0.081)	(0.074)
R^2	0.834	0.678	0.710	0.759
N	31,174	64,308	45,176	45,367

Notes: This table reports OLS results with fixed effects for both origin region r and target region s. In column (1) we consider migration flows where the origin and destination are both "urban" regions. In column (2) we consider migration flows where the origin and destination are both "peripheral" regions. In column (3) we consider urban-to-peripheral, and in column (4) we consider peripheral-to-urban migration flows. "Urban" regions are defined as regional types 1–5 in the classification system of the German Federal Board for Regional Planning (BBR). "Peripheral" areas are defined as regional types 6–9.Robust standard errors are reported in parentheses.
**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

Table 4: Region-Pair-Specific Differences (Entire Population)

	(1)	(2)	(3)
	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$
Dialect Similarity	0.184*** (0.025)	0.132*** (0.025)	0.128*** (0.025)
Geographical Distance	-1.265*** (0.035)	-1.245*** (0.035)	-1.248*** (0.035)
Travel Distance	-0.201*** (0.046)	0.161*** (0.045)	-0.162*** (0.045)
Religious Borders	0.018 (0.011)	-	0.025** (0.010)
Historic Borders	-	-0.300*** (0.018)	-0.301*** (0.018)
R^2	0.745	0.749	0.750
N	186,025	186,025	186,025

Notes: This table reports OLS results with fixed effects for both origin region r and target region s. In columns (1) and (3) we control for differences in religious denominations in 1890 by including a dummy variable that equals unity if the majority of the population in the source region had a different religion than those in the destination region. In columns (2) and (3) we include a dummy that equals unity if the current migration flow extends across a historical administrative border between 38 member states and 4 independent cities that were part of the German Confederation at the time of its foundation in 1815. Robust standard errors are reported in parentheses.
**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

Table 5: Subsample: East-West (Entire Population)

	(1)	(2)	(3)
	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$	$\ln(M_{rs}/L_r)$
	East-West	*West-East*	*East-West and West-East*
Dialect Similarity	0.213***	0.160***	0.187***
	(0.036)	(0.033)	(0.024)
Geographical Distance	-1.580***	-1.443***	-1.513***
	(0.067)	(0.073)	(0.050)
Travel Distance	-0.507***	-0.508***	-0.507***
	(0.082)	(0.073)	(0.056)
R^2	0.708	0.534	0.633
N	35,581	34,023	69,604

Notes: This table reports OLS results with fixed effects for both origin region r and target region s. In column (1) we consider migration flows where the origin is located in former East Germany and the destination is located in former West Germany. In column (2) we consider migration flows where the origin is located in former West Germany and the destination is located in former East Germany. In column (3) we pool East-to-West and West-to-East migration flows. Robust standard errors are reported in parentheses.
**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

Table 6a: Subsample: Soil Quality (Entire Population)

	(1)	(2)	(3)	(4)
	$\ln(M_{rs}/L_r)$ *Good-Good*	$\ln(M_{rs}/L_r)$ Bad-Bad	$\ln(M_{rs}/L_r)$ Good-Bad	$\ln(M_{rs}/L_r)$ Bad-Good
Dialect Similarity	0.179***	0.099*	0.223***	0.194***
	(0.032)	(0.056)	(0.028)	(0.052)
Geographical Distance	-1.431***	-1.127***	-1.123***	-1.195***
	(0.048)	(0.071)	(0.056)	(0.070)
Travel Distance	0.004	-0.510***	-0.333***	-0.259***
	(0.063)	(0.090)	(0.068)	(0.091)
R^2	0.748	0.760	0.751	0.727
N	71,836	26,529	43,803	43,857

Notes: This table reports OLS results with fixed effects for both origin region r and target region s. In column (1) we consider migration flows where the origin and destination both have good soil quality. In column (2) we consider migration flows where the origin and destination both have bad soil quality. In column (3) we consider migration flows from regions with good to regions with bad soil quality, and in column (4) we consider migration flows from regions with bad to regions with good soil quality. "Good soil quality" refers to regions with no limitations to agricultural use according to the European Soil Database (esdb) compiled by the European Soil Data Centre. "Bad soil quality" refers to regions with one ore more limitations to agricultural use. Robust standard errors are reported in parentheses.
**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

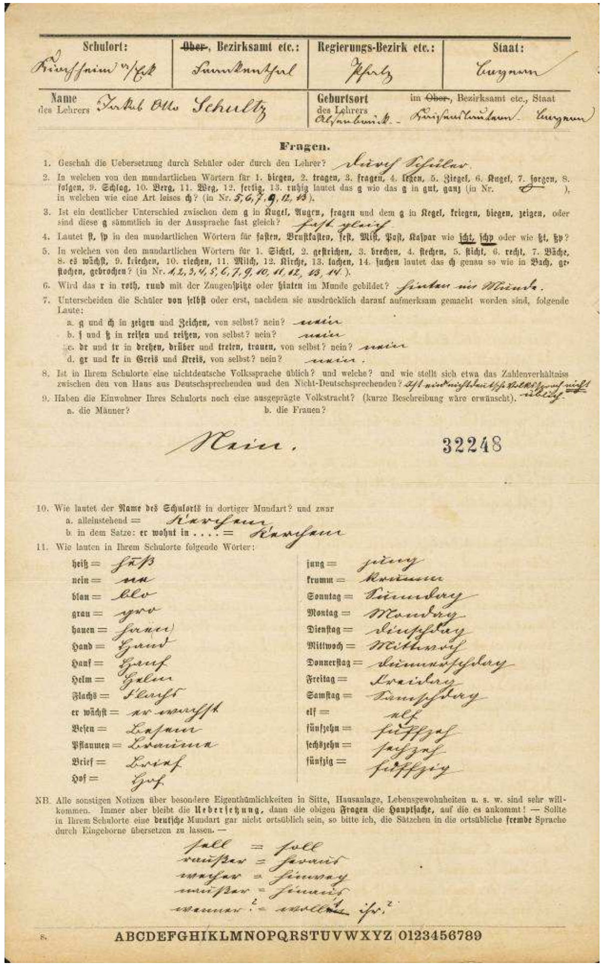
Table 6b: Subsample: Slope (Entire Population)

	(1)	(2)	(3)	(4)
	$\ln(M_{rs}/L_r)$ *Steep-Steep*	$\ln(M_{rs}/L_r)$ *Flat-Flat*	$\ln(M_{rs}/L_r)$ *Steep-Flat*	$\ln(M_{rs}/L_r)$ *Flat-Steep*
Dialect Similarity	0.056 (0.036)	0.246*** (0.050)	0.298*** (0.041)	0.304*** (0.044)
Geographical Distance	-1.359*** (0.042)	-1.335*** (0.073)	-1.110*** (0.083)	-1.094*** (0.072)
Travel Distance	-0.281*** (0.057)	-0.286*** (0.096)	-0.284*** (0.101)	-0.266*** (0.087)
R^2	0.734	0.832	0.750	0.717
N	88,628	18,236	39,250	39,911

Notes: This table reports OLS results with fixed effects for both origin region r and target region s. In column (1) we consider migration flows where the origin and destination both are steep regions. In column (2) we consider migration flows where the origin and destination both are flat regions. In column (3) we consider migration flows from regions with steep slope to regions with good slope, and in column (4) we consider migration flows from regions with flat slope to regions with good slope. For each region, slope is measured as the difference between the maximum and minimum elevation in meters. We can then classify a region ith above-average slope as "steep", and with below-average slope as "flat". Robust standard errors are reported in parentheses.

**** statistically significant at the 1% level; ** statistically significant at the 5% level; * statistically significant at the 10% level.*

Figure 1a: Exemplary Questionnaire of the Language Survey



Schulort:	~~Ober~~, Bezirksamt etc.:	Regierungs-Bezirk etc.:	Staat:

Name des Lehrers Schultz

Geburtsort des Lehrers im ~~Ober~~, Bezirksamt etc., Staat

Fragen.

1. Geschah die Uebersetzung durch Schüler oder durch den Lehrer? Durch Schüler.
2. In welchen von den mundartlichen Wörtern für 1. biegen, 2. tragen, 3. fragen, 4. legen, 5. Ziegel, 6. Kugel, 7. sorgen, 8. folgen, 9. Schlag, 10. Berg, 11. Weg, 12. fertig, 13. ruhig lautet das g wie das g in gut, ganz (in Nr. —), in welchen wie eine Art leises ch? (in Nr. 5, 6, 7, 9, 12, 13).
3. Ist ein deutlicher Unterschied zwischen dem g in Kugel, Augen, fragen und dem g in Kegel, kriegen, biegen, zeigen, oder sind diese g sämmtlich in der Aussprache fast gleich? fast gleich
4. Lautet st, sp in den mundartlichen Wörtern für fasten, Brustkasten, fest, Mist, Post, Kaspar wie scht, schp oder wie st, sp?
5. In welchen von den mundartlichen Wörtern für 1. Sichel, 2. gestrichen, 3. brechen, 4. stechen, 5. Licht, 6. recht, 7. Bäche, 8. es wächst, 9. kriechen, 10. riechen, 11. Milch, 12. Kirche, 13. lachen, 14. suchen lautet das ch genau so wie in Bach, gestochen, gebrochen? (in Nr. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14).
6. Wird das r in roth, rund mit der Zungenspitze oder hinten im Munde gebildet? hinten im Munde.
7. Unterscheiden die Schüler von selbst oder erst, nachdem sie ausdrücklich darauf aufmerksam gemacht worden sind, folgende Laute:
   a. g und ch in zeigen und Zeichen, von selbst? nein? nein
   b. s und ß in reisen und reißen, von selbst? nein? nein
   c. dr und tr in drehen, drüber und treten, trauen, von selbst? nein? nein
   d. gr und kr in Greis und Kreis, von selbst? nein? nein.
8. Ist in Ihrem Schulorte eine nichtdeutsche Volkssprache üblich? und welche? und wie stellt sich etwa das Zahlenverhältniss zwischen den von Haus aus Deutschsprechenden und den Nicht-Deutschsprechenden? [illegible] nicht üblich.
9. Haben die Einwohner Ihres Schulorts noch eine ausgeprägte Volkstracht? (kurze Beschreibung wäre erwünscht).
   a. die Männer? b. die Frauen?

Nein.

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10. Wie lautet der Name des Schulorts in dortiger Mundart? und zwar
    a. alleinstehend = Karchem
    b. in dem Satze: er wohnt in .... = Karchem
11. Wie lauten in Ihrem Schulorte folgende Wörter:

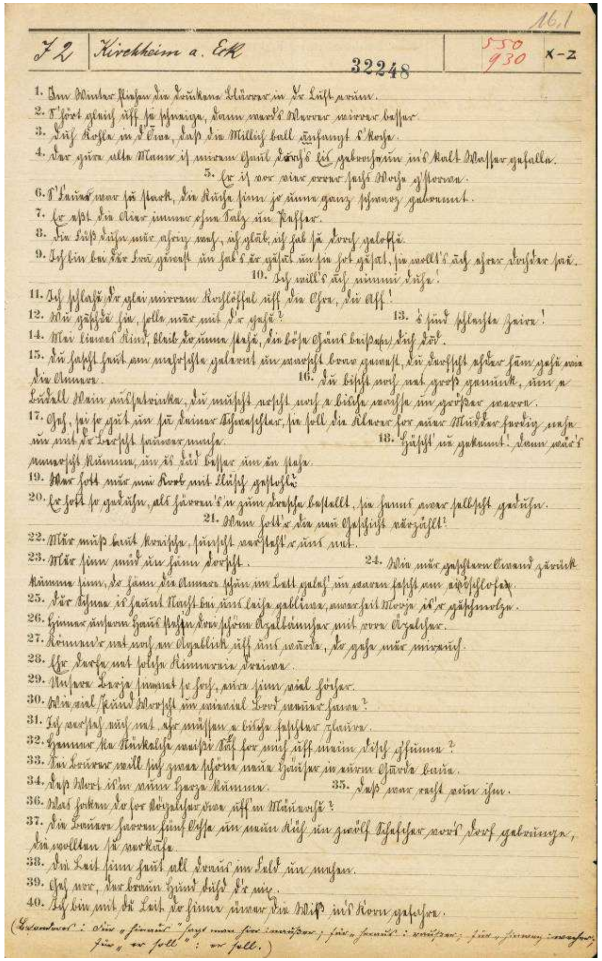
heiß =	häß	jung =	jung
nein =	na	krumm =	krumm
blau =	blo	Sonntag =	Sunndag
grau =	gro	Montag =	Mondag
hauen =	haue	Dienstag =	Dienschdag
Hand =	Hand	Mittwoch =	Mittwoch
Hanf =	Hanf	Donnerstag =	Dunnerschdag
Helm =	Helm	Freitag =	Fraidag
Flachs =	Flachs	Samstag =	Samschdag
er wächst =	er wachst	elf =	elf
Besen =	Besem	fünfzehn =	fuffzeh
Pflaumen =	Brauma	sechzehn =	sechzeh
Brief =	Brief	fünfzig =	fuffzig
Hof =	Hof		

NB. Alle sonstigen Notizen über besondere Eigenthümlichkeiten in Sitte, Hausanlage, Lebensgewohnheiten u. s. w. sind sehr willkommen. Immer aber bleibt die Uebersetzung, dann die obigen Fragen die Hauptsache, auf die es ankommt! — Sollte in Ihrem Schulorte eine deutsche Mundart gar nicht ortsüblich sein, so bitte ich, die Sätzchen in die ortsübliche fremde Sprache durch Eingeborne übersetzen zu lassen. —

fall = foll

[illegible]

8. ABCDEFGHIKLMNOPQRSTUVWXYZ 0123456789



72	Kirchheim a. Eck 32248		550 930	X-Z

[illegible]

Figure 1b: Exemplary Hand-Drawn Map by Georg Wenker

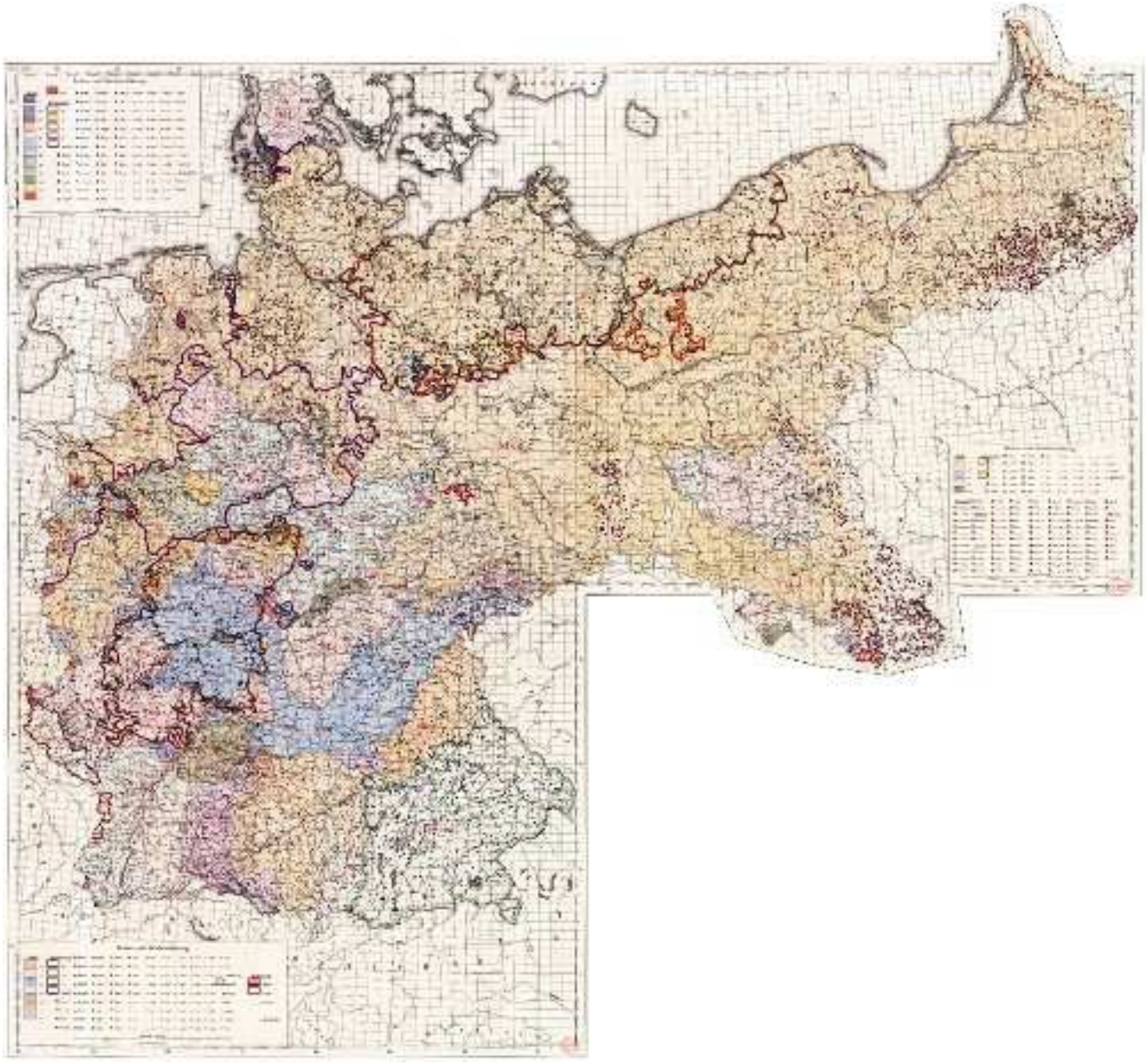
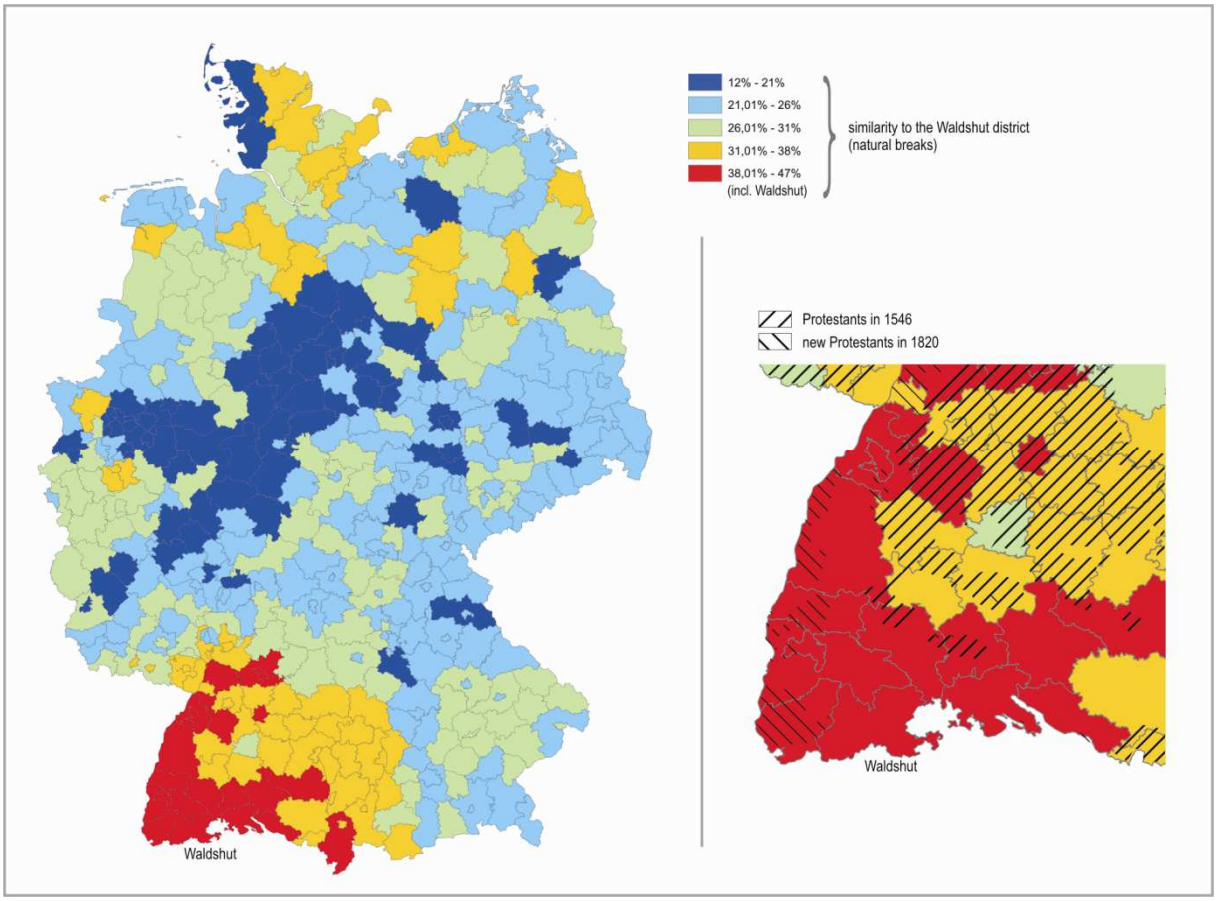
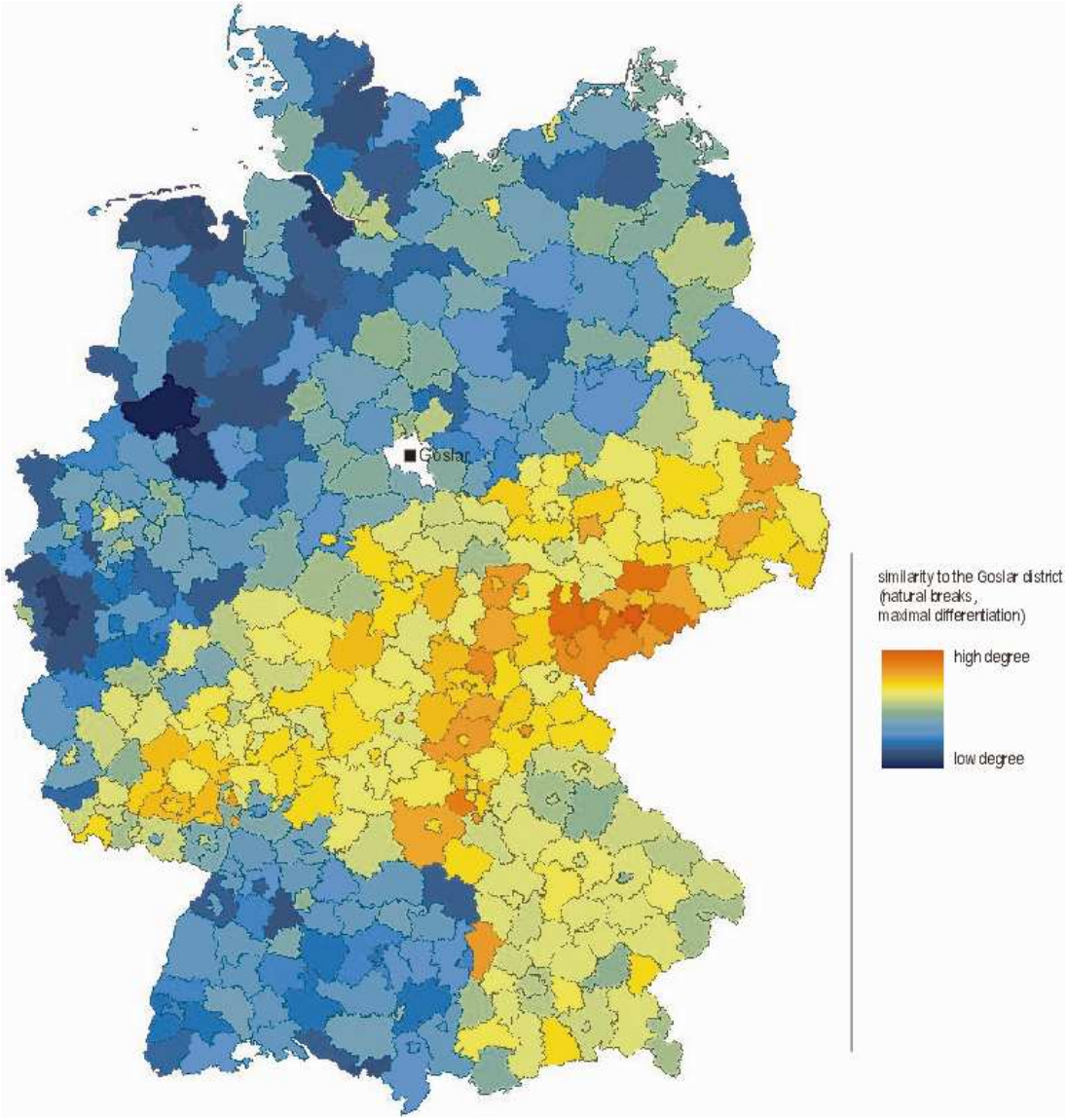


Figure 2: Distribution of Religious Denomination in Southern Germany



Notes: Similarity of all districts to the reference point Waldshut (marked). Red indicates highest familiarity and yellow indicates higher familiarity, while the green and blue indicate less familiarity. Data on religious denomination are taken from Steger et al. (1989).

Figure 3: The Language Enclave Goslar



<u>Notes</u>: Similarity of all districts to the reference point Goslar (white spot). Red indicates highest familiarity and warmer tints (yellow and green) indicate higher familiarity, while the bluish tints indicate less familiarity.

Table A1: Extended Data Description

Variable	Description and Source
Geographical Distance	The geographical distance between two districts is calculated as Euclidean distance between each pair of districts' centroids.
Historical Border Dummy	Historic borders refer to 38 member states and 4 independent cities that were part of the German Confederation at its foundation in 1815. Data are taken from a map in *Putzger – Historischer Weltatlas*, 89th edition, 1965. The dummy equals unity if a region pair does not belong to the same historic state.
Religious border dummy (1890)	The districts' historic shares of Catholics and Protestants in 1890 are calculated from a map in *Meyers Konversations Lexikon*, 4th edition, 1885–1892. The dummy equals unity if a region pair has different religious affiliations, i.e. an above average share of Catholics and Protestants respectively.
Soil	Soil concerns the main limitation to agricultural exploitation. The variable distinguishes between regions that have no limitation to agriculture and regions that have limitations due to less suitable soil characteristics. 1 no limitation to agricultural use 2 gravelly (over 35% gravels diameter < 7.5 cm) 3 stony (presence of stones diameter > 7.5 cm, impracticable mechanization) 4 lithic (coherent and hard rock within 50 cm) 5 concretionary (over 35% concretions diameter < 7.5 cm near the surface) 6 saline (electric conductivity > 4 mS.cm-1 within 100 cm) 7 others For our purpose, we collapse all limitations and create a binary variable that distinguishes regions that are more or less suitable for agriculture. The data stem from the European Soil Database (esdb) and are compiled by the European Soil Data Centre.
Slope	Slope is measured as the difference between the maximum and minimum elevations in meters. Flat regions are regions with a below average slope while steep regions are characterized by an above average slope.

Variable	**Description and Source (continued)**
Travel Distance	The travel distance is calculated in car minutes from one district's capital to the other.
Urban	This variable is based on a standard classification of German districts (*siedlungsstrukturelle Kreistypen*) according to their density and their spatial status (cf. Federal Office for Building and Regional Planning 2003). For our purpose, *urban areas* are districts characterized by a minimum city size of 100,000 inhabitants or a population density larger than 150 inhabitants per km². All other regions are classified as *peripheral areas.*

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