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The impact of language borders on the spatial decay of agglomeration and competition spillovers

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Abstract

There is now strong evidence that "soft" institutions are interrelated with the working of the economy. For example, in a geographical setting there is evidence that language borders affect interpersonal relationships, but there is no equivalent evidence regarding the effects of language borders on agglomeration or competition spillovers. This paper examines whether language affects the geographical extension of agglomeration and competition spillovers by observing the geography of employment patterns in a linguistically discontinuous setting. Our findings, for the first time, provide empirical evidence that language borders shape the distance decay of competition spillovers, independent of governance, and institutional issues.

KEYWORDS

agglomeration, competition, economic geography, language, spatial decay

JEL CLASSIFICATION

O18; R11; R12; Z10

1 | INTRODUCTION

A growing body of literature highlights that language, and in particular the presence of a language border, affects economic outcomes, institutions, and consumer preferences. Linguistic borders have been demonstrated to have an impact on economic behavior and might therefore lead to regional differentiation. At the same time, the existing literature on agglomeration spillovers is characterized by a largely unresolved debate regarding their effects in shaping, or being shaped by, economic geography. Moreover, there is no previous evidence on the role played by language in shaping these agglomeration spillover effects.

In this context, the aim of this study is to contribute to the existing literature by examining whether there is any detailed empirical evidence indicating that language borders influence the geographical extension of different types of agglomeration spillovers within the same country.

To capture any such spillover effects, we examine empirically how employment patterns in one locality are related to those in neighboring localities, and we analyze whether these relationships differ across language borders in a manner which is distinct from simply different locality administrative borders. In particular, we examine whether employment patterns differ across linguistic borders, after controlling for geographical, economic, and topographical features. Our tracking of employment patterns is not in any way meant to be a test or an advocating of any particular model of regional growth or spillovers, as this topic has been a source of much debate over the last three decades. Rather, the methodology we employ is simply the most direct method of identifying whether the geography of agglomeration spillovers is affected by linguistic differences, while making no claims as to the mechanisms underlying any such linkages or spillovers. The analysis focuses on Switzerland, which represents an appropriate case-study for examining these types of differences, because, as underlined by Eugster et al. (2011, 2017) and Eugster and Parchet (2019), these clearly defined and sharp language borders are not associated with changes in the geographical or political setting. Neither the nature nor the quality of the institutional and governance set-up varies according to the local linguistic context, so any observed effects cannot be attributed to either national or regional governance issues.

Our empirical approach demonstrates that language borders do indeed affect the spatial decay of some spillovers. More specifically, competition externalities are enhanced when firms are located close to municipalities belonging to a different linguistic area. To the best of our knowledge, this is the first time that the effects of language borders on agglomeration or competition spillovers have ever been observed empirically. More generally, our empirical results support those scholars arguing that culture shapes, and is shaped by, economic geography.

The rest of the paper is structured as follows. In Section 2 we present a review of the relevant literature. In Section 3 the econometric model is described. The database is presented in Section 4, followed by the empirical results in Sections 5 and 6 concludes.

2 | LITERATURE REVIEW

A growing body of literature highlights that the presence of a language border affects economic outcomes, consumer preferences, and institutions. The literature on the "economics of language" emerged following the early contribution of Marschak (1965), who combines for the first time economic concepts with linguistic analysis. More specifically, different studies explore the effects of language on economic growth, institutional quality, trade, migration, consumer choice, or labor income (Adserà & Pytliková, 2015; Barry & Miller, 1995; Bleakley & Chin, 2004; Chen, 2013; Grenier, 1984; Hočevar, 1975; Pool, 1972). Hence, a linguistic border may impact on economic behavior and economic geography processes in different ways, which in turn may lead to regional differentiation. In particular, different studies show that different linguistic areas are associated with different voting patterns (Goldberg, 2017), different fiscal preferences (Eugster & Parchet, 2019), different demands for redistributive social insurance (Eugster et al., 2011), different behavior in international trade (Egger & Lassmann, 2015), different preferences on long-term care (Gentili, Masiero, & Mazzonna, 2017), or different attitudes towards work (Eugster et al., 2017).

Moreover, language borders are also often, but not always, associated with international borders, and we know from international economics that international borders significantly affect all types of economic behavior. Moreover, the literature on border effects (Brakman, Garretsen, Van Marrewijk, & Oumer, 2012) also highlights that the presence of different types of borders may shape economic outcomes, consumer behavior, and the spatial extension of spillovers, and this is also the case for international borders within integrated economic areas (Brakman et al., 2012). However, using international borders to disentangle the linguistic impacts of borders on economic behavior from the administrative and legal impacts of borders is complex and in many cases is almost impossible. Our research here allows us to remove the effects of administrative borders and to focus specifically on the effects of language on economic behavior.

At the same time, the existing literature on agglomeration spillovers is characterized by a largely unresolved debate regarding the effects of these spillovers in shaping, or being shaped by, economic geography. Indeed, recent meta-analyses (Beaudry & Schiffauerova, 2009; De Groot, Poot, & Smit, 2015; Melo, Graham, & Noland, 2009) highlight that the results are still rather unclear and inconclusive in determining whether localization or urbanization economies generate different outcomes in different contexts, although we do know that any observed spillover effects attenuate with distance (Fotheringham & Pitts, 1995; Rice, Venables, & Patacchini, 2006; Rosenthal & Strange, 2003; Saito & Wu, 2016; Smit & De Groot, 2013). As such, there is no general consensus on the spatial extension of these spillovers, and no previous evidence on the role played by language in shaping these effects. In fact, traditional analyses generally do not include language as a variable, thereby disregarding whether various linguistic environments heterogeneously affect the geographical extension of agglomeration or competition spillovers. In particular, the fact that different spatial units (e.g., municipalities, regions) may or may not be separated by a language border is typically not considered, neglecting whether and how this may impact on the externalities arising from the concentration of firms.

To better understand how language may impact on the different costs and benefits related to the regional concentration of firms, our research aims at verifying whether the existence of linguistic differences across Swiss municipalities has an impact on the geographical extension of the benefits that firms might gain from being located near to other business activities. The underlying research question of this study is the following: do linguistic discontinuities impact on the spatial decay of agglomeration or competition spillovers?

As highlighted by Hofstede (2001), in the Swiss context the various linguistic regions are clearly associated with different cultures, with wide cultural differences between the language areas. In fact, language also represents a dimension of culture (Tabellini, 2008). Hence, from a broader perspective, this paper also relates to the literature on the effects of culture on economic outcomes (Alesina & Giuliano, 2015; Fernandez, 2011; Guiso, Sapienza, & Zingales, 2006), highlighting how culture and the economy are interrelated, via the influence of culture on shaping the "soft" or informal institutional underpinnings of the economy. Following these ideas, for economic geographers there are broadly two lines of argumentation deployed in the literature. First, some economic geographers (Pike, Rodríguez-Pose, & Tomaney, 2011; Storper, 2013) consider that culture and informal or soft institutions heavily shape and are shaped by economic geography, at least as much as by hard institutions. These arguments tend to focus on the nature and the quality of the institutional settings and in particular on the role played by the institutional set-up in facilitating participation and engagement by different constituencies in the economy. Second, there are other economic geography arguments and evidence that cultural markers, defined primarily in terms of ethnic diversity (Bakens, Mulder, & Nijkamp, 2013; Nijkamp, Poot, & Bakens, 2015; Tselios, Noback, McCann, & van Dijk, 2015; Tselios, Noback, Van Dijk, & McCann, 2015), influence interpersonal relationships, and in a spatial setting these interpersonal relationships in turn influence local economic outcomes. Yet, in general the links between economic geography and culture still remain rather vague and contested. There are some scholars who argue that culture cannot be modeled as such, particularly as it pertains to the former argument; while other scholars are skeptical of the role played by culture in shaping economic geography, unless this can be demonstrated analytically in a formal model setting, something which has never previously been done.

In this paper we do not engage in these types of conceptual, theoretical or methodological debates, and our purpose is not to understand the mechanism through which culture affects the geography of agglomeration spillovers. Rather, our aim is simply to examine whether there is any detailed empirical evidence that the presence of a language border affects the spatial decay of agglomeration or competition spillovers. To capture any such spillover effects, we examine how local employment patterns are related to linguistic differences between localities.

In general, the absence of previous studies on the relationship between language and agglomeration spillovers implies that there is no clear guideline or model allowing us to form a priori hypotheses. However, there are some heuristics that can give us some ideas on how language and agglomeration and competition spillovers might be related. Previous studies on the economic effects of language diversity, and more generally of cultural diversity, indicate that the direction of the impact could be either positive or negative. Cultural diversity can increase the economic performance because of skill complementarities (Lazear, 1999), learning processes (Berliant & Fujita, 2008), or augmented social capital (Putnam, 2007). On the other hand, the presence of a language border may also create communication barriers or social conflicts that generate excessive transaction costs (Kochan et al., 2003). Given that both forces take place at the same time, it is difficult to form ex-ante hypotheses on the effects of a language border on economic outcomes. However, the nature of the various types of agglomeration and competition mechanisms may help to form some expectations. Specifically, specialization externalities tend to imply that learning forces are concentrated within "industrial communities," suggesting that linguistic differences might act as an obstacle to wider spread effects. Alternatively, Jacobs (1969) indicates that some learning mechanisms are facilitated in diverse environment, implying that the coexistence of different languages might boost agglomeration spillovers across various spatial scales. In general, diversified cities and regions tend to exhibit wide ranging linkages (Caragliu, de Dominicis, & De Groot, 2016; McCann & Acs, 2011). Again, while there are grounds for believing that linguistic differences may shape the patterns of spillovers, the net result is ambiguous and therefore it is difficult to suggest an a priori hypothesis. We therefore set out to examine whether there is any detailed empirical evidence indicating that language borders influence the geographical extension of different types of agglomeration spillovers within the same country.

To investigate these issues, Switzerland represents a very interesting case because it does not suffer from problems of poor institutions, it has strong and homogeneous general economic conditions (Nunziata & Rocco, 2016) and it consists of four language regions: German, French, Italian, and Romansh.[1] We know that language does not always coincide with culture, in that there might be situations in which the same culture is shared among groups of people with different languages, or circumstances in which different cultures coexist within the same linguistic area. Moreover, in Switzerland people generally speak more than one national language[2] and might therefore be able to communicate with people from another linguistic region. Nevertheless, even though language borders do not stop communication between the different language areas in Switzerland, Eugster et al. (2017) show how the language border between Swiss linguistic areas is historically determined, stable over time and sharp[3] with clear cultural gaps, because native languages are the medium through which attitudes, norms, beliefs, and values are transmitted from one generation to the next.

Moreover, to isolate language differences, we follow Eugster et al. (2011, 2017) and Eugster and Parchet (2019) by considering a language border within the same canton (state), such that the language border does not coincide with the cantonal border and where demographic, geographic, or institutional characteristics are identical. More specifically, the French-German language border in Switzerland crosses three bilingual cantons:[4] Berne, Fribourg, and Valais and we consider only firms directly located at the language border, where it is reasonable to assume that at this border there are no additional factors other than language changing in such a discontinuous way. Hence, the language border in the three bilingual cantons represents an empirical design allowing us to properly identify the impact of a linguistic discontinuity on the geography of agglomeration spillovers. Figure 1 highlights the borders of the three bilingual cantons as well as the municipalities within these cantons located at <15-min road travel time

[1]These are the four official languages in Switzerland. German is spoken by 63.7% of the Swiss population, French by 20.4%, Italian by 6.5%, and Romansh by 0.5%.

[2]According to Werlen (2008), about 73% of the inhabitants of the French speaking areas of Switzerland speak also another national language. This value is equal to 85% for the inhabitants of the German speaking parts and 92% for those of the Italian speaking regions.

[3]Eugster et al. (2017) indicate that at the language border between the French and the German speaking regions of Switzerland, the number of inhabitants whose mother tongue is French drops from >80% to <20% within 5 kilometers, and vice versa for native German speakers.

[4]Eugster and Parchet (2019) indicate that the language border in these cantons is even sharper, with the percentage of native French (German) speakers jumping from 85% (9%) to 5% (90%) when crossing it.

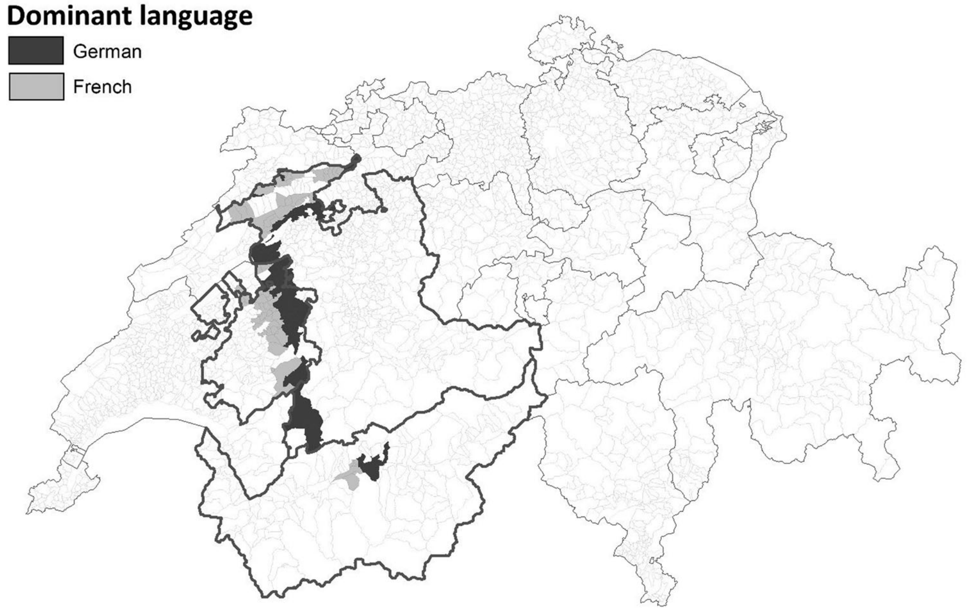

FIGURE 1 Dominant national language in the Swiss municipalities located at the French-German language border in the three bilingual cantons (Bern, Fribourg, and Valais), 2000. *Source*: Federal Population Census (2000) of the Swiss Federal Statistic Office

from the French-German language border, distinguished by their dominant language, French (in light gray) and German (in dark gray).

3 | METHODOLOGY

In our analysis, the aim is to examine whether employment patterns and distributions observed across different distances differ according to linguistic borders they traverse. Yet, our task is not simply a matter of adding a linguistic variable to existing analytical frameworks. Rather, our aim is to examine empirically whether linguistic differences shape the spatial distance-decay properties of agglomeration and competition spillovers. Following Van Oort et al. (2012) and De Groot et al. (2015), it is important that the empirical methodology we apply is able to account for the possibility of hierarchies in the data. Therefore, we analyze a cross-classified multilevel model in which firms are nested into both municipalities[5] and sectors. This implies that the model accounts for possible correlation within the same sector and within the same municipality. Hence, the model that we estimate has the form represented in the following equation:

$$y_{fmst} = \beta_0 + \sum_{k=1}^{K}\beta_{k(tv)}(x_{kfmst} - \bar{x}_{kfms}) + \sum_{k=1}^{K}\beta_{k(ti)}\bar{x}_{kfms} + \sum_{h=1}^{H}\gamma_h z_{hmt} + \sum_{i=1}^{I}\delta_i AI_{imst} + \sum_{r=1}^{R}\sum_{i=1}^{I}\theta_{ri(sl)} \sum_{\substack{n\neq m \\ \forall\, n\in r \\ \forall\, lang_n = lang_m}} w_n AI_{inst}$$

$$+ \sum_{r=1}^{R}\sum_{i=1}^{I}\theta_{ri(dl)} \sum_{\substack{n\neq m \\ \forall\, n\in r \\ \forall\, lang_n \neq lang_m}} w_n AI_{inst} + \xi\, D_{year} + \lambda\, D_{canton} + \mu_m + \mu_s + \varepsilon_{fmst}, \qquad (1)$$

[5]As explained in the next section, this analysis considers distance in terms of road travel time. Hence, regardless of the type of spatial units considered, the analysis considers those areas that are located within the specific travel time distance. Moreover, as highlighted in Briant et al. (2010), the size and shape of spatial units do not represent a major problem when compared with other specification problems.

where y_{fmst} is the performance of firm f, located in municipality m, operating in sector s in time t. As explained in the next section, we use as dependent variable the establishment-level employment growth. Additionally, $(x_{kfmst} - \bar{x}_{kfms})$ is the time-varying component of the kth firm-level variable, whereas $\bar{x}_{kfms}$ is its time-invariant component.[6] z_{hmt} is the hth municipal characteristics, K and H are the number of firm-level regressors and municipal regressors, respectively. Moreover, AI_{imst} is the ith agglomeration index, with I being the total number of agglomeration indices. $\theta_{ri(sl)}$ and $\theta_{ri(dl)}$ allow us to measure the geographical extension of agglomeration spillovers in municipalities with the same language and in those with a different language, respectively. As explained in the next section, we follow Rosenthal and Strange (2003) and we build R concentric rings at different distances from municipality m and for each type of agglomeration economies i we compute its spatial lag, by weight averaging the indices of the municipalities n intersected by ring r, where w_n represents the weight of municipality n. To analyze whether the existence of language borders has an impact on the spatial decay of agglomeration spillovers, we compute two different spatial lags for agglomeration economies: one for municipalities n intersected by ring r that share the same language of municipality m and one for those that do not share the same language. Finally, D_{year} is a dummy variable capturing year fixed effects, D_{canton} is a variable capturing cantonal fixed effects, $\mu_m \sim N(0, \sigma_m^2)$, $\mu_s \sim N(0, \sigma_s^2)$, and $\varepsilon_{fmst} \sim N(0, \sigma_f^2)$ are error terms at the municipal, sectoral and individual levels, respectively.

4 | DATA AND VARIABLES

This study analyses a large balanced panel data set constructed from the official Swiss structural business statistic (STATENT), offered by the Swiss Federal Statistical Office (FSO) and covering the period 2011–2013. This database provides basic information on all establishments in Switzerland, with about 500,000 observations annually. As explained above, to accurately identify and isolate the effect of the presence of a language border on the geography of agglomeration and competition spillovers we only consider firms directly located at the language border in the three Swiss bilingual cantons. More specifically, we only consider firms located in municipalities in the cantons of Berne, Fribourg, and Valais and located at no more than 15 min from the French-German language border (road travel time distance). Moreover, we only consider observations present in all the 3 years and located in municipalities with at least three establishments per year.[7] This database has been combined with Swiss official secondary data at the municipal level. After selecting the data as described above, the resulting database comprises 17,799 establishments from both the manufacturing and service sectors and located in 133 Swiss municipalities. Table 1 provides some descriptive statistics indicating that the establishments located at the language border are not systematically different from the entire population of establishments located in Switzerland in terms of establishment characteristics and agglomeration spillover indices for the locations where these establishments are located (a more comprehensive description of these variables is presented later in this section).

Following the spirit of the seminal papers in the analysis of agglomeration economies (for an overview see Beaudry & Schiffauerova, 2009; and Combes & Gobillon, 2015), this study uses as our dependent variable the establishment-level employment growth, computed as the difference in the log of number of employees between year t and year $t+1$. In the literature this is the most widely used indicator of agglomeration-spillovers (Beaudry & Schiffauerova, 2009), and is the only dependent variable which our data permits us to employ. The agglomeration-related literature suggests that in some cases such spillovers might be labor saving, or the labor supply may be inelastic, and therefore they may not necessarily translate into employment growth (Combes, Magnac, & Robin, 2004; Suedekum, 2008). However, using Mundlak's

[6]As explained in the next section, we control for firm-level heterogeneity bias applying Mundlak's (1978) approach, which allows us to estimate the time-varying and time-invariant components of firm-level variables.

[7]This selection procedure is required because from the data set it is not possible to distinguish between establishments that became insolvent from those that are censored due to merger or voluntary liquidation. Buehler et al. (2012) find in their analyses that in Switzerland, between 1995 and 2000, about 6% of firms become insolvent and 9% exit due to merger or voluntary liquidation. Hence, we believe that this selection procedure does not generate problems of selection bias because we are not excluding only establishments that failed, and they only represent a minor part of Swiss establishments.

TABLE 1 Descriptive statistics comparing the establishments at the language border with the overall population of establishments in Switzerland

	Sample		Population	
	Mean	*SD*	Mean	*SD*
Establishment-level variables				
Log employment	9.02	36.40	9.04	48.78
Employment growth	0	0.28	0	0.29
Employment female ratio	46.93	40.45	45.41	40.38
Agglomeration spillovers				
Specialization	4.21	23.77	4.02	34.39
Competition	2.10	3.72	2.02	3.67
Diversity	0.28	0.15	0.33	0.16
Observations	17,799 establishments		475,088 establishments	

approach allows us to consider the net effect on employment growth, net of labor saving, and capital/labor substitution occurring at the level of each firm.

As seen in the previous section, the explanatory variables can be divided into establishment-level variables, municipal-level variables, and agglomeration indices, which vary across both sectors and municipalities. Additionally, to compare the different estimates, we normalize all the independent variables. Specifically, we follow Enders and Tofighi (2007) and we standardize the municipal-level variables around their grand mean and the firm-level variables around their group mean. This approach allows the effects of the firm-level variables to capture only within municipalities differences, and not between municipalities.

4.1 | Agglomeration and competition economies indices

The analysis considers three different typologies of spillovers: specialization, competition, and diversity. As described in Groot et al. (2014), the vast majority of the studies studying agglomeration spillovers uses indices based on shares. Hence, to be most consistent with the literature, in this study we consider the following indices. To measure specialization, we consider a simple location quotient, computed as the ratio of the employment share of sector *s* in municipality *m* divided by the same ratio at the national level,[8] as shown in the following equation:

$$S_{lq} = \frac{E_{ms}/E_{m_*}}{E_{_*s}/E_{_{**}}}, \quad (2)$$

where E_{ms} is the employment in municipality *m* and sector *s*, E_{m_*} is the employment in municipality *m* and all sectors, $E_{_*s}$ is the employment in all municipalities and sector *s*, and $E_{_{**}}$ is the employment in all municipalities and all sectors. In terms of competition we consider the relative number of firms per employee, computed as the number of firms in sector *s* in municipality *m* divided by the number of employees working in the same sector and in the same municipality, scaled by the same ratio at the national level,[9] as indicated in the following equation:

$$C_{rfpe} = \frac{F_{ms}/E_{ms}}{F_{_*s}/E_{_*s}}, \quad (3)$$

[8]A value of specialization above 1 means that in municipality *m* the employment share of sector *s* is higher than the national average.

[9]A value of competition above 1 implies that in municipality *m* there are more firms per employee in sector *s* than at the national level, thus there is higher level of competition.

where F is the number of firms. Finally, we measure diversity as the ratio of the inverse of a modified Hirschman–Herfindahl index of sectoral concentration of all sectors in municipality m, except the considered sector s, divided by the same ratio at the overall national level,[10] as in the following equation:

$$D = \frac{\left[\sum_{s=1, s' \neq s}^{S} (E_{ms'}/(E_{m*} - E_{ms}))^2\right]^{-1}}{\left[\sum_{s=1, s' \neq s}^{S} (E_{*s'}/(E_{**} - E_{*s}))^2\right]^{-1}}. \tag{4}$$

To compute all these indices, we use data on the total number of firms and employees per sector and municipality, which are obtained from the STATENT provided by the FSO.

To measure the geographical extension of agglomeration and competition spillovers, we adopt the approach used in Rosenthal and Strange (2003) and applied in various other studies (Baldwin, Beckstead, Brown, & Rigby, 2008; Baldwin, Brown, & Rigby, 2010; Fu, 2007; Graham, 2009; Rosenthal & Strange, 2008; Saito & Wu, 2016; Smit & De Groot, 2013). Specifically, for each municipality m we build concentric rings at different distances from the centroid of that municipality and we compute for each ring the spatial lag of the three types of agglomeration spillovers by weight averaging the indices of the municipalities intersected by the corresponding ring. Agglomeration spillovers are by definition higher when there is a larger working force. To account for the fact that different municipalities with a similar value of agglomeration indices might have different sizes in terms of workers, the weighting procedure considers the size of the surrounding municipalities in terms of number of employees and gives more importance to those municipalities with a larger working force. In addition, for each ring and for each typology of agglomeration spillovers we build two different spatial lags: one for those municipalities within the ring which have the same language of municipality m, and one for those municipality which have a different language. From a theoretical perspective there is no a priori guidance on how many rings to consider and how large these rings should be. However, from an empirical point of view it is possible to have a meaningful insight by considering the spatial distribution of cities and municipalities. After analyzing this distribution in the Swiss context,[11] we impose a cutoff distance at 45-min travel time and we take into consideration rings of 15-min travel time because they provide reasonably detailed information about the spatial decay of the concentration of firms. The advantage of road travel time is that it allows us to compare regions characterized by very different topographical environments, which is crucial in a context like Switzerland where there are both flat areas and regions with very high mountains.[12] Thus, as shown in Figure 2, in which we graphically represent the case of the municipality of Jaun[13]—marked in black—, following this approach, for each typology of agglomeration spillovers and for each linguistic group we obtain three different spatial lags—marked in gray in Figure 2, with decreasing intensity as we consider rings that are farther away and with the language border represented by the solid black line.[14]

Mameli et al. (2014) demonstrate that the empirical results on the analysis of agglomeration economies can be very different depending on the level of sectoral aggregation considered. Furthermore, the authors find that it is generally preferable to analyze more disaggregated data. Hence, this study focuses on the study

[10]Higher values of diversification imply that the employment share of all the other sectors in municipality m are more similar. On the contrary, lower values of this index mean that the majority of the workforce in municipality m is employed in few sectors.

[11]The spatial distribution of cities and municipalities in Switzerland is presented in Appendix A.

[12]Considering travel time distances implies that from a graphical perspective the rings have a modified circular shape, depending on the morphological characteristics of the surrounding area.

[13]The only reason the graphical representation is focusing on the municipality of Jaun is that it is located near a language border and it belongs to the bilingual canton Fribourg, which allows us to show how we consider the language border in our analysis.

[14]Appendix B shows the descriptive statistic of the dependent variable, the three typologies of agglomeration spillovers and their spatial lags. Appendix C presents the correlation between the agglomeration indices and their spatial lags.

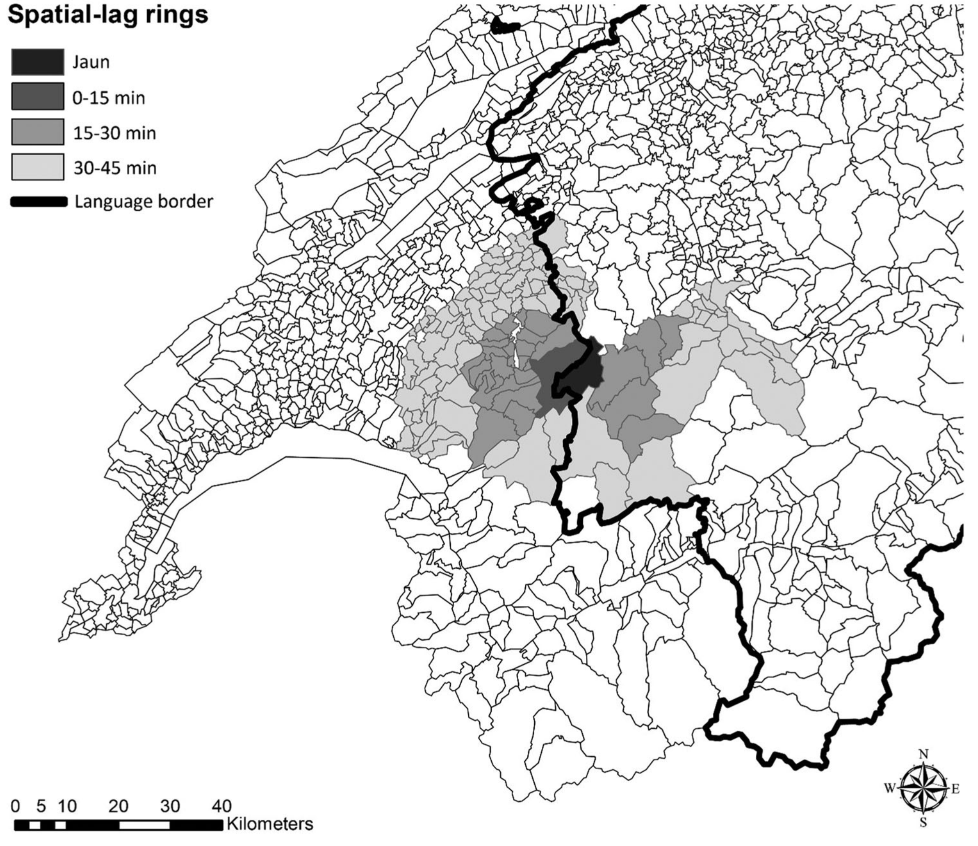

FIGURE 2 Spatial-lag rings

of the spatial decay of agglomeration spillovers using a NOGA 2008 four-digits sectoral specification,[15] which allows us to analyze 545 different sectors.

4.2 | Establishment-level variables

The accessibility to establishment-level information allows us to capture the effects related to internal economies of scale and also potential size-related congestion effects, by controlling for log-linear and log-quadratic effects of the size of establishments, computed as the number of employees of each establishment (following Audretsch & Dohse, 2007; Carroll & Hannan, 2000; Evans, 1987; Jovanovic, 1982; Raspe & Van Oort, 2008, 2011). Additionally, this study controls for the gender composition of the workforce at the establishment level, computed as the number of female workers divided by the total number of employees. Using the STATENT database allows us to consider all the establishments located in Switzerland. However, it contains very few variables at the establishment level, so to correct for establishment-level heterogeneity bias we follow Mundlak's (1978) approach. As highlighted in Bell and Jones (2015), this procedure allows us to estimate the time-invariant component of establishment-level variables, which provides fixed effects estimates, and the time-varying component of the same variables. Hence, the application of this approach allows us to capture the unobserved characteristics at the establishment level, solving potential problems of establishments' self-selection into certain areas.

[15]The NOGA 2008 is modeled after the latest version of the Statistical classification of economic activities in the European Community (NACE, Rev. 2).

4.3 | Municipal-level variables

To avoid problems of omitted-variable bias which might cause problems of identification with regard to the measure of the effects of agglomeration spillovers and their spatial extension, we control for a large variety of characteristics at the municipal level, which can be classified into five broad categories.[16]

The first groups all the demographic information at the municipal level in year *t* (following Audretsch & Dohse, 2007; Brülhart & Sbergami, 2009; Combes, 2000; Mameli et al., 2014; Raspe & Van Oort, 2008, 2011). The second category collects all the socioeconomic information at the municipal level in year *t* (following Audretsch & Dohse, 2007; Blanchard, Solow, & Wilson, 1995; Brülhart & Sbergami, 2009; Gordon & McCann, 2000; Henderson, Kuncoro, & Turner, 1995; Raspe & Van Oort, 2008, 2011). The third category of municipal-level independent variables groups all the information related to the private and public level of investments in 11 types of infrastructure in every municipality in year *t* (as done in in De Bok & Van Oort, 2011; Eberts & McMillen, 1999; Fingleton & McCann, 2007; Mameli et al., 2014; Raspe & Van Oort, 2011). The fourth category includes municipal-level independent variables providing information about the infrastructure accessibility of each municipality in year *t* (following De Bok & Van Oort, 2011; Eberts & McMillen, 1999; Fingleton & McCann, 2007; Mameli et al., 2014; Rosenthal & Strange, 2004). Finally, the fifth category collects information concerning the native language composition of each municipality.

5 | RESULTS

Table 2 reports the estimates of the effects of agglomeration spillovers at various distances from their location, taking into consideration linguistic differences. The reported results are based on three different specifications of the model, to show the robustness of our findings. In particular, in Model 1 of Table 2 we only consider as explanatory variables the three types of agglomeration and competition spillover indices and the related spatial lags. In Model 2 of Table 2 we also include the establishment-level variables. Finally, in Model 3 of Table 2 we consider the full model by adding also the municipal level variables.[17]

The results allow us to separately analyze the geographical extension of the three typologies of agglomeration and competition spillovers considered, differentiating between the spatial decay in regions with the same language from those with a different language. Specifically, as shown in Figure 3, for each typology of agglomeration and competition spillover we can graphically represent their effects on employment growth at the firm level at various distances (on the horizontal axis) in areas with the same language (marked in light gray) and in areas with a different language (marked in the dark gray), with the 95% confidence interval in each case (represented with vertical lines around the point estimates). This graphical representation allows us to clearly visualize whether the pattern of the spatial extension of the various types of agglomeration and competition spillovers differ between regions with the same language from those with a different language.

The results, as shown in Figure 3, indicate that the direct effect of specialization externalities as well as the related spatial lags are not significantly different from zero in any of the model specifications. Hence, on average, for firms located close to the language border the concentration of business activities operating in the same industrial sector does not affect their employment growth, regardless of the presence of a language border. Similarly, the direct effect of diversity externalities and the related spatial lags are not significantly different from zero in any of the model specifications. Hence, on average, for firms located close to the language border the level of local diversity does not affect their employment growth, regardless of the presence of a language border.

[16]The list of the control variables at the municipal level included in each category is presented in Appendix D.

[17]As an additional robustness check to show that our findings are not a spurious outcome of a particular selection of establishments, we have performed the same analysis considering all the establishments in the three Swiss bilingual cantons and the results are entirely in line with those presented in Table 2. The results are available upon request.

TABLE 2 Cross-classified multilevel model on employment growth at the establishment level in Switzerland

	Model 1—only agglomeration spillovers		Model 2—add establishment-level variables		Model 3—full model	
Specialization	−0.0027(0.0033)		0.0010(0.0027)		0.0010(0.0027)	
Spatial lags	Same language	Different language	Same language	Different language	Same language	Different language
Specialization 0–15 min	0.0002(0.0033)	−0.0019(0.0031)	−0.0012(0.0028)	−0.0023(0.0026)	−0.0012(0.0028)	−0.0024(0.0026)
Specialization 15–30 min	−0.0004(0.0034)	−0.0042(0.0033)	−0.0000(0.0028)	−0.0030(0.0027)	−0.0000(0.0028)	−0.0030(0.0027)
Competition	0.0185***(0.0032)		−0.0064* (0.0027)		−0.0065*(0.0027)	
Spatial lags	Same language	Different language	Same language	Different language	Same language	Different language
Competition 0–15 min	−0.0128***(0.0033)	0.0109**(0.0031)	−0.0106***(0.0027)	0.0112**(0.0030)	−0.0106***(0.0027)	0.0112***(0.0030)
Competition 15–30 min	0.0019(0.0033)	−0.0031(0.0032)	0.0037(0.0028)	−0.0006(0.0027)	0.0037(0.0028)	−0.0006(0.0027)
Diversity	−0.0127(0.0261)		−0.0236(0.0233)		−0.0235(0.0233)	
Spatial lags	Same language	Different language	Same language	Different language	Same language	Different language
Diversity 0–15 min	0.0257(0.0549)	0.1173(0.1106)	0.0376(0.0457)	0.1162(0.0928)	0.0385(0.0458)	0.1169(0.0928)
Diversity 15–30 min	−0.0374(0.0609)	0.0707(0.0669)	−0.0032(0.0497)	0.0666(0.0548)	−0.0030(0.0497)	0.0670(0.0547)
Random effects						
Municipal-level variance	0.0000		0.0000		0.0001	
Sector-level variance	0.0002		0.0005		0.0005	
Establishment-level variance	0.0796		0.0518		0.0518	
Municipal-level variables	No		No		Yes	
Establishment-level variables	No		Yes		Yes	
Mundlak correction	No		Yes		Yes	
Canton fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
Deviance	22,231		7,945		7,485	
Observations	35,598; 133 municipalities; 349 sectors		35,598; 133 municipalities; 349 sectors		35,598; 133 municipalities; 349 sectors	

Note: standard errors between parentheses.

*$p < .1$.

**$p < .05$.

***$p < .01$.

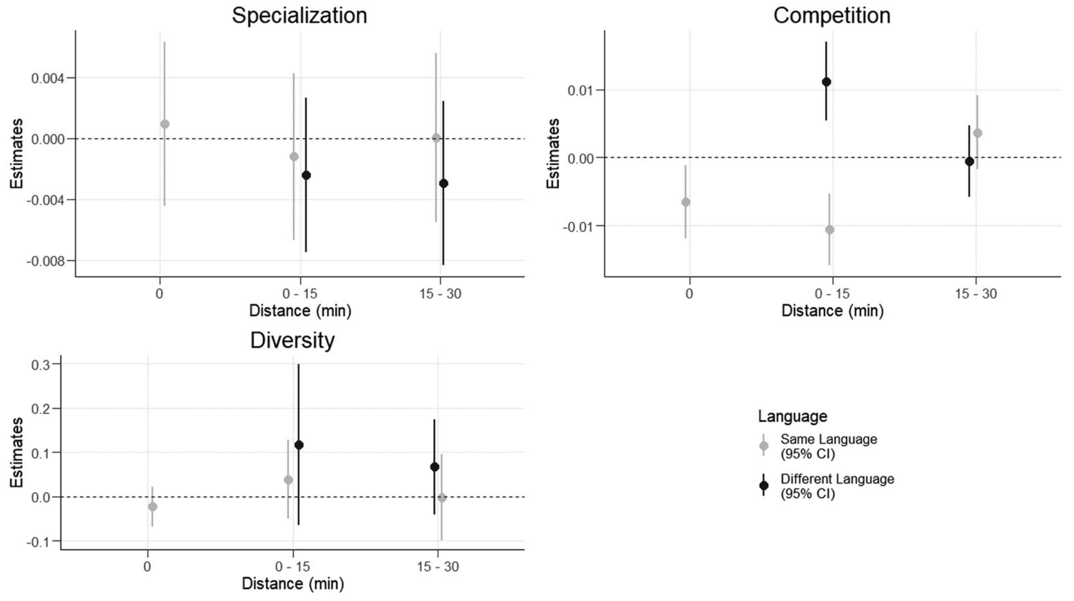

FIGURE 3 The geographical extension of agglomeration and competition spillovers

In contrast, the direct estimate of competition spillovers at the municipal level is significantly negative. Considering the spatial lag of competition in municipalities located <15 min travel time away, the effect is negative and statistically significant in municipalities with the same language, whereas the result is positive and statistically significant in municipalities with a different language. At distances above a 15-min travel time the results are not significantly different from zero. Hence, the estimates for competition effects follow different patterns depending on the presence of a language border. More specifically, for firms close to the language border employment growth is significantly higher when there are high levels of competition in municipalities belonging to a different linguistic region and located <15-min travel time away. Moreover, these results are robust to the model specification.

These results clearly indicate that the existence of a language border affects the geographical extension of certain spillovers. In particular, firms located close to a language border benefit from competition on the other side of this border and they suffer from competition at the same side of the linguistic border. Moreover, our results also indicate that competition externalities attenuate with distance, which is consistent with the findings of Hoogstra and Van Dijk (2004) and Smit and De Groot (2013). As far as we are aware, this is the first time that the pure effects of language borders on geographical spillovers have ever been observed empirically.

6 | CONCLUSIONS AND DISCUSSION

In the context of Switzerland our results demonstrate that language, and in particular the presence of a language border, shapes the economic geography of spillovers. These particular economic geography transmission mechanisms are mediated and altered by linguistic discontinuities and this, as far as we are aware, have not been econometrically modeled or observed before. According to our results, competition externalities are enhanced when firms are located close to municipalities belonging to a different linguistic area. These effects attenuate and then disappear after distances of a 15-min travel time.

Exactly why these particular empirical results emerge is a different question which we have not sought to answer here, in part because this was not our original aim, and also in part because our data do not allow us to specifically examine these issues. Nevertheless, the existing literature allows us to suggest the following two possibilities, although, at this stage these explanations can only be tentative and speculative and require further research. The first possible explanation is the competitiveness-contestability argument (Porter, 1990), and the second possible explanation is the capabilities argument (Teece, 2000). In terms of the first possible explanation, the competitiveness literature (Porter, 1990) highlights how highly competitive and contestable market environments may both limit individual firm growth while at the same time providing greater opportunities for market access. Our results suggest that the balance of these two potentially opposing forces plays out differently across the linguistic border, with the former relating to the same locality while the latter relates more to the neighboring localities. Regarding the second possible explanation, the capabilities types of arguments suggest that knowledge-related soft institutional factors such as language may shape how the firm best deploys its resources to capture local and cross-border markets. These two explanations are not mutually exclusive of each other and indeed may act as complements, although without other evidence and data they remain largely speculative. Yet, further insights can be potentially sought in the growing evidence-base within the economics of culture (Beugelsdijk & Maseland, 2010; De Jong, 2009; Hofstede, 2001). Importantly, and as already mentioned, in the case of Switzerland the various linguistic regions are clearly associated with different cultures (Hofstede, 2001), so our findings do appear to lend support to those who argue that culture affects the economy and economic geography in distinct ways.

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REFERENCES

Adserà, A., & Pytliková, M. (2015). The role of language in shaping international migration. *The Economic Journal*, *125*(586), F49–F81.

Alesina, A., & Giuliano, P. (2015). Culture and institutions. *Journal of Economic Literature*, *53*(4), 898–944.

Audretsch, D. B., & Dohse, D. (2007). Location: A neglected determinant of firm growth. *Review of World Economics*, *143*(1), 79–107.

Bakens, J., Mulder, P., & Nijkamp, P. (2013). Economic Impacts of cultural diversity in The Netherlands: Productivity, utility and sorting. *Journal of Regional Science*, *53*(1), 8–36.

Baldwin, J., Beckstead, D., Brown, W., & Rigby, D. (2008). Agglomeration and the geography of localization economies in Canada. *Journal of Economic Geography*, *42*(1), 117–132.

Baldwin, J. R., Brown, W. M., & Rigby, D. L. (2010). Agglomeration economies: Microdata panel estimates from Canadian manufacturing. *Journal of Regional Science*, *50*(5), 915–934.

Barry, C., & Miller, P. W. (1995). The endogeneity between language and earnings: International analyses. *Journal of Labor Economics*, *13*(2), 246–88.

Beaudry, C., & Schiffauerova, A. (2009). Who's right, Marshall or Jacobs? The localization versus urbanization debate. *Research Policy*, *38*(2), 318–337.

Bell, A., & Jones, K. (2015). Explaining fixed effects: Random effects modeling of time-series cross-sectional and panel data. *Political Science Research and Methods*, *3*(1), 133–153.

Berliant, M., & Fujita, M. (2008). Knowledge Creation as a Square Dance on the Hilbert Cube. *International Economic Review*, *49*(4), 1251–1295.

Beugelsdijk, S., & Maseland, R. (2010). *Culture in economics: History, Methodological reflections and contemporary applications*. Cambridge: Cambridge University Press.

Blanchard, O., Solow, R., & Wilson, B. (1995). *Productivity and unemployment*. MIT mimeograph.

Bleakley, H., & Chin, A. (2004). Language skills and earnings: Evidence from childhood immigrants. *Review of Economics and Statistics*, *86*(2), 481–496.

De Bok, M., & Van Oort, F. (2011). Agglomeration economies, accessibility and the spatial choice behavior of relocating firms. *Journal of Transport and Land Use*, *4*(1), 5–24.

Brakman, S., Garretsen, H., Van Marrewijk, C., & Oumer, A. (2012). The border population effects of EU integration. *Journal of Regional Science*, *52*(1), 40–59.

Briant, A., Combes, P. P., & Lafourcade, M. (2010). Dots to boxes: Do the size and shape of spatial units jeopardize economic geography estimations? *Journal of Urban Economics*, *67*(3), 287–302.

Brülhart, M., & Sbergami, F. (2009). Agglomeration and growth: Cross-country evidence. *Journal of Urban Economics*, *65*(1), 48–63.

Buehler, S., Kaiser, C., & Jaeger, F. (2012). The geographic determinants of bankruptcy: Evidence from Switzerland. *Small Business Economics*, *39*(1), 231–251.

Caragliu, A., de Dominicis, L., & De Groot, H. L. F. (2016). Both Marshall and Jacobs were right! *Economic Geography*, *92*(1), 87–111.

Carroll, G., & Hannan, M. (2000). *The Demography of corporations and industries*. Princeton: Princeton University Press.

Chen, M. K. (2013). The effect of language on economic behavior: Evidence from savings rates, health behaviors, and retirement assets. *American Economic Review*, *103*(2), 690–731.

Combes, P., & Gobillon, L. (2015). The empirics of agglomeration economies. In G. Duranton, V. Henderson, & W. Strange (Eds.), *Handbook of regional and urban economics* (Vol. 5, pp. 247–348). Amsterdam: Elsevier Science.

Combes, P. P. (2000). Economic structure and local growth: France, 1984–1993. *Journal of Urban Economics*, *47*(3), 329–355.

Combes, P. P., Magnac, T., & Robin, J. M. (2004). The dynamics of local employment in France. *Journal of Urban Economics*, *56*(2), 217–243.

Eberts, R., & McMillen, D. (1999). Agglomeration economies and urban public infrastructure. In P. Cheshire, & E. Mills (Eds.), *Handbook of regional and urban economics* (Vol. 3, pp. 1455–1495). Amsterdam: Elsevier Science.

Egger, P. H., & Lassmann, A. (2015). The causal impact of common native language on international trade: Evidence from a spatial regression discontinuity design. *The Economic Journal*, *125*(584), 699–745.

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*, *12*(2), 121–138.

Eugster, B., Lalive, R., Steinhauer, A., & Zweimüller, J. (2011). The demand for social insurance: Does culture matter? *The Economic Journal*, *121*(556), F413–F448.

Eugster, B., Lalive, R., Steinhauer, A., & Zweimüller, J. (2017). Culture, work attitudes, and job search: Evidence from the Swiss language border. *Journal of the European Economic Association*, *15*(5), 1056–1100.

Eugster, B., & Parchet, R. (2019). Culture and taxes. *Journal of Political Economy*, *127*(1), 296–337.

Evans, D. S. (1987). The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries. *The Journal of Industrial Economics*, *35*(4), 567–581.

Fernandez, R. (2011). Does culture matter? In J. Benhabib, M. Jackson, & A. Bisin (Eds.), *Handbook of social economics* (pp. 481–510). North-Holland.

Fingleton, B., & McCann, P. (2007). Sinking the iceberg? On the treatment of transport costs in new economic geography. In B. Fingleton (Ed.), *New Directions in Economic Geography* (pp. 168–203). Cheltenham: Edward Elgar.

Fotheringham, A. S., & Pitts, T. C. (1995). Directional variation in distance decay. *Environment and Planning A: Economy and Space*, *27*(5), 715–29.

Fu, S. (2007). Smart café cities: Testing human capital externalities in the Boston metropolitan area. *Journal of Urban Economics*, *61*(1), 86–111.

Gentili, E., Masiero, G., & Mazzonna, F. (2017). The role of culture in long-term care. *Journal of Economic Behavior and Organization*, *143C*, 186–200.

Goldberg, A. (2017). *The impact of cleavages on Swiss voting behaviour: A modern research approach*. Cham: Springer.

Gordon, I. R., & McCann, P. (2000). Industrial clusters: Complexes, agglomeration and/or social networks? *Urban Studies*, *37*(3), 513–532.

Graham, D. J. (2009). Identifying urbanisation and localisation externalities in manufacturing and service industries. *Papers in Regional Science*, *88*(1), 63–84.

Grenier, G. (1984). The effects of language characteristics on the wages of Hispanic American males. *The Journal of Human Resources*, *19*(1), 35–52.
De Groot, H., Poot, J., & Smit, M. (2015). Which agglomeration externalities matter most and why? *Journal of Economic Surveys*, *30*(4), 1–27.
Groot, S., De Groot, H., & Smit, M. (2014). Regional wage differences in the Netherlands: Micro evidence on agglomeration externalities. *Journal of Regional Science*, *54*(3), 503–523.
Guiso, L., Sapienza, P., & Zingales, L. (2006). Does culture affect economic outcomes? *Journal of Economic Perspectives*, *20*(2), 23–48.
Henderson, V., Kuncoro, A., & Turner, M. (1995). Industrial development in cities. *Journal of Political Economy*, *103*(5), 1067–1090.
Hočevar, T. (1975). Equilibria in linguistic minority markets. *Kyklos*, *28*(2), 337–357.
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Thousand Oaks CA: Sage Publications.
Hoogstra, G. J., & Van Dijk, J. (2004). Explaining firm employment growth: Does location matter? *Small Business Economics*, *22*(3-4), 179–192.
Jacobs, J. (1969). *The economy of cities*. New York: Random House.
De Jong, E. (2009). *Culture and economics: On values, economics and international business*. London: Routledge.
Jovanovic, B. (1982). Selection and the evolution of industry. *Econometrica*, *50*(3), 649–670.
Kochan, T., Bezrukova, K., Ely, R., Jackson, S., Joshi, A., Jehn, K., … Thomas, D. (2003). The effects of diversity on business performance: Report of the diversity research network. *Human Resource Management*, *42*(1), 3–21.
Lazear, E. P. (1999). Globalisation and the market for team-mates. *The Economic Journal*, *109*(454), 15–40.
Mameli, F., Faggian, A., & McCann, P. (2014). Estimation of local employment growth: Do sectoral aggregation and industry definition matter? *Regional Studies*, *48*(11), 1813–1828.
Marschak, J. (1965). Economics of language. *Behavioral Science*, *10*(2), 135–140.
McCann, P., & Acs, Z. J. (2011). Globalization: Countries, cities and multinationals. *Regional Studies*, *45*(1), 17–32.
Melo, P. C., Graham, D. J., & Noland, R. B. (2009). A meta-analysis of estimates of urban agglomeration economies. *Regional Science and Urban Economics*, *39*(3), 332–342.
Mundlak, Y. (1978). On the pooling of time series and cross section data. *Econometrica*, *46*(1), 69–85.
Nijkamp, P., Poot, J., & Bakens, J. (2015). *The economics of cultural diversity*. Cheltenham: Edward Elgar.
Nunziata, L., & Rocco, L. (2016). A tale of minorities: Evidence on religious ethics and entrepreneurship. *Journal of Economic Growth*, *21*(2), 189–224.
Pike, A., Rodríguez-Pose, A., & Tomaney, J. (2011). *Handbook of local and regional development*. New York: Routledge.
Pool, J. (1972). National development and language diversity. In J. Fishman (Ed.), *Advances in the sociology of language* (pp. 213–230). The Hague: Mouton.
Porter, M. (1990). *The competitive advantage of nations*. Houndmills: MacMillan.
Putnam, R. D. (2007). E Pluribus Unum: Diversity and community in the twenty-first century the 2006 Johan Skytte Prize Lecture. *Scandinavian Political Studies*, *30*(2), 137–174.
Raspe, O., & Van Oort, F. (2008). Firm growth and localized knowledge externalities. *Journal of Regional Analysis and Policy*, *38*(2), 1–17.
Raspe, O., & Van Oort, F. G. (2011). Firm heterogeneity, productivity and spatially bounded knowledge externalities. *Socio-Economic Planning Sciences*, *45*(1), 38–47.
Rice, P., Venables, A. J., & Patacchini, E. (2006). Spatial determinants of productivity: Analysis for the regions of Great Britain. *Regional Science and Urban Economics*, *36*(6), 727–752.
Rosenthal, S., & Strange, W. (2004). Evidence on the nature and sources of agglomeration economies. In J. Henderson, & J. Thisse (Eds.), *Handbook of regional and urban economics* (Vol. 4, pp. 2119–2171). Amsterdam: Elsevier Science.
Rosenthal, S. S., & Strange, W. C. (2003). Geography, industrial organization, and agglomeration. *Review of Economics and Statistics*, *85*(2), 377–393.
Rosenthal, S. S., & Strange, W. C. (2008). The attenuation of human capital spillovers. *Journal of Urban Economics*, *64*(2), 373–89.
Saito, H., & Wu, J. (2016). Agglomeration, congestion, and U.S. regional disparities in employment growth: Agglomeration, congestion, and U.S. regional disparities. *Journal of Regional Science*, *56*(1), 53–71.
Smit, M. J., & De Groot, H. L. F. (2013). Stocking up: The role of temporal and spatial R&D stocks. *European Planning Studies*, *21*(5), 637–665.
Storper, M. (2013). *Keys to the City: How economics, institutions, social interaction, and politics shape development*. Princeton: Princeton University Press.
Südekum, J. (2008). Convergence of the skill composition across German regions. *Regional Science and Urban Economics*, *38*(2), 148–159.

Tabellini, G. (2008). Presidential addressinstitutions and culture. *Journal of the European Economic Association*, *6*(2-3), 255–294.
Teece, D. J. (2000). Strategies for managing knowledge assets: The role of firm structure and industrial context. *Long Range Planning*, *33*(1), 35–54.
Tselios, V., Noback, I., Van Dijk, J., & McCann, P. (2015). Integration of immigrants, bridging social capital, ethnicity and locality. *Journal of Regional Science*, *55*(3), 416–441.
Tselios, V., Noback, I., McCann, P., & van Dijk, J. (2015). Local social engagement, satisfaction and embeddedness in the Netherlands: Which effects matter and for whom? *Environment and Planning A*, *47*(5), 1132–1154.
Van Oort, F. G., Burger, M. J., Knoben, J., & Raspe, O. (2012). Multilevel approaches and the firm-agglomeration ambiguity in economic growth studies. *Journal of Economic Surveys*, *26*(3), 468–491.
Werlen, I. (2008). Sprachkompetenzen der erwachsenen Bevölkerung in der Schweiz. *Technical Report*, *Swiss National Research Project*, 56.

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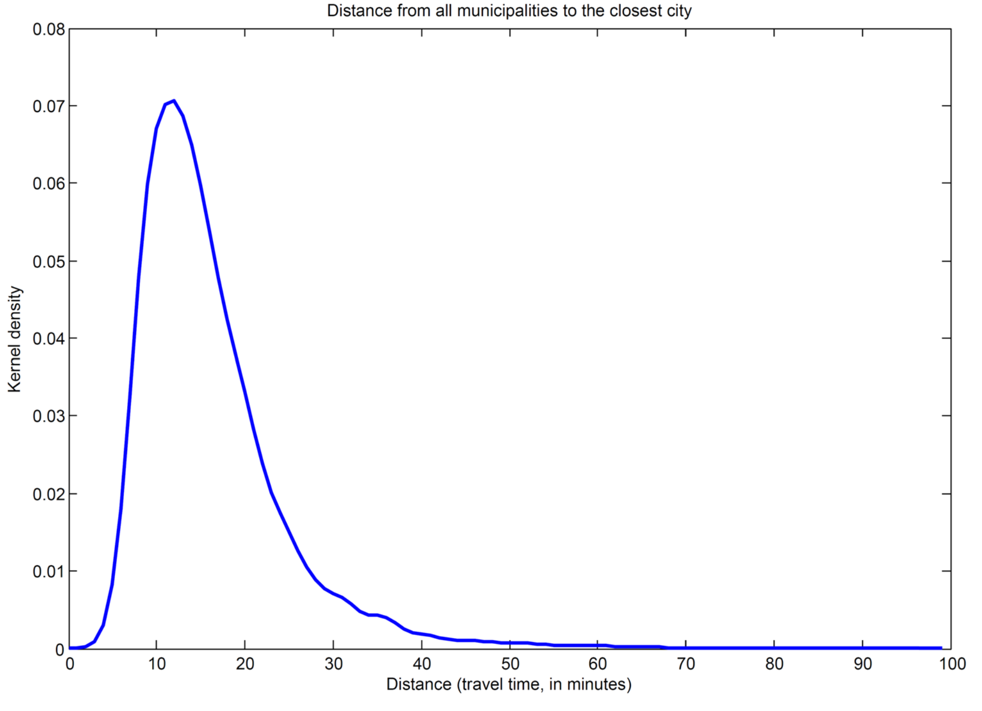
APPENDIX A

Kernel density of distance between all municipalities and the closest city



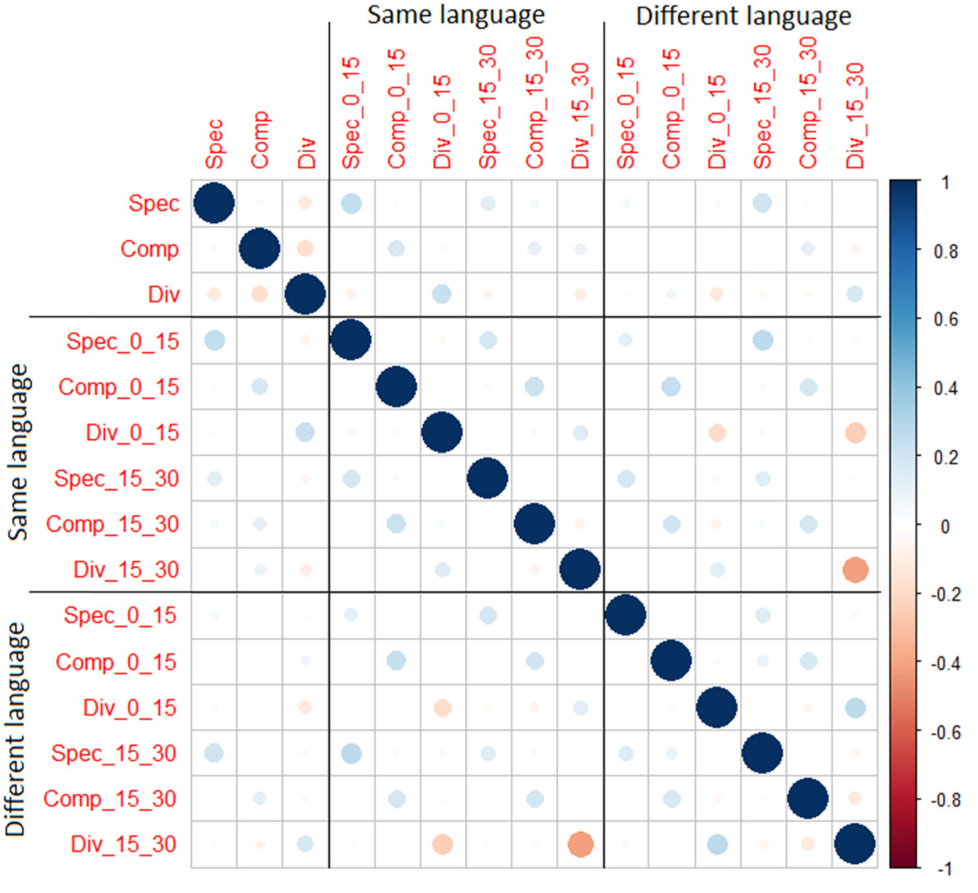
APPENDIX B

TABLE B1 Descriptive statistics

	Mean	*SD*	Min.	Max.
Employment growth	0	0.28	−4.47	3.97
Specialization	4.21	23.77	0	1,822.60
Spatial lags same language:				
Specialization 0–15 min	1.23	2.70	0	115.46
Specialization 15–30 min	1.05	1.62	0	163.24
Spatial lags different language:				
Specialization 0–15 min	1.04	7.71	0	510.21
Specialization 15–30 min	1.14	1.69	0	143.60
Competition	2.10	3.72	0	328.28
Spatial lags same language:				
Competition 0–15 min	1.43	1.86	0	154.30
Competition 15–30 min	1.35	1.14	0	30.91
Spatial lags different language:				
Competition 0–15 min	1.32	2.36	0	54.80
Competition 15–30 min	1.31	1.15	0	36.35
Diversity	0.28	0.15	0.01	0.69
Spatial lags same language:				
Diversity 0–15 min	0.26	0.11	0	0.56
Diversity 15–30 min	0.27	0.09	0.09	0.52
Spatial lags different language:				
Diversity 0–15 min	0.19	0.13	0.02	0.69
Diversity 15–30 min	0.32	0.10	0.07	0.65
Observations	35,598; 133 municipalities; 349 sectors			

APPENDIX C

Correlation between agglomeration economies indices and their spatial lags



APPENDIX D

TABLE D1 Municipal level variables

Variable	Definition	Source
Demographic information		
Population	Number of inhabitants	STATPOP-FSO
Population growth	Growth rate of number of inhabitants	STATPOP-FSO
Active population ratio	Percentage of population between 20 and 64 years old	STATPOP-FSO
Population density	Inhabitants per square kilometer	STATPOP-FSO
Foreign population ratio	Percentage of population without Swiss nationality	STATPOP-FSO
Net migration rate	Difference between immigrants and emigrants divided per 1,000 inhabitants	STATPOP-FSO
Socioeconomic information		
Average income	Average level of income	FTA-FSO
Cross-border commuters ratio	Number of cross-border commuters divided per 100 inhabitants	CCS-FSO
Human capital (no postmandatory)	Percentage of population with no postmandatory education in the year 2000[a]	Federal Population Census (FSO)
Human capital (postmandatory, no university)	Percentage of population with postmandatory education without a university or equivalent degree in the year 2000[a] (reference category)	Federal Population Census (FSO)
Human capital (university)	Percentage of population with university or equivalent education level in the year 2000[a]	Federal Population Census (FSO)
Level of taxation	Municipal tax rate	FTA-FSO
Social capital (voter turnout)	Turnout for the federal election in 2011	Vote and elections statistics (FSO)
Social capital (no profit employees ratio)	Number of employees in NON PROFIT organization per inhabitant	STATENT-FSO
Infrastructure investment		
Investment (supply of energy)	Per capita level of investments in the construction of infrastructures related to the supply of energy	Statistic of housing and construction (FSO)
Investment (waste disposal)	Per capita level of investments in the construction of infrastructures related to the waste disposal	Statistic of housing and construction (FSO)
Investment (road system)	Per capita level of investments in the construction of road system	Statistic of housing and construction (FSO)
Investment (other transportation systems)	Per capita level of investments in the construction of other transportation systems	Statistic of housing and construction (FSO)
Investment (education buildings)	Per capita level of investments in the construction of buildings designed for educational and research activities	Statistic of housing and construction (FSO)
Investment (health care buildings)	Per capita level of investments in the construction of buildings designed for health care system	Statistic of housing and construction (FSO)
Investment (culture and free time buildings)	Per capita level of investments in the construction of buildings designed for leisure and free time activities	Statistic of housing and construction (FSO)
Investment (houses)	Per capita level of investments in the construction of houses	Statistic of housing and construction (FSO)

(Continues)

TABLE D1 (Continued)

Variable	Definition	Source
Investment (agricultural buildings)	Per capita level of investments in the construction of buildings designed for agricultural activities	Statistic of housing and construction (FSO)
Investment (industrial buildings)	Per capita level of investments in the construction of buildings designed for industrial activities	Statistic of housing and construction (FSO)
Investment (other infrastructure)	Per capita level of investments in the construction of other infrastructures	Statistic of housing and construction (FSO)
Infrastructure accessibility		
Distance nearest highway ramp	Travel time distance between the centroid of each municipality and the centroid of the closest municipality with a highway ramp	Federal Office for Spatial Development
Distance nearest train station	Travel time distance between the centroid of each municipality and the centroid of the closest municipality with a railway station	Federal Office for Spatial Development
Distance nearest airport	Travel time distance between the centroid of each municipality and the centroid of the closest municipality with one of the three main Swiss international airports	Federal Office for Spatial Development
Distance nearest custom	Travel time distance between the centroid of each municipality and the centroid of the closest municipality with a custom	Federal Office for Spatial Development
Industrial area rate	Ratio of industrial and commercial area divided by the total settlement and urban area	GEOSTAT-FSO
Language information		
German speaking ratio	Percentage of population of having as mother tongue German[b] (reference category)	Federal Population Census (FSO)
French speaking ratio	Percentage of population of having as mother tongue French[b]	Federal Population Census (FSO)
Italian speaking ratio	Percentage of population of having as mother tongue Italian[b]	Federal Population Census (FSO)
Romansh speaking ratio	Percentage of population of having as mother tongue Romansch[b]	Federal Population Census (FSO)

Abbreviations: CCS, Cross-border Commuters Statistics; FSO, Federal Statistical Office; FTA, Federal Tax Administration; STATPOP, Statistics of the Population and Households.

[a]Year 2000 is the last available year concerning the education achievement of the Swiss population at the municipal level.

[b]Year 2000 is the last available year concerning the cultural composition of the Swiss population at the municipal level.