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Ethnolinguistic diversity, quality of local public institutions, and firm-level innovation

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ABSTRACT

Institutional quality is crucial for innovation and economic growth. In this article, we exploit historical linguistic differences across Slovenian municipalities between the Italian, German, and Slovenian-speaking population prior to World War 1, as a plausible exogenous source of variation in firm-level innovation to estimate the effect of institutional quality on innovation. Employing a set of limited dependent variable and instrumental variable models, we show that greater historical exposure to multilingualism is associated with markedly better quality of government and provision of public goods, more impartial local government administration, and lower prevalence of corruption, which in turn predicts systematically more vibrant economic activity, greater economic complexity, and higher rates of firm-level innovation at the local level. The estimated effects are robust to a variety of specification checks and do not appear to be sensitive to the choice of ethnic and linguistic diversity measures.

1. Introduction

The notion that institutional quality matters for sustainable growth, productivity, innovation and long-run development can only be seldom disputed (North and Weingast, 1989; Knack and Keefer, 1995; Acemoglu et al., 2005; Rodríguez-Pose, 2013; Harper, 2018). Without the loss of generality, the conventional wisdom stipulates that an institutional environment with low transaction costs, robust rule of law, and high-quality government institutions reduces the costs of cooperation and facilitates both economic specialization and growth. Thus, societies without an impartial and robust rule of law, rigorously controlled corruption, and effective government administration can rarely flourish in the long run and are prone to both institutional sclerosis (Rothstein and Teorell, 2008) and economic stagnation (Olson, 1982). By contrast, societies with impartial, effective, and accountable institutional framework tend to have higher levels of social capital as citizens exhibit a greater degree of social trust, well-being, and individual happiness than societies without such framework (Holmberg et al., 2009). On the other hand, how much institutional quality really matters for productivity, innovation, and economic development, and which layers of institutions are most important, has remained largely unanswered.

Most of the studies examine the impact of institutions on growth and development at the country level. Such studies are prone to statistical identification issues and hardly shade any light on the relationship between legal institutions and economic development (Leamer (1983); Angrist, Pischke (2009); Klick (2010); Helland and Klick (2011); Klerman et al. (2011); Helland (2016)). The fundamental issue stems from omitted variable bias inherent in cross-country studies. Aggregate correlations between various measures of legal institutions and economic growth can thus hardly provide any evidence on the impact of legal institutions on growth and development (Sobel and Coyne, 2011; Olson, 2010). On the other hand, sub-national variation in institutional quality holds out more hope to identify the effects on growth and development by holding an array of other factors constant, and partially overcome the identification bias inherent in cross-country setup (Armor et al., 2009).

In this article, we exploit within-country variation in municipality-

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and regional-level quality of public institutions quality in a cross-section of Slovenian municipalities. We construct several indicators of institutional quality, which allow us to capture subnational spatial differences in the legal institutions, and examine their impact on innovation, productivity and growth. Despite the common political framework and shared national history and culture, large innovation and productivity differences exist across Slovenian municipalities and regions. As we will show, there are many indications that high productivity, efficient reliance, innovation and inclusive growth critically depend on the quality of public institutions of different Slovenian regions. Namely, municipalities with higher quality of the local public sector and governance present higher levels of innovation, as well as a higher probability of a valid patent with either the European Patent Office (hereinafter EPO) or the US Trademark Office. By exploiting the historical differences in linguistic diversity prior to World War 1 as a plausibly exogenous source of contemporary innovation, we show that the estimated effects of local institutional quality appear to be causal. Particularly, our analysis shows that the effect of institutional quality is large and substantial, the impact of the impartiality of municipal self-government is similar but slightly lower, and whilst the impact of corruption is large and negative (i.e., a higher value of the index means less corruption).

Several caveats should be stated. First, linguistically diverse societies per se tend to exhibit higher levels of creativity and innovation which implies that regardless of the choice of the benchmark year, historical ethnolinguistic diversity may not serve a plausibly exogenous source of present-day productivity and innovation since multilingualism may spread more rapidly in the multiethnic areas whilst a direct effect may dissipate over time in the presence of decline in multilingualism. By contrast, our argument implies that a historical exposure to the multilingual environment promulgates the formation of various informal institutions, especially cultural traits and civic virtues geared towards higher levels of social trust, preference for horizontal cooperation opposed to vertical control, greater levels of social capital such as volunteerism, participation in civil initiative and non-profit motives among several others. Alongside or independently of the efficiency of formal institutional framework, by transmitting these traits to the offspring either through the generations, the historical exposure to multilingualism may persist over a long period of time and establish a plausibly exogenous source of variation in long-term productivity and innovation. Second, another potential objection to the historical linguistic diversity as a plausibly exogenous source of variation in long-term innovation may arise from the non-exogeneity of the initial conditions. For instance, Italian and German settlement within Slovenia may have occurred in the areas with better institutional quality at the micro level such as greater efficacy of formal institutions and more impartial administration of justice. If the settlement of linguistic groups coincides with more productive interpersonal norms such as greater propensity to trust members outside their monolingual community, which may entail a higher ethnolinguistic diversity and pose a source of long-term persistence. Relatedly, a source of long-term productivity and innovation may equally emanate from the culture or linguistic spirit since either Italian or German-speaking groups may simply perform better in terms of productivity when they coexist with other ethnic groups.

Although the validity of the potential caveats to the identification of the nexus between institutional quality and firm-level innovation can seldom be dispute, it should be noted that our identification strategy exploits the variation in the exposure to multilingualism before World War 1 to consistently estimate the effect of local institutions on firm-level innovation at the local level rather than linguistic diversity per se. In this respect, our strategy exploits the historical formation of informal institutions through the local multilingual interaction to estimate the effect of the efficiency of formal institutions framework on present-day productivity at the local level. Since the exposure to multilingualism rather than linguistic diversity per se posits a plausible source of variation in long-term innovation, it is considerably less likely that the underlying exclusion restriction would be violated. To address the validity of exclusion restriction, we further isolate the effect of institutions on innovation by controlling for contemporary ethnic composition at the municipal level. In the lieu of very low persistence between pre-war ethnic diversity and its contemporary counterpart, we show that the exclusion restriction remains both stable and valid.

The main ambition of this article is to shed light on the interrelationships between the patterns of innovation, productivity, and the local public institutional quality. In this respect, we examine the contribution of different layers of institutional quality generated by different Slovenian municipalities and regions on the firm-level innovation. The rest of the paper is structured as follows. Section 2 offers theoretical framework linking institutional quality to the different sources of economic growth and shows the recent innovation patterns. Section 3 discusses the data and construction of key variables. Section 4 presents the results, robustness checks, the counterfactual scenario and policy implications. Section 5 concludes.

2. Conceptual framework

2.1. Institutions, specialization and productivity

It is widely acknowledged that inclusive and broad-based economic and social development cannot be sustained without raising productivity growth. Yet, attaining high productivity growth is not possible without the institutional framework that supports open markets under a robust rule of law, low transaction costs, effective government administration and lack of opportunities for corruption. Such institutional framework has an innate tendency to generate low transaction costs which spurs allocative efficiency and fosters economic specialization (Coase, 1937, 1961, 1988, 1998). In a world of positive transaction costs, the institutional environment should play a crucial role in determining how resources are used and consequently have also a crucial impact on productivity, innovation and economic growth (Coase, 1994). The existing empirical evidence promulgates the notion that institutional framework may be one of the root causes of the differences in economic growth and development in the long run (Glaser et. al, 2004, Rodrik et al., 2004). On this subject, North (, 1990, 2005) also advances the argument that the inability of societies to develop effective, low-cost enforcement of contracts is the most important source of both historical stagnation and contemporary underdevelopment in the third world. Williamson (1996, 1985, 1975) and Matthews (1986), on the other hand, stress the vital importance of transaction costs in long-term relationships and argue that institutions significantly matter and are susceptible to analysis. The conventional wisdom advocates a strong importance of historical legacies of institutional regimes for long-term economic development (Umlauft, 1876; Taylor, 1948; Nunn, 2009). The persistence of historical legacies of distinctive institutional experiences and their effects of productivity, innovation and human capital formation has been long recognized (Ingrao, 2019; Ostrom, 2008; Guiso et al., 2008; Tabellini, 2010).

The question that remains, however, is whether institutional differences at the subnational level matter for firm-level innovation, specialization and complexity. The existing subnational evidence suggests that to a more inclusive institutional framework corresponds better long-run economic performance (Bruhn and Gallego, 2012, Michalopoulos and Papaioannou, 2014), higher levels of trust (Charron and Rothstein, 2018), and more complex and diversified productive structures (Hidalgo and Hausmann, 2009; Chávez et al., 2017; Gao and Zhou, 2018; Reynolds et al., 2018; Davies and Maré, 2021).

Identifying the effect of institutional quality on subnational innovation is impossible without plausibly exogenous sources of variation. Most of the existing measures of such variation are prone to problems of omitted variables or are conceptually unsuitable to establish the proposition that institutions may invariably be the root cause for innovation or other economic outcomes (Helland and Klick, 2011). This is because

they tend to change slowly over time, reflect factors other than institutional quality itself, or coincide with major wars or revolutions. One potential remedy is to exploit historical circumstances (Grier, 1999, Engerman and Sokoloff and Engerman, 2000, Acemoglu et al., 2001, Bertocchi and Canova, 2002, Lange, 2004, Banerjee and Iyer, 2005, Dell, 2010, Dell et al., 2018) that eventually lead to institutional persistence (Acemoglu and Robinson, 2006; Nunn, 2009; Robinson, 2012; Acemoglu et al., 2021). One such circumstance may emerge from historical linguistic diversity.

2.2. Ethnolinguistic diversity, institutional quality and innovation

It is well established that a linguistically diverse society allows for more ideas, a broader pool of talents and skills, and positively contributes to that diversity of experiences and perspectives which in turn increases the potential for enhancing productivity and innovation (Alesina and Ferrara, 2005, Montalvo and Reynal Querol 2005, Tabellini, 2016, Desmet et al., 2017, Ljunge and Stenkula, 2021). Historical linguistic diversity is, by default, determined outside the current stream of technology and incentives to innovate. This is likely to provide the missing plausibly exogenous source of variation in innovation in a common legal and political system where many factors can be held fixed to control for the problem of omitted variable bias inherent in cross-country comparisons (Rodrik, 2012). Another plausible explanation resides in the power of historical exposure to multilingualism on cultural and institutional evolution. As argued by Guiso et al. (2016), certain attitudes or informal institutions may be transmitted to mono- or multilingual offspring and that may persist over time, in parallel to the existence of efficient formal institutions, including religion or national rigidities. Recently, Dewaele and Wei (2013) found that a high level of multilingualism makes people more tolerant of ambiguity and diversity (Lovrits, 2022). In other words, multilingualism appears to increase brain plasticity (Pliatsikas, 2019), reduce cognitive impairment (Perquin et al., 2013), and encourage emotional intelligence (Dewaele, 2021), making individuals more welcoming of different cultures and socioeconomic attitudes, as well as multi-competent (Franceschini, 2011). Dewaele and Botes (2020) also show how multilingualism positively affects flexibility, social initiative, and open mindedness, all factors that significantly contribute to creativity and innovation. A positive relationship between multilingualism and creativity was also observed by Fürst and Grin (2018). On this subject, one may think of the economic success that characterizes the polyglot Swiss cantons (Gstöhl, 2002) and the Italian region of Trentino Alto-Adige, where levels of higher education, international links, and industrial development are the highest in the country (Gaddi et al., 2021). An additional strand of literature suggests that multilingualism tends to nurture certain cognitive aptitudes that further improve general mental control and cognitive flexibility (Bialystok et al., 2012; Bialystok, 2017), which has been linked to higher creative (Pan and Yu, 2018), greater fitness of the mind, improved verbal creativity, and more versatile thinking skills (Okoh, 1980).

In this respect, we exploit the differences in linguistic diversity across Slovenian municipalities between the Italian, German, and Slovenian-speaking population prior to the partition of Austrian Empire in 1910 as a plausibly exogenous source of variation in firm-level innovation to isolate the effect of institutions on innovation. We show that more ethnically diverse local population is associated with markedly better local institutional quality, more impartial local government administration, and lower prevalence of corruption, which in turn predicts systematically more vibrant economic activity, greater complexity and higher rates of firm-level innovation at the local level. By contrast, the municipalities with historically concentrated presence of Slovenian- and Slavic-speaking population tend to have greater prevalence of corruption, less impartial government administration and lower overall governance efficacy, and entail non-trivial welfare losses in terms of foregone innovation that could take place with greater exposure to Latin and Germanic linguistic cleavages.

Considering the specific historical context of the Austrian Empire, we note that territories exposed to a larger extent to the Italian language in Slovenia are generally characterized by institutions of higher quality. On the one hand, this may be due to the Habsburg institutional affiliation itself. In this regard, a study by Becker et al. (2016) illustrates how European countries that shared the institutional framework of the Habsburg Empire were more likely to experience higher levels of trust and lower levels of corruption in the longer term. On the other hand, local communities in the Littoral-Carso-Gorizia region may benefit from the exposure to the civic virtues, social capital and entrepreneurship path-dependency historically present in the neighboring northern Italian regions (Guiso et. al, 2016). In other words, the economic and moral proactivity of regions part of the Austrian Empire, including Lombardy, may have been exported to Slovenia, either due to family or work migration, causing positive spillover effects in the country. Economic history shows that, prior to World War 1, communities in Northern Italy were better educated, more skilled, and less corrupt that in Southern Italy long before unification in 1861 (Felice, 2018a). The historical divide, then, contributed to affecting institutional performances in the long term, negatively in the South and positively in the North (Felice, 2018b). As a result, the North of Italy, area of interest for our analysis, developed into an open-access order (North et al., 2009; Di Martino et al., 2020), which by definition provides better services to its citizens. This sharply contrasted with the reality of the South, where the lack of civic traditions eventually led to bad democracy levels in the long term (Putnam et al., 1992). Historical evidence also sheds light on the proactive attitude of local elites in the North whilst being ruled by the Habsburgs in the 19th century. In Lombardy, for instance, this contributed to the creation of numerous scientific societies, generous investments in favor of new systems of manufacturing, communication, and transport, as well as collaborations between governors, commercial institutions, and technical experts (Focacci, 2019). Turin, Genoa, and Trieste were similarly the final destinations of 'small elites that had developed a strong entrepreneurial spirit [and] good technical expertise' (Caglioti, 2008). The typical inclusive institutions present in the territory, together with what Lacaita (1990) called 'productive intelligence', ultimately, allowed for local innovation and economic development. In connection to this, the Littoral-Carso-Gorizia region is also the only Slovenian region with direct access to the sea, as well as it is the closest to Western markets. This, too, may contribute to explaining its higher level of institutional quality compared to the more isolated Eastern regions. It should be noted that the comparision of institutional quality hinges on the current exposure within Slovenia.

Among the most significant catalysts for multilingual exposure we find the Free State of Fiume and the Free Territory of Trieste. As argued by Agri (2021), the history of Fiume was denoted by a specific legislative position in the Habsburg Empire. Self-governed since 1468, in 1779 Marie Therese of Austria granted to it the connotation of 'separate body' of the Hungarian crown. Over the 19th century, Fiume had to defend itself from Croatian nationalism, which led to the coexistence of two powers once World War I exploded; namely, the Croatian one and the 'Fiumian' one. In 1918, the National Council of Fiume officially unrecognized the Croatian authority and transformed the Council of Fiume to the Italian National Council (CNI). Croatians, Slovenians, Serbs on the one hand and the Italians of Fiume on the other, both self-proclaimed their governments and asked for annexation to the respective states. In October 1918, Fiume became part of the Italian Kingdom. However, after Italians, French, and Americans started entering the city of Fiume, in 1919 the CNI declared once again its supreme power of their city, port, and district. When the CNI was forced to unfold in favor of a temporary military-based government, a coup d'état led by famous Italian poet D'Annunzio helped establish an independent command and a special statute. This quickly escalated in the proclamation of Fiume as independent in 1920, when people of different cultures and languages coexisted. Similar is the more recent case of Trieste, autonomous during the Austro-Hungarian Empire, and then subject to Italian sovereignty

from 1920. Under the Habsburg, Trieste 'became an arena exemplifying how the 'many' —the heterogenous, the complicated, the overlapping, the unquantifiable— could be contained within a while' (Kirchner Reill, 2012). A range of languages and dialects coexisted in Trieste, including Italian, Ladin, Friulian, Slovene, Croatian, Serbian, German, Romanian, and Greek (Sluga, 2001). Its multinational composition made it the most European city, *urbs europeissima*, with intellectuals strongly believing in the social, cultural, political, and economic power of residing in such a polyglot and multicultural city, and empire (Pappalardo, 2021). After the German Nazis occupied the city in 1944, Yugoslavian shortly took over in 1945, ending with Trieste being under the control of the Anglo-American Forces (Coloni and Clegg, 2022). In 1947, Trieste became a Free Territory, conceived as under the control of the United Nations Security Council, with its own Government and Statute. However, no consensus was ever reached on the election of permanent members, 'leading to the current status under the administration of three countries: Italy, Slovenia and Croatia' (Coloni and Clegg, 2022). Overall, it is in linguistically diverse areas that creative interaction across competing languages takes place (Simon, 2013), often giving rise to innovative thinking.

With respect to innovation, it is evident that the economics of property rights in intellectual goods is now well understood and has been extensively discussed in the ground-breaking literature (Kitch, 1977; Merges and Nelson, 1994; Landes and Posner, 2003; Posner, 2011). In this regard, institutional framework conditions have been identified as important factors for influencing innovation activities of firms, industries and whole economies (Carlin and Soskice, 2006; Crafts, 2006; Blind, 2012). It must be emphasized, however, that not all patentable inventions are patented since, in some cases, firms rely on trade secrets or, due to very difficult and costly copying, patent protection may not seem worthwhile. In order to achieve better understanding of the extent to which various firms make us of the patent system Mansfield (1986) suggest the exploration of the propensity to patent as a proxy for firm level innovation which we accommodate in the empirical analysis.

2.3. Historical background

2.3.1. Italian linguistic influence

Since the demise of the Roman empire, the territory of present-day Slovenia has been at the intersection of Latin, Slavic, Germanic linguistic influence. After the independence from Yugoslavia in 1991, the constitution enshrined Slovene as the official language whilst Italian and Hungarian have been recognized as the co-official languages in their residential municipalities. More specifically, the Italian language is recognized as a mother tongue language of the Italian minority and as the co-official language in the Slovenian Istria. Public usage of Italian is both permitted and protected by law. Members of the Italian-speaking community are entitled to primary and secondary education in their native language, radio and television programs in Italian and to the communication with authorities in Italian.[1] Despite the large-scale exodus of Italian-speaking population from Istria and Trieste after the end of World War 2, Italian linguistic and cultural influence within modern-day Slovenia is both substantial and ubiquitous (Cavaion, 2020), emanating from a shared historical and institutional legacy of the Roman empire and culture. Even though the estimated fraction of native Italian speakers is 2%, the findings from 2012 Eurobarometer invariably suggest that around 12% of the Slovenian population aged 15 is fluent in Italian either as a mother-tongue or as a foreign language, which is indicative of the substantial exposure to the multilingual influence. Fig. 1 presents the fraction of Italian speakers by country based on 2012 Eurobarometer, and ranks Slovenia in the fourth place worldwide together with Swizerland and Uruguay. Panel (b) breaks down the Italian native speakers subnationally across selected European regions for which the data is available. It becomes apparent that the fraction of native Italian speakers in the bilingual areas within Slovenia is comparable with other regions in the Mediterranean area such as Istria and Catalonia.

2.3.2. German linguistic influence

The presence of German language and its Bavarian dialect can be traced back to the 8th century when large parts of the modern-day Slovenia have been subjected to the Bavarian rule. Prior to the disintegration of the Austrian Empire, many immigrants from German-speaking areas adopted Slovene as a mother tongue whilst others retained German as their mother tongue. Large German-speaking communities were concentrated in urban areas of Lower Styria (i.e. Untersteiermark), Gottschee County in southern Slovenia and in the settlements around Apace (Abstaller Feld) along the Mura river in eastern Slovenia. The 1910 Austrian Census identified 9% of the population as native German speakers. German-speaking majorities were found in towns such as Maribor (Marburg an der Drau), Celje (Cilli), Ptuj (Pettau), Kočevje (Gottschee), Slovenj Gradec (Windischgrätz), Slovenska Bistrica (Windisch Feistriz), Ormoz (Friedau) and Dravograd (Unterdrauburg) amongst several others. After the end of World War 1, the share of German speakers decreased significantly after a massive emigration from Yugoslavia into German-speaking territories in Austria, Switzerland and Germany. German-speaking majorities were still present in Gottschee and Abstall whereas many former German speakers have adopted Slovene as a mother-tongue language. In the aftermath of the World War 2, ethnic Germans in modern-day Slovenia were resettled from areas occupied by Italy into the German-occupied zone that had been annexed by Germany in 1941 during the invasion of Yugoslavia and Greece. An overwhelming majority of Germans after the end of the war was either expropriated by postwar socialist authorities through the infamous AVNOJ[2] decree, expulsed or murdered by the Yugoslav partisans. Although only 0.2% of the population declared German as the mother tongue in 2002 Census, autochthonous German influence has persisted over time which is indicated by the relatively large share of non-native German speakers. Fig. 2 depicts the share of German speakers across and within selected countries. Panel (a) depicts the share of German speakers across EU countries and suggests that around 27% of the Slovenian population is fluent in German, representing one of the highest shares in the European Union. Panel (b) exhibits the share of native German speakers in selected areas in 1910 using the Austrian Census data, and identifies a substantial German linguistic imprint prior to World War 1.

3. Data and methods

3.1. Dependent variable

Our dependent variable is the number of valid patents granted by the European Patent Office and US Patent and Trademark Office. Patent intensity is captured two-fold as *(i)* binary indicator of firm-level presence of the valid patent in the municipality and as *(ii)* the number of valid patents. The former variable captures the overall presence of firm-level innovation at the local level whilst the latter denotes the intensity of innovation and allows to better grasp the differences in the magnitude

[1] In terms of further detail, Italian is the co-official language in twenty-three different settlements across four distinctive municipalities (Ankaran-Ancarano, Izola-Isola d'Istria, Koper-Capodistria, Piran-Pirano).

[2] AVNOJ is a common abbreviation for The Anti-Fascist Council for the National Liberation of Yugoslavia which was a deliberative and legislative body established by Communist Party of Yugoslavia under the leadership of Josip Broz Tito to resist axis occupation of the country during World War 2. By 1944, the Western Allies formally recognised the AVNOJ as the Yugoslav legislative body.

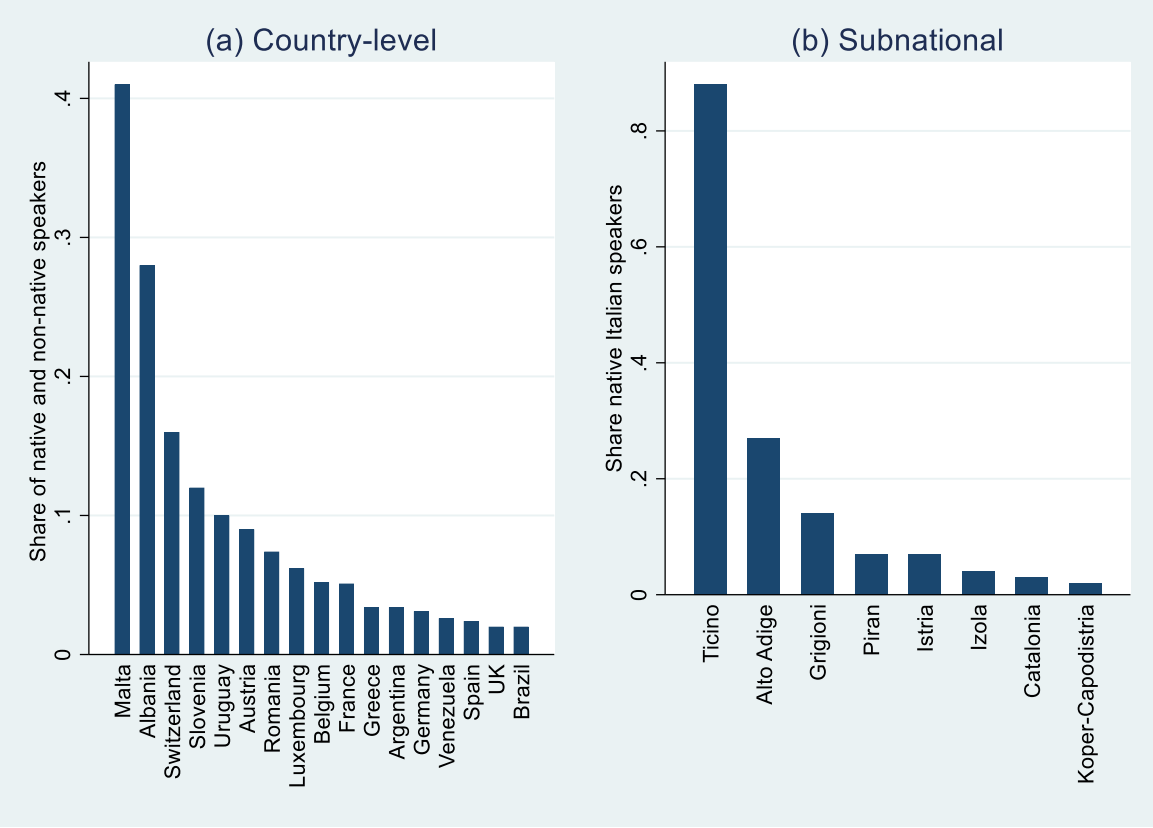

Fig. 1. Geographic distribution of Italian speakers across and within selected countries in 2010 s.

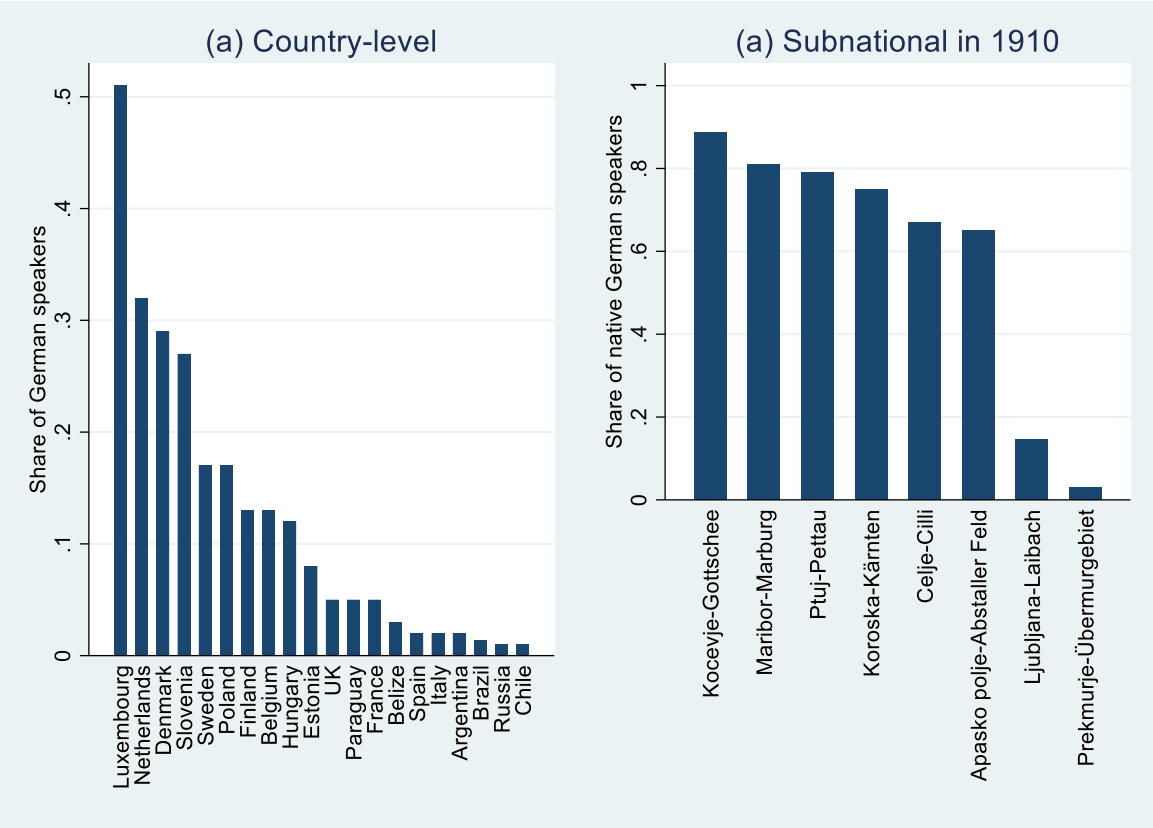

Fig. 2. Geographic distribution of German speakers across selected countries and within Slovenia.

of innovation across municipalities as well as to plausibly capture the marginal effect of institutional quality on firm-level innovation. It also posits innovation as a dynamic variable opposed to a more static one and allows us to better distinguish between high and low intensity of firm-level innovation.

Our data on the legal status of patent applications is taken from EPO's PATSTAT and USPTO Patent Database, which contain bibliographic and legal status firm-level patent data from leading industrialized and developing countries for the period 1995–2015. Patent presence is detected in 15% of the municipalities, whereas the number of valid patents ranges up to 41 patents per municipality. Albeit imperfect, patent grant by the EPO and USPTO serves as a crude proxy for firm-level innovation and productivity. In Fig. 3, we present the Slovenian EPO patent activity for number of patent applications and grants (valid patents) for 35 technology fields in the 2011–2020 period and patent applications per technology field. Fig. 4 presents the spatial distribution of firm-level innovation across the full cross section of Slovenian municipalities. The shaded areas represent a dummy variable indicating whether a valid EPO or USPTO patent grant is present in the municipality. Although patent activity appears to be somewhat more prevalent in western municipalities, notable contrasts in the intensity of patenting activity are perceptible among the municipalities hosting a firm with a valid patent grant. Only one valid patent is, for instance, found in municipalities such as Kamnik and Ajdovscina, whereas 33 patents and 41 patents are present in Ljubljana and Domzale.

3.2. Measuring institutional quality

Our approach to measure institutional quality in Slovenian municipalities is constrained by the lack of observable and measurable characteristics to provide insights into the variation in institutional quality. To address these concerns, our approach relies on the extraction of the residual component of the institutional quality from the observable subnational institutional quality series. Our aim is to extract a latent variable component of institutional quality from the higher-aggregation level and project it to the local level using the set of pre-determined geographic characteristics that cannot be manipulated. In this respect, our approach is similar to Magnusson's and Tarverdi (2020) method of estimating governance quality combined with the plausibly exogenous characteristics used for a linear projection of the institutional quality to the local level. Our set of the institutional quality variables comprises well-recognized and established indicators of *(i)* government quality, (ii) impartiality of government administration and *(iii)* prevalence of corruption. Table 1 uncovers the descriptive statistics for the pre-determined geographic variables used to recover the residual component of institutional quality.

Our definition of government quality relies on Rothstein and Teorell (2008), encompassing the traditions and institutions by which local authority is exercised, including the process of selection, monitoring and replacement, capacity of the local institutions to effectively formulate and implement sound policies, and respect of citizens for the institutions that govern economic and social interactions among them (Kaufmann et al., 2011). Second, the definition of government impartiality is more complex and directly hinges on the exercise of public power. This means that an impartial government official shall not take into consideration anything about the citizen or case that is not beforehand stipulated in the policy or the law and shall be unmoved by special relationships or personal preferences, treating citizens irrespective of personal relationships and personal likes and dislikes (Strömberg, 2000; Cupit, 2000). Third, our definition of corruption emphasizes the abuse of public power on behalf of the government official for private gain. Herewith, we attempt to combine both perception- and experienced-based measures of the extent to which elites and private interests exercise public power for private gains that are not limited to cases of petty or grand forms of corruption, but also pertain to special interests that may pose a source of local state capture.

To this end, we exploit the subnational variation in the quality and impartiality of government administration, and prevalence of corruption at NUTS 2 regional level in the European Union using the updated version of Charron et al. (2019) institutional quality data.[3] Due to the constrained availability of governance data at the subnational level in Slovenia, our focus in the empirical analysis is on the most recent year, although a longitudinal approach would be preferable. Following Magnusson and Tarverdi (2020), our goal is to extract the residual component of each governance indicator from the available NUTS2 regional level of aggregation based on the set of pre-determined time--invariant covariates that are orthogonal to the institutional quality variable of interest. This allows us to residualise the regional institutional quality to the municipal level. Suppose we observe a continuum of municipalities indexed by $i = 1, 2, \ldots N$ and a continuum of regions $j = 1, 2, \ldots J$ where$i \in N \in J$. For the full cross section of NUTS2 regions $j = 1, 2, \ldots J$ we estimate a canonical regression of the following form:

$$q_{j\in J} = \eta_0 + X'_{j,i\in N}\alpha + \varepsilon_{j,i\in N}$$

where q denotes the institutional quality variable, and $\mathbf{X}$ denotes the vector of pre-determined physical geographic covariates such as latitude, longitude, landlocked indicator, precipitation, mean temperature and elevation level as well as the indicators of climatic zone based on the Köppen-Geiger climate classification scheme (Kottek et al., 2006; Peel et al., 2007). The stochastic disturbances are denoted byε. From the canonical regression of institutional quality on the pre-determined physical geographic characteristics, we compute the residual component for the full cross section of Slovenian municipalities$i = 1, 2, \ldots N$:

$$e_{i\in N} = \widetilde{q}_{i\in N,j} - \overline{\mathrm{q}}_{i\in N,j}$$

where$\widetilde{q}$ denotes the observed realization of institutional quality and $\overline{\mathrm{q}}$ represents the predicted level of institutional quality. Notice that the institutional quality residuals convey an important interpretation. First, a positive residual component indicates the level of institutional quality that is higher than the one plausibly expected in geographically similar areas at NUTS2 level captured by $j = 1, 2, \ldots J$. Second, a zero residual component indicates the level of institutional quality as expected in geographically similar areas. And third, a negative residual component suggests that the implied level of institutional quality is worse than what would be expected in places with geographically similar conditions. This implies that the residual component can be used to determine the overall spatial disparities of institutional quality based on the difference between the observed and predicted level of quality. The substance of the residuals may indicate whether the observed institutional quality embeds a cluster of inclusive or more exclusionary local political and economic institutions. The overall institutional quality is recovered from the observed component at NUTS2 level and the exogenous physical geographic component:

$$Q_{i\in N} = q_{j\in J} + e_{i\in N}$$

where Q denotes the overall institutional quality, q is the observed institutional quality in j-the region at NUTS2 level, and e is the exogenous residual component. The interpretation of the residual component is both straightforward and intuitive. A zero residual indicates the institutional quality at the level expected by the pre-determined geographic characteristics, and highlights neither disproportionate institutional premium nor a sizeable loss. A positive residual indicates the level of quality that is disproportionately better than expected given

[3] The dataset contains estimates of governance quality, impartiality and prevalence of corruption for 208 regions for the time period 2010–2021 at NUTS2 regional level. The dataset is based on the largest survey ever undertaken to measure perceptions of quality of government collecting the opinions of over 129,000 respondents across 27 EU member states (Charron et. al, 2021)

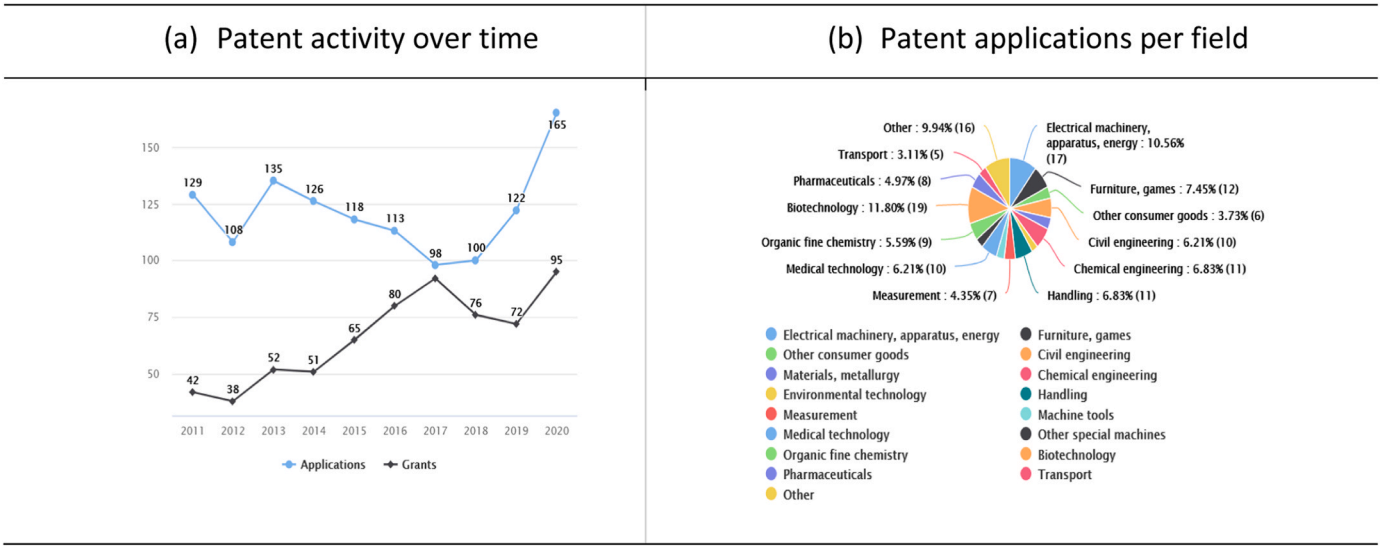

Fig. 3. Aggregate patent activity in Slovenia, 2011–2020.

the geographical characteristics. It implies that regions with positive residuals have considerably better latent quality of institutions than other regions with similar geographic endowments, highlighting institutional quality premium. By contrast, a negative residual suggests that the latent quality of institutions is considerably worse than the one expected by the geographic characteristics. Regions of municipalities with a negative residual are therefore characterized by the institutional quality penalty since their geographic peers from the donor pool enjoy considerably better quality. It should be stressed that the residual recovery approach is per se unable to fully recover and reconstruct the level of institutional quality and therefore is constrained by the ex-ante limitation emanating from the lack of observability of true quality at the local level. Nonetheless, by leveraging certain dimensions of quality against the pre-determined characteristics, our approach is able to delineate between the subnational entities characterized by institutional quality premium and their peers marked by the institutional quality penalty as a rough proxy of the nexus between the extractive and inclusive institutional framework (Acemoglu and Johnson, 2005).

Fig. 5 presents the spatial distribution of the first principal component of institutional quality, leveraging the indicators of quality, impartiality and corruption into a single latent variable with the maximum possible share of common variation. Municipalities are clustered into four quartiles ranging from low (in black), lower-middle (in dark gray), upper-middle (in light gray) and high (in white) quality ladders. The first principal component of institutional quality ranges from −1.56 in the municipality of Grad (*Felsőlendva*) to 4.68 found in municipality of Lenart v Slovenskih Goricah (*St. Leonhard in Windischbühel*). Municipalities with the lowest estimated institutional quality also include Ljubno (*Laufen*), Vuzenica (*Saldenhofen*), Apace (*Abstall*), and Ravne na Koroskem (*Gutenstein in Kärnten*). Municipalities with the highest estimated institutional quality also include Gorje (*Göriach*), Kranjska Gora (*Kronau*), Ajdovscina (*Aidussina*), and Vipava (*Vipacco*). The general thrust of these comparisons suggests that the institutional quality is substantially better in Western and North-Western Slovenia whilst the level in Eastern municipalities is considerably lower. Given that only two regions within Slovenia have access to the sea, it should be noted that municipal-level distance from the sea is an important factor behind the distance to the international markets in Western Europe, particularly in Italy and to a lesser degree, Austria. Thus, the proximity to the sea is a non-trivial pre-determined geographic variable that can potentially reshape the level of institutional quality substantially. To mitigate these concerns, we re-estimate the institutional quality residuals by leveraging Slovenian municipalities against NUTS2 regions through the restricted set of pre-determined variables without the sea access variable. The correlation between the full-vector institutional quality scores and the scores without the sea access variable is between + 0.89 (p-value = 0.000) and + 0.94 (i.e. p-value = 0.000) and arguably indicates a very strong similarity of the scores, and confirms the absence of biases in the scores possibly arising from the proximity to the Western markets. Table 2 reports the correlation coefficients in greater detailed for each institutional quality variable.

Table 3 compares the institutional quality of Slovenian NUTS3 regions with their European Union peers and provides several illustrative examples of the residual component on the nexus between more inclusive and less inclusive institutional framework. Specifically, the quality of governance, impartiality of government administration, and prevalence of corruption is compared to the set of best-performing and worst-performing regions whilst providing the regions with the closest estimated level of institutional quality. A glimpse of the comparison reveals that the regions with the best institutional quality predominantly can be found in Northern and Central Europe, although this is not uniform. For instance, the best-performing region in terms of estimated quality of governance is La Rioja in Spain, whereas regions from Denmark, Sweden, Austria, Luxembourg, Germany, and the Netherlands consistently exhibit the highest scores on institutional quality. In terms of the impartiality of government administration, regions such as Styria (i.e. *Steiermark*) and Lower Austria (i.e. *Niederösterreich*) can be found among

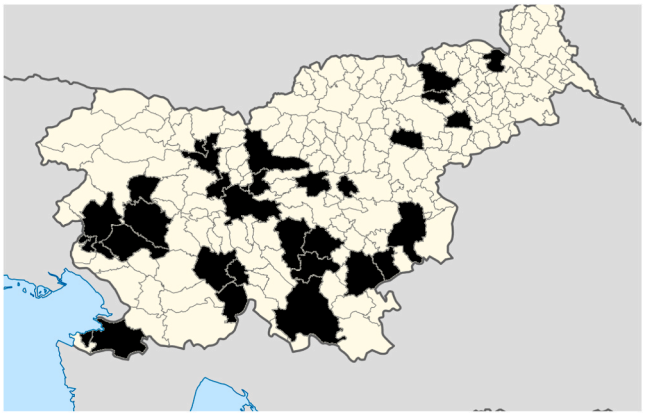

Fig. 4. Spatial distribution of patenting activity across Slovenian municipalities.

Table 1
Pre-determined geographic sources of variation in institutional quality in treatment-control matched sample.

	# obs	Mean	Std	Minimum	Maximum
Panel A: Baseline sample: NUTS2 regions					
Latitude	602	46.85	6.64	-21.11 (La Réunion)	65.58 (Norrbotten)
Longitude	602	14.68	9.40	61.72 (Guadeloupe)	55.53 (La Réunion)
Landlocked	602	0.74	0.42	0 (Blekinge)	1 (Freiburg)
Island	602	0.06	0.24	0 (Provence-Alpes-Côte d'Azur)	1 (Sicily)
Precipitation	602	845.34	284.75	213 (La Rioja)	3160 (Guyane)
Sunshine duration	602	1916.01	359.23	1252 (East Finland)	3414 (Cyprus)
Mean annual temperature (C)	602	10.49	3.10	1.4 (Norrbotten)	26.1 (Martinique)
Altitude	602	220.06	188.16	1 (Stockholm)	1047 (Harghita)
Size of land area	602	6610.19	11876.22	88 (Copenhagen)	98244 (Norrbotten)
Panel B: Treatment sample: Slovenian municipalities					
Latitude	212	46.22	0.32	45.5 (Kostel)	16.83 (Hodos)
Longitude	212	15.06	0.76	13.52 (Brda-Collio)	16.45 (Lendava-Lendva)
Landlocked	212	0.97	0.15	0 (Piran-Pirano)	1 (Ljubljana)
Precipitation	212	1093.28	154.14	784 (Hodos)	1363 (Osilnica)
Sunshine duration	212	1756.57	75.91	1619.88 (Lenart)	2060.64 (Koper-Capodistria)
Mean annual temperature (C)	212	9.95	1.26	6.2 (Jezersko)	14.4 (Koper-Capodistria)
Altitude	212	322.76	171.24	2 (Izola-Isola)	1544 (Gorje)
Size of land area	212	95.94	89.22	1 (Sveta Ana)	555 (Kocevje)

the benchmark cases. By contrast, the worst level of institutional quality is found in South-Eastern Europe, particularly Bulgaria and Romania, as well as in Southern Italy in regions such as Campania and Calabria.

The institutional quality of Slovenian regions appears to be quite far from the upper tier. Our estimates suggest that Western regions such as Littoral-Carso and Gorizia consistently exhibit the highest scores of institutional quality and are comparable with regions such as Central Portugal/Coimbra, Castilla y León in Spain, and Haute Normandie in France. Central Slovenian regions appear to score mediocrely in terms of quality of governance and are tied together with the Region de Murcia in Spain, whilst Eastern Slovenian regions score significantly below the average and are mostly comparable with Southern European regions with lower per capita income such as Algarve in Portugal or Notio Aigaio in Greece or with Central-South-Eastern European regions mainly from Czech Republic and Romania. The general thrust of this comparison reinforces the notion of a stark gap in the institutional quality between East and West that can be invoked from within-country variation in institutional quality.

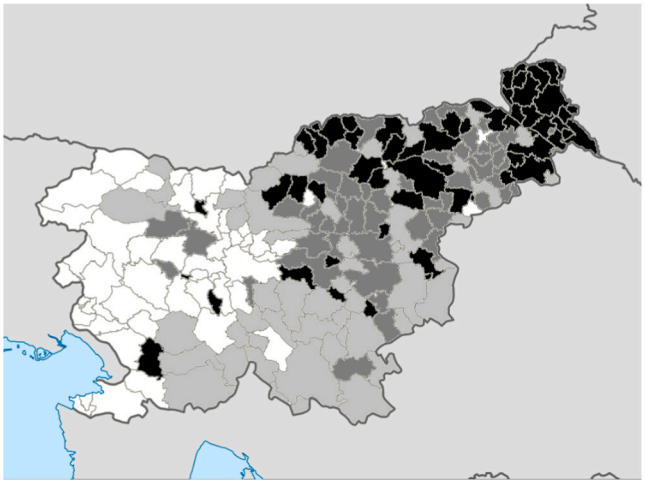

Fig. 5. Institutional quality across Slovenian municipalities.

3.3. Covariates

The set of confounding variables that, aside from the quality of local institutions, simultaneously affect the patent activity consists of municipal-level observable variables; namely, population density (i.e., defined as the number of inhabitants per sq. km2), physical size of the municipality (i.e., in km2), mean annual temperature (in °C), average age of the residents, number of graduates per capita, and birth rate per 1000 residents. The set of covariates also out to partially mitigate the inherent omitted variable bias whereupon the effect of institutional quality could be driven by the demographic, human capital or other auxiliary differences between the municipalities. The corresponding

Table 2
Correlation between institutional quality residuals with and without sea access pre-determined variable.

	European quality of government	Quality component	Impartiality component	Corruption component
Correlation coefficient (Rho)	+0.94 (0.000)	+0.81 (0.000)	+0.98 (0.000)	+0.92 (0.000)

Table 3
Institutional quality in NUTS2 European and NUTS3 Slovenian regions.

Quality of governance			Impartiality of government administration			Prevalence of corruption		
Best-performing regions								
1	La Rioja (ES)	4.454	1	Aland Islands (FI)	4.326	1	Aland Islands (FI)	4.320
2	Aland Islands (FI)	4.099	2	Steiermark (AT)	4.320	2	Oberpfalz (DE)	3.104
3	Helsinki-Uusimaa (FI)	3.997	3	Niederösterreich (AT)	3.326	3	Oberfranken (DE)	2.870
4	Jönköping (SE)	3.130	4	Pohjois Itä-Suomi (FI)	2.796	4	Helsinki-Uusimaa (FI)	2.848
5	Oberpfalz (DE)	3.081	5	Jönköping (SE)	2.766	5	Jönköping (SE)	2.792
6	Pohjois-Itä-Suomi (FI)	3.038	6	Helsinki-Uusimaa (FI)	2.720	6	Trier (DE)	2.549
7	Västmanland (SE)	2.946	7	Oberösterreich (AT)	2.678	7	Luxembourg City (LU)	2.498
8	Midtjylland (DK)	2.691	8	Kronoberg (SE)	2.448	8	Rheinhessen-Pfalz (DE)	2.467
9	Uppsala (SE)	2.617	9	Kärnten (AT)	2.401	9	Remich (LU)	2.373
10	Örebro (SE)	2.403	10	Drenthe (NL)	2.395	10	Pohjois-Itä Soumi (FI)	2.326
…			…			…	…	…
158	Centro PT	0.252	**95**	**Gorizia**	**1.173**	**153**	**Littoral-Carso**	**0.331**
161	**Gorizia**	**0.220**	**96**	**Littoral-Carso**	**1.172**	154	Castilla y León (ES)	0.293
…	…	…	97	Weser-Ems (DE)	1.146	…	…	…
…	…	…	…	…	…	**156**	**Gorizia**	**0.281**
164	**Littoral-Carso**	**0.201**	**111**	**Central Slovenia**	**0.981**	157	Champagne-Ardenne (FR)	0.278
165	Haute-Normandie FR	0.191	112	Hannover (DE)	0.975	…	…	…
…	…	…	**113**	**Upper Carniola**	**0.951**	**161**	**Central Slovenia**	**0.251**
…	…	…	…	…	…	162	Hainaut (BE)	0.136
177	**Central Slovenia**	**0.057**	**222**	**Mura**	**-0.787**	…	…	…
178	Región de Murcia ES	0.055	**223**	**Lower Sava**	**-0.793**	167	Navarra (ES)	0.052
…	…	…	224	Galati (RO)	-0.794	**168**	**Upper Carniola**	**0.040**
…	…	…	…	…	…	**…**	**…**	**…**
189	**Upper Carniola**	**-0.098**	230	Bacs-Kiskun (HU)	-0.841	**200**	**Littoral-Inner Carniola**	**-0.558**
190	Picardie (FR)	-0.123	**231**	**South East Slovenia**	**-0.844**	201	Razgrad (BG)	-0.567
…	…	…	…	…	…	**202**	**Lower Sava**	**-0.573**
192	Crete (EL)	-0.155	234	Vrancea (RO)	-0.872	203	Sibenik-Knin (HR)	-0.585
193	**Lower Sava**	**-0.178**	**235**	**Central Sava**	**-0.873**	…	…	…
194	**South East Slovenia**	**-0.189**	236	Buzau (RO)	-0.891	**207**	**Central Sava**	**-0.615**
…	…	…	…	…	.	208	Silistra (RO)	-0.616
198	**Littoral-Inner Carniola**	**-0.248**	**237**	**Drava**	**-0.899**	…	…	…
199	Nicosia (CY)	-0.259	**238**	**Savinja**	**-0.901**	**210**	**South East Slovenia**	**-0.631**
…	…	…	…	…	…	211	San Gwann (MT)	-0.640
201	**Mura**	**-0.273**	**240**	**Littoral-Inner Carniola**	**-0.916**	…	…	…
202	Southeast Czech Rep.	-0.278	241	Hunedoara (RO)	-0.920	216	Larnaca (CY)	-0.706
203	**Central Sava**	**-0.288**	…	…	…	**217**	**Mura**	**-0.714**
…	…	…				…	…	…
206	**Savinja**	**-0.335**	**248**	**Carinthia**	**-0.968**	**224**	**Drava**	**-0.759**
207	Notio Aigaio (EL)	-0.337	249	Caras Severin (RO)	-0.972	225	Arad (RO)	-0.761
…	…	…	…	…	…	…	…	…
210	**Drava**	**-0.345**	…	…	…	**228**	**Savinja**	**-0.795**
211	Central Czech Rep.	-0.356	…	…	…	**229**	**Carinthia**	**-0.803**
…	…	…	…	…	…	230	North East Czech Rep.	-0.817
218	**Carinthia**	**-0.439**	…	…	…	…	…	…
219	Algarve (PT)	-0.445	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…
Worst-performing regions								
385	Ilfov (RO)	-3.501	385	Dobrich (BG)	-2.719	385	Blagoevgrad (BG)	-2.994
386	Constanta (RO)	-3.515	386	Campania (IT)	-2.771	386	Bucharest (RO)	-3.054
387	Campania (IT)	-3.850	387	Lombardia (IT)	-2.898	387	Botosani (RO)	-3.055
388	Calabria (IT)	-4.105	388	Sardegna (IT)	-3.054	388	Suceava (RO)	-3.104
389	Constanta (RO)	-4.377	389	Lubelskie (PL)	-3.057	389	Ilfov (RO)	-3.316
390	Tulcea (RO)	-4.511	390	Calabria (IT)	-3.745	390	Campania (IT)	-3.330

Source: own calculation based on Charron et. al. (2019)

data used to construct these variables is taken from the Statistical Office's latest *Slovene Statistical Regions and Municipalities in Numbers* series.

3.4. Instrumental variables

Our instrumental variables comprise the historical measures of municipal-level ethnic diversity before the outbreak of World War 1. Specifically, we extract municipal-level shares of linguistic K groups where $K = \{Slovenian, Italian, German\}$ for the year 1910. This applies to the Austrian population for four distinctive former Austrian provinces overlaying current administrative division; namely, Carniola,[4] Styria,[5]

[4] Spezialortsrepertorium von Krain. Bearbeitet auf Grund der Ergebnisse der Volkszählung vom 31. Dezember 1910. Herausgegeben von der Statistischen Zentralkommission. Wien: Verlag der Deutschösterreichischen Staatsdruckerei, 1918.

[5] Spezialortsrepertorium von Steiermark. Bearbeitet auf Grund der Ergebnisse der Volkszählung vom 31. Dezember 1910. Herausgegeben von der K. K. Statistischen Zentralkomission. Wien: Verlag der Deutschösterreichischen Staatsdruckerei, 1919.

Table 4
Descriptive statistics.

	# obs	Mean	StD	Min	P25	P75	Max
Panel A: Outcomes							
Valid EPO and US patent	212	0.15	0.35	0	0	0	1
# of valid EPO and US patents	212	0.76	4.26	0	0	0	41
Panel B: Treatment variables: institutional quality scores							
Quality of local government	212	-0.25	0.32	-0.56	-0.47	-0.11	2.20
Impartiality of local government	212	-0.37	1.02	-1.19	-1.08	0.87	1.87
Corruption in local government	212	-0.59	0.54	-1.12	-1.00	-0.09	1.02
Panel C: Structural covariates							
Population density	212	115.02	126.98	5	48	132.5	1053
Size of municipality	212	4.17	0.94	0	3.56	4.76	6.31
Mean annual temperature	212	9.95	1.263	6.2	9.35	10.3	14.4
Age of residents	212	43.37	1.966	38	42.2	44.6	50.6
Graduates per capita	212	7.90	1.936	0	7	9	16
Share of foreign-born population	212	5.36	3.50	0.6	2.7	7	16.8
Birth rate per 1000 residents	212	9.55	2.21	4.2	8	10.75	19.5
Panel D: Instrumental variables							
Garcia-Montalvo – Reynal-Querol ethnic diversity index	212	2.69	0.52	1	2.55	3	3
Alesina ethnic diversity index	212	0.075	0.13	0	0	0.11	0.49
Share of pre-WW1 German speakers	212	0.04	0.11	0	0	0.04	0.80
Share of pre-WW1 Italian speakers	212	0.02	0.09	0	0	0	0.77
Share of pre-WW1 Slovenian speakers	212	0.94	0.14	0.2	0.94	1	1

Carinthia [6] and Littoral.[7] Based on the share of linguistic diversity, we construct a simple measure of linguistic diversity similar to Alesina et al. (2003):

$$Diversity_{i\in N,1910} = 1 - \sum_{k=1}^{K} p^2_{k\in K,i\in N,1910}$$

where p denotes k-th group's linguistic share in i-th municipality in the year 1910, indicating their relative size. The value of the index is in the range between 0 and 1 and may represent the probability that two randomly selected individuals in i-th municipality come from different linguistic groups. Notice that higher values of the index represent a more linguistically diverse population and, thus, a higher number of distinct ethnic groups. Despite its relatively straightforward interpretability, the linguistic diversity index may not properly reflect the linguistic polarization. Given the relative size of the group, linguistic polarization provides an insight into the ethnic composition of the population, uncovering the disparity between the dominant linguistic group and the linguistic minorities. Following Garcia-Montalvo and Reynal-Querol (2005), we construct linguistic polarization index as follows:

$$Polarization_{i\in N,1910} = 1 - \sum_{i=1}^{K} \left(\frac{\Omega - p_{i\in N,k\in K}}{\Omega} \right)^2 \times p_{i\in N,k\in K}$$

where $k = 1, 2, \ldots K$ and Ω denotes the share of the dominant linguistic group, and p_i is the relative group size. The tendency of the index moves towards the total number of groups for very homogenous communities and towards one for more linguistically diverse communities. Therefore, higher values of the index indicate more linguistically polarized communities with a higher share of the dominant group. The index may also reflect whether municipalities with the predominant Slovenian speakers perform differently with respect to the institutional quality compared to other municipalities with higher shares of Italian and German speakers. To investigate the influence of each linguistic group on institutional quality, we also consider the separate share of linguistic groups denoted by $S_{k\in K,i\in N,1910} = f\left(s^k_{1910,i\in N}\right)$ where S represents k-th group of linguistic shares. Table 4 presents the descriptive statistics for the outcome variables, institutional quality measures, covariates and instrumental variables combined. Fig. 6 presents the disparities in ethnolinguistic diversity and polarization in a full cross-section of Slovenian municipalities before World War 1 as our source of variation in the exposure to multilingualism to estimate the effect of institutional quality on firm-level innovation.

Our findings show that, on average, German-speaking areas in the Eastern part of Slovenia present less impartial and more corrupt government administration. While high levels of human capital usually contribute to boosting innovation, it is plausible to think that settlers in this area had a type of knowledge not directly related to long-term innovation. On the one hand, settlers could be industrious, cautious, and prepared for arduous tasks but not sufficiently skilled for challenges in trade, science, or technology. As reported by Sević (2000), long before the 1860 s, German settlers, favored over newcomers from other nationalities, 'were spared paying all taxes and fees for a period of ten years' if they were farmers, and additional five years if they were craftsmen. On the other hand, even if individuals did possess the science-based education typical of pre-war Germany (König, 1996), they may have suffered from a severe lack of exposure to classical studies. On this subject, Ben-Haim (1999) was one of the first ones to argue how technological education alone is not sufficient to face societal challenges, develop civilization, and make responsible decisions. More recently, O'Mahony et al. (2019) provide evidence concerning the pivotal role played by humanities in benefiting businesses, governments and societies. This is perhaps relevant in explaining difficulties in German-speaking territories to establish high-quality governments focused on the progress of society. It also supports the argument by Hakhverdian and Mayne (2012) that, in corrupt societies, education relates negatively to institutional trust, therefore creating a vicious circle for governance. More in general, empirical research has found that the effects of 'bad' colonialism can be persistent (Angeles and Neanidis, 2015), with negative effects on economic development and trust in the long term (Bruhn and Gallego, 2012), including the possibility to generate extractive institutions (Acemoglu and Robinson, 2012).

Conversely, Italian-speaking areas are characterized by lower levels of corruption, more impartiality, and higher institutional quality. As anticipated in Section 2, this can be explained by the historical development of inclusive and open-access institutions in Northern Italy, where levels of civic capital increased substantially over time (Felice,

[6] Spezialortsrepertorium der Österreichischen Länder. Spezialortsrepertorium von Kärnten. Bearbeitet auf Grund der Ergebnisse der Volkszählung vom 31. Dezember 1910. Herausgegeben von der Statistischen Zentralkommission. Wien: Staatsdruckerei, 1918.

[7] Spezialortsrepertorium der Österreichischen Länder. Spezialortsrepertorium für das Österreichisch-Illyrische Küstenland. Bearbeitet auf Grund der Ergebnisse der Volkszählung vom 31. Dezember 1910. Herausgegeben von der Statistischen Zentralkommission. Wien: Wien: Staatsdruckerei, 1918

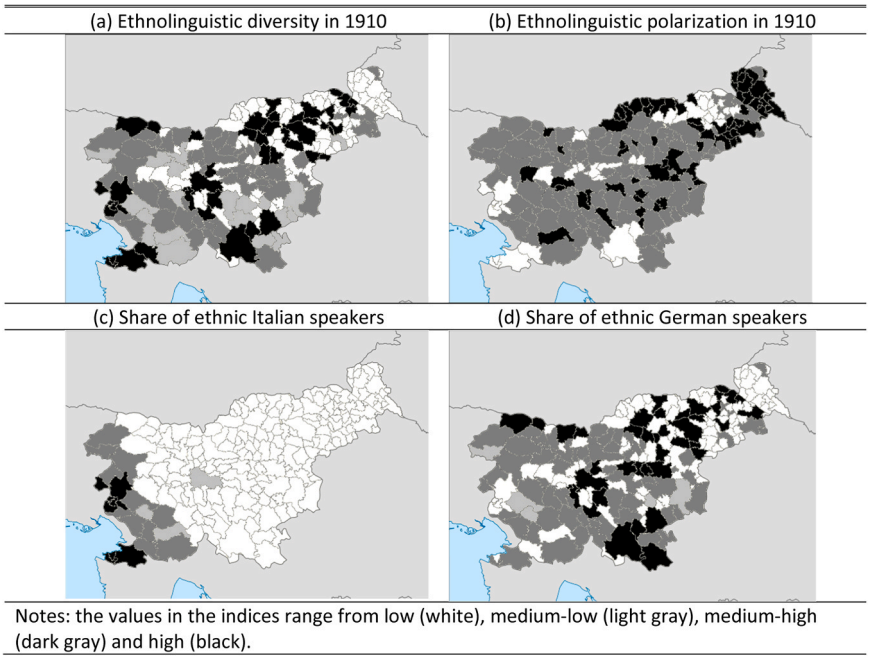

Fig. 6. Ethnolinguistic diversity and polarization across Slovenian municipalities before World War 1.

2018a). On this subject, it is perhaps interesting to note that one of the countries with higher corruption control accounts for Italian history when trying to understand what makes governance successful in these terms. In her analysis focused on Denmark, Mungiu-Pippidi (2013) illustrates how, since the 11th century, city-states in Italy 'turned into self-governing 'communes' and managed to build elaborate constitutions, strong administrations, and effective bureaucracies'. Additionally, to avoid conflict of interests, city managers were elected from a different city 'so that no local candidates could be favored', as well as participation in the governance of the city-state was encouraged through a quota system. In other words, Italian participation in government, either directly or indirectly, has been quite substantial and impartial for a long time. Although the mean share of ethnic pre-WW1 Italian speakers is around 2%, it should be noted that the historical presence of ethnic Italian linguistic influence and a non-zero share is scattered across fifteen current-day municipalities or roughly 7% of the full sample. Taken together with the implicit spillover effects, this implies that testing the null hypotheses is not limited by the a very narrow set of observations that could pose as hypothetical outliers. Fig. 7 presents the municipalities where the presence of ethnic Italian speakers is greater

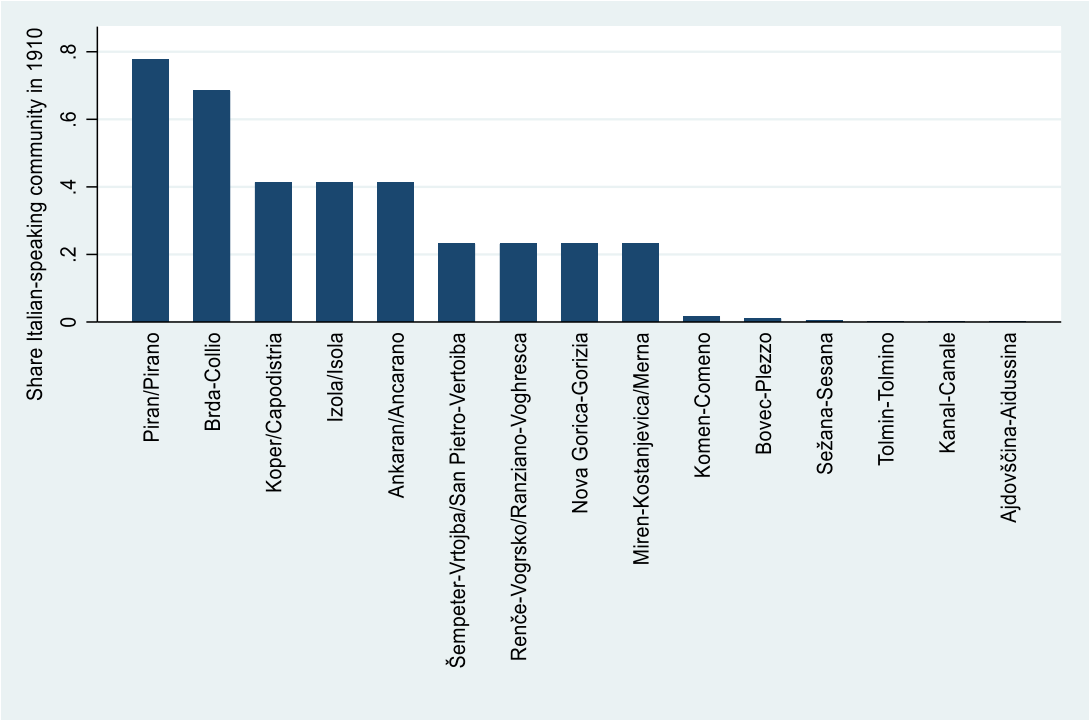

Fig. 7. Geographic dispersion of ethnic Italian speakers before World War 1.

than zero both in absolute and relative terms.

4. Identification strategy

Our aim is to examine the contribution of institutional quality at the local-level firm innovation consistently. To this end, our empirical strategy is to estimate the following cross-sectional specification:

$$y_{i\in N} = \widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\boldsymbol{\beta}} + \varepsilon_{i\in N} \tag{1}$$

where y is the firm-level innovation variable in i-th municipality, $\widehat{\theta}_0$ is the constant term, Q the estimated institutional quality, $\mathbf{X}$ the vector of covariates and ε the random error. Standard errors are clustered at the municipality-level using Huber-White sandwich variance-covariance estimator. Our key coefficient of interest is $\widehat{\theta}_1$, which captures the contribution of local institutional quality to firm-level innovation at the municipal level, where we expect $\widehat{\theta}_1 > 0$. Since firm-level innovation activity at the municipal level is also captured by a binary variable indicating whether an EPO or USPTO-approved patent grant is present in the municipality, we separately estimate the following probit specification:

$$\Pr(y_{i\in N} = 1|X) = \int_{-\infty}^{X'_i\beta} \varphi(t)\cdot dt = \Phi\left(\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right) \tag{2}$$

where $\Phi(\cdot)$ denotes the standard normal distribution function under the condition that for each covariates, $\lim_{X'_i\beta\to+\infty} \Pr(Y = 1|x) = 1$ and $\lim_{X'_i\beta\to-\infty} \Pr(Y = 1|x) = 0$ hold. Since the normality assumption behind the residual distribution may be violated, we further estimate the following logit municipal-level specification:

$$\begin{aligned}\Pr(y_{i\in N} = 1|X) &= \frac{\exp\left\{\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right\}}{1 + \exp\left\{\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right\}} = \\ &= \Lambda\left\{\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right\}\end{aligned} \tag{3}$$

where $\Lambda(\cdot)$ indicates the logistic cumulative distribution function with the symmetric shape. Notice that our interest lies in the marginal effects of institutional quality on the propensity of firm-level innovation where we compute the partial derivatives from probit and logit specifications In Eqs. (2) and (3):

$$\frac{\partial E(y_{i\in N})}{\partial Q_{i\in N}} = \frac{\exp\left\{\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right\}}{1 + \exp\left\{\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right\}} \times \widehat{\theta}_1 \tag{4}$$

$$\frac{\partial E(y_{i\in N})}{\partial Q_{i\in N}} = \Phi\left(\widehat{\theta}_0 + \widehat{\theta}_1 \cdot Q_{i\in N} + X'_{i\in N}\widehat{\beta} + \varepsilon_{i\in N}\right) \times \widehat{\theta}_1 \tag{5}$$

which denotes the marginal effect of institutional quality on the local-level innovation evaluated at the sample means of the data using continuous functions with first derivatives. To this end, we apply Oehlert (1992) first-order Taylor series expansion approach to approximate the moment functions of random variables. One of the potential caveats behind the effect of institutional quality on local firm-level innovation concerns the reverse causality and omitted variable bias. Namely, whether it is better quality of local governance that fosters firm-level innovation or, conversely, whether it is municipalities with a higher rate of innovation that are better able to afford and provide higher-quality governance, along with more impartial government administration and lower prevalence of corruption. The first possible chain of causation implies that institutions may cause innovation, whilst the other side entails demand-induced pressure on institutional change that may arise from localized comparative advantages. If the reverse causation is true, a more vibrant firm-level innovation may induce the local politicians and officials to promulgate better quality of governance rather than vice versa. Moreover, the presence of omitted variable bias implies that$\mathrm{cov}(Q_{i\in N}, \varepsilon_{i\in N}) \neq 0$. We address the endogeneity of institutional quality at the local level by deploying a two-stage least square (2SLS) approach and estimate the following first-stage equation for institutional quality:

$$\begin{aligned}Q_{i\in N} = \widehat{\alpha}_0 + \widehat{\alpha}_1 f\left(1 - \sum_{k=1}^{K} p^2_{i\in N,1910}\right) + \widehat{\alpha}_2\left[f\left(s^k_{1910,i\in N}\right)\right] + \\ + \widehat{\alpha}_3\left[1 - \sum_{i=1}^{K}\left(\frac{\Omega - p_{i\in N,k\in K}}{\Omega}\right)^2 \times p_{i\in N,k\in K}\right] u_{i\in N}\end{aligned} \tag{6}$$

where $1 - \sum_{k=1}^{K} p^2_{i\in N,1910}$ denotes linguistic diversity index, $1 - \sum_{i=1}^{K}\left(\frac{\Omega - p_{i\in N,k\in K}}{\Omega}\right)^2 \times p_{i\in N,k\in K}$ is the linguistic polarization index, and $f\left(s^k_{1910,i\in N}\right)$ is the k-th linguistic group shares in the year 1910. By default, valid instrumental variables for institutional quality should satisfy two criteria. First, the proposed set of instrumental variables must influence the outcome variables only through the institutional quality and not through other channels. In particular, the exogeneity assumption cannot be tested directly since only plausible counterexamples can be invoked. Since the linguistic diversity variables are determined historically, it is plausible to assume that these instrumental variables evolve outside the current stream of incentives for innovation and may not be prone to any sort of influence or manipulation. Econometrically, the exogeneity assumption implies that $\mathrm{cov}\left(1 - \sum_{k=1}^{K} p^2_{i\in N,1910}, \varepsilon_{i\in N}\right) = 0$, $\mathrm{cov}\left(1 - \sum_{i=1}^{K}\left(\frac{\Omega - p_{i\in N,k\in K}}{\Omega}\right)^2 \times p_{i\in N,k\in K}, \varepsilon_{i\in N}\right) = 0$ and$\mathrm{cov}\left(f\left(s^k_{1910,i\in N}\right), \varepsilon_{i\in N}\right) = 0$, respectively.

Second, the proposed instrumental variable should be able to account for the systematic cross-sectional variation in institutional quality, which implies that the linguistic diversity variables and institutional quality should exhibit a substantial non-zero correlation to satisfy the relevance criteria. The set of relevance criteria can be written through the following covariance restrictions, $\mathrm{cov}\left(Q_{i\in N}, 1 - \sum_{k=1}^{K} p^2_{i\in N,1910}\right) \neq 0$, $\mathrm{cov}\left(Q_{i\in N}, f\left(s^k_{1910,i\in N}\right)\right) \neq 0$,and$\mathrm{cov}\left(Q_{i\in N}, 1 - \sum_{i=1}^{K}\left(\frac{\Omega - p_{i\in N,k\in K}}{\Omega}\right)^2 \times p_{i\in N,k\in K}\right) \neq 0$, respectively. In contrast with the exogeneity assumption, the relevance assumption is directly testable empirically. If the exogeneity and relevance assumptions are satisfied, the notion of valid instrumental variables becomes more plausible. In quantitative terms, by letting $Z = \left[1 - \sum_{k=1}^{K} p^2_{i\in N,1910}, 1 - \sum_{i=1}^{K}\left(\frac{\Omega - p_{i\in N,k\in K}}{\Omega}\right)^2 \times p_{i\in N,k\in K} f\left(s^k_{1910,i\in N}\right)\right]$ denote the full vector of instrumental variables, the presence of the exogeneity assumption implies that$\mathrm{cov}(Z_{i\in N}, \varepsilon_{i\in N}) = 0$. Then it follows immediately, that the instrumental variable estimator $\widehat{\theta}_1$ is consistent and reflects the true effect of institutional quality on innovation, irrespective of the sample standard deviation of the error term and institutional quality variable, which implies that:

$$\mathrm{plim}\widehat{\theta}^{IV}_1 = \theta_1 + \frac{\mathrm{cov}(Z_{i\in N}, \varepsilon_{i\in N})}{\mathrm{cov}(Z_{i\in N}, Q_{i\in N})} \times \frac{\sigma_{\varepsilon_{i\in N}}}{\sigma_{Q_{i\in N}}}$$

where $\text{plim}\widehat{\theta}_1^{IV} = \theta_1$ provided that $\text{cov}(Z_{i\in N}, \varepsilon_{i\in N}) = 0$ holds.

5. Results

5.1. Baseline results

Table 5 reports the estimated effect of institutional quality on local-level innovation. To capture the multifaceted firm-level innovation at the local level, we estimate both probit and logit specifications deploying the dichotomous nature of innovation. In these specifications, the dependent variable is whether the EPO and USPTO-approved patent grant is present at the local level. We further capture the intensity of firm-level innovation by constructing the knowledge-intensity variable, which roughly captures the share of total patent grants at the local level. To this end, we estimate a simple Tobit model with right-tail observational censoring given that the value of the intensity variable is zero in those municipalities without valid patent grants.

Column (1) reports the linear probability estimated effect of institutional quality on the probability of the valid EPO and USPTO patent grant. The evidence suggests that improving the institutional quality is associated with significantly higher probability of valid patent grant. In particular, the estimates suggest that the probability of valid patent grant increases by 12% in response to one basis point improvement in the quality of local government. In addition, statistically significant effects of improved government impartiality are perceptible. The point estimate suggests that the equivalent 1 point improvement in the impartiality of local government administration tends to increase the probability of valid patent grant by 3.7%, respectively. In addition, a more rigorous anti-corruption framework at the level tends to foster the probability of patent grant by 8.7%, respectively. The point estimates confirm the importance of institutional quality for firm-level innovation at the local level. Columns (2) and (3) present the corresponding probit and logit estimated effects of institutional quality on innovation. Compared to the linear probability models, probit and logit estimates suggest that improving the quality of governance tends to increase the propensity to patent in the range between 8.2% and 10.3%, respectively. The point estimates are both statistically significant at 5% level. Similar to linear probability estimates, the magnitude of the coefficient on the impartiality of the government administration in Panel B is noticeably smaller whilst statistically significant, thereby reaffirming the notion that a more impartial local government tends to reinforce firm-level innovation considerably. In a similar vein, the higher level of corruption prevalence variable (i.e., which corresponds to the lower prevalence of corruption) tends to increase the propensity towards a valid patent grant in the range between 5.8% and 7.2%. The estimated coefficients are statistically significant at 5%, indicating a detrimental effect of corruption on firm-level innovation that is reasonably robust across the multitude of our specifications. Column (4) reports tobit estimated effects of institutional quality on local innovation using left-censored knowledge-intensity dependent variable. The estimates uncover a somewhat greater elasticity of innovation with respect to institutional quality compared to the specifications with binary innovation outcomes. In particular, estimates in column (4) arguably highlight a marked positive contribution of improved local government quality. A reasonable improvement in the quality of governance by one basis point is associated with a 4.2% knowledge-intensity increase, whilst the equivalent improvements in the impartiality and prevalence of corruption augment the intensity by 1% and 2.2%, respectively. Both point estimates are also statistically significant at 10% and 5%, which implies that the improving the quality of institutions matters and may further ameliorate an original context of lack of innovation.

Perhaps one of the most pressing policy-relevant questions behind our estimates arises from the counterfactual scenario. In particular, one wonders what the potential level of firm-level innovation at the local level would be if the municipalities improved the quality of local institutions to a certain attainable threshold. Although an attainable benchmark of institutional quality frontier may be disputable and subject to rigorous theoretical discussion, we set the benchmark at the attainable level by seeking the nearest counterpart of Slovenian municipalities and regions where two criteria are met: *(i)* a high level of

Table 5
Institutional Quality and Local Innovation in a Cross- Section of Slovenian Municipalities.

	Linear probability model	Probit	Logit	Tobit
	(1)	(2)	(3)	(4)
	Valid EPO and US Trademark Office Approved Patent			Knowledge-intensity: share valid EPO and US patents
Panel A: Treatment variable: quality of local government				
β	.121	.103**	.082**	.042**
	(.090)	(.052)	(.041)	(.021
95% Confidence bounds	[−.055,.299]	[−.0002,.206]	[.0009,.164]	[.0007,.084]
McFadden R2	0.17	0.25	0.25	0.23
Count R2		0.87	0.87	
Wald Test	6.18	32.62	33.47	3.49
(p-value)	(0.000)	(0.000)	(0.000)	(0.002)
Panel B: Treatment variable: impartiality of local government administration				
β	.037	.031*	.025*	.009
	(.027)	(.017)	(.014)	(.007)
95% Confidence bounds	[−.017,.092]	[−.002,.064]	[−.003,.054]	[−.005,.024]
McFadden R2	0.20	0.25	0.25	0.21
Count R2		0.88	0.88	
Wald Test	6.20	32.77	33.74	3.45
(p-value)	(0.000)	(0.000)	(0.000)	(0.003)
Panel C: Treatment variable: prevalence of corruption in local government administration				
β	.087*	.072**	.058**	.022*
	(.052)	(.033)	(.029)	(.014)
95% Confidence bounds	[−.016,.191]	[.006,.138]	[.0004,.116]	[−.006,.051]
McFadden R2	0.21	0.26	0.26	0.22
Count R2		0.88	0.87	
Wald Test	6.48	35.09	35.88	3.48
	(0.000)	(0.000)	(0.000)	(0.002)
# municipalities	212	212	212	212

Notes: the table reports the estimated effect of institutional quality on firm-level innovation across the full cross-section of Slovenian municipalities. Standard errors are adjusted for the arbitrary heteroscedasticity and serially correlated spatial stochastic disturbances using Eicker-Huber-White sandwich estimator. Heteroskedasticity-consistent standard errors are denoted in the parentheses. Asterisks denote statistically significant coefficients at 15% (a), 10% (*), 5% (**), and 1% (***), respectively.

overall institutional quality and *(ii)* geographic proximity to ensure that the institutional quality frontier is both easily interpretable and plausible. One such candidate region is the Austrian region of Steiermark which ranks 21st among EU regions from Table 2 on institutional quality dimension, 4th on the impartiality of government administration, and 67th on the prevalence of corruption, and scores well above the level of Slovenian regions and municipalities. Our strategy is to predict the hypothetical level of innovation if the observed institutional quality of municipalities were to improve to the frontier level exemplified by Steiermark using our preferred probit specification from Column (2).

Fig. 8 reports the counterfactual estimations for the full cross section of Slovenian municipalities. More specifically, the figure displays the increase in the probability beyond the baseline predicted municipal-level probabilities of the valid EPO and USPTO patent grant if the score of institutional quality at the local level were the same as that of Steiermark. In the next step, we build the counterfactual distributions for the baseline probabilities at the observed level of institutional quality and the probabilities in response to the benchmark level of quality. The evidence suggests that the probability of valid patent grant increases between 15% and 42% beyond the baseline predicted probability in response to getting the institutional quality to the level of Steiermark. Although the augmented probabilities are fairly uniform across the municipalities, Western municipalities tend to gain somewhat more than their Eastern peers. The estimated counterfactual is somewhat lower for the impartiality of government administration where the probability of patent grant improves in the range between 7% and 16% with Western municipalities exhibiting somewhat greater increase than their Eastern peers. Similar improvement in the probability of patent grant is found with respect to the hypothetical improvement in the prevalence of corruption where the counterfactuals indicate an increase in the probability beyond the predicted level between 1.5% and 8%. A closer look at the counterfactual distributions also suggests that improving the institutional quality across all dimensions is associated with less spatially dispersed patent granting probabilities. Comparing the peaks of the distribution functions implies that the scaled counterfactual distributions exhibit about four times higher probability of patent granted compared to the real observed distributions. These insights underpin the significant relevance of institutional quality for firm-level innovation. This particular notion is further bolstered by the peak-to-peak comparison of the distributions, suggesting that the implied probability of the peak of the scaled counterfactual distribution is noticeably higher than the actual level with the observed density, which further indicates relatively large firm-level innovation gains derived from improving institutional quality to the feasibly attainable institutional frontier.

5.2. *Instrumental variable estimates*

Table 6 presents the instrumental variable estimated effects of institutional quality on firm-level innovation across the municipalities. Panel A reports the structural estimates whilst Panel B presents first-stage OLS estimates for the institutional quality variables based on the plausibly exogenous variation in historical linguistic diversity. First-stage estimates indicate a clear and discernible importance of historical linguistic diversity for contemporary institutional quality and confirm a sizeable institutional persistence (Acemoglu and Robinson, 2006; Nunn, 2009), suggesting that historical exposure to multilingualism largely matters for firm-level innovation.

In particular, first-stage estimates suggest that municipalities with greater linguistic diversity between Slovenian, Italian and German ethnic groups have, on average, 0.8 standard deviation higher quality of local government administration, ceteris paribus. The point estimate is

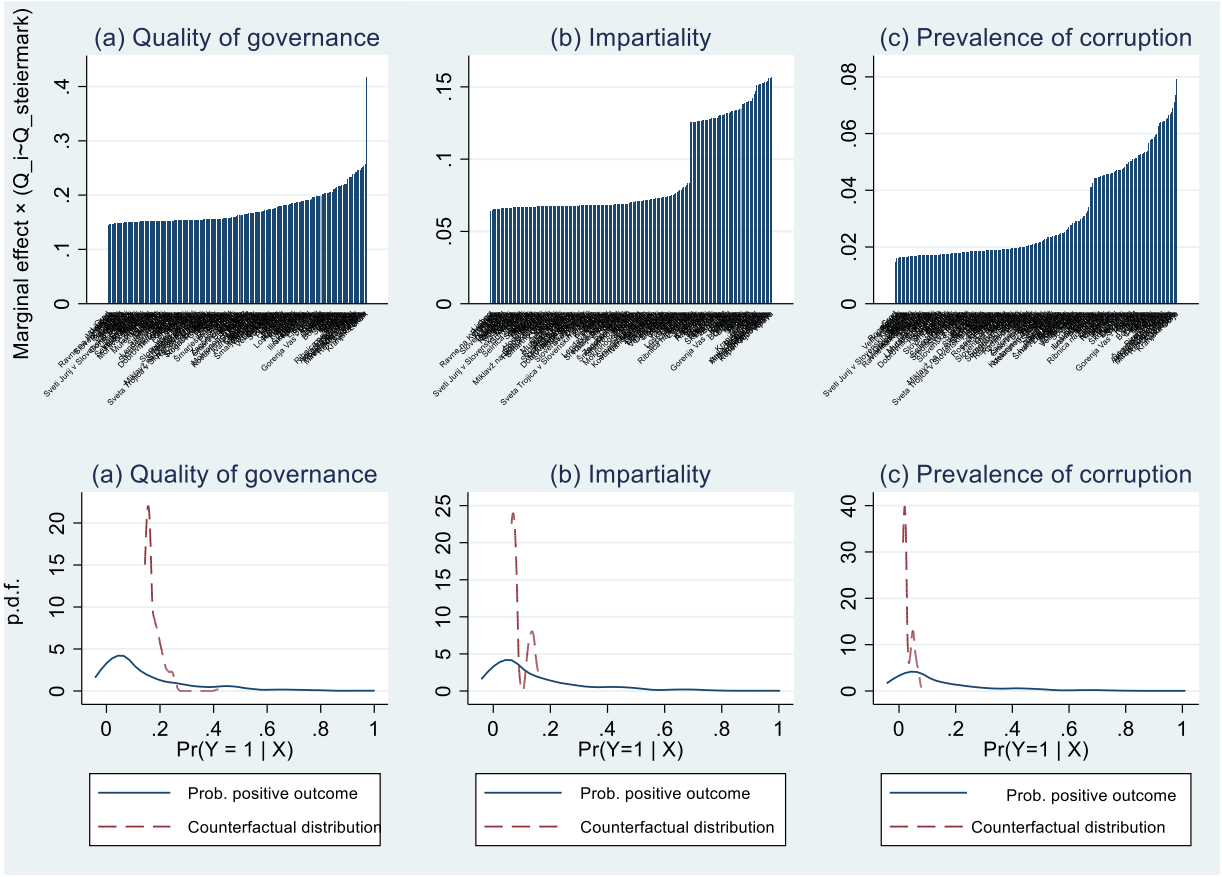

Fig. 8. Counterfactual distribution of firm-level innovation across municipalities.

Table 6
IV Estimated Effect of Local Institutional Quality on Local Innovation.

	Dependent variable: Valid EPO and US Trademark Office Approved Patent											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Treatment variable: quality of local government				Treatment variable: impartiality of local government				Treatment variable: prevalence of corruption in local government			
Panel A: Dependent variable: quality of local government												
β	.516*	.516*	.491*	.565**	.351a	.351a	.182	.183**	.569*	.569*	.242	.291***
	(.322)	(.322)	(.305)	(.243)	(.231)	(.231)	(.137)	(.088)	(.342)	(.342)	(.203)	(.148)
95% confidence bounds	[−.114, 1.148]	[−.114, 1.148]	[−.101, 1.094]	[.090, 1.094]	[−.102,.805]	[−.102,.805]	[−.086,.451]	[.008,.357]	[−.102, 1.240]	[−.102, 1.240]	[−.156,.642]	[.0006,.582]
Panel B: First-stage OLS estimates for institutional quality variables												
Alesina linguistic diversity index in 1910	.834***				1.226***				.758**			
	(.334)				(.646)				(.373)			
Garcia-Montalvo / Reynol-Querol ethnic polarization index in 1910		-.208***	-.225***	-.023		-.306**	-.501***	.312		-.189**	-.333***	.136
		(.083)	(.062)	(.090)		(.161)	(.207)	(.242)		(.093)	(.118)	(.130)
Share of German-speaking population> 15%			.050	.242			-.591	.587			-.437***	.242
			(.214)	(.180)			(.448)	(.463)			(.241)	(.247)
Share of Italian-speaking population> 15%				.583***				2.350***				1.356***
				(.179)				(.459)				(.241)
Sanderson-Windmeijer F-test on excluded instruments (p-value)	[0.013]	[0.000]	[0.001]	[0.000]	[0.059]	[0.059]	[0.052]	[0.000]	[0.043]	[0.043]	[0.021]	[0.000]
Kleibergen-Paap underidentification LM test (p-value)	[0.025]	[0.006]	[0.012]	[0.013]	[0.076]	[0.076]	[0.092]	[0.011]	[0.058]	[0.058]	[0.051]	[0.006]
Cragg-Donald weak identification test	24.57	12.22	12.31	12.22	5.19	5.19	3.66	8.65	6.93	6.93	5.55	11.24
Implied IV size distortion	< 10%	< 10%	< 15%	< 15%	< 20%	< 25%	< 25%	< 25%	< 20%	< 20%	< 25%	< 15%
Implied relative IV bias		< 15%		< 10%				< 20%				< 10%
Hansen J-test on overidentifying restricions (p-value)			0.68	0.44			0.11	0.27			0.072	0.188

Notes: the table reports instrumental variables estimated effect of institutional quality on firm-level innovation across the municipalities. Panel A reports the structural second-stage estimates using the predicted institutional quality from Panel B where first-stage OLS estimates of institutional quality model are reported. The first-stage specification includes Alesina et al. (2003) linguistic diversity index, Garcia-Montalvo and Reynol-Querol (2005) ethnic polarization index together with the dummy variables indicating the municipalities where the share of Italian and German linguistic group in the year 1910 is greater than 15%. Standard errors are adjusted for the arbitrary heteroscedasticity and serially correlated spatial stochastic disturbances using Eicker-Huber-White sandwich estimator. Heteroskedasticity-consistent standard errors are denoted in the parentheses. Asterisks denote statistically significant coefficients at 15% (a), 10% (*), 5% (**), and 1% (***), respectively

statistically significant at 1%. At the same time, municipalities with a disproportionate ethnic concentration of Slovenian-speaking population have about 0.21 standard deviation drop in the quality of the local government compared with ethnically less concentrated municipalities. The effects are particularly large with respect to the impartiality of the government administration, for which a 0.30 standard deviation drop is found in the municipalities with an increasing proportion of the Slovenian-speaking population in 1910. Furthermore, municipalities with a greater degree of ethnic diversity in 1910 have disproportionately more impartial government administration and lower rates of corruption down to the present day. We further decompose the ethnic diversity by adding two additional instrumental variables to the first-stage battery; namely, the dummy variables indicating whether more than 15% of the local population in 1910 were Italian or German speakers. Subsequently, these variables are added to the linguistic diversity indices. The evidence suggests that municipalities with sizeable Italian-speaking community in 1910 tend to have by 0.58 standard deviation (p-value = 0.000) higher quality of governance (p-value = 0.000), 2.3 standard deviation (p-value = 0.000) better impartiality of government administration, and 1.3 standard deviation less prevalent corruption than the municipalities without the sizeable Italian-speaking community. At the same, the coefficient on linguistic dominance of the Slovenian-speaking population is negative and statistically significant across the multitude of specifications with p-value = 0.000 consistently.

Several caveats should be noted behind the internal validity of the exclusion restriction. First, it may be possible that individuals with the cooperation-enhancing cultural norms that can be linked to higher institutional quality settle in different geographic areas typically in a closer proximity to the international markets where quality-enhancing cultural norms of cooperation and trust can flourish. Although this particular hypothesis cannot be directly ruled out, it should be noted that the autochtonous presence of Italian-speaking community prior to World War was not confined to the areas around Trieste, Istria and Friuli Venezia Giulia as the only possible nexus behind the access to international markets. The presence of German-speaking community in eastern Slovenia and isolated language islands elsewhere (i.e. Gottschee, Oberseeland) was also concentrated around widespread and low-cost landline access to the international markets in Western Europe, particularly in present-day Austria, Switzerland and, Germany given a close proximity to markets in Vienna, Graz, Munich and Zürich which implies that a certain degree of similar interpersonal norms ought to have been presented among the German-speaking community as well which at least partially mitigates the concern arising from the culture-contingent geographic settlement.

Second, it is not entirely possible to examine whether the Italian linguistic presence coincides with better initial legal and political institutions and more productive norms of interpersonal relations such as trust. If such initial conditions were pivotal, it would likely that our first-stage coefficients on the link between ethnolinguistic diversity and institutional quality were statistically weak, inherently reflecting the omission of an important initial conditions and rendering the notion of linguistic diversity's influence on institutional quality slightly questionable. Third, an additional threat against the validity of the exclusion restriction arises from the ability of non-productive individuals to move out of the multilingual areas because they are not able to adapt to the increasing exposure to multilingualism. Against the backdrop, we partially mitigate this particular concern by augmenting our first-stage specification with the ethnic polarization index proposed by Garcia Montalvo and Reynal-Querol (2005) which partly reflects the strength of the most dominant linguistic group and takes higher values when a greater fraction of individuals not akin to the multilingual interaction prevails. Although the polarization index does not fully capture the scale of aversion to multilingualism, it does sufficiently indicate the exposure to multilingual influence and the subsequent openness towards the trust- and cooperation-enhancing individual proclivities within the local communities prior to World War 1. This may also indicate that a dominant Italian linguistic imprint is more productive in the context of multilingual interaction and coexistence with other linguistic minorities opposed to a monolingual environment. As indicated in Panel B of Table 3, the estimated first-stage coefficient on the ethnic polarization index is consistently negative and statistically significant whilst the estimated coefficients on the strength of Italian linguistic imprint is both positive and statistically significant. It should be noted that the 15% threshold used to build a binary indicator of the strength of exposure to the multilingual influence is robust to the change of threshold as the effect of similar magnitude is reached both in the first stage and second stage of the model when the threshold is pushed from 5% to 25% benchmark, respectively.

Since the correlation coefficients between the share of Italian-speaking and German-speaking population prior to World War 1 and the present-day share of foreign-born population are + 0.26 (i.e. p-value = 0.000) and −0.05 (i.e. p-value = 0.398), this implies a relatively low degree of persistence and suggests that our theoretical argument does not appear to be weakened. At the same time, it should be note that the threat against the low persistence does not overlap with a high degree of religious diversity since prior to World War 1, more than 95% of the population prior to World War 1 were Roman Catholics regardless of the linguistic group based on the Austrian Census. Even after the end of the Austrian Empire, 1921 National Census identified 97% of the population as Catholic whilst Protestants represented 2.5% of the population and the remaining religious groups shares (i.e. Muslim, Eastern Orthodox) stood at less than 1%. Taken together, this implies almost zero overlap between ethnolinguistic diversity and religious diversity. And third, it should be emphasized that ethnolinguistic diversity is per se not necessarily a valid instrument for institutional quality to measure the effect on firm-level innovation as linguistically diverse societies tend to be more creative and innovative and a direct effect may dissipate over time alongside the disappearance of multilingualism as indicated by the collapse of the Austrian Empire in 1918. Nonetheless, our set of instrumental variables reflects a local-level historical exposure to the multilingualism. We show that such exposure promulgates the formation of certain attitudinal traits and informal institutions such as greater tolerance and trust that are transmitted to the offspring which tends to persist over longer period of time either together with or independently of the efficiency of formal institutions (Guiso et. al, 2016). To tease out and partially separate these effects, we add a control variable indicating the present-day share of foreign-born population at the municipal level and show that the estimated effect of institutional quality on firm-level innovation remains unchanged.

Table 7 reports the instrumental variable estimated effect of local institutional quality on firm-level innovation by adding the contemporary share of foreign-born population to the battery of covariates. Furthermore, to address the robustness of the first-stage specification to linguistic composition, the variables indicating whether the share of Italian and German speakers prior to World War 1 is either above or below the 15% threshold are replaced by the continuous shares of each linguistic group at the local level to capture the full distribution of each linguistic minority opposed to the reliance on the potentially outlying observations. The evidence confirms the positive and statistically significant effect of improved institutional quality on firm-level innovation. The estimated second-stage coefficients appear to be both positive and statistically significant at conventional levels. Panel B exhibits the

Table 7
Instrumental Variables Estimated Effect of Local Institutional Quality on Local Innovation.

	Dependent variable: Valid EPO and US Trademark Office Approved Patent											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Treatment variable: quality of local government				Treatment variable: impartiality of local government				Treatment variable: prevalence of corruption in local government			
Panel A: Dependent variable: quality of local government												
β	2.094**	1.953***	1.423**	1.423**	.952***	.952**	.214	.214	1.821***	1.821***	.460	.460
	(.948)	(.785)	(.594)	(.594)	(.176)	(.176)	(.237)	(.237)	(.364)	(.364)	(.437)	(.437)
95% confidence bounds	(.235, 3.954)	(.414, 3.492)	(.258, 2.587)	(.258, 2.587)	(.606, 1.298)	(.606, 1.298)	(−.250,.680)	(−.250,.680)	(1.106, 2.536)	(1.106, 2.536)	(−.396, 1.316)	(−.396, 1.316)
Panel B: First-stage OLS estimates for institutional quality variables												
Alesina linguistic diversity index in 1910	.844***			.545*	1.305**			-.329	.757**			-.108
	(.331)			(.308)	(.675)			(.662)	(.362)			(.340)
Garcia-Montalvo / Reynol-Querol ethnic polarization index in 1910		-.248***	-.136			-.326***	.082			-.189**	.027	
		(.059)	(.105)			(.168)	(.165)			(.091)	(.085)	
Share of German-speaking population in 1910			.083*	.083*			.438***	.438**			.206**	.206**
			(.049)	(.049)			(.172)	(.172)			(.092)	(.092)
Share of Italian-speaking population in 1910			.890**	.890**			4.583***	4.583***			2.443***	2.443***
			(.372)	(.372)			(.962)	(.962)			(.484)	(.484)
Sanderson-Windmeijer F-test on excluded instruments (p-value)	[0.012]	[0.001]	[0.000]	[0.000]	[0.058]	[0.000]	[0.000]	[0.000]	[0.041]	[0.041]	[0.000]	[0.000]
Kleibergen-Paap underidentification LM test (p-value)	[0.024]	[0.011]	[0.002]	[0.002]	[0.074]	[0.000]	[0.000]	[0.000]	[0.051]	[0.051]	[0.004]	[0.004]
Cragg-Donald weak identification test	25.02	13.23	13.85	13.85	5.65	5.65	14.96	14.96	7.08	7.08	15.71	15.71
Implied IV size distortion	< 10%	< 15%	< 10%	< 10%	< 20%	< 20%	< 5%	< 5%	< 20%	< 20%	< 5	< 5
Implied relative IV bias	< 10%	< 15%	< 15%	< 15%	< 20%	< 20%	< 5%	< 5%	< 20%	< 20%	< 15%	< 15%
Wald exogeneity test (p-value)	[0.119]	[0.139]	[0.279]	[0.279]	[0.057]	[0.057]	[0.924]	[0.924]	[0.059]	[0.059]	[0.902]	[0.902]
Hansen J-test on overidentifying restricions (p-value)			[0.495]	[0.495]			[0.162]	[0.162]			[0.167]	[0.167]
Log-likelihood test (p-value)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
# municipalities	212	212	212	212	212	212	212	212	212	212	212	212

Notes: the table reports instrumental variables estimated effect of institutional quality on firm-level innovation across the municipalities. Panel A reports the structural second-stage estimates using the predicted institutional quality from Panel B where first-stage OLS estimates of institutional quality model are reported. The first-stage specification includes Alesina et al. (2003) linguistic diversity index, Garcia-Montalvo and Reynol-Querol (2005) ethnic polarization index together with the dummy variables indicating the municipalities where the share of Italian and German linguistic group in the year 1910 is greater than 15%. Standard errors are adjusted for the arbitrary heteroscedasticity and serially correlated spatial stochastic disturbances using Eicker-Huber-White sandwich estimator. Heteroskedasticity-consistent standard errors are denoted in the parentheses. Asterisks denote statistically significant coefficients at 15% (a), 10% (*), 5% (**), and 1% (***), respectively.

estimated first-stage ethnolinguistic diversity coefficients. The evidence suggests that local communities characterized by higher ethnic and linguistic diversity and lower ethnic polarization prior to World War 1 tend to have a higher quality of the public goods provision, a substantially more impartial government administration and considerably lower prevalence of corruption. At the same time, the evidence reinforces our prior findings on the overwhelmingly large and positive influence of the Italian linguistic imprint on present-day institutional quality opposed to considerably less positive effect of the German linguistic influence. In the second stage, reported in Panel A, higher quality of public goods provision, an improved impartiality of government administration as well as reduced prevalence of corruption predicts systematically more vibrant and dynamic economic performance reinforced by statistically significantly higher rates of firm-level innovation. The F-statistics on the first-stage coefficients on instrumental variables implies that the null hypotheses can be easily rejected whilst at the same time the first-stage variables indicating the degree of historical exposure to multilingualism do not seem to be ridden with either weak identification or underidentification of the structural relationship between institutional quality and firm-level innovation.

5.3. Leveraging the front lines and population displacement at the end of World War 2

It should be emphasized that any instrumental variable purported to establish a plausible source of variation in economic outcomes such as innovation is prone to violation of exclusion restriction in the absence of either broad theory of institutions (Helland, 2016) or more exogenous but sharp changes in legal institutions (Helland and Klick, 2011). Although such sharp changes are seldom and can only rarely be found, they can typically provide a more fertile and less futile ground for a more exhaustive causal identification in a setup such as regression discontinuity design which rests on the number of observations much larger than the overall size of our sample to facilitate a reasonably credible identification strategy (Dell 2011, Becker et. al, 2016, Wahl, 2017, Oto-Peralías, Romero-Ávila, 2017, Spruk and Kovac, 2020) preferably using household-level or large-scale locality-level data on economic, political and social outcomes.

Although the absence of a purer form of quasi-experimental variation in the change of the institutional regime posits a clear ex-ante limitation to our approach, we partially mitigate these concerns by leveraging the robustness and sensitivity of our estimates to the municipal-level

Table 8
Instrumental variable estimated Tobit model of knowledge-intensity and local institutional quality across Slovenian municipalities.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Treatment variable: quality of local government			Treatment variable: impartiality of local government			Treatment variable: prevalence of corruption in local government		
	Full-sample	w/o former Free State of Fiume	w/o former Free Territory of Trieste	Full-sample	w/o former Free State of Fiume	w/o former Free Territory of Trieste	Full-sample	w/o former Free State of Fiume	w/o former Free Territory of Trieste
	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood	Maximum Likelihood
*Panel A: Instrumental variable:*Alesina et al. (2003) *linguistic diversity index in 1910*									
β	.206*	.203*	.256*	.133*	.132*	.202	.242*	.228*	.448
	(.125)	(.123)	(.176)	(.087)	(.087)	(.297)	(.134)	(.141)	(.423)
Cragg-Donald weak identification test	25.01	24.88	16.24	5.65	5.65	5.65	7.08	7.03	1.98
Implied IV size distortion	< 5%	< 5%	< 10%	< 20%	< 20%	< 20%	< 15%	< 20%	< 25%
Panel B: Instrumental variables: Garcia-Montalvo and Reynol-Querol (2005) ethnic polarization index in 1910 + Share of German speakers in 1910									
β	.157**	.154**	.210**	.038*	.038*	.059*	.067*	.066*	.095*
	(.074)	(.073)	(.099)	(.025)	(.025)	(.042)	(.042)	(.041)	(.065)
Cragg-Donald weak identification test	17.75	17.73	11.40	14.76	14.93	7.96	18.56	18.58	10.48
Implied IV size distortion	< 15%	< 15%	< 15%	< 15%	< 15%	< 20%	< 15%	< 15%	< 20%
Panel C: Instrumental variables: Garcia-Montalvo and Reynol-Querol (2005) ethnic polarization index in 1910 + Share of Italian speakers in 1910									
β	.137**	.135**	.179***	.026*	.026*	.042**	.051**	.051**	.081***
	(.066)	(.066)	(.070)	(.018)	(.015)	(.017)	(.027)	(.027)	(.031)
Cragg-Donald weak identification test	18.88	18.83	12.65	14.61	14.50	11.69	19.51	19.54	12.46
Implied IV size distortion	< 15%	< 15%	< 15%	< 15%	< 15%	< 15%	< 10%	< 15%	< 15%
# municipalities	212	207	208	212	207	208	212	207	208
# left-censored obs	188	183	186	188	183	186	188	183	186
# uncensored obs	24	24	22	24	24	22	24	24	22

Notes: the table reports instrumental variables estimated effect of institutional quality on firm-level innovation across the municipalities. The dependent variable denotes censored number of valid USPTO and EPO-granted firm-level patents for each municipality. Panel A reports the structural second-stage estimates using the predicted institutional quality from the set of instrumental variables using information on Alesina et al. (2003) linguistic diversity index for the year 1910. Panel B reports instrumental variable estimates using the first-stage specification consisting of García-Montalvo and Reynal-Querol (2005) ethnic polarization index and the share of German speakers for the year 1910. Panel C reports instrumental variable estimates using the first-stage specification consisting of García-Montalvo and Reynal-Querol (2005) ethnic polarization index and the share of Italian speakers for the year 1910. Standard errors are adjusted for the arbitrary heteroscedasticity and serially correlated spatial stochastic disturbances using Eicker-Huber-White sandwich estimator. Heteroskedasticity-consistent standard errors are denoted in the parentheses. Asterisks denote statistically significant coefficients at 15% (a), 10% (*), 5% (**), and 1% (***), respectively.

observations affected by the large-scale displacement of the Italian-speaking population at the end of World War 2 in Trieste and Fiume territories. A massive displacement of ethnic Italian population from Fiume and Trieste at the end of World War 2 may serve as a rough approximation of the sharp exogenous shock. Given the cross-sectional nature of our dataset, we are unable to perform a panel-level analysis with our data and instead tackle the sensitivity of our estimates to the exclusion of front-line municipalities. Replicating the baseline analysis on a sub-sample without the front-line municipalities where the Istrian-Dalmatian exodus unfolded then indicate the fraction of the effect driven by the post-WW2 population displacement of ethnic Italians. As a further robustness check on the stability of the structural relationship between local institutional quality and firm-level innovation, we replace the dependent variable by the number of patents and apply instrumental variables Tobit estimator to obtain the point estimates and marginal effects of institutional quality.

Table 8 reports instrumental variable Tobit estimates of the relationship between the firm-level patent stock and local-level institutional quality. Columns (1) through (3) report the estimated effect of the quality of local government on local-level knowledge intensity using the first-stage variation in Alesina et al. (2003) ethnic diversity index for the year 1910 to consistently estimate the effect of governance quality on firm-level innovation. The evidence confirms our prior estimates and invariably suggests that 1 basis point increase in the institutional quality predicts an increase in the patent stock between 20% and 25%, respectively. The estimated series of coefficients appears to be statistically significant at 10%. Therefore, a reasonable and modest improvement in institutional quality by 1 standard deviation (i.e. roughly 0.32 basis point) is associated with an increase in the stock of USPTO- and EPO-valid patents between 6% and 8%, respectively. It should be noticed that the exclusion of municipalities that belonged to Fiume and Trieste territories prior to the large-scale population displacement does not render the positive effect of improving institutional quality on firm-level innovation insignificant. Quantitatively similar magnitude of the coefficients are evident in Panel B and Panel C where ethnic diversity index is replaced by García-Montalvo and Reynal-Querol (2005) ethnic polarization index coupled with the share of German-speaking in Italian-speaking community. In our preferred set of specifications in Panel A, structural effect size distortion induced by the ethnic diversity index appears to be less than 5% and less than 10%, respectively.

Columns (4) through (6) report the effect of the impartiality of local government administration on firm-level innovation using the information on the local-level knowledge intensity. The estimated structural coefficients confirm the positive effect of more impartial government administration on firm-level innovation, and suggests that municipalities where local governments exercise the authority without catering to the special interests tend to have more vibrant, productive and dynamic knowledge-based economies. Regardless of whether historical ethnic diversity or polarization is used to instrument government impartiality, our estimates from Panel C suggest that 1 basis point improvement in the impartiality variable predicts an increase in the local-level USPTO and EPO-approved patent stock between 2.6% and 4.2%. Although the magnitude of the effect is noticeably smaller compared to the quality specifications across columns (1) through (3), the evidence corroborates the notion that more impartial exercise of public authority is associated with a more vibrant and innovation-led economic activity at the local level. Splitting the municipal-level observations from former Fiume province and Trieste territory does not render the positive effect of impartiality insignificant, suggesting that the estimated impacts are robust to the exclusion of post-WW2 front lines and the associated population displacement from the base sample.

Lastly, columns (7) through (9) exhibit the estimated effect of the prevalence of corruption on firm-level innovation. The evidence confirms a large and negative effect of the increasing prevalence of corruption on firm-level innovation indicated by the negative sign of the coefficient. Splitting the former Fiume and Trieste municipalities off the full sample does not seem to affect the magnitude and significance of the estimates. Our preferred set of estimates in Panel C implies that 1 basis point improvement in the corruption level (i.e. a drop in the prevalence of corruption) predicts an increase in the patent stock between 5.1% and 8.1%, respectively. The estimated structural coefficient appears to be statistically significant at 5%, respectively. The evidence indicates unambiguous support for the notion of large economic payoffs from a more rigorous and stronger anti-corruption framework. For instance, an improvement of the corruption index from the worst-performing level (i.e. found in municipality Grad- Felsőlendva) to the best-performing level (i.e. found in municipality Gorje-Goirach) tends to expand the stock of USPTO- and EPO-valid patents between 6% and 9%, respectively. The estimated effect is robust to the exclusion of Fiume and Trieste front lines from the full sample.

5.4. External validity of the structural estimates

One of the ultimate caveats behind our results concern the external validity of the empirical estimates. Our evidence portends several major findings generally suggesting that municipalities with a greater historical exposure to the multilingualism before World War 1 tend to enjoy better quality and provision of public goods, substantially more impartial administration of government, and noticeably less prevalent abuse of public power of private gains in the exercise of public authority. The question that remains concerns the external validity of our findings asking whether there is any suggestive evidence that multilingual regions are characterized by higher institutional quality and more vibrant economic performance, particularly in the similar geographic areas such as the bilingual cantons in Switzerland (i.e. Bern, Freiburg-Fribourg, Ticino-Tessin, Valais-Wallis) and Italy (i.e. Trentino-Alto Adige).

Against the backdrop of a potential threat to the external validity of our estimates, the potential generalizability of our results appears to be consistent with prior findings suggesting that ethnically and linguistically more diverse regions tend to experience higher quality of institutions. For instance, Alesina and Zhuravskaya (2011) compile a novel subnational dataset on ethnic and linguistic composition for a large cross-section of countries and show that ethnically and linguistically more segregated regions have a lower quality of government whereupon social trust appears to be an important channel of influence. In addition, further evidence from the U.S suggests that the share of city-level spending on productive public goods such as education, roads, sewers and trash pickups is inversely related to the ethnic fragmentation (Alesina et al., 1999), indicating ethnic conflict as an important determinant of local public finance where per se affects the institutional quality. In terms of further example, Dahlberg et al. (2012) exploit the exogenous variation in immigrant shares stemming from a nationwide program placing refugees in municipalities throughout Sweden for the period 1985–1994 and find that increased immigration from ethnically diverse areas tends to lower the preferences for redistribution, particularly among high-income earners. Based on the apartment block-level evidence from France, Algan et al. (2016) find that increasing ethnic diversity tends to reduce social anomie, further lowering the opportunities for violent confrontation which per se should result in a better quality of governance and improve the provision of public goods. Using the cross-country subnational data at a spatial resolution one by one degree, Montalvo and Reynal-Querol (2021) analyse the effect of local diversity on local economic growth, and find evidence of a large and positive effect, especially for small geographic areas, and offer some support for the notion that economic benefits of ethnic diversity outweigh the costs of ethnic heterogeneity. An important channel behind the positive effect of ethnolinguistic diversity on economic performance and institutional quality arises from the local ethnolinguistic interaction which tends to reduce the level of antagonism that individuals feel towards others (Desmet et al., 2020).

Ethnic tolerance and diversity have been linked with better civic outcomes. For instance, Hainmueller et al. (2015) examine the

long-term effect of Swiss citizenship on the political integration of immigrants. By exploiting a natural experiment in that some municipalities used referendums to decide on naturalization requests of immigrants, they employ the identification strategy based on fuzzy regression discontinuity design and show that naturalization generates long-lasting improvements such as higher levels of turnout, efficacy and political knowledge compared to those immigrants who barely lost their referendum and were rejected Swiss passport. Their analysis lends some credence to the external validity of our estimates by showing how better governance and ethnic diversity helps promote citizenship in the Tocquevillian sense. Moreover, Desmet et al. (2012) develop a linguistic tree between more than 6000 world languages and show that deep linguistic cleavages predict both civil war and present-day preferences for redistribution. They also show that linguistic diversity tends to promote economic growth if the linguistic groups have the ability to coordinate, interact and organize in the networks of production, trade and knowledge, which in turn affects specialization and the division of labor, facilitates the efficiency of public goods provision and promulgates the virtuous cycle of growth instead of the vicious cycle of coordination failures.

In terms of further example, D'Inguilio and Evangelista (2020) investigate the relationship between the institutional quality and innovation capacity of Italian provinces and find evidence of a strong positive effect of institutional quality on innovation capacity whereupon best quality and effectiveness of government can be found among the bilingual and linguistically diverse regions in the north of Italy with greater exposure to multilingualism such as Trentino-Alto Adige, Valle d'Aosta, Friuli Venezia Giulia and Veneto. In this respect, Nifo and Vecchione (2014) use the data on a sample of 47,300 Italian graduates and by employing a series of Heckman's probit estimations show that an improvement of institutional quality at the level of provinces leads to a statistically significant drop in the probability of the brain drain and outward migration of graduates. Furthermore, our findings are consistent with Melcarne and Spruk (2019) showing that bilingual regions in the north of Italy have substantially greater propensity to vote in favor of the republican government during the 1946 referendum on the institutional form of the Italian government opposed to the regions in the south where both amoral familism and inexperience with the city states and self-government traced back the Middle Ages, and disproportionate preference for the preservation of the monarchy prevailed. Additional studies have shown that improving government effectiveness at the subnational level tends to reduce income inequality (Barra et al., 2023). Our results are also aligned with the evidence presented in Rothstein et al. (2013) highlighting the regional differences in institutional quality between the multilingual northern Italian regions and monolingual southern Italian peers and show that the quality gap may explain inferior economic performance of the latter[8] which implies that the notion that multilingualism regions enjoy better quality of government can scarcely be disputed although further analysis of mechanisms is necessary to better understand the most proximate transmission mechanism behind the effect.

6. Conclusion

In this paper, we examine the contribution of institutional quality to firm-level innovation across the full cross-section of the Slovenian municipalities. Using a novel dataset of institutional quality leveraging municipal- and region-level indicators of quality, impartiality and corruption in government administration, we estimate the observed and unobserved governance components relying on Magnusson and Trivedi (2020) parametrization in the presence of cluster dependence for the full sample of NUTS2 and some NUTS3 regions in the European Union, building on Charron et al. (2019) subnational institutional quality dataset. Leveraging the observed and unobserved components of institutional quality at the local level, we effectively compare the institutional quality scores of Slovenian municipalities with the rest of Europe and uncovered a substantial gap between Eastern and Western Slovenia. In particular, the institutional quality scores of Western Slovenian municipalities generally tend to be similar to those typically found in Western European regions in France, Spain and Belgium. By contrast, the estimated institutional quality in Eastern Slovenian municipalities is comparable with South-Eastern European regions in Greece, Bulgaria and Romania and with some Central-European peers in Czech Republic and Hungary.

Our estimates suggest that better institutional quality, more impartial government administration, and lower prevalence of corruption at the local level is associated with significantly higher probabilities of patent grant by the European Patent Office and the US Trademark and Patent Office. The counterfactual simulations uncover large and broad-based gains from improving the local institutional quality to the frontier level. By exploiting the variation in historical linguistic diversity before World War 1, we address the endogeneity of institutional quality with respect to the firm-level innovation and show that reverse causation is unlikely whilst the proposed instrumental variables on historical linguistic diversity appear to be both relevant for institutional quality and plausibly exogenous to contemporary innovation. In particular, the municipalities with a greater linguistic diversity between Italian, German, and Slovenian ethnic groups, a lower disproportionate concentration of Slovenian-speaking population, and a greater share of Italian-speaking population tend to have considerably better institutional quality, more impartial government administration and lower prevalence of corruption up to the present day. In turn, the predicted institutional quality robustly explains the cross-municipal differences in the intensity of firm-level innovation.

Our normative implications for the policymakers invariably highlight an important interplay between institutional quality and firm-level innovation. In particular, improving the governance of local administration in terms of both quality and impartiality, whilst drastically reducing both the scope and opportunities for corruption, can substantially accelerate the pace of innovation. Moreover, improving the institutional quality environment at the local level appears to be superior to the generous subsidy schemes in the active pursuit of industrial policy which may present a source of ex-ante opportunities for corruption and pursuit of special interests which, in the end, may have clear and strong countervailing effects on firm-level innovation.

Declaration of Competing Interest

The authors jointly declare no conflict of interest.

Data availability

Data will be made available on request.

[8] By way of example, Rothstein et. al. (2013) argue: "*In addition, Bolzano, after centuries of political conflict, has learned to use its linguistic diversity and special autonomous region to its advantage, sheltering citizens from outside competition from the regional job market, keeping unemployment remarkably low, and creating a dynamic of many employment opportunities and levels of wealth, along with clear mechanism of accountability from its own active German-speaking media and citizens who are aware of the government's special autonomous policy-making powers. In the region of Campania, on the other hand, the presence of organized crime is well documented … which severely distorts the free market by creating an extra hurdle for firms entering the private sector. Resources and the public sector have been diverted by organized crime, which one could argue explains the relatively low level of trust in public institutions and other citizens in the region in general. Campania is highly dependent on transfers from outside sources, in particular Rome and Brussels, creating a dynamic of dependency and weakening the accountability mechanism between citizens and elected politicians.*"

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.irle.2023.106155.

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