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LIKE AN INK BLOT ON PAPER: TESTING THE DIFFUSION HYPOTHESIS OF MASS MIGRATION, ITALY 1876 -1920

Yannay Spitzer and Ariell Zimran

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
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Abstract

Why were the poorer countries of the European periphery latecomers to the Age of Mass Migration? We test the diffusion hypothesis, which argues that mass emigration was delayed because it was primarily governed by a gradual process of spatial diffusion of migration networks. We propose a model of migration within a spatial network to formalize this hypothesis and to derive its testable predictions. Focusing on post-unification Italy, we construct a comprehensive municipality- and district-level panel of emigration data over four decades, and use it to show that the testable predictions of the diffusion hypothesis are validated by the data. The emerging picture is that Italian mass migration began in a few separate epicenters from which it expanded over time in an orderly pattern of spatial expansion, and that the epidemiological characteristics of this expansion match those underlying our model. These findings strongly support the diffusion hypothesis and call for a revision of our understanding of one of the most important features of the Age of Mass Migration - the delayed migration puzzle.

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Yannay Spitzer - yannay.spitzer@huji.ac.il
The Hebrew University of Jerusalem and CEPR

Ariell Zimran - ariell.zimran@vanderbilt.edu
Vanderbilt University, NBER

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Like an Ink Blot on Paper

Testing the Diffusion Hypothesis of Mass Migration, Italy 1876–1920

Yannay Spitzer
yannay.spitzer@huji.ac.il

The Hebrew University of Jerusalem and CEPR

Ariell Zimran
ariell.zimran@vanderbilt.edu

Vanderbilt University and NBER

January 2023

Abstract

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1 Introduction

During the *Age of Mass Migration*, tens of millions of Europeans migrated to the New World and many others relocated within Europe (Abramitzky and Boustan 2017; Hatton and Williamson 1998). This movement is understood to have been primarily driven by large gaps in living standards between the sending and receiving countries (O'Rourke and Williamson 1999; Williamson 1995), which resulted in high returns to migration (e.g., Abramitzky, Boustan, and Eriksson 2012). But a number of fundamental patterns within this broad phenomenon are more difficult to explain, and in many cases are inconsistent with the canonical push-pull paradigm of migration (Sjaastad 1962; Todaro 1969). A case in point is what we refer to as the *delayed migration puzzle.* Despite having the highest real wages in Europe, western European countries, such as Britain and Germany, were the early leaders in transatlantic mass migration, beginning in the 1840s or earlier (Cohn 2009). Southern and eastern European countries, such as Italy, the Austro-Hungarian Empire, and the Russian Empire, although far poorer and thus facing even larger potential gains from migration, lagged behind for several decades.[1] As can be seen in Figure 1, it was not until the 1890s that these countries suddenly surged to dominance, taking the lead in both the absolute number of migrants and in the rate of migration to the United States.[2] Why were Europeans from the poorest countries latecomers to mass migration? Why did millions of potential migrants forego for decades the opportunity to earn higher wages abroad before suddenly embracing this technology?

This paper tests the *diffusion hypothesis*, which Gould (1980) originally proposed as an explanation for the delayed migration puzzle. In essence, this hypothesis, as we operationalize it, views emigration as sharing the epidemiological properties of an infectious disease.[3] Just as individuals do not contract one unless exposed to someone else who has been infected, this hypothesis holds that, regardless of the strength of the incentive to do so, individuals generally cannot emigrate unless one of their close contacts has already emigrated.[4] Scaled up to the community level, this implies that, even in places with high emigration potential,[5] emigration is limited in the absence of connections to networks of prior migrants. Further scaled up to the national level, this implies that emigration initially emanates from only a few *epicenters.* As individuals from these

[1] As Hatton and Williamson (1998, p. 56) put it, "the poorest had the most to gain by a move to higher living standards."

[2] Formally, the correlation between origin-country real wages and emigration was not negative (as the push-pull model predicts) until the 1890s. Cross-sectional real wage differences were also poor predictors of emigration rates within countries (Baines 1995, ch. 4). For more graphs depicting the European delayed migration puzzle, see Online Appendix Figure B.1. The correlation of emigration and real wages was positive until the 1890s, when emigration from southern and eastern Europe surged.

[3] To be clear, we do not intend the use of an epidemiological model or analogy to imply any normative judgements regarding migration. It is instead a useful analogy to describe the spread of a phenomenon within a population.

[4] In our formal model, we do permit pioneers, who can migrate without being connected to a prior migrant. The key is that these pioneers are relatively rare.

[5] By high emigration potential, we mean strong incentives for emigration.

places emigrate, their contacts in nearby places become connected to friends and relatives abroad, such that neighboring places sequentially connect one another to networks, leading "the contagion of emigration [to] spread over the map much like an ink blot on paper" (Moya 1998, p. 113).[6] The result of such a process in Italy was that regions closer to the epicenters produced mass emigration early on, whereas regions farther away, many of which faced similar push factors and thus had similar potential for emigration, had to wait, sometimes for several decades, before their potential was abruptly unleashed when they were reached by the expanding networks of migration. In sum, according to the diffusion hypothesis, the main cause for the delay of mass emigration from the European periphery was the initial absence of links to migration networks in otherwise emigration-prone places and the time that it took for these networks to expand over space. The gradual rise in migration to the United States, which appeared to cross the threshold of mass emigration in the 1890s, was, in fact, an accumulation of many sequential rapid surges of local mass emigration that, by the 1890s, had spread to reach a sufficiently large part of Italy.

Some social historians have followed Gould (1980) in considering the diffusion hypothesis to be an important part of the explanation for the evolution of mass migration (e.g., Baines 1995; Lowell 1987; Moya 1998). In economic history, however, it has remained a minority view. The literature has instead been dominated by versions of what we call the *modernization hypothesis*. Traced back at least as far as as Thistlethwaite (1960 [1991]), its common denominator is that a lack of economic modernization delayed migration, and its eventual onset triggered it through such mechanisms as the release of poverty traps, the loosening of connections to the land, and the increase of demographic pressures. The delayed migration puzzle is thus explained by the earlier onset of modernization in northwestern Europe than in the southern and eastern periphery. Networks were important, but their absence was no more than a short-term impediment—where internal conditions were well suited for emigration,[7] some pioneers led the way within a few years, causing migration networks to develop spontaneously. Returning to the epidemiological analogy introduced above, the modernization hypothesis views migration as sharing the epidemiology of cancer. Places characterized by high risk factors will spontaneously develop high prevalence, and the timing will not depend on proximity to already infected places (though spatial correlation in the underlying conditions might make it appear so). The modernization hypothesis is an *internalist* explanation for the timing of the onset of mass migration, in the sense that it focuses on factors internal to a given location rather than interactions between locations.

[6] Gould (1980, p. 283) used a similar analogy: "One might describe this process as one of 'diffusion,' at least in the mechanical sense in which a drop of ink on a small piece of blotting paper gradually 'diffuses' over the whole area."

[7] Internal conditions include both factors incentivizing emigration and local factors that may have been responsible for temporarily restraining emigration from places where the incentives for migration were strong. We think of these all collectively as push factors.

The modernization hypothesis was canonized by Hatton and Williamson's (1998, chs. 2, 5, 6) study of the Age of Mass Migration, which concluded the diffusion hypothesis to be disproved. The question of the causes for the delayed migration puzzled has largely been dormant ever since.

In this paper, we revisit the diffusion hypothesis. Strong motivation to reconsider it is given by maps documenting the evolution of the geographic origins of the Italian emigration to North America.[8] The maps in Figure 2 report the district-level rates of North America-bound emigration by half decade from the late 1870s.[9] In Figure 3, municipality-level maps do the same at a finer administrative level, but with data starting only in 1884.[10] The visual evidence appears to be consistent with the diffusion hypothesis. Migration rates were initially very high in a small number of epicenters. Over time, migration spread in a seemingly orderly and spatially consecutive manner to the rest of the country. Many regions that had at first produced no migration at all turned out to be enthusiastic participants once this movement reached them; conversely, by the end of the Age of Mass Migration, the initial epicenters no longer stood out in terms of their emigration rates, inconsistent with their leadership being the product of a particular proclivity for emigration. Our analysis builds on this preliminary evidence by introducing two innovations relative to prior tests of the diffusion hypothesis: a theoretical framework from which we derive its testable predictions and a sufficiently detailed dataset with which to test them. Our findings lead us to the conclusion that the diffusion hypothesis is the best and most parsimonious explanation for the temporal and spatial patterns of Italian migration, including its delayed beginnings and eventual surge.

The first step in our analysis is to formalize the diffusion hypothesis, proposing a model that combines a simple push-pull framework of migration with an underlying epidemiological process of diffusion over a spatial network. This model treats migration as a technology that becomes available to individuals once a person to whom they are linked has migrated. Having gained the option of emigration, individuals can then choose whether or not to move based on typical push and pull factors, such as income differences or demographic pressures. If they migrate, their connections subsequently gain the option of migration. We explicitly distinguish between intra- and inter-place diffusion; the latter, which can create a pattern of spatial diffusion and is absent from standard migration frameworks, is modeled as migration options generated by friends and relatives in neighboring places. *Pioneers*—individuals who migrate without being linked to a prior migrant—are allowed by this framework, as are personal contacts spanning long distances. When both are sufficiently rare, our model can generate a persistent delay in emigration from emigration-prone

[8]The construction of these maps is discussed in section 4.2.
[9]By district, we refer to the Italian *circondario* or *distretto*.
[10]By municipality, we refer to the Italian *comune*.

but unlinked regions and a staggered and spatially ordered entry into mass migration from otherwise similar places. Otherwise, the model collapses, at the limit, to a standard push-pull one and explanations for delayed migration must rely on internal factors, as in the modernization hypothesis.

When pioneers and long-distance contacts are sufficiently rare, migration will be characterized by the following patterns.

1. *Convergence.* As the technology of emigration spreads across the country, a major source of variation in emigration is removed; over time, the variation diminishes and at the limit approaches the level explained only by variation in internal characteristics. Migration rates across the country thus exhibit σ-convergence. When places are newly exposed to migration networks, their migration potential is unleashed, leading to β-convergence as these places experience greater growth in emigration than in already-linked areas.

2. *S-shaped local time trends.* At the local level, migration rates should evolve along an S-shaped curve, initially low, then rapidly increasing once networks arrive, and finally reaching a state of saturation in which they plateau around the level determined by push and pull factors.

3. *Correlated destinations.* Since networks are both destination-specific and likely to be shared by neighboring places, the correlation between the destination choices of migrants from any two places in the country of origin should diminish with respect to the distance between them. As networks become more widely diffused over time, the distribution of destinations should become more similar conditional on the distance between places.

4. *Frontier effect and spatial expansion.* Defining the *frontier* of emigration to be the contour of places that had experienced mass emigration by the previous period, the *frontier effect* is the prediction that in each period, the probability of a place outside the frontier to enter mass emigration should be negatively related to its distance from the frontier. This should result in *spatial expansion*: places farther from the epicenters of emigration should enter mass emigration later than places closer to these epicenters.

In the second step of our analysis, we test these predictions in the context of Italian emigration during the period 1876–1920, which Gould's (1980) seminal paper cites as a paradigmatic case of the diffusion hypothesis. Italy constitutes an ideal laboratory in which to test for the existence of a diffusion process. It was sufficiently large and had enough internal variation to enable us to observe diffusion processes evolving gradually within its borders. Moreover, Italy was among the largest migrant source countries, sending

14.3 million migrants during our study period (relative to a 1901 population of about 32.5 million), with nearly 5 million of them headed to the United States. Italian emigration statistics that we digitized for this project document this movement in fine detail, and form the basis of our panel dataset of emigration rates at the district and municipality level, covering more than 8,000 municipalities in over 280 districts and 28 consistently defined destinations over four decades. Compounded by the wealth of municipality- and district-level statistics that we collected, we are able, for the first time, to characterize the spatial evolution of Italian emigration and to test the diffusion hypothesis at a time and place in which it is suspected to have operated. We focus primarily on Italian migration to North America, which we can observe from its early stages in the 1870s through its surge in the 1900s and peak in the years leading to World War I.[11]

We discover in the data a series of stylized facts corresponding to the patterns predicted by our model: among them are (a) The coefficient of variation in municipality-level emigration rates to North America fell to less than half its initial value between 1890 and 1914—evidence of σ-convergence. Furthermore, this pattern was driven by laggards catching up with leaders in a pattern of β-convergence—municipalities in the bottom quartile of pre-1900 emigration rates to North America experienced a 50-times greater increase in average annual emigration rates after 1900 than municipalities in the top quartile of pre-1900 emigration rates. (b) The average municipality, regardless of when it first entered mass migration, experienced an S-shaped time trend, increasing in its migration rate from essentially zero to about 25 per thousand over a period of 20 years, after which its emigration rate plateaued. (c) A one-standard deviation increase in distance between two provinces was associated with an increase in the dissimilarity index of their destinations of 0.104, or just under half of a standard deviation, and this dissimilarity declined by 0.198, or about one standard deviation, from 1876–1880 to 1911–1914. (d) An increase in distance from the previous half-decade's frontier of mass migration from 0 to 150 km (about one standard deviation) was associated with an 80-percent decline in the average emigration rate to the United States from just under 5 per thousand to about 1 per thousand. This frontier effect clearly translated into a pattern of spatial expansion, as a one-standard deviation increase in distance from epicenters was associated with a decline in the hazard of entering mass migration of about 40 percent.

We also identify several patterns that are incongruous with the modernization hypothesis. Any of its versions would predict an earlier onset of mass migration in more "modernized" places. But hazard models

[11] The other two main streams of emigration were to other countries in Europe and to South America. Emigration to Europe was often characterized by extremely high rates of repeat migration that disproportionately inflate the emigration counts, potentially more so in places closer to the border, which might artificially create a spatial trend. Emigration to South America started earlier, and so we can only observe the later stages of its development. We also provide analyses in which we study emigration to all destinations, with similar findings to those for emigration to North America.

find no evidence that modernization was systematically associated with the timing of mass emigration. We also do not find that modernization can explain strong convergence of emigration rates over time. Most importantly, to the extent that modernization did play a role in determining emigration rates, we show that its impact was small relative to the consistent first-order role of diffusion, and, moreover, different markers of modernization disagree on the direction of its effect. We also find that the diffusion processes were specific to the destination. While this is not strictly inconsistent with internalist explanations, this result requires a more complex version of the modernization hypothesis to explain it, yet it derives directly from the diffusion hypothesis. We therefore conclude that the modernization hypothesis cannot offer a plausible, simple, and complete explanation for the stylized facts that we document for the Italian mass migration.

In the third and final step of our analysis, we confirm the existence of the spatial contagion mechanism as the most likely cause for the frontier effect and spatial expansion. The diffusion hypothesis, unlike the modernization hypothesis, implies that, conditional on all relevant characteristics, emigration from one place triggers subsequent emigration nearby. Identifying this causal effect is an empirical challenge. It could be that neighboring places shared unobserved characteristics that affected the timing of the onset of mass migration or the magnitude thereof; or that a time-trend in such characteristics was correlated among neighbors; or even that there did exist a process of spatial diffusion moving across the country, but that the diffusing characteristic was not personal links to previous migrants but some other migration-inducing characteristic, such as local policies (Andrews and Seguin 2015), industrialization (Franck and Galor 2022), or demographic trends (in the spirit of Spolaore and Wacziarg 2009).

To evaluate the causal effect of spatial contagion, we estimate a spatial lag model of migration using an instrumental variables strategy. Intuitively, we compare two identical places equidistant from a source of emigration (an emigration epicenter or the frontier of mass emigration). The underlying incentives for migration in these places are thus similar and the only difference between them is that the neighboring population around the first municipality is on average closer to the source relative to the second. Because of that, more of the first place's neighbors have been exposed to migration and spatial contagion makes emigration from the first higher. This source of variation in exposure to neighbors' migration is exogenous under the assumption that the *orientation* of the spatial distribution of neighbors (i.e., whether they are on average closer or farther from the source) is independent of its characteristics, and we use it to identify the causal effect of neighbors' lagged migration on a place's own migration. Our preferred specifications yield an estimated elasticity of own emigration with respect to the emigration of nearby municipalities of 0.54–0.60, thus confirming the existence of the spatial contagion mechanism.

The accumulated evidence leads us to view the diffusion hypothesis as the best available explanation for the set of stylized facts of the Italian emigration that we document. Although some of them could plausibly be generated by alternative explanations, the diffusion hypothesis is the most parsimonious theory that can explain them all. Our conclusion is therefore that the rising magnitude of emigration from Italy and the evolution over time of its geographic origins was primarily governed by a process of spatial diffusion. Leaving the question of initial conditions aside and taking the 1870s as the starting point, the fact that Italy took two or three more decades to reach mass emigration at the national level can be largely accounted for not by a fundamental change in the Italian economy as the modernization hypothesis argues, but by the lack of migration networks throughout most of the country in the 1870s and the time that it took for these networks to develop.

For several reasons we cannot claim to have fully resolved the delayed migration puzzle. First, we do not explain *why* certain individuals were pioneers and certain places were epicenters. While testing the diffusion hypothesis, we take it as given that some locations and individuals had taken initial leadership and that their selection may not have been random. Moreover, in the absence of a cross-country comparative study we cannot assess whether a similar diffusion process took place earlier in countries that led migration or whether the evolution of emigration in countries that entered mass migration earlier was altogether different. In particular, we do not test whether there was a continent-wide process of diffusion (nor do we suspect that one existed), in which Italy had to wait until foreign networks percolated through its borders; with the obvious exception of overland migration to European destinations, most of the Italian epicenters were located far away from its land borders, which suggests that their emergence was either spontaneous or triggered by maritime trade contacts or by rare long-range relations between individuals.[12] In terms of our model, we believe that pioneers and long-distance contacts were rare enough such that most Italian regions had to wait for the networks to diffuse, but not so rare as to cause Italy as a whole to wait for cross-border diffusion. What the evidence does tell us is that the diffusion hypothesis explains the main patterns of the evolution of Italian mass migration, while leaving aside the question of the timing and the selection of epicenters; in particular, it explains why this movement took several decades to build up before becoming one of the greatest migration flows in modern history. It is, therefore, a plausible part of the explanation for the broader delayed migration puzzle, though it leaves open the question of precisely how and why the countries that came late to mass migration were different from the leaders.

[12]The historical literature also suggests that the origins of migration were likely linked to maritime trade. For instance, Foerster (1919, p. 324) provides anecdotal evidence consistent with this notion: "To the Genoese merchants who had come [to New York] in earlier years were added, after 1860, Palermitan merchants who dealt in the citrous [*sic*] fruits and oils."

This paper contributes to the literature seeking to explain the delayed migration puzzle. Recent evidence on Jewish emigration from the Pale of Settlement is strongly suggestive of a diffusion process being the primary determinant of its macro trends (Spitzer 2021). We provide the first formalization of the diffusion hypothesis, derive its testable predictions, and carry out its first comprehensive empirical test. Our findings revise our understanding of the geographic evolution of mass emigration from the European periphery and position the diffusion hypothesis as a strong and plausible rival explanation to that accepted in the literature.

This paper also offers a more general lesson to the economics of migration. It is well understood that liquidity constraints pose a significant impediment to migration from developing economies, and often the conclusion is that extreme poverty must be alleviated before mass migration is generated (Burchardi, Chaney, and Hassan 2019; Gray, Narciso, and Tortorici 2019; McKenzie and Rapoport 2007). The lesson that we draw from the Italian migration is that *social* liquidity constraints trump financial ones, in the sense that the former are the real bottleneck, and that they can solve the latter. It is possible that the friends and relatives effect may be so strong that the spatial spread of networks could, by itself, switch a region from little or no migration to extremely high rates of migration within a short period of time and independently of any internal structural changes, such as poverty alleviation, urbanization, or sectoral shifts.

2 Background

2.1 Italy and the Delayed Migration Puzzle

"[P]ractically all emigration from Italy is primarily due to purely economic causes" (US Congress 1911a, p. 153). The report of the Dillingham Commission reflected in this view the scholarly consensus that mass emigration from Italy was primarily driven by large and persistent gaps in standards of living between Italy and the destination countries (e.g., Hatton and Williamson 1998). Despite this consensus, no widely accepted theory exists that is capable of explaining either the geographic variation in emigration within Italy or its geographically staggered rollout.

Italy exhibited its own delayed migration puzzle in miniature. As we show in Figure 4, the cross-province correlation between 1876 income (specifically, real wages as measured by Federico, Nuvolari, and Vasta 2019) and emigration to all destinations was positive in the first stages of the Italian migration, only turning to the expected negative sign in the 1890s. Moreover, Italian regions that were seemingly comparable in terms of conditions conducive to mass emigration had widely different timings of its onset.[13] This perplexing fact

[13]See Online Appendix Figure B.2 for an example.

did not go unnoticed by contemporary observers (US Congress 1911a, p. 164).[14] For example, as can be seen in Figures 2 and 3, mass emigration gradually spread south through the western *Mezzogiorno*, from one neighboring province to another:[15] Salerno in Campania in the late 1870s, Cosenza in northern Calabria in the 1880s, Catanzaro and Reggio Calabria in southern Calabria during the 1890s, and finally Messina, across the strait, around the turn of the century.[16] Real wages were not far apart in these provinces, and at the very least, their ranking was orthogonal to the order in which they entered mass emigration. Our general point, applied to this case, is that this 25-year trickle south of emigration across this rather equally poverty-stricken region cannot be explained by underlying economic conditions. This suggests that the *underlying causes* of emigration and the *trigger* that caused the potential for emigration to actually materialize in any given area were separate factors.[17]

Several explanations for the geographic patterns of emigration in Italy have been proposed. Consistent with the modernization hypothesis, Foerster (1919) suggested that emigration from poorer places had begun later as a result of liquidity constraints.[18] Italy has also featured as an important case study for testing the modernization hypothesis: while Faini and Venturini (1994) have found statistical evidence consistent with such a role of liquidity constraints in delaying emigration, Hatton and Williamson (1998) found instead that the determinants of migration, both across European countries and across Italian provinces, were real wage gaps relative to destinations, demographic pressures, and the level of employment in agriculture (a negative measure of industrialization). Following Thistlethwaite (1960 [1991]), they concluded that "mass emigration in Europe had to await the forces of industrialization at home and a glut in the mobile age cohort driven by a demographic transition that industrialization produced" (Hatton and Williamson 1998, p. 46).[19]

However, a number of important patterns in Italy and elsewhere in Europe challenge the modernization hypothesis. In general, studies show neither positive nor negative systematic correlations between economic conditions and emigration in the Age of Mass Migration (Baines 1995). More specifically, evidence that mass emigration and economic or demographic modernization emerged in the same places is inconsistent

[14] Foerster (1919, p. 104) pointed out that "It is significant that emigration should not have originated where misery was greatest."

[15] Online Appendix Figure B.3 provides maps of Italian regions and provinces for reference.

[16] This geographic progression was described in detail by Foerster (1919, pp. 102–104).

[17] In the words of Foerster (1919, p. 48), "The fact that emigration from Campania was abundant before it became so in Calabria, and that it only as much as ten or fifteen years later assumed large proportions in Sicily, need signify merely that the *occasion which turned a passive into an active cause* arose earlier in one compartment than in another" (emphasis added).

[18] "[Emigration] began where there was the chance of saving enough money for passenger fares and has best maintained itself where wages were at a minimum level" (Foerster 1919, p. 104).

[19] According to MacDonald (1963) and MacDonald and MacDonald (1964), the propensity to emigrate was a result of different constellations of agricultural organization and communal relations. This view, somewhat similar to Hirschman's (1970) *Exit, Voice, and Loyalty*, has gained traction in the socio-historical literature (e.g., Baily 1999; Barton 1975; Silverman 1968; Sturino 1990; Yans-McLaughlin 1977), but came under criticism by Gabaccia (1984a,b, 1988).

and contested at best. For instance, Jewish emigration from the Pale of Settlement in the Russian Empire began in a few impoverished provinces in the northwest, only later spreading to nearby centers of Polish industrialization, and much later to the relatively well-to-do communities in central and eastern Ukraine (Spitzer 2021). Similarly, Ireland's early leadership in migration predated its industrialization, and there is no evidence of rising demographic pressure there when its emigration first began to surge before the Great Famine (Cohn 2009; Mokyr 1983; Mokyr and Ó Gráda 1982).

Within Italy, the Dillingham Commission noted that industrial and large urban centers tended to produce less emigration.[20] Modernization indicators have also been shown to perform poorly in explaining emigration, both in time-series analysis (Ardeni and Gentili 2014) and when accounting for multiple destinations (Moretti 1999). In particular, the geographic distribution of early Italian emigration bears little resemblance to that of early Italian industrialization, which occurred in concentrated geographic pockets, primarily in the northwest (Ciccarelli and Fenoaltea 2013; Federico, Nuvolari, and Vasta 2019; Iuzzolino, Pellegrini, and Viesti 2013). Some of these industrialization hotspots, such as in Liguria and in the Alpine slopes, were indeed emigration leaders, but the nearby Po Valley never developed mass emigration. Moreover, other emigration epicenters were in the northeast, in the center, and in the south. Some had existing traditional and extractive industries, yet they were generally not a part of the industrialization movement. Neither were broad demographic trends associated with the evolution of emigration. The north led Italy's Demographic Transition (Del Panta 1997, p. 10; Vecchi 2011, Table S6), yet the early sources of mass emigration were spread throughout the country. Recent attempts to assess the relationship between demographic pressures and emigration have been inconclusive, and have lacked statistical power or credible identification (Ardeni and Gentili 2014; Faini and Venturini 1994; Gomellini and Ó Gráda 2013; Hatton and Williamson 1998).

Evidence on the diffusion hypothesis is even scarcer. Gould (1980, Figure 1) highlighted σ-convergence patterns across provinces within regions in Italy, as well as in Hungary and Portugal. He also informally argued that there existed β-convergence and S-shaped sub-national time series in Italy (pp. 282–288). Spitzer (2021) found both σ- and β- convergence in the case of Jewish migration from the Pale of Settlement. Qualitative evidence similarly indicated diffusion in Scandinavian (Lowell 1987) and Spanish (Moya 1998) emigration. In the first econometric test of the diffusion hypothesis, Hatton and Williamson (1998) found persistence in the emigration rates of Italian provinces over time (see also Gomellini and Ó Gráda 2013)—evidence that networks were important in determining the size of migratory flows—but failed to find a relationship

[20]"It will be seen that as a rule the heaviest emigration originated in the compartimenti where the proportion of industrial workers was the smallest . . . and it is well known that comparatively little Italian emigration originates in the large cities" (US Congress 1911a, p. 175).

between literacy—which they viewed as a factor that could have facilitated the spread of information—and emigration rates. They concluded that diffusion "offers few empirical predictions and says nothing about why emigration rates eventually declined" (p. 15) and that "while such forces [as diffusion] mattered, there is little evidence that persistence or literacy dominated [Italian] provincial emigration rates with anything like the force often assigned to them in the qualitative literature" (p. 121).

Prior attempts to test the diffusion hypothesis have been limited by two missing factors—a complete theoretical framework from which to derive testable predictions, and a sufficiently long, rich, and geographically disaggregated panel dataset with which to identify the *inter*-place transmission of emigration. Therefore, on the basis of the existing literature, we view the diffusion hypothesis as one that is plausible and capable of explaining a fundamental puzzle of the economics of the Age of Mass Migration, but which has yet to be rigorously tested. This paper makes significant advances on both fronts, and thus provides the most comprehensive evidence yet on the validity of the diffusion hypothesis.

2.2 The Role of Networks in Italian Emigration

Is the diffusion hypothesis plausible within the social context of post-unification Italy? Is the available historical evidence consistent with it? Although the notion that emigration had epidemic-like features was widely recognized by contemporaries,[21] the full implication of the hypothesis—that diffusion was the *primary* determinant of the timing of the onset of mass migration—is absent in any contemporary account, including Foerster (1919) and the Dillingham Commission Report (US Congress 1911a), arguably the two most comprehensive contemporary inquiries into the causes of Italian emigration.

For such an explanation to be plausible, the social structures that supported emigration must have had certain non-trivial characteristics. They had to be sufficiently strong to support chain migration. They had to be local, yet occasionally crossing community boundaries. And when they did cross community boundaries, they had to reach primarily over short distances, only rarely spanning longer distances. Furthermore, alternative mechanisms that supported migration, such as direct recruitment by foreign governments and businesses or poaching by shipping agents, had to be either negligible or themselves dependent on migration networks. Finally, pioneers had to be rare. In what follows, we survey the relevant evidence from the historical literature to evaluate the plausibility of these conditions in Italy during the Age of Mass Migration.

To what extent did Italians engage in chain migration? Much of the debate concerning the sociology of Italian emigration evolved as a reaction to Banfield (1958) and Handlin (1951), who cast doubt on the

[21]The usage of metaphors such as "migration fever" prevailed in virtually every sending country (Moya 1998, pp. 95–96).

viability of strong personal and communal relations among south Italian immigrant peasants in the United States, and by implication also on the prospects of strong migrant networks. However, subsequent literature has modified this view of weak social links, showing that both kin- and municipality-based ties played an important and constructive role during and after migration (Bell 1979; Briggs 1978; Gabaccia 1984b; Nelli 1967; Vecoli 1964; Yans-McLaughlin 1977). It portrays the Italian migration to the United States as being dominated by characteristics of chain migration: early migrants provided funding, information, accommodations, assistance in the labor market, and close examples of successful migration to their friends and kin, who in turn would do the same for theirs (Baily 1999; Cinel 1982; MacDonald and MacDonald 1964; Sturino 1990). As one immigrant put it, "Immigrants almost always came to join others who had preceded them—a husband, or a father, or an uncle, or a friend" (quoted in Yans-McLaughlin 1977, p. 59). This assertion is supported by recent empirical analysis (Spitzer and Zimran 2018).[22] Further support for the importance of chain migration comes from the ubiquity of town-to-town migration—the specialization of specific towns or small regions in Italy in migration to specific towns in the United States.[23] This pattern was also noticed by contemporary observers, such as the Dillingham Commission, which particularly emphasized the role that letters and the ubiquity of return migrants played in enabling migration.[24]

While the importance of social networks in the Italian migration is documented beyond doubt in the historical literature, the diffusion hypothesis crucially depends on one particular feature of these networks—that they spread gradually across municipalities. For this, there had to exist some (though not necessarily many) short-distance contacts across municipalities, while long distance contacts had to be scarcer or weaker. What historical evidence exists supporting the existence of such contacts? Small-region networks were documented among immigrants in Cleveland (Barton 1975) and among immigrants in Chicago from the Calabrian Rende region (Sturino 1990). Similarly, studies of many smaller US cities found small-region clusters of Italian settlement,[25] and evidence of Italian organizations divided along provincial lines.[26] Weaker evidence to the same effect is the tendency of Italian American communities within the great metropolitan

[22] In a sample of 31,476 adult Italian passengers arriving at Ellis Island between 1907 and 1925, 33 percent of all males and 72 percent of all females reported joining an immediate family member already present in the United States. Almost all of the rest named other relatives and friends, such that the share of passengers not reporting any contact in the United States was only 5 percent (Spitzer and Zimran 2018, Table A.1). In fiscal years 1908–1910, only 5.9 percent of North Italian and 1.1 percent of South Italian immigrants to the United States did not report joining either a friend or a relative (US Congress 1911b, p. 363, Table 40).

[23] For examples see cases listed by MacDonald and MacDonald (1964, Appendix II) and Cinel (1982, p. 28).

[24] All of these features of chain migration are clearly illustrated in the case study of Antonio Squadrito (Online Appendix C), an early migrant from the Sicilian town of Gualtieri-Sicamino. Within less than a decade, a small number of early migrants were followed by "more than one tenth of the population" (Brandenburg 1904, p. 109).

[25] For example, in Buffalo (Yans-McLaughlin 1975, pp. 25–26), St. Louis (Mormino 1986 [2002]), Tampa and Ybor City (Pizzo 1981, pp. 128–130), and Pittsburgh (Bodnar, Simon, and Weber 1982, p. 47).

[26] For example, in San Francisco (Cinel 1982) and Buffalo (Yans-McLaughlin 1975, p. 125).

centers, such as New York, Chicago, and Toronto, to cluster by small areas of origin, thus forming "many Little Italies" (Baily 1999; Nelli 1967; Park and Miller 1921; Sturino 1990; Vecoli 1983; Zucchi 1985). In the case study of Antonio Squadrito (Online Appendix C), his followers included residents from four or five different neighboring localities. Outside of the literature on emigration, Lecce, Ogliari, and Orlando (2022) show that social contacts across nearby Italian towns existed in the context of trade, marriage, and linguistic ties.

Were there viable alternatives to chain migration that were independent of geographic proximity to previous migrants? Recruitment by labor agents was another method on which some Italians relied in their migration to the United States, in particular under the *padrone* system (Iorizzo 1966; Koren 1897; Nelli 1964; Peck 2000). However, it was not altogether disconnected from social networks; instead, it depended on them.[27] Even as some agents recruited workers from across Italy, "the emigrant relied on his townspeople to get in touch with the network of agencies and sub-agencies which eventually would lead to a job and cash" (Zucchi 1985, p. 121).[28] Some governments, such as Argentina and Brazil, and later Australia, New Zealand, and certain Canadian provinces, had policies of assistance and subsidies for immigrants (Baines 1995; Kelley and Trebilcock 1998). But subsidized emigration was ultimately banned in Italy by the 1902 Prinetti Decree (Baily 1999; Foerster 1919; Gould 1980), and even before that assisted migration was a rarity, particularly among US-bound immigrants. When assisted migration did exist, it was rarely independent of social networks (US Congress 1911a, pp. 61–64). In brief, insofar as overseas emigration was facilitated by such alternatives to chain migration networks, there is little evidence that they were capable of inducing the migration of Italians who were not yet part of these networks. The alternatives were not substitutes but complements to chain migration.

3 Theoretical Model

Our model describes a world in which the diffusion of chain migration networks over space may or may not have been an important determinant of the timing of mass migration. We are then able to determine the

[27]The recruiting padrone had sub-agents who would travel back to "collect a work force in their home town in Italy" (MacDonald and MacDonald 1964, p. 86), and he "kept his paesani [fellow townsmen] together" (MacDonald and MacDonald 1964, p. 86). The padrone banker was "generally a paesano" (Foerster 1919, p. 391), and the US-based labor boss was "an extension of the informal networks" (Baily 1999, p. 98). The Dillingham Commission agreed with this assessment: "actual and direct contract-labor agreements cannot be considered as the direct or immediate cause of any considerable portion of the European emigration . . . immigrants, or at least newly arrived immigrants, are substantially the agencies which keep the American labor market supplied with unskilled laborers from Europe. . . . as a rule, each immigrant simply informs his nearest friends that employment can be had and advises them to come. It is these personal appeals which, more than all other agencies, promote and regulate the tide of European emigration to America" (US Congress 1911a, p. 61).

[28]Such was the case of four boys whose departure was assisted by Antonio Squadrito (Online Appendix C).

model's testable predictions under parameterizations that make network diffusion the primary determinant of the timing of mass migration. These predictions form the basis of our empirical analysis.

As in the traditional push-pull framework (Sjaastad 1962; Todaro 1969), individuals' incentives for migration in our model are determined by push and pull factors, such as real wage gaps between the origin and the destination or factors espoused by the modernization hypothesis. Our main departure from the push-pull paradigm is that we nest the decision of whether or not to migrate within a Susceptible-Infectious-Recovered (SIR)-like epidemiological model, with an underlying geographic network structure and an explicit role for inter-place transmission.[29]

3.1 Basic Setup

Individuals may be in one of three states. They begin as *unlinked.* These individuals are not able to migrate regardless of the incentive to do so. *Linked* individuals have access to the migration technology—a necessary condition for migration. Unlinked individuals may switch to being *linked* in one of two ways—when one of their contacts migrates,[30] or spontaneously. Every period, linked individuals make a choice of whether or not to migrate based on push and pull factors. If they migrate, they become a *migrated* individual and their unlinked contacts become linked. If the migrated individual had become linked spontaneously (rather than through the emigration of one of his contacts), he is a *pioneer.* Individuals have both *intra-place connections* to other individuals in their same municipality and *inter-place connections* to individuals in other municipalities. For simplicity, the following discussion will focus on the case of a single destination. When there are multiple destinations, the progress of individuals from unlinked to linked to migrated is separate for each destination and individuals linked to more than one destination decide whether to migrate to one of them or to remain in the origin.

The main state variables of the model for municipality i in period t are $\mathfrak{S}_{it} = \{U_{it}, L_{it}, M_{it}, N_{it}\}$, where U_{it}, L_{it}, and M_{it} denote the share of individuals within the municipality who belong to each of the three states (unlinked, linked, and migrated) and N_{it} is a measure of the exposure of municipality i to emigrants in all other municipalities. The latter can be thought of as the probability that any out-of-municipality contact

[29]The SIR model is originally due to Bernoulli (1776) and Kermack and McKendrick (1927), and has been applied in economics by Burnside, Eichenbaum, and Rebelo (2016) and Eichenbaum, Rebelo, and Trabant (2021), among others.

[30]This switch can capture prior migrants providing material support to potential migrants and the provision of information by prior migrants to potential migrants, among others. All are consistent with the spirit of our model, which requires only that an individual's contacts' migration somehow enable his own. These mechanisms are indistinguishable in our data and we are agnostic as to which one of them carried more weight.

of an individual in municipality i is a migrated person. It takes the form

$$N_{it} = \frac{\sum_{j \neq i} M_{jt} P_j d_{ij}^{\pi}}{\sum_{j \neq i} P_j d_{ij}^{\pi}}, \tag{1}$$

where P_j is the population of municipality j, d_{ij} is the distance between municipalities i and j, and $\pi < 0$ is the rate at which the likelihood that an individual in municipality i has a contact in municipality j decays with distance. By definition, $U_{it}, L_{it}, M_{it}, N_{it} \in [0, 1]$ and $U_{it} + L_{it} + M_{it} = 1$.

The main parameters of the model are the set $\Theta = \{\lambda, \delta, \alpha, \pi\}$, where $\lambda > 0$ is the number of individuals in the same municipality to which each individual is connected, which determines the rate of intra-place transmission; $\delta > 0$ is the number of individuals in other municipalities to which each individual is linked, which determines the rate of inter-place transmission; and $\alpha > 0$ is the rate at which individuals spontaneously gain the option to emigrate, which governs the prevalence of potential pioneers.

Let m_{it} denote the probability that a linked individual from municipality i chooses to migrate in period t; that is, $e_{it} = m_{it} L_{it}$ is the rate of emigration out of the total population. The variation across municipalities in the probability m_{it} reflects the underlying variation in incentives for or impediments to migration internal to municipality i, which are distinct from linkage status, such as the income level or the degree of economic modernization.

In each period, the timeline is as follows. First, individuals who were linked in the previous period decide whether or not to migrate; then, new links are created, caused by individuals who emigrated in the first part of the period, or by spontaneous generation. The implied laws of motion for the state variables are then

$$\Delta M_{it} = m_{it} L_{it},$$

which is the change in the fraction of the population that has already migrated. The fraction of individuals exiting the susceptible state is the rate of those who become linked,

$$\Delta U_{it} = -[1 - (1 - \alpha)(1 - \lambda \Delta M_{it})(1 - \delta \Delta N_{it})] U_{it};$$

that is, new linked individuals are created either spontaneously, from linkages to newly migrating individuals in the municipality, or from linkages to newly migrating individuals in other municipalities. These individuals are added to the fraction linked, for which the law of motion is

$$\Delta L_{it} = -m_{it} L_{it-1} + [1 - (1-\alpha)(1-\lambda \Delta M_{it})(1-\delta \Delta N_{it})] U_{it};$$

that is, those who become linked are added and those who migrate are lost.

3.2 Discussion

The diagram in Figure 5 shows a hypothetical chain of events that illustrates the main concepts of the model. There are three municipalities, A, B, and C. The first individual to migrate was a_1 from municipality A. He was a pioneer, in the sense that he migrated after switching spontaneously from susceptible to linked without contact with a prior migrant. He was connected to two other residents of municipality A, a_2 and a_3, and his migration converted them from unlinked to linked. This is a case of *intra-place diffusion* of the migration technology. Eventually, a_2 and a_3 also decided to migrate, converting four more unlinked individuals in municipality A to being linked. As the process proceeds, municipality A is likely to quickly become *saturated*, in the sense that all individuals would either become linked or will have already migrated, leaving no more unlinked individuals. At this point, municipality A's migration rate is determined solely by push and pull factors and not by the rate at which the migration technology diffuses. Municipality A is an *epicenter*, since migration was already common there before arriving in its neighboring municipalities.

The migration of individual a_3 also linked b_1, an out-of-town contact in neighboring municipality B. This is a case of *inter-place diffusion*, which caused a *spatial contagion* of migration from municipality A to municipality B. If individual b_1 were eventually to migrate, municipality B would likely advance towards saturation with some time lag relative to municipality A, transmit the migration technology to its neighboring municipalities, and so on. Municipality C, on the other hand, is further from A, and without receiving the migration technology through an inter-place linkage, one of its residents, individual c_1, spontaneously gained the option to migrate. If he migrates, he becomes a pioneer and is likely to start a new chain of migration spreading from municipality C.

This model is similar to the traditional way that international migration has been modeled (e.g., Hatton and Williamson 1998; McKenzie and Rapoport 2010) in that the fundamental incentives are the same—migrants are driven by push and pull factors, captured by the migration probability m_{it}. In addition, in emphasizing the important role of chain migration in determining the size of migratory flows, our framework shares common ground with the standard analysis of migration, but with two notable differences. First, our conceptualization of the friends and relatives effect at the micro level is different. Our model views a network connection to be necessary for migration rather than as simply a continuous cost shifter. But at the aggregate level this difference is largely immaterial, or at most a matter of a different arbitrary choice of functional form: in both models, current aggregate migration from a municipality is some function of past migration. The substantive difference is that our model allows the inter-place diffusion of migrant networks, a feature that enables the formalization of spatial diffusion.

Under different parameterizations, our model can capture both diffusionist and internalist explanations for the timing of the onset of mass emigration. Three key parameters distinguish between these two different types of dynamics. To the extent that pioneers are rare (α is small), out-of-municipality contacts are frequent (δ is large), and very remote out-of-municipality contacts are rare (π is large), migration will be dominated by a process of spatial diffusion. As a rule, mass emigration will not take off before the migration technology arrives through the diffusion of short-distance inter-place contacts. Even regions in which the incentives for emigration are high and no internal characteristic hinders migration may be prevented from producing mass emigration for a long period of time. Moreover, no change in local push factors is necessary for mass emigration to suddenly be ignited.

Conversely, when the model does not have the above parameterization, it simply collapses in the limit to a standard push-pull model.[31] If a place does not produce mass emigration, it must be because the internal characteristics of that place are not conducive to emigration—either individuals there lack the incentive to emigrate or some characteristic of the place constrains migration (Hatton and Williamson 1998, p. 39). While networks are important, their absence cannot (at least for long) prevent the realization of emigration from places where the incentives are strong: networks supporting migration will spontaneously be generated wherever local factors are conducive to emigration without waiting for them to arrive through the inter-place transmission process. Thus, conditional on local characteristics, the timing of the onset of mass emigration in a place is independent of whether or not migration was already present among its neighbors.

[31] When the bulk of the country has achieved saturation, the differences between the two parameterizations are largely eliminated. As a result, our model can also capture a phenomenon in which improvements in standards of living eventually reduce migration—when everyone is linked, the migration decision is based solely on push and pull factors, and smaller wage differences reduce the incentive to emigration. Hatton and Williamson (1998) argue that the typical curve of migration has an inverse-U shape, as emigration eventually eliminates real wage gaps, thus reducing the incentive to emigrate. They reject the diffusion hypothesis for failing to predict the downward-sloping side of the curve (p. 15), which is seen in the cases of German and Scandinavian emigration. But this insight regarding the drivers of emigration at saturation shows that, if indeed real wage gaps are eliminated, then a decline following saturation is perfectly consistent with the diffusion hypothesis. The fact of the matter is that very little reduction of real wage gaps occurred between Italy and the United States before World War I.

3.3 Predictions

When the parameters of the model are such that spatial diffusion is dominant, the model makes several predictions that can be evaluated in the data, as demonstrated in the simulations of Online Appendix D.

Prediction 1 (Convergence)**.** The overall cross-place variation in the rates of emigration caused by underlying variation in push factors is initially augmented by the variation in access to the emigration technology. As a growing number of places are infected and approach saturation, the latter source of variation is gradually eliminated, such that the overall variation levels off around a lower rate, reflecting only variations in push factors. This leveling is manifested by a pattern of σ-convergence—cross-sectional measures of dispersion of migration rates will decline steadily, until they stabilize when the entire country is saturated.[32] Second, this process generates a pattern of β-convergence. Places that are latecomers to migration due to an initial absence of linkage to prior migrants experience rapidly rising migration rates shortly after linkage, whereas places that are already saturated have higher rates but little or no growth. With convergence in migration rates coming from laggards catching up, the β-convergence prediction implies a strong negative relationship between past migration rates and future growth in migration. To be clear, the diffusion hypothesis does not predict that all places will converge to a uniform rate of emigration. Due to variation in local push factors, a significant amount of variation may remain even when the country is saturated.[33]

Prediction 2 (S-Shaped Local Trends)**.** Before any individual in a place is linked, the place's emigration rate will be zero. Once the first individuals in a place are exposed, intra-place diffusion will generate a rapid increase in the emigration rate as individuals become linked, emigrate, and link their connections. Eventually, the place will reach saturation when nearly everyone is linked, and the rate of emigration will stabilize around a level determined by push factors. When combined, these three phases will create an S-shaped local time series of emigration rates. A steadily and gradually rising trend in national emigration rates will be a result of the accumulation of many successive and sharply rising local S-curves that also generated the convergence in Prediction 1. This, too, was an observation linked by Gould (1980) to diffusion, and is also a common prediction of the of the technology-adoption literature (e.g., Bass 1969; Jovanovic and Lach 1989).[34]

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[32] This prediction was first suggested and assessed by Gould (1980), who measured cross-regional Gini coefficients in Italy, Portugal, and Hungary.

[33] Gould (1980, p. 314) points out that "The process of diffusion . . . did not guarantee that pioneer migration would be followed by a mass movement increasing in some predetermined mathematical progression. If the conditions were not propitious: if the income gain was insufficiently large, for example, or the conditions of the migrant community unacceptable in some other way, the pioneer movement would prove still-born." Such was the case, for instance, in the case of migration from the Spanish province of Málaga to Argentina, which was initiated by migration subsidies, but faded after these were removed (Sánchez Alonso 2015).

[34] The standard SIR model follows the S with a declining portion of the curve coming from immunity due to prior exposure. In this case, we do not predict such a decline for two reasons. First, the rates of emigration, even where they were the highest,

Prediction 3 (Correlated Destinations)**.** Two neighboring places will typically share the same destination-specific networks due to their proximity. Therefore, they should have similar migration options and a similar distribution of destinations. On the other hand, two distant places are more likely to be part of different networks, potentially leading to different destinations. Moreover, as the network of migration to each destination spreads across the country, the set of potential destinations of any two places will become increasingly similar. Therefore, the prediction is that the similarity in the distribution of migration destinations of two places should increase with the proximity between places and increase over time.

Prediction 4 (Frontier Effect and Spatial Expansion)**.** The mechanism that undergirds the diffusion process is *spatial contagion*—the transmission of the migration technology from places already engaged in emigration to neighboring places. The immediate prediction that follows from it is the *frontier effect*: defining the *frontier* in any given period to be the boundary of an area that has already crossed a certain threshold level of emigration, the probability that a place enters mass emigration in the current period is positively related to its proximity to the frontier in the previous period. This ultimately results in *spatial expansion* of mass emigration, such that, starting from the early sources of mass emigration (the epicenters), successive places will enter mass emigration in spatial order from near to far.

To be clear, spatial expansion and the frontier effect can be the product of other mechanisms, and section 6 is dedicated to showing that in our case it was most likely the product of spatial contagion. However, beyond being a prediction that is consistent with the basic mechanism, the frontier effect in itself is a crucial component of the diffusion hypothesis. Places not already experiencing mass migration must only rarely begin to do so unless they are close enough to places where the migration technology has already arrived. If spatial contagion occurs but it is not strong enough to dominate the evolution of emigration and produce the frontier effect, then emigration does not spread primarily by spatial diffusion, and the diffusion hypothesis fails. The same is true in that the frontier effect must generate spatial expansion from epicenters. Therefore, the frontier effect and spatial expansion are not only predictions but also necessary conditions that must be satisfied.

We do not expect evidence supporting any single prediction to individually validate the diffusion hypothesis, as each of them could potentially be rationalized by some combination of alternative explanations (some with more difficulty than others) as we discuss in more detail in section 5.5. Our goal is to document a number of new stylized and striking facts about the Italian emigration, all of which can be parsimoniously

were never high enough to completely deplete the population. Second, the continual entry of individuals into the age cohorts associated with emigration would keep the pool of potential emigrants well stocked. Indeed, despite 14 million departures from Italy over our study period, the population grew from nearly 27 million in 1871 to nearly 38 million in 1921.

explained by the diffusion hypothesis alone.

4 Data

4.1 Sources and Construction

Our main data source is the *Statistica della Emigrazione Italiana per l'Estero*.[35] This series of volumes was published approximately every two years from the 1870s to the 1920s by the Italian *Direzione Generale della Statistica*. We digitized three data panels from this source. The first is a panel of annual emigration counts spanning the period 1884–1920 at the level of the municipality (*comune*), of which there were more than 8,300 in Italy.[36] The second is a series of annual emigration counts at the district level (*circondario* or *distretto*), of which there were 284, which enables us to extend our temporal coverage to begin 8 years earlier in 1876. The last is an annual panel (1877–1920) of emigration counts for 28 consistently defined destinations (usually countries) at the level of the province (*provincia*), of which there were 69 in Italy.[37] We focus in most of our analysis on three aggregated main destinations—North America, South America, and Europe, which together comprised 96.8 percent of all Italian emigration during the period 1877–1920.[38]

The *Statistica della Emigrazione per l'Estero* has previously been used by a number of studies of Italian emigration (e.g., Ardeni and Gentili 2014; Faini and Venturini 1994; Gould 1980; Hatton and Williamson 1998; Moretti 1999), but none has used data at a level finer than the province-decade. The high resolution of the municipality-level Italian emigration data that we collected yields perhaps the most detailed data in terms of geographic disaggregation and temporal coverage available on a migration flow as large, as geographically varied in origin and destination, and as historically important as that from Italy during the Age of Mass Migration.[39] These features are essential to our study of the spatio-temporal expansion of migration and thus to our evaluation of the diffusion hypothesis—the spread of emigration over space simply cannot be observed at a sufficiently fine level with data at the level of the province or higher, and smaller countries with

[35] Detailed citations for this and the other historical statistical publications that we use are given in Online Appendix E.

[36] We have data for 8,317 municipalities, though a lack of population counts in some cases limits our sample of municipalities with known emigration rates to 8,029.

[37] The publications omit tables for 1879 for the district and province-by-destination data and for 1888 for the province-by-destination data. In 1916 and 1917, there was virtually no transatlantic migration because of World War I, and consequently there were no volumes published for these years.

[38] These data are based on contemporary jurisdictional boundaries, which experienced some changes during our study period, as well as in the century since. Online Appendix F describes how we harmonized these data to fit consistently defined geographic units.

[39] Karadja and Prawitz (2019) and Lowell (1987) use highly detailed data on emigration from Sweden–a country with less than one-sixth of Italy's population. Boberg-Fazlić, Lampe, and Sharpe (2021) use individual and parish level data on Danish emigrants. Fernández-Sánchez (2021) uses detailed data from a single region of Spain. Work in progress by Fontana et al. (2021) also uses the Italian emigration data.

available locality-level data, such as Sweden or Denmark (Boberg-Fazlić, Lampe, and Sharpe 2021; Karadja and Prawitz 2019; Lowell 1987) are characterized by distances too short to observe a full diffusion process.

The emigration counts are based on passports issued to would-be emigrants by local administrative officials. Although it provides the most comprehensive data available on Italian migration, there are some known issues with this source, such as inaccurate reporting by the mayors (*sindaci*) of the Italian municipalities.[40] The most concerning issue is a 1901 change in Italian law.[41] Prior to this law, passports were helpful, but costly, and not strictly required; after 1901, they became free and compulsory when departing from Italy for trans-Atlantic destinations (Foerster 1919, p. 11). It is therefore potentially concerning that the figures document a surge in emigration, in particular to the United States, between 1900 and 1901.[42] But US arrival data (Barde, Carter, and Sutch 2006) show growth in Italian arrivals from 1900–1901 that closely matches the increase in our data, reducing the concern that this surge was spurious or that many emigrants avoided taking out passports prior to the policy change.[43] Another issue is that the municipality-level data for 1884–1903 aggregate some municipalities with low but non-zero emigration rates into a single figure for each district. Municipalities included in this aggregation will appear to have an emigration rate of zero in these years. We address this concern in Online Appendix G, where we repeat our main municipality-level analyses assigning the aggregate emigration to unlisted municipalities, with similar results. This concern does not affect the district-level data.

Another concern raised by Foerster (1919, ch. 2) and Hatton and Williamson (1998, ch. 6) is that the distinction in the emigration data between temporary and permanent immigration, when it is made, is unreliable. We agree, but we do not view this as a deficiency. Return migration was frequent (Bandiera, Rasul, and Viarengo 2013), but the intended duration of migration upon departure was subject to unpredictable changes (Ward 2017). Our goal is to explain the total movement of labor, permanent or temporary, and therefore we ignore this distinction and count both cases equally. However, the issue of return and repeat migration becomes acute in the northern border regions, where seasonal migration across the border was so frequent that in several municipalities the total number of leavers throughout the period exceeded the total population. While this is an encouraging indication that even easy overland exits were documented in the data, it leads us to treat border-region emigration in particular, and, more generally, emigration to Europe

[40] See the discussion of the accuracy of the Italian emigration data by Foerster (1919, pp. 10–22).

[41] See Foerster (1919, pp. 11, 21) and Hatton and Williamson (1998, p. 98).

[42] According to Foerster (1919, p. 21), the Italian official statistics were less precise than the American immigration data, and that around 1901 there was a change from under- to over-enumeration of Italian emigrants. (Hatton and Williamson 1998, ch. 6) describe this surge as spurious, but this is largely due to their distinction between temporary and permanent migration, which we address below.

[43] This is shown in Online Appendix Figure B.4. Although there is little difference around 1901, larger differences emerge later in the study period.

as a whole, with caution.

Our benchmark specifications use emigration rates based on 1901 population as the denominator, and we verify robustness to using 1881 population instead (Online Appendix H).[44] Since the smallest geographic unit for which destination data are available is the province, we impute destination-specific emigration rates for each municipality and district based on the province-year-specific weights of destinations.[45] As described above, our main focus is on migration to North America (the United States and Canada).[46]

In addition to the emigration data, we draw, from a wide range of sources, a battery of municipality- and district-level post-unification characteristics that are potentially relevant for determining emigration rates. Their purpose is two-fold. First, they serve as control variables in the various statistical tests for the predictions of the diffusion hypothesis. Second, some of them proxy for local features that, according to the modernization hypothesis, might have determined the timing of mass emigration, and we use them in order to assess the validity of this view. Municipality-level data include geographic characteristics (elevation, distance to the coast, and distance to land borders), distance to the nearest railway line in 1881 (Ciccarelli and Groote 2017), birth and death rates in 1881, per capita membership in mutual aid societies in 1878, and per capita deposits in postal savings banks in 1886.[47] District-level data are digitized from the 1881 census—the earliest with the data that we require—and include demographic and labor-force composition—the fraction of the male labor force employed in agriculture or industry (including traditional cottage industries), the fraction of the population younger than 15 years old, and the fraction of males aged 15 or older who were literate. Altogether, these variables account for market access, industrialization, demographic pressures, social capital, and financial development; their summary statistics are presented in Online Appendix Tables B.1 and B.2.

[44]We use 1901 population because it is the population reported in the 1904–1905 volume of the emigration statistics, which is the first volume in which the emigration of all municipalities is reported regardless of magnitude. It thus enables us to secure population measures that are most comparable to those of our emigration data. A related issue to the distinction between the legal and actual population is internal migration. While mass internal migration is largely a phenomenon of the Fascist and post-World War II period (A'Hearn and Venables 2013, p. 625), there is some evidence of significant population movements in other settings, such as along the former borders after unification (A'Hearn and Rueda 2022). But it is clear that this was overall a minor phenomenon (and a poorly documented one) relative to international migration. We are grateful to Brian A'Hearn for a helpful discussion on this topic. See also Spitzer, Tortorici, and Zimran (2022) for a discussion of the relative magnitudes of internal and international migration.

[45]A potential consequence of this is that there may be artificial within-province-period correlation in municipalities' emigration to a particular destination that does not extend past provincial borders. We address this issue by repeating our main results using data for all destinations in Online Appendix I. Our results are qualitatively unaffected in general.

[46]We add Canada because the volumes for early years do not distinguish between the two countries in the provincial counts. Canada comprised 2.4 percent of all migrants to North America in an average year in which counts for Canada and the United States were separately reported, and never more than 7.5 percent.

[47]Sources for these data are described in Online Appendix E. There are a number of potential measures of the presence of credit, savings, or liquidity, as described in more detail by Spitzer, Tortorici, and Zimran (2022). Using the postal savings banks data from 1886 combines a variety of desirable features: the banks are sufficiently small so as to potentially have been relevant to individuals and the data are sufficiently close to our benchmark year of 1881; thus, the postal savings data enable us to capture the presence of local savings and liquidity without introducing too many distinct variables.

4.2 Summary Statistics

Figures 2 and 3 present maps of emigration rates for municipalities and districts by half decades.[48] In Figure 2, these are at the district level and begin in 1876. In Figure 3 they are at the municipality level and begin in 1884.[49] As discussed above, they provide visual evidence of the existence of spatial expansion, as well as for the approach to saturation in the latter periods. Interestingly, the map of emigration to all destinations in the final period bears a remarkable resemblance to the topographical map of the country (compare Online Appendix Figure B.10, panel f and Online Appendix Figure B.11): the coefficient of correlation between emigration and elevation is 0.37 in the 1911–1914 half decade. Though investigating its causes is beyond the scope of this paper,[50] this strong correlation is clear indication that elevation was, in a sense, a first-order determinant for a place's potential for emigration, yet its importance is visible only after the diffusion process was nearly complete. This attests to the power of the absence of networks in constraining migration from otherwise emigration-prone places.

We define an epicenter of emigration to North America to be a district that had an average annual emigration rate of at least 1 per thousand to North America during the period 1876–1883, and which did not have a neighboring district with a greater annual average emigration rate to North America in this period. This criterion defines 6 epicenter districts, marked in Figure 6.[51] We measure the distance from the epicenter as the distance of each municipality from the nearest capital municipality of an epicenter district. For South America, we devise a similar definition but with a higher threshold of 5 per thousand because we only begin to observe the South America-bound emigration when it was already well developed.[52] Because the Europe-bound emigration was clearly greatest in the districts sharing a land border with neighboring European countries, we use the distance to this border as the measure of distance to the European epicenter. Finally, we define the *frontier of mass migration* to a destination to be the contour of districts that had ever achieved an emigration rate of at least 5 per thousand by a given half decade.

As shown in Figure 6, the evolution of the frontiers diverged meaningfully across the three major destination groups. While there is some similarity between the geographic origins of the three flows—for instance, emigration rates from Tuscany and Latium were low regardless of the destination, and both the North and

[48] This length of period smooths out short-term fluctuations in emigration without obscuring longer-term trends.

[49] Online Appendix Figures B.5–B.10 present analogous figures for migration to South America, to Europe, and to any destination.

[50] This relationship has previously been remarked upon by Gould (1980, pp. 290–291), Cinel (1982, p. 31), and Sturino (1990, p. 14).

[51] These are Sala Consilina in Salerno, Isernia in Campobasso, Corleone in Palermo, Chiavari and Albenga in Genova, and Pozzuoli in Napoli.

[52] The epicenters of South American emigration that we identify are Lagonegro in Potenza, Chiavari in Genoa, Asiago in Vicenza, and Gemona in Udine, and are also marked in Figure 6.

South American flows had epicenters in Campania, Basilicata, and Calabria—there are also major differences. The north-south divide in the contrasting European and North American flows is clear, but may have been the product of lower migration costs to Europe in the north and the greater prevalence of repeat migration where distances to the border were shorter. Other differences, however, are harder to explain by some destination-specific regional advantages. For example, Veneto in the northeast had extremely high rates of migration to South America, but low rates to North America, and to some extent the same was true in the northwest. Similarly, Sicilian migration to South America came primarily from the southern half of the island, whereas migration to North America spread out from its northwest.

5 Patterns

In this section, we check whether each of the four predictions laid out in section 3 are substantiated in the data. Throughout this section, the geographic units of analysis are the district and the municipality, and, except where otherwise indicated, the temporal unit of analysis is the half decade. The main destination of interest is North America. We present analogous results for migration to all destinations in Online Appendix I

5.1 Convergence

Figure 7 examines the trend in the annual cross-sectional dispersion of emigration at the district and the municipality, for emigration to North America. Our preferred measure is the coefficient of variation because it is both normalized by scale and, unlike the standard deviation of log-emigration, can account for cases of zero migration. There is clear evidence of steady, almost perfectly monotone, σ-convergence, with the coefficient of variation decreasing from around 4 in 1880 to just over 1 in 1910.[53]

Figure 8 shows that this σ-convergence was not the product of a tendency of all places to regress towards the mean, but of β-convergence—new areas entering mass emigration, and areas that had already experienced migration achieving saturation and stabilizing emigration rates. We compute the average annual emigration rate for each place for the periods before and after 1900 and plot the relative change between the two periods against the rate in the first period. As the β-convergence prediction implies, there is a strong,

[53]Due to the tendency to not report the specific migration counts of municipalities producing little migration in the early years, one might expect to see an exaggeration of the downward trend in cross-municipality variation. However, the district totals were almost always fully reported, and the trends of the decline in variance based on either municipality or district data is very similar. This suggests, first, that the problem of omission of low migration counts is not detrimental; and second, that the decline in variance occurred across larger units rather than within them. This is consistent with the idea that the arriving tide of migration lifted all boats in the same area.

negative, and nearly monotonic relationship between these variables. Places with the highest emigration rates in the first period experienced almost no growth. The average municipality in the top quartile of pre-1900 migration experienced approximately a quadrupling of emigration rates, while emigration from bottom-quartile municipalities grew more than 200-fold. Importantly, not a single district and only very few municipalities reduced their emigration rates at all. This is clear evidence that the β-convergence is not a simple case of mean-reversion or of churning of leading and lagging places due to random shocks. Instead, the rate of migration in the early period was the effective lower bound for the rates in the later period. Considering that real wage gaps relative to destination countries were roughly stable, this is strongly consistent with the notion of saturation—emigration rates plateaued around their full potential when the diffusion of links was completed.[54]

A natural concern is that the β-convergence patterns are spuriously generated by measurement errors or by idiosyncratic random shocks, as the pre-1900 emigration rates enters positively into the right-hand side and negatively into the left-hand side. In Online Appendix J, we present a variety of exercises showing that this correlation may have been partly augmented by such bias, but that it is nevertheless real and strong.

5.2 S-Shaped Local Trends

Prediction 2 is that the typical course of the evolution of emigration at the local level followed an S-shaped curve. Figure 9 plots a smoothed time series of migration rates for district (panels a and c) or municipalities (panel b and d) with the time measure normalized so that year zero is the first year in which the area reached an emigration rate of at least 5 per thousand. Panels (a) and (b) present both the average migration rate for each year-since-mass-migration bin alongside the median and quartiles of the distribution, smoothed over time. A clear S-shape is evident for both the municipality- and district-levels for all quartiles and for the mean, the latter with tight confidence intervals.[55] The average municipality took about 25 years to make the transition from little migration to saturation, and once a place contracted migration, the surge was rapid and largely irreversible.

Panels (c) and (d) of Figure 9 divide the municipalities and districts by the period in which they first reached the mass emigration threshold. Regardless of when the migration surge in a place began, it followed roughly the same path, except that in the late 1890s the surge appears to have been somewhat faster. Summing up the evidence on the convergence and the S-shaped time series, the continuous national surge

[54] This also means that no place had an inverse-U-shaped emigration curve, regardless of the length of its emigration experience.

[55] That is, the confidence intervals are such that only an S-shaped curve for the average municipality can be drawn within them.

in emigration during the period from unification to World War I was not the product of a rising tide that lifted all boats. Rather, places were sequentially lifted from no migration to their mass migration potential.

5.3 Correlated Destinations

The data on emigration by destination at the province level enable us to test Prediction 3 regarding correlated destinations. We compute a dissimilarity index V_{ijt} between the destination-country distributions of the emigration flows of every province pair ij in every half decade t. The dissimilarity index has the convenient feature of being interpretable as the fraction of the emigration flow from province i that would have to have been rerouted to match the destination distribution of province j (or vice versa). Panel (a) of Figure 10 presents a nonparametric regression for each half decade of the dissimilarity indices of each province pair against the distance between the provinces. The relationship is clearly positive, as expected: pairs farther from one another had more dissimilar destination choices. Moreover, conditional on distance, dissimilarity indeed seems to diminish from period to period. Dissimilarity that increases with distance could also be the result of greater dissimilarity between the characteristics of provinces, which might affect destination choices, rather than between their migration networks. It is therefore important to control for within-pair differences in characteristics in a formal test of this pattern. The prediction of diminishing dissimilarity over time, however, does not have such straightforward alternative explanation.

We estimate an equation of the form

$$V_{ijt} = \alpha_t + \beta \log(d_{ij}) + \mathbf{x}'_{ij}\gamma + \varepsilon_{ijt},$$

where α_t are half-decade fixed effects and d_{ij} is the distance between the capitals of provinces i and j and the controls $\mathbf{x}_{ij}$ are absolute differences between provinces in their individual-level 1881 agricultural employment share, industrial employment share, literacy rate, and fraction under age 15.[56] Panel (b) of Figure 10 plots the half-decade fixed effects from this regression with the 1876–1880 half decade as the excluded category, as well as the fixed effects from a similar regression limiting attention to province pairs less than 300 kilometers apart. There is a clear decline in the fixed effects over time, and the decline is particularly monotone for province pairs within the 300-kilometer range.[57]

[56] We present the estimates of β in Online Appendix Table B.3, using all destinations or different combinations of destinations, with and without control variables. The upward slope of the dissimilarity-distance relationship is robust to the inclusion of controls and to a focus on different time periods or sets of destinations, casting doubt on the notion that increasing differences in local characteristics over distance can explain our results.

[57] In more intuitive terms, the baseline specification suggests that moving from the 25th to the 75th percentile of distance between provinces entails a 0.17-standard deviation greater dissimilarity. Over the period between 1876–1880 and 1911–1914,

5.4 Spatial Expansion and the Frontier Effect

Figure 11 shows the main evidence regarding the frontier effect. In panel (a), the rates of emigration at the district level are plotted in a non-parametric regression against the distance from the frontier a half-decade earlier, including in the sample in each period only places that had not yet produced mass migration to North America.[58] When pooling all periods together, the expected trend is sharp and clear (notice that the scale of the vertical axis is logarithmic). At a distance of 25 kilometers, the rate of emigration is on average 3.2 per thousand. It then decays rapidly to 2.3 at 50 kilometers, 1.0 at 100 kilometers, and 0.3 at 150 kilometers; beyond that, the effect of the frontier weakens, as should be expected at distances that are unlikely to allow for personal contacts. The same pattern is apparent, albeit with some volatility, in each half-decade separately as well. Distance from the frontier is more than a characteristic that correlates with emigration rates; the general absence of high emigration rates beyond 100 kilometers from the expanding frontier of mass migration suggests that proximity to this frontier of mass migration was, in most cases, *necessary* for the onset of mass emigration.[59]

A formal test for the frontier effect is presented in panel (b) of Figure 11. We regress emigration rates on period-specific functions of distance from the previous period's frontier. To account for places with zero recorded emigration, we use the binomial maximum likelihood estimation described in Appendix A. The estimates are indeed universally negative, and are statistically significant until the half decade beginning 1915. Moreover, adding controls for local characteristics does not reduce, and sometimes increases, the estimates. This suggests that the frontier effect is not driven by spatial trends in observed characteristics.[60]

The diffusion hypothesis also implies that the frontier effect led to another observable pattern—that places situated farther from the initial epicenters contracted emigration later than nearby places. To validate this pattern, panel (a) of Figure 12 plots non-parametric regressions of the logarithm of half-decade average annual North American emigration rates against distance from the nearest epicenter, which is fixed over time (as opposed to distance from the frontier in Figure 11, which changes each period).[61] Districts closer to the epicenters were indeed emigration leaders throughout the study period, as evidenced by the negative slopes

the dissimilarity of any pair of provinces diminished by 0.20 standard deviations of the 1876–1880 distribution.

[58] Online Appendix Figure B.13 presents analogous results with the municipality as the unit of analysis.

[59] Pooled over all periods, the share of districts entering North American mass migration for the first time was 36.4 percent when the previous half-decade's frontier was less than 50 kilometers away, as opposed to 2.2 percent when it was over 100 kilometers away.

[60] Online Appendix Figure B.15 shows that the frontier effect was destination specific, formalizing the visual evidence in Figure 6. It repeats the analysis of panel (b) of Figure 11, but in addition to the relationship between emigration to North America and distance to the North American frontier, it also shows the relationship between migration to European and the South American frontiers. Out of the three main streams, only migration to North America is systematically negatively correlated with distance to the North American frontier.

[61] Online Appendix Figure B.14 presents analogous results with the municipality as the unit of analysis.

of the curves. There is also a gradual leveling of the curve as more distant areas entered into emigration, to the point that it is nearly flat by the last half decade. Emigration rates from districts under 50 kilometers from the epicenter were 5.8 times greater than from districts 50–100 kilometers away, and 20.8 times greater than those in the range 100–200 kilometers in the period 1876–1880. By 1911-1914 these ratios had shrunk to 0.9 and 2.3, respectively.

We test this pattern formally in panel (b) of Figure 12 by regressing emigration rates on half-decade-specific functions of distance from the nearest epicenter, using the binomial maximum likelihood regression. At both the district and the municipality level, the coefficients on distance from epicenter are initially negative and monotonically decline in magnitude over time. As in the frontier regressions, this pattern is robust to controls, and it is notable that after adding them the coefficients of the last periods for the municipality-level data become indistinguishable from zero. In other words, distance from the epicenters was highly predictive of emigration rates at the beginning of the Italian migration, and ceased to be so by the time it reached saturation.

Finally, to formalize the notion that distance from the epicenters determined the timing of entry into mass emigration, Table 1 presents the results of semiparametric Cox proportional hazard models (Zeng, Mao, and Lin 2016) for the timing of entry into the frontier of mass emigration to North America, focusing on the district as the unit of observation (since that is the unit of analysis that we consider when determining whether a place has entered the frontier of mass migration). Coefficients below 1 indicate that an increase in the variable in question is associated with a lower hazard, and thus with a later onset of mass emigration. Column (1) shows that a one-standard deviation increase in distance from the epicenter was associated with a 42 percent lower hazard of achieving mass migration at any time. Columns (2) and (3) show that this pattern is robust to controlling for broad region (i.e., north, south, and center) and to controlling for the various district-level characteristics that we observe. Thus, distance from epicenters was a determinant of the timing of the onset of mass emigration as well as the rate.

In sum, our findings complement the β-convergence prediction in showing that the laggards who caught up with the leaders were really the more distant places narrowing the gap relative to those closer to the epicenters. In order to enter mass emigration, places had to be situated close to the recent frontier of mass emigration. This, in turn, generated a pattern of spatial expansion from the epicenters outwards, whereby farther places experienced a later onset of mass migration. Moreover, the robustness of these findings to local controls suggests the spatial trends in emigration were not likely a result of systematic spatial trends in underlying characteristics. As a rule, emigration from distant places was delayed, sometimes by decades, for no apparent reason other than their location relative to the epicenters.

5.5 Examining the Modernization Hypothesis

The key advantage of the diffusion hypothesis, and among the strongest evidence of its validity, is that it can parsimoniously explain all of the patterns that we have documented above. Nevertheless, some of these patterns "might be explained in other ways" than by diffusion (Hatton and Williamson 1998, p. 99). In this section we assess the degree to which the incumbent explanation—the modernization hypothesis—can explain the stylized facts that we find.

The key feature of any plausible form of the modernization hypothesis is that more modernized places are predicted to experience an earlier onset of mass emigration. To test this, we repeat the hazard regressions on a set of district-level modernization measures around 1881. We present the results in Table 2, where all the explanatory variables are normalized for comparability and the rates of emigration are for all destinations.[62] Column (1) repeats the basic regression from Table 1, but using distance from any emigration epicenter. Columns (2) and (3) report the hazard ratios associated with a one-standard deviation increase in each of four modernization proxies. In column (2), these are the share of workers in agriculture (a negative proxy for economic development), the birth rate (a proxy for demographic pressures), literacy, and urbanization measured as the share of the population living in municipalities with over ten thousand residents. Column (3) replaces the birth rate with an alternative proxy for demographic pressure—the fraction of the population under age 15. Two of these proxies seem to act in a direction opposite to the one predicted by the modernization hypothesis: districts that were more agricultural and less urbanized developed mass emigration earlier. Literacy is positively associated with earlier mass emigration, as expected, although more weakly than the distance to the epicenter. The results for our proxies for demographic pressure are mixed: only the fraction of population under age 15 is positively associated with earlier mass emigration, as expected, though again more weakly than distance to the epicenter.[63]

Column (4) adds measures of mortality, social capital, and financial development. None show a statistically significant relationship with the onset of mass emigration. After adding distance to epicenter to the regressions in columns (5) and (6), literacy no longer has the expected sign while mortality becomes statistically significant with the expected sign, yet still relatively weak. Distance to the epicenter, however, remains unchanged in its strength as a predictor of a late start, with the mass emigration hazard more than doubling

[62] We do not separate emigration by destinations because this separation is not implied by the modernization hypothesis. Destination-specific regressions yield the same qualitative outcomes.

[63] For this reason, we use the fraction under age 15 as our preferred proxy for demographic pressure in the rest of the table.

with each standard deviation reduction in distance. We conclude that the evidence on the importance of modernization factors in determining the timing of mass emigration is at best mixed and weak, whereas the distance from the epicenter is consistently a first-order predictor.

A naïve version of the modernization hypothesis would argue that modernization factors simply augmented other push factors in increasing the demand for migration.[64] This view, however, fails to offer a simple explanation for the patterns of convergence in emigration rates, since the factors triggering early emigration would also be associated with higher rates overall. Leaders would simply be situated on a higher emigration path. As shown above, it is hard to make the case that, as a rule, early adopters had the highest emigration potential.

A more nuanced version of the modernization hypothesis would rationalize convergence as a result of a process in which places sequentially modernize, experiencing a surge in emigration during this transition, such that the convergence in emigration mirrors convergence in modernization—that is, modernization is a factor that unleashes demand for migration induced by other factors. If that were the case, then early modernization should predict higher emigration early on, but at a diminishing rate as time goes by, similar to the evidence on the diminishing importance of the distance to the epicenter (Figure 12).

In Figure 13 we examine whether a dynamic in which early modernization diminishes over time as a predictor of emigration rates is borne out in the data. In each period, we regress district-level emigration to any destination on distance to epicenters and modernization factors (all normalized, for comparability). In the early periods, the coefficients are qualitatively the same as in the hazard regressions, where only three modernization proxies (literacy, the fraction of the population under 15, and the death rate) have the expected sign and the distance to the epicenter is by far the strongest predictor. Over time, all coefficients indeed converge towards zero, yet the two modernization proxies that affect in the expected direction do so from a relatively low starting point, and in the case of the fraction of the young population the convergence is barely noticeable.[65] We conclude from this that, unlike distance from epicenters, modernization factors are not a likely source for the extraordinarily strong convergence in emigration rates that we document.

Another way in which the diffusion hypothesis outperforms the modernization hypothesis is by providing a straightforward explanation for why migration streams to different destinations were at least partly independent of each other (Figure 6), and why similarity in destinations increased with proximity and over time (section 5.3). These patterns are not strictly inconsistent with internalist explanations—it could be

[64] This version is implied by Hatton and Williamson's (1998) analysis.

[65] Results are similar for the variables excluded from this figure for clarity—1881 birth rate, mutual aid members per capita, and postal savings credit per capita.

argued that the overall level of emigration was not affected by a diffusion process, but that the destination was chosen based on the networks that were available in the vicinity. Such an explanation does, however, still emphasize the importance of inter-place networks and raises questions as to how, given their dominance, emigration can start in their absence. That is, the most generous interpretation is that the modernization hypothesis requires a more complex or an ad hoc explanation for these patterns, which derive directly from the diffusion hypothesis.

To be clear, we do not argue that internal factors, including different aspects of modernization, did not affect emigration. What we do learn from this brief examination of the modernization hypothesis is that it does not appear to offer a plausible, simple, and complete explanation for the set of stylized facts of the Italian emigration, neither in its naïve version nor in a more nuanced form. To the extent that internal factors do play a role in determining the rates of emigration, their impact is small relative to the consistent first-order role of the diffusion process. Most importantly, there is no evidence that modernization was systematically associated with the timing of mass emigration, and it is hard to explain the convergence in emigration rates as a result of some dynamics of modernization.

6 The Spatial Contagion Mechanism

The building block of the diffusion hypothesis is the spatial contagion mechanism. In this section we set out to establish that spatial contagion was indeed the mechanism that caused the diffusion of Italian emigration. Verifying the causal power and the economic significance of spatial contagion is important because it is a key differentiating feature that is not inherent to any internalist explanation. The challenge is to show that the correlation between a place's rate of emigration and its neighboring places' lagged rates of emigration reflects a strong causal relationship rather than simply a correlation driven by other spatially correlated and potentially unobserved local factors that cause emigration to arise in neighboring places around the same time.

6.1 The Rationale of the Instrumental Variables Approach

We develop an instrumental variable approach to identify the causal effect of lagged neighbors' emigration. The baseline estimation equation is a spatial lag model of the form

$$\log(e_{it}) = \alpha_t + \beta \log(e_{\neg it-1}) + \mathbf{x}_i' \delta_t + \varepsilon_{it}, \tag{2}$$

where e_{it} is the rate of emigration from municipality i in half decade t, α_t are period (half-decade) fixed effects, $\mathbf{x}_i$ is a vector of controls, and δ_t is a period-specific vector of coefficients. We specify equation (2) in logarithmic form rather than in levels in order to make the effects proportional to the level of migration.[66] We cluster standard errors at the district level, which permits correlation between any municipality-half decade observation within the same district, either over space, over time, or both.[67]

The regressor of interest in equation (2) is $e_{\neg it-1}$, which we refer to as *lagged emigration exposure*. This is a lag of a weighted average of emigration rates of all other municipalities, with greater weight exerted by nearer and more populous municipalities. In a manner analogous to equation (1), we define this object as

$$e_{\neg it} = \frac{\sum_{j \neq i} e_{jt} N_j d_{ij}^{\theta}}{\sum_{j \neq i} N_j d_{ij}^{\theta}}, \tag{3}$$

where N_j is the population of municipality j, d_{ij} is the distance between municipalities i and j, and θ is the rate at which the influence of other municipalities' j emigration rates on that of municipality i decays over distance. The numerator is a measure of effective proximity to emigration, whereas the denominator is a measure of effective proximity to population. The measure $e_{\neg it}$ is thus a population- and distance-weighted average emigration rate in the neighborhood of municipality i. Like N_{it} in our model, it can be thought of as the emigration rate among an individual's out-of-municipality contacts in the previous period.[68] A value of $\theta < 0$ implies that more distant municipalities have a smaller impact than do nearer municipalities and a value of $\theta < -2$ is consistent with an individual's frequency of contacts diminishing with distance. For computational tractability we separate the estimation of θ from that of other parameters. We estimate equation (2) by NLS and arrive at a value of $\theta = -2.83$, which we later use throughout our main analysis.[69] The coefficient of interest in equation (2) is β, which can be interpreted as an elasticity of emigration with respect to lagged emigration exposure.

[66] This is consistent, for example, with Mahajan and Yang (2020), who find in linear regressions that the effect of hurricanes on migration increases in the size of the network, which represents the base level of migration. This assumption appears to fit the data better, at least by the criterion of generating seemingly normal distributions. Spitzer (2021) and Spitzer, Tortorici, and Zimran (2022) also focus on the logarithm of emigration instead of its level.

[67] Such spatial lag models have recently been used to study diffusion in other settings (e.g., Aidt and Leon-Ablan 2022; Aidt, Leon-Ablan, and Satchell 2022). Ours, however, is the first to pair this model with an instrumental variables strategy based on the epidemiological intuition of diffusion.

[68] The measure $e_{\neg it}$ satisfies two desirable conditions. The first is that it is robust to splitting municipalities. The second is that it is robust to uniform changes in population density. If the measure of exposure were a function of the number of emigrants (rather than the local *rate* of emigration), then doubling the population everywhere near a municipality (with an accompanying doubling of the number of emigrants) would double an individual's emigration exposure. To reflect the limited number of connections that a person can have, our measure is robust to population density, which would have no impact on the proximity-weighted emigration rate. The implied assumption is that the number of links that any individual has outside of his municipality is fixed and independent of the population density in the neighborhood.

[69] As we show in Online Appendix L, our findings are robust to using alternate values of θ selected by estimating equation (2) with different sets of controls or fixed effects.

The obvious challenge in estimating equation (2) by OLS is that any local determinant of emigration, including unobserved ones, are likely to be spatially correlated, biasing upwards the estimate of β. Identification of the effect of emigration exposure on emigration therefore requires that we find a source of variation in neighbors' emigration that is independent of a place's own internal demand for emigration.

The diagram in Figure 14 illustrates the intuition behind our instrumental variables approach. Consider two municipalities, A and B, that are observably identical in all of their internal characteristics. In particular, they are equidistant from a source of emigration (an epicenter or a frontier) at a distance d_2. The only difference between the two municipalities is that the neighboring population of municipality A is distributed such that on average it is closer to the source than is municipality A, whereas the neighboring population of municipality B is on average farther from the source than municipality B itself. The average neighbor of municipality A is therefore likely to encounter the spreading wave of emigration earlier than is the average neighbor of municipality B, not because of any feature that is correlated with any of municipality A or B's internal characteristics, but simply due to the different spatial orientation of their neighbors with respect to the source. Therefore, we can construct an instrumental variable for emigration exposure based on the weighted distance of a municipality's neighbors to the source.

6.2 Implementation of the Instrumental Variables Approach

In practice, the instrumental variable for emigration exposure $\tilde{e}_{\neg it}$ is constructed in a manner analogous to the actual emigration exposure measure $e_{\neg it}$. That is, it is defined as

$$\tilde{e}_{\neg it} = \frac{\sum_{j \neq i} \tilde{e}_{jt} N_j d_{ij}^{\theta}}{\sum_{j \neq i} N_j d_{ij}^{\theta}}, \tag{4}$$

but instead of being a weighted average of actual emigration, e_{jt}, it is a weighted average of estimated emigration, $\tilde{e}_{jt}$, which is only based on municipality j's distance to nearest emigration source. In particular, to construct $\tilde{e}_{jt}$, we estimate a non-parametric regression of the form

$$\log(e_{jt} + \varepsilon) = f_t(z_j) + u_{jt}; \tag{5}$$

that is, a period-specific non-parametric regression of log emigration on distance from the nearest emigration source.[70] We then set $\tilde{e}_{jt} = \exp[\hat{f}_t(z_j)]$ and estimate equation (2) using $\log(\tilde{e}_{\neg it})$ as an instrument for

[70] The addition of $\varepsilon = 0.0001$ on the left-hand side of equation (5) is needed to ensure that municipality-half decades with no emigration are included in the construction of emigration exposure.

$\log(e_{\neg it})$.[71] The key identifying assumption underlying this strategy is that, conditional on a municipality's distance from the nearest emigration source, the spatial orientation of its neighbors (i.e., whether on average they are closer or farther from the source) is random. Importantly, the distance to the emigration source need not be exogenous; the strategy merely uses the observed fact that a municipality's distance to the emigration source is correlated with its emigration rates. Returning to the illustration in Figure 14, since the neighbors of municipality A are on average closer to the emigration source, we expect that the actual emigration exposure of municipality A, which is a weighted average of the neighbors' actual emigration, will be greater than that of municipality B, whose neighbors are on average farther from the emigration source. For the same reason, the predicted emigration of the neighbors of municipality A is on average greater than is that of municipality B's neighbors, and as a result the weighted average of these predicted measures will also be greater.[72] The latter is then used as an instrument for the former. Notice that this source of variation, stemming from random differences in the geographic orientation of the neighboring population, which are likely to be small, is at risk of suffering from low statistical power; as we discuss below, this poses difficulties in some of our specifications.

In all of our specifications, we control for a municipality-period's own value of predicted emigration $\tilde{e}_{it}$, computed as in equation (5), allowing the coefficient to vary by period. This is the most straightforward way of controlling for the municipality's own location with respect to the source, as our strategy requires; the identifying variation is in predicted emigration exposure conditional on own predicted emigration, and using $\tilde{e}_{it}$ ensures that both expected values are calculated in the same way. Our baseline specifications restrict the sample to municipalities situated between 50 and 250 kilometers from the sources of emigration.[73]

6.3 Hidden Threats to the Validity of the Instrument

The baseline specifications also include controls for the geometry of national borders and for population density. Each of these are crucial in addressing potential risks to the validity of the instrument which are not plainly visible. First, consider a municipality that is located on the contours of Italy—either on the

[71] It is not necessary to adjust standard errors for the use of this generated instrument (Wooldridge 2002, pp. 116–117).

[72] Put differently, municipalities A_H and B_L are predicted to have greater emigration than municipalities A_L and B_H because of their distances to the epicenter. Because A_H and B_H constitute a greater share of neighbors of municipalities A and B, respectively, than do municipalities A_L and B_L, municipality A's estimated emigration exposure is greater than municipality B's.

[73] When using the epicenter-based instrument, removing the range restriction strengthens the results substantially. For the frontier-based instrument, the restriction is necessary in order to avoid an undue influence of municipalities actually within the frontier of mass migration. Since an estimate of the migration rates of all municipalities is necessary in constructing the instrument, it is necessary to take a stance on the appropriate distance from the frontier of municipalities already within it, and we set that distance to zero. However, this creates a mass point in the distribution, in which all municipalities have the same estimated migration, limiting the available variation. The range restriction assures that we are looking sufficiently far away so that these municipalities do not exert an excessive influence.

coast or on the land border. For geometric reasons (and because we do not observe municipalities directly on the other side of the land border), any source of emigration within the country will tend to be closer to the municipality's average neighbors than to the municipality itself.[74] This regularity will cause a positive correlation between predicted emigration exposure and position along the coast or the land border. If such locations have systematically different emigration potentials, this would amount to an endogeneity problem. We address this threat by controlling for half decade-specific functions of distance to the coast and to the land border.

The second hidden threat comes from variation in population density around a municipality. Consider a case in which the predicted emigration of a municipality is a downward sloping *convex* function of distance to the source (which in our case, it is). Then a reduction of the population density around the municipality would be associated with a greater average predicted emigration of its neighbor, while keeping own predicted emigration unchanged.[75] If population density is correlated with unobserved determinants of emigration, this would create endogeneity in the instrument. A straightforward way to address this issue is to control for a measure of population density, for which we use the denominator of the right-hand side of equation (3).

Another threat comes from the fact that the predicted values of municipality i's neighbors $\tilde{e}_{jt}$ are in small part based on municipality i's own realized rate of emigration, which creates a small possibility of endogeneity in predicted emigration exposure.[76] This is accounted for by controlling for the municipality's own lagged predicted emigration $\tilde{e}_{it-1}$. An alternative way to remove this source of endogeneity altogether is to estimate equation (5) while excluding the source catchment into which a municipality falls. For example, the emigration exposure for municipalities whose nearest emigration epicenter is the district of Corleone is constructed by estimating equation (5) for all municipalities except those for which the nearest epicenter is Corleone and then applying the prediction to all municipalities in the Corleone catchment. For distance from the frontier, a municipality's estimated emigration is constructed by estimating equation (5) excluding a municipality's own province.[77]

[74]For a simple example, consider a municipality located at the corner of a grid. When the source of emigration is located strictly inside the grid, there exists a positive radius around the corner municipality within which every other municipality is closer to the source than itself. Exceptions to this rule are conceivable in real-life data, but are unlikely to occur systematically.

[75]It is easy to see this in the simple example in which the population is positioned along a line; a proportional expansion of the neighboring population away from the municipality would leave the weight of each municipality unchanged, but due to Jensen's inequality, the increase in predicted emigration of the municipalities closer to the source will be greater than the reduction in predicted emigration of municipalities farther from the source.

[76]Consider municipality i at a distance d from the source. The predicted rate of emigration for municipalities $j \neq i$ that are at a distance of just above or below d is a weighted average of actual emigration rates that includes that of municipality i.

[77]The solution is different because the frontier is not a small number of places, each with a well-defined catchment.

6.4 Results

Table 3 presents the results of our estimation.[78] Panel A uses an instrument based on distance from emigration epicenters. Column (1) includes no controls beyond those described above, and only period fixed effects. The first-stage F-statistic clearly passes the Staiger and Stock (1997) threshold. The estimated elasticity of a municipality's own emigration with respect to the portion of lagged neighbors' emigration driven by variation in their own distance from epicenters is approximately 1 and statistically significant, as is to be expected in the presence of a spatial contagion mechanism. Column (2) adds controls for period-specific functions of latitude, longitude, elevation, exposure to cities,[79] 1881 district shares of employment in industry and agriculture, distance to rail, district-level literacy and fraction aged 15 or less, 1881 birth and death rates, 1878 mutual aid society members per capita, and 1886 postal savings credit per capita. Doing this only slightly attenuates the coefficient on lagged emigration exposure. Columns (3)–(8) add increasingly fine fixed effects at the region, region-period, province, province-period, district, and district-period, respectively. The magnitude of the coefficient is further attenuated, and the precision of the estimate and the strength of the instrument (as measured by the first-stage F-statistic) diminish, particularly when controlling for period-specific regional fixed effects. As mentioned above, the identifying variation is likely very small, and thus as the control becomes very tight statistical power is eroded. Nevertheless, except for the specifications that control for district fixed effects, in which statistical power is all but lost, the estimated elasticities are in the range 0.5–1 and are at least marginally statistically significant.

Panel B of Table 3 repeats the same estimation, but uses the distance to the dynamic frontier rather than the static epicenter to construct the instrument. Since, as shown above, the predictive power of the distance to the epicenter diminishes over time whereas that of the distance to the frontier does not, this is likely to

[78] Analogous OLS results are in Online Appendix Table B.4. Online Appendix Table B.5 presents results of using a more standard approach of estimating a spatial lag model of the form

$$\log(e_{it}) = \alpha_t + \beta \log(e_{\neg it-1}) + \gamma \log(e_{it-1}) + \mathbf{x}_i' \delta_t + \varepsilon_{it},$$

instrumenting for lagged emigration exposure using half decade-specific functions of neighbors' characteristics (e.g., Aidt and Leon-Ablan 2022). This is operationalized by using the binomial maximum likelihood estimator of Appendix A to estimate neighbors' emigration as a function of all observables (including distance from epicenter) and then constructing an instrument as in equation (4). The results are qualitatively similar to the main results, albeit with far greater statistical power. However, although this type of instrument can capture diffusion in the sense that it can document a causal effect of neighbors' emigration on own emigration, the use of all covariates in constructing the instrument implies that it does not necessarily capture the diffusion of migration coming from the gradual spread of networks over the country. Our preferred approach, on the other hand, by basing identification solely on the orientation of neighboring population relative to the oncoming tide of diffusion, ensures that we capture only diffusion of that type, which is what we are primarily interested in. Put differently, the local average treatment effect arising from the more conventional approach is less helpful in making our argument than is the local average treatment effect coming from our preferred approach.

[79] That is, we construct a measure analogous to equation (3), but use city population instead of number of emigrants. The cities in question are Bologna, Catania, Firenze, Genova, Messina, Milano, Napoli, Palermo, Roma, Torino, and Venezia. We include this measure because urban areas are likely to be differentially responsive when they are reached by the expanding tide of emigration. Returning to Figure 14, if municipality A is neighbored by urban areas and municipality B is not, we expect differences in the degree to which they are exposed to emigration by their neighbors.

increase the strength of the instrument without violating its exogeneity. As in the regressions that estimate the frontier effect (section 5.4), the sample changes for each period to include only municipalities that had not yet reached the frontier. The results are qualitatively the same as in panel A, but with a meaningful improvement in the strength of the instrument and in statistical power.

In Online Appendix Table B.6, we repeat the analyses of Table 3, but, as described above, we construct the instrument based on estimating equation (5) while excluding a municipality's own catchment area. Both the estimates and the statistical power are somewhat sensitive, but the qualitative results remain unchanged: estimates that have sufficient statistical power point at an elasticity in the range of 0.5–1.

To be sure, the results of this section are not entirely satisfying in terms of precision or stability, likely due to the limited variation in the instrument, leaving little statistical power under a large enough set of fixed effects. Nevertheless, despite the demanding constraints, the outcomes of this exercise broadly point at an economically significant contagion effect, most likely at an elasticity of 0.5 or more. While we cannot pinpoint the precise reasons behind this effect, it appears that it had to do with physical proximity between populations. Based on our reading of the sociology of the Italian migration (section 2.2) and of other similar movements, we argue that the most plausible explanation is that there existed inter-place diffusion of migration networks.[80] The evidence on the spatial contagion mechanism is not meant to stand alone as a proof of the diffusion hypothesis. Rather, we view it as a part of a wider body of evidence, together with the results of section 5, which, on the whole, is most parsimoniously explained by the diffusion hypothesis and is difficult to rationalize under alternate hypotheses.

7 Summary of Robustness Checks

The Online Appendix presents a variety of robustness checks for the main results. Online Appendix G repeats the main results incorporating municipalities that are not listed in the earlier emigration statistics volumes, but which may have been included in the data for "Other Municipalities" provided for each district, by allocating this extra emigration equally to all of these unlisted municipalities. Online Appendix H uses 1881 population as the basis for computing emigration rates. Online Appendix I repeats the results using data on emigration to all destinations instead of only to North America. Among other issues, this addresses the

[80] An alternative explanation could be that emigration in one municipality caused some change—such as in the economy or the culture of the place—and that this change spilled over to neighboring municipalities and caused emigration there. The local effects of emigration in that period is indeed a subject that lacks quantitative evidence. While we suspect that such effects did exist, we find it hard to believe that their spillovers to neighboring communities were sufficiently strong to be a major cause for emigration. Yet even if they were, such spillover effects would have been part of a slightly different version of the diffusion hypothesis, which would have kept all of the important implication of our preferred version.

concern that the correlation of emigration from municipalities in the same province may have been inflated by the fact that the emigration-by-destination data (which are not used in this case) are available only at the province level. Online Appendix K repeats the results including municipalities with no emigration in a particular half decade. which are otherwise excluded due to the use of the logarithm of emigration as the main outcome in many analyses. Online Appendix L repeats the results of section 6 using different values of θ to compute lagged emigration exposure and the instrument. Finally, Online Appendix M repeats the estimates of section 6 using increasingly fine geographic fixed effects as in Barsbai et al. (2017). As a rule, the results are not qualitatively affected.

8 Conclusion

The question of why emigration from the European periphery was delayed is one of the fundamental puzzles of the Age of Mass Migration. In this paper, we test the diffusion hypothesis—an influential yet heretofore neither widely accepted nor rigorously tested explanation for this puzzle that attributes the delay to the staggered spatial expansion of chain migration networks. We formalize this hypothesis by developing a model of migration within a spatial network and deriving from it broad patterns and testable predictions. We then use a newly constructed dataset to show that these patterns and predictions correspond to the major stylized facts of Italian mass migration to North America in the period 1876–1920. Using an instrumental variables strategy, we show that the most likely mechanism to have generated these stylized facts was spatial contagion. Moreover, our findings strongly suggest that diffusion was not merely one factor among many that affected migration, but a first-order cause for the macro-patterns of the Italian migration. On the other hand, modernization factors lack such explanatory power. Thus, our answer to the question of why mass emigration from Italy was delayed by several decades puts aside economic and demographic transformations and changes in economic incentives as immediate explanations. Rather, the timing of the onset of mass migration varied so widely across Italy, occurring in some places in the 1870s and in others as late as the 1910s, because of the staggered process of spatial diffusion of migration networks. By implication, this is also the reason why it took the Italian migration three decades to reach its peak and fulfill its potential from the moment relatively cheap transatlantic voyages had become available.

Weighing the diffusion hypothesis against the modernization hypothesis, we conclude that the former ought to be preferred. While some of the patterns in the data are not inconsistent with some versions of the modernization hypothesis, and while modernization factors possibly did meaningfully affect the demand for migration, this hypothesis cannot account for the totality of the evidence, at least not without many arbitrary adjustments. On the other hand, the diffusion hypothesis offers a parsimonious and historically plausible explanation that rationalizes the major stylized facts of the Italian migration. Hence, it is favored by Occam's razor. However, the diffusion hypothesis stops short of offering a complete explanation for the delayed migration puzzle. First, it leaves open the question of the formation of the epicenters. More importantly, its explanatory power is confined to the level of the country and does not scale up to the level of the continent, as it appears that Italian emigration epicenters were generated spontaneously rather than by infection across the border. Did northwestern European countries experience their own diffusion process? If so, how similar was it, and why did it occur earlier than in Italy? If not, why, and why was the periphery different? The answers to these questions may yet again invoke the modernization hypothesis at the cross-country level. But any such version of this hypothesis will have to contend with its incapacity to explain the course of emigration across regions within Italy. At the very least, it will be a heavily modified one.

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Tables

Table 1: Survival time regressions

Variables	(1)	(2)	(3)
Distance to North American epicenter	0.583^{a}	0.655^{a}	0.562^{a}
	(0.054)	(0.052)	(0.064)
Observations	284	284	284
Broad region FE	No	Yes	Yes
Controls	No	No	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1
Notes: This table presents estimated hazard ratios for semiparametric Cox proportional hazard models for the timing of entry into the frontier of mass migration to North America. Hypothesis testing is relative to a null hypothesis of a hazard ratio of 1. All variables are standardized to have mean 0 and standard deviation 1. The unit of observation is a district. The data run from the 1876–1880 half decade to the 1916–1920 half decade. The date of entering the mass migration frontier is intervaled by half decade. Broad region fixed effects are for the center and south (with the north as the excluded category). Controls are a district's share of agricultural employment, share of industrial employment, literacy rate, fraction under age 15, birth rate, and death rate, all in 1881, as well as its mean elevation, mutual aid society members per capita in 1878, and postal savings deposits per capita in 1886.

Table 2: Survival time regressions

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Distance to epicenter	0.524[a]				0.470[a]	0.467[a]
	(0.039)				(0.057)	(0.059)
Ag. labor share		1.165[b]	1.076	1.064	1.089	1.089
		(0.075)	(0.067)	(0.068)	(0.077)	(0.077)
Literacy rate		1.283[a]	1.285[a]	1.279[a]	0.774[a]	0.788[c]
		(0.073)	(0.073)	(0.088)	(0.074)	(0.101)
Share Urban 1881		0.792[a]	0.812[b]	0.828[c]	0.795[b]	0.793[b]
		(0.069)	(0.077)	(0.080)	(0.074)	(0.076)
Fraction under 15			1.295[a]	1.306[a]	1.200[a]	1.204[a]
			(0.076)	(0.087)	(0.080)	(0.083)
Birth Rate (1881)		0.912				
		(0.071)				
Death Rate (1881)				0.963	0.860[c]	0.857[b]
				(0.069)	(0.067)	(0.067)
Mutual Aid Members per capita (1878)				1.063	1.100	1.108
				(0.094)	(0.094)	(0.099)
log(Postal Savings Deposits per capita) (1886)				0.927	0.943	0.932
				(0.069)	(0.065)	(0.083)
Observations	284	284	284	284	284	284
Broad region FE	No	No	No	No	No	Yes

Significance levels: [a] p<0.01, [b] p<0.05, [c] p<0.1

Notes: This table presents estimated hazard ratios for semiparametric Cox proportional hazard models for the timing of entry into the frontier of mass migration to any destination. Hypothesis testing is relative to a null hypothesis of a hazard ratio of 1. All variables are standardized to have mean 0 and standard deviation 1. The unit of observation is a district. The data run from the 1876–1880 half decade to the 1916–1920 half decade. The date of entering the mass migration frontier is intervaled by half decade. Broad region fixed effects are for the center and south (with the north as the excluded category).

Table 3: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.956^a	0.878^a	0.657^a	0.641^a	0.602^a	0.475^c	0.977^b	0.176
	(0.104)	(0.122)	(0.177)	(0.217)	(0.151)	(0.244)	(0.415)	(0.448)
Observations	31,463	31,463	31,463	31,463	31,463	31,462	31,463	31,427
F-statistic	30.71	42.75	19.33	12.07	21.57	8.552	23.50	6.559
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.942^a	0.881^a	0.634^a	0.749^a	0.666^a	0.632^a	0.238	0.418^c
	(0.136)	(0.157)	(0.160)	(0.166)	(0.176)	(0.162)	(0.588)	(0.232)
Observations	11,207	11,206	11,206	11,205	11,206	11,196	11,206	11,170
F-statistic	64.51	55.20	60.20	46.14	49.19	44.85	19.58	28
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, distance to railroad, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

Figures

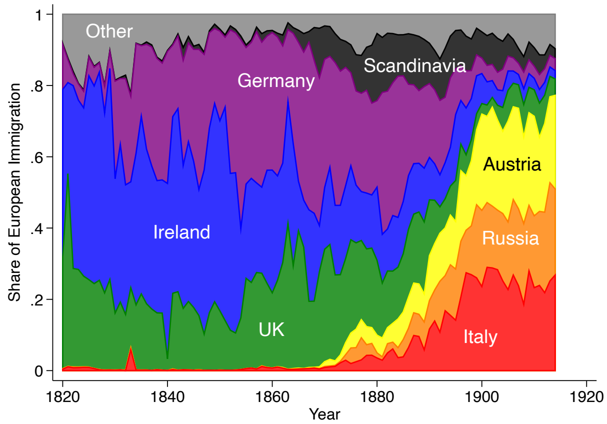


Figure 1: Distribution of origin countries for US immigration from Europe

Source: Barde, Carter, and Sutch (2006)

Note: This graph shows the share of European immigration to the United States coming from each source country. The "Austria" data are from Barde, Carter, and Sutch's (2006) data for "Other Central Europe," which cover Central Europe other than Germany and Poland.

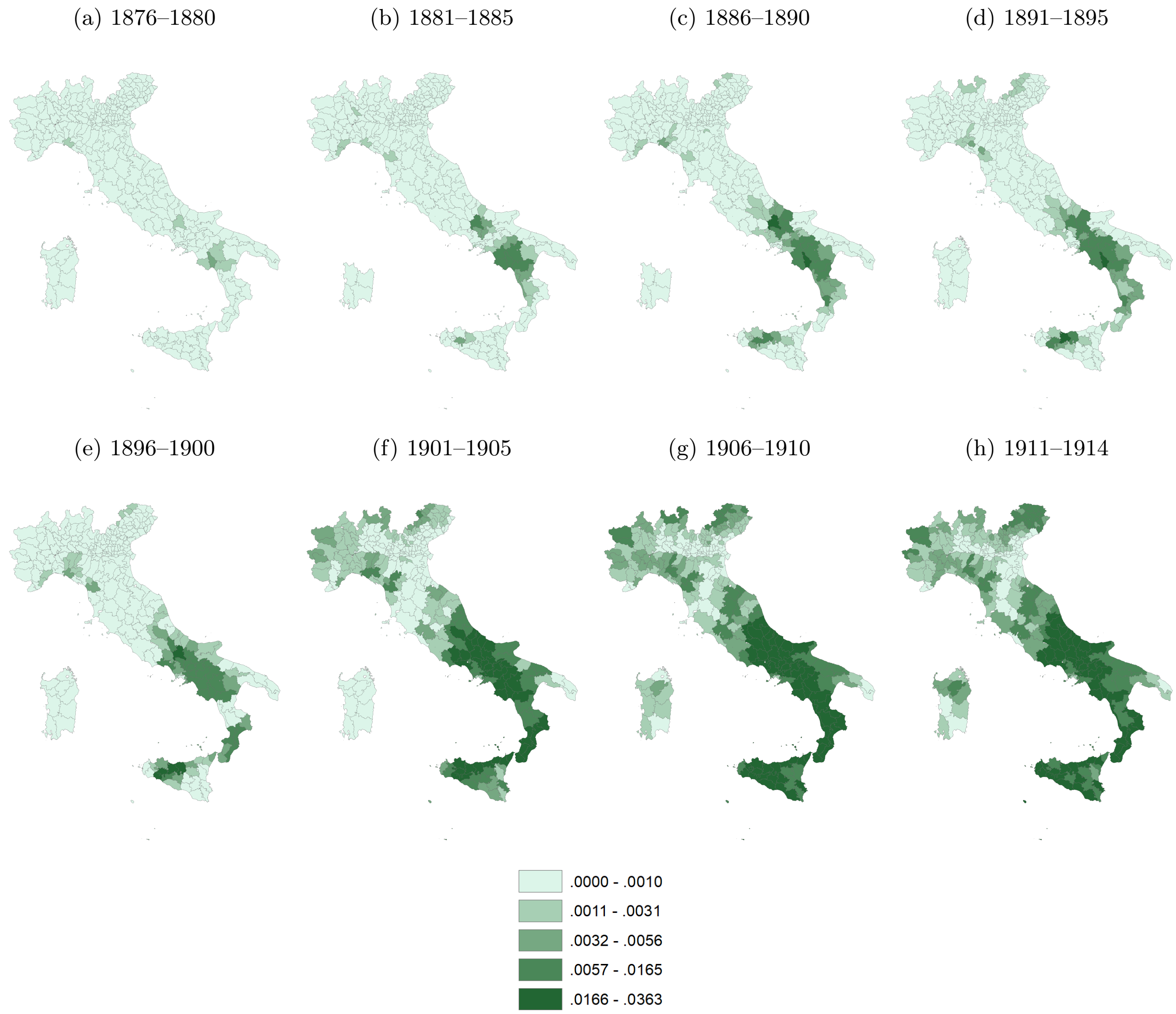


Figure 2: District-level emigration rates to North America

Note: Each panel presents a district's average annual emigration rate to North America in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

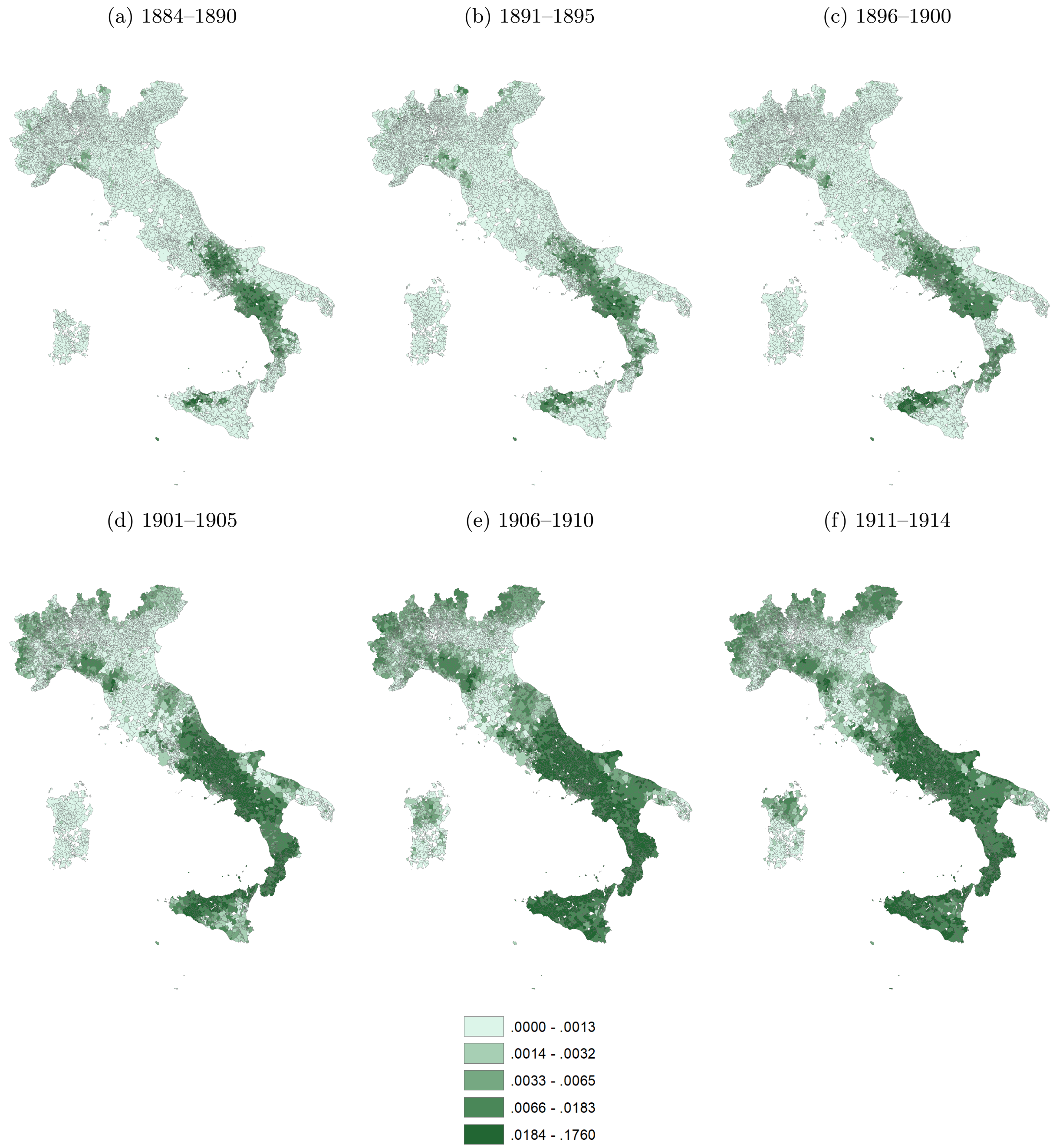


Figure 3: Municipality-level emigration rates to North America

Note: Each panel presents a municipality's average annual emigration rate to North America in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

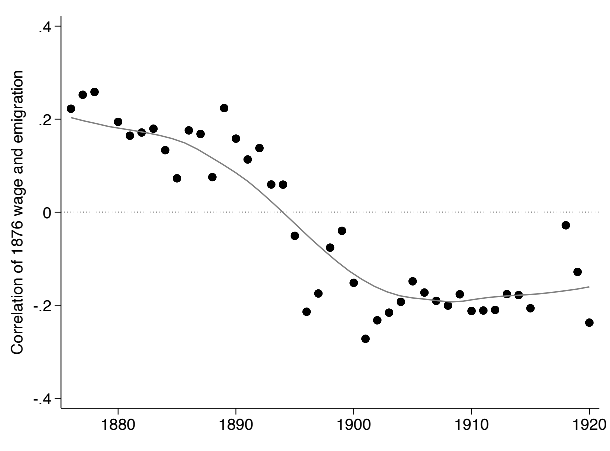


Figure 4: Correlation of province-level emigration and 1876 wages

Source: Real wage data are from Federico, Nuvolari, and Vasta (2019). The source of provincial emigration rates is described in text.

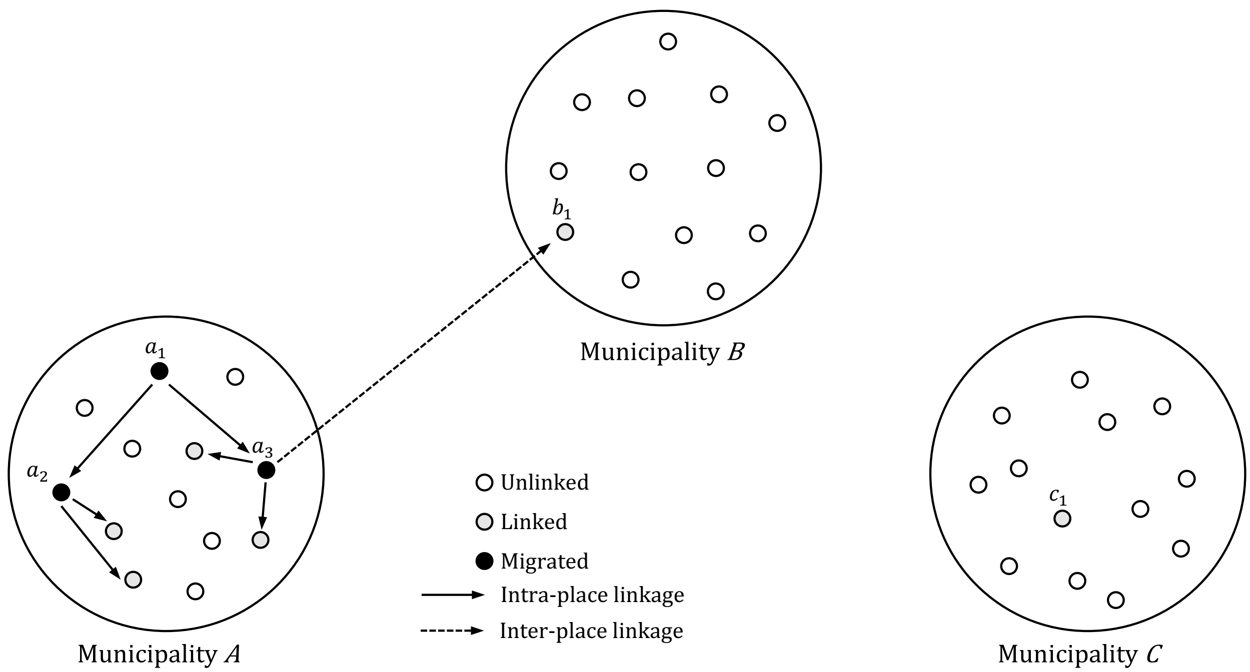


Figure 5: Intra- and inter-place transmission of the migration technology

Note: See explanation in section 3.2. Arrows indicate the direction of the diffusion of the migration "technology," not the direction of linkage.

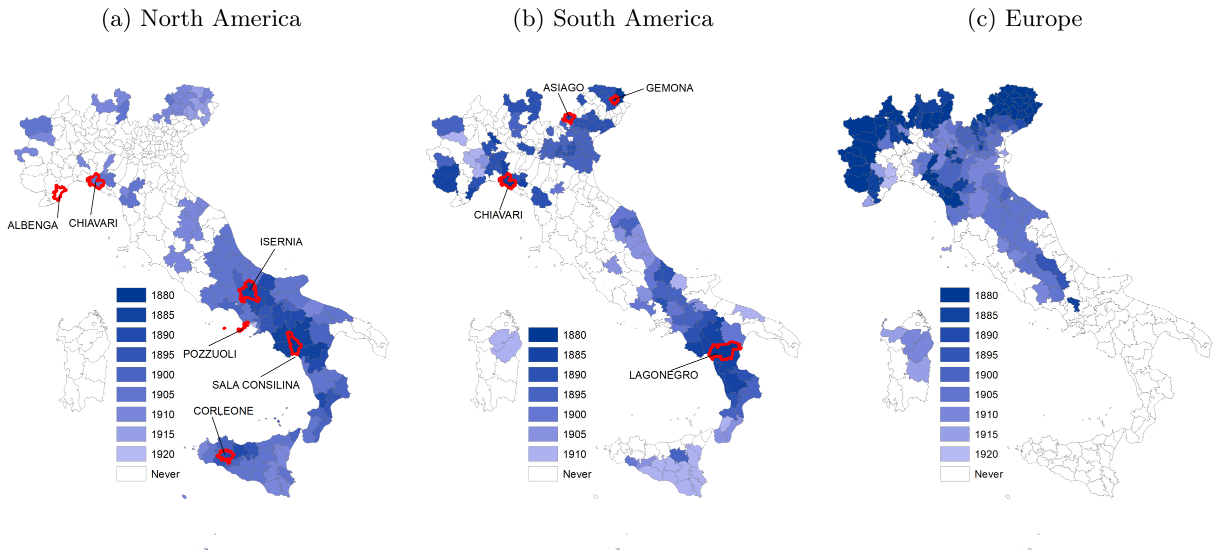


Figure 6: Epicenters and frontiers of mass migration by destination

Note: Districts are shaded according to the half decade in which they first achieved an average annual emigration rate to the listed destination of at least 5 per thousand. Darker districts entered the frontier earlier. In panels (a) and (b), the districts labeled and highlighted with a bold outline are epicenter districts. For migration to North America, the epicenters are Albenga and Chiavari in Liguria, Isernia in Abruzzi e Molise, Pozzuoli and Salerno in Campania, and Corleone in Sicily. For migration to South America, the epicenters are Albenga in Liguria, Asiago and Gemona in Veneto, and Lagonegro in Basilicata. We define the epicenter of migration to Europe to be the European land border.

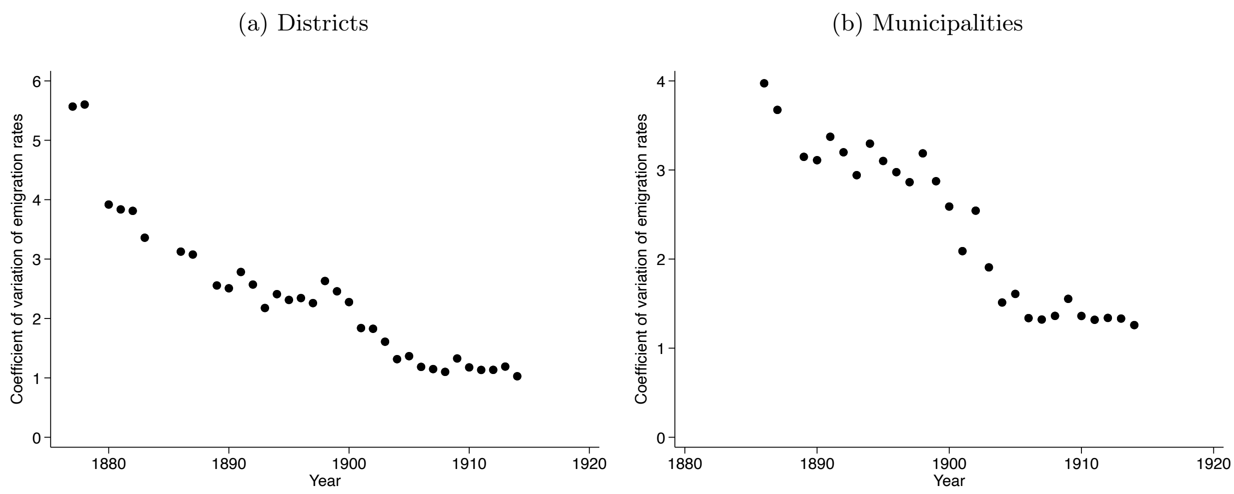


Figure 7: σ-convergence in emigration rates to North America

Note: Each point represents the coefficient of variation in emigration rates to North America in a particular year.

(a) Districts (b) Municipalities

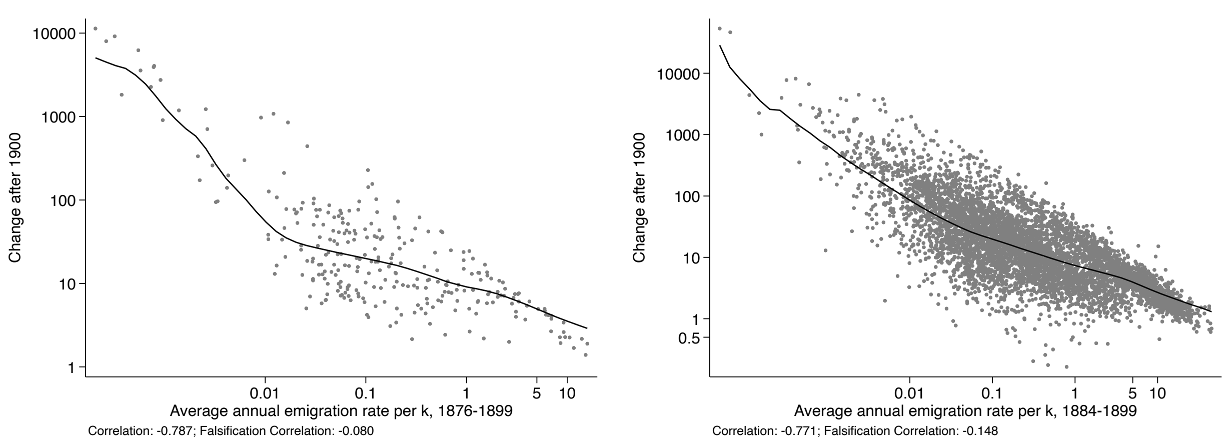


Figure 8: β-convergence in emigration rates to North America

Note: Each point represents a municipality or district. The x-axis is the average annual emigration rate for a district for 1876–1899 or a municipality for 1884–1899 on a log scale. The y-axis is the ratio of the average emigration rate before and after 1900, also on a log scale. The falsification correlation is the correlation of the change in emigration and emigration after 1900; that it is not positive indicates that the negative relationship shown in the graphs is unlikely to be spurious, as explained in Online Appendix J.

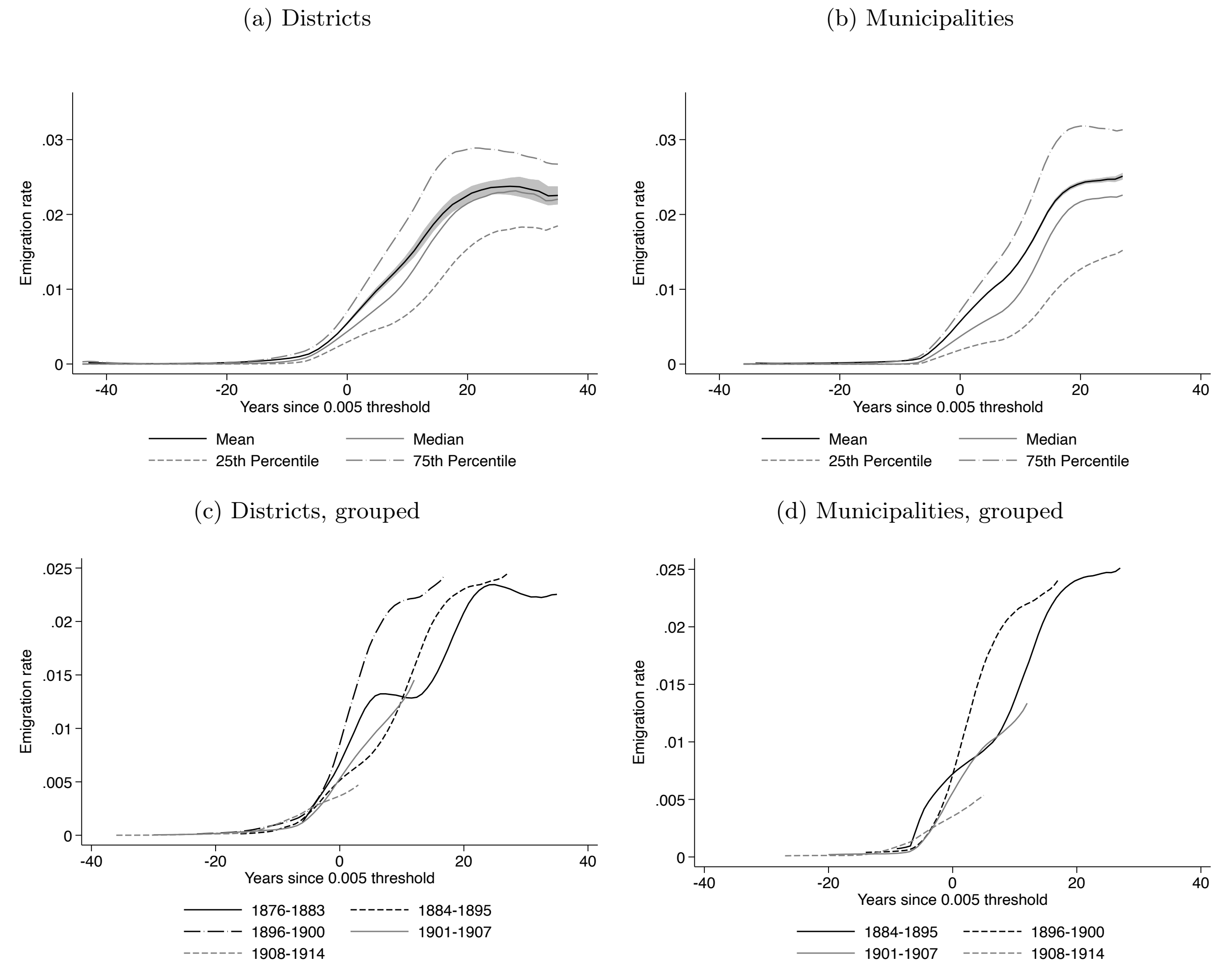


Figure 9: S-shaped time series of migration to North America

Note: Panels (a) and (b) plot a non-parametric regression (the mean), as well as quartiles of emigration rates to North America against time, normalized so that year 0 is the first year in which a place had an emigration rate of at least 5 per thousand. Shaded areas are 95-percent confidence intervals for the mean. Panels (c) and (d) are the same as (a) and (b) but divide areas according to the half decade in which they crossed the threshold.

(a) Nonparametrics (b) OLS with Half-Decade FE

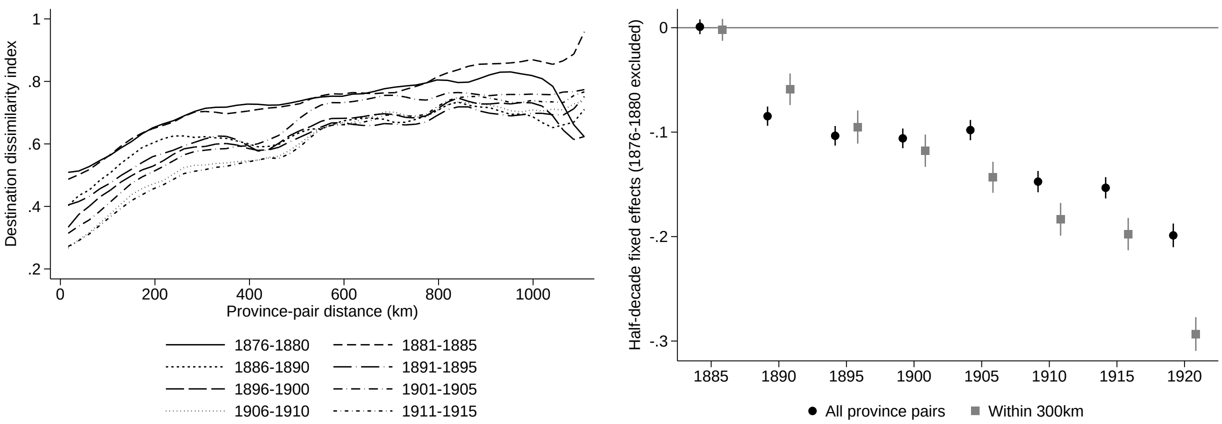


Figure 10: Destination dissimilarity by distance and half decade

Note: Panel (a) plots non-parametric regressions for each half decade of the dissimilarity index between two provinces' emigration and the distance between them. Panel (b) plots half-decade fixed effects from a regression of dissimilarity on province-pair distance and these fixed effects, excluding the 1876–1880 half decade.

(a) Districts (b) Coefficients

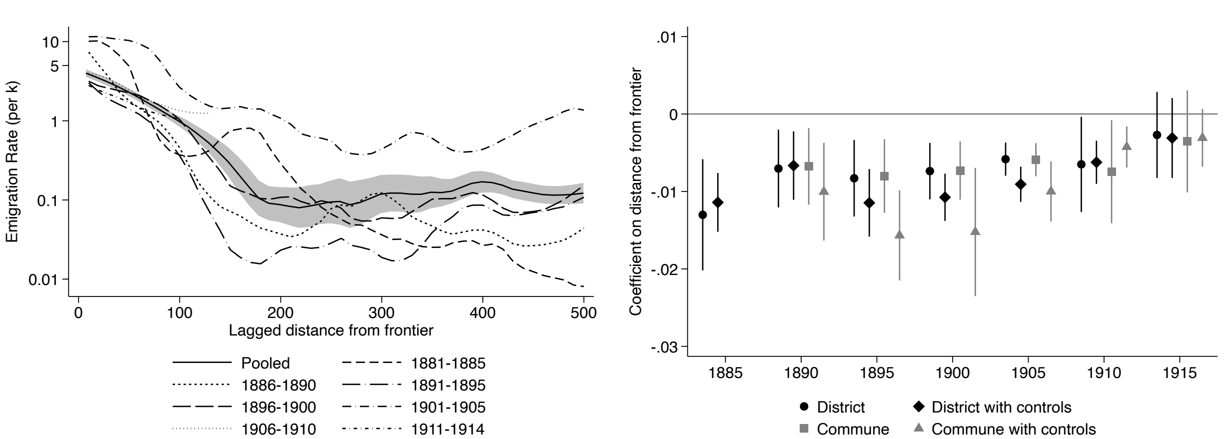


Figure 11: Emigration rates to North America by distance to the mass migration frontier (km)

Note: Panel (a) presents non-parametric regressions of the log of average annual migration rates for the whole sample and for each half decade on the distance from a district that had ever achieved an average annual migration rate of at least 5 per thousand by the previous half decade, limiting the sample to districts that had not yet achieved this threshold. Shaded areas are 95-percent confidence intervals. Panel (b) estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of lagged distance from the frontier of mass migration to North America and plots the coefficients on lagged distance from the frontier. Panel (b) also includes regressions controlling for half decade-specific functions of various controls.

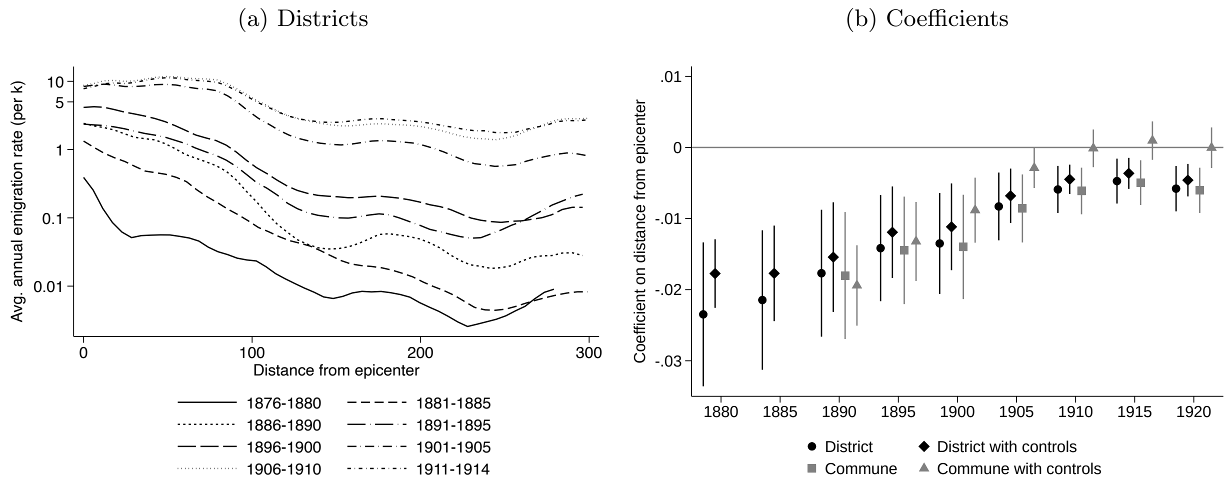


Figure 12: Emigration rates to North America by distance to epicenter (km)

Note: Panel (a) plots non-parametric regressions of the log of the average annual emigration rate for each half decade against distance to the nearest epicenter of emigration to North America. Panel (b) estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of distance from the nearest epicenter of emigration to North America and plots the coefficients on distance from epicenter. Panel (b) also includes regressions controlling for half decade-specific functions of various controls.

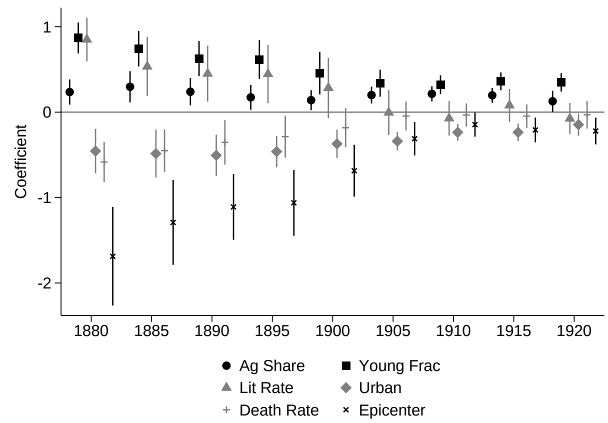


Figure 13: Relationship of migration to various local characteristics

Note: This figure presents the results of a regression of emigration to any destination on year-specific functions of various district characteristics. All explanatory variables are standardized to have mean zero and standard deviation one.

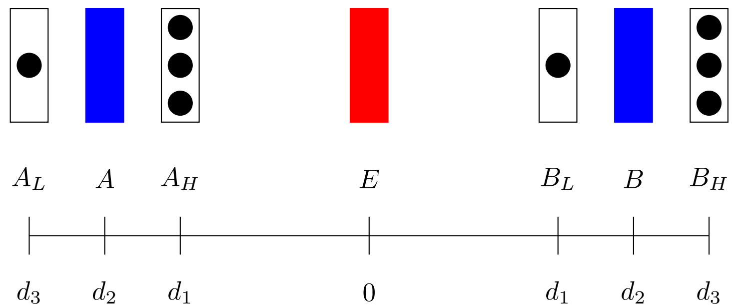


Figure 14: Illustration of the identification strategy

Note: Rectangles indicate municipalities and circles indicate population. The population of municipalities A and B and of the epicenter municipality E are unimportant to the example and are not specified. Municipalities A_H and B_H are more populous than municipalities A_L and B_L, respectively. The number line indicates each municipality's distance from the epicenter municipality E; for instance, municipalities A and B are both at distance d_2 from the epicenter.

A Binomial Maximum Likelihood Regression

In Figures 11, 12, 13, and B.15, we estimate a regression in which municipality or district i's emigration rate in period t, p_{it}, is expressed in the logit form

$$p_{it} = \frac{\exp(\nu_t + \eta_t z_i + \mathbf{x}_i' \gamma_t)}{1 + \exp(\nu_t + \eta_t z_i + \mathbf{x}_i' \gamma_t)},$$

where z_i is municipality i's distance from the nearest epicenter of emigration to North America, ν_t is a period-specific intercept, η_t and γ_t are period-specific coefficients, and $\mathbf{x}_i$ are controls. This method is intended to address observations of zero migration by treating these as cases in which all individuals have a strictly positive migration probability, p_{it}, but the realization of every resident of the municipality is to stay. After determining this logit migration demand, we use the binomial distribution to determine the probability that a given number of emigrants are observed from municipality i in time period t given p_{it} and the municipality's baseline population N_i, which enables us to estimate ν_t, η_t, and γ_t by maximum likelihood. The log-likelihood function after removing constants is

$$\mathfrak{L} = \sum_i \sum_t e_{it} N_i \log(p_{it}) + (1 - e_{it}) N_i \log(1 - p_{it}),$$

where e_{it} is the realized (i.e., observed) rate of emigration and the model is estimated by maximum likelihood.

Online Appendix for

Like an Ink Blot on Paper
Testing the Diffusion Hypothesis of Mass Migration, Italy 1876–1920

Yannay Spitzer
The Hebrew University of Jerusalem & CEPR

Ariell Zimran
Vanderbilt University & NBER

January 2023

B Additional Tables and Figures

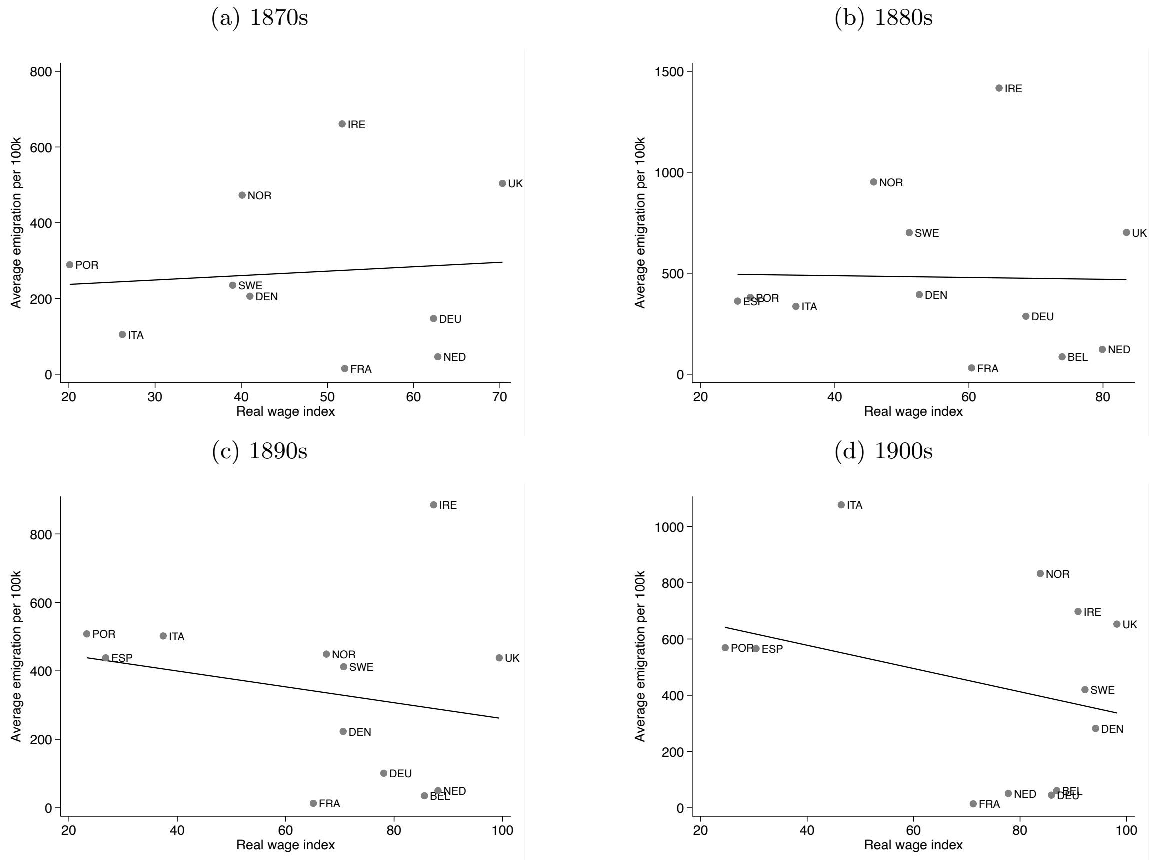


Figure B.1: Emigration and real wages

Source: Emigration data are from Ferenczi and Willcox (1929). Wage data are from Hatton and Williamson (1998).

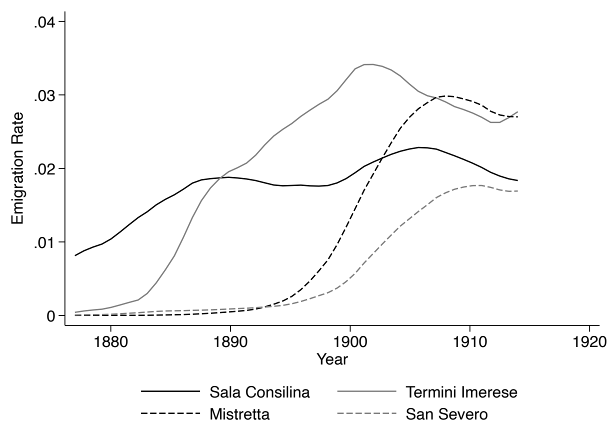


Figure B.2: Time series of emigration to North America from selected districts

Note: The four districts in this figure are Sala Consilina in Salerno, Termini Imerese in Palermo, Mistretta in Messina, and San Severo in Foggia. The epicenter district of Sala Consilina was selected because it had the highest emigration rate to North America in the period 1876–1883. The remaining three districts were selected because their estimated pre-1884 emigration rates as implied by their observables were among the most similar to that predicted for Sala Consilina. Some discretion was exercised in the choice of these example districts for purposes of exposition. The time series are smoothed using a local linear regression. The main takeaway in this figure is that, even though the four districts were observationally very similar, they experienced very different time series of emigration, surging into S-shapes in order of their distance from the nearest epicenter (not necessarily Sala Consilina).

(a) Regions (b) Provinces

Figure B.3: Maps of Italian provinces and regions

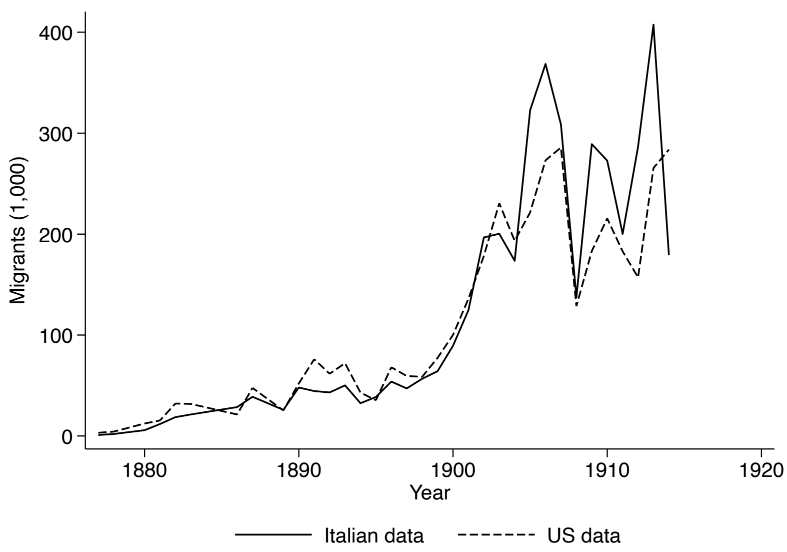


Figure B.4: Comparison of Italian emigration data and US immigration data

Note: The Italian data are for North America-bound emigrants from our transcriptions of the *Statistica della Emigrazione Italiana per l'Estero* and are based on calendar years. The US data are for immigrants arriving from Italy from Barde, Carter, and Sutch (2006) and are based on fiscal years.

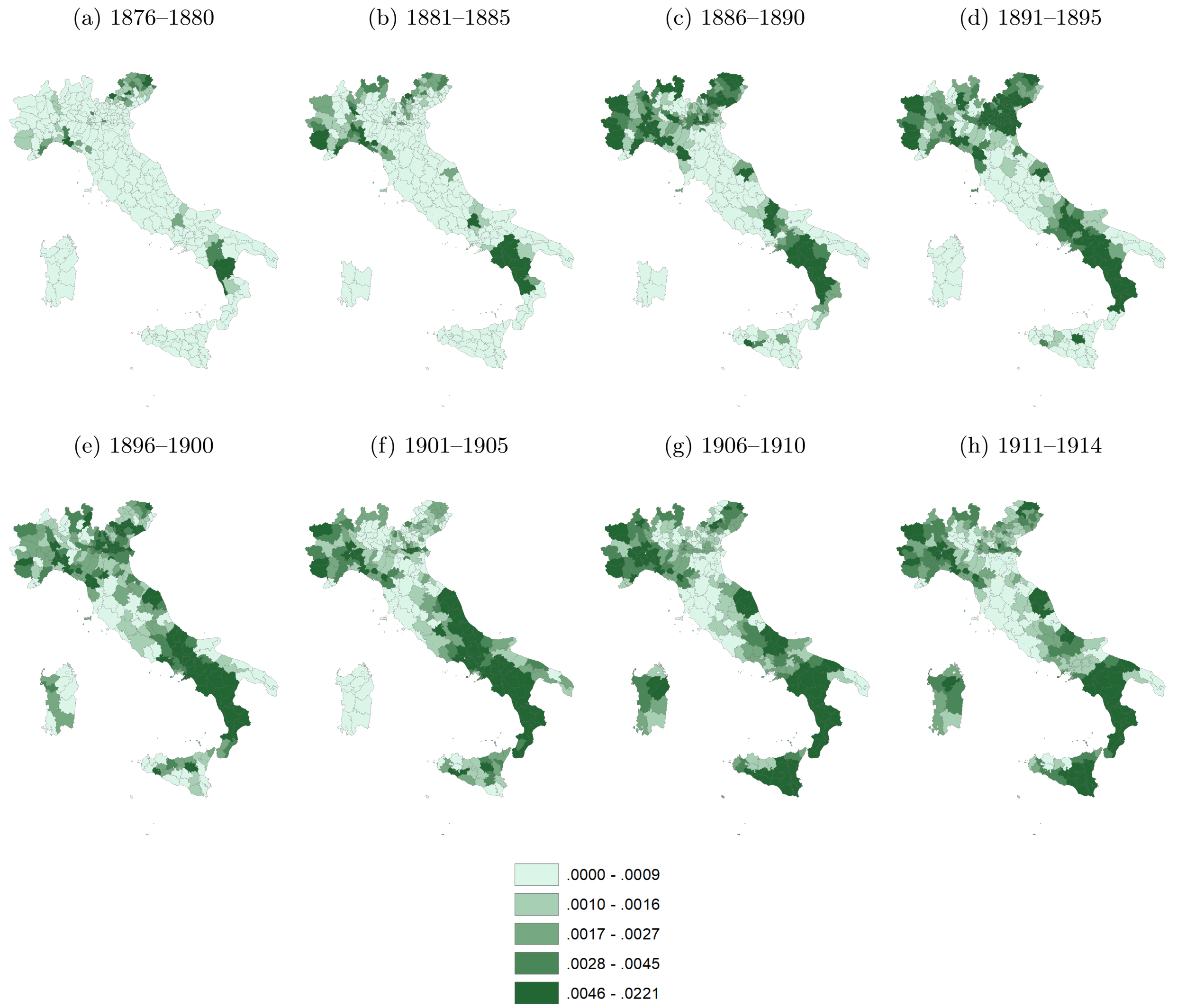


Figure B.5: District-level emigration rates to South America

Note: Each panel presents a district's average annual emigration rate to South America in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

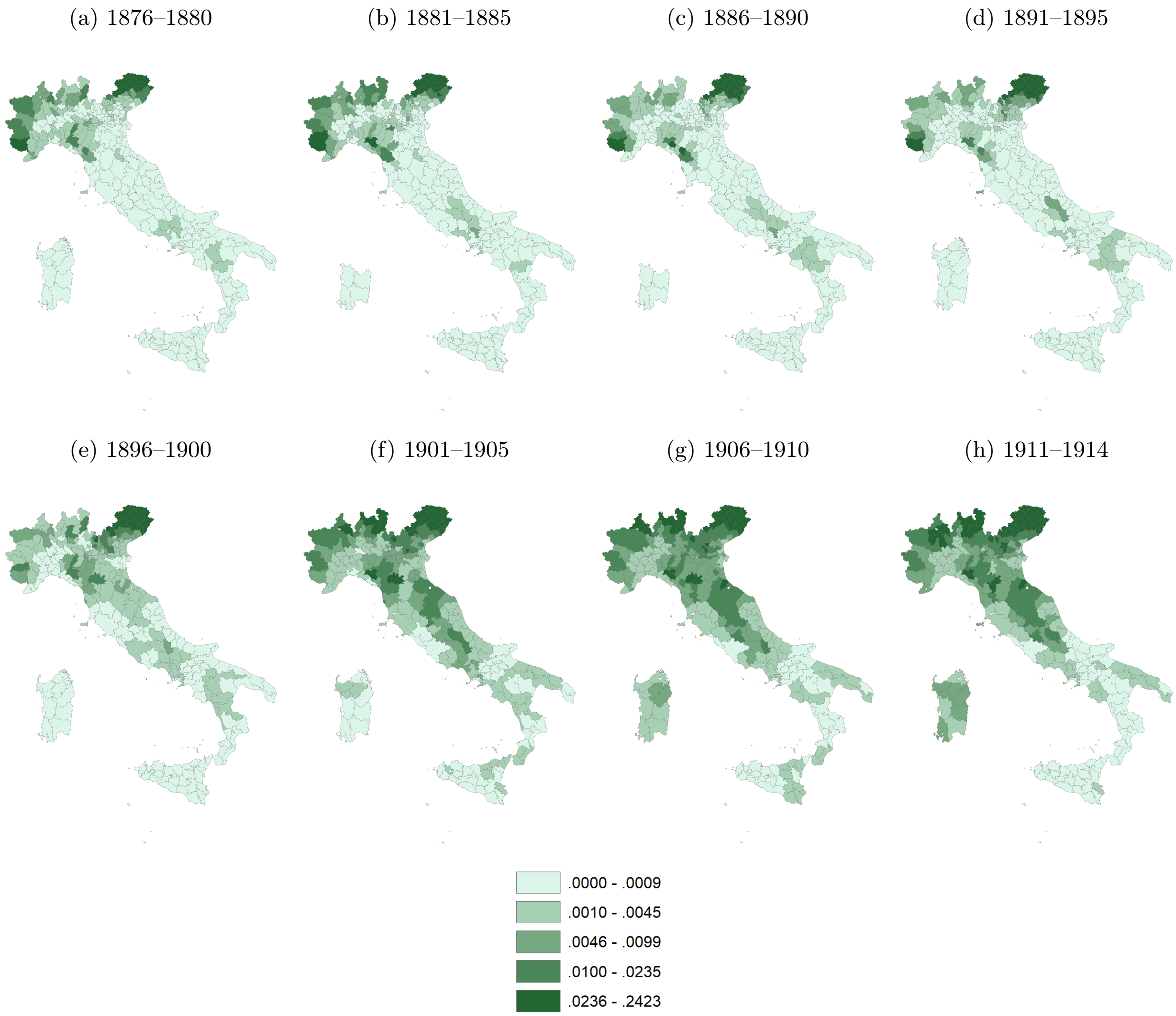


Figure B.6: District-level emigration rates to Europe

Note: Each panel presents a district's average annual emigration rate to Europe in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

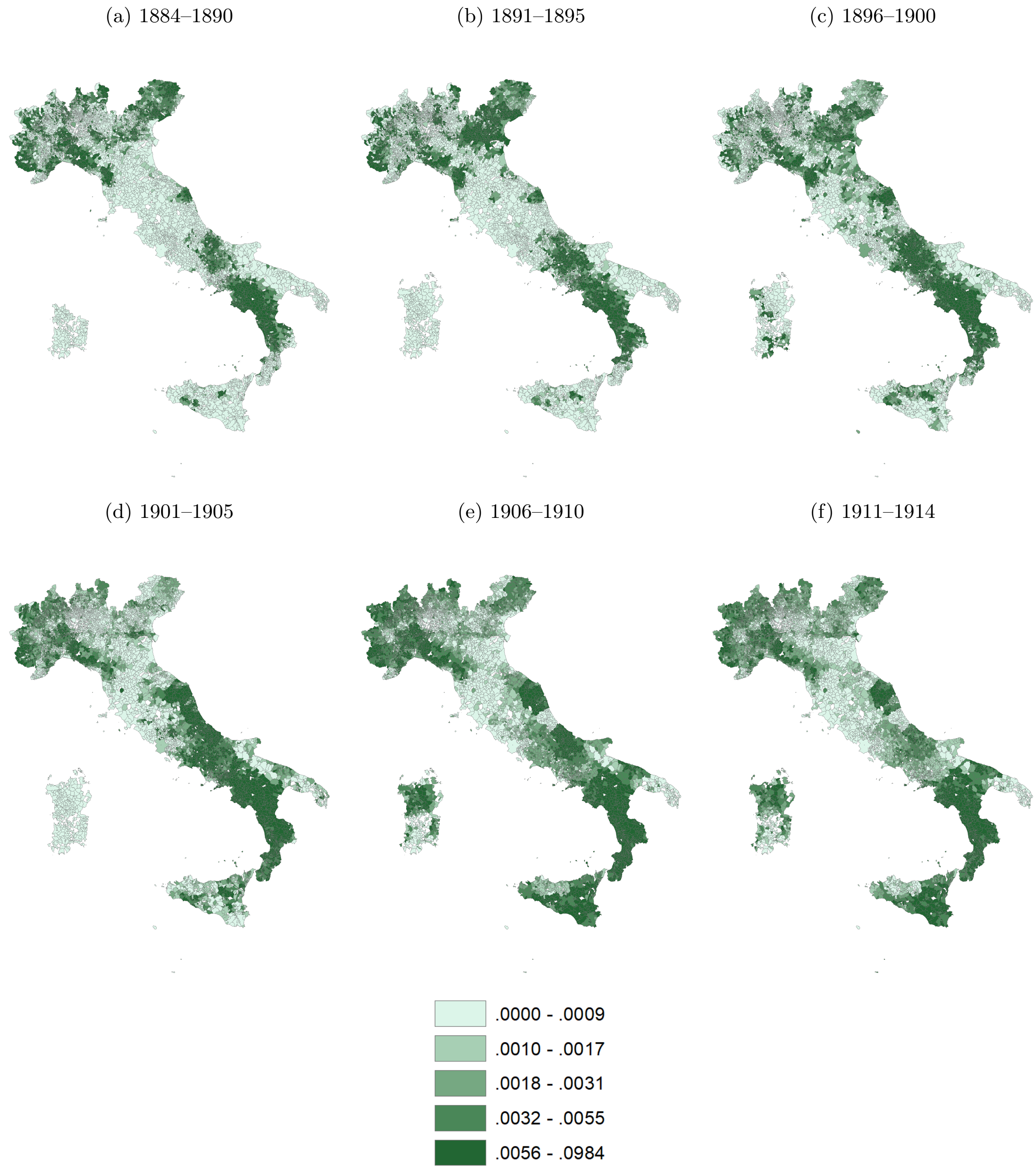


Figure B.7: Municipality-level emigration rates to South America

Note: Each panel presents a municipality's average annual emigration rate to South America in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

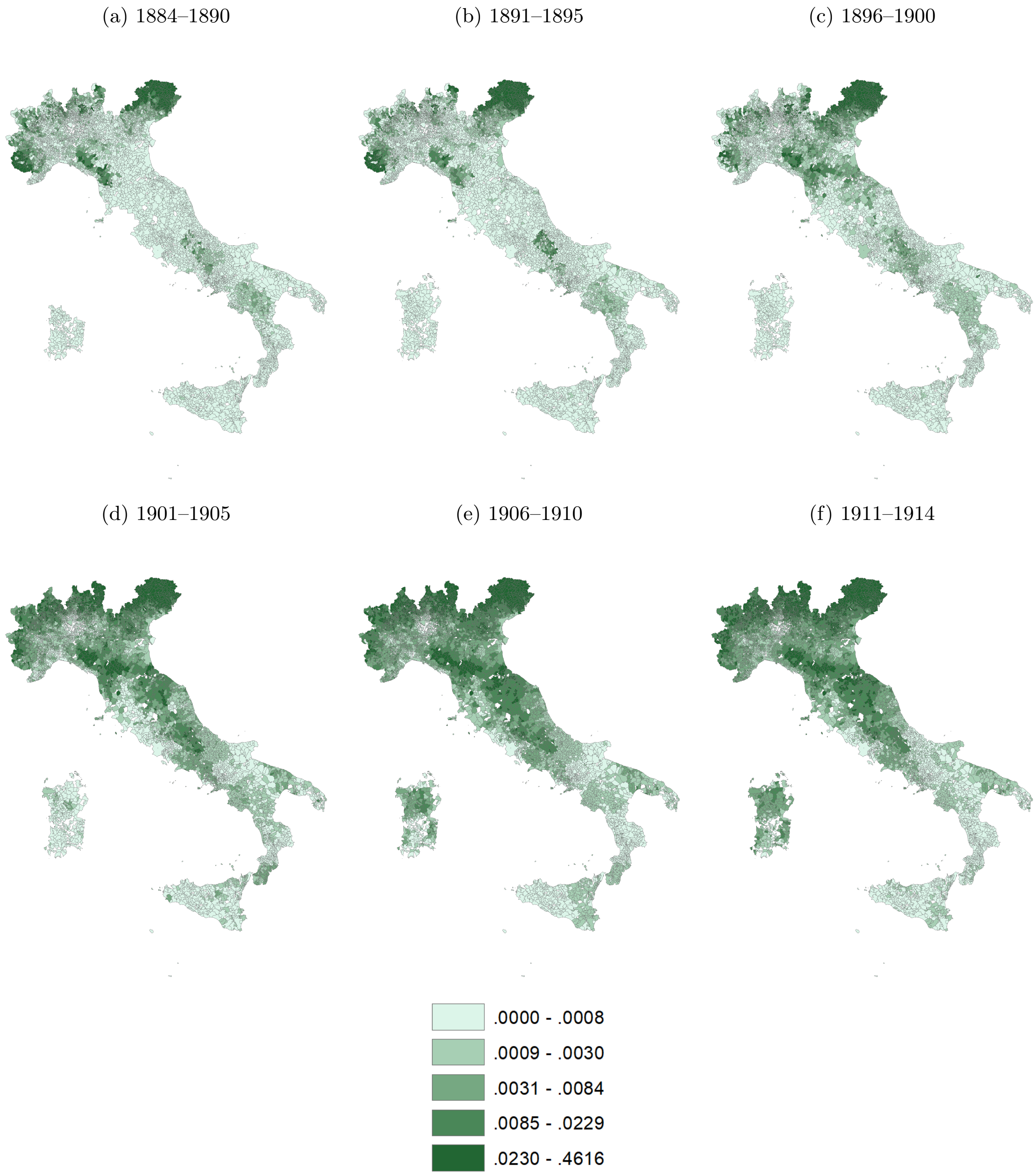


Figure B.8: Municipality-level emigration rates to Europe

Note: Each panel presents a municipality's average annual emigration rate to Europe in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

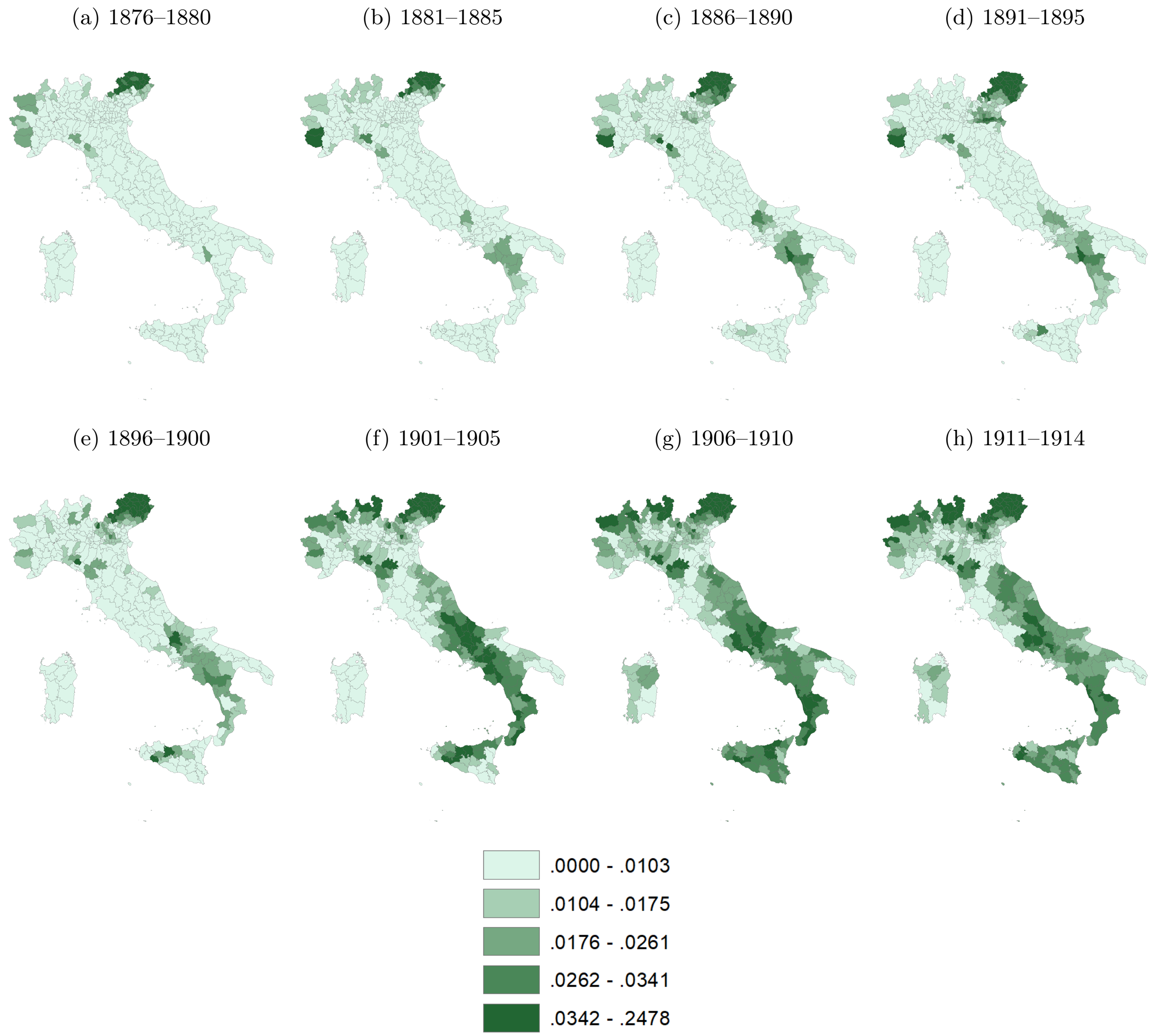


Figure B.9: District-level emigration rates to any destination

Note: Each panel presents a district's average annual emigration rate to any destination in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

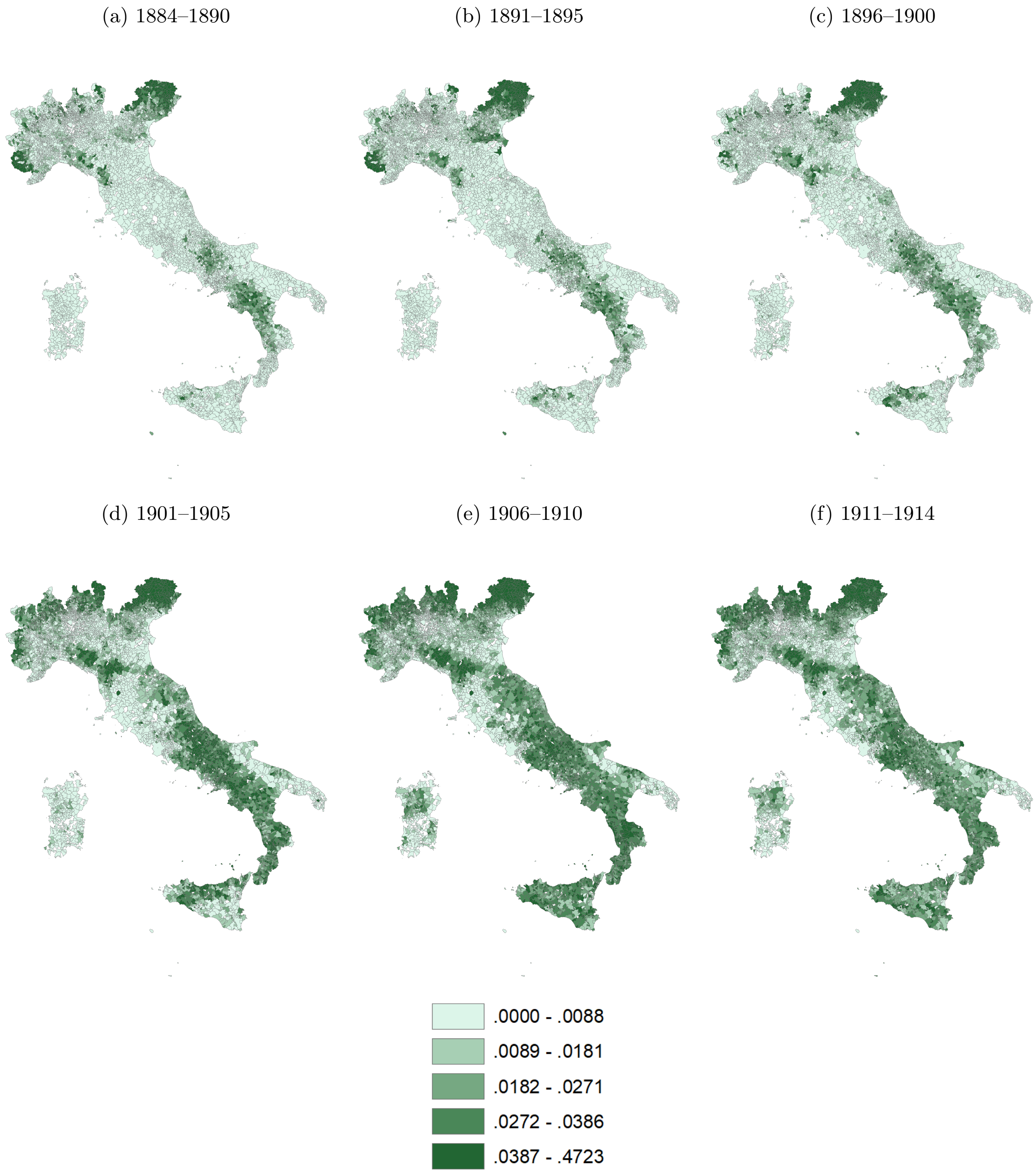


Figure B.10: Municipality-level emigration rates to any destination

Note: Each panel presents a municipality's average annual emigration rate to any destination in the period in question. Scale is based on quintiles of emigration rates in 1911–1914.

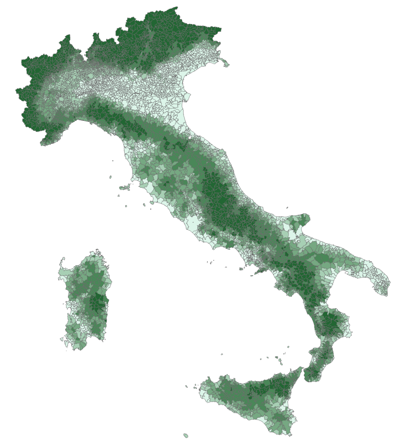


Figure B.11: Elevation

Source: Shuttle Radar Topography Mission (Jet Propulsion Laboratory 2014)

Note: Darker shading indicates greater elevation.

Table B.1: Summary statistics for time-varying variables

	District	Commune						
Variable	(1) All	(2) All	(3) 1884–1890	(4) 1891–1895	(5) 1896–1900	(6) 1901–1905	(7) 1906–1910	(8) 1911–1914
Any Emigration	0.990	0.772	0.582	0.566	0.674	0.969	1.000	0.995
	(0.100)	(0.420)	(0.493)	(0.496)	(0.469)	(0.173)	(0.000)	(0.070)
Emigration Rates (per k)								
All Destinations	15.564	15.674	9.509	10.039	11.518	22.896	26.373	27.480
	(21.615)	(22.899)	(20.080)	(21.942)	(24.335)	(26.095)	(20.669)	(24.590)
North America	3.334	4.805	1.446	1.502	2.009	7.184	9.035	8.935
	(6.339)	(8.843)	(4.382)	(4.114)	(5.042)	(11.952)	(11.166)	(10.706)
South America	2.658	3.249	3.151	3.660	3.387	3.903	4.472	3.478
	(3.882)	(5.068)	(5.530)	(6.852)	(5.284)	(5.173)	(4.864)	(3.717)
Europe	9.173	8.448	4.313	4.669	5.919	11.273	12.450	14.622
	(20.045)	(19.038)	(15.955)	(18.314)	(21.940)	(21.908)	(17.203)	(21.770)
Mass Emigration								
All destinations (>10 per thousand)	0.464	0.446	0.272	0.276	0.310	0.613	0.772	0.770
	(0.499)	(0.497)	(0.445)	(0.447)	(0.463)	(0.487)	(0.420)	(0.421)
North America (> 5 per thousand)	0.184	0.246	0.084	0.093	0.125	0.312	0.426	0.452
	(0.388)	(0.431)	(0.278)	(0.290)	(0.331)	(0.463)	(0.494)	(0.498)
South America (> 5 per thousand)	0.164	0.217	0.216	0.237	0.241	0.277	0.305	0.228
	(0.370)	(0.412)	(0.412)	(0.425)	(0.428)	(0.448)	(0.460)	(0.420)
Europe (> 5 per thousand)	0.327	0.307	0.134	0.132	0.163	0.417	0.499	0.521
	(0.469)	(0.461)	(0.341)	(0.338)	(0.369)	(0.493)	(0.500)	(0.500)
Within North American Frontier	0.173	0.194	0.031	0.069	0.095	0.132	0.281	0.366
	(0.379)	(0.395)	(0.173)	(0.253)	(0.293)	(0.339)	(0.450)	(0.482)
Distance to North American Frontier (km)	288.062	246.347	410.926	392.245	391.055	349.372	74.415	53.385
	(241.148)	(243.451)	(221.203)	(238.929)	(240.525)	(226.968)	(73.068)	(70.924)
Observations	2,545	56,083	7,909	8,029	8,029	8,029	8,029	8,029
Units	284	8,029	7,909	8,029	8,029	8,029	8,029	8,029

Notes: Observations are at the district-half decade level in column (1) and at the municipality-half decade level in columns (2)–(8). Columns (1) and (2) have multiple observations for each municipality or district (one for each half decade). Columns (3)–(8) have one observation for each municipality. Standard deviations in parentheses.

Table B.2: Summary statistics for time-invariant variables

Variable	(1) All	(2) North	(3) Center	(4) South
Panel A: District-level Data				
District Share of Male Labor in Agriculture	0.547	0.555	0.547	0.534
	(0.109)	(0.101)	(0.135)	(0.109)
District Share of Male Labor in Industry	0.216	0.237	0.191	0.192
	(0.070)	(0.074)	(0.058)	(0.056)
District Adult Male Literacy Rate	0.468	0.582	0.453	0.279
	(0.183)	(0.149)	(0.127)	(0.055)
District Population Fraction Under Age 15	0.328	0.334	0.309	0.327
	(0.024)	(0.024)	(0.026)	(0.018)
Observations	284	154	41	89
Panel B: Municipality-level Data				
Distance to Railroad (1881, km)	9.853	8.871	7.992	12.486
	(12.437)	(12.178)	(9.209)	(13.758)
Mean Elevation (m)	451.418	471.039	390.918	445.771
	(425.914)	(503.853)	(260.907)	(324.431)
Distance to North America Epicenter (km)	149.796	162.926	138.351	132.067
	(90.280)	(68.928)	(78.142)	(120.294)
Distance to South America Epicenter (km)	168.408	124.097	219.139	222.421
	(101.971)	(49.260)	(107.815)	(127.637)
Distance to European Border (km)	240.432	45.426	238.222	586.443
	(264.104)	(37.066)	(122.753)	(173.120)
Distance to Coast (km)	68.738	106.680	30.388	20.045
	(57.649)	(50.310)	(26.493)	(18.982)
Birth Rate (1881)	0.037	0.036	0.036	0.040
	(0.009)	(0.008)	(0.007)	(0.010)
Death Rate (1881)	0.026	0.024	0.027	0.030
	(0.010)	(0.008)	(0.010)	(0.012)
Mutual Aid Members per capita (1878)	0.007	0.009	0.007	0.002
	(0.026)	(0.033)	(0.018)	(0.011)
Postal Savings Deposits per capita (1886, 100s)	5.266	5.970	8.182	2.618
	(21.929)	(24.037)	(32.064)	(5.921)
Observations	8,028	4,371	1,187	2,470

Notes: Observations are at the district level in Panel A and at the municipality level in Panel B. Standard deviations in parentheses. Observation numbers are the minimum with observations for all variables, excluding places whose emigration rates cannot be calculated due to a lack of population data. Distance from railroad is 0 for any municipality with a rail line passing through it in 1881, and the distance from the nearest municipality border to the rail line for all other municipalities. Distance to the epicenters of North America- and South America-bound emigration are from the municipality centroid to the centroid of the epicenter district's capital city. Distance to the European border is from the municipality centroid.

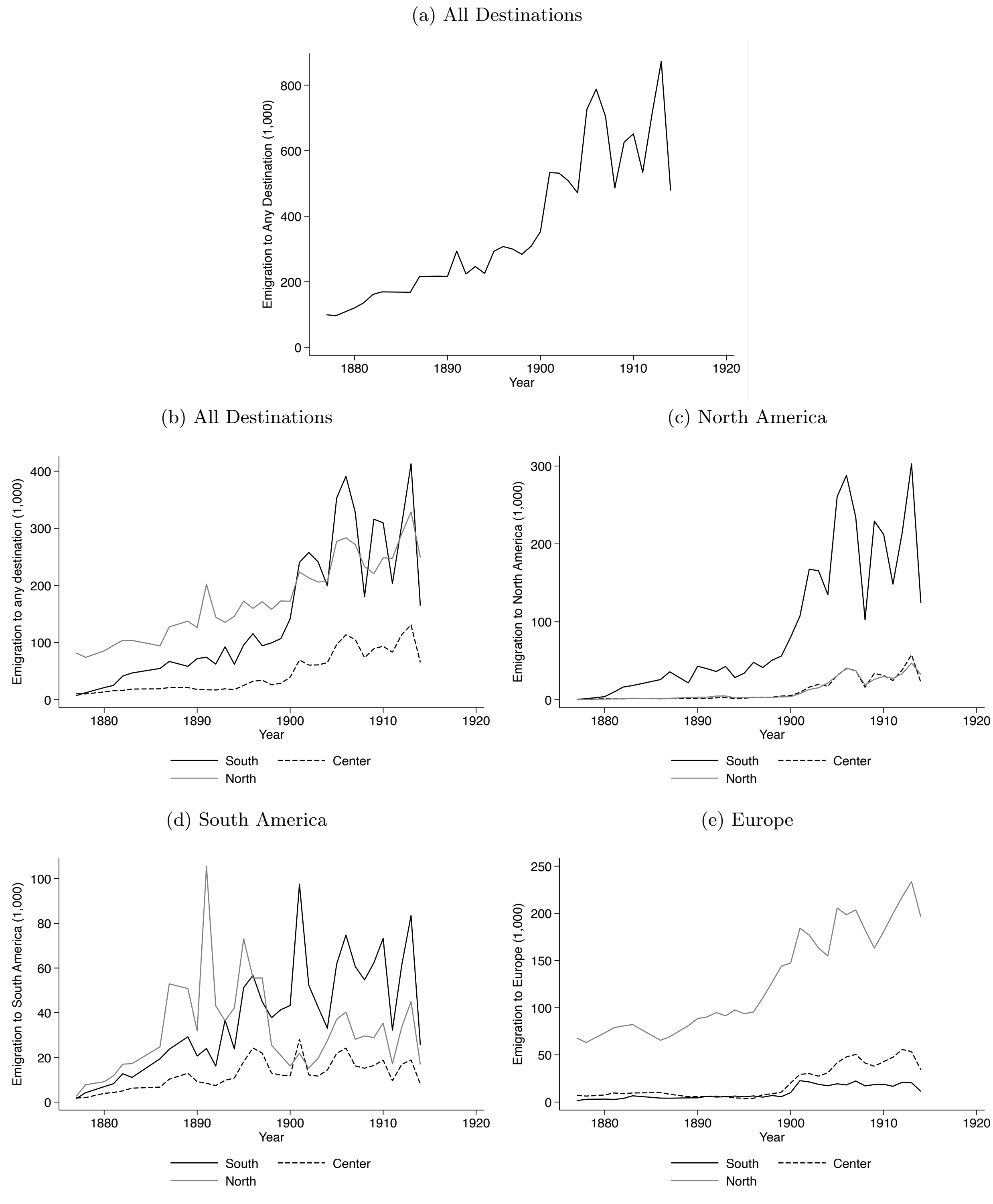


Figure B.12: Emigration by origin and destination, 1876–1914

Note: These figures are based on our province-by-destination data. South includes the regions of Abruzzo, Campania, Puglia, Basilicata, Calabria, Sicilia, and Sardinia. Center includes the regions of Liguria, Toscana, Marche, Umbria, and Latium. North includes the regions of Piemonte, Lombardia, Veneto, and Emilia Romagna.

Table B.3: Destination dissimilarity and distance between provinces

Variables	(1) All	(2) All	(3) Major	(4) Minor
log(Distance)	0.134^a	0.120^a	0.113^a	0.073^a
	(0.003)	(0.004)	(0.004)	(0.004)
Observations	21,114	21,114	21,114	21,114
R-squared	0.303	0.313	0.220	0.127
Controls	No	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1
Notes: Dependent variable is the dissimilarity index in the emigration destination distribution of the two provinces making up a province pair in a given half decade. Unit of observation is a province pair-half decade. Standard errors clustered by province pair. All regressions include half-decade fixed effects. Major destinations are US, Canada, France, Argentina, Uruguay, Switzerland, Austria-Hungary, Germany, and Brazil. Controls are absolute differences in agricultural and industrial employment shares, literacy rates, fraction under age 15, birth rate, death rate, mutual aid society members per capita, and log postal savings deposits per capita.

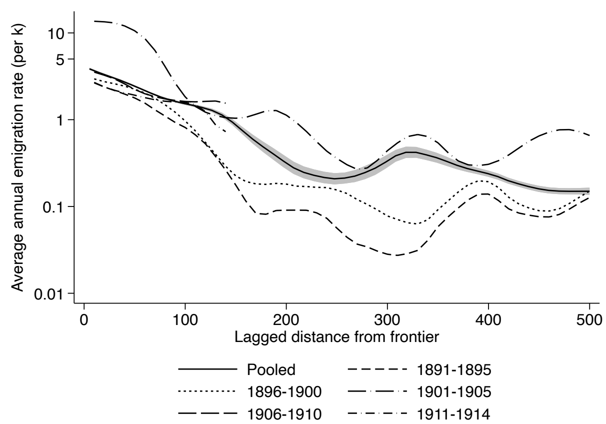


Figure B.13: Emigration rates to North America by distance to the mass migration frontier (km)

Note: This figure is analogous to panel (a) of Figure 11, but focuses on the municipality as the unit of analysis.

Figure B.14: Emigration rates to North America by distance to epicenter (km)

Note: This figure is analogous to panel (a) of Figure 12, but focuses on the municipality as the unit of analysis.

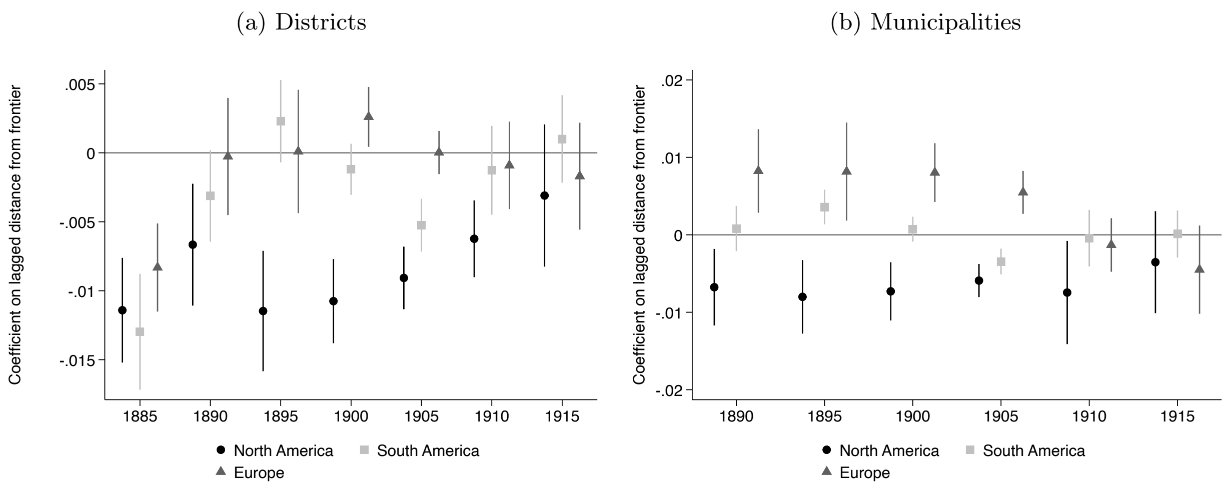


Figure B.15: Emigration to various destinations by distance to the mass migration frontier for North America (km)

Note: This figure repeats the binomial maximum likelihood regressions of panel (c) of Figure 11, but includes results for migration to South America and Europe in addition to those for migration to North America.

Table B.4: Spatial contagion results, OLS

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: 50–250km from epicenters								
Lagged Emigration Exposure	0.957^a	0.942^a	0.804^a	0.836^a	0.657^a	0.719^a	0.528^a	0.597^a
	(0.031)	(0.030)	(0.032)	(0.032)	(0.031)	(0.030)	(0.031)	(0.035)
Observations	31,463	31,463	31,463	31,463	31,463	31,463	31,463	31,463
R-squared	0.717	0.751	0.763	0.773	0.782	0.813	0.793	0.840
Panel B: All municipalities								
Lagged Emigration Exposure	0.979^a	0.932^a	0.818^a	0.841^a	0.666^a	0.714^a	0.554^a	0.590^a
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.024)	(0.027)	(0.031)
Observations	41,169	41,165	41,165	41,165	41,165	41,165	41,165	41,165
R-squared	0.732	0.763	0.774	0.785	0.792	0.823	0.804	0.850
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A limits the sample to municipalities between 50 and 250km of the epicenters of mass migration to North America, whereas Panel B does not. Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, distance to railroad, birth rate, death rate, mutual aid members per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

Table B.5: Spatial contagion results, standard instrumentation approach

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged Emigration Exposure	0.619^a	0.826^a	0.803^a	0.794^a	0.585^a	0.619^a	0.503^a	0.513^a
	(0.038)	(0.149)	(0.181)	(0.170)	(0.128)	(0.114)	(0.096)	(0.067)
Lagged Own Emigration	0.348^a	0.258^a	0.245^a	0.267^a	0.284^a	0.339^a	0.263^a	0.356^a
	(0.030)	(0.066)	(0.067)	(0.061)	(0.038)	(0.027)	(0.028)	(0.018)
Observations	35,332	35,329	35,329	35,329	35,329	35,327	35,329	35,284
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic	392.6	43.93	34.30	37.09	86.73	69.22	117	119

Significance levels: [a] p<0.01, [b] p<0.05, [c] p<0.1

Notes: Standard errors clustered at the district level. All specifications include at least half-decade fixed effects. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, distance to coast, distance to the European land border, population, distance to railroad, birth rate, death rate, mutual aid members per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

Table B.6: Spatial contagion results, epicenter-based IV, other catchments

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.745^{a}	0.740^{a}	0.534^{b}	0.452	0.665^{a}	0.489	1.025^{b}	−0.636
	(0.199)	(0.147)	(0.267)	(0.458)	(0.157)	(0.366)	(0.481)	(1.523)
Observations	31,463	31,463	31,463	31,463	31,463	31,462	31,463	31,427
F-statistic	11.75	16.43	6.343	2.382	17.22	3.698	9.771	1.004
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.362	0.908^{a}	0.784^{a}	0.662^{b}	1.518^{a}	0.612	0.104	0.667
	(0.237)	(0.225)	(0.267)	(0.306)	(0.529)	(0.378)	(0.828)	(0.460)
Observations	11,195	11,194	11,194	11,193	11,194	11,184	11,194	11,158
F-statistic	38.90	28.73	25.01	19.83	25.40	13.41	13.71	10.78
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration, but basing the predicted estimation only on municipalities in other epicenter catchments. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration, but basing the prediction only on municipalities in other provinces. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

C The Migration of Antonio Squadrito's Group in October 1903

Antonio Squadrito was born around 1877 in the small Sicilian town of Gualtieri-Sicamino, near Messina. In 1898 he decided to migrate to the United States, among the first in his municipality to do so. In New York he had a "distant relative from a northern province," and his passenger manifest listed his American contact as an uncle living on 21st Street, but he paid for his travel by borrowing money from his father, Giovanni. He arrived at the Battery on July 7, 1898, and his first job was in a quarry in Rhode Island. Soon thereafter, several opportunities arose. He befriended another Italian who owned a barbershop in Stonington, CT, and joined him as an employee, gradually paying off his loan. Shortly after, his boss had to leave the business and forced Antonio to take a loan to purchase the shop. The shop prospered, and Antonio had his older married brother Giuseppe come in to help him. Giuseppe was followed by their father and two younger brothers. In June 1903 Antonio married Harriet H. Burtch-Gardiner, who, at 66, was 41 years his senior.[81] That the same summer, he travelled back to his hometown with the purpose of helping the migration of a large number of friends and relatives. By that time, five years after Antonio had first left Sicily, emigration was already widespread in Gualtieri-Sicamino, as can be seen in Figure C.1, which plots migration rates for the municipality and the broader district of Messina.

While in Sicily, Antonio collected a large group of individuals whose migration he facilitated (listed in Table C.1), mainly close and more distant relatives from Gualitieri-Sicamino and from other neighboring places. Among them were his sister-in-law, her four-year-old niece, her brother, and her nephew, all from Gualtieri-Sicamino and destined for Stonington. The others had other destinations in the United States, where they reported having relatives. A sixteen-year-old girl—a cousin from the neighboring municipality of San Filipo—and five young men—all neighbors and family friends from Gualtieri-Sicamino—were traveling to Boston and to New York. Four farmer boys from Soccorso,[82] a detachment (*frazioni*) of Gualtieri-Sicamino, were on their way to the mines in Pennsylvania. They reported relatives in Philadelphia, but in reality they were illegally contracted laborers, and the uncle of one of them was the middleman (perhaps a *padrone* of sorts) who helped to recruit them. The entire group left for Messina en route to Napoli. From Napoli they embarked on the steamship *Prinzess Irene* on October 2, 1903, and arrived at Ellis Island on October 14. Broughton Brandenburg, the journalist and self-proclaimed immigration specialist who followed Squadrito's entourage and documented their migration, noted that this sort of group migration organized by a friend or relative was so common, that "The most notable feature was the ease with which one could detect that

[81] Her wealth, estimated at $60,000, was inherited from her deceased husband, a whaling ship captain (Brandenburg 1904, p. 44).

[82] Brandenburg (1904) mistakenly referred to it as "Socosa."

every seventh or eighth person had been to America before, and now had gathered around him a group of from two to thirty friends, relatives, and neighbors, going over in his care, just as our party was going in the care of Antonio Squadrito and myself" (Brandenburg 1904, p. 172).

In fact, the group was planned to be larger, as they had expected passengers from other municipalities to join them in Messina. These were Giuseppe Cardillo, accompanied by a few other people, and the Papalia family from Monforte San Giorgio, a small town situated about ten kilometers west of Gualtieri-Sicamino. Cardillo's hometown is unknown and so is the specific relation between the two families and the Squadritos. Eventually, according to Brandenburg (1904, p. 133), Cardillo's group decided to postpone their travel and the Papalias ended up taking the next steamer. Indeed, two weeks later, on October 28, Michele and Maria Papalia, originally from Monforte San Giorgio, and their five-year-old daughter Rosina were recorded arriving at Ellis Island on board the steamship *Lahn*, where they were listed as American citizens returning home to New York. All in all, the extended group that planned their joint voyage comprised of neighbors, friends, relatives, and other acquaintance from five different localities, at least four of which were within a short distance from one another.

How does this case fit the theoretical framework proposed in section 3? Clearly, it shows that the reality was more complex than the stylized story about a linear chain in which one individual links others in his geographic environment who depend on him, and leads them to the same destination. It is not clear, for example, how crucial the role played by Antonio Squadrito's relative was in enabling his own migration in 1898, and therefore it is impossible to tell whether or not he was a real pioneer. Even if he were linked by his relative, it is hard to tell whether this linkage conformed to our assumption that social contacts were largely local, because although he was a relative, according to Brandenburg he was from a "northern province" (Brandenburg 1904, p. 43). Furthermore, many in the group relied on additional contacts in the United States. They were supported by Antonio, but he was not their sole sponsor, and it is probable that they would have migrated even without his help. Indeed, only a few were destined to join him in Stonington. Networks merged and diverged to different destinations, and it is unknown whether the emigration from Gualtieri-Sicamino could be traced back to a single local founding father or to several ancestors separately linked from other municipalities, and whether any of them were virtual pioneers. Nevertheless, those going to other destinations were still relying on other personal links, usually family members. Even those who were in reality contracted laborers were recruited through a relative. If the case of Squadrito's group is indicative, then in a broad sense, the Italian transatlantic movement occurred within local networks based both on intra-place and on short-distance inter-place links. This is precisely the core insight that the theoretical framework that we propose is meant to capture.

Table C.1: Antonio Squadrito's group, on board *Prinzess Irene*, arriving October 14, 1903

First Name	Last Name	Sex	Age	Relation to Antonio Squadrito	Place of Origin	Joining	Destination
Antonio	Squadrito	M	26		Gualtieri-Sicamino	Brothers, Giuseppe, Carmelo, and Gaetano	Stonington, CT
Carmela	Squadrito	F	32	Sister in law	Gualtieri-Sicamino	Husband, Giuseppe Squadrito (Antonio's brother)	Stonington, CT
Caterina	Squadrito	F	4	Niece	Gualtieri-Sicamino	Father, Giuseppe Squadrito	Stonington, CT
Giovanni	Pulejo	M	49	Brother in law, probably also a cousin	Gualtieri-Sicamino	Brother, Nicola	Boston, MA
Felice	Pulejo	M	16	Nephew	Gualtieri-Sicamino	Uncle, Nicola	Boston, MA
Concetta	Fomica	F	15	Cousin	San Filipo	Uncle, Stefano Senedile, Boston	Boston, MA
Antonio	Nastasia	M	16	Neighbor	Gualtieri-Sicamino	Uncle, Tommaso Trovato, Boston	Boston, MA
Gaetano	Mullura	M	16	Neighbor	Gualtieri-Sicamino	Uncle, Nicolo Puleo, Boston	Boston, MA
Nicola	Curro	M	27	Family friend	Gualtieri-Sicamino	Cousin, Angelo Ragusa, New York	New York, NY
Nunzio	Giunta	M	23	Fellow townsman	Gualtieri-Sicamino	Cousin, New York	New York, NY
Antonio	Genino	M	21	Fellow townsman	Gualtieri-Sicamino	Uncle, Giuseppe Maucino, Philadelphia	Philadelphia, PA
Salvatore	Niceta	M	20	Farm boy from detached village	Soccorso	Brother, Giuseppe Niceta, Philadelphia	Philadelphia, PA
Benedetto	Runzio	M	21	Farm boy from detached village	Soccorso	Cousin, Giuseppe Niceta, Philadelphia	Philadelphia, PA
Luciano	Sofia	M	17	Farm boy from detached village	Soccorso	Cousin, Giuseppe Niceta, Philadelphia	Philadelphia, PA
Salvatore	Damico	M	23	Farm boy from detached village	Soccorso	Brother in law, Antonio Salvatore, Philadelphia	Philadelphia, PA

Sources: Brandenburg (1904) and the Statue of Liberty-Ellis Island Foundation

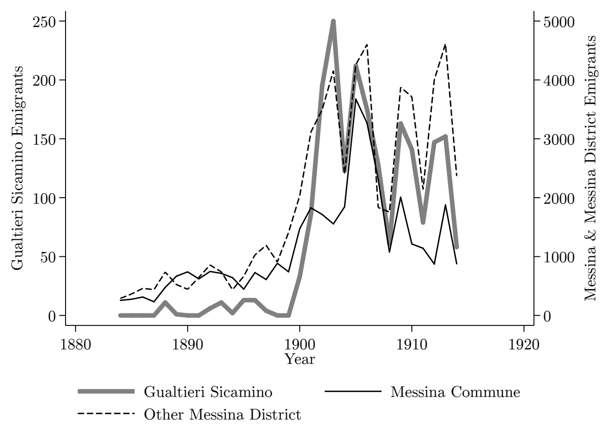


Figure C.1: Emigration from Gualtieri-Sicamino and Messina District

Note: This figure presents migrant counts for Gualtieri-Sicamino from 1884–1914. Gualtieri-Sicamino is part of the district of Messina. The other lines in the figure present the migrant counts for the municipality of Messina and for all of the district of Messina except Gualtieri-Sicamino and the municipality of Messina.

D Model Simulations

This appendix presents the results of a simulation that generates the main predicted patterns discussed in Section 3.3.

D.1 Demand for Migration

We simulate a diffusion process over a 40×40 grid. Each square represents a place whose population is drawn from a distribution similar to that of 1881 Italian municipalities according to Zipf's Law.[83] The distance between each pair of places is the Euclidean distance between the centers of the squares. There are two destinations, a and b, and we arbitrarily assign two epicenters, one for each destination, in opposite corners of the grid. Each epicenter is assigned an initial share of the population $L_1 = 0.1$ that is already linked to the respective destination at the beginning of period 1; other than that, there has been no prior migration and there are no linked individuals in any other place.

The diffusion parameters are as follows:

$$\Theta = \{\alpha, \lambda, \delta, \pi\} = \{10^{-4}, 25, 20, 4\}$$

For simplicity, we assume symmetry between the two destinations, homogeneity across origins, and immutability over time. The demand for migration has a simple logit form. At any period, the probability of migration to destination $d \in \{a, b\}$ for an individual from place i who is linked to destination d alone is:

$$m_i^d = \frac{exp^{\eta_i}}{1 + \exp^{\eta_i}}$$

where η_i stands for the strength of the local push factors in place i, and in the benchmark simulation is simply $\eta_i = \eta = -4.5$. The demand for migration to destination $d \in \{a, b\}$ for an individual linked to both destinations is:

$$m_i^d = \frac{exp^{\eta_i}}{1 + 2\exp^{\eta_i}}.$$

D.2 Predictions

We present here a series of figures generated from a single simulation that exemplifies each of the main predicted patterns. The simulation was run over 60 periods, during which the country moved from only a

[83] Specifically, the largest place has a population of 1,000,000, the n$^{\text{th}}$ largest place has a population of $\frac{1{,}000{,}000}{n}$, and places are assigned a random location across the grid.

small fraction of the population linked, in the two corner epicenters, to virtual saturation.

D.2.1 Convergence

Figure D.1(a) demonstrates σ-convergence, corresponding to real-data Figure 7. The vertical axis presents the coefficient of variation of emigration rates to destination a across all places. Over time, the variation decreases monotonically until all places are saturated.[84] Figure D.1(b) demonstrates β-convergence, corresponding to real-data Figure 8. Each dot represents one place. The horizontal axis has the rate of emigration to destination a in the first 30 periods, and the vertical axis has the log of the ratio between the rate of emigration in the remaining 30 periods and the first 30 periods. The pattern of β-convergence is apparent in that the increase in the rate of emigration is negatively correlated with the rate of emigration in the early period.

D.2.2 S-Shaped Local Trends

Figure D.2 demonstrates how the typical emigration path from all places follows an S-shaped trend, regardless of the timing of the onset of mass emigration. As in real-data Figure 9, the time scale is shifted for each place such that period zero is the first period in which the emigration to destination a had reached one per thousand. The places are binned into four quartiles, by the period in which mass emigration was reached. Each bin is represented by three curves, for the mean and for the 25$^{\text{th}}$ and the 75$^{\text{th}}$ percentiles in each period since mass emigration.

D.2.3 Correlated Destinations

In Figure D.3, corresponding to Figure 10, each curve represents the relationship between the distance between each pair of places and the dissimilarity of their destination choices, where the dissimilarity index is based on total emigration over segments of 10 periods. The upward slope of all curves over the bulk of the range of distance means that places farther from one another have less similar distributions of destinations.[85]

[84] Notice that the coefficient of variation converges to zero because the places are assumed to be homogeneous; if they were heterogeneous in terms of push factors (η), then it would converge to a positive value.

[85] That the curves for the early periods begin to slope downwards at the longest distances is the product of the specific structure of the simulation. Suppose that the epicenters are placed in the northwest and southeast corners of the grid. The northeast and southwest corners are at the maximum possible distance from one another, but are reached by the spreading waves of migration to each destination roughly simultaneously, and thus develop similar destination choice profiles. This will arise in any case in which there are two destinations with one epicenter each, and will occur along the axis orthogonal to that between the epicenters. For two reasons we do not consider this part of the prediction dispositive in our case. First, in the case of a long narrow strip (such as Italy) between the epicenters that excludes the northeast and southwest corners, the same pattern cannot arise. Second, with more than one destination and more than one epicenter per destination, the pattern is less likely to arise.

That the slopes are shifted downward over time means that all pairs become increasingly similar in their destination choices.

D.2.4 Spatial expansion and the frontier effect

Figure D.4(a), corresponding to real-data Figure 11, plots for each 10-period segment the relationship between the distance to the frontier of mass emigration to destination a in the previous segment (using the threshold of 1 per thousand) and current segment's log emigration rate.[86] The prediction is that within each segment of time, all curves are strongly downward sloping, indicating the close dependence of emigration on proximity to the frontier. Figure D.4(b), corresponding to real-data Figure 12, does the same with respect to distance to the nearest epicenter. The downward sloping curves become increasingly flat over time, indicating an initially strong association between proximity to the epicenters and emigration that gradually diminishes as the country becomes saturated.

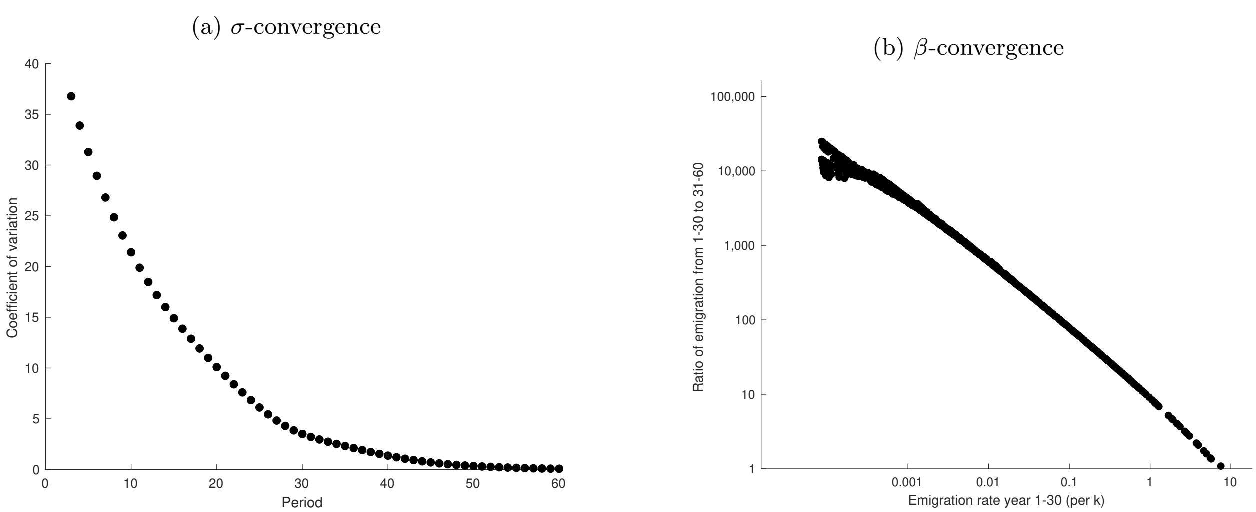


Figure D.1: Convergence

[86]The distance to the frontier in periods 1–10 is arbitrarily defined to be the distance to the epicenters, since there is no prior emigration.

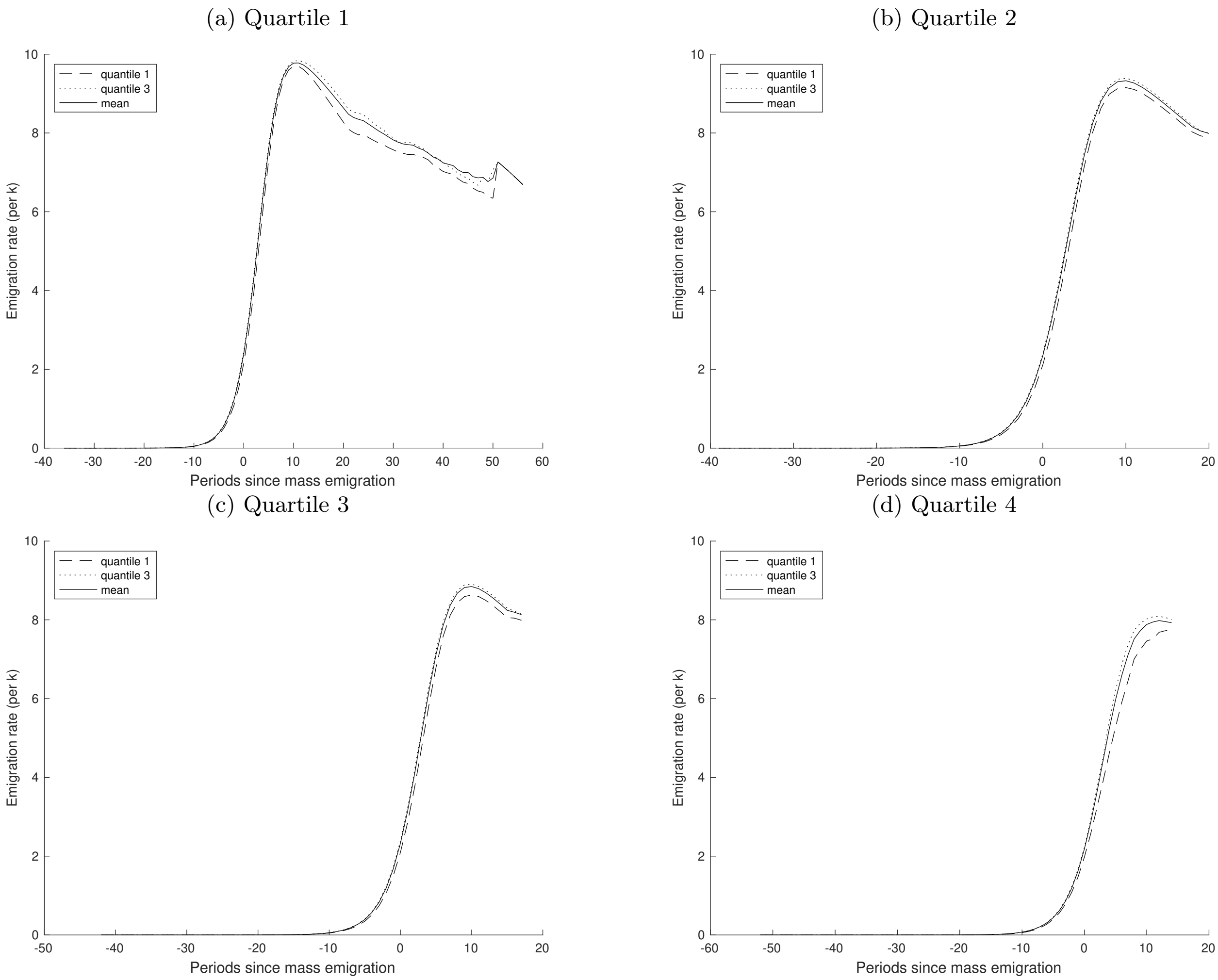


Figure D.2: S-shaped local trends

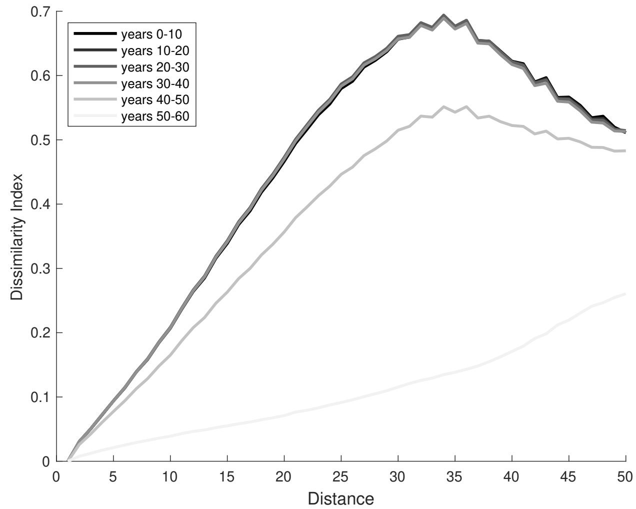


Figure D.3: Correlated destinations

(a) Emigration and distance from the frontier

(b) Emigration and distance from the epicenters

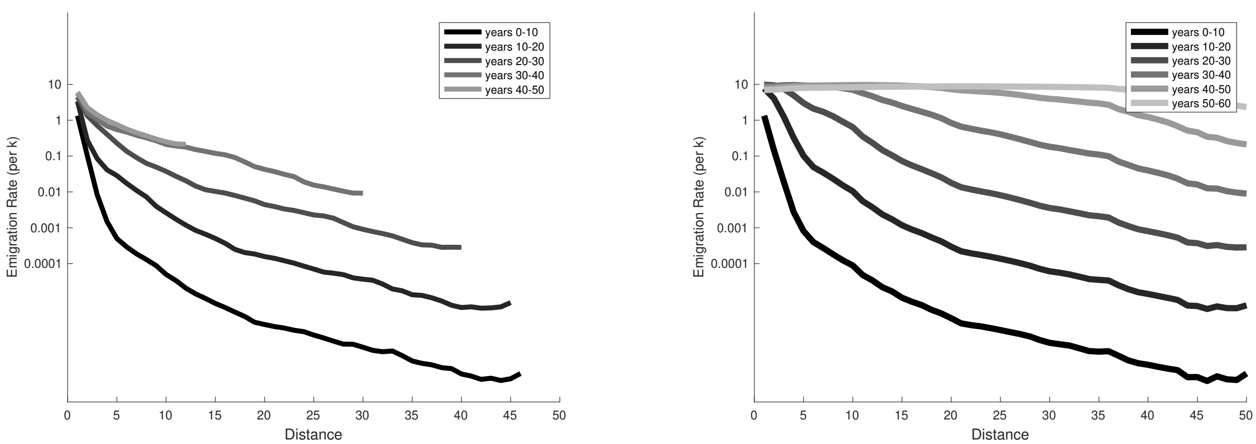


Figure D.4: Spatial expansion and the frontier effect

E List of Historical Statistical Publications

This appendix lists the historical statistical publications that provided our raw data. All of our emigration data (and our population data for 1901) were from *Statistica della Emigrazione Italiana per l'Estero* (some with an additional subtitle), published by the Ministero di Agricoltura, Industria, e Commercio, Direzione Generale della Statistica. Table E.1 lists the publication year and press of each volume that we used.

Our 1881 census data are from the *Censimento della Popolazione del Regno d'Italia al 31 Dicembre 1881* published by the Ministero di Agricoltura, Industria, e Commercio, Direzione Generale della Statistica and Tipografia Bodoniana. The literacy and age data are from Table II of Volume II, "Popolazione classificata per età, sesso, stato civile, e istruzione elementare," published in 1883. The employment-by-industry data are from Table I of Volume III, "Popolazione classificata per professioni o condizione," published in 1884.

Our data on municipality population for 1881 are from the *Comuni e Loro Popolazione ai Censimenti dal 1861 al 1951*, published by the Istituto Centrale di Statistica and Azienda Beneventana Tipografica Editoriale in 1960.

Our data on births and deaths in 1881 are from Table I of the *Movimento dello Stato Civile Anno XX.—1881*, published by the Ministero di Agricoltura, Industria, e Commercio, Direzione Generale della Statistica and Tipografia Bodoniana in Rome in 1882.

Our data on postal savings credit in 1886 are from the *Relazione intorno al servizio delle Casse Postale de Risparmio durante l'Anno 1886*, published by the Stamperia Reale in Rome in 1888.

Our data on membership in mutual aid societies are from the *Statistica delle Società di Mutuo Soccorso, Anno 1878*, published by the Ministero di Agricoltura, Industria, e Commercio, Direzione Generale della Statistica and the Stamperia Reale in Rome in 1880.

Table E.1: Sources of emigration data

Years of Coverage	Publication Year	Press
1876	1877	Elzeviriana
1877–1878	1880	E. Sinimberghi
1879	1880	Cenniniana
1880–1881	1882	Bodoniana
1882	1883	Fratelli Centenari
1883	1884	Camera dei Deputati
1884–1885	1886	Camera dei Deputati
1886	1887	Aldina
1887	1888	Aldina
1888	1889	Aldina
1889	1890	dell'Opinione
1890	1891	dell'Opinione
1891	1892	dell'Opinione
1892	1893	Cooperativa Romana
1893	1894	Cooperativa Romana
1894–1895	1896	Bontempelli
1896–1897	1899	Nazionale G. Bertero
1898–1899	1900	Nazionale G. Bertero
1900–1901	1903	Nazionale G. Bertero
1902–1903	1904	Nazionale G. Bertero
1904–1905	1906	Nazionale G. Bertero
1906–1907	1908	G. Civelli
1908–1909	1910	Nazionale G. Bertero
1910–1911	1913	Nazionale G. Bertero
1912–1913	1915	Ludovico Cecchini
1914–1915	1918	Ludovico Cecchini
1918–1920	1925	Provveditorato Gener. dello Stato

F Preparing Official Statistics for Analysis

The data that we collected from the *Statistica della Emigrazione Italiana per l'Estero* volumes and from the 1881 Italian census required considerable preparation before they could be used for analysis. At the municipality level, the main difficulties are the changing of municipality names over time, and the combination or division of municipalities to form other municipalities. A key source for this effort was the *Comuni e Loro Popolazione ai Censimenti dal 1861 al 1951*, published by ISTAT (the Italian statistical bureau) in 1960. This publication describes the changing borders of municipalities, allowing us to create consistently defined municipalities over the entire sample period, based on borders in 1904. Another difficulty arose from the existence of two sometimes conflicting records for the same municipality-year in cases when two different volumes presented data for the same year. In this case, we used data from the later-published volume.

Our analysis also requires knowing the geographic location of each municipality. For municipalities that still exist (the vast majority), we were able to simply match the list of municipality names to a GIS file of modern municipalities (ISTAT 2018) whose historical provinces could be determined using a shapefile of historic province boundaries (ISTAT 2019). This was more difficult in the case of historic municipalities that were consistently defined throughout our study period but have since ceased to exist. For instance, the municipality of Santo Stefano di Briga existed throughout our study period, but has since been incorporated into the municipality of Messina. The best guess of geographic location that we are able to derive is thus to place Santo Stefano di Briga in the same place as Messina. This simplification is a possible source of error, but because most municipalities are quite small, the resulting error is likely to be small.

Another issue was the mapping of districts. To our knowledge, no shapefile of Italian districts existed at the time that we cleaned our data, though one has since become available (ISTAT 2019). We constructed the shapefile that we use by merging the polygons of all municipalities assigned to a particular district. For municipalities that were created after our study period, we determined the municipality of which they were once a part, and assign the modern municipality to the district of the historic municipality from which it was split. Comparison of our resultant shapefile to a map that we were able to locate of historical districts, as well as that provided by ISTAT, shows that our generated shapefile is extremely accurate.

Another issue arose from the fact that northern provinces that were previously part of the Austro-Hungarian Empire had *distretti* instead of *circondari*. We treat both of these as districts, but the *distretti* were smaller and were eventually eliminated, creating provinces with a single *circondario*. For the emigration data, we can reconstruct the *distretti* totals from the municipality-level data. For the census data, we must use province-level data on literacy and employment for these northern provinces.

G Results Including Data on "Other Municipalities"

This appendix addresses the fact that for years 1903 and earlier, the emigration of some municipalities was not listed in the *Statistica della Emigrazione Italiana per l'Estero*, but was instead included in an aggregate report for each district under the header of "Other Municipalities in this District." To ensure that this is not responsible for driving results, we allocate this unassigned emigration equally to the excluded municipalities and repeat the main results. Since this does not affect the district-level data, those results are not repeated here.

Figure G.1: σ-convergence in emigration rates to North America

Note: Each point represents the coefficient of variation in emigration rates to North America in a particular year.

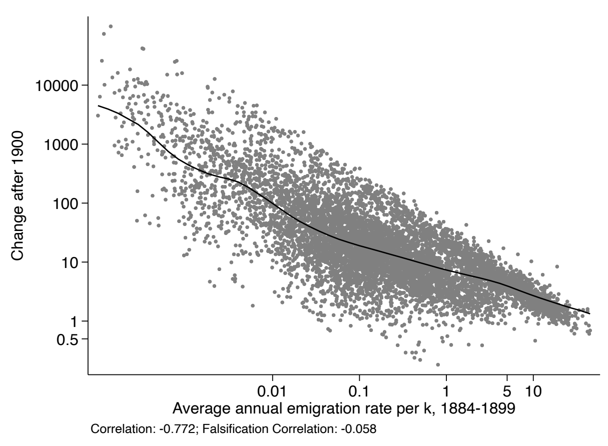
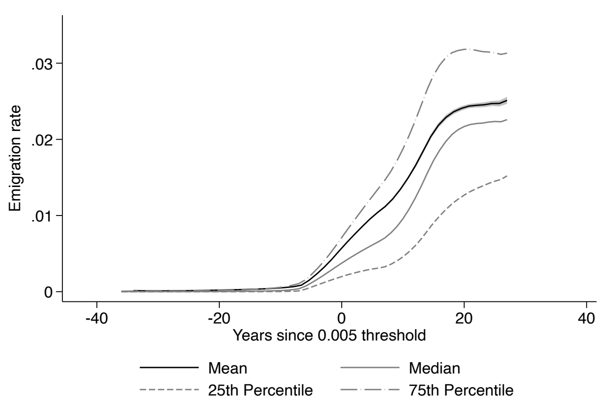


Figure G.2: β-convergence in emigration rates to North America

Note: Each point represents a municipality. The x-axis is the average annual emigration rate for 1884–1899 on a log scale. The y-axis is the ratio of the average emigration rate before and after 1900, also on a log scale. The falsification correlation is the correlation of the change in emigration and emigration after 1900; that it is not positive indicates that the negative relationship shown in the graphs is unlikely to be spurious, as explained in section 5.1.

(a) Municipalities

(b) Municipalities, grouped



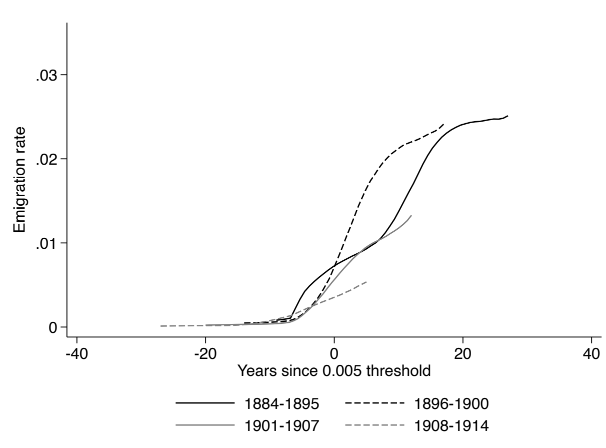


Figure G.3: S-shaped time series of migration to North America

Note: Panels (a) plots a non-parametric regression of emigration rates to North America against time, normalized so that year 0 is the first year in which a place had an emigration rate of at least 5 per thousand. The shaded area is a 95-percent confidence interval. Panel (b) divides municipalities according to the half decade in which they crossed the threshold.

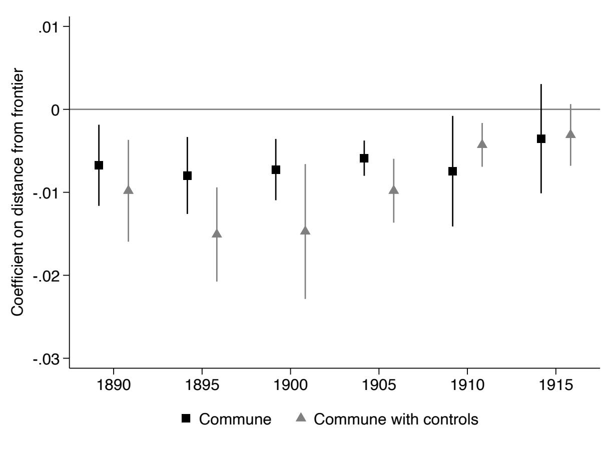


Figure G.4: Emigration rates to North America by distance to the mass migration frontier (km)

Note: This figure estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of lagged distance from the frontier of mass migration to North America and plots the coefficients on lagged distance from the frontier. Panel (b) also includes a regression controlling for half decade-specific functions of various controls.

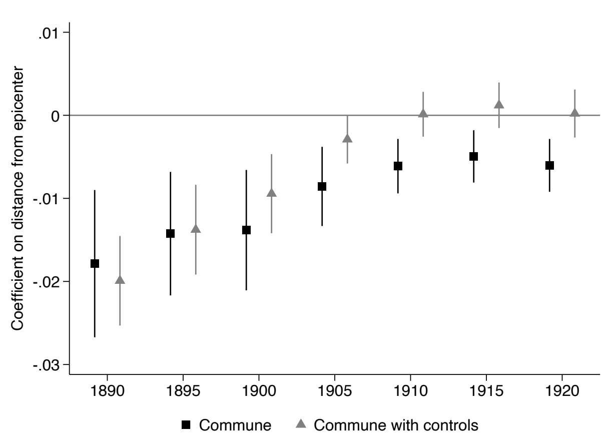


Figure G.5: Emigration rates to North America by distance to epicenter (km)

Note: This figure estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of distance from the nearest epicenter of emigration to North America and plots the coefficients on distance from epicenter. It also includes a regression controlling for half decade-specific functions of various controls.

Table G.1: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.936^a	1.013^a	0.763^a	0.670^a	0.756^a	0.493^b	1.055^a	0.244
	(0.110)	(0.109)	(0.181)	(0.222)	(0.161)	(0.228)	(0.348)	(0.281)
Observations	36,697	36,697	36,697	36,697	36,697	36,697	36,697	36,668
F-statistic	37.86	55.91	20.68	15.46	26.69	12.75	34.15	12.66
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.834^a	0.875^a	0.534^b	0.622^a	0.611^a	0.484^a	0.315	0.358^c
	(0.192)	(0.184)	(0.216)	(0.207)	(0.179)	(0.170)	(0.384)	(0.187)
Observations	12,670	12,668	12,668	12,667	12,668	12,658	12,668	12,639
F-statistic	77.19	83.45	78.03	70.23	81.45	79	61.16	53.69
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

H Results with 1881 Population

The main results use 1901 population as the denominator in calculating emigration rates. This appendix repeats the main results using 1881 population as the denominator.

(a) Districts (b) Municipalities

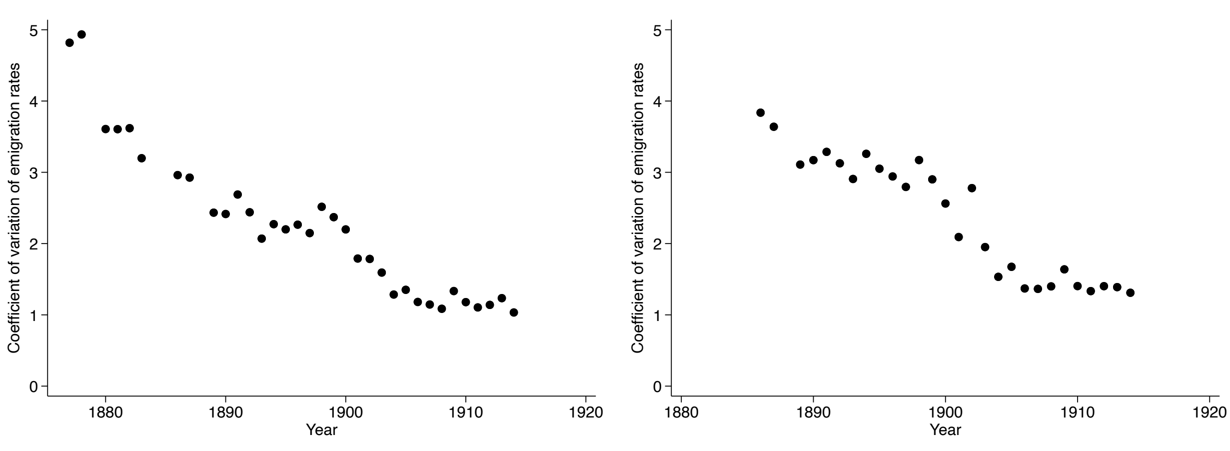


Figure H.1: σ-convergence in emigration rates to North America

Note: Each point represents the coefficient of variation in emigration rates to North America in a particular year.

(a) Districts (b) Municipalities

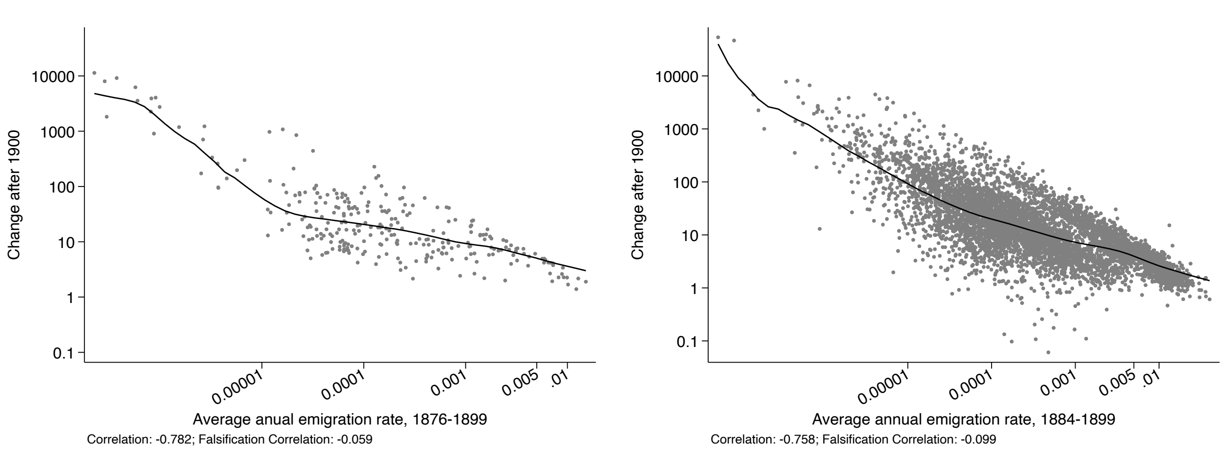


Figure H.2: β-convergence in emigration rates to North America

Note: Each point represents a municipality or district. The x-axis is the average annual emigration rate for a district for 1876–1899 or a municipality for 1884–1899 on a log scale. The y-axis is the ratio of the average emigration rate before and after 1900, also on a log scale. The falsification correlation is the correlation of the change in emigration and emigration after 1900; that it is not positive indicates that the negative relationship shown in the graphs is unlikely to be spurious, as explained in section 5.1.

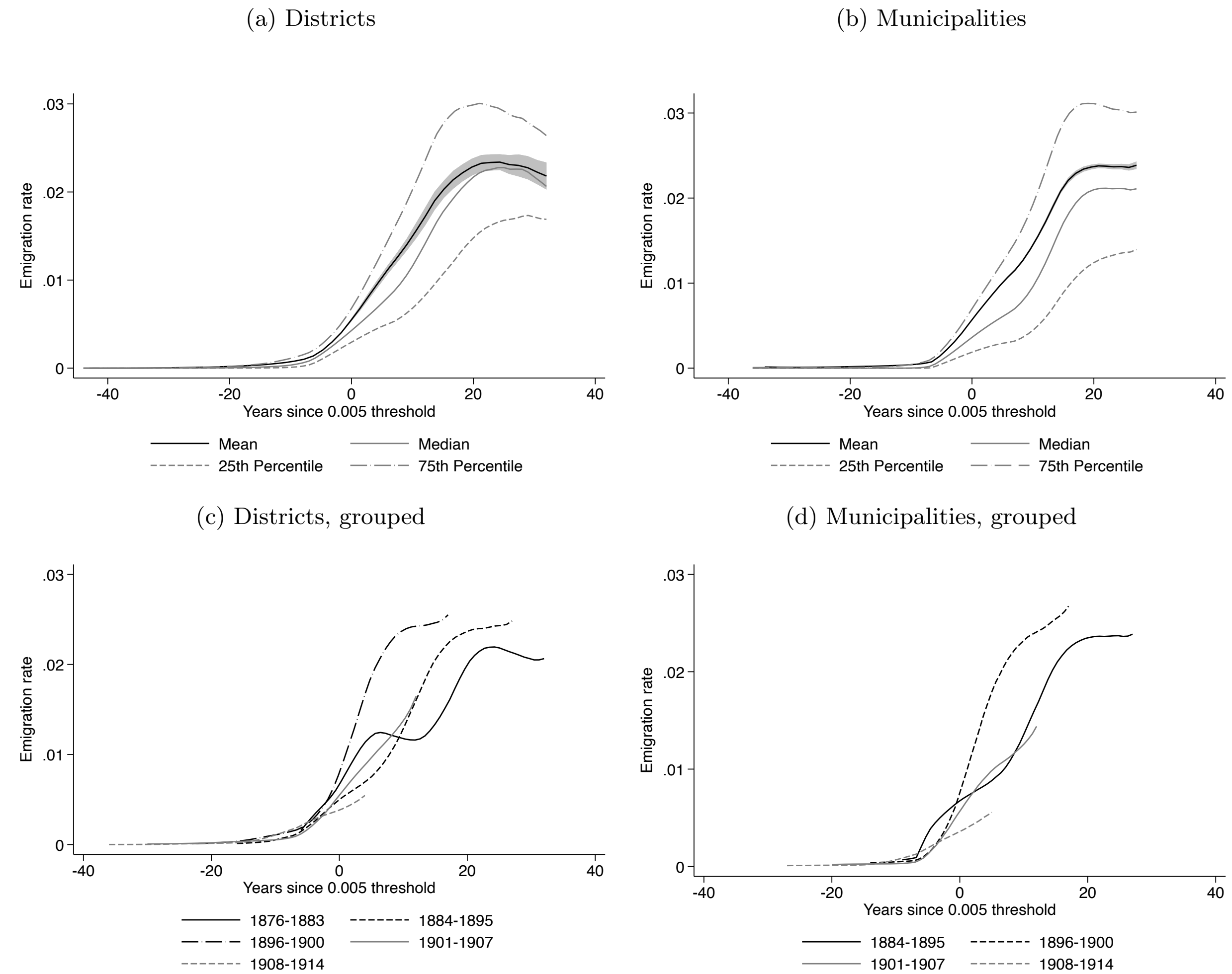


Figure H.3: S-shaped time series of migration to North America

Note: Panels (a) and (b) plot a non-parametric regression (the mean), as well as quartiles of emigration rates to North America against time, normalized so that year 0 is the first year in which a place had an emigration rate of at least 5 per thousand. Shaded areas are 95-percent confidence intervals for the mean. Panels (c) and (d) are the same as (a) and (b) but divide areas according to the half decade in which they crossed the threshold.

(a) Districts (b) Coefficients

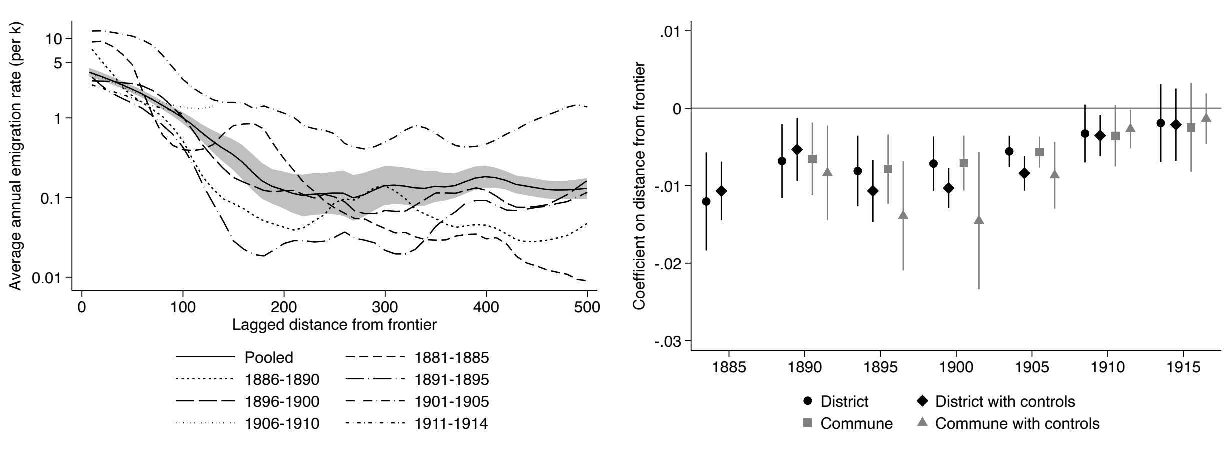


Figure H.4: Emigration rates to North America by distance to the mass migration frontier (km)

Note: Panel (a) presents non-parametric regressions of the log of average annual migration rates for the whole sample and for each half decade on the distance from a district that had ever achieved an average annual migration rate of at least 5 per thousand by the previous half decade, limiting the sample to districts that had not yet achieved this threshold. Shaded areas are 95-percent confidence intervals. Panel (b) estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of lagged distance from the frontier of mass migration to North America and plots the coefficients on lagged distance from the frontier. Panel (b) also include regressions controlling for half decade-specific functions of various controls.

(a) Districts (b) Coefficients

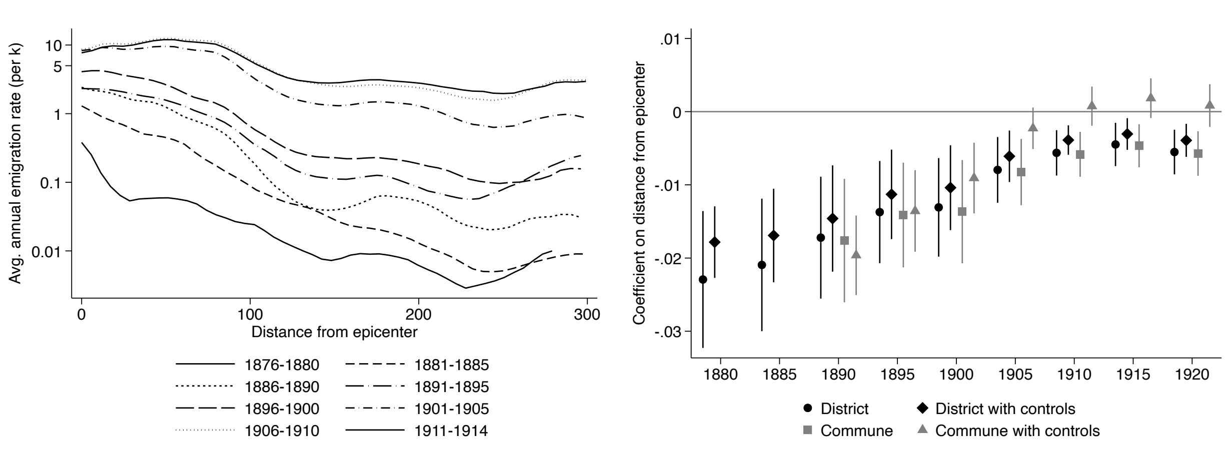


Figure H.5: Emigration rates to North America by distance to epicenter (km)

Note: Panel (a) plots non-parametric regressions of the log of the average annual emigration rate for each half decade against distance to the nearest epicenter of emigration to North America. Panel (b) estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of distance from the nearest epicenter of emigration to North America and plots the coefficients on distance from epicenter. Panel (b) also includes regressions controlling for half decade-specific functions of various controls.

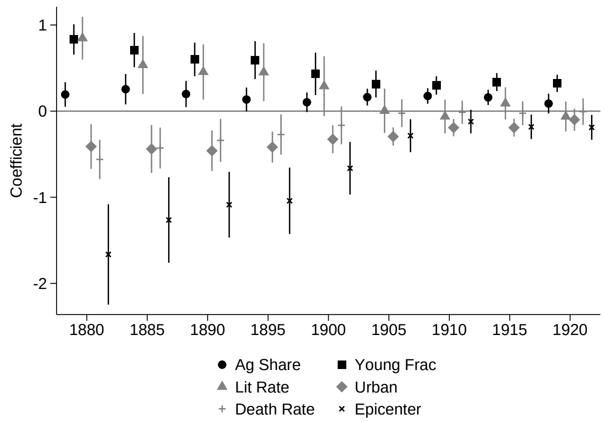


Figure H.6: Relationship of migration to various local characteristics

Note: This figure presents the results of a regression of emigration to any destination on year-specific functions of various district characteristics. All explanatory variables are standardized to have mean zero and standard deviation one.

Table H.1: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.957^a	0.882^a	0.629^a	0.632^b	0.645^a	0.621^a	0.946^b	0.389
	(0.095)	(0.125)	(0.199)	(0.245)	(0.140)	(0.213)	(0.368)	(0.394)
Observations	31,573	31,573	31,573	31,573	31,573	31,572	31,573	31,537
F-statistic	35.88	41.18	16.07	9.913	24.60	10.41	25.09	6.645
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.925^a	0.909^a	0.701^a	0.834^a	0.714^a	0.686^a	0.312	0.545^b
	(0.126)	(0.148)	(0.151)	(0.159)	(0.171)	(0.157)	(0.553)	(0.219)
Observations	11,372	11,371	11,371	11,370	11,371	11,361	11,371	11,335
F-statistic	78.87	76.82	73.46	53.58	56.10	52.12	19.99	30.95
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

I Results for Migration to All Destinations

This appendix repeats the main results of the paper, but focuses on migration to all destinations rather than on migration to North America alone. This addresses the concern that some of the local correlation in emigration rates could be the product of the fact that the emigration-by-destination data are available only at the province level. It focuses on distance to all epicenters rather than only distance to epicenters of emigration to North America and on the frontier of mass emigration to any destination rather than only on the frontier of mass migration to North America. The results are, for the most part, qualitatively unchanged, with two exceptions. The first concerns the S-shaped time series (Figure I.3). For the case of all destinations, these are not S-shaped, but continuously increasing after places cross the mass migration threshold. This may be the consequence of surges to several destinations combining to create a continuous increase, and shows that even in this case, the surge is rapid and virtually irreversible once mass emigration begins in a place. The second concerns the results of the spatial contagion model using the instrument based on distance to the frontier of mass migration (Panel B of Table I.1). In this case, all of the sample limitations imposed in the analysis, together with the loss of observations of zero emigration, yield a sample so small that statistical power is substantially weakened.

(a) Districts (b) Municipalities

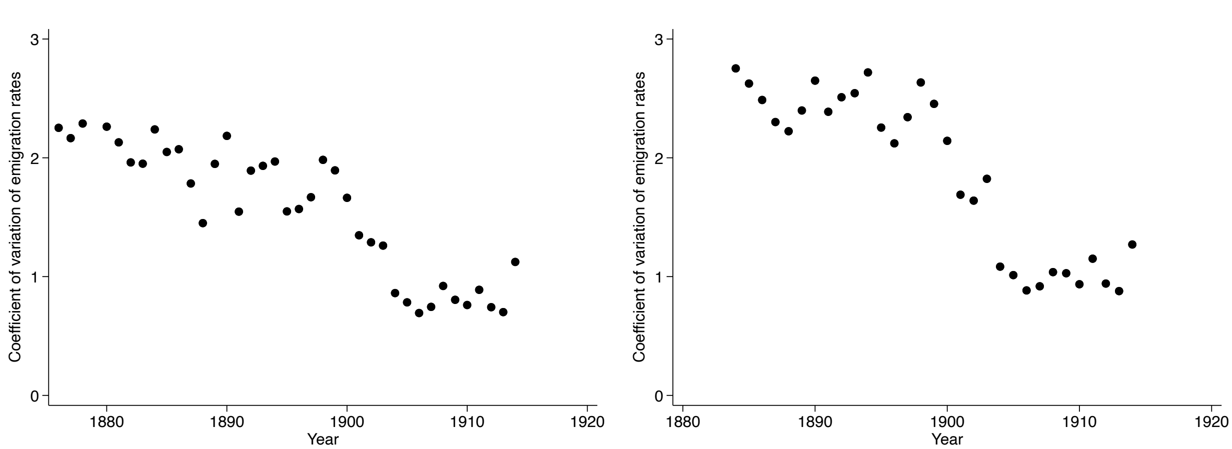


Figure I.1: σ-convergence in emigration rates to all destinations

Note: Each point represents the coefficient of variation in emigration rates to all destinations in a particular year.

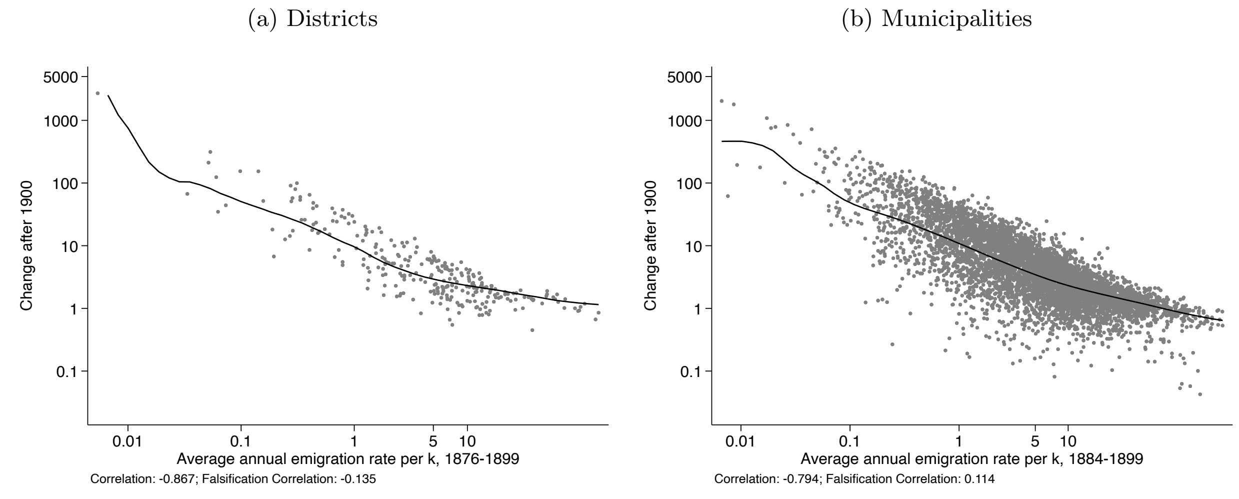


Figure I.2: β-convergence in emigration rates to all destinations

Note: Each point represents a municipality or district. The x-axis is the average annual emigration rate for a district for 1876–1899 or a municipality for 1884–1899 on a log scale. The y-axis is the ratio of the average emigration rate before and after 1900, also on a log scale. The falsification correlation is the correlation of the change in emigration and emigration after 1900; that it is not positive (or if it is, that its magnitude is considerably less than the plotted negative correlation) indicates that the negative relationship shown in the graphs is unlikely to be spurious, as explained in section 5.1.

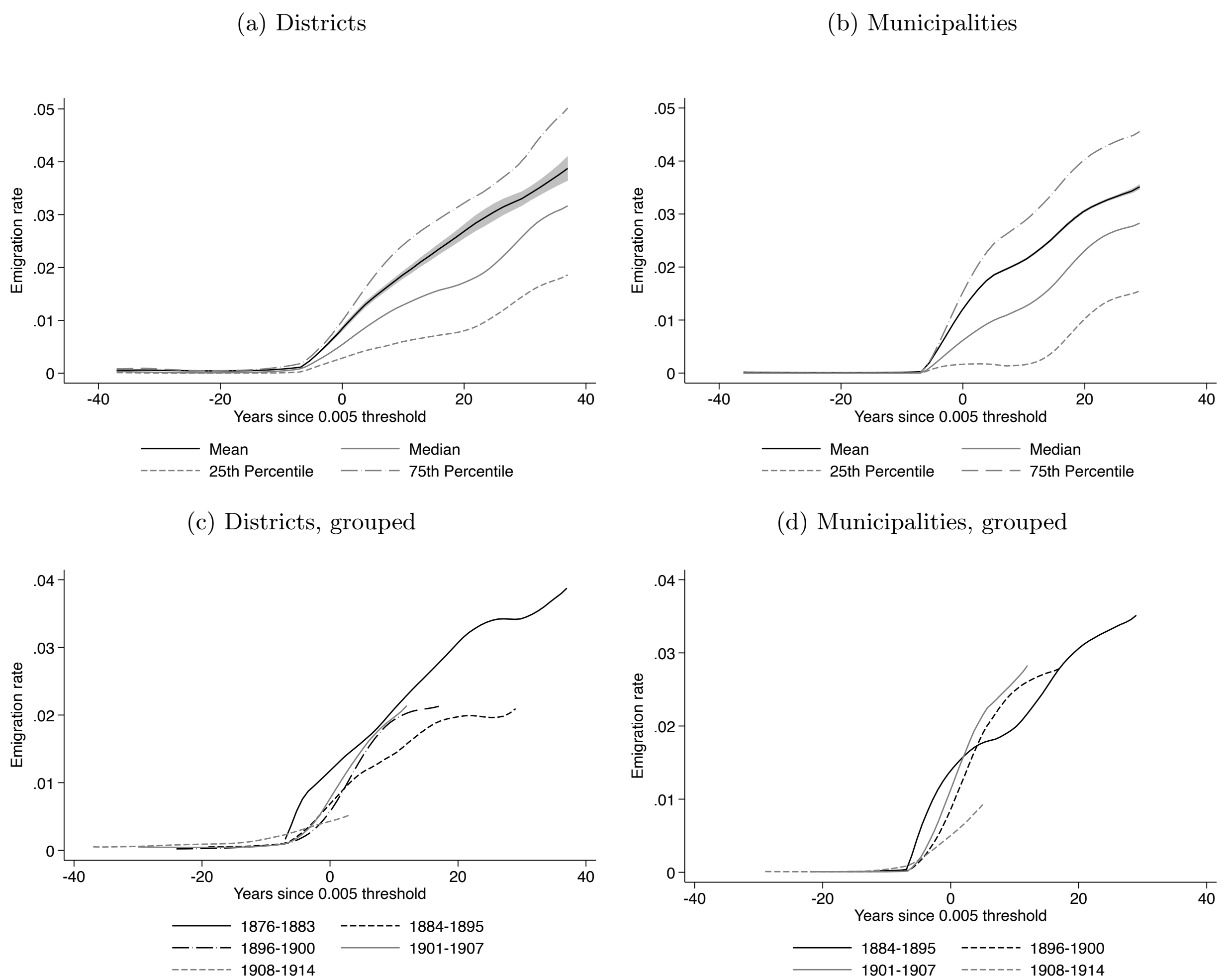


Figure I.3: (Non-)S-shaped time series of migration to all destinations

Note: Panels (a) and (b) plot a non-parametric regression (the mean), as well as quartiles of emigration rates to any destination against time, normalized so that year 0 is the first year in which a place had an emigration rate of at least 5 per thousand. Shaded areas are 95-percent confidence intervals for the mean. Panels (c) and (d) are the same as (a) and (b) but divide areas according to the half decade in which they crossed the threshold.

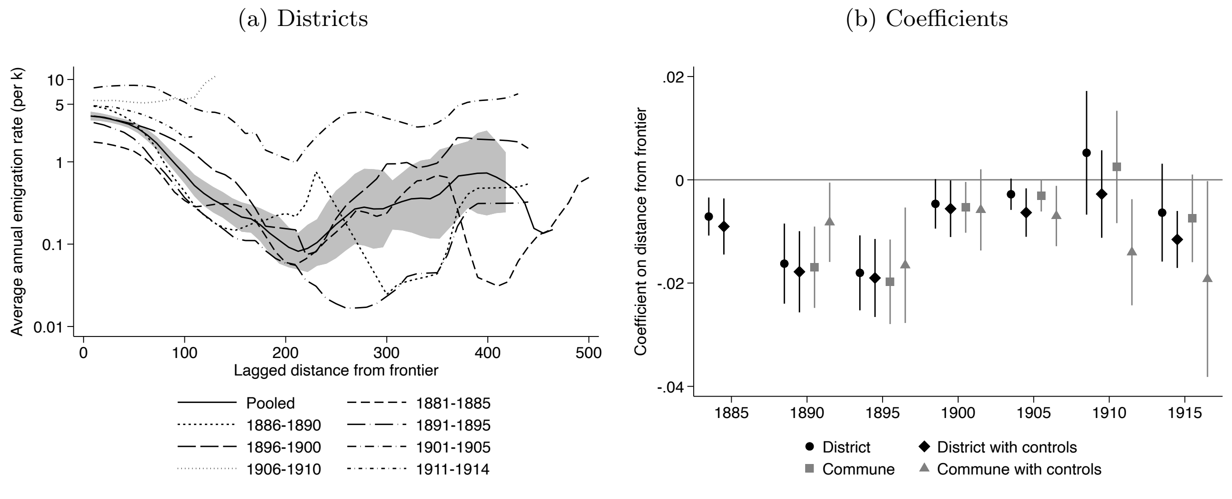


Figure I.4: Emigration rates to all destinations by distance to the mass migration frontier (km)

Note: Panel (a) presents non-parametric regressions of the log of average annual migration rates for the whole sample and for each half decade on the distance from a district that had ever achieved an average annual migration rate of at least 5 per thousand by the previous half decade, limiting the sample to districts that had not yet achieved this threshold. Shaded areas are 95-percent confidence intervals. Panel (b) estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of lagged distance from the frontier of mass migration and plots the coefficients on lagged distance from the frontier. Panel (b) also includes regressions controlling for half decade-specific functions of various controls.

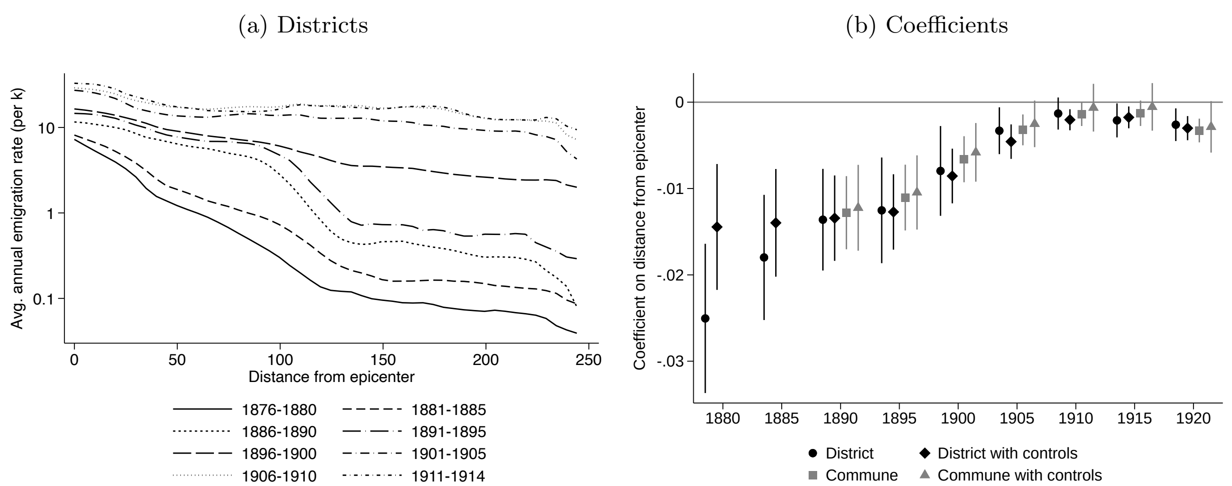


Figure I.5: Emigration rates to all destinations by distance to epicenter (km)

Note: Panel (a) plots non-parametric regressions of the log of the average annual emigration rate for each half decade against distance to the nearest epicenter of emigration. Panel (b) estimates a binomial maximum likelihood regression of emigration rates on half decade-specific functions of distance from the nearest epicenter of emigration and plots the coefficients on distance from epicenter. Panel (b) also includes regressions controlling for half decade-specific functions of various controls.

Table I.1: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	-0.222	0.775^a	0.647^a	0.588^a	0.715^a	0.662^b	0.460	0.630
	(1.268)	(0.142)	(0.225)	(0.223)	(0.229)	(0.328)	(0.326)	(0.451)
Observations	20,238	20,238	20,238	20,238	20,238	20,238	20,238	20,186
F-statistic	1.259	23.59	17.92	14.55	19.46	11.80	7.421	6.900
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.315	0.303	0.267	0.483^c	0.358	0.636^b	0.210	0.024
	(0.283)	(0.276)	(0.335)	(0.265)	(0.322)	(0.289)	(0.461)	(0.381)
Observations	1,689	1,688	1,688	1,684	1,688	1,682	1,685	1,668
F-statistic	27.43	36.24	27.67	30.46	47.89	53.13	33.38	38.76
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to any destination. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

J Robustness Checks for β-Convergence

Table J.1 provides a more detailed test of the β-convergence prediction than the one presented in Figure 8, including exercises that address concerns over spurious correlations. We estimate analogous regressions of the form

$$\log\left(\frac{e_{i1}}{e_{i0}}\right) = \alpha + \beta \log(e_{i0}) + \mathbf{x}_i'\gamma + \varepsilon_i, \tag{J.1}$$

where e_{i0} and e_{i1} are the rates of emigration from municipality i before and after 1900, respectively, and $\mathbf{x}_i$ is a vector of controls. Column (1) performs this estimation with no added controls, essentially replicating the findings of Figure 8. Columns (2)–(4) of Table 3 repeat the same estimation with the addition of a variety of control variables and then of province and district fixed effects. These four columns include, under "Falsification," the coefficient from repeating the estimation of equation (J.1) with emigration in the second period, $\log(e_{i1})$, as the regressor. The fact that this coefficient is positive in columns (3) and (4) indicates that there is some merit to concerns that the relationship may in part be the product of measurement error or idiosyncratic shocks; but since the absolute value of the falsification coefficient is more than 4 times smaller, we can still conclude that, even if the coefficient is biased in this way, the convergence is not fully spurious. Figure 8 shows the results of a similar robustness check. The negative coefficient in this case for a regression of the change in the emigration rate and the emigration rate in the *later* period (the "Falsification Correlation" in the notes to the figures) implies that the relationship is indeed driven by convergence, even if the slope is downward biased. If the true relationship were zero, then this falsification coefficient would be positive and of the same absolute magnitude.[87]

In columns (5)–(8) of Table J.1, we take a direct approach to addressing concerns of a spuriously negative relationship. Specifically, we use distance from the nearest epicenter of emigration to North America as an instrument for $\log(e_{i0})$. This strategy exploits the fact that emigration expanded spatially from these initial epicenters. To be clear, the object of this analysis is not to identify a causal effect, but to clear the possible source of spurious correlation discussed above. Although the first-stage F-statistics become weak in the most restrictive specifications, the coefficients are statistically significant and closely match those of the OLS regressions. This strongly suggests that the strong β-convergence was not a result of the suspected mechanical bias.

[87] See Spitzer (2021) and Spitzer, Tortorici, and Zimran (2022) for similar analyses.

Table J.1: β-convergence

Variables	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
Lagged Own Emigration	-0.521^a	-0.739^a	-0.831^a	-0.855^a	-0.514^a	-0.793^a	-0.823^a	-0.913^a
	(0.021)	(0.017)	(0.012)	(0.012)	(0.043)	(0.062)	(0.157)	(0.208)
Observations	5,856	5,855	5,855	5,855	5,856	5,855	5,855	5,849
R-squared	0.592	0.770	0.882	0.915	0.592	0.766	0.801	0.823
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
1st Stage F					55.107	94.214	11.507	7.449
FE	None	None	P	D	None	None	P	D
Falsification	−0.150	−0.010	0.183	0.176				
	(0.054)	(0.073)	(0.065)	(0.057)				

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1
Notes: Standard errors clustered at the district level. Unit of observation is a municipality. Dependent variable is the change in the log of the emigration rate to North America from the pre-1900 period to the period 1900 and later. Controls include latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, distance to railroad, birth rate, death rate, mutual aid society members per capita, and log postal savings deposits per capita. Instrument is the distance to the nearest epicenter of emigration to North America. P denotes province-level fixed effects included. D denotes district-level fixed effects included. The falsification coefficient is the coefficient from regressing the change in emigration on emigration in the post-1900 period; if it is either negative or positive but of a smaller magnitude than the main coefficient of interest, this is evidence that the relationship is not spurious.

K Results Including Observations with No Migration

Whenever the object of interest is the logarithm of emigration, municipalities with no emigration in a particular half decade must be excluded. In this appendix, we repeat the main results using $\log(e_{it} + \varepsilon)$, where $\varepsilon = 10^{-5}$ instead of $\log(e_{it})$ in order to incorporate these municipality-half decades into the analysis. This is not necessary when the binomial maximum likelihood regression is used (since that is designed to account for cases of zero migration), and so this appendix only repeats the results where the change is necessary. The results are, for the most part, qualitatively unchanged. The results using the epicenter distance-based instrument (Panel A of Table K.1) are somewhat weaker than those of the main text, however, and in some cases the combination of a decline in the magnitude of the coefficient and an increase in the standard error has caused some estimates to cross past conventional levels of statistical significance. On the whole, however, these results, in particular when viewed in combination with those of Panel B of Table K.1, are consistent with those of the main text.

Table K.1: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.725^a	0.763^a	0.429^c	0.432	0.410^c	0.424	0.214	0.125
	(0.134)	(0.131)	(0.250)	(0.272)	(0.225)	(0.296)	(0.474)	(0.441)
Observations	37,128	37,128	37,128	37,128	37,128	37,128	37,128	37,104
F-statistic	29.04	47	18.60	13.12	24.75	10.38	27	8.256
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.723^a	0.950^a	0.675^a	0.775^a	0.703^a	0.611^a	0.268	0.479^c
	(0.185)	(0.213)	(0.207)	(0.198)	(0.223)	(0.208)	(0.537)	(0.271)
Observations	12,877	12,875	12,875	12,873	12,875	12,864	12,875	12,850
F-statistic	60.61	48.56	45.66	42.29	41.83	40.97	30.60	23.06
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

L Robustness to Choice of θ

This appendix verifies the robustness of the results in section 6 to alternative choices of the parameter θ, which governs the rate at which the influence of other municipalities on the emigration exposure of a municipality declines with the distance between them. In particular, two alternate values of θ are considered. Whereas that in the main text was chosen on the basis of estimating equation (2) by non-linear least squares without controls, the alternate values in this appendix were chosen after performing this estimation with controls and with province-half decade fixed effects. The results are qualitatively unaffected.

L.1 θ=-2.86

Table L.1: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.718^a	0.827^a	0.596^a	0.582^b	0.567^a	0.459^c	0.955^b	-0.095
	(0.182)	(0.127)	(0.185)	(0.234)	(0.149)	(0.247)	(0.452)	(0.577)
Observations	31,463	31,463	31,463	31,463	31,463	31,462	31,463	31,427
F-statistic	11.92	33.05	15.19	8.903	19.93	7.495	18.99	4.241
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.769^a	0.835^a	0.620^a	0.731^a	0.660^a	0.600^a	0.168	0.343
	(0.179)	(0.163)	(0.164)	(0.170)	(0.183)	(0.163)	(0.652)	(0.242)
Observations	11,207	11,206	11,206	11,205	11,206	11,196	11,206	11,170
F-statistic	28.90	42.32	47.11	36.80	35.56	32.87	14.22	20.05
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

L.2 θ=-2.98

Table L.2: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	1.109^{a}	0.928^{a}	0.710^{a}	0.691^{a}	0.626^{a}	0.477^{c}	1.011^{b}	0.380
	(0.081)	(0.119)	(0.177)	(0.210)	(0.163)	(0.257)	(0.394)	(0.393)
Observations	31,463	31,463	31,463	31,463	31,463	31,462	31,463	31,427
F-statistic	52.15	51.83	23.03	15.40	22.24	9.397	26.21	9.081
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	1.079^{a}	0.930^{a}	0.650^{a}	0.769^{a}	0.674^{a}	0.664^{a}	0.304	0.485^{b}
	(0.119)	(0.155)	(0.160)	(0.166)	(0.174)	(0.166)	(0.539)	(0.231)
Observations	11,207	11,206	11,206	11,205	11,206	11,196	11,206	11,170
F-statistic	96.83	65.04	69.36	53.38	60.59	54.27	25.23	35.81
Additional FE	None	None	C	CT	P	PT	D	DT
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Significance levels: [a] p<0.01, [b] p<0.05, [c] p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. C denotes region (compartimento)-level fixed effects. P denotes province-level fixed effects. D denotes district-level fixed effects. CT, PT, and DT denote region-time, province-time, and district-time fixed effects.

M Results With Grid Fixed Effects

This appendix repeats the estimation of section 6, but instead of using fixed effects based on actual geographic divisions (i.e., region, province, and district), we use fixed effects for grids of various sizes, ranging from grid cells of 90-by-90 kilometers to 15-by-15 kilometers. This method, based on that used by Barsbai et al. (2017), is intended to show that the estimates are not the product of bias caused by unobservables by making a coefficient stability argument—if the coefficients are largely unchanged in the face of fixed effects for finer and finer grid cells, it is unlikely that local characteristics are responsible for the relationship. Although the results for the epicenter-based instrument are in many cases rendered statistically insignificant by these very fine controls, the results for the frontier-based instrument are robust, and moreover are largely stable across specifications.

Table M.1: Spatial contagion results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Epicenter-based instrument								
Lagged Emigration Exposure	0.524^{c}	0.385	0.584^{a}	0.429	0.622^{a}	0.682	0.708^{a}	1.766^{c}
	(0.297)	(0.768)	(0.218)	(0.624)	(0.176)	(0.636)	(0.157)	(0.926)
Observations	31,463	31,435	31,463	31,409	31,463	31,280	31,463	30,341
F-statistic	12.32	2.087	24.07	3.466	37.96	3.028	49.69	3.968
Panel B: Frontier-based instrument								
Lagged Emigration Exposure	0.664^{a}	0.777^{a}	0.820^{a}	0.829^{a}	0.625^{c}	0.684^{b}	0.987^{c}	0.579
	(0.197)	(0.186)	(0.228)	(0.191)	(0.328)	(0.298)	(0.572)	(0.470)
Observations	11,205	11,182	11,202	11,166	11,199	11,093	11,159	10,674
F-statistic	49.37	53.63	34.57	59.16	25.40	36.49	15.26	26.68
Additional FE	G	GT	G	GT	G	GT	G	GT
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grid Size	90	90	60	60	30	30	15	15

Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Notes: Panel A uses instruments constructed on the basis of a municipality's distance to the nearest epicenter of mass migration. Panel B uses instruments constructed on the basis of distance to the frontier of mass migration. Sample limited to municipality-half decades between 50 and 250km of the migration source (i.e., the epicenter or frontier). Standard errors clustered at the district level. All specifications include at least half-decade fixed effects and control for half decade-specific functions of own predicted lagged emigration based on distance from the emigration source, local population, distance to coast, and distance to the European frontier. Dependent variable is the log of the emigration rate to North America. Unit of observation is a municipality-half decade. Controls include half decade-specific functions of latitude, longitude, elevation, agricultural employment share, industrial employment share, literacy rate, fraction under age 15, birth rate, death rate, mutual aid society membership per capita, and log postal savings deposits per capita. G denotes the inclusion of grid fixed effects for grid cells of the specified size4 (e.g., 90-by-90km). GT denotes the inclusion of grid-half decade fixed effects.

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