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Abstract

Local institutions have long been regarded as key drivers of economic development. However, little is known about the role of institutions in preparing places to cope with public health crises and pandemics. This paper sheds light on how the nature of a local institution, city autonomy, influenced variations in the incidence of the Black Death —possibly the worst pandemic ever recorded— across cities in Western Europe between 1347 and 1352. We examine urban autonomy not only because it represented a major political shift in medieval times, but because, more importantly, it also represents a key prototype of modern political institutions. By exploiting data on the spatial variation of Black Death's mortality rates and duration using OLS and 2SLS methods, we uncover that city autonomy reduced mortality rates by, on average, almost 10 percent. Autonomous cities were in a better position to adopt swift and efficient measures against the pandemic than those governed by remote kings and emperors. This relationship has been confirmed by a series of placebo tests and robustness checks. In contrast, there is no evidence to suggest that city autonomy was a factor in reducing the duration of the pandemic in European cities.

Keywords: Local institutions, pandemics, city autonomy, Black Death, Europe

JEL Codes: N43, N93, O17

1. Introduction

While the role of cities in promoting economic development has been widely acknowledged, its negative externalities, such as air pollution, crime and pandemics, have only been taken seriously when they endanger citizens' health and lives (Duranton et al, 2015). The recent outbreak of Covid-19 has cast the role of pandemics for cities in another light. It has become evident that, as a consequence of the agglomeration of individuals and geographic proximity in cities (often combined with a lack of preventative measures), urban dwellers are a highly vulnerable group to the spread of disease. The high urban mortality and infection rates of SARS, Ebola, and COVID-19 have reminded everyone how vulnerable cities are to pandemics, even in modern times (Atkeson, 2020; Bowles et al., 2016; Desjardins et al., 2020; Qiu et al., 2018). This observation has been confirmed through reviewing the impacts of historical pandemics, including Justinian's plague, the Black Death, and the 1918 influenza pandemic, on human lives.

The sheer density of cities is considered by many a factor that limits the efficiency of any measure taken against pandemics (Almond, 2006; Jedwab et al., 2019). Often, cities are at the mercy of disease and their variations in performance during pandemics is often considered to be dependent on luck. This has led some researchers on pandemics to treat them as exogenous shocks (Weil, 2010; Young, 2005). In the field of applied economics, it is becoming increasingly popular to treat the outbreak of epidemics as a natural experiment to examine the impact of external shocks on the local economy (Almond, 2006; Dittmar & Meisenzahl, 2020; Donaldson & Keniston, 2016; Jedwab et al., 2019). In this respect, there is little differentiation between anti-pandemic efforts made by cities and those by their inhabitants. However, are the short-term consequences of pandemics truly random? Are institutional factors really unimportant to the control of pandemics? More importantly, are changes to city governance while fighting epidemics futile?

In this paper, we intend to answer these questions by systematically reviewing how differences in urban institutions affected the spread of the Black Death during its initial outbreak between 1347 and 1352. It should be noted that, although the biggest outbreak of the plague took place during this period, there were recurrent outbursts later in the century and in the following centuries. Numerous European cities, in particular, witnessed repeated episodes of the Black Death, as was the case of London between the 14th and 17th centuries (Earn et al., 2020). Nevertheless, the biggest shock and incidence took place during the initial outbreak. Taking this into account, as well as a lack of complete pan-European data on the incidence of subsequent outbreaks, we focus our attention on the initial mid-14th century outbreak.

The Black Death has been chosen for three reasons. First, it is possibly the largest demographic shock in the history of mankind. It is estimated that one- to two-thirds of Europe's population died from the plague between 1347 and 1352 (Ziegler, 2013). Entire villages disappeared, while many cities went into permanent decline. Although the Black Death has attracted attention from many disciplines, research on the political rationale behind the large variation in mortality rates across Western European cities remains limited. Most political research on the Black Death emphasizes the interaction between wars and the plague in Eurasia (Caferro, 2018; Jackson, 2018). Only a few pieces of research (Ormrod, 1996; Palmer, 2000) have specifically investigated into the plague from the perspective of rule of law or national government. However, while all of these works examine how political influence evolved after the outbreak of an epidemic, the political system's response to the Black Death has largely been ignored. Some cities were almost completely devastated, while others were mostly spared by the plague. Differences in local institutions may have played a role in these variations.

Second, the Black Death is the first pandemic in history that was recorded in detail, with information on mortality rates, durations of specific waves, and the impact on cities' populations (Alfani & Murphy, 2017; Benedictow, 2004). The data available make it possible to comprehensively analyse whether the different plague prevention measures adopted by cities made a difference for the impact of the pandemic.

Third, the Black Death is often identified as a crucial turning point in history, which may still have a profound impact on modern development (Herlihy, 1997). There is a popular view that the Black Death is the key element in Europe's divergence from the rest of the world (Diamond, 2013; Epstein, 2000; North & Thomas, 1973). Some even declare that the plague set Western Europe on a path to faster economic development by contributing to the onset of a high-income Malthusian equilibrium (Clark, 2008). However, without a deep understanding of what caused significant variations in the Black Death's impact from city to city, it is difficult to assess the validity of these arguments.

We use new city level data stemming from Christakos et al. (2005) to uncover what has led to the considerable variations in the Black Death's impact across Western European cities between 1347 and 1352. Based on our knowledge, although explorations of the Black Death differ, few papers directly focus on the role of institutions in the Black Death, especially from the perspective of the local government. In fact, we know next to nothing about the effects of local institutions in dealing with the spread of the pandemic and its impact. However, in this period, the autonomy and governance of European cities varied significantly from one city to another. Did cities with greater autonomy, which may have enabled them to react faster and differently against the spread of the plague, perform better than cities that were under the tight control of remote kings and emperors?

To answer these questions, we will look at the link between city autonomy in Europe during the Middle Ages and Black Death mortality rates during the initial outbreak of the plague. Our results show that greater autonomy has led to a considerable reduction in pandemic death rates. This finding is robust to the inclusion of a gamut of geographic, social, and political covariates. The impact of city autonomy was therefore significant, but not seconded by the political factors considered in this analysis. Urban autonomy facilitated a more nimble and effective adoption of measures against the diffusion of the disease within the city. Nevertheless, the duration of the Black Death pandemic in different cities was relatively random. Based on our results, none of the variables considered have any impact on reducing the epidemic duration.

Our search contributes to literature on the geography of plague by bringing into light the local institutional dimension. Most of the perspectives driven by politics focus on the direct impact of the pandemic on local politics and political economy. In contrast, our research question explores the political rationale behind variations in the impact of the plague. In addition, by considering possible errors in historical local data, our paper explores whether this is the case by means of different experiments and trials to ensure that the estimates are reliable.

The remainder of this paper proceeds as follows: section 2 describes the historical context of the Black Death and the diversity of autonomous cities at that time. Section 3 introduces the model and data used in this study. Section 4 presents the estimated results, and section 5 offers a conclusion.

2. Historical context

2.1 The Black Death

The Black Death was one of the most devastating pandemics recorded in human history. The plague reached Europe in October 1347, when 12 ships from the Black Sea were moored in the

Sicilian port of Messina (Hajar, 2012). The people on the dock found that most of the sailors on the ship were dead and those still alive were dying, covered in blood and pus. The Sicilian government decided to expel these ships immediately, but it was too late. Based on estimations, over the following five years, the Black Death killed over 20 million people in Medieval Europe, which is around one to two-thirds of the population at that time (Benedictow, 2004).

Scientists have understood the Black Death from an epidemiological perspective. It was spread by a bacillus called *Yersinia pestis* (named after Alexandre Yersin, who discovered the germ at the end of the 19th century). Under normal conditions, Yersinia pestis transmits poorly from person to person, but it can have a high transmission rate under exceptional circumstances, as has happened in the past in Manchuria (Nishiura 2006), Madagascar (Randremanana et al., 2019), and arguably also in Europe during the Black Death (Dols, 1979). A series of recent paleo-genomic studies have explored the paths of transmission and found that during the Black Death, both natural rodent-based foci within Europe and repeated introductions from Central/Eastern Asia contributed to its spread (Demeure et al., 2019).

The heterogeneous effects of the play remain, however, still inconclusive. Recent bioarcheological research has shown that the impacts of the Black Death could have been influenced by people's age and pre-existing health status (DeWitte & Wood, 2008). Godde et al. (2020) support this, suggesting that frail individuals were more vulnerable to the illness. However, they find that the risk of death in the elderly did not increase at all. Gender could have played a greater role in differences in incidence. Using data from Hainaut, Curtis and Roosen (2017) found the Black Death was sex-selective, killing all women than men in its initial stages. However, a synthetic study by Godde and Hens (2021) has come to the conclusion that in London the plague killed both females and males indiscriminately. Overall, variations in the transmission patterns of the plague may have been shaped by specific conditions in different cities and countries.

Medieval cities were notorious for high levels of ill-health and bad living conditions, compared to rural and nomadic lifestyles. Pest infestation was common. Water-supply infrastructure built to ensure public access to clean water only existed in a few cities, such as medieval London (Salzman, 2017). In most cities, water was transported from outside and then shared between many people for different uses. Disease vectors, such as fleas and bedbugs, easily carried bacteria between humans. Roundworms and whipworms were not restricted to the poor, who might not have clean water or clean clothes in their house. Even Richard III, the king of

England, was infected by roundworms. Although privies have been built in Medieval Europe for a long time, they were not in sufficient supply, meaning that faecal contamination of food was rife (Mitchell, 2015). Furthermore, sewage ran in the gutter and people threw their faeces and urine directly out of the window (Gottfried, 2010). These bad living environments in the cities directly affected people's health both before and during the Black Death era. Bioarcheological evidence has shown that health conditions in London generally decreased in the 13th century, which possibly contributed to the high mortality rates in the city during the Black Death (DeWitte, 2015). By measuring heath conditions considering adult stature, DeWitte and Hughes-Morey (2012) found that poor health —proxied by short stature— was associated with higher mortality rate during the Black Death.[1] Insalubrious living conditions caused cities in Medieval Europe facilitated the spread of the Black Death.

The incidence of the Black Death across cities in Europe in its initial stages were, however, far from homogenous. From 1347 to 1352, mortality rates varied greatly from city to city. In some cities, such as Leuven, Arras, and Douai, reported mortality rates were lower than 10 percent. In contrast, mortality rates in places including Yarmouth, Scicli in Sicily, and Ciudad Real exceeded 70 percent of the city population. What factors explain such large variations in mortality? Some scholars argue that ports and centres of trade routes were hit the hardest by the Black Death (Yue et al., 2017). However, counterexamples abound and make it impossible to reach a definite conclusion. For example, the Italian port of Genoa reportedly had a Black and Death mortality of about 35 percent. This was lower than that of inland Verona (45 percent), but also lower than in the port of Venice (60 percent) (Christakos et al., 2005: 163). Although there are some rough descriptive statistics and case studies, historical accounts have not rationalized the patterns in the data (Cohn & Alfani, 2007; Theilmann & Cate, 2007). More importantly, when the Black Death appeared, European societies were unprepared to face the threat. However, as it became clear that the plague was there to stay, a process of institutional adaptation occurred. This institutional adaptation became an example of how humans react to a change in their environment.

2.2 Urban autonomy

One factor that has generally been overlooked is the role of local institutions in confronting the plague. Urban governments in Western Europe had been diverging for more than 200 years

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[1] has been argued that stature is positively related to the health condition of adults (DeWitte & Hughes-Morey, 2012).

before the Black Death hit.[2] Following the collapse of the Carolingian Empire, some cities started to develop forms of local participative government and demand representation in national policymaking. The first occurrences of autonomous cities were in Spain and Italy in the 11th century and quickly spread across Europe in the following centuries (Van Zanden et al., 2012). Urban elites such as lawyers, merchants, and entrepreneurs became increasingly influential in these cities (Belloc et al., 2016). Members of the elite soon began to form associations and make agreements to cooperate on issues of common concern (Guiso et al., 2016). As a result, autonomous cities started to slowly evolve (Jones, 2003). Citizens who had previously been excluded from urban governance began to partake in the sessions of the city government. Within the processes, citizens gradually learned how to regulate economic and social issues and resolve their disputes with a decentralized approach. Citizen participation improved across all of Europe and, in some cases, the need for central authority and authoritarian leaders became redundant (Belloc et al., 2016). Within autonomous cities, personal freedom was no longer threatened by distant kings and was protected by local laws. City autonomy also brought about a greater scrutiny of government officials' actions by local citizens and new forms of regulation. It is worth noting that not all the people living in autonomous cities had the qualification of citizenship and were allowed to participate in the political process. Citizenship in Italy only awarded to men who owned a house after coming of age. Women, servants and minorities (mostly Jews and Muslims at the time) were excluded (Belloc et al., 2016). In some places citizenship was also linked to either patronage (by religious authorities or nobles) or membership of associations (mainly guilds) (Alsayyad & Roy, 2016).

The increase in the number of politically autonomous cities in the late Middle Ages has been considered a factor in the economic and political rise of Europe at the time (Weber, 1956). Research by Acemoglu et al. (2005), De Long and Shleifer (1993), and Jacob (2010) also points to the positive effect that autonomous cities had on urban development. Acemoglu et al. (2005) argued that rapid economic development mainly occurred in places with non-absolutist initial institutions. The greater the level of local authority and the fewer the constraints on economic activity imposed by the state, the higher the incentives and opportunities for economic and urban expansion. As a key political institution, urban autonomy could effectively limit the

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[2] In this study, we have followed the definition and data provided by Bairoch et al. (1988), Christakos et al. (2005) and Stasavage (2014). The Western European countries considered include modern-day Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Portugal, Spain, Switzerland, and the UK.

power of the monarchy, secure property rights, and stimulate economic development (Frank, 1978; North, 1978; North & Thomas, 1973).

However, research so far has been limited to linking urban autonomy to economic outcomes. How city autonomy affected reactions to a severe public health crises, such as the Black Death, has attracted limited attention. Our knowledge of the topic is, so far, restricted to a number of anecdotes that point to a more rapid and active reaction of self-governing cities relative to other cities (Geltner, 2020). Autonomous cities seemed to have led the introduction of more effective health measures and institutions. At a local level, within an infected community, human contact was limited by quarantines and other temporary restrictions on freedom of movement (Alfani & Murphy, 2017). Venice, considered a classic example of a well-organized autonomous city, took a series of measures that illustrated they understood that the Black Death was not just bad air. Specifically, officials in the city inspected wine, fresh meat, and the water; ships were boarded and searched; new burial regulations were put in place, meaning that corpses were thrown into barges; measures were also introduced to restrict population clustering. Houses affected by the plague were painted with vinegar and fumigated with sulphur, while religious processions were banned unless a license was granted. The city also established a command-and-control centre where all decisions concerning the pandemic were centralised and communicated to the population (CitiesX, 2018). Non-autonomous cities, by contrast, did not have the luxury of adopting their own measures and had to wait for decisions to be made by distant kings in, say, Paris, London, or Toledo, or by the Pope in Rome (Hohenberg & Lees, 1995). It is not always the case that autonomous cities made rapid and/or suitable decisions against a pandemic everyone knew little about, but they at least had more initiative relative to cities with no or a far lower degree of autonomy. In view of this we can formulate two basic hypotheses:

H1: Within the European cities, autonomous cities fared better than non-autonomous cities in terms of reported mortality rates during the initial outbreak of the Black Death.

H2: Within the European cities, autonomous cities adopted measures that shortened the duration of the pandemic than those adopted by non-autonomous cities.

3. The model and data

3.1 The research design and model

As discussed, the primary objective of this paper is to investigate whether and to what extent the urban autonomy could affect the severity of the Black Death. Considering that our data structure is cross-sectional, to test the two hypotheses above, omitted variable bias and reverse causality could be the most important problems in the empirical stage of our research. To relieve these concerns, our empirical strategy takes both Ordinary Least Squares (OLS) analysis and instrument variable strategy. Basic OLS regression helps us observe changes in the coefficient of urban autonomy when different covariates are gradually added to the model. Thus, Ordinary Least Squares (OLS), with a set of controlled variables and spatial fixed effects, are introduced to explore the interactions between the Black Death and autonomous cities. After the OLS analysis, we will use a suitable instrument to deal with the endogeneity more thoroughly. The model adopts the following form:

$$Mortalityrate/Duration_{i,1347-1352} = \beta_1 Autonomous\ city_i + \beta_2 X_i + \beta_3 Z_i + \alpha_c + \varepsilon_i \quad (1)$$

where i represents a city, and the outcome variables are, $Mortalityrate_{i,1347-1352}$, which stands for the Black Death-related mortality rates in percentages (the proportion of deaths in the overall population) in the years between 1347 and 1352; $Duration_{i,1347-1352}$, which depicts how long the Black Death lasted, measured in months. The independent variable of interest, $Autonomous\ city_i$, is a dummy variable that measures whether a city had a high degree of self-governance during the years of the plague.

X_i represents a vector of economic, political, and socio-demographic characteristics of the city (including whether the city was a capital city, or if it had a bishop, archbishop, or a university). Specifically, urban population is chosen because we consider that the epidemic could spread faster in populous cities; capital cities usually control abundant political and economic resources and may be able to cope well when facing the plague; a parliament, a bishop and an archbishop were all important political and religious institutions in medieval Europe. By considering these factors, we compare the impacts of the plague with the impacts of urban autonomy. Universities, as the proxy variable of human capital at the regional level, are likely to provide more feasible strategies when dealing with diseases.

Z_i corresponds to a vector that includes the city's geographic factors, such as whether the city was on a river, the sea, along a Roman road, as well as indications of the soil quality and elevation above sea level. Transportation methods and routes such as rivers, seas, hubs and roman roads are included in the analysis because they tend to accelerate the spread of pandemics, which lead to increases in mortality and in their duration. Soil quality and elevation can help us, to some extent, analyse the impact of natural resources on the spread of the Black Death.

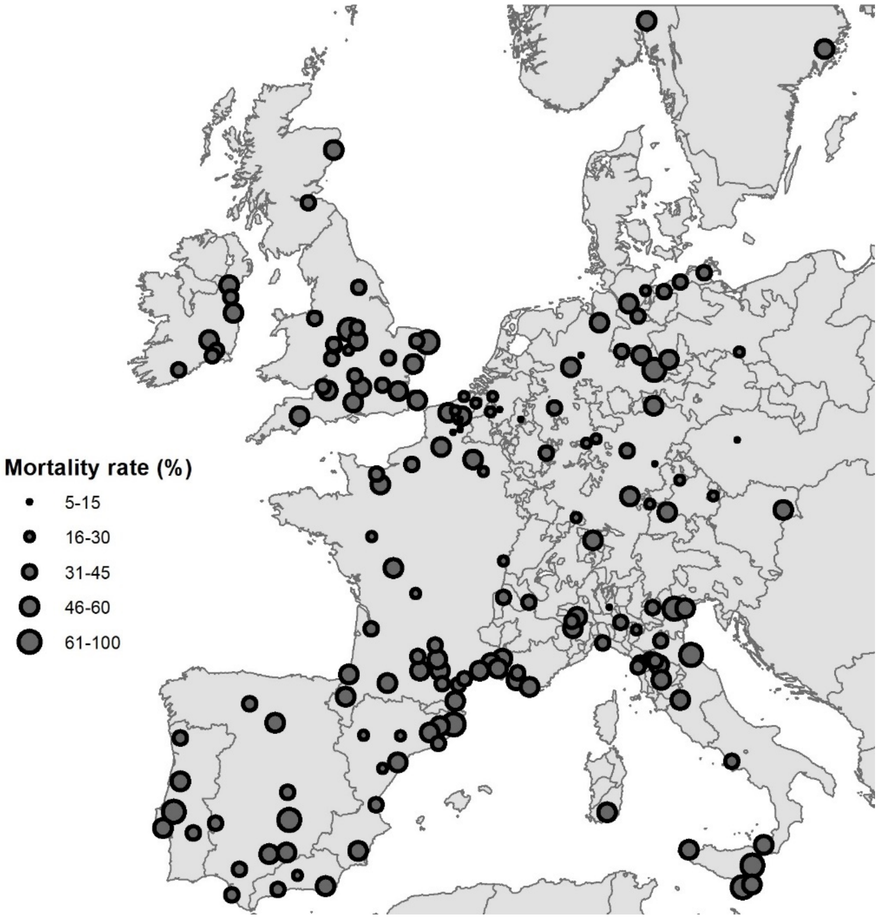
To control regionally correlated unobserved variables, we include country dummies to add the spatial fixed effects α_c into the regressions. Europe being a vast and diverse continent makes it difficult to compare cities across countries directly due to weather, cultural, and geographical differences. Introducing country fixed effects may help us capture other unobserved effects. Furthermore, to deal with the potential within-country correlation of the error term, we cluster the standard error at the country level for all specifications.

3.2 Data

In this section we outline the sources and attributes of the data. In our research, one of the challenges is to quantify reasonably both explanatory and outcome variables —namely the severity of the incidence of the Black Death and urban autonomy— in medieval times. Both mortality and duration data of the Black Death is provided by Christakos et al. (2005), who collected, processed, and verified the Black Death data for a large number of European cities systematically. Regarding our explanatory variable, urban autonomy, we follow Bosker et al. (2013) and Stasavage (2014), and use a dummy variable to distinguish whether a city is autonomous or not. In the following section, we will introduce the data sources of the dependent, independent, and control variables in more detail.

The Black Death. Data on the Black Death has been taken from Christakos et al. (2005). These authors compiled data on reported mortality rates based on information from a wide array of historical sources. They carefully examined each data point and judged between conflicting estimates based on the best available information. They also collected information on the duration of the Black Death in certain cities. According to their dataset, the average mortality rate in European cities was approximately 42.57 percent, with the average duration of a wave of the plague lasting 6.3 months. The distributions of mortality rates and duration within Western European cities are shown in Figures 1 and 2.

Figure 1: Mortality rate of the Black Death



Although no geographical pattern emerges in terms of mortality, Figure 1 identifies a number of hotspots where the wreck associated with the Black Death was higher than elsewhere. The highest incidence was found in Sicily, central Italy, southern France, Catalonia, and southern England.[3] The incidence was lower in southern Germany, Belgium, and most of central and northern France. In terms of the duration of the plague, the Black Death lasted longer in Belgium, northern France, central Germany, Andalusia, and in isolated cities such as Toledo, Barcelona, and Naples (Figure 2). There seems to be no correlation between reported mortality rates in cities and the duration of the plague there (Figure A2 in appendix). Naples, for example,

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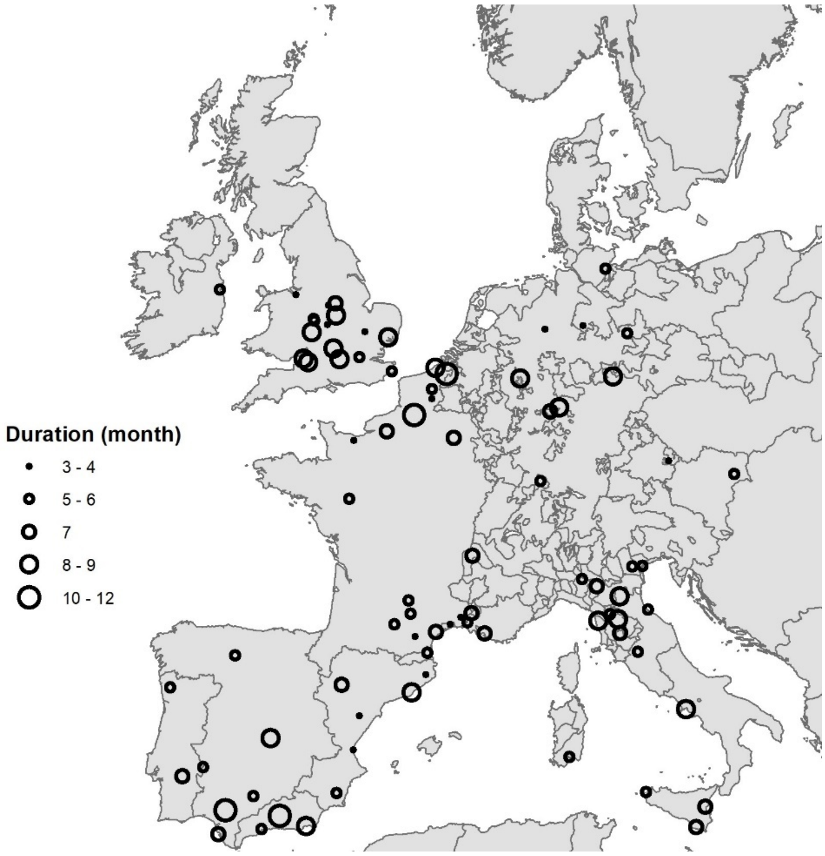
[3] To have a more intuitive understanding of the countries and boundaries we are discussing, we use the boundaries of modern countries.

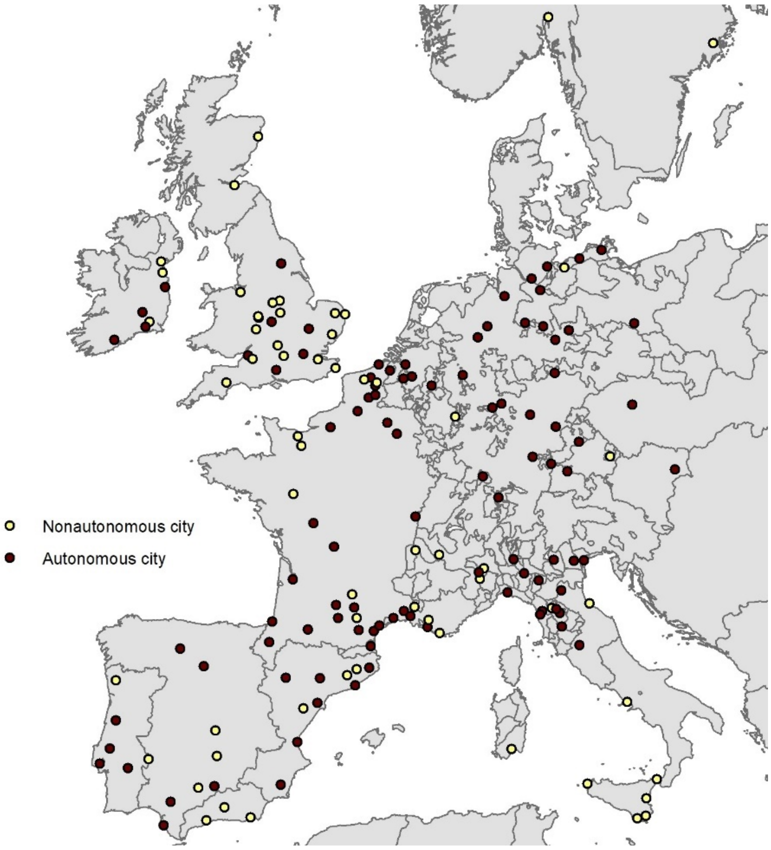
suffered the plague for a long time, but its mortality rate was low. In the Sicilian cities of Scicli and Syracuse, the pandemic was shorter, but its impact was far more devastating.

Figure 2: Duration of the Black Death



Autonomous cities. To measure the autonomy of cities, we use data provided by Bosker et al. (2013) (Figure 3). These authors classified cities according to their degree of local participative government. Cities were classed as autonomous if they had institutions for self-governance and the members of these institutions were chosen by the inhabitants of the city itself, not by outside rulers, i.e., if there was a local urban participative organization that made decisions about local urban affairs. Evidence of the presence of consuls, official documents like notarial acts signed by the representatives of cities, and the presence of imperial charters to grant self-governance to cities, were the criteria used to indicate whether a city was autonomous. To further verify the accuracy of our data and as a means to ensure robustness, we also adopt a stricter definition of urban autonomy provided by Stasavage (2014).

Figure 3: The location of autonomous and nonautonomous cities



City population. The main source of city population data is Bairoch (1988). This source reported population estimates for cities in 1300. The criterion for inclusion in the dataset is a city population greater than 1,000 inhabitants at the beginning of the 14th century. To expand the sample size, we also add the population of 14 cities that were mentioned by Christakos et al. (2005) (Figure A1 in appendix).

Social and political controls. We consider whether a city was a capital city. We also register whether it was a bishopric or an archbishopric, respectively, based on the information provided by McEvedy and Jones (1977). Capitals and cities high up in the ecclesiastical hierarchy were important seats of power and, therefore, more likely to attract people and economic activity based on the presence of a sovereign or bishop. We use information provided by Bosker et al. (2013) to establish whether a city had a university or not. In Europe, universities started to appear from the twelfth century onwards across the continent. As a breeding ground for knowledge and development, the effect of universities on urban development can be considered essential (Cantoni & Yuchtman, 2010). Furthermore, we also document whether a city belonged to a political entity where it could participate in the political process by having representatives in an active parliament (Van Zanden et al., 2012).

Geographic controls. The geographical characteristics included in the analysis concern a city's opportunities for long-distance trade and its degree of agricultural development. Using data from Nussli (2011), we capture a city's potential for water-based trade in medieval times by documenting whether it was located within ten kilometres of the sea or a river. In the case of land-based transportation, we resort to Bosker et al.'s (2013) work to document whether a city was on a former Roman road or a hub of a Roman road. An advantage of using Roman roads was their uniformity across Europe. To capture the agricultural potential of a city, data from Ramankutty et al. (2002) is utilised. These authors combine information on soil quality into one index, indicating the probability of viable agriculture in a given place in medieval times. Finally, we also collect each city's elevation from Jarvis et al. (2008). The elevation is reported in metres. It should be noted that these covariates were taken from data for the year 1300 because it is closest to the start of the pandemic.

Our primary sample consists of a total of 162 cities that had more than 1000 inhabitants in 1300 and for which records of Black Death mortality rates are available. These cities made up close to 60 percent of the urban population of Western Europe in this period. Out of the 162 cities, we have plague duration information for 83. The descriptive statistics of variables are summarized in Table 1.

Table 1: Descriptive Statistics

Variable	**Obs.**	**Mean**	**S.D.**	**Min**	**Max**
Mortality rate	162	42.56864	14.96201	5	100
Duration	83	6.349398	1.889856	3	12
Autonomous city	162	0.62963	0.484401	0	1
River	162	0.759259	0.428859	0	1
Sea	162	0.234568	0.425042	0	1
Hub roman road	162	0.351852	0.479029	0	1
Roman road	162	0.234568	0.425042	0	1
Soil quality	162	0.724261	0.227047	0.117	0.999
Elevation	162	123.8148	168.0637	0	934
Population (logged)	162	2.164298	1.32459	-0.69315	5.010635
Capital	162	0.12963	0.336937	0	1
Parliament	162	0.345679	0.477064	0	1
Bishop	162	0.462963	0.500173	0	1
Archbishop	162	0.135803	0.343641	0	1
University	162	0.092593	0.29076	0	1

4. Empirical analysis

4.1 Ordinary Least Square (OLS) estimates

Table 2 reports the baseline results of the mortality rates of the Black Death. We begin by considering the autonomy of a city as our variable of interest. To provide a benchmark, at first, the only control introduced is country fixed effect in medieval times, which eliminates the spatial correlations in column (1), before controlling for other covariates. The coefficient for the autonomy of a city is negative and significant (Table 2, column (1)). City autonomy is strongly related to lower Black Death mortality. Geographic, social, and political controls were gradually added in columns (2) to (7). The result of adding these controls does not undermine the significance of the coefficient for city autonomy. Once factors such as the size of the city, its accessibility, the agricultural potential of surrounding areas, and its position in the political and/or ecclesiastical hierarchy are controlled for, city autonomy remains a strong factor connected to lower mortality rates during the Black Death. As column (7) suggests, being an autonomous city could have reduced the mortality associated with the plague by 5.22 percent on average, compared to non-autonomous cities.

When it comes to geographic factors, elevation is significantly linked to lower Black Death mortality rates (column 2). Cities located at high altitudes are frequently less accessible and have less convenient transportation than cities located along trade roads or at crossroads. This is crucial for preventing the spread of a pandemic, as the cost of exchanging goods and trade is higher and this limits the influx of travellers who may bring the disease in their carts. A lower accessibility to other cities may have become an advantage during the Black Death and elevation may have provided natural protection against the spread of the disease. Soil quality is positively related to mortality in some of the regressions (Columns (5) - (7)), meaning that areas with fertile land and markets for agricultural produce were more exposed to the plague (Heinonen-Tanski & van Wijk-Sijbesma, 2005). Other geographic factors, such as being a port or trade centre, do not appear connected with Black Death mortality during the first outbreak. This is consistent with Christakos et al.'s (2005). However, it is worth noting that, according to some authors (e.g., Yue et al., 2017), ports and trade centres remained more vulnerable to the plague.

Table 2: City autonomy and mortality rate of the Black Death

	Black death mortality rate (percent, 1347-1352)						
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Autonomous city	-6.187**	-6.278***	-4.598***	-4.526***	-4.855***	-5.200***	-5.222***
	(2.334)	(1.254)	(0.799)	(0.732)	(0.832)	(0.662)	(0.652)
River		-2.318	-1.289	-1.292	-1.178	-1.252	-1.277
		(3.236)	(3.391)	(3.409)	(3.181)	(3.043)	(3.088)
Sea		-0.600	0.844	1.019	1.357	1.378	1.380
		(3.048)	(2.647)	(2.907)	(2.592)	(2.574)	(2.603)
Hub roman road		-3.512	-2.001	-2.035	-1.794	-2.561	-2.563
		(2.019)	(2.078)	(2.030)	(2.061)	(2.929)	(2.943)
Roman road		-0.414	-0.282	-0.289	0.0860	0.0122	0.0563
		(2.137)	(2.155)	(2.139)	(1.920)	(2.205)	(2.147)
Soil quality		8.312	8.952	8.924	10.25**	10.92*	10.95*
		(6.079)	(5.795)	(5.765)	(4.419)	(5.456)	(5.448)
Elevation		-2.157**	-2.456***	-2.405**	-2.293**	-2.257**	-2.254**
		(0.751)	(0.786)	(0.944)	(0.777)	(0.868)	(0.874)
Population			-2.463***	-2.401***	-2.292***	-2.416***	-2.427***
			(0.394)	(0.503)	(0.441)	(0.362)	(0.393)
Capital				-0.763	-0.613	-0.928	-0.897
				(3.393)	(3.689)	(4.124)	(4.176)
Parliament					3.308	3.191	3.222
					(4.850)	(4.336)	(4.191)
Bishop						1.609	1.586
						(2.015)	(1.968)
Archbishop						2.959	2.982
						(4.865)	(4.921)
University							0.386
							(2.688)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	162	162	162	162	162	162	162
R-squared	0.276	0.336	0.366	0.367	0.371	0.374	0.374

Robust standard errors adjusted for clustering at the country level are given in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Columns (3) - (7) of Table 2 consider social and political factors. Column (3) shows that the population size is both significantly and negatively related to mortality rates. This implies that larger cities were, in contrast to expectations, less affected by high reported mortality rates statistically. This is in line with Roosen (2017: 45-47), who using the Hainaut mortmain accounts, rejected the previous widespread belief of an urban/rural divide in the incidence rates of the plague. Our results support Roosen's (2018) view that rural areas did not fare better during the Black Death. Carozzi et al. (2020) also report similar results during the COVID-19 pandemic, when checking the interactions between urban density and the severity of COVID-19. Larger cities were often the seats of power and may have had better resources to combat the consequences of the plague. Nevertheless, we find no association whatsoever between a raft of political and religious factors and the incidences of the Black Death (Table 2, columns (4) to (7)). While some institutionalists have argued that an active parliament is another key element behind Europe's rise (De Long & Shleifer, 1993; North & Weingast, 1989), we find no evidence that hosting a parliament provided any protection against the spread of the Black Death, once city autonomy has controlled for. Similar results emerge in the case of universities (Table 2, column (7)). The fact that universities at the time were mostly concerned with teaching theology and philosophy, rather than science and medicine, may help to explain this result.

Table 3: City autonomy and Black Death duration

	Duration of Black Death (month, 1347-1352)						
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Autonomous city	-0.0509	0.00730	-0.257	-0.314	-0.343	-0.384	-0.392
	(0.427)	(0.635)	(0.690)	(0.676)	(0.681)	(0.660)	(0.669)
River		0.104	0.0221	-0.0309	0.00423	-0.0151	-0.0307
		(0.836)	(0.803)	(0.771)	(0.765)	(0.770)	(0.757)
Sea		0.136	-0.0513	-0.208	-0.160	-0.112	-0.114
		(0.827)	(0.807)	(0.769)	(0.775)	(0.692)	(0.690)
Hub roman road		0.813	0.615	0.647	0.644	0.387	0.391
		(0.768)	(0.751)	(0.756)	(0.773)	(0.918)	(0.925)
Roman road		-0.000975	0.0141	0.0104	0.0341	0.146	0.174
		(0.362)	(0.356)	(0.358)	(0.361)	(0.180)	(0.147)
Soil quality		0.677	-0.128	0.00167	0.259	0.502	0.559
		(1.049)	(1.356)	(1.257)	(1.148)	(1.442)	(1.414)
Elevation		0.0746	0.0962	0.0415	0.0562	0.0912	0.0906
		(0.112)	(0.0929)	(0.101)	(0.0836)	(0.0615)	(0.0633)
Population			0.433*	0.374	0.395	0.313	0.297
			(0.199)	(0.210)	(0.225)	(0.172)	(0.177)
Capital				0.559	0.539	0.303	0.333
				(0.339)	(0.325)	(0.371)	(0.399)
Parliament					0.388	0.331	0.353
					(0.423)	(0.293)	(0.301)
Bishop						0.324	0.306
						(0.596)	(0.606)
Archbishop						1.439*	1.443*
						(0.747)	(0.764)
University							0.168
							(0.354)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83	83	83	83	83	83	83
R-squared	0.107	0.152	0.193	0.199	0.204	0.249	0.250

Robust standard errors adjusted for clustering at the country level are given in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In Table 3, we estimate the factors that may be connected to the duration of the Black Death pandemic in different cities. In this case the information available is limited to 83 out of the 162 cities included in the original analysis. Here, virtually none of our variables are linked to how long the city was affected by the Black Death, implying that the duration of the pandemic in each city was relatively random. With the exception of the presence of an archbishopric, none of the variables are significant. The negative sign for city autonomy points to a potential reduction in the duration of the Black Death, but the coefficients of the OLS results are not significant at any level. Interestingly, in Christakos et al.'s (2005) research, there is a positive correlation between city size and the duration of an epidemic, which contradicts our findings. In Table 3A (in appendix), we find that a positive relationship between urban population size and the duration only exists when the regression is estimated without country FE or other controls (shown in column (1) of Table A1). Thus, the positive relationship between population and duration is likely to be biased and influenced by other characteristics of cities.

4.2 Two-Stage least squares (2SLS) estimates

Our variable of interest, whether a city was autonomous or not, is likely to be associated with a myriad of factors. Although we have already controlled for many possible confounding ones, the problem of omitted variables may remain. To tackle this challenge, we adopt a strategy introduced by Persson and Tabellini (2009) and Acemoglu et al. (2014) in their analysis of democratic transitions of countries. We instrument city autonomy with the proportion of other cities with an urban autonomy status in the same region, leaving out the observation of the city concerned. The regional polygon data represents a second-level administrative division of Europe in the 14th century, which is the most precise regional level data available[4]. Transitions into or out of autonomous cities occur in regional waves that reflect learning and spillover effects in neighbouring localities and create a power vacuum at the regional level of government. This variable meets the exclusion restriction that is conditional for other covariates and country fixed effects, as we assume that regional waves of the autonomous transitioning of political institutions could have influenced the impact of the Black Death. As a result, the potential influence of omitted variable bias on the regression coefficients is largely minimized.

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[4] Both the regional definition and data are provided by Nussli (2011) (http://www.euratlas.com/about.html).

Specifically, we posit that a city's autonomous status, c, was influenced by the degree of autonomy of neighbouring cities. Therefore, we consider R_c as the geographic region where a city is located. The regional influence that city c experienced to become autonomous is defined by:

$$I_c = \{c' : c' \neq c, R_{c'} = R_c\} \tag{2}$$

$$Z_c = \frac{1}{|I_c|} \sum_{c'} \in I_c \tag{3}$$

The 2SLS estimates are shown in Table 4. The instrument, city autonomy in the region, is always significant, both in the first stage and in the reduced form regression (F-statistics for the excluded instrument range from 13.6–22.4). Specifically, column (1) in Table 4 shows that city autonomy itself has a significant impact on Black Death mortality rates when country fixed effects are introduced. Adding additional controls slightly decreases the magnitude of the coefficient, but the causal relationship between the autonomy of a city and lower Black Death mortality rates remains strong and highly statistically significant (columns (2) to (7)). The instrumented coefficient for city autonomy is larger than the OLS estimate, indicating that the Black Death mortality rate was 9.29 percent lower in cities with a substantial degree of self-rule. This suggests that the OLS result underestimates the effect of the city autonomy on the incidence of the pandemic. Overall, our 2SLS results are consistent with the OLS results and demonstrate that autonomous cities performed much better than their more centrally governed counterparts in their tackling of the pandemic.

Table 4: City autonomy and mortality rate of the Black Death, 2SLS results

	Black death mortality rate (percent, 1347-1352)						
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Autonomous city	-11.6243***	-8.7177***	-8.7944***	-8.5551***	-9.1506***	-9.2885***	-9.2885***
	(3.9847)	(2.5383)	(2.9166)	(3.0114)	(2.8389)	(3.0135)	(3.0135)
River		-0.6611	-0.6510	-0.6106	-0.6906	-0.7322	-0.7322
		(3.0064)	(2.8405)	(2.8393)	(2.6348)	(2.6109)	(2.6109)
Sea		-1.6484	-1.6362	-1.4121	-2.3933	-2.3943	-2.3943
		(1.9530)	(1.8157)	(1.7387)	(2.7338)	(2.7331)	(2.7331)
Hub roman road		0.6220	0.5831	1.0443	1.0072	1.0036	1.0036
		(2.3518)	(2.6566)	(2.3103)	(2.2972)	(2.3191)	(2.3191)
Roman road		0.8159	0.8337	1.1092	0.9173	1.0331	1.0331
		(2.2049)	(1.8990)	(2.1177)	(2.4616)	(2.4622)	(2.4622)
Soil quality		10.5854*	10.6156*	11.9200**	12.7423**	12.8609**	12.8609**
		(5.9784)	(5.7034)	(5.0321)	(6.0030)	(6.0658)	(6.0658)
Elevation		-2.4543***	-2.4647***	-2.3248***	-2.3101***	-2.3040***	-2.3040***
		(0.6937)	(0.8373)	(0.6818)	(0.7375)	(0.7438)	(0.7438)
Population		-2.0836***	-2.0906***	-2.0090***	-2.1514***	-2.1693***	-2.1693***
		(0.6879)	(0.6859)	(0.5735)	(0.4250)	(0.4112)	(0.4112)
Capital			0.1556	0.1975	-0.0848	0.0019	0.0019
			(3.3322)	(3.2087)	(3.4935)	(3.4933)	(3.4933)
Parliament				3.8850	3.6355	3.7141	3.7141
				(3.5677)	(3.0940)	(2.9035)	(2.9035)
Bishop					2.5127	2.4841	2.4841
					(2.0286)	(1.9889)	(1.9889)
Archbishop					3.4961	3.5582	3.5582
					(4.6012)	(4.6684)	(4.6684)
University						0.8283	0.8283
						(1.8221)	(1.8221)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	162	162	162	162	162	162	162
R-squared	0.2519	0.3549	0.3545	0.3622	0.3644	0.3639	0.3639
First stage F	22.4	15.5	13.5	13	19	21.2	21.2

Robust standard errors adjusted for clustering at the country level are given in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

4.3 Placebo tests and robustness checks

4.3.1 Placebo tests

So far, we have established that city autonomy in medieval times was an institution that helped protect cities from the devastation of the Black Death. However, it is worth noting that dealing with any type of data referring to medieval times involves a certain degree of uncertainty. Although the data we use are the best available from a comparative perspective, the mortality rate and duration of the Black Death may have been underestimated.[5] For example, Roosen

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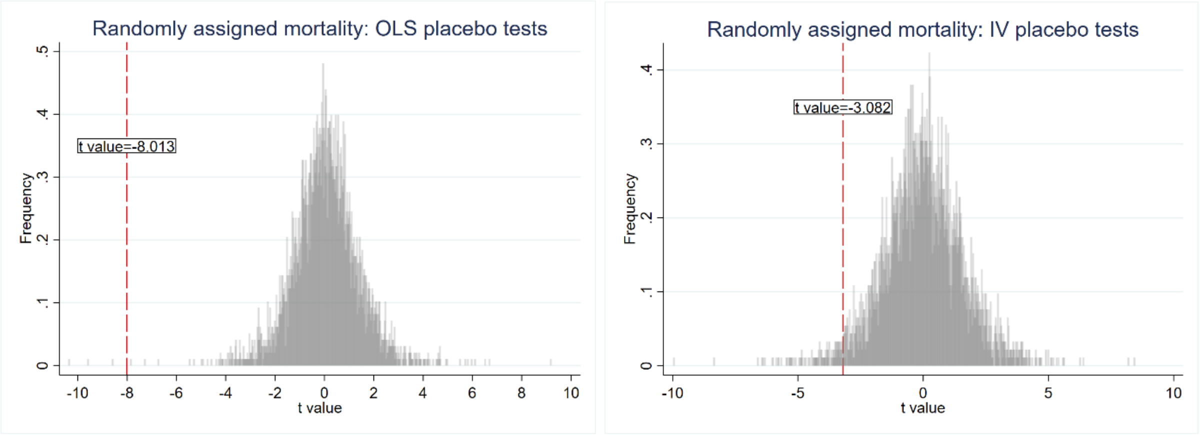
[5] We are grateful for reviewers' kind reminders on the possible flaws in the data quality of the Black Death.

(2017) considers that the data by Christakos et al. (2005) for the case of Belgium may have incurred in some errors during the process of extrapolation. This may challenge Christakos et al.'s (2005) argument that cities in Belgium had the lowest mortality rates in the early stages of the Black Death. As both of our mortality and duration data for the Black Death is extracted from Christakos et al (2005), our estimates may also be affected by potential inaccuracies in the data. To address concerns that our baseline results are not related to potential estimation errors of historical data, we resort to Monte Carlo simulations to conduct a series of placebo tests.

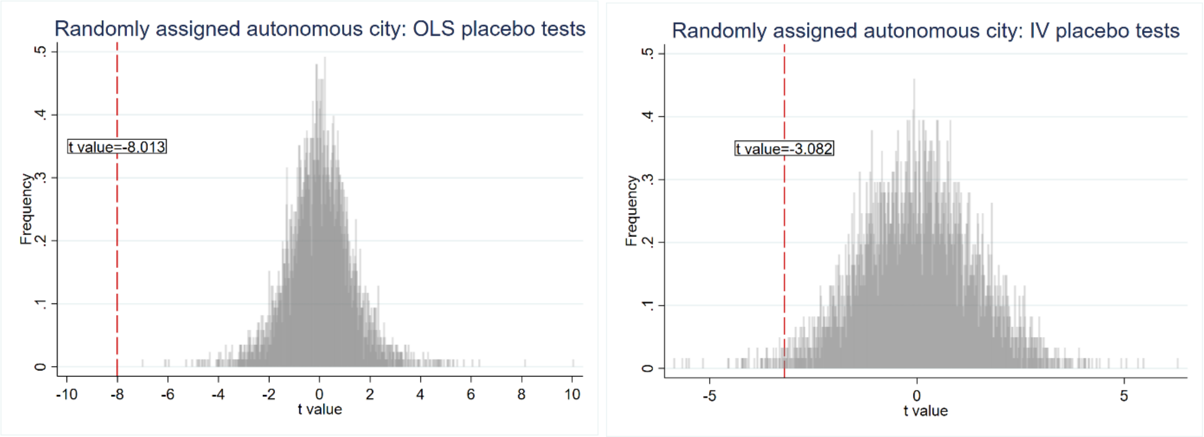
In the first set of Monte Carlo simulation trials, we compare the estimated effects with the distribution of placebo treatment effects when the mortality rates of cities were randomly assigned. Specifically, we randomly scramble the mortality rates of the 162 cities included in the sample. We then estimate placebo treatment effects according to both OLS and 2SLS models in the baseline analysis. Figures 4(a) and 4(b) plot the distribution of t-statistics from the placebo treatment effects, after running the regressions 5,000 times. The vertical lines mark the location of the t-statistics of the actual treatment effect. Among the 5,000 trials, we find that cases in which the corresponding t value exceeds the baseline OLS and 2SLS results are relatively few. The share of the placebo t-statistics that is larger than the actual statistic (P (t<=T)) can be interpreted as analogous to a p-value. It represents the probability that a randomly assigned mortality rate will present an effect at the same or higher level of significance than the actual mortality rate. Our results show that both P(t<=T) for OLS and 2SLS are smaller than 0.001. These results are also supported by Figures 4(a) and 4(b). Consequently, we can safely reject the null that our result is indifferent to the placebo treatment effects at all significance levels.

Figure 4: The distribution of t-statistics from randomly assigned mortality placebo tests


(a) (b)

Another potential concern is that the same systematic data bias may also exist in our treatment variable: city autonomy. To address this concern, we verify our baseline results by randomly allocating the autonomous cities following the same approach. The simulations show that our baseline results are stable as well (Figure 5) and that P(t<=T) for both OLS and 2SLS are smaller than 0.001. This implies that our causal results are extremely unlikely to be caused by systematic data errors.

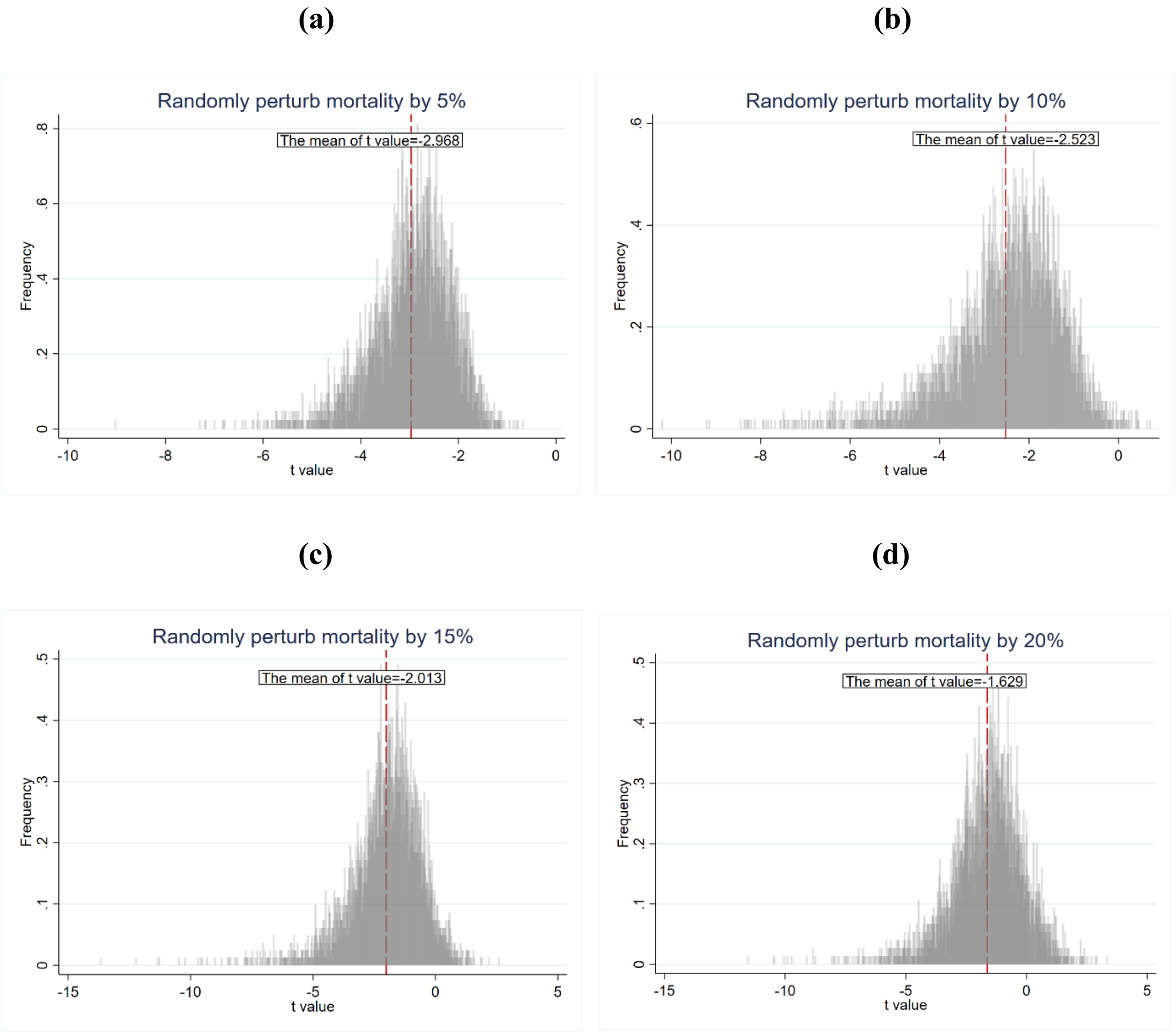
Figure 5: The distribution of t-statistics from randomly assigned autonomous city placebo tests


(a) (b)

However, it should be noted that even if no systematic errors in the data are detected, this does not imply that the results of the baseline estimations are completely robust. It is common in historical data that some records of observations may deviate from reality. To address this concern, we conduct a second set of placebo tests. The logic behind this set of tests is to randomly select a proportion of observations (i.e., 20 or 30 percent) in the sample and alter the mortality data by a certain percentage (i.e., 1 - 20 percent). In practice, we first randomly select one-third of observations and modify their value by a certain percentage. For instance, if we hypothesize that one-third of the observations have a 5 percent measurement error, the alteration (or perturbation) level is set at 5 percent. In this case, if a region's reported mortality rate is 10 percent, once being selected, its mortality rate would increase to 15 percent. Second and to get the distribution of the random events, we perform Monte Carlo simulations, running the regressions 5,000 times. Executing this trial helps us examine the distribution of t-statistics by randomly altering the mortality rate by different percentages then. We can test how robust our results are in the case where there is a certain degree of errors in the mortality data. If manipulating the mortality rate by a small range (i.e., 1-3 percent) makes our results insignificant, it means that the estimations are fragile and possibly affected by inaccuracies in the mortality data. In Figures 6(a)-(d) we report the results of randomly altering one third of reported mortality rates by 5 - 20 percent, respectively.

Figures 6(a) - (c) confirm that our baseline estimates are firmly robust when altering one third of the mortality data randomly by between 5 and 15 percent. The mean results of a random perturbation on morality by 5 and 10 percent are both greater than 2.5 (Figures 6(a) - (b)). As Figure 6(c) shows, the mean of the distribution of t-value is greater than 2 even after changing the mortality rate by 15 percent. According to the simulations, our results will only become invalid when the mortality data is manipulated by 20 percent. Figure 6(d) shows, the average of the distribution of the t-value is 1.63 when altering city mortality by 20 percent. However, it is unlikely that the mortality data for one-third of the cities included in the sample have errors greater than 20 percent, given the mean and standard deviation of mortality in the Black Death. Therefore, this second set of placebo tests further confirms that our results are reliable.

Figure 6: Distribution of t-statistics by randomly assigned mortality by certain percentage-points in one third of cities


(a) (b) (c) (d)

Similar experiments on the relationship between local institutions and the duration of the Black Death are conducted in Figure A3 (in appendix), and we have also found that our baseline results are credible.

4.3.2 Robustness checks

Concerns that our baseline results could be driven by bias and errors may not be fully solved by the above placebo tests. To further verify our results, we implement several robustness checks to resolve the concerns from the perspective of data measurement, sample selection, and model design.

Firstly, there are two slightly different criteria being used currently to measure autonomous cities. Our current measurement of city autonomy so far employed was collected by Bosker et al. (2013). In this study, cities were considered as autonomous if there was an indication of the presence of a local urban participative organization that made decisions about local urban affairs. Stasavage (2014) provides an alternative indicator, using a more restrictive definition of autonomy than Bosker et al. (2013). Therefore, the concern is that our significant results could be false when we use a more stringent definition of urban autonomy.

Table 5: Robustness check of the measure of city autonomy

	Black death mortality rate (percent, 1347-1352)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	OLS	2SLS	2SLS	2SLS
Autonomous city	-5.0368**	-4.4568***	-4.0081***	-13.8824**	-14.9301***	-10.1545***
	(1.8674)	(1.1838)	(0.5651)	(6.5676)	(4.6051)	(2.2042)
River		-2.7820	-1.3861		-0.8676	-0.4797
		(3.5536)	(3.3497)		(2.4577)	(2.7031)
Sea		-0.7974	1.4926		-1.2613	0.9239
		(3.0169)	(2.4686)		(2.9523)	(2.3525)
Hub roman road		-3.8534*	-2.5212		-2.4176	-2.1250
		(1.9946)	(2.9784)		(2.3392)	(3.0228)
Roman road		-0.8405	-0.1232		2.4302**	1.5250
		(2.2279)	(2.0609)		(1.2269)	(1.9406)
Soil quality		6.6294	9.7097		9.2953	11.5606*
		(6.6541)	(5.8718)		(6.2422)	(6.0379)
Elevation		-2.0814**	-2.1896**		-2.0711***	-2.1908***
		(0.7457)	(0.8573)		(0.6795)	(0.7413)
Population			-2.6179***			-2.4033***
			(0.4469)			(0.3509)
Capital			-1.4888			-0.6256
			(4.0361)			(3.7141)
Parliament			3.2076			4.1530
			(4.2674)			(3.0223)
Bishop			1.2892			2.6042
			(2.0680)			(1.9680)
Archbishop			2.6840			3.3629
			(5.1796)			(4.8453)
University			-0.2098			-0.2512
			(2.9098)			(1.4790)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	162	162	162	162	162	162
R-squared	0.2666	0.3228	0.3687	0.1991	0.2377	0.3420
First stage F				49.8	21.2	12.8

Robust standard errors adjusted for clustering at the country level are given in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To relieve this concern, Table 5 replicates both OLS and 2SLS estimates of Tables 3 and 4 by replacing the variable of interest, autonomous city, with Stasavage’s (2014) indicator. The estimated coefficient of city autonomy remains negative and significant across all different OLS and 2SLS specifications. The magnitude of the 2SLS coefficient of the autonomous city is larger when using Stasavage's (2014) measure. The coefficients for the control variables, by and large, do not change.

Table 6: Robustness check of ruling out small cities

	Black death mortality rate (percent, 1347-1352)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	OLS	2SLS	2SLS	2SLS
Autonomous city	-6.2666**	-6.6982***	-6.3029***	-16.6175***	-8.5776***	-6.0257**
	(2.3523)	(1.1259)	(0.9851)	(4.4059)	(2.8146)	(2.5797)
River		-1.9550	-1.6520		-1.6823	-1.6831
		(3.2170)	(2.7570)		(2.7615)	(2.4933)
Sea		0.2185	1.7892		0.2212	1.8130
		(3.3485)	(2.8923)		(3.0228)	(2.5112)
Hub roman road		-2.0202	-2.1487		-1.7699	-2.1601
		(2.2691)	(3.2965)		(1.9251)	(2.7654)
Roman road		1.8357	2.0992		2.3957*	2.0340
		(1.6431)	(1.8190)		(1.3589)	(1.7586)
Soil quality		9.7289*	14.0955**		10.6314**	13.9735***
		(4.7881)	(4.7473)		(5.1689)	(5.0634)
Elevation		-2.3483**	-2.3186**		-2.3446***	-2.3157***
		(0.8621)	(1.0307)		(0.7624)	(0.8871)
Population			-2.7916***			-2.8095***
			(0.4833)			(0.3871)
Capital			-0.7178			-0.7800
			(4.4259)			(3.6542)
Parliament			2.4999			2.4787
			(3.1898)			(2.7262)
Bishop			2.2978			2.2346
			(2.2088)			(2.1071)
Archbishop			4.2004			4.1609
			(4.8487)			(4.6225)
University			1.1840			1.1618
			(2.7566)			(2.5823)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	148	148	148	148	148	148
R-squared	0.2661	0.3359	0.3663	0.0304	0.3335	0.3663
First stage F				76.3	55.6	38.5

Robust standard errors adjusted for clustering at the country level are given in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The second issue is that the population dataset from Bairoch (1988) only includes cities with more than 1,000 inhabitants. For 14 cities, which were smaller than 1,000 inhabitants, we relied on the population information provided by Christakos et al. (2005). There might be a concern that our results are driven by the inclusion of these small cities. By ruling out cities that were not included in Bairoch's (1988) urban population records, Table 6 shows that excluding these cities which were less than 1000 people indeed reduces the magnitude of our coefficients. The coefficient of 2SLS estimation decrease from 9.29 to 6.03. However, the negative relationship between the city autonomy and Black Death mortality rates still holds and the results are not biased towards small cities.

Furthermore, it is also possible that our findings are affected by a lack of weather data from the medieval era. For example, by drawing on the case of Azerbaijan, Morris et al. (2013) find the climate and plagues are likely to be historically related. To reduce this concern, we replace the contemporary country fixed effect with the historical sovereign state fixed effect. Compared to modern European countries, there are more sovereign states in the Middle Ages. Thus, replacing the current country fixed effect with the historical spatial fixed effects could help us better control for weather-related effects . Table 7 shows that, although the magnitude of our variable of interest has decreased to some extent, the results are still valid when using historical boundaries as the fixed effect.

In addition to the impact of weather, the specific season of the initial plague outbreak may also affect our estimates. We have further collected the data related to the starting dates of plague released by Christakos et al. (2005). In Table A1, we find that the reported mortality rates in cities where the plague hit dropped significantly in the summer, when compared with rates in the spring. More importantly, adding the season dummies confirms our 2SLS results and further enlarges the magnitude of the coefficient of autonomous cites by more than 7 percent compared to 2SLS results in the baseline.

Table 7: Robustness check by using the boundary in the 14th century

	Black death mortality rate (percent, 1347-1352)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	OLS	22SLS	2SLS	2SLS
Autonomous city	-4.4949**	-5.2393**	-3.1416*	-4.7561***	-5.8014***	-3.0388*
	(1.5309)	(1.7070)	(1.6739)	(1.5933)	(1.7132)	(1.6875)
River		0.4937	1.2626		0.5810	1.2535
		(2.7741)	(3.0736)		(2.2722)	(2.5345)
Sea		1.8597	2.3713		1.9928	2.3545
		(2.6710)	(2.6173)		(2.0731)	(1.8751)
Hub roman road		-1.1269	0.1372		-1.0629	0.1375
		(3.9400)	(4.8908)		(3.1202)	(3.7703)
Roman road		-0.3340	0.3096		-0.2460	0.2988
		(3.0486)	(2.9872)		(2.2730)	(2.2049)
Soil quality		13.7428	13.1637		13.8268**	13.1451*
		(7.7321)	(9.1442)		(6.3222)	(7.2614)
Elevation		-1.0075	-1.5040		-1.0184	-1.5022
		(1.2182)	(1.3416)		(0.9940)	(1.0673)
Population			-3.8821***			-3.8880***
			(1.0604)			(0.7493)
Capital			-1.0864			-1.1052
			(4.3550)			(3.4661)
Parliament			2.1280			2.1410
			(3.1664)			(2.7543)
Bishop			1.4125			1.3892
			(2.2477)			(1.7791)
Archbishop			5.1373			5.1222
			(5.9267)			(4.5941)
University			-3.9977			-4.0077
			(4.8697)			(3.6105)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	162	162	162	162	162	162
R-squared	0.4233	0.4510	0.5162	0.4233	0.4508	0.5162
First stage F				16	16.3	15.6

Robust standard errors adjusted for clustering at the country level are given in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

By proposing that both cities and their citizens are vulnerable to the short-term consequences of pandemics, a number of economists have considered the variations in mortality rates from infectious diseases to be largely random (Almond, 2006; Donaldson & Keniston, 2016). Hence, it has often been the case that reported differences in the Black Death incidence have been attributed mainly to chance and not to institutional or any other factors that may have influenced the preparation and reaction of cities in medieval Europe, when confronted with a plague of this dimension. However, were geographic and institutional factors really irrelevant in determining the differential incidences of the Black Death across cities in Europe?

In this paper we have provided empirical evidence of the links between local institutions at the time of the Black Death and the variation of the incidences of the pandemic across Western Europe. We have shown that city autonomy was at the centre of differences in pandemic-related mortality across cities. Comparing to their counterparts, autonomous cities performed better in the face of one of the most devastating pandemics the Western world has ever faced. Specifically, cities with a high degree of autonomy reduced —depending on estimations— Black Death mortality rates by between 5.22 and 9.29 percent. A large set of placebo tests and robustness checks confirms the robustness of this result.

City autonomy in medieval times was, moreover, a far stronger tool in mitigating the effects of the plague than nearly all other geographical and political characteristics of cities at the time considered. Being a capital city, hosting a parliament, or having a bishop or an archbishop at the beginning of the 14th century did not reduce the incidence of the plague. In other words, among various political factors at the time, only city autonomy and the powers it granted local citizens have provided some protection against the deadliest of pandemics. In our analysis, we also find that larger cities performed better when confronting the pandemics in the case of Black Death. Finally, the elevation of the city was the only physical geographic factor linked to a lower Black Death mortality rate.

While city autonomy influenced reported mortality rates, it did not affect the lengths of the pandemic in different cities. None of the other controls were connected to a reduction in the duration of the Black Death wave in a given city. Hence, it seems that the factors behind the duration of the pandemic in different cities are relatively random in contrast to the mortality rate results.

There are, of course, several limitations to the research presented here. Firstly, in this paper, we refer to the autonomous city as if autonomy is a binary indicator. However, in practice, it is important to realize that the situations were far more complex. As Stasavage (2014) argues, autonomy was certainly a question of degree. Cities like Venice had complete autonomy over almost all government affairs. In contrast, cities like Ghent enjoyed a substantial degree of autonomy over certain types of affairs, but were still subject to princely intervention. However, due to the limited number of historical records, the full extent of the influence of a city's autonomy on the pandemic cannot yet be analysed. The second problem is understanding the mechanisms through which an autonomous institution helped limit the incidence rates of the Black Death. Further research is needed in this respect. Thirdly, due to data limitations, we only focus our research on the interaction between local institutions and the initial outbreak of the plague. It should be noted that the plague did not end in 1352 and that numerous European cities had recurrent outbreaks in the following decades and centuries. Studying the influence of city autonomy across recurrent outbreaks and the overall impact of the Black Death over time would be very interesting, but requires a substantial improvement in data availability.

This paper suggests, in line with Rodríguez-Pose and Burlina (2021), that good local government institutions play an essential role in a pandemic, even in medieval times when the objective conditions to fight disease were far weaker than today. When confronted with the challenge of what is possibly the worst pandemic ever recorded, autonomous city governments were more effective in adopting better prevention measures. Thus, improving the quality of local institutions can be a good way of fighting pandemics. It helped self-governing cities in medieval Europe and it could also deliver better results today.

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Appendix A

Figure A1: The urban population in 1300

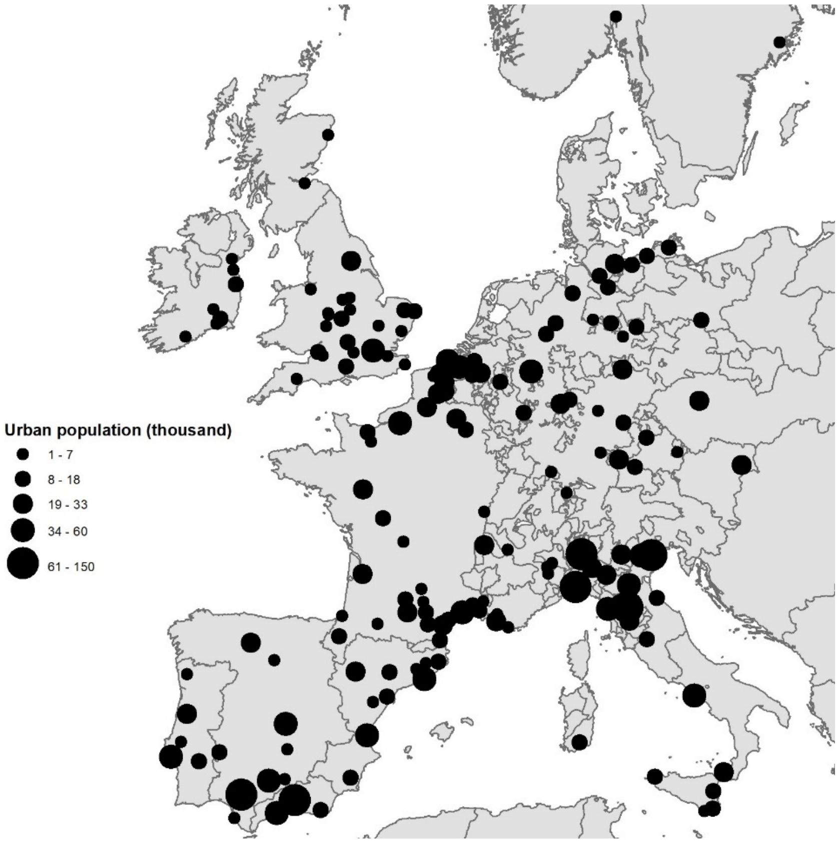


Figure A2: Mortality rate and duration of the Black Death

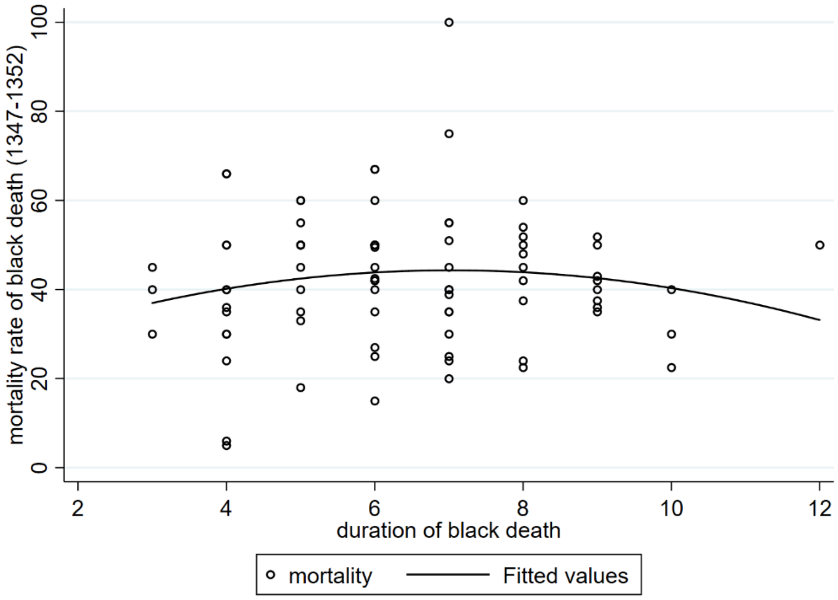
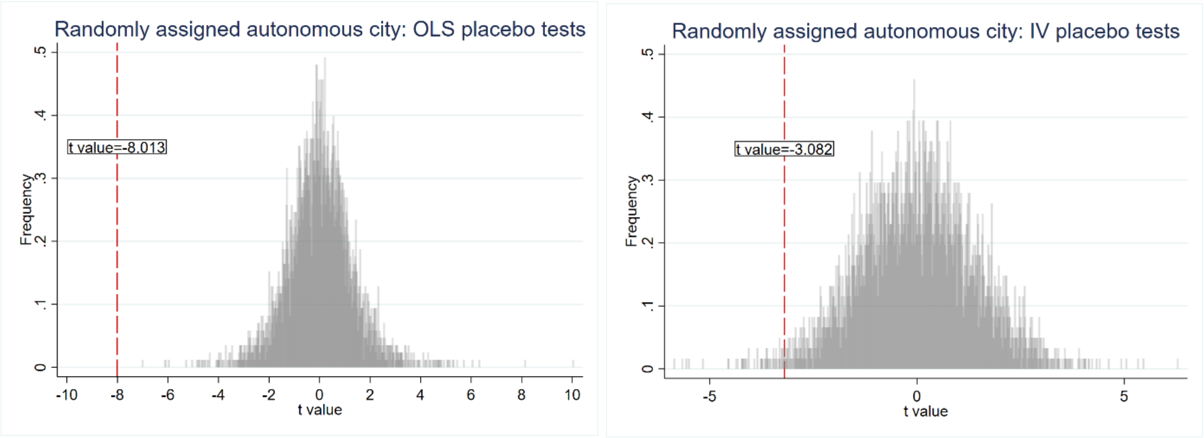


Figure A3 Distribution of t-statistics by randomly assigned duration by certain months in one third of cities



(a)

(b)

Figure A4 Distribution of t-statistics by randomly assigned duration by certain months in one third of cities

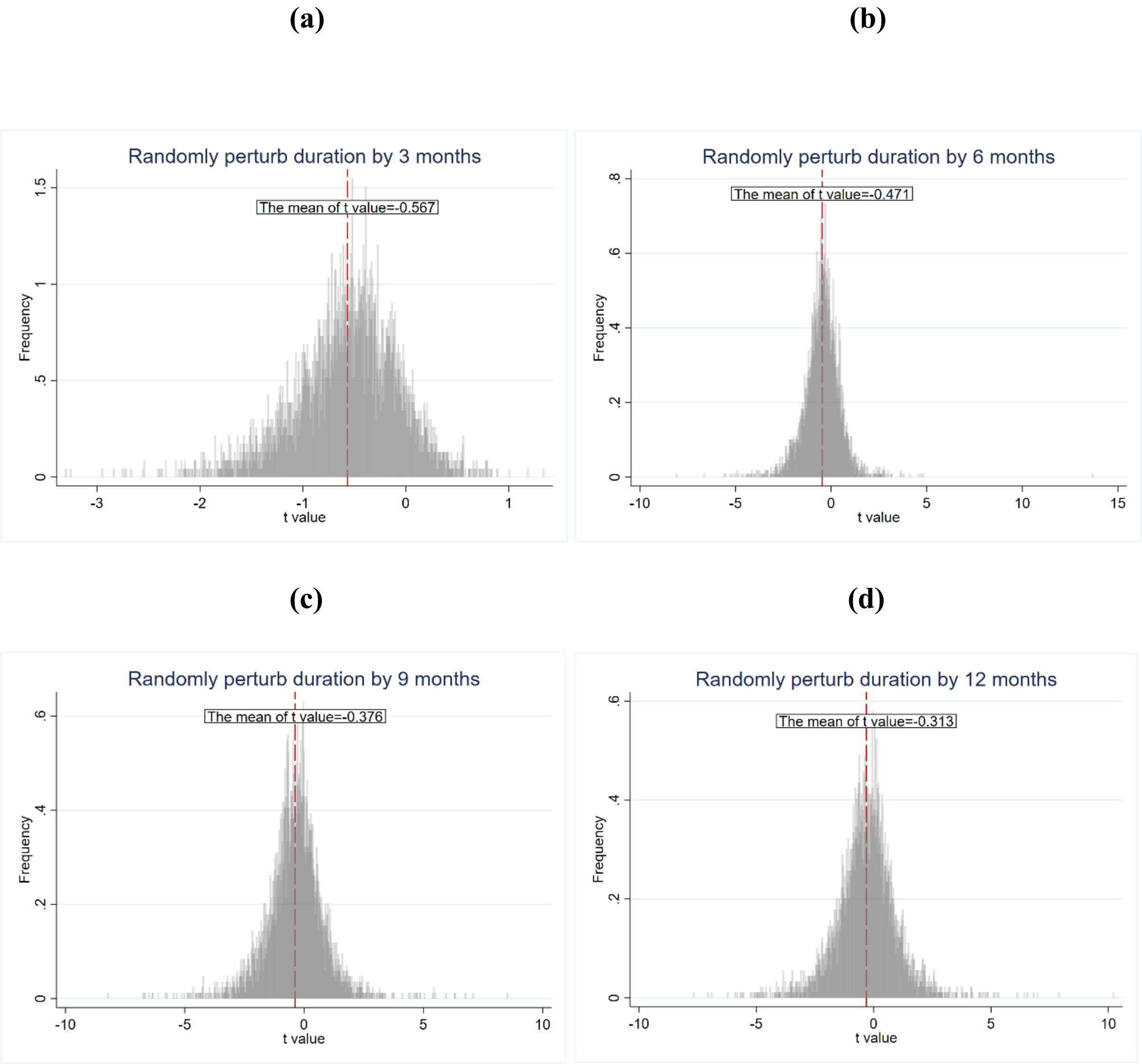


Table A1: Robustness check by adding season of the initial outbreak

	Black death mortality rate (percent, 1347-1352)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	OLS	2SLS	2SLS	2SLS
Autonomous city	-5.3303	-5.0968*	-4.5161	-12.2863***	-13.5922*	-16.7747**
	(3.3068)	(2.5335)	(2.8691)	(4.1114)	(7.1185)	(7.8730)
Summer	-7.5837**	-6.1900**	-6.2956**	-8.0935***	-6.8651***	-7.1305***
	(3.1355)	(2.3664)	(2.5870)	(3.0189)	(2.2549)	(2.2924)
Autumn	-1.0766	-0.2566	-1.7139	-2.3161	-1.4018	-2.6956
	(3.9265)	(2.8164)	(2.5837)	(3.9219)	(3.1447)	(1.9727)
Winter	-3.3282	-4.1989	-4.6306	-3.7396	-4.7596	-5.7260
	(4.5067)	(4.6288)	(5.2878)	(3.9486)	(3.9220)	(4.2611)
River		-1.1406	-0.6715		1.1184	1.6921
		(3.7896)	(3.8836)		(4.5414)	(3.5225)
Sea		-1.9536	-1.5753		-1.4385	-2.9276
		(4.3063)	(4.6870)		(4.2226)	(3.5993)
Hub roman road		-2.3389	-1.8430		-1.5634	-1.7804
		(2.8702)	(3.3297)		(2.7349)	(3.4216)
Roman road		0.4484	1.1231		2.7157	3.0008
		(3.2099)	(3.0513)		(3.4343)	(3.1639)
Soil quality		7.6065	9.9916		10.8757	13.7428
		(8.9627)	(9.8860)		(9.9293)	(9.6359)
Elevation		-2.5756**	-2.9488**		-2.3935**	-2.8457***
		(0.9485)	(1.1018)		(0.9697)	(1.0488)
Population			-1.9504			-0.6566
			(1.3929)			(1.4666)
Capital			1.8877			5.3458
			(6.6008)			(3.9841)
Parliament			1.2865			1.9927
			(4.2621)			(2.2631)
Bishop			2.0795			3.1252
			(1.6145)			(2.3200)
Archbishop			3.9595			3.8957
			(4.8428)			(3.7960)
University			-2.3045			-2.8454**
			(3.7351)			(1.2865)
country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	122	122	122	122	122	122
R-squared	0.2743	0.3444	0.3684	0.2268	0.2820	0.2552
First stage F				24.5	38.8	14.7

Robust standard errors adjusted for clustering at the country level are given in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A2: Robustness check by adding season of the initial outbreak

	Duration of Black Death (month, 1347-1352)					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	OLS	OLS	2SLS	2SLS	2SLS
Autonomous city	-0.1688	-0.1567	-0.5133	-0.5855	-0.8549	-4.9226
	(0.4140)	(0.6582)	(0.7395)	(0.8614)	(1.2105)	(7.0475)
Summer	0.1242	-0.0233	-0.2837	0.0991	-0.0759	-0.5450
	(0.5776)	(0.6414)	(0.5842)	(0.4428)	(0.4951)	(0.5671)
Autumn	-0.2144	-0.1140	0.0119	-0.2497	-0.1555	-0.0703
	(0.2193)	(0.1784)	(0.3280)	(0.2455)	(0.1651)	(0.7642)
Winter	0.6553*	0.7356*	0.5649	0.6672**	0.7253**	0.4458
	(0.3202)	(0.3397)	(0.7959)	(0.3202)	(0.3664)	(0.9086)
River		0.1598	0.1420		0.2112	0.2570
		(0.8594)	(0.8114)		(0.7026)	(0.5425)
Sea		0.2301	-0.1022		0.1380	-1.5944
		(0.7077)	(0.7532)		(0.5319)	(1.4641)
Hub roman road		0.9577	0.6561		0.9971	0.3855
		(0.8854)	(1.0943)		(0.7269)	(1.0730)
Roman road		0.1851	0.2597		0.3867	0.9216
		(0.3302)	(0.2301)		(0.5199)	(0.9557)
Soil quality		0.3021	0.3647		0.6848	2.2471
		(1.1392)	(0.9776)		(1.3887)	(3.0007)
Elevation		0.1539	0.1583		0.1508*	0.0197
		(0.0970)	(0.1778)		(0.0820)	(0.3748)
Population			0.2594			0.8014
			(0.2584)			(1.1283)
Capital			0.4017			2.0896
			(0.5926)			(2.8899)
Parliament			0.3806			0.2912
			(0.2655)			(0.5096)
Bishop			0.0841			0.3866
			(0.5320)			(0.9626)
Archbishop			1.1912			1.0163***
			(0.8892)			(0.3541)
University			-0.1716			-0.4659
			(0.2567)			(1.3095)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76	76	76	76	76	76
R-squared	0.1262	0.1802	0.2592	0.1167	0.1566	-0.5150
First stage F				2.85	2.94	0.34

Robust standard errors adjusted for clustering at the country level are given in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3A: The relationship between city size and duration

	Duration of Black Death (month, 1347-1352)	
	(1)	(2)
VARIABLES	duration	duration
Population	0.340**	0.297
	(0.170)	(0.177)
Autonomous city		-0.392
		(0.669)
River		-0.0307
		(0.757)
Sea		-0.114
		(0.690)
Hub roman road		0.391
		(0.925)
Roman road		0.174
		(0.147)
Soil quality		0.559
		(1.414)
Elevation		0.0906
		(0.0633)
Capital		0.333
		(0.399)
Parliament		0.353
		(0.301)
Bishop		0.306
		(0.606)
Archbishop		1.443*
		(0.764)
University		0.168
		(0.354)
Country FE	No	Yes
Observations	83	83
R-squared	0.047	0.250

Robust standard errors adjusted for clustering at the country level are given in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix B

Variable descriptions and sources

Variable	Description	Source
Outcome variables		
Mortality rate	mortality rate of the Black Death from 1347 to 1352	Christakos et al. (2005)
Duration	duration of the Black Death from 1347 to 1352	Christakos et al. (2005)
Explanatory variables		
Autonomous city	whether city had institution for self-governance	Bosker et al. (2013); Stasavage (2014)
River	whether city is within 10km from a river	Nussli (2011)
Sea	whether city is within 10km from a coast	Nussli (2011)
Hub roman road	whether city locates on the hub of Roman road	Bosker et al. (2013)
Roman road	whether city locates on a former Roman road	Bosker et al. (2013)
Soil quality	The probability that certain location could be cultivated	Ramankutty et al. (2002)
Elevation	elevation	Jarvis et al (2008)
Population (logged)	urban population in 1300	Bairoch (1988); Christakos et al. (2005)
Capital	whether city was a capital in 1300	McEvedy & Jones (1978).
Parliament	whether city had representatives in an active parliament in 1300	(Van Zanden et al., 2012)
Bishop	whether city had the presence of the bishop in 1300	Bosker et al. (2013)
Archbishop	whether city had the presence of the archbishop in 1300	Bosker et al. (2013)
University	whether city had the presence of the university in 1300	Bosker et al. (2013)