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## WORKING PAPER SERIES

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**Working Paper n. 508**

**This Version: January, 2014**

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<http://www.igier.unibocconi.it>

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# **Plague and long-term development: the lasting effects of the 1629-30 epidemic on the Italian cities**

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January 2014

## **Abstract**

The paper aims to analyze the effects of plague on the long-term development of Italian cities, with particular attention to the 1629-30 epidemic. By using a new dataset on plague mortality rates in 49 cities covering the period 1575-1700 ca., an economic geography model verifying the existence of multiple equilibria is estimated. It is found that cities affected only by the 1629-30 plague recovered in the short run, whereas cities affected by both the 1575-77 and 1629-30 epidemic show persistent decline in the long run. This new finding contrasts with previous literature and is hence interpreted in the light of the new concept of “urban frailty”.

*Keywords:* Plague, Italian cities, Urban development, Urban demography, Multiple equilibria, Early modern period, Mortality crises.

## **Acknowledgements**

We thank Paolo Malanima and Luca Mocarelli, as well as seminar participants at Bocconi University, for many helpful comments.

## **1. Introduction**

How did pre-industrial economies react to extreme mortality crises like those caused by severe epidemics of plague? Were health shocks of this kind able to shape long-term development patterns? While past research focused on a very limited number of exceptionally severe shocks, like the Black Death (for example, Voigtländer and Voth, 2012), this paper analyzes the consequences of what was by far the worst mortality crisis affecting Italy during the Early Modern period: the 1629-30 plague. For this later shock much more data is available than for the Black Death, allowing us to study its impact on the development pattern of a large sample of Italian cities.

The consequences for the Italian economies of the 1629-30 plague are a long debated issue. Most of the literature has argued in favor of a positive impact of the contraction in population as this would have implied a reduction in labour supply and hence an increase in wage with a consequent increase in living standards and long-term growth (Malanima 2002; Malanima and Capasso, 2007). Recently, however, a re-evaluation of its demographic characteristics has led scholars to formulate the hypothesis that this plague was the source of the relative decline of seventeenth-century Italy (Alfani 2013a). In this paper we take a different approach, arguing that the interaction between two waves of plague, i.e. the one in 1575-77 and the one in 1629-30, caused a productivity shock, worsening the trajectory of development of Italian cities. In this way, we add to previous studies empirical evidence on the hypothesis of the lasting negative effect of the plague.

In particular, after assembling a new database of mortality rates in a sample of cities, we estimate a model of population growth allowing for different regimes of growth. We found that cities affected only by the 1629-1630 plague recovered from the shock in the short run, whereas cities affected also by the 1575 wave showed a persistent, long-term effect (i.e. up to 1800) on the pattern of population growth. This heterogeneity in the effects of the plague is interpreted as further evidence of the hypothesis that plague waves may potentially be considered as determinants of the decline of economic regions or whole countries.

## **2. Plague waves in Early Modern Italy: an overview**

During the first two centuries of the Early Modern period, Europe was still badly affected by plague. In the sixteenth century, frequent plague waves of varying intensity repeatedly struck all corners of the continent, focusing however on cities and highly urbanized areas. In the seventeenth century, endemic plague progressively disappeared from Western Europe. For example in England, the last epidemic to strike London dates to 1665-66 (ending with the famous Great Fire), although isolated cases are recorded in the city until at least 1679 (Slack 1985, 68-9). In the Low Countries, the last plague affecting Amsterdam occurred in 1663-64 (Duncan and Scott 2001, 331; Van Bath 1965). In France, the last plague wave began a few years later, in 1668, spreading to the northern parts of the country (Biraben 1975). In central Europe plague lingered longer, until at least 1679, the date of the so-called 'Great Plague' of Vienna.<sup>1</sup>

It has recently been suggested that during the seventeenth century southern Europe, and especially Italy, was affected by plague much more severely than the northern part of the continent. This would be on account of higher mortality rates in the cities, and more importantly, to a greater capacity of plague to affect rural areas as well as cities. In its turn, the damage done to the rural areas would also curb the potential for recovery of the cities, by destroying the demographic surplus traditionally produced in the countryside which, in normal conditions, was continuously transferred to the cities (Alfani 2013a). This characteristic of seventeenth century Italian plagues would differentiate them both from those affecting Europe in the same century, and from those affecting Italy in the sixteenth century (Alfani 2010a).

On the whole, sixteenth century Italy was affected relatively lightly by plague (Alfani 2013b). Even the worst epidemic, in 1575-77, was mostly restricted to cities and spread to a much more limited part of the Peninsula than the great seventeenth century plague waves. This is also the first plague that can be studied systematically, due to the presence of particularly abundant documentation as well as of a considerable amount of specific research. During the seventeenth century, one interesting characteristic of Italian plagues is

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<sup>1</sup> A recent overview of seventeenth-century European plagues, including a discussion of the factors which could have led to the disappearance of endemic plague from the continent, is provided by Alfani (2013b).

that they never overlapped – in fact, we cannot mention any single community in the whole of the Peninsula affected more than once by a plague epidemic throughout the century<sup>2</sup>. Moreover, in that period the number of plague waves affecting Italy is limited to two main ones, in 1629-30 and 1656-57, and a regional plague affecting only Sicily in 1624 (Alfani 2010a; 2013a; Del Panta 1980). Figure 1 details the territorial coverage of the four plague waves mentioned. During the seventeenth century the cities included in the figure were affected by the plague exactly once, and could in addition have been affected by the 1575-77 wave. This is of crucial relevance for our study since we argue that the interaction between the two waves was a factor undermining the growth process of the Italian cities.

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<sup>2</sup> The situation was very different in northern Europe, where, for example, London was affected by four serious plague epidemics during the seventeenth century and Amsterdam by six (Alfani 2013b).

Figure 1: Territorial coverage of the main Italian plagues of the Early Modern period



A brief description of each of the three plague waves relevant to this article is necessary.

*1575-77*: although this was the most severe plague affecting Italy during the sixteenth century, its territorial coverage was limited compared to the later plague waves. It entered the peninsula from central Europe and the first Italian city to be affected was Trento, where the disease was present from September 1574. During the spring of 1575 the plague started to spread to much of Veneto, affecting all of the main cities of the Venetian Republic such as Venice, Padua, Verona and Vicenza. Later it infected a large part of Lombardy and Emilia but failed to cover the whole of the North and to spread to central and southern Italy, even though the epidemic lasted until 1577 and lingered still longer in certain areas (the last city affected, Genoa, was struck in 1579). In the same period, Sicily in southern Italy was also infected, but this was probably an independent plague epidemic which seemingly had reached the island onboard a pirate ship returning from northern Africa (Alfani 2013b, 89-93; Del Panta 1980). The 1575-77 plague wave showed a markedly urban character as most rural communities were spared, including those placed in the territories of infected cities (Alfani 2010a; 2013b, 92-3).

*1629-30*: this was the most serious seventeenth-century plague wave in the whole of Europe, originating probably in northern France in 1623 and later spreading to England, the Low Countries, Germany, France, and Switzerland (Duncan and Scott 2001; Eckert 1996; Alfani 2013a). By 1628-29, northern Italy was besieged as all the territories just beyond the Alps were infected. The wartime conditions meant that any preventive measures put in place by the wary Italian states were ineffective: in October 1629, French and Spanish troops crossed the Alps to the West and North respectively, to participate in the War of the Mantuan Succession (1627-31). Winter temporarily arrested the spread of the disease, but when spring 1630 came, the plague advanced quickly, covering all of the North save for Liguria and parts of Friuli and Piedmont (Alfani 2013a; Del Panta 1980). All major cities in the area were affected, as well as most rural communities. According to a recent estimate, excluding Liguria a northern Italian city had just a 5% probability of being spared, while a rural community had a slightly higher chance, 7% (Alfani 2013a). What is more, mortality

rates during this epidemic were particularly high, so that it can be estimated that overall 30-35 per cent of the northern Italian population died , amounting to about two million victims (Alfani 2013a). In 1630-31 the epidemic affected also Tuscany in central Italy, although much less severely . From Lombardy, then under Spanish rule, plague spread by sea to Catalonia.

The 1629-30 plague wave is certainly the most deadly of the early modern period and changed the structure and development pattern of many Italian cities. Barbot and Percoco (2013) first made an attempt to study the effect of the plague on the composition of neighborhoods and on spatial segregation in Milan through the analysis of housing rental contracts and found that the relevance of social interactions in the city began in the aftermath of the health shock.

*1656-57*: if in 1630 Spain had been infected by sea from Italy, about 25 years later the contrary happened. Plague had been afflicting Andalusia, the Balearic archipelago and the rest of the Spanish Mediterranean since 1647<sup>3</sup> (Perez Moreda 1988). In 1652 it reached Sardinia, ravaging the island for some years. Only in 1656 did it manage to cross to mainland Italy, infecting Naples and later spreading to the rest of the South, with the exception of Sicily and parts of Calabria and Apulia. To the North, the disease reached Rome a couple of months after infecting Naples and also spread to most of central Italy, sparing however the Granduchy of Tuscany, which had been struck by the previous wave (Fusco 2007; Del Panta 1980). It also spread by sea to Liguria, affecting precisely the areas that had been spared by the 1629-30 epidemic (Alfani 2013a). The available estimates of overall mortality in the Kingdom of Naples are in the 30-43 per cent range (Fusco 2009), corresponding to 0.87-1.25 million victims (Alfani 2013a).

### **3. Database**

This article makes use of a new database of plague mortality rates for the whole of Italy in the period 1575-1700, thus covering all the major plague waves mentioned in the earlier section. The final and complete version of the database is used here for the first time and



includes information about 49 Italian cities, including all the main ones. This is by far the largest and most complete collection of plague mortality rates existing for Early Modern Italy.

The information comes from a combination of sources, including state sources, chronicles, and micro-demographic reconstructions. For reasons of space, it is impossible to list here all the original material and the publications of reference. Moreover multiple estimates are available for many cities. All existing estimates have been collected and compared; for the purpose of this article, only the most reliable have been retained. Precedence has been given to estimates resulting (in this order, when applicable): 1. from micro-demographic reconstructions; 2. from information about both the pre-plague population and the number of plague victims; 3. from detailed local studies produced by historical demographers or social-economic historians; 4. from documentation produced by health boards or by other city- or state-level authorities; 5. from chronicles. Additional information present in the database includes the geographic position of each city, the State to which it belonged, its institutional status, and the size of its population at different points in time.

Figure 1 details the geographic position of all cities included in the database, and also provides information about which ones were affected by each plague wave. Table 1 charts descriptive statistics about local mortality rates during the three main plague waves.

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<sup>3</sup> Ending in 1654, this was the worst plague to strike Iberia during the seventeenth century.

Table 1. Urban mortality rates during the Early Modern plagues

Plague wave	N. of cities	Median mortality (per thousand)	Mean mortality (per thousand)	Standard deviation (per thousand)	Max mortality (per thousand)	\Min mortality (per thousand)
1575-77 (without South*)	11	220	242	110	444 (Brescia)	79 (Vicenza)
1629-30	32	380	359	177	722*** (Mantua)	15 (Pistoia)
1629-30 (without Tuscany**)	26	400	388	165	722*** (Mantua)	80 (Ivrea)
1656-57	16	476	414	197	783 (Bari)	51 (Melfi)

Notes: \* The only southern Italian city included in the database which was affected by plague in the period is Palermo (40 per thousand mortality rate). It has not been included in the table as probably the Sicilian epidemic was totally independent from the one affecting the North.

\*\* For reasons not entirely clear yet, Tuscany was affected in an exceptionally light way by this plague wave. See Alfani 2013b for a discussion.

\*\*\* The very high mortality rate experienced by Mantua incorporates the victims of the siege suffered by the city during the plague. Excluding Mantua, the maximum mortality would be that experienced by Verona (615 per thousand).

The data presented in table 1 clearly shows a marked difference in mean and median urban mortality rates between the 1575-77 and both the 1629-30 and 1656-57 plague waves. This difference has already been described in recent publications, which also pointed out that an even more significant difference is to be found in overall mortality across large areas, given the inability of the 1575-77 epidemic to spread pervasively to the rural areas (Alfani 2010a). The urban mortality rates of the 1629-30 and 1656-57 plagues are exceptional also when compared to contemporary plagues in other parts of Europe. For example, in the Low Countries, even the 1664 plague epidemic, the worst affecting Amsterdam during the seventeenth century, killed no more than 120-160 per thousand of the urban population (Van Bath 1965). Higher plague mortality rates were experienced by other Dutch cities, like Leiden in 1635 (265 per thousand), but nowhere in northern Europe were mortality rates in the 400-500 per thousand range to be found: even in the worst cases, mortality was well below the median values characterizing the Italian plague waves. Of course, there was

much variability across the peninsula: the fairly high standard deviations of mortality found for all three plague waves are consistent with what we know from the general literature on plague, reflecting a number of factors such as the varying ability of health institutions to manage the epidemic, the different period of the year when the disease reached each city, and so on (Alfani 2013; Alfani and Cohn 2007; Del Panta 2007; Fusco 2007).

#### **4. The economic consequences of the last Italian plagues: open questions**

Plague has recently started to recover a popularity which it had long lost among economic historians. The Black Death, pandemic of the fourteenth century, has been singled out as a possible factor favoring Europe over the main Asian economies particularly India and China . According to Pamuk (2007), the Black Death was a powerful exogenous shock capable of leading to a long-lasting increase in wages throughout Europe and triggering institutional innovation, and consequently would lie at the root of the Great Divergence. The positive impact of the Black Death on European institutions and economic structures had earlier been underlined by scholars like Herlihy (1997) and Epstein (2000); the latter described the Black Death as an agent of "creative destruction" capable of moving the European economies to a higher growth path. Recently, Voigtländer and Voth (2013) showed, by means of a two-sector Malthusian model, how the demographic shock caused by the Black Death could have triggered a transition to a new steady state characterized by higher per-capita income. Crucial to this was not only the massive size of the population loss caused by the Black Death, but also the way in which it favoured, indirectly and in association with other factors like the frequent wars, the establishment in Europe of a demographic regime characterized by particularly high mortality. The latter point had also been made by Clark, who underlined the positive impact on European living standards of the new mortality regime shaped by the Black Death and the subsequent plague waves (Clark 2007, pp. 99-102). Related to this, Malanima (2012) focused on the way in which the pandemic altered the functional distribution of income, favouring labour.

If the Black Death has attracted a significant amount of recent research, the same is not true for the subsequent plague waves. Economic historians have generally tended to consider late Medieval and Early Modern plagues as a kind of prolongation of the Black Death, with

the capacity to ensuring the long-lasting impact of the initial shock but seemingly not deserving of any individual attention. Another general and quite widespread implication is that late Medieval and Early Modern plagues were, like the Black Death, ultimately beneficial to the economies, as they allowed for an increase in per-capita resources and higher wages. Finally, late Medieval and Early Modern plague has long been considered a kind of "great equalizer", striking now one area of Europe now another, but in the medium to long run affecting similarly all corners of the continent; this implication also seems to come from a bold generalization based on the research conducted on the Black Death.

A recent comparative study of plague across seventeenth century Europe has argued that in that period, the disease affected the continent very unevenly. Italy in particular was struck very badly, with the loss of 30-35 per cent of the total population in the North and 30-43 per cent in the South (Kingdom of Naples), while in northwestern Europe plague intensity can be estimated to be in the 8-10 per cent range in England, in the 11-14 per cent range in France, and in the 15-25 per cent range in the Dutch Republic (Alfani 2013a, 4). The damage done by the Italian plagues was also very concentrated in time (one wave per area, see earlier sections) while elsewhere in Europe it amounted to the combined effect of many plague waves striking repeatedly the same area throughout the century. It has been argued that seventeenth-century plague had a displacement effect on the Italian economies, moving them not to a higher long-term growth path, as is generally believed was the case for the Black Death, but to a lower one (Alfani 2013a, 16-20). This view contrasts with earlier literature on the economic impact of plague in Italy. Malanima, in particular, argued that even the seventeenth-century epidemics were beneficial in the medium-long term, as they improved the standards of living of the survivors (Malanima 2002, p. 345; Malanima and Capasso 2007).

In this paper we contend the hypothesis that the plague was beneficial for the Italian economies, and specifically for the urban economies, on the basis of a very intuitive argument. Let us assume that we can evaluate the living standards in an economy on the basis of observed remuneration, that is it is possible to describe the economy solely on the basis of its labour market, as in figure 2.

Figure 2: The effect of the plague on labor supply

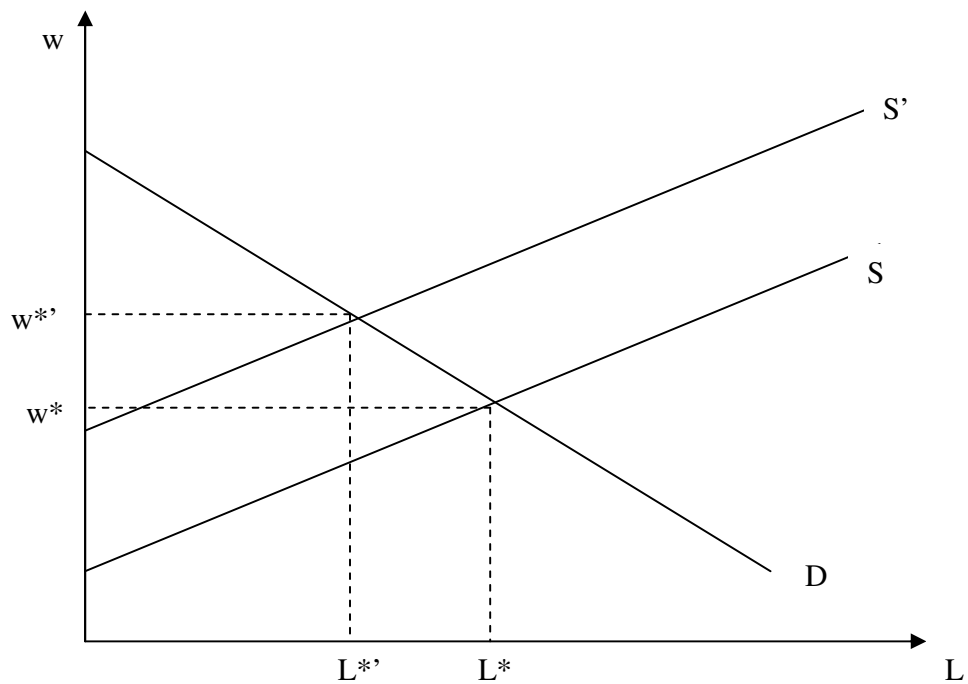
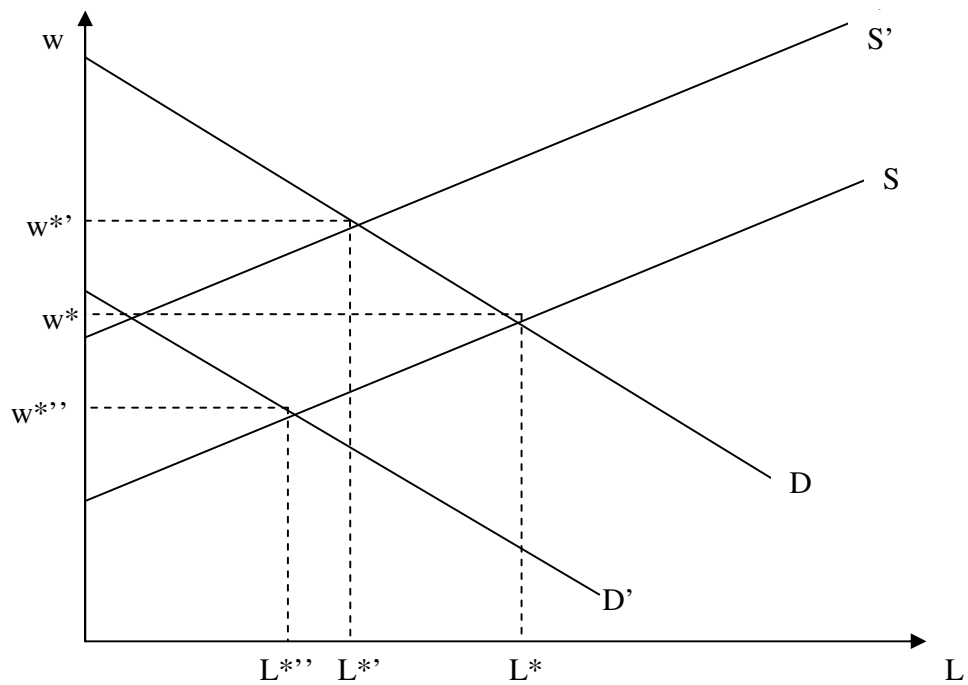


Figure 3: The combined effect of the plague on labor supply and productivity



The basic argument proposed by Malanima and Capasso (2007) is that the plague is a shock in the labour supply which, as a result of mortality, contracts from  $S$  to  $S'$ , increasing the wage of survivors (from  $w^*$  to  $w^{**}$ ). This line of reasoning, however, relies on the assumption that there is no change in productivity. To see the relevance of this assumption, let us consider figure 3 in which a shock in labour productivity shifts labour demand from  $D$  to  $D'$ . In this case, there is no reason to assume *ex ante* that the plague has had a positive impact on wages, since its net impact will depend on the size of the labour supply shock relative to the productivity shock.

But why should the plague have had an impact on labour productivity? The reasons for this hypothesis are manifold and rely on the extensive and lasting demographic and economic effects of extreme health shocks. Possibly the most important factor is the damage done by the plague to the stock of human capital existing in northern Italy. As recently argued by Alfani (2013a), mortality rates in the order of 300-500 per thousand indicated that the disease was no longer a "plague of the poor" as had been the case for earlier epidemics since at least the fifteenth century, but had become a universal killer (see Alfani 2013b, Alfani and Cohn 2007 and Cohn 2010 for an overview of the way in which the characteristics of the disease changed from the Middle Ages to the Early Modern period). This determined a shortage of skilled work available for the sophisticated manufactories which were the backbone of the northern Italian urban economies of the early seventeenth century. Already at the time of the 1575-77 plague, urban governments had some trouble in recovering the lost human capital, namely by means of measures favouring the immigration of skilled workers - even against the will of the local guilds, like in Venice (Preto 1978, 117-18; Alfani 2013b, 107-9). This could be done, however, since other important Italian manufacturing cities were spared and the existing human capital could be re-distributed over a larger area. What is more, the fact that rural areas were generally not affected by this plague wave ensured that unskilled labour was abundant and ready to move in to fill the gaps opened in the cities. This resulted in a widening gap differential in the wages paid to skilled and unskilled labour (Pullan 1964, 416-17). However, the great plague of 1629-30 had very different consequences, due to the fact that 1. it affected *all* the major manufacturing cities of central-northern Italy; 2. it affected rural areas as badly as the cities.

Therefore , the skilled workers they needed were not lured to one given city, as all the cities offered the same incentive, and even the traditional, steady immigration of unskilled labour from rural areas was interrupted, for a time at least.

In his classic study of the consequences of plague on the Venetian labour market, Pullan holds that the 1629-30 epidemic "had created labour shortages crippling to industry" (Pullan 1964, 422). Studies related to other cities suggest that the same was happening elsewhere, for example in Cremona (Mocarelli 2008; Andreozzi 2010), while the available data on urban productions (especially textiles) show that the plague was able to displace the production trend to a decidedly lower path (Alfani 2013a, 18-19). Some studies suggest that larger cities, and in particular capital cities, might have been a little quicker to recover but this was to the detriment of the smaller cities, from which they lured away not only the surviving skilled workers but also members of the merchant elite. Seemingly, this was the case of Milan whose recovery hindered that of places like Como, Cremona and Bergamo (Moioli 1999, 49; D'Amico 2001, 700).

Mass destruction of human capital can determine, per se, a serious productivity shock. However, in the historical context of early seventeenth century Italy, it came to be associated with other factors detrimental to productivity. The 1629-30 plague affected the economies of the peninsula at the worst possible moment, that is when their manufactories were dealing with increasing competition from northern European competitors. As already mentioned, this event was very unlike the Black Death as it affected specific areas of the continent much more severely than others (many of which were entirely spared); this is why it could have had a general displacement effect (Alfani 2013a). From the specific point of view of the cities, the plague favoured two processes detrimental to the urban economies : the transfer of capital from the manufactories to investment in land, which seemed to offer better opportunities and safer revenues; and the transfer of part of the production from the cities to rural areas, where they were also able to escape the rigidities of the guild system. We will discuss these developments later; what needs to be pointed out now, is that both processes tended to reduce the availability of capital for the urban manufactories - the other factor which could have caused a serious negative shock to productivity.

Having clarified some of the reasons why plague could have proved detrimental to the economy, this article will now contribute to the ongoing debate about the actual consequences of severe epidemics, by providing a novel empirical test of whether plague was able to displace the Italian urban economies, and whether displacement led to a higher or a lower growth path. The focus will be placed especially on the 1629-30 epidemic, the worst to affect the richer part of the Peninsula, but as will be seen the interacting effects of the 1575-77 and 1629-30 plagues are possibly the most important explanation for different local outcomes. Changes in city size will be used as an indicator of economic growth (or decline) over the long run, as is common procedure in the literature on historical urban economics literature (Bosker et al., 2008; Percoco, 2013a, 2013b).

## 5. Methodology

In previous sections we set out our hypothesis that the plague of 1630 had significant and persistent effects on relative city size growth. In this section, we present our methodological approach by building on the seminal paper by Davis and Weinstein (2002), further applied by Brakman et al. (2004) who based their analysis on a new economic geography framework in which if a shock is small, then the economy recovers to the initial stable equilibrium. If the shock is large enough, then the economy converges to a new equilibrium.

Let us consider a process of relative city size growth in the form:

$$(1) \quad s_{it} = \Omega_i + \varepsilon_{it}$$

And

$$(2) \quad \varepsilon_{it+1} = \rho\varepsilon_{it} + v_{it+1}$$

Where  $s_{it}$  is relative size of city  $i$  at time  $t$ , i.e. it is the ratio between city population and total Italian population.  $\Omega_i$  is a long run equilibrium around which city size oscillates given



an error structure given by equation (2) and an iid error term  $v_{it+1}$ . Parameter in equation (2) satisfies the condition  $0 \leq \rho \leq 1$ .

By combining equations (1) and (2) and by considering differences, we have the following equation:

$$(3) \quad g_{it+1} = (\rho - 1)v_{it} + [v_{it+1} + \rho(\rho - 1)\varepsilon_{it}]$$

Where  $g_{it+1} = s_{it+1} - s_{it}$ . In equation (3), if  $\rho = 1$ , then  $g_{it+1}$  follows a random walk as it reduces to  $g_{it+1} = v_{it+1}$ ; while if  $0 < \rho < 1$ , then a shock has a persistent effect of the growth rate of relative city size.

It is difficult to identify a shock  $v_{it+1}$ , hence we make the assumption that  $v_{it+1} = g_{it}$ , that is our specification to be estimated is:

$$(4) \quad g_{i1650-1700} = \alpha + \beta g_{i1600-1650} + controls_i + \varepsilon_i$$

Where the dependent variable is the growth rate in relative size of city  $i$  between 1650 and 1700, whereas  $g_{i1600-1650}$  is the growth between 1600 and 1650, in a period comprising the effect of the 1630 plague. In equation (4) we also include control variables, such as if city  $i$  is a capital city or not and dummies for geographical macro-areas (North, Center and South).

The parameter of our interest is  $\beta$  which is equal to  $\rho - 1$  in equation (3). Hence, if  $\beta = 0$ , then the growth rate over the period 1650-1700 follows a random walk (other things being equal); if  $\beta = -1$ , then the shock over the period 1600-1650 is completely undone in the period 1650-1700. Finally, if  $0 < \beta < 1$ , then the shock has a permanent effect on city growth.

In order to identify the shock imposed by the plague in 1630, we need to estimate equation (4) by means of an instrumental variable procedure. This is because  $g_{i1600-1650}$  is a noisy proxy for the shock imposed by the 1630 plague.

To this end, we propose the use of the logarithm of mortality rate for the plague in 1630 as an instrument to identify parameter  $\beta$ .

For the aims of this article, we focused on the cities for which acceptable estimates of the population size at 50-year intervals since at least 1600 were available or could be produced. The resulting sample consists of 35 cities across the Italian peninsula (see Appendix).

## 6. Results

The methodology presented in the previous section postulates the estimation of a system of equations following a two step procedure.

Table 2 documents estimates of several specifications of the first stage regression in which the dependent variable is the cumulative growth rate of relative city size. Our instrument to predict exogenously such growth rate is the mortality rate in the cities caused by the 1630 plague. Importantly enough, our variable of interest is always significant across specifications with a point estimate of the elasticity of about -0.03. Furthermore, in model 2 and 3 we control also for the status of capital city (with a moderately significant and positive coefficient) and for the geographical macro-area in which the city is located. In model 3 we control also for the plague in 1575 (as a dummy variable) and find no significant effect. Further to be noted is the fact that the coefficient for the South is not significantly different from zero, indicating that the South did not experience differential negative growth across the period, probably because the area was not affected by the 1630 plague.

Table 2: First stage regressions (Dependent variable is relative city size growth 1600-1650)

	(1) Growth 1600- 1650	(2) Growth 1600- 1650	(3) Growth 1600- 1650
Log mortality rate of 1630 plague	-0.035*** (-5.480)	-0.023*** (-3.036)	-0.025*** (-2.967)
Capital city		0.172* (1.745)	0.186* (1.760)
Center		-0.185** (-2.090)	-0.119 (-0.931)
South		-0.001 (-0.00815)	0.012 (0.143)
Plague 1575			-0.118 (-1.086)
Constant	0.066* (1.765)	0.092 (1.167)	0.086 (1.026)
Observations	35	35	35
R-squared	0.338	0.454	0.479

Robust t-statistics in parentheses

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

In table 3 we report estimates of second stage regressions. Model 1 reports a coefficient associated to cumulative growth over the period 1600-1650 equal to -0.868, indicating, according to the model presented in the previous section, that the plague of 1630 had a permanent effect. The coefficient maintains its sign and significance also in models 2 and 3, although with smaller magnitude. Interestingly, when our dependent variable is cumulative growth over the periods 1650-1750 and 1650-1800 (models 4 and 5), the effect of the shock sustained over the period 1600-1650 loses significance. The same is true for the effect of the plague of 1575 which was found significant in model 3. What is more, in model 3, when we introduced the dummy for the 1575 plague, the magnitude and significance of the effect of the 1630 shock decreased substantially, indicating a potential interaction between the two events. Note however that the coefficient related to all demographic shocks stays negative throughout the models. Interestingly, the coefficients associated to South are always negative (although not always significant), indicating a negative differential growth

across the period not dependent on the 1630 plague (but possibly due to the 1656-57 plague).

Table 3: Second stage regressions (Dependent variable is relative city size growth; IV estimates)

	(1) Growth 1650-1700	(2) Growth 1650-1700	(3) Growth 1650-1700	(4) Growth 1650-1750	(5) Growth 1650-1800
Growth 1600-1650	-0.868*** (-4.837)	-0.571*** (-2.720)	-0.480** (-2.474)	-0.149 (-0.552)	-0.037 (-0.0874)
Capital city		0.115* (1.700)	0.111* (1.900)	-0.009 (-0.120)	-0.011 (-0.0972)
Center		0.115 (1.518)	0.198** (2.437)	0.267** (2.269)	0.296* (1.860)
South		-0.166*** (-3.024)	-0.143** (-2.240)	-0.061 (-0.715)	-0.040 (-0.351)
Plague 1575			-0.117* (-1.717)	-0.098 (-1.049)	-0.143 (-1.311)
Constant	-0.001 (-0.0396)	-0.089* (-1.951)	-0.103** (-2.183)	-0.157** (-2.441)	-0.215** (-2.318)
Observations	35	35	35	35	35
R-squared	0.396	0.628	0.667	0.375	0.254

Robust t-statistics in parentheses

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

In table 4 we test explicitly for an interaction between the plague of 1575 and the shock to relative city size in 1600-1650 due to the plague. To this end, we have divided our sample into two groups: one comprising the cities affected by the 1575 plague and one comprising the cities not affected by that epidemic. Models 1 and 2 report estimates of the model when the dependent variable is cumulative growth over 1650-1700. Interestingly, the coefficient associated to cumulative growth in 1600-1650 is significant and equal to -0.539, hence indicating a permanent effect, only for the cities affected by the plague in 1575. This lasting

effect is relatively absorbed across the centuries, since the coefficient declines moderately when we consider growth in 1650-1750 and 1650-1800 (models 3-6). It should be noted that the coefficient for the growth in 1600-1650 is never significant for the cities not affected by the plague in 1575.

Table 4: The combined effect of 1575 and 1630 plagues (IV estimates; second stage)

	(1)	(2)	(3)	(4)	(5)	(6)
	Growth	Growth	Growth	Growth	Growth	Growth
	1650-1700	1650-1700	1650-1750	1650-1750	1650-1800	1650-1800
	– Cities not	– Cities	– Cities not	– Cities	– Cities not	– Cities
	affected by	affected by	affected by	affected by	affected by	affected by
	the plague	the plague	the plague	the plague	the plague	the plague
	in 1575	in 1575	in 1575	in 1575	in 1575	in 1575
Growth 1600-1650	-0.191	-0.539***	0.592	-0.524***	0.873	-0.451***
	(-0.300)	(-13.09)	(1.036)	(-8.603)	(0.645)	(-4.766)
Capital city	0.108	0.040	-0.054	0.039	-0.081	0.024
	(1.208)	(0.494)	(-0.405)	(0.382)	(-0.367)	(0.193)
Center	0.289	0.128***	0.500**	0.052***	0.555	-0.026
	(1.387)	(7.926)	(2.153)	(2.859)	(1.479)	(-1.219)
South	-0.183***		-0.064		-0.093	
	(-2.899)		(-0.583)		(-0.519)	
Constant	-0.151	-0.148*	-0.287**	-0.143	-0.341*	-0.147
	(-1.304)	(-1.755)	(-2.028)	(-1.296)	(-1.866)	(-1.189)
Observations	23	12	23	12	23	12
R-squared	0.674	0.609	0.152	0.519	0.270	0.411

Robust t-statistics in parentheses

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

Table 5: The combined effect of 1575 and 1630 plagues (IV estimates; second stage; only cities in the Center-North)

	(1)	(2)	(3)	(4)	(5)	(6)
	Growth 1650-1700 – Cities not affected by the plague in 1575	Growth 1650-1700 – Cities affected by the plague in 1575	Growth 1650-1750 – Cities not affected by the plague in 1575	Growth 1650-1750 – Cities affected by the plague in 1575	Growth 1650-1800 – Cities not affected by the plague in 1575	Growth 1650-1800 – Cities affected by the plague in 1575
Growth 1600-1650	-0.455 (-0.825)	-0.503*** (-13.09)	0.214 (0.559)	-0.496*** (-8.603)	1.677 (0.754)	-0.441*** (-4.766)
Capital city	0.161* (1.841)	0.039 (0.494)	-0.022 (-0.197)	0.038 (0.382)	-0.232 (-0.593)	0.025 (0.193)
Center	0.204 (1.135)		0.380** (2.318)		0.784 (1.240)	
Constant	-0.142 (-1.239)	-0.039 (-0.503)	-0.253** (-2.414)	-0.097 (-1.018)	-0.470 (-1.314)	-0.150 (-1.350)
Observations	20	11	19	11	20	11
R-squared	0.656	0.505	0.169	0.464	0.346	0.382

Robust t-statistics in parentheses

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

As a robustness check, in table 5 we have excluded cities in the South as for those cities the process of decline started well before the cities in the Centre-North and also because the plague of 1575 did not affect cities in the South. Note that our results do not change significantly and the coefficient of interest is only slightly smaller than estimates in table 4, but always comfortably in the interval (-1,0), indicating a strong persistence of the shock effects.

## 7. Discussion

Our regression analysis confirmed what has recently been hypothesized about the ability of plague to displace economies to lower growth paths - and not always, or not necessarily, to higher ones as has been argued by many earlier works dedicated to the Black Death epidemic. Consequently, our analysis confirms that the economic consequences of severe

demographic shocks need to be understood and studied on a case-by-case basis, as the historical context in which they occurred can lead to very different outcomes.

More generally, our analysis offers a novel perspective on the timing and the causes of the relative decline of the central and northern Italian economies compared to other areas of Europe. At the end of the sixteenth century and in the early seventeenth, these economies were still very strong as stated by the most recent overall evaluation of the Italian economic trend during the Early Modern period (Alfani 2013b) and consistently with the revisionist literature which for some decades has been developing the notion of "relative decline" to describe the fortunes of Italy during the seventeenth century (Sella 1997; Lanaro 2006). According to Malanima (2006), the century when Italy as a whole faced its deepest crisis was in fact the eighteenth. This however leaves open the question of when the progressive decline of the northern Italian economies started. Alfani suggested that the turning point is the 1629-30 plague : "The long sixteenth [1494-1628] and short seventeenth [1629-1710] centuries were clearly separated by a fall (a 'catastrophe') in the population and in product, for which the plague was mainly responsible" (Alfani 2013b, 173). Later he demonstrated that plague had a deeply different demographic impact across seventeenth century Europe, and developed an "epidemiological hypothesis" to explain the origin of the relative decline of the most advanced areas of Italy compared to northern Europe (Alfani 2013a). This article provides support to this hypothesis, demonstrating that plague had a permanent negative effect on many key Italian cities, particularly those already exposed to the 1575 wave. In other words, although it seems plausible that Malanima is right in pointing to the eighteenth century as the period when (in relative terms, and broadly speaking) Italy touched the bottom level, the process leading to such an outcome began in the seventeenth century, and was "caused" by the mortality crises in that period, inasmuch as they displaced the area towards a lower growth path.

The decline of the urban economies and especially of their manufacturing sector - possibly triggered, as we argued, by a negative productivity shock caused by plague - needs to be better placed into perspective, as one fundamental argument put forward by those who introduced the notion of relative decline, notably Sella (1997), is that during the seventeenth century production moved, to a degree at least, from the cities to the rural

areas. This meant being able to make use of the abundant labour present in the country in addition to escaping the rigidities of the urban guild system. However, in the medium and long run it also implied a re-focusing of the northern Italian manufacturing sector on the production of semi-finished products (like silk) and of lower-quality products. By the beginning of the seventeenth century, when demographic recovery after the plague was completed, the northern Italian states were unable to also recover the position of centrality in the European economy which they had enjoyed up until the eve of the plague. The decline of their cities, which is reflected in urbanization levels lagging behind those of a century earlier (in the centre-North of the Peninsula, urbanization rates (cities with a population of at least 5,000) can be estimated at around 18.4% in 1600 and 16.9% in 1700. Malanima 2005, 103), is clearly an essential explanatory factor of this ultimate failure to keep the same pace as the most dynamic areas of Europe. To put it bluntly, we should not forget that even a relative decline is still a decline.

One final point to underline, is that our regression analysis provides strong support for the need to consider the 1575-77 and 1629-30 epidemics together, as seemingly it was the interaction of the two, much more than the local intensity of the 1629-30 outbreak, which explained the different outcomes across the cities included in our database. This is an entirely novel finding, which is worthy of further research as it might lead us to think differently about the economic consequences of epidemics. We will tentatively introduce the notion of frailty, which is commonly used in demographic and health studies to describe the relative risk of death of an individual compared to other members of a population (Vaupel 1988). Among the determinants of frailty, there are the health conditions experienced in earlier life. Similarly, we can hypothesize that the susceptibility of a city to suffer permanent negative effects from an epidemic depends on it having experienced an earlier severe epidemic or not. The implication is that an epidemic could reduce the economic "health" of a city in such a way as to make its economic structures "frail", a condition which could prove undetectable with the indicators usually employed to study long-term economic dynamics in the past. If a subsequent exogenous health shock occurred, frail cities would be affected more severely than non-frail cities, even at parity in mortality rates (and consequently, at parity of apparent severity of the mortality crisis).



In our analysis, we have paid particular attention to the labour market. It is not totally clear how the labour market could be made "frail" by a health shock, unless we consider factors such as the limit of the ability of the manufacturing sector and the guild system to import skills from the outside (the huge intake of foreigners following the 1575-77 epidemic could have made it difficult to attract more after the 1630 crisis), the ratio of production of new skills locally (the way in which plague affected the apprenticeship system, for example), the extent to which labourers could rely on local networks for different forms of help and protection, something which we might think would depend on the amount of time spent in the city (skilled workers migrating to a city after 1575 might have found themselves more exposed to the risk of dying in 1629-30 than those present from before 1575 or than the children of long-time dwellers inheriting their parents' network). All these, however, are only tentative and provisional explanations for a fascinating phenomenon which could be fully understood only by means of new historical research.

## **8. Conclusion**

This article has provided an overview of the demographic impact of plague on Italian Early Modern cities, from the 1575-77 epidemic up until the last great seventeenth century plagues. It has introduced the largest-existing database of urban mortality rates in plague years, allowing us, first, to demonstrate the particularly high severity of the last Italian plagues (in the two final waves, mean mortality rates in cities were in the order of 400 per thousand), and secondly, to analyze their economic impact.

Using the methods of economic geography to study the ability of a mortality crisis to alter the growth path followed by a city, we found evidence that the 1629-30 plague affecting Tuscany and northern Italy was able to displace some of the most dynamic and economically advanced Italian cities, like Milan or Venice, moving them to a lower growth path. Demonstrating that the plague had a permanent negative effect on many key Italian urban economies, the article has provided support to the recently-formulated hypothesis that the origins of the relative economic decline of the northern part of the Peninsula are to be found in particularly unfavorable epidemiological conditions. More generally, the article has provided a useful new perspective on Italian long-term economic trends, including

aspects like the establishment of a North-South divide, the falling-back of northern Italy compared to its main European competitors, and the final consequences of the progressive "ruralization" of the Italian economies during the seventeenth century.

Finally, the article has introduced the notion of frailty, applied to labour markets and to economic structures in general, to understand how the consequences of an epidemic could in fact depend on earlier health shocks. This idea opens the way for a new understanding of how epidemics might have affected preindustrial economies in the long run.

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