Cities and Economic Development

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Cities and Economic Development

Today, cities are centers of economic development

- Sources of technological innovation and adoption
- People work better when they can directly interact
- Evidence for increasing returns – being around other people makes everybody more productive

Figure : Population Density and Per Capita Income in U.S., 2000

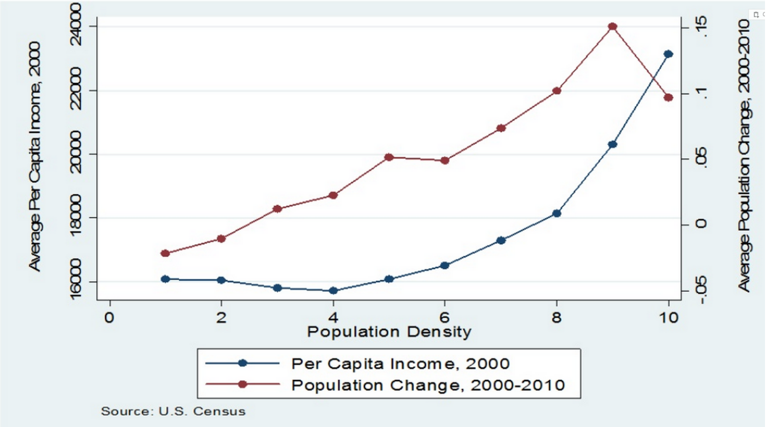
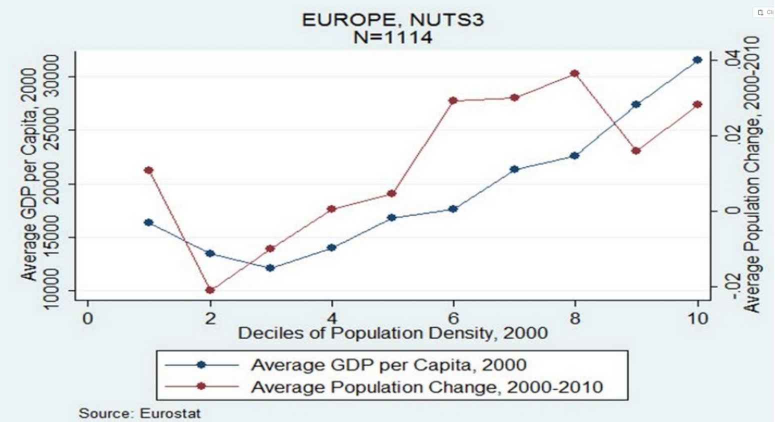
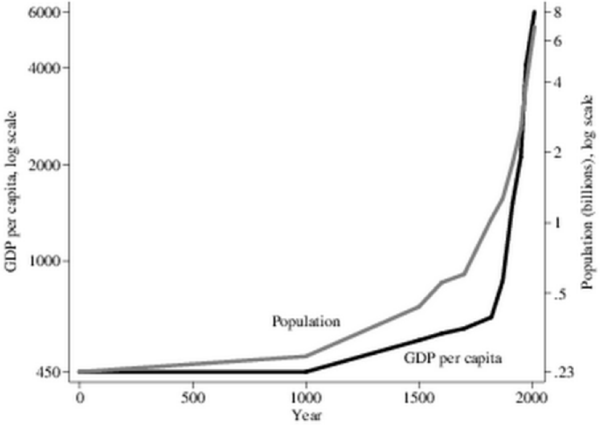


Figure : Population Density and Per Capita Income in E.U., 2000



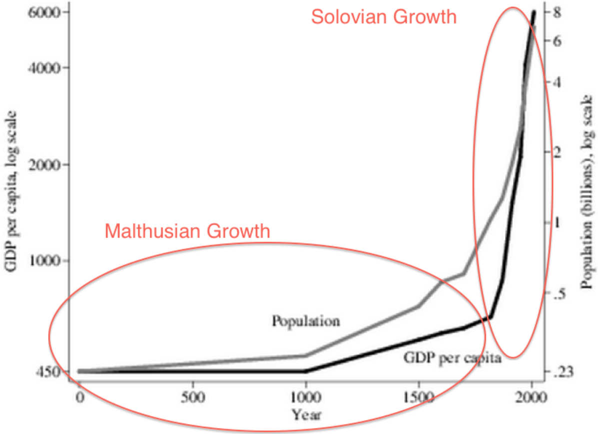
Historically, Cities and Development also Correlated

Figure : World Population and GDP Per Capita, 0 A.D. to 2000 A.D.



TWO GROWTH REGIMES: MALTHUS AND SOLOW

Figure : World Population and GDP Per Capita, 0 A.D. to 2000 A.D.



Low / No Growth Before 1800 Not Explained by Lack of Tech Progress

Scholars like Joel Mokyr at Northwestern have shown technological change fairly constant during medieval and early-modern period. In medieval period, for example...

- **Printing**: Watermark (1282), Spectacles (1280's), Paper (13th c), Movable Type Printing (1440's)
- **Time**: Hourglass (1338), Mechanical Clock / Escapement (13th - 14th c)
- **Agriculture**: Heavy Plough (5th - 8th c), Hops (11th c), Horse Collar (6th - 9th c), Horseshoes (9th c), Wine Press (12th c)

LOW GROWTH BEFORE 1800 EXPLAINED BY MALTHUSIAN MODEL

- Two Assumptions
  1. When income per capita increases, people respond by having more children (no demographic transition)
  2. There is some fixed factor of production. Usually considered to be 'land', or more realistically, high transportation costs.
- This results in economic stagnation.
- All increases in technology go to higher population density rather than higher income per person.
- In other words, big cities are a proxy for economic development (technological accumulation, ability to trade, etc. . .) in a Malthusian world

Explaining The Malthusian Model

Figure : Equilibrium in the Malthusian Model

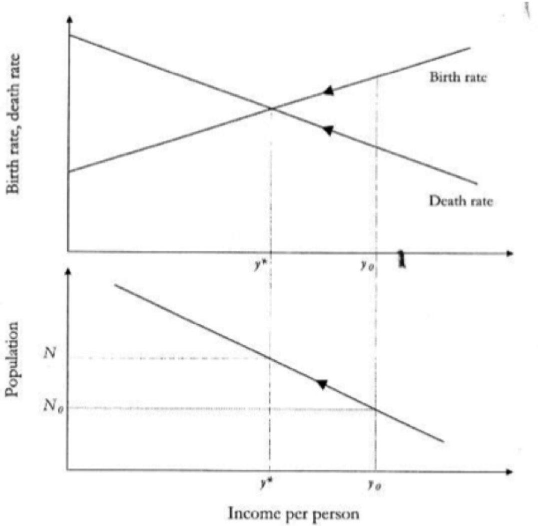


Figure 2.1 Long-run equilibrium in the Malthusian economy.

Technological Innovation Leads to Higher Population Density

Figure : Equilibrium in the Malthusian Model

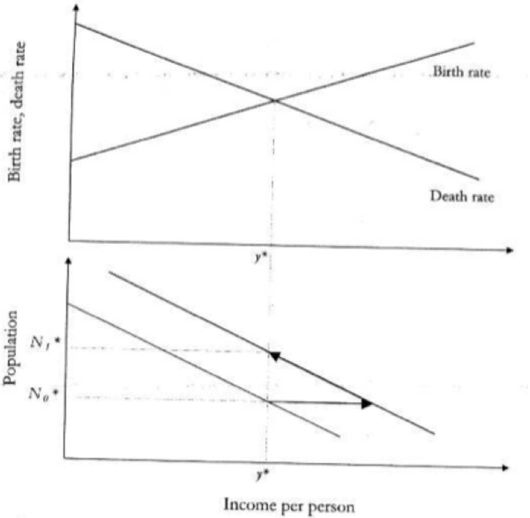


Figure 2.5 Effects of isolated technological advance.

Low Growth Before 1800 Explained by Malthusian Model

- In a Malthusian World, all increases in technology go to increases in population density.
- Furthermore, there are actually quite beautiful theory and data out there which show this also works in the other direction – higher population density leads to a more rapid accumulation of technology.
- But I leave establishing this last point for another lecture and ask you instead to take my word on it...
- Also, in a Malthusian World, the only way to increase income per capita is by either raising mortality rates or decreasing birth rates
- This last point is why economics is often referred to as the 'Dismal Science'.

Using the Black Death to Test Theories of Urban Growth and Spatial Distribution

- I've hopefully convinced you by now that explaining why urbanization occurs is important, both historically and today.

- I'm going to use the rest of my time with you to describe some of my research (joint with Remi Jedwab and Mark Koyama) which uses the European Black Death (1346-1353) as a natural experiment to test two theories from Urban Economics and Economic History:

   1. **Question 1**: What can the Black Death teach us about why cities emerge where they do?

   2. **Question 2**: Did the Black Death generate greater urbanization in certain parts of Europe?

Question 1: Why Do Cities Emerge Where They Do?

- There are two prominent theories about why cities are where they are:

  1. **Spatial Amenities** – cities locate in places with favorable geography or infrastructure. If this is true, then we don't have to worry about whether cities are in the 'right' place.
  2. **Increasing Returns** – cities locate where they do because that's where all the people are. If this is true, then we might have to worry about whether cities are in the 'right' place. Cities can get 'locked in' to a certain equilibrium which may not adjust when trade routes, technology, or other factors change.

EVIDENCE FOR SPATIAL AMENITIES I

Figure : Japanese Cities Bombed More Heavily in WWII Grew Faster

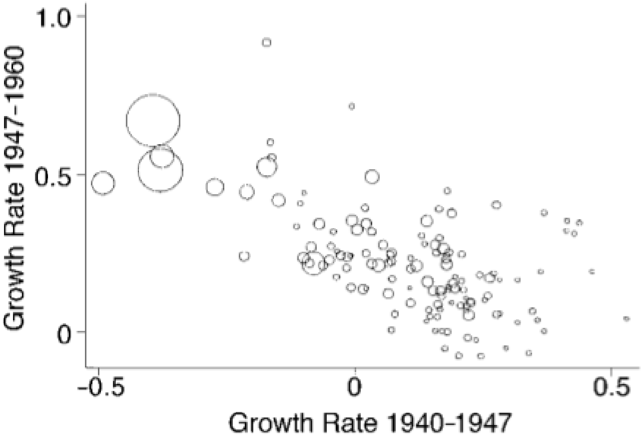


FIGURE 1. EFFECTS OF BOMBING ON CITIES WITH MORE THAN 30,000 INHABITANTS

Evidence for Spatial Amenities II

Figure : Growth Rates of Hiroshima and Nagasaki

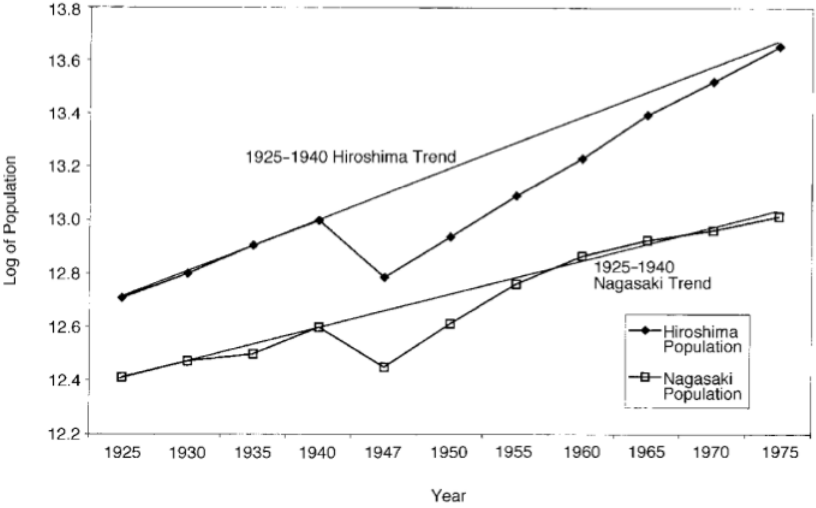
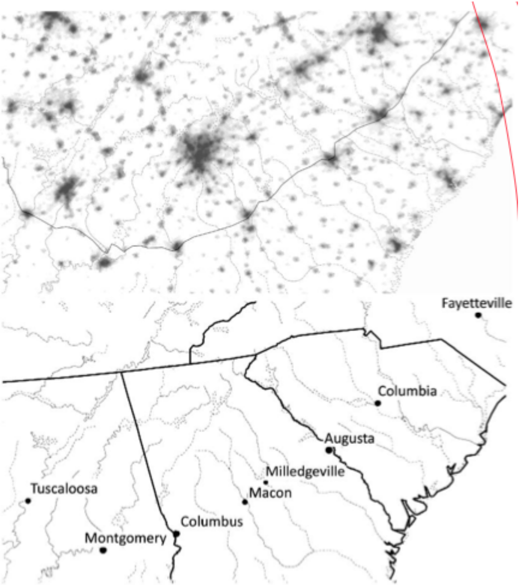


Figure 2. Population Growth

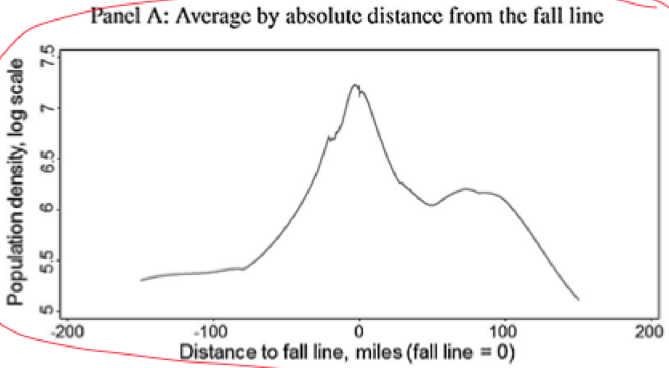
Evidence for Increasing Returns I

Figure : The Fall Line and City Size in the U.S.



Evidence for Increasing Returns II

Figure : The Fall Line and Population Density in the U.S. Today



Question 2: Did the Black Death Generate Urbanization?

The Black Death Brought with it at least two of the Four Horsemen of the Apocalypse

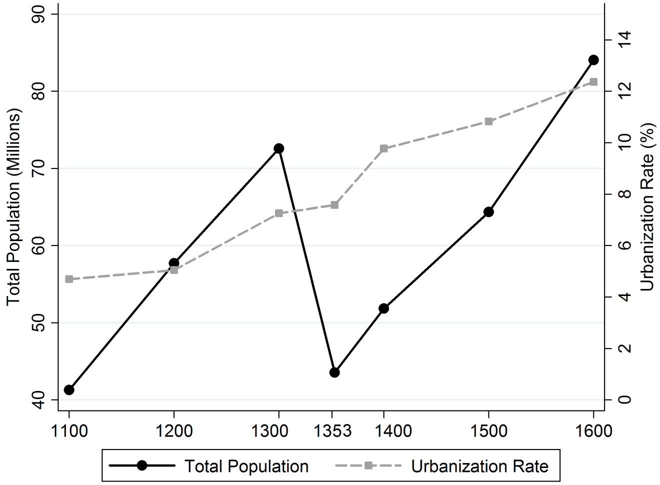
- **Pestilence**: Yersinia pestis is a bacterium that typically infects ground rodents in Central Asia, Kurdistan, Western Asia, Northern India and Uganda. Mongol invasions of 13th c probably served to spread it into Europe by 1346. There it manifested as both bubonic and pneumonic plague.
- **Death**: The Black Death killed ≈ 40 % of Europe's population. Lots of heterogeneity. Some cities wiped out. Others untouched.

QUESTION 2: DID THE BLACK DEATH GENERATE URBANIZATION?

- The Black Death may have also **increased urbanization**.
- Large loss of life meant that surviving population had higher wages.
- Engel's Law states that as incomes increase, people spend less on food.
- This increases demand for products made in cities (manufactures) and decreases demand for farm products.
- The end result could be urban growth.

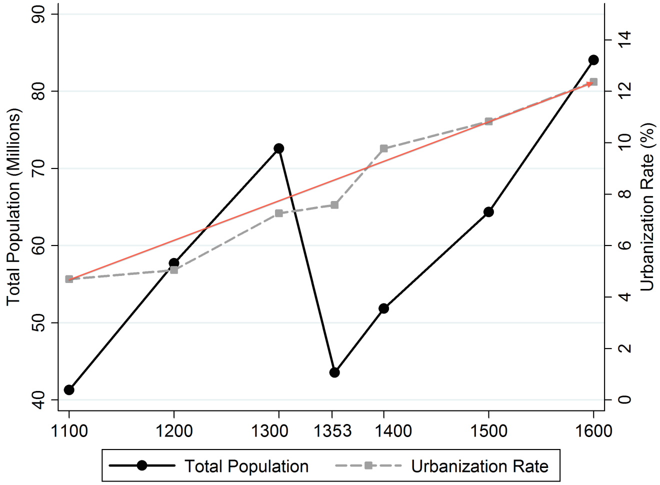
Question 2: Did the Black Death Generate Urbanization?

Figure : Evolution of Europe's Total Population and Urbanization Rate, 1100-1600



Question 2: Did the Black Death Generate Urbanization?

Figure : Evolution of Europe's Total Population and Urbanization Rate, 1100-1600



The Black Death and Urban Development

Will do the following:

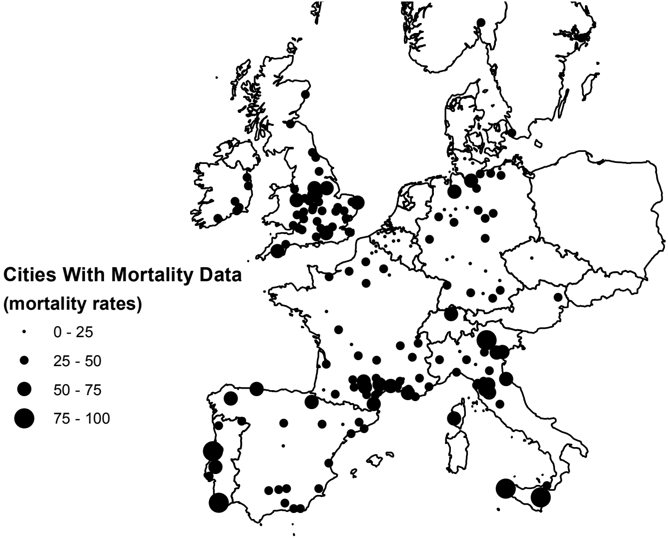
- Describe the data we use
- Establish that Black Death rates were plausibly **random** across cities: unrelated to initial pop: mortality was not a function of physical and economic geography, or institutions
- Present evidence that there was an urban 'reset' after Black Death – In other words, spatial amenities aren't the whole story. There is evidence for **increasing returns**.
- Present evidence that places with higher Black Death mortality rates grew faster – In other words, Black Death **spurred urbanization**.

Data

- Black Death mortality rates in 1346-1353 ($\approx$1350). Data for 139 cities. (Source: Christakos et al 2005.)
- City populations in 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1750, 1800 and 1850. 473 cities $>$ 1,000 inh. in 1300 (Source: Chandler 1987 and Bairoch 1988.)
- Main sample: 139 cities existing in 1300 for which we have the mortality rate.
- Secondary sample: 473 using extrapolated mortality.
- Data on various controls proxying for locational fundamentals, increasing returns and institutions:
    - Coastlines, rivers, average temperature, latitude, longitude;
    - Roman roads, medieval trade routes, universities, Hanseatic League;
    - Types of political institutions, bishoprics and archbishoprics, location of battles.

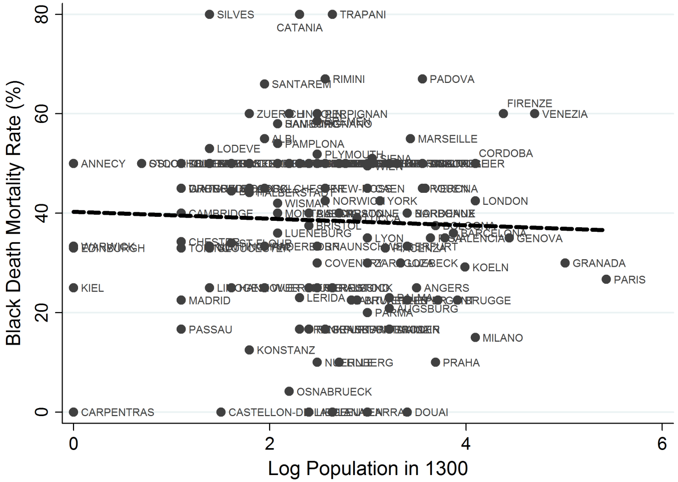
DATA

Figure : Black Death Mortality Rates in 1347-1353



Black Death Mortality Rates Were Random

Figure : Mortality Rates and 1300 Population



This figure plots mortality rates for 139 existing cities in 1300 for which we have mortality data. It shows that mortality rates are uncorrelated with population in 1300 Sources: see data appendix

Black Death Mortality Rates Were Random

TABLE 2: CITY CHARACTERISTICS AND BLACK DEATH MORTALITY RATES

Dependent Variable:	Black Death Mortality Rate (%, 1347-1351)			
	(1)	(2)	(3)	(4)
Locational Fundamentals:				
Coast 10 Km Dummy	4.75			5.16
	(3.18)			(3.89)
Rivers 10 Km Dummy	-0.96			0.98
	(3.02)			(3.63)
Elevation (m)	-0.01			-0.02
	(0.01)			(0.01)
Average Temperature 1500-1600	-1.01			-0.79
	(1.28)			(1.51)
Cereal Suitability 25 Km	3.20			2.69
	(2.04)			(1.90)
Grazing Suitability 25 Km	-2.13			-2.51
	(2.28)			(2.67)
Longitude (d)	-0.10			0.22
	(0.24)			(0.42)
Latitude (d)	-1.50*			-1.59*
	(0.78)			(0.89)

Black Death Mortality Rates Were Random

TABLE 2: CITY CHARACTERISTICS AND BLACK DEATH MORTALITY RATES

Dependent Variable:	Black Death Mortality Rate (%, 1347-1351)			
	(1)	(2)	(3)	(4)
Increasing Returns:				
Log City Population in 1300		-0.06		-2.96
		(1.64)		(2.06)
Hanseatic League Dummy		3.77		10.78
		(5.89)		(6.85)
Market & Fair Dummy		-6.33		-2.92
		(3.89)		(4.13)
University Dummy		3.29		1.15
		(4.40)		(4.97)
Major Roman Road (MRR) 10 Km Dummy		3.35		-2.99
		(7.32)		(6.34)
MRR Intersection 10 Km Dummy		2.43		-1.92
		(4.84)		(5.70)
Any Roman Road (ARR) 10 Km Dummy		0.82		0.93
		(7.02)		(6.86)
ARR Intersection 10 Km Dummy		-0.65		6.05
		(5.46)		(5.89)
Medieval Land Route (MLR) 10 Km Dummy		1.46		3.16
		(3.22)		(3.36)
MLR Intersection 10 Km Dummy		-3.98		-1.01
		(5.15)		(5.58)

Black Death Mortality Rates Were Random

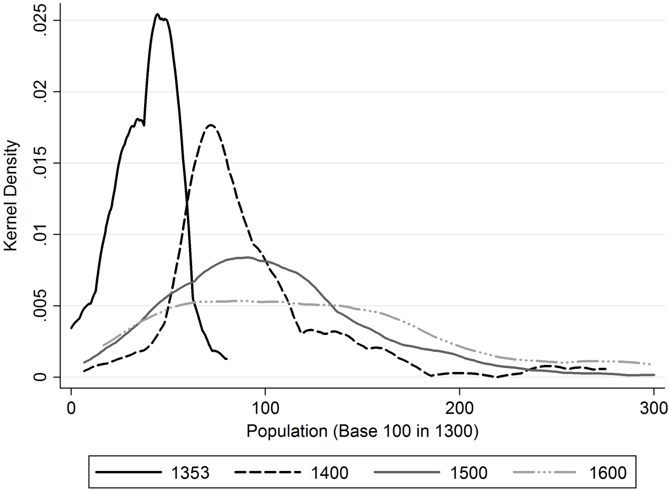
TABLE 2: CITY CHARACTERISTICS AND BLACK DEATH MORTALITY RATES

Dependent Variable:	Black Death Mortality Rate (%, 1347-1351)			
	(1)	(2)	(3)	(4)
<u>*Institutions:*</u>				
Monarchy in 1300 Dummy			4.94	5.58
			(4.44)	(5.75)
State Capital in 1300 Dummy			-0.72	3.24
			(4.15)	(5.54)
Autonomous City in 1300 Dummy			-3.75	-0.95
			(3.78)	(4.28)
Battle within 100 Km in 1300-50 Dummy			-3.91	-1.19
			(3.04)	(3.38)
Bishopric before 1350 Dummy			7.83**	3.86
			(3.01)	(3.53)
Archbishopric before 1350 Dummy			5.71	2.39
			(3.58)	(4.35)
Parliamentary Activity in 1300-1400			0.51	1.67
			(3.83)	(4.90)
Number of observations; R-Squared	139; 0.15	139; 0.06	139; 0.12	139; 0.24

Notes: The sample consists of 139 cities (i.e. localities larger than 1,000 inhabitants) that already existed in 1300 and for which the Black Death mortality rate is available. Robust SE's: * p<0.10, ** p<0.05, *** p<0.01

The Black Death Reset The Urban Network

Figure : Distribution of City Sizes (Base 100 in 1300) for the Existing Cities in 1300, 1300-1600



Kernel distribution of city sizes (base 100 in 1300) for the 139 existing cities in 1300 for which we also know their Black Death mortality rate, for the years 1353, 1400, 1500 and 1600. Population in 1353 is proxied by their population in 1300 times their Black Death mortality rate in 1347-1353.

THE BLACK DEATH RESET THE URBAN NETWORK

Figure : Evolution of Europe's Total Urban Population, 1100-1600

Evolution of the total urban population. The total urban populations in 1353 are proxied by the total urban populations in 1300 times the average urban mortality rate in 1347-1353, which we estimate as 37.5%.

The Black Death Reset The Urban Network

A tale of two cities

Hamburg

- Population of 8,000 individuals in 1300.
- Morality rate of 58%
- Recovered quickly—a population of 22,000 by 1400.

Montpellier

- Population of 35,000 in 1300.
- 50% mortality rate.
- It did not recover: its population in 1400 was 17,000, a 45% decline. It fell from being the 4th largest French city to the 20th.
- Decline of Montpellier continued for centuries; the city did not exceed its 1300 population until 1850.

The Black Death Reset The Urban Network

- Do cities with better locational fundamentals recover more quickly?
- Do cities located close to infrastructure or other sources of increasing returns recover more quickly?
- Do political institutions affect the speed of recovery?

HETEROGENEOUS EFFECTS, 1300-1600: Panel A

Dependent Variable:	Percentage Change in City Population (%)		
Sample of Cities:	138	460	460
Mortality Rates:	*Existing*	*Extrapolated 139*	*Extrapolated 185*
	(1)	(2)	(3)
Locational Fundamentals:	Effect of Black Death Mortality Rate (%) x Dummy:		
Coast 10 Km Dummy	1.49	-0.16	0.11
Mediterranean Coast 10 Km Dummy	1.90**	3.20***	3.27***
Atlantic Coast 10 Km Dummy	9.88	-0.96	0.12
North-Baltic Coast 10 Km Dummy	5.44	-2.09	0.29
Rivers 10 Km Dummy Dummy	-0.44	-0.61	-0.59
High Elevation (m) Dummy	-1.12	-1.20	1.06
High Av.Temperature 1500-1600 (d) Dummy	-0.63	1.27	1.06
Low Cereal Suitability 25 Km Dummy	0.23	0.58	0.55
Low Grazing Suitability 25 Km Dummy	2.03*	1.03	0.97
Western Europe (Low Longitude) Dummy	1.05	-0.57	-0.58
Southern Europe (Low Latitude) Dummy	-0.92	0.59	0.38
Number of observations	138	460	460

HETEROGENEOUS EFFECTS, 1300-1600: Panel B

***Dependent Variable*:**	**Percentage Change in City Population (%)**		
Sample of Cities:	138	460	460
Mortality Rates:	*Existing*	*Extrapolated 139*	*Extrapolated 185*
	(1)	(2)	(3)
Increasing Returns:	Effect of Black Death Mortality Rate (%) x Dummy:		
Low Log City Population in 1300 Dummy	-4.43	-2.76*	-2.67*
Hanseatic League Dummy	4.97**	4.05*	3.78*
Market & Fair Dummy	0.63	0.10	0.00
University Dummy	0.11	2.32	2.24
Major Roman Road (MRR) 10 Km Dummy	-1.99	-1.99	-2.04
MRR Intersection 10 Km Dummy	0.41	-0.14	-0.16
Any Roman Road (ARR) 10 Km Dummy	0.04	-2.70	-2.81
ARR Intersection 10 Km Dummy	1.30	4.97*	5.13*
Medieval Land Route (MLR) 10 Km Dummy	0.83	-0.43	-0.42
MLR Intersection 10 Km Dummy	-1.75	-1.36	-1.53
Number of observations	138	460	460

HETEROGENEOUS EFFECTS, 1300-1600: Panel B

Dependent Variable:	Percentage Change in City Population (%)		
Sample of Cities:	138	460	460
Mortality Rates:	*Existing*	*Extrapolated 139*	*Extrapolated 185*
	(1)	(2)	(3)
Institutions:	Effect of Black Death Mortality Rate (%) x Dummy:		
Monarchy in 1300 Dummy	0.98	2.60***	2.47***
State Capital in 1300 Dummy	0.26	1.69	1.51
Autonomous City in 1300 Dummy	1.94**	0.38	0.39
Battle within 100 Km in 1300-50 Dummy	0.57	-0.42	-0.29
Bishopric before 1350 Dummy	-1.73*	-0.80	-0.89
Archbishopric before 1350 Dummy	0.36	2.57	2.43
Parliamentary Activity in 1300-1400	0.08	0.90	0.77
Number of observations	138	460	460

Two effects standout:

Threshold effects Cities with low initial populations in 1300 grew more slowly if they suffered from high Black Death morality relative to cities which had comparatively large populations in 1300.

Cities like Paris, London and Venice were large in 1300 and bounced back from the Black Death shock relatively quickly but for many small cities the Black Death represented a permanent shock to their populations.

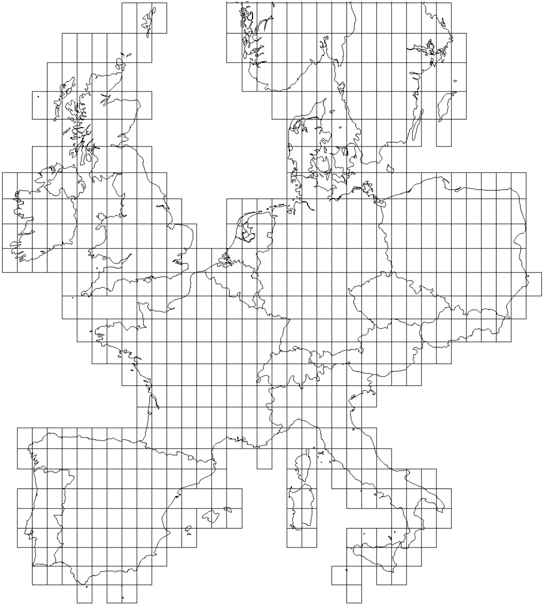
The Hanseatic League. Hanseatic cities recovered rapidly.

A one standard deviation increase in Black Death morality was associated with approximately 64 % ($\approx 4 \times 0.16$) faster growth than in a non-Hanseatic city.

Did Higher Black Death Mortality Rates Spur Urbanization?

- To test whether Black Death spurred urbanization we conduct a cell-level analysis.
- Requires us to extrapolate Black Death mortality rates for all of Europe based on known rates
- This results in 565 cells for which we know the Black Death mortality rate. 344 had a city in our dataset at one point between 1300-1600, and 243 had a city in 1300.
- Differentiate between cells that had cities in 1300 from those that did not.
- Did the Black Death stimulate future city growth more in cells that were urban in 1300 or in those that were rural?
- Engel Effect implies that higher incomes should lead to greater demand for urban manufactured goods and hence city growth.
- We find Black Death mortality is associated with faster growth in cells that were rural in 1300.

Cell-level analysis: 1x1 Degree Grid



Cell-level analysis: Extrapolation of Plague Mortality

To extrapolate our mortality estimates we assume:

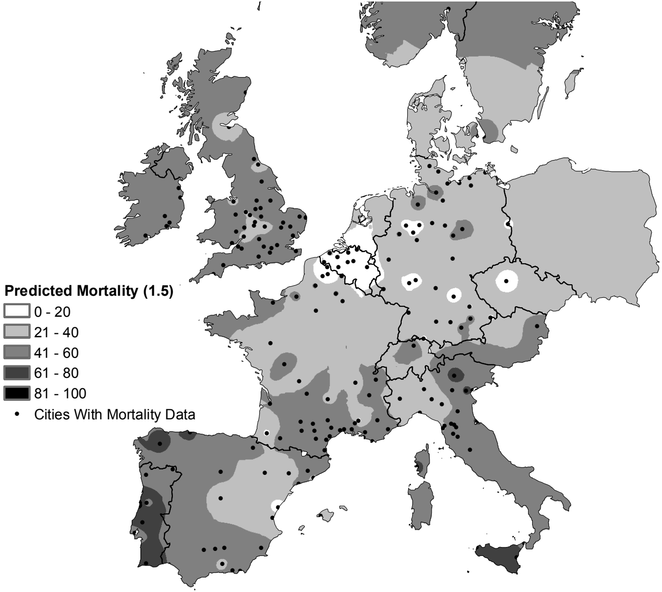
1. there exist some underlying causes of mortality rates which are unobserved;
2. these causes have a large random component (i.e. are external to our model of subsequent city growth);
3. these causes are also spatially correlated.

To impute missing mortality rates we create a two-dimensional surface of predicted plague mortality using an inverse distance weighted function of mortality rates.

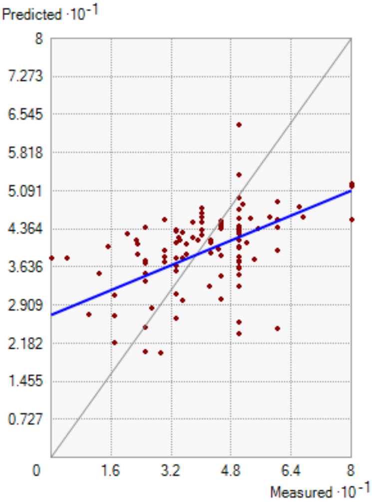
For every point on the surface, a predicted mortality rate is generated using the closest 15 cities within a 1,000 km circle.

Weights are determined by $p \geq 0$, referred to as *power*. As power decreases, the influence of more distant points increases. If $p = 0$, all points receive equal weight in determining all other points on the map. Influence of more distant points decreases exponentially as p increases.

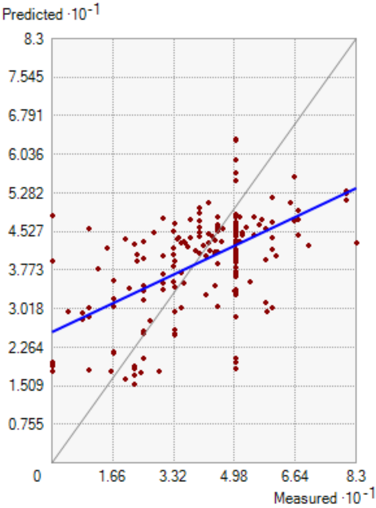
Cell-level analysis: Extrapolation of Plague Mortality



Extrapolation of Plague Mortality



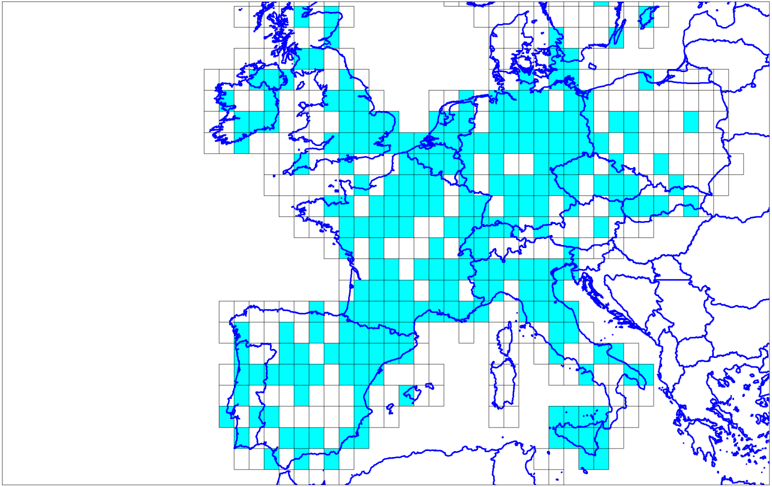
((a)) 139 City Sample



((b)) 185 City Sample

Predicted vs. measured mortality rates at the optimal power. The 139 city sample consists of cities with reported mortality rates that existed in 1300. The 185 city sample consists of all cities with reported Black Death mortality rates.

Cell-level analysis: 243 Cells with Cities in 1300



Cell-level analysis: 344 Cells with Cities between 1300 and 1600

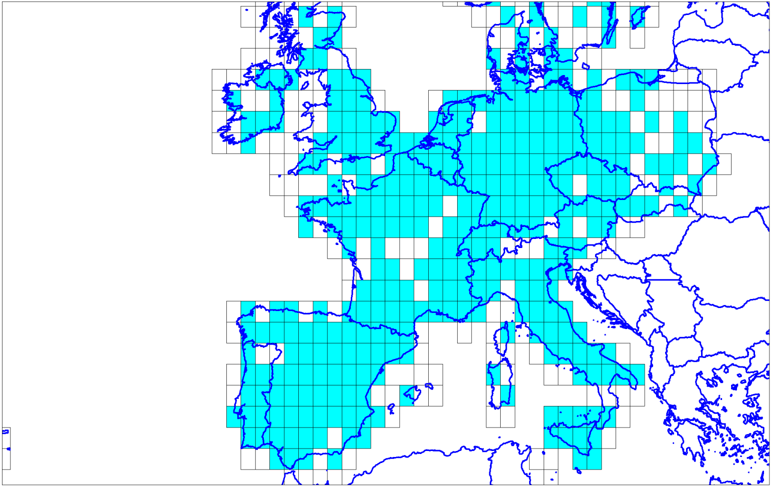


TABLE 4: CELL-LEVEL ANALYSIS, 1300-1600

Dep.Var.:	**Percentage Change for Existing Cities in 1300**	**Absolute Change for New Cities**	**Absolute Change for New Cities**	**Absolute Change for All Cities**
Cells:	with a City in 1300	with a City in 1300	with a City in 1300-1600 but no City in 1300	with a City in 13-1600
	(1)	(2)	(3)	(4)
1300-1400	-0.90***	-0.06**	-0.00	-0.24***
	(0.30)	(0.03)	(0.03)	(0.08)
1300-1600	0.56	0.13	0.24**	0.28
	(0.78)	(0.15)	(0.11)	(0.25)
Observations	243	243	101	344

Notes: This table shows the effects for various periods (1300-1400; 1300-1600) of the average Black Death mortality rate (%) of each 1x1 degree cell (using the spatially extrapolated mortality rates based on 139 cities) in 1347-1351 on: (1) the percentage change in city population (%) for the existing cities in 1300 for the 243 cells with a city in 1300; (2) the absolute change in city population (inh.) for the non-existing cities in 1300 for the 243 cells with a city in 1300; (3) the absolute change in city population (inh.) for the new cities in 1300 for the 101 cells with a city at one point in 1300-1600 but with no city in 1300; and (4) the absolute change in city population (inh.) for all (existing and new) cities in 1300 for the 343 cells with a city at one point in 1300-1600. Robust SE's: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. See Web Appendix for data sources.

Cell-level analysis

- Focusing on the 243 cells with a city in 1300, we obtain a coefficient of -0.90^{***} for 1300-1400 and 0.56 for 1300-1600 (Col. 1). This is comparable to city-level analysis.
- Col. (2) focuses on the absolute growth of new cities in the 243 urbanized cells in 1300. We obtain a coefficient of 0.13 for growth between 1300-1600.
- In Col. (3) we look at the 101 cells that did not have a city in 1300 but in which new cities emerged between 1300 and 1600. Here we find that the Black Death had a large effect: 0.24^{***} on long-run city growth. The coefficient we obtain of 0.24 implies that a morality rate of 50% during the Black Death in a particular cell was associated with 12,000 additional inhabitants by 1600.
- Column (4) looks at all cells (those with and without cities in 1300). We confirm our main results (negative short-run effects; positive but insignificant long-run effects).

Black Death prompted urban growth in those cells which were rural but had no effect on average in those cells with large cities in 1300.

The Black Death Reset The Urban Network

Figure : Evolution of Europe's Total Urban Population, 1100-1600

Evolution of the total urban population. The total urban populations in 1353 are proxied by the total urban populations in 1300 times the average urban mortality rate in 1347-1353, which we estimate as 37.5%.

CONCLUSION

- Understanding cities is important if one wants to understand economic growth more generally.
- Two specific questions are:
  1. Why do cities emerge where they do?
  2. What is responsible for historical city growth?
- The Black Death (1346-1353) is an extremely useful natural experiment to test theories about these questions – in large part because it appears to have struck cities randomly. **AND IT WAS A HUGE SHOCK!!!**
- I've provided evidence that increasing returns explains a lot about why cities locate where they do – this means there could be large inefficiencies. The urban network could be too stable.
- I've also provided evidence that in the aftermath of the Black Death, rural areas with greater mortality rates experienced above average growth. This is a possible explanation for the long-run origins of the Great Divergence (a.k.a. the Industrial Revolution).

Extra Slides

Exogeneity of Black Death Mortality

- Was Black Death mortality really independent of city size?
- Unique feature of Bubonic plague is 'that the densities of rats and rat fleas overrule the effects of the density of the susceptible human population that is the decisive factor for the dynamics of epidemic spread in the case of all diseases that spread directly between human beings by cross infection' (Benedictow, 2005, 284).
- Bubonic plague is spread by the fleas that live on black rats. These fleas only target humans when their hosts are dead. Rats are territorial animals. In rural areas a single rat colony may cohabit with a single household. In urban areas people live closer together and the ratio between rats and humans will tend to be lower:

  > *'This epidemiological model provides a basic explanation for how plague may wreak havoc after having arrived at some small-scale residential unit, and why, in the case of plague, severity of impact on human population does not increase with mounting density of human settlement' (Benedictow, 2005, 33)*

Empirical Strategy

We estimate:

$$\%\Delta\text{Pop}_{i,t} = \alpha + \beta_t D_{1348} + \mathbf{X}_i + \gamma_c + \epsilon_{i,t} \tag{1}$$

- where $\%\Delta\text{Pop}_{i,t}$ is the percentage population growth in city i in period (century) t: $\text{Pop}_t / \text{Pop}_t - \text{Pop}_{t-1}$.
- D_{1348} is a measure of the mortality rate of the Bleak Death;
- γ_c represent either historical or modern country fixed effects;
- and $\mathbf{X}_i$ is a vector of city specific controls.

TABLE 1: BLACK DEATH MORTALITY RATES AND CITY GROWTH, 1100-1600

	Dependent Variable: **Percentage Change in City Population (%)**							
Period:	1300-1400	1100-1200	1200-1300	1400-1500	1500-1600	1300-1500	1300-1600	1300-1850(n)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Black Death Mortality Rate (%)	-0.85***	-0.15	0.05	0.46**	0.39	-0.43	-0.15	0.22
	(0.31)	(0.37)	(0.62)	(0.21)	(0.30)	(0.32)	(0.51)	(0.43)
	[-1.5;-0.2]	[-0.9;0.6]	[-1.2;1.3]	[0.1;0.9]	[-0.2;1.0]	[-1.1;0.2]	[-1.2;0.9]	[-0.6;1.1]
Obs.	139	59	87	138	138	138	138	139
R^2	0.12	0.00	0.00	0.02	0.01	0.01	0.00	0.00

Notes: This table shows the effects of the Black Death mortality rate (%) in 1347-1351 on the percentage change in city population (%) for various periods. In column (8), this change is normalized ("(n)") by the mean percentage change in city pop. (%) over the period. The main sample consists of 139 cities (i.e. localities $\geq$ 1,000 inh.) that already existed in 1300 and for which the mortality rate is available. We use the pop. of each city in 1300 as regression weights. Robust SE's: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

TABLE 3: ROBUSTNESS CHECKS: PANEL A

	Dependent Variable: **Percentage Change in City Population (%)**							
	Baseline	*(2)-(6): Black Death Mortality Data*					*(7)-(8): Pop. Data*	
		Extrap139	*Extrap185*	*Heaping50*	*Raw*	*Extrap89*	*Bairoch*	*Chandler*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1300-1400	-0.85***	-0.72***	-0.70***	-0.77**	-0.96**	-0.71***	-0.71*	-0.87**
	(0.31)	(0.22)	(0.22)	(0.32)	(0.41)	(0.24)	(0.43)	(0.38)
1300-1600	-0.15	0.31	0.34	-0.09	-0.38	0.64	0.02	1.16***
	(0.51)	(0.50)	(0.48)	(0.51)	(0.67)	(0.51)	(0.53)	(0.23)
Obs.	139	467	467	107	89	467	139	56

TABLE 3: ROBUSTNESS CHECKS: PANEL B

	Locational Funda-mentals (9)	*Increasing Returns* (10)	*Institutions* (11)	*All Controls* (12)	*All +Quartic* (13)	*All +Extrap89* (14)	*All +Battles* (15)
1300-1400	-0.55*	-0.73***	-0.91***	-0.65***	-0.82***	-0.49*	-0.69***
	(0.31)	(0.27)	(0.31)	(0.24)	(0.24)	(0.26)	(0.24)
1300-1600	0.68	-0.28	-0.15	-0.06	-0.27	0.30	-0.21
	(0.56)	(0.45)	(0.49)	(0.62)	(0.68)	(0.52)	(0.63)
Obs.	139	139	139	139	139	467	139

TABLE 3: ROBUSTNESS CHECKS: PANEL C

	State 1300 FE	*Country 2010 FE*	*1200-1300*	*No Pop. Weights*	*Level Model*	*Panel Model*	*Log-Log Model*
	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1300-1400	-0.81**	-0.60**	-1.10***	-0.84***	-0.86*	-1.09*	-0.35***
	(0.39)	(0.27)	(0.38)	(0.24)	(0.46)	(0.56)	(0.11)
1300-1600	0.58	-0.36	-0.14	-0.00	0.00	-0.03	-0.13
	(1.09)	(0.53)	(0.61)	(0.50)	(0.64)	(0.52)	(0.16)
Observations	91	134	87	138	139	133	133

TABLE 3: ROBUSTNESS CHECKS: PANEL D

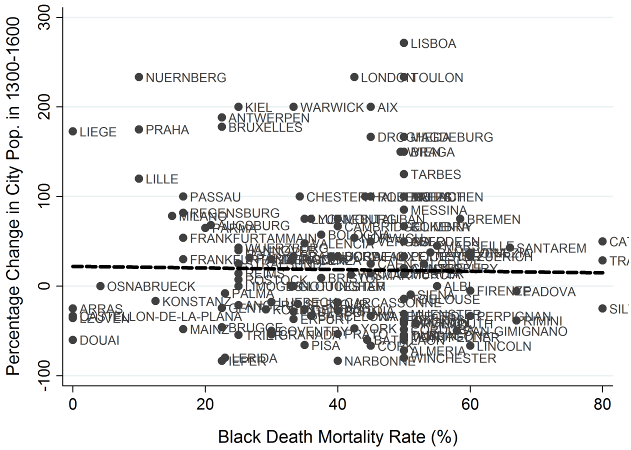
	(25)-(27): Clustering of SE's:			*(28)-(32): Excluding the Observations of :*			
	State1300	*Country*	*Conley100*	*France*	*Germany*	*Italy*	*Spain*
	(25)	(26)	(27)	(28)	(29)	(30)	(31)
1300-1400	-0.85***	-0.85**	-0.85***	-0.76**	-1.05***	-1.09***	-0.93***
	(0.29)	(0.37)	(0.33)	(0.38)	(0.36)	(0.42)	(0.32)
1300-1600	-0.15	-0.15	-0.15	-0.23	-0.30	0.14	-0.08
	(0.57)	(0.39)	(0.51)	(0.63)	(0.57)	(0.78)	(0.50)
Observations	139	139	139	110	118	125	120

Robustness Summary

Results are robust to:

- Using spatially extrapolated mortality rates for full sample
- Using different city population data sets
- Adding pre-Black Death controls
- Adding fourth-order polynomial in longitude and latitude
- Controlling for post-Black Death battles, sea trade
- Adding 1300 state fixed effects
- Adding 2015 country fixed effects
- Using various specifications
- Clustering standard errors differently
- Excluding each country one by one

Figure : The Heterogenous Response of Urban Growth to the Black Death



The figure plots the percentage change in city population for the 139 cities for which we have mortality data between 1300-1600. It shows that the response of urban growth to the Black Death shock was highly heterogenous.. To improve visibility we excluded the top and bottom 5% of observations.

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