

# **Gifts of Mars: Warfare and Europe's Early Rise to Riches**

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Today, per capita income differences around the globe are large – varying by as much as a factor of 35 across countries (Hall and Jones 1999). These differentials mostly reflect the “Great Divergence” (Sam Huntington) – the fact that Western Europe and former European colonies grew rapidly after 1800, while other countries grew much later or stagnated. What is less well-known is that a “First Divergence” preceded the Great Divergence: Western Europe surged ahead of the rest of the world long before technological growth became rapid. Europe in 1500 was already twice as rich on a per capita basis as Africa, and one-third richer than most of Asia (Maddison 2007). In this essay, we explain how Europe’s tumultuous politics and deadly penchant for warfare translated into a sustained advantage in per capita incomes.

Much of the European advantage in per capita incomes emerged after the Black Death of 1350, which killed between one-third and one-half of the European population. In the three centuries after 1400, European per capita incomes grew rapidly, while Africa and Asia stagnated (Maddison 2001). By 1700, Western Europeans produced 2.5 times more than Africans, and 70-85 percent more than Indians, Chinese, and Japanese.

Within Europe, there was also divergence: UK incomes were 75 percent higher in 1700 than they had been in 1500; Dutch incomes increased by 180 percent. At the opposite end of the spectrum were the laggards: Italy probably showed essentially no increases in productive capacity over these two centuries; Spain grew by only 28 percent. Urbanization rates tell a similar story. Where data on per capita income is poor, it makes for a good substitute (Wrigley 1985; Nunn and Qian 2011). This is because urbanization will reflect both the productivity of the urban sector (creating goods that can be traded for food) and of agriculture (which needs to generate a surplus above subsistence to feed cities).

Table 1 shows comparative figures for Europe and China, for both urbanization rates and GDP per capita. Europe may have been slightly ahead of China in terms of per capita incomes in Roman times; by the High Middle Ages, it had declined both absolutely and in relative terms, before showing rapid increases. The urban share in China was already around 3 percent in the eighth century; Europe, in contrast, probably lagged behind substantially.<sup>1</sup> By 1500, European urban shares were already higher than in China; by 1650, they were twice those in the Far East.<sup>2</sup>

<sup>1</sup> Maddison (2007) estimates that the share of Europeans living in cities of more than 10,000 inhabitants was zero. Bosker, Buringh, and Van Zanden (2008) present alternative figures, showing higher urban shares in the Iberian peninsula – under Arab rule at the time.

<sup>2</sup> The evidence in favor of Chinese underperformance has been questioned. Pomeranz (2001) points out that comparing the most advanced countries of Europe such as England and the Netherlands with all of China is unfair. The Yangtze area, China’s leading agricultural producer, did much better than the rest of the country. However, a decade of detailed research has now firmly established that early modern European incomes were indeed much higher than Chinese ones. Broadberry and Gupta (2012) estimate that Chinese and Indian wages already lagged European ones as early as 1550; by 1800, the gap was massive. Allen et al. (2011) similarly show that real urban wages in China were much lower than in Europe. Allen (2009) shows that even in the Yangtze area, per capita incomes were on a downward path during the early modern period.

Table 1: The “First Divergence” – Europe vs China

Urbanization rate*			GDP per capita**		
year	China	Europe	year	China	Europe
762	3		1	450	550
1000		0	960	450	422
1120	3.1		1300	600	576
1500	3.8	5.6			
1650	4	8.3	1700	600	924
1820	3.8	10	1820	600	1,090

\* percentage of the population living in cities with more than 10,000 inhabitants

\*\* in 1990 “international” dollars

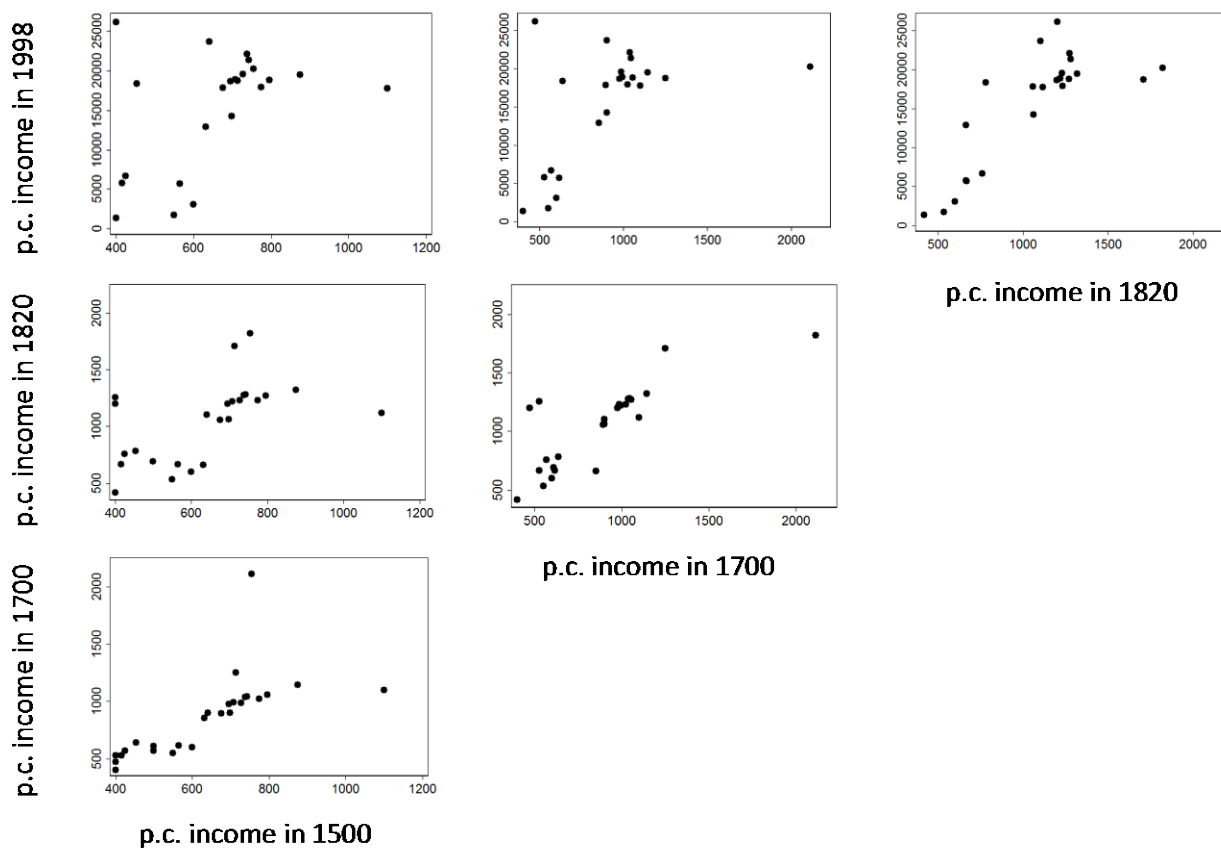
Source: Maddison (2007).

The First Divergence matters not only for incomes at that time: The countries that surged ahead also conquered vast parts of the globe in the nineteenth century, and remain amongst the first rank of economic nations today. Countries that failed to grow in the early modern period remained poor for centuries; only some caught up more recently.

For example, the same countries that surged ahead after 1500 were also the first to undergo an Industrial Revolution (Comin, Easterly, and Gong 2010). Figure 1 illustrates the persistence of per capita income over the long term, plotting levels in 1500, 1700, 1820, and 1998 against each other. The correlation coefficient ranges from 0.46 to 0.8, and is highly significant in every pairwise comparison. A naïve regression of income levels in 1998 on per capita income in 1500 can explain more than 20 percent of total variance; incomes in 1820 predict 64 percent of cross-sectional differences. If the relationship is already strong when looking at countries, it is even stronger when adjusted for ancestral population movements (Putterman and Weil 2010). One of the best predictors of an individual’s income today is the level of riches attained by that person’s ancestors hundreds of years ago.

In this paper, we argue that Europe’s rise to riches during the First Divergence was driven by the nature of its politics after 1350 – a highly fragmented continent characterized by constant warfare and major religious strife. Our explanation emphasizes two crucial and inescapable consequence of political rivalry: war and death. No other continent in recorded history fought so frequently, for such long periods, killing such a high proportion of its population. When it comes to destroying human life, the atomic bomb and machine guns may be highly efficient, but nothing rivaled the impact of early modern Europe’s armies spreading hunger and disease.

Figure 1: Scatterplot of Per Capita Incomes in 1500, 1700, 1820, and 1998



Note: Data are from Maddison (2001), and the countries with data availability for 1500-1820 include the European countries, as well as Brazil, Mexico, China, India, Indonesia, Japan, Philippines, Iran, Iraq, Turkey, Egypt, and Morocco.

In a Malthusian world, the amount of land per person was the prime determinant of per capita output. Wars were so common, and their impact was so severe, that they raised average death rates in early modern Europe significantly.<sup>3</sup> In turn, this spelled higher land-labor ratios in agricultural production and thus higher per capita income (Voigtländer and Voth 2013a). War therefore helped Europe's precocious rise to riches because the survivors had more land per head available for cultivation. We argue that the feedback loop from higher incomes to more war and higher land-labor ratios was set in motion by the Black Death in the middle of the fourteenth century. As surplus incomes – over and above subsistence – increased, tax revenues surged. These in turn financed near-constant wars on an unprecedented scale. Wars raised mortality not primarily because of fighting itself; instead, armies crossing the continent spread deadly diseases such as the plague, typhus, or small pox. The massive, continued destruction of human life that followed

<sup>3</sup> In England, for example, average life expectancy fell from 40 in 1580 to around 32 in 1700.

reduced population pressure. In our view, it was a prime determinant of Europe's unusually high per capita incomes before the Industrial Revolution.

A rapidly growing literature on persistence in economic performance has sought explanations for the long arm of history – the puzzling extent to which past economic performance continues to predict present economic outcomes. Focusing on the British case, Voigtländer and Voth (2006) model productivity advance as an externality from capital use, and show how higher pre-modern incomes can improve the chances of industrializing. Comin, Easterly, and Gong (2010) argue that technological leadership is bequeathed from generation to generation, while Spolaore and Wacziarg (2009) conclude that genetic distance to the technological leader – a proxy for how long ago two populations shared a common ancestor – is a key predictor of per capita incomes.

We begin by describing the economic logic of the Malthusian world, explain why existing interpretations struggle to make sense of Europe's early and sustained lead in per capita income, and introduce the evidence for our own interpretation in more detail. We also compare our results for Europe with the Chinese case before discussing why alternative interpretations of the First Divergence are ultimately unconvincing.

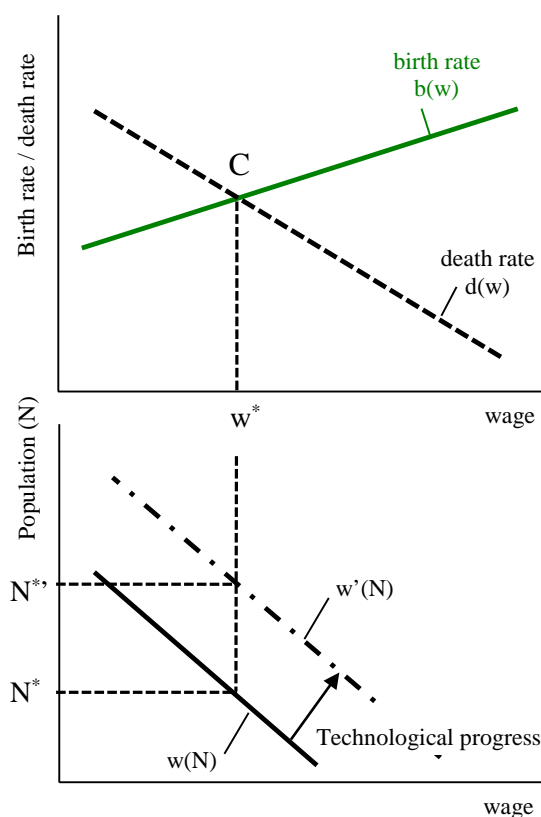
### **The Puzzle: Sustained Riches in a Malthusian World**

Malthus today is a byword for economic stagnation. His “iron law of wages” implies that technical advances cannot lead to greater riches: Whenever additional income became available, it would translate into population growth. In the Malthusian worldview, fertility reacted faster to positive income shocks than technology could grow, and wages quickly returned to their previous levels. In the polemical novel *A Modern Utopia*, H.G. Wells (1905) summarized this view by writing that earlier generations “spent the great gifts of science as rapidly as it got them in a mere insensate multiplication of the common life.”

The underlying reason is that – with land as a key factor of production in fixed supply – marginal returns to labor declined quickly. Population growth spelled lower land-labor ratios and fewer units of land per head meant lower productivity. After the Industrial Revolution, the world escaped the Malthusian trap by finding ways to produce output that relied less and less on non-reproducible factors of production (Hansen and Prescott 2002). Land is a negligible part of the capital stock in most modern economies; population growth only has second-order effects for output per head.

A well-known implication of the Malthusian model is that death and birth rates alone pin down the long-run equilibrium wage. Fewer births, or a higher death rate, both translate into higher incomes, because of reduced population pressure. Thus, high mortality could be good news for living standards of the survivors. Indeed, European incomes peaked after the Black Death in 1350, reaching levels not attained again until the nineteenth century. In other words, it took until the reign of Queen Victoria (1819-1901) for per capita incomes to return to the levels last seen under Richard III (1452-1485).

Figure 2: Unique Equilibrium in the Malthusian Model



Note: In the Malthusian model, birth rates increase with wages, while death rates decline (upper panel). Wages, in turn, depend negatively on population (lower panel) – due to decreasing returns to labor in an economy with fixed land supply. The intersection of birth and death rates yields zero population growth, and thus a stable population  $N^*$ . If mortality shocks move wages beyond  $w^*$ , population grows. Rising population exerts downward pressure on wages, and the economy returns to point C. If technology improves, the  $w(N)$  schedule shifts out, so that a higher population can be sustained at any given wage. However, technological change does not affect the steady state wage  $w^*$ .

Figure 2 illustrates the standard Malthusian model. Death rates fall as wages increase; birth rates rise. Where the two intersect at point C, population growth is zero. This defines the equilibrium wage  $w^*$ . As the lower panel shows, there is a trade-off between population size and average wages, reflecting declining marginal returns. The system is self-equilibrating: Temporary reductions in population size (due to a one-off mortality shock, such as the Black Death) will lower population and raise wages. Population growth will set in, and it will continue until the economy returns to the same equilibrium levels of population  $N^*$  and  $w^*$ . An innovation in technology will raise wages above  $w_C$  temporarily (to see this, move horizontally from  $N^*$  to the new technology schedule  $w'(N)$  in Figure 2). As a result, population grows. This, in turn will reduce land-labor ratios, leading to lower wages. In the long run, the economy will return to  $w_C$ , but at a higher population level  $N^{*'}$ . Therefore, one-off technological improvements will not raise wages in a sustainable fashion.

The Black Death boosted effective resources per unit of labor to an extent that could not be reversed within a few generations. In the long run, incomes should have returned to the pre-plague level. After 1350, wages indeed spiked in Europe, and then trended downwards as population recovered. But in this particular case, incomes never returned to pre-plague levels. To understand why, we need to think through the logic of Malthusian forces more generally.

The world prior to the Industrial Revolution was largely governed by Malthusian forces (Ashraf and Galor 2011; Clark 2007): that is, higher wages caused population growth to accelerate; higher population pressure reduced incomes. Some authors have doubted that Malthusian forces were strong in Europe before 1800. Since population influences wages, and wages influence population size (via marriage rates and mortality), it is not easy to identify directions of causality. Three approaches have been pursued. Nicolini (2007) and Crafts and Mills (2009) use vector autoregressions -- which begin by not making any assumptions about directions of causality -- to argue that Malthusian forces were relatively weak. Anderson and Lee (2002) offer similar findings. Kelly (2005) instead uses weather as an instrument for wages, and finds significant evidence for rising fertility and declining mortality in response to positive shocks to agricultural productivity in medieval and early modern England. This suggests that Malthusian forces were strong, with population growth responding quickly to increasing income. The results by Kelly seem more in line with the aggregate evidence: In England before 1750, there was a sharp trade-off between population size and per capita incomes (Wrigley and Schofield 1989). This pattern also holds true outside Europe: Chen and Kung (2012) use weather variability to show that Malthusian forces were important in Qing China.

In a Malthusian world, neither technological advances nor improvements in institutions can lead to sustained increases in per capita output. A high rate of technological change in the pre-modern era was 0.25-0.5 percent annually—which implies a 28-64 percent increase over a century—while the average was about 0.1 percent annually (Galor 2005). On the other hand, human populations can easily expand at an annual rate of 3 percent or more, which implies an increase of more than 1,800 percent over a century. In other words, in a Malthusian economy the race between technology and population size is the turtle against the hare – technological change can almost never rise fast enough to overcome the deleterious effects of population growth. The same logic applies for institutional improvements. They, too, can improve the mapping from resources to output, just like technological advances—but it is highly unlikely that institutional improvements outpaced the ability of human populations to grow.

### **High and Stable Incomes after the Black Death: The Effects of War**

At its worst, early modern war from about 1400 to 1700 was more deadly than World War II in the most affected areas. During 1941-45, for example, the Soviet Union lost an estimated 24 million citizens, both combatants and civilians, out of a population of 168 million. This amounts to a loss of nearly 15 percent. German losses were somewhat smaller in proportion to the size of the population, while Polish ones were greater -- 17 percent of Poland's population died during wartime after 1939. By comparison, the United States and the United Kingdom during World War II only registered mild losses of less than 1 percent. In contrast, the two greatest periods of conflict

in the early modern period – the Religious Wars in late sixteenth-century France, and the Thirty Years War in Germany – claimed approximately 20 and 33 percent of the population, respectively.<sup>4</sup> While these estimates have large margins of error, war in the age of the musket could clearly be more devastating than in the age of tanks and aerial bombardment. How do we explain this puzzling fact?

The deadliness of war principally depends on two factors – the lethal power of weaponry, and the frequency with which non-combatants and soldiers succumb to hunger and disease. The killing power of modern arms is many times greater than it was in the past (Ferguson 2002, 2007), but death from hunger and disease has become less frequent over time. Before the nineteenth century, the disease channel was the most important driver of war-related mortality (Landers 2005). There are many examples. When Europeans arrived in the Americas, even minor ailments like the flu killed natives in large numbers. Major diseases like smallpox wiped out entire populations (Diamond 1997). It has been estimated that European diseases caused a collapse in Meso-American population size by 75 percent or more.

Something similar, if milder, occurred when an army marched through isolated villages in the European countryside. They brought the local population into contact with new diseases, causing major spikes in mortality. Trade could also spread diseases: the last plague outbreak in Western Europe, in Marseilles in 1720, was caused by a ship from the Levant. But armies were more potent vectors of disease. Typhus probably reached Europe via Spanish soldiers who contracted it on Cyprus; syphilis might have been brought back from the Americas, and plague famously spread throughout the Old World after a Mongol army infected the Genoese defenders of a trading outpost on the Crimea in 1347 (McNeill 2010). The more isolated populations were, the greater the mortality impact of a new disease. Exposure to new diseases was deadly for soldiers as well: During colonial wars in Africa, annual death rates could reach one-fifth or more.<sup>5</sup> As late as the early nineteenth century, Russian troops occupying Swedish islands caused a major increase in death rates – without any fighting. Prussian troops contracted smallpox when campaigning in France during the Franco-Prussian War, leading to an epidemic at home once they returned (Landers 2003a).

War did not just create temporary spikes in death rates; it raised average death rates by up to one third because it was so common.<sup>6</sup> One way to understand the effectiveness of war as a vector for disease is to look at the pattern of plague outbreaks in Europe. Following the catastrophic

<sup>4</sup> Total military and civilian deaths during World War II come from Clodfelter (1992) for the United States, United Kingdom, Japan, and Poland; from Hubert (1998) for Germany; and from Ellman and Maksudov (1994) for the USSR. Population estimates come from U.S. Census Bureau (2000); Mitchell (1988); Statistics Bureau of Japan (2011); Hubert (1998); Ellman and Maksudov (1994); Piotrowski (1997). For French religious wars, we use the death toll in Knecht (1996) and the population estimate in Dupâquier (1988), and Clodfelter (1992) for the German Thirty Years War.

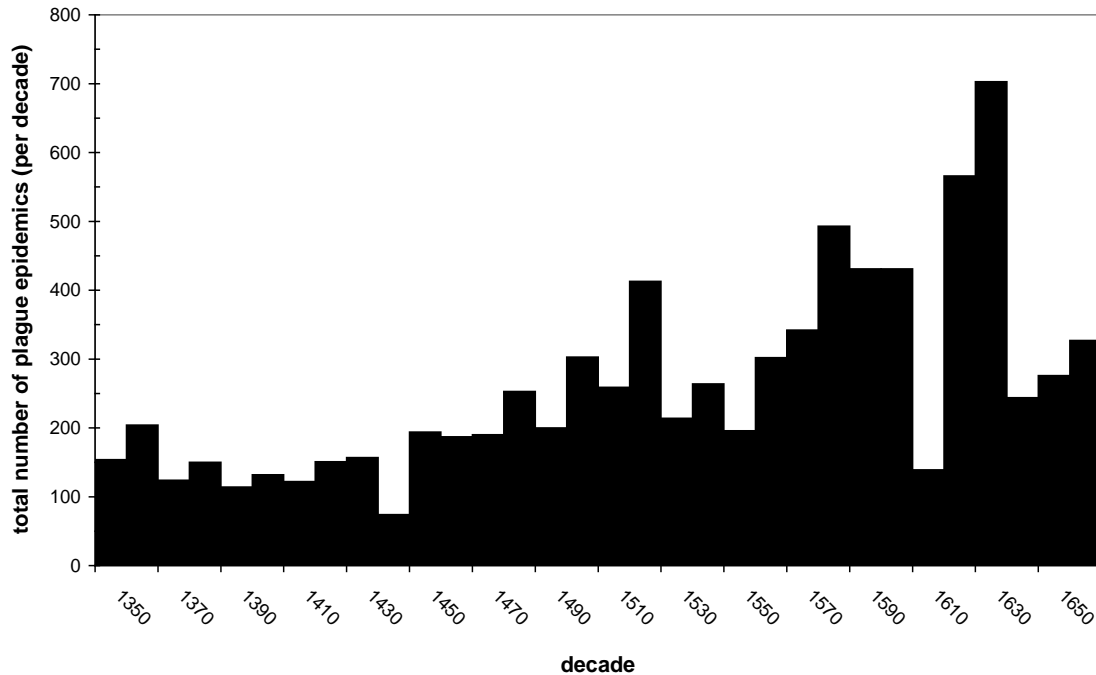
<sup>5</sup> During the two-month Logo expedition to what is now the country of Mali in 1874, the implied annual death rate was 2,940/1,000, which means that the average soldier had a life expectancy of around 4 months (Curtin 1998).

<sup>6</sup> We explain the details of this calculation in Voigtländer and Voth (2013a), where we marry micro-evidence on changes in death rates in regions affected by war (traced from data on which areas saw fighting or were traversed by armies) with estimates of the share of population exposed and the likely mortality impact.



outbreak of the Plague in 1348, a wave of epidemics followed. The detailed historical records demonstrate that many of them were spread by marauding armies. Figure 3 shows the number of epidemics per year, for the period 1350-1650. They increase gradually, numbering 20-30 per decade after 1350. From the early 1500s onwards, the pattern changes as the frequency of plague outbreaks rises rapidly.

Figure 3: Plague Outbreaks in Europe, 1350-1650



Source: Biraben (1975)

The disease channel was a particularly potent killer in Europe because of geographical fragmentation. The continent is divided by large mountain ranges such as the Alps and the Pyrenees, so that the movement of armies brought populations into contact with new germs. Political fragmentation also mattered: It went hand-in-hand with frequent warfare. Since the fall of Rome, Europe has never been dominated by a single power – the bids for supremacy by the Habsburgs, by France and Germany all conspicuously failed. Religious strife and dynastic conflict provided a large number of potential flashpoints; it took very little for war to erupt. European states in the early modern era fought each other like no other continent in recorded history has done before or since. Mortality was so high partly because wars lasted so long: The Religious Wars in sixteenth-century France lasted for 36 years; the Thirty Years War, 30 years; the War of Spanish Succession for 13 years, the war of the Austrian Succession, eight years; and the Napoleonic Wars, 23 years. In comparison, twentieth century wars were relatively brief affairs, with World War I lasting four years, World War II for six years, and the Korean War for three years. Military technology was partly to blame – the rise of modern fortifications made long drawn-out sieges a necessity.

During the period 1500-1700, on average, almost every year saw a war between great powers under way. Warfare was not only frequent after 1500; it was a near-permanent feature of

the political landscape. Tilly (1990) calculates that for every 100 years in the sixteenth and seventeenth centuries, there was a great power war under way in 95 of them; the rate for the eighteenth century is only marginally lower. In comparative terms, the nineteenth century saw much lower frequency of conflict, with only 40 out of 100 years affected, as shown in Table 2. Even the twentieth century -- termed the “Age of Extremes” by Hobsbawm (1994) -- only saw a major armed conflict in a little more than half of all years.

Table 2: Frequency of War

Century	Number of wars	Average duration (years)	Percentage years under warfare
16 <sup>th</sup>	34	1.6	95
17 <sup>th</sup>	29	1.7	94
18 <sup>th</sup>	17	1.0	78
19 <sup>th</sup>	20	0.4	40
20 <sup>th</sup>	15	0.4	53

Source: Tilly (1990). A year is considered “under warfare” if there is at least one war involving the great powers taking place during any part of that year. The great powers are England, Spain, France, Austria, Russia, and the Ottoman Empire.

Of course, wars are not equal in their destructiveness; the Thirty Years War lasted for three decades and killed millions; the War of Jenkin’s Ear (1739-41) lasted for two years and only caused minor casualties – although it did eventually merge into the War of the Austrian Succession. One indicator of intensity is battle frequency. Europe saw fewer than 100 battles per century from the ninth through the thirteenth century. The number of battles then jumped to 138 in the fourteenth century, and rose steadily to 521 major battlefield engagements in the eighteenth century. If one looks at the percentage of the population affected, the numbers tell a similar story of extremely high levels of conflict: At the height of early modern warfare, during the Thirty Years War, close to half of the European population was affected by military conflict in a given year.<sup>7</sup>

Given these rising levels of war and disease, why were Europeans so much more productive by 1700 than they had been in the Middle Ages – and so much more productive than the rest of the world? We argue that the particular type of warfare that characterized Europe after the Middle Ages is an important part of the answer. Before 1800, battlefield deaths and direct victims of armed force were few; civilian and military deaths from disease were plentiful. The imbalance between violent killing and death from disease also has important implications for the economic impact of

<sup>7</sup> For a detailed derivation of this figure, see Voigtländer and Voth (2013a).

war. It acted more like a neutron bomb: because of disease, early modern warfare destroyed human life quickly, while it did not wreak havoc on infrastructure on a scale comparable to modern wars.<sup>8</sup>

Recovery could be quick where only wooden houses needed rebuilding. Since European agriculture did not rely on elaborate irrigation systems (as did the Middle East, for example), the direct effects of war were limited to destroyed farm buildings, stores, and livestock. All of these typically could recover or be rebuilt in short order. As Malthus (1798) observed:

The fertile province of Flanders, which has been so often the seat of the most destructive wars, after a respite of a few years, has appeared always as fruitful and as populous as ever. Even the Palatinate lifted up its head again after the execrable ravages of Louis the Fourteenth.

Similarly, after the Turkish siege of Vienna in 1683, the speed of recovery was astonishing. As one observer put it: “the suburbs ... as well as the neighboring countryside ... have been completely rebuilt in a short space of time” (Tallett 1992). Land left fallow increased in fertility. Livestock had high rates of reproduction, so that herds could be rebuilt quickly.

War as practiced in this time therefore combined two characteristics that mattered for economic outcomes: it was highly destructive of human life, and it was largely ineffective in destroying infrastructure and capital stock. While the amount of useful land and the size of the capital stock only fell little as a direct result of war, military conflict before 1800 was massively destructive of human life. In other words, war was highly effective in increasing the ratio of land and capital relative to the size of the population. In a Malthusian world, frequent war could act as a powerful force raising per capita incomes for the survivors.

Thus, our theory is based on what we call a “Malthusian circle.” In our view, the Black Death acted as a temporary shock, propelling those Europeans who survived to a higher steady-state level of income. The higher income level led to more tax revenues for government, which increased the frequency of war. War spread more disease, thus leading to higher mortality and causing a further increase in land-labor ratios. In turn, this led to higher incomes, higher taxes, disease, and higher per capita incomes for the survivors.

### **Empirical Evidence for Two Key Hypotheses**

Our argument for a “Malthusian circle” involves two key steps: Rising incomes after the Black Death should have led to higher government revenues, and most of these were spent on war. Our argument also implies that warfare had a silver lining: By shifting death schedules upwards it spelled higher per capita incomes for survivors. Thus, countries that fought more wars should have

<sup>8</sup> A key exception is the destruction of cities. When early modern cities were taken after a siege, they sustained damage that is comparable or worse than that of aerial bombardment during World War II. For example, when Magdeburg was taken by Imperial forces in 1631, the entire city was burned to the ground, more than 90 percent of homes were destroyed, and an estimated 20,000 (out of 35,000) inhabitants lost their lives. The bombing of Dresden caused 20,000-25,000 casualties, out of a population of 650,000 (Cunningham 2000; Neutzner 2010). While the destruction of cities was not minor, there are few countries where the urban share exceeded 10 percent before 1700.

seen greater increases in their per capita incomes over the early modern period. Here, we consider evidence bearing on this hypothesis.

### *Incomes and Taxes*

Government revenues in Europe exploded after 1500. In 1509, the main European powers had annual silver revenues equivalent to 214 tons; by 1789, this had risen 32-fold, to 6,845 tons. Only a small part of the overall increase reflected a decline in the value of silver; most of it came from much higher taxes on (rising) income.<sup>9</sup> In Table 3, we show total tax revenue and the average tax burden per capita, as a multiple of urban daily wages. The data are ultimately derived from detailed, country-level data on fiscal revenues over time, extracted from the administrative archival records preserved for each state. All tax revenues are expressed in terms of silver, and have been compiled in a comparable format by Karaman and Pamuk (2010). Countries included are England, France, Venice, Prussia, Poland, the Dutch Republic, Spain, Austria, and the Ottoman Empire. Data on urban wages are from Allen et al. (2011). The rise in tax revenues is also dramatic when expressed relative to income: In 1509, the average European taxpayer had to render unto his prince the equivalent of less than four days' pay; by 1789, on the eve of the French Revolution, this had tripled to more than 12 days' wages.

Table 3: Tax Revenues in Europe

year	Total Tax Revenue (tons of silver)	Average Tax Per Capita (daily urban wage equivalents, p.a.)
1509	214	3.7
1559	456	3.6
1609	1,116	4.9
1659	2,215	5.7
1709	2,667	8.1
1759	3,808	9.9
1789	6,846	12.2

Notes: Data are from Karaman and Pamuk 2010, who use country-level historical compilations of revenue statistics. The main database is the European State Finance Database (ESFD).<sup>10</sup> They use silver as the measure of fiscal revenue because all national currencies were convertible into it. The original source for the urban wage series is Allen 2001.

Taxes after 1500 rose much faster than population size. One factor that supported growing tax revenue was growth in per capita incomes – the very fact at the root of the First Divergence. O'Rourke and Williamson (2002) estimate that European *surplus* incomes – that is, the amount above subsistence -- on average grew by 0.4-0.5 percent per year from a very low base, much faster than incomes themselves. As income grew above subsistence levels, they could increasingly be taxed by the belligerent princes of early modern Europe. Out of every unit increase in “surplus”

<sup>9</sup> Inflation after 1550 ran at less than 2% p.a.

<sup>10</sup> It is available at [www.esfdb.org](http://www.esfdb.org).

above-subsistence incomes, European states successfully appropriated about one third (Voigtländer and Voth 2013a).

The vast majority of early modern tax revenues was spent on war. European states at this time routinely spent 70-80 percent of their income on armies and navies. In wartime, spending exceeded revenue by a large margin; repaying the past debts thus accounted for a good share of the remaining expenditure.

At this time, financial strength mattered a great deal for military success. Warfare during the early middle ages had been a relatively cheap affair; armies were small, and usually consisted mainly of vassals who were obliged to follow their prince into battle (Landers 2003a). In the early modern period, a “military revolution” transformed the face of battle. Armies used firearms which required extensive training; standing armies became the norm. Huge new fortifications were necessary to protect cities, because medieval city walls had been rendered ineffective by the invention of the cannon. These costs quickly bankrupted fiscally weaker states, and financial prowess became a prime determinant of military success. As a Spanish 16th-century soldier and diplomat, Don Bernardino de Mendoza, eloquently put it – “victory will go to whoever possesses the last escudo” (Parker 1977).

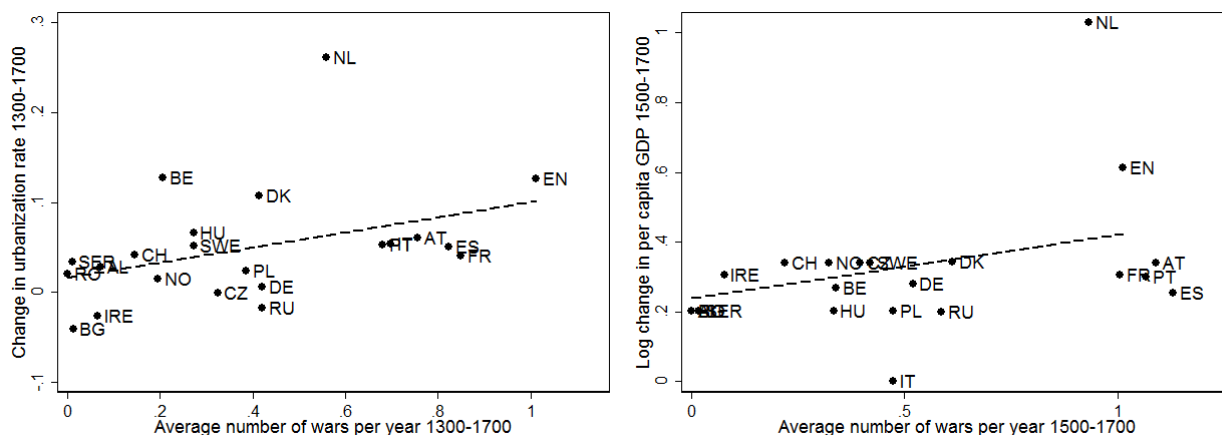
### *War and Rising Riches*

Did the continuous and near-universal warfare on the European continent lead to higher incomes? We combine data on the incidence of early modern warfare at the country level with two indicators for economic development, urbanization and per capita GDP. The size of urban centers is from Bairoch, Batou, and Chèvre (1988), which we combine with population estimates from McEvedy and Jones (1978) to obtain the percentage living in urban areas. As a result, we have country-level urbanization rates covering the early modern period between 1300 and 1700. As a consistency check, we also use urbanization data from DeVries (1984), which are available from 1500 onwards. In addition, we use per capita income data from Maddison (2001) which is available in 100-year intervals from 1500 onwards. To measure the extent of warfare, we employ the years of warfare from Kohn (1999).

We analyze a cross-section of states in early modern Europe. To measure economic progress we use the change in urbanization between 1300 and 1700, and the change in per-capita income between 1500 and 1700. Our explanatory variable is war frequency over the time interval corresponding to each of the two outcome variables. The left panel of Figure 4 shows that a higher war frequency between 1300 and 1700 is associated with a larger increase in urbanization. Countries with above-average frequencies of armed conflict, such as the Netherlands, France, and England, gained urban population at a quick rate; those fighting fewer wars, such as Ireland, Switzerland, and Norway, saw only limited progress. The correlation coefficient is 0.40. The same pattern is visible for per capita income (right panel), with a correlation coefficient of 0.28.<sup>11</sup>

<sup>11</sup> Here, we use data starting in 1500, as calculated by Maddison (2001).

Figure 4: Warfare and European Development



We look at the relationship between warfare and income growth in a variety of ways. First, we split the countries into two groups, those with below-average and above-average war frequency. We find that both measures of urbanization as well as per capita GDP grew significantly faster in countries with an above-average number of wars. For example, urbanization rates grew by 7.4 percentage points between 1300 and 1700 in countries with above-mean war frequency, vs. 2.8 in the remainder. Per capita income grew almost twice as fast in 1500-1700 in countries with above-average warfare. These differences are statistically significant at the 5 percent level.

In simple bivariate regressions, we also find a large and statistically significant relationship between the number of wars and increases in urbanization. The baseline specification implies that in a country with one war per year on average between 1300 and 1700, urbanization rates rose by 7.6 percentage points faster over the same period, as compared to a country without warfare. Two close examples for these numbers are England, with 1.012 wars per year between 1300 and 1700 and a relatively high degree of urbanization, and Romania, with zero.<sup>12</sup>

## The Chinese Mirror

So far, we have focused on patterns within Europe, but this begs the question why other parts of the globe did not “benefit” on a per capita basis in the same way. After all, war (and plagues) were hardly a European prerogative. Here, we focus on the case of China, which is particularly instructive because its starting position in the Middle Ages was seemingly so strong:

<sup>12</sup> We also experimented with using country fixed effects, as well as adding a dummy variable for Western Europe, for Roman heritage, etc. None of these alternative specifications undermines our result. Below, we discuss one prominent alternative interpretation (Acemoglu, Johnson, Robinson 2005) in more detail. When we add their preferred variable, Atlantic coastline, it is statistically significant, but war remains highly significant. There is good evidence to suggest that trade opportunities across the Atlantic also helped to raise incomes. But all of our comparisons suggest that war mattered over and above the effects of trade.

It was politically unified, had a career bureaucracy chosen by competitive exam, and an impressive track record in terms of useful inventions and innovations.

That China had fallen behind significantly in per capita income by the early nineteenth century is not in doubt. Urbanization rates were low; incomes were a small fraction of their European equivalents. The country was also politically and militarily weak, and was about to be humiliated at the hands of European powers.

Our interpretation attributes a good part of China's relative decline to its low levels of military conflict. After the Yuan Dynasty (1271-1368) was deposed in a series of revolts, comparative peace reigned. Under the Ming and Qing Dynasties (1368-1644; 1644-1912), the country remained politically unified for a half a millennium. Frequency of military conflict was dramatically lower in China: Europe saw 443 wars during the period 1500-1800 (a frequency of 1.48 wars per year), involving 1,071 major battles. The corresponding figures for China are 91 wars between 1350 and 1800 (a frequency of 0.2 per year), and only 23 major battles – most conflicts were peasant revolts (Tilly 1992; Jaques 2007). In other words, the frequency of war per year was 85 percent lower, and the number of major battles, 98 percent lower than in Europe.

Not only was war less frequent in China; it also caused fewer deaths. The majority of the population tilled the soil within a few hundred kilometers of the Eastern seaboard. There were few natural obstacles to population movements and trade. The epidemiological evidence, where it exists, suggests that disease pools were largely integrated by the year 1000 (McNeill 1976). As a result, diseases spread by troops did not have the same devastating impact in China as they did in Europe.

In this setting, China experienced considerable population pressure. During the early modern period, Chinese population increased by an estimated 280 percent; the corresponding figure for Europe is 140 percent (Maddison 2007). Europeans visiting China noticed the abundance and the cheapness of labor. As Malthus (1798) observed: “The country (China) is rather over-peopled ... and labour is, therefore, so abundant, that no pains are taken to abridge it.”

The view that China fell behind economically, and that its demography is partly to blame, is controversial. In *One Quarter of Humanity*, Lee and Wang (2001) challenged the earlier consensus that Chinese fertility rates were much higher than European ones. While marriage was universal, they argued, within-marriage fertility rates were relatively low. The current consensus view is that there is some merit in the argument, but that total fertility rates in Europe were probably still markedly lower (especially taking into account how much higher incomes were).<sup>13</sup>

If population pressure in China was much higher than in Europe, but higher fertility rates were only part of the answer, then lower mortality must be part of the story. Notice that China being poorer should actually have produced relatively *high* mortality rates: after all, many health risk factors and diseases before 1900 were nutrition-sensitive, and lower incomes probably resulted

<sup>13</sup> The relevant variable in a Malthusian setting is the income-adjusted fertility rate, accounting for the upward-sloping birth schedule in the Malthusian model. Total fertility rates measure the expected number of children a woman would have over the course of her life.

in higher death rates from tuberculosis and the like. Thus, the absence of major war-induced mortality is a plausible explanation for why Ming and Qian China experienced such a substantial population boom.

### **Alternative Interpretations**

We are not the first to examine Europe's relative rise to riches after 1500. Alternative interpretations have emphasized the role of technological innovations, of institutional improvements, and of fertility restriction. Theoretically, it is possible that a positive income shock driven by all or one of these factors gave rulers the means to fight more – explaining the positive correlation between war and income growth, but without any causal connection. Such an alternative interpretation is unlikely, for several reasons.

Acemoglu, Johnson, and Robinson (2005) show that European outperformance was largely driven by states bordering the Atlantic. In England and the Dutch Republic, trading opportunities strengthened the bourgeoisie, which in turn succeeded in constraining the powers of rulers. On the Iberian peninsula, in contrast, the discovery of the Americas gave extra resources to powerful monarchs; as a result, institutional quality declined. The implication of this argument is that North-Western Europe owed its precocious lead over the rest of the world to institutional improvements, most of which occurred along the Western seaboard of the continent. Their interpretation is part of a broader approach to European – and in particular, British – outperformance.

Another prominent interpretation emphasizes Europe's growing ability to innovate (Mokyr 1992) and contrasts it with technological decline elsewhere. While medieval Europe had even forgotten some of the useful inventions of Rome – such as concrete – technological creativity flourished after 1500. From the invention of the printing press with moveable letters and the barometer to vastly improved sailing ships, steel ploughs, and hot air balloons, Europe excelled at producing new and useful goods in the early modern period. In contrast, the famous “four great inventions” of China (compass, gunpowder, printing, and paper making) marked an early period of technological advance that found no echo in the early modern period. The underlying reasons for Europe's technological advance at this time are still a subject of research, but it seems plausible that the shortage of labor helped to encourage a search for labor-saving devices, and that ongoing military conflict created pressure for innovations and a conduit for spreading ideas (Allen 2009b).

The principal problem with both the technological and the institutional interpretation is that they are not well-suited to explaining income divergence in a world dominated by demographic forces. Ashraf and Galor (2011) demonstrate that there are no significant gains in per capita incomes from productivity improvements during the Malthusian era. The reason is that human populations typically grow rapidly when faced with abundance. For productivity improvements to push up per capita living standards, they would have to be faster than the rate of population growth.<sup>14</sup> In terms of orders of magnitude, this was highly improbable in the period before 1950

<sup>14</sup> In Voigtländer and Voth (2013a), we show that in a calibrated Malthusian model, even a sudden jump from technological stagnation to ongoing technological growth at the early modern rate of 0.1% p.a. would not have had a substantial impact on p.c. income or urbanization.



(human populations can easily grow at more than 3% p.a., while technological change was probably less than 0.1% p.a. on average).

This leaves demographic interpretations. In any Malthusian system, incomes are ultimately determined by mortality and fertility rates. Europe's level of mortality regime was uniquely high, and war was an important component of it. Other factors also contributed to the fact that, at least for some part of this time period, mortality rates could rise at the same time as incomes grew. As incomes rose, Europeans crowded into more and larger urban centers. Cities in Europe before 1850 were veritable death traps, with mortality rates much higher than fertility rates. Poor sanitation and urban overcrowding were to blame. Therefore, not only did the development of cities reflect rising per-capita incomes; these cities also helped to sustain incomes, much in the same way as war did, by keeping land-labor ratios high.

While the mechanism of disease-ridden cities adding to mortality is the same as for war, it is quantitatively much smaller. Even as late as 1800, only 10 percent of Europeans lived in cities with more than 10,000 inhabitants (DeVries 1984). Even if these city-dwellers suffered markedly higher mortality, they could not influence aggregate death rates by much.<sup>15</sup>

A similar argument applies to the effect of trade. Trade typically increases with incomes, and it can act as a potent vector for diseases. While little is known quantitatively about the volume of trade before 1800, it is reasonable to assume that increasing contact between distant population centers led to the exchange of germs and higher mortality. In related work, we estimate the size of the plausible effects, and find that they are quantitatively small, adding no more than 0.25 percentage points to annual European death rates of approximately 3% (Voigtländer and Voth 2013a).

Another factor that could have helped hold down Europe's population growth and thus improve its performance in a Malthusian world is fertility restriction. Europe evolved a unique form of fertility limitation. Europeans of this time typically married late -- in their mid-20s, not much earlier than they do today. A significant share of women also remained unmarried (Hajnal 1965). The reasons for this phenomenon (which only existed west of a line from St. Petersburg in Russia to Trieste in Italy) are complex. Most interpretations emphasize economic factors, such as the culturally determined need for newlyweds to set up a new household ("neo-locality"), the availability of fluid urban labor markets, inheritance rules, and the increasing use of females in pastoral agriculture (De Moor and Van Zanden 2010; Voigtländer and Voth 2013b).

## Conclusion

The "First Divergence" -- Europe pulling ahead long before the Industrial Revolution -- has long posed a puzzle for growth theorists and economic historians. In a world with strong

<sup>15</sup> There are some exceptions: In the Netherlands, for example, the urbanization rate was so high that urban mortality on its own may have increased overall death rates by 0.5 percentage points, relative to a baseline of 3% (Voigtländer and Voth 2013a).

Malthusian forces, incomes should not have had much scope to rise and then stay elevated over long periods. And yet, this is what happened in early modern Europe.

In this paper, we argue that a good part of Europe's precocious rise to riches reflected "gifts from Mars" – permanently high per capita incomes for the survivors were an indirect consequence of near-constant, and deadly, warfare. We first show that despite small army size and relatively primitive weapons technology, war in the centuries before 1800 was a potent destroyer of human lives. The main cause of death was not armed force itself, but the spreading of disease: A single army of 6,000-8,000 men, dispatched from La Rochelle by Cardinal Richelieu to fight in the Mantuan war in 1628 may have killed up to a million people by spreading the plague on its march from France to northern Italy (Landers 2003b; Biraben 1975).

In a Malthusian world, population losses generally created higher incomes for the survivors – there was more land available per capita. These effects should have been transitory; as population recovered, gains in per capita output ought to have been reversed. After the Black Death hit in 1348-50, population losses were massive, and so were gains in per capita income, but one would expect these gains to fade over time. However, with income gains much greater than what could be eroded by population growth in a generation or two, rulers found ample surplus income (over and above subsistence) to tax. As they appropriated this surplus to a growing extent after 1350, war frequency surged. Rulers effectively treated war as a luxury good, and as money became available, fought ever more of them. The high frequency of war in turn made it easier to sustain the gains in living standards for those who survived.

The war channel for greater riches was particularly potent in Europe because of political fragmentation. Plagues also hit Justinian Rome, China, and the Middle East (McNeill 2010), without similar consequences. The Black Death in 1348-50 only acted as a catalyst for a simultaneous rise in the frequency of warfare and of per capita incomes because there were so many European states and statelets that could fight each other. And fight they did: war became a near-constant feature of early modern Europe.

In Dan Brown's *Inferno* the chief villain is a geneticist about to unleash a diabolical virus. He points to the experience of the Black Death to suggest that population losses can be beneficial, and that good economic times will follow. Our research suggests that this is misguided – sometimes, history offer little guidance for policy implications today. Most parts of the world have clearly escaped from Malthusian constraints; land-labor ratios no longer determine per capita income, except in the poorest countries. Instead, human capital, institutions and technology are key. This also means that the synergistic link between war, population losses, and higher incomes that we described is unlikely to occur again. As a result of technological advances, war today is vastly more destructive. It annihilates capital stock on a greater scale than it did in Europe before 1800. In addition, due to the complementarity between human capital and modern technology, the negative effects of population losses are much greater in modern wars. These changes in the nature of war and of production ensure that the silver lining caused by military conflict is much fainter today than it was in early modern Europe – effective resources per survivor will not increase as much after modern wars as they did when war was the "sport of princes".

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