The Long-Run Effects of Agricultural Productivity on Conflict, 1400–1900*

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Abstract: This paper provides evidence of the long-run effects of a permanent increase in agricultural productivity on conflict. We construct a newly digitized and geo-referenced dataset of battles in Europe, the Near East, and North Africa from 1400–1900 ce and examine variation in agricultural productivity due to the introduction of potatoes from the Americas to the Old World after the Columbian Exchange. We find that the introduction of potatoes led to a sizeable and permanent reduction in conflict.

Keywords: Conflict, Natural Resources, Long-run Development.

JEL Classification: D74; O13; Q34.

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1. Introduction

Understanding the relationship between a permanent rise in agricultural productivity and conflict is a central question for political economy and development economics. A large body of literature provides important evidence that transitory positive productivity shocks reduce conflict. However, there is much less evidence on the effect of a permanent rise in agricultural productivity. This is somewhat surprising given that economic development and change in the equilibrium level of conflict are both long-run processes, and economic growth has historically been characterized by permanent increases in agricultural productivity.

In agrarian economies, typical to historical societies and low-income countries today, increasing agricultural productivity can affect conflict for several reasons. On the one hand, improved agricultural productivity can reduce conflict. For example, the increase in productivity could reduce the requirement for land, which can reduce the competition over its control.[1] Similarly, an increase in agricultural productivity could increase real wages and the opportunity cost of fighting. On the other hand, improved agricultural productivity would increase conflict if the availability of cheap food reduces the cost of maintaining large armies. Thus, the net effect is ambiguous *ex ante* and, whether or not improved agricultural productivity reduces conflicts is, ultimately, an empirical question.

The goal of this paper is to make progress on this question by providing empirical evidence on the long-run relationship between a permanent increase in agricultural productivity and conflict. Our analysis faces two challenges. First, to examine the long-run effects, we need to observe conflict over a long time horizon. Second, to establish a causal relationship, one needs to find plausibly exogenous variation in a permanent change in agricultural productivity.[2] The principal contribution of our study is to address these two difficulties. To deal with the lack of data, we constructed a new dataset that includes all conflicts documented in two most extensive sources in the historical conflict literature, Clodfelter (2008) and Brecke (1999, forthcoming). We then manually digitized and geo-referenced information on the location of each battle to construct a

[1] This assumes that the demand for food is price inelastic such that an increase in productivity is not fully offset by an increase in demand, which leads to a decline in food prices and the value of land that is used to produce food.

[2] To understand this problem, assume that we find a negative association between conflict and agricultural productivity in the data. This does not necessarily mean that increased productivity reduces conflict, since the association is also consistent with reverse causal channels – i.e., reduced conflict could increase agricultural productivity or there may be a third factor which influences both variables – i.e., better institutions could both increase productivity and reduce conflict.

dataset that records the date and location of battles in Europe, North Africa and the Near East from 1400 to 1900 CE.

To establish the causal link from agricultural productivity to violent conflicts, we examine the introduction of potatoes from the Americas to the Eastern Hemisphere, which provides an exogenous increase in agricultural productivity in regions that were geographically and climatically suitable for potato cultivation. As Nunn and Qian (2011) have shown, this resulting increase in agricultural productivity led to increased population density, urbanization and health as measured by adult height.

Studies of contemporary conflict often take the polity as the unit of observation and examine conflict between polity pairs. In our setting there is a lack of continuity in polities over time and, so, such a strategy is not possible. Instead, we conduct our analysis at the geographic grid-cell level. Specifically, we construct a balanced panel of cells over time and compare outcomes across grid cells with different suitabilities for potato cultivation, before and after the introduction of potatoes.

Our analysis relies on a *differences-in-differences* (DD) estimation strategy that compares conflict in grid cells that are suitable for cultivating potatoes with those that are less suitable before and after the introduction of potatoes. Our unit of observation is a 400km$\times$400km grid cell during a fifty-year period. As we explain, we feel that these units best capture spatial and temporal spillovers, which are particularly important as one moves to finer levels of disaggregation. Since potatoes began to be adopted as a field crop in Europe in the late 1600s, we interpret 1700 as the effective date of introduction. Our baseline specification controls for grid-cell fixed effects, which accounts for all time-invariant differences across cells, and for time fixed effects, which isolates all changes over time that have similar effects across cells. It also controls for the interaction of the time fixed effects with the suitability for the cultivation of staple crops that existed before the introduction of potatoes, namely wheat, wet rice, dry rice, barley, and rye.

We find that the increase in agricultural productivity brought about by the introduction of potatoes dramatically reduced conflict. The relative decline began soon after the introduction and persisted over time. On average, a one-standard-deviation increase in potato cultivation reduced conflict by 0.26 standard deviations.

There are two important caveats for interpreting our results. The first is the concern of spatial spillovers, which is particularly important for conflicts between distant actors. For example, it is possible that the introduction of potatoes in a region suitable for its production induces that region to become aggressive towards another region that is less suitable for potato cultivation. This will cause the DD estimates to be negative, but they simply reflect a movement of conflicts from more-suitable to less-suitable locations. We undertake several tests to better understand whether our findings are due to this form of spatial spillover. First, we find that our results are similar when we extend the unit of analysis to larger grids, such as 800km $\times$800km cells, which is roughly the size of France today. Second, we also find that our estimates are similar if we exclude conflicts that involve actors who are distant from one another.

A second caveat stems from the concern that suitability for potato cultivation may be correlated with other factors that caused a reduction in conflict in the eighteenth and nineteenth centuries. To address this, we document the correlates of potato suitability and show that our results are robust to controlling for these factors as well. Specifically, we control for suitability to other staple crops introduced by the Columbian Exchange (e.g., maize, cassava, and sweet potatoes), geographic characteristics (e.g., distance to the nearest ice-free coastline, elevation, ruggedness, latitude, longitude, etc.) and weather shocks. To allow the influences of agricultural and geographical controls to vary over time in a flexible way, we interact each variable with time fixed effects. These controls also address the potentially confounding influences of changes in military and agricultural technology to the extent that such changes had differential effects depending on terrain or other geographic characteristics that are correlated with crop suitability.

As we discuss below, potatoes are highly resistant to cold weather and their adoption and cultivation could have insured against starvation during unusually cold weather spells. Thus, we test the possibility that potatoes may have reduced conflict by helping to smooth consumption through particularly cold winters. To investigate this, we construct an annual panel with historical winter-temperatures and estimate the interaction of cold temperature shocks and the introduction of potatoes. We find no evidence that the effect of potatoes on conflict was greater in years with particularly cold winters. Thus, it does not appear that cold winters are a primary driver of our results.

Our findings make several contributions to the growing literature on the determinants of conflict. For example, the pioneering studies of Miguel, Satyanath and Sergenti (2004) and Dube and Vargas (2013) link conflict to rainfall and commodity price shocks, which they interpret as evidence that increases in the opportunity cost of arming will reduce conflict. More generally, our study adds to the small but rapidly growing number of empirical studies that attempt to provide causal evidence on the determinants of conflict. These studies have found that conflict is, for instance, affected by foreign aid (Dube and Naidu, 2013, Crost, Felter and Johnston, 2014, Nunn and Qian, 2014).

Our findings support these earlier works in showing that conflict is sensitive to resource shocks. However, we conceptually and empirically differ from existing related work based on two accounts: One, we examine the long-run effects of a permanent change in productivity as opposed to transitory shocks. Distinguishing between the effects of transitory shocks versus permanent shocks is important since responses to transitory shocks might reflect shifts in the timing of conflict, and it is not conceptually obvious how such shocks should affect the equilibrium levels of conflict. By contrast, the finding that increased agricultural productivity from the introduction of potatoes reduced the levels of conflict for the subsequent two hundred years is likely to reflect a reduction in the equilibrium levels of conflict. To the best of our knowledge, the only other study to examine the effect of a permanent change is Jia (2014), which focuses on the role of sweet potatoes as insurance in reducing rebellions in historical China. Two, our empirical investigation covers a very large geographic domain and abstracts from country- and polity-level analyses. This allows us to explore geographic spillover effects whereby a permanent but localized agricultural productivity shock could lower conflict in areas suitable for potato cultivation but raise them in surrounding areas that are less so. Such spatial spillovers would influence the location of conflicts without affecting the propensity for conflict in general.

Our findings also contribute to prior studies that examine the determinants of historical conflict. For example, Onorato, Scheve and Stasavage (2014) estimate the relationship between military technology and army size among thirteen European powers from 1600 to 2000. Gennaioli and Voth (2015) study the importance of war finance for military success and provide important evidence for how this affected state-building in Europe during the Early Modern period.[3] Most closely related are studies of how natural resource endowments affect conflict. For example, Caselli, Morelli and Rohner (2013) provide cross-sectional evidence that the likelihood of inter-state conflict increases when at least one of the countries has mineral resources, especially if the resources are close to the border. Similarly, Acemoglu, Golosov, Tsyvinski and Yared (2012)

[3]They use an alternative dataset on historical battles constructed by Jaques (2007), which is quite similar to ours. See the Data Section for more discussion.

provide a theoretical basis for how an increase in natural resources such as oil can increase conflict.[4]

Our findings also add to the existing literature on the long-term effects of agricultural productivity, especially recent studies that investigate the long-term effects of the introduction of New World food crops on population density and economic growth (Nunn and Qian, 2011, Chen and Kung, 2016, Cherniwchan and Moreno-Cruz, 2019).

Finally, our study makes a general contribution to the conflict research literature by constructing a comprehensive digitized and geo-referenced dataset of conflicts. We hope that this dataset will facilitate future empirical research as we intend to make the dataset publicly available.

The rest of our paper is organized as follows. Section 2 discusses the historical background and the conceptual framework. Section 3 describes the data and empirical strategy. Section 4 presents the baseline estimates and robustness results. Section 5 provides additional findings. Section 6 offers concluding remarks.

2. Background and Conceptual Framework

A. *Conflicts*

We now turn to a discussion of the historical features of conflict that are relevant for our empirical investigation. Within the historical context of our study, conflicts were often waged to gain control of land, a key input in agricultural production. There was significant diversity in the individuals who were involved in the fighting. As Tilly (1992, pp. 68–71) explains, ordinary people had weapons at their disposal and nobles had a legal right to wage private wars in many parts of the Old World and throughout most of history. "Europeans followed a standard war-provoking logic: everyone who controlled substantial coercive means tried to maintain a secure area within which he could enjoy the returns from coercion" (Tilly, 1992, p. 70). In practice, this means that the conflicts that we examine include those between peasants, the nobility and/or sovereign rulers in any combination. The conflicts often include two actors, but they can also include more than two.

[4]For two other papers on the causality from resource shocks to the outbreak and incidence of civil wars, see Besley and Persson (2008) and Brückner and Ciccone (2010). Also, see Montalvo and Reynal-Querol (2005), Esteban and Ray (2011), Esteban, Mayoral and Ray (2012) for empirical and theoretical evidence on the relationship between ethnic polarization and conflict. Our study is also related to the large body of studies in political science that documents relationships between a number of economic factors and the incidence of civil war (Collier and Hoeffler, 1998, 2001, Fearon and Laitin, 2003, Sambanis, 2002).

Since new polities emerge and existing polities disappear over time, the identities of the actors can change in an ongoing conflict as well.

Conflict scholars have long recognized that the difficulty in defining the onset and termination of wars is how to aggregate or disaggregate sequential or simultaneous wars.[5] Consider the extreme example of the Hundred Years' War, which lasted from 1337 to 1453, and included at least five large polities (England, France, Scotland, Bohemia, Burgundy) engaging in armed conflict on both sides of the English Channel. In our study, we follow the strategy of the empirical literature on modern conflicts and avoid such difficulties by using "battles" as units of observation (defined as a location with conflict in a calendar year) rather than the larger war, (i.e., a series of battles which could be spread over many different locations and years) to which a battle may have belonged.

Several additional aspects are important to note about the context of our study. First, warfare in the medieval and pre-industrial eras was a highly seasonal activity, with hostilities typically coming to a halt during the winter months, only to be picked up again with the onset of warmer weather in the spring (Iyigun, 2008, 2015). This suggests that the incentive to arm might have been highly sensitive to agricultural wages. This motivates us to include an opportunity cost mechanism in our framework, which we discuss in the next section. Second, as past studies have noted, changes in military technology made warfare more expensive over time (e.g., Tilly, 1992). However, this should not affect the validity of our empirical strategy, which compares conflict across regions with differing levels of productivity within the same period, as well as conflict over time. We will discuss this more when we conduct our robustness exercises.

B. *The Potato and Agricultural Productivity*

Potatoes are native to South America and came to the Eastern Hemisphere via Europe during the Columbian Exchange. Upon arrival in the 16th Century, they were initially seen as an exotic curiosity rather than an edible crop. One of the first accounts of potatoes being widely cultivated is from England in the 1690s, where potatoes were used as a supplement to bread (Langer, 1963, McNeill, 1999). By the late-18th century, potatoes had become an important field crop in countries such as France, Austria, and Russia. Once Europeans began cultivating the potato, it spread fairly rapidly to other parts of the Western Hemisphere by European mariners who carried it to ports

[5] For a detailed discussion, see Levy (1983, pp. 63–69).

across Asia and Africa (Langer, 1963, McNeill, 1999). Since there are no data on the time of adoption for each region and the actual date of adoption may be endogenous to factors that could influence conflict, we follow Nunn and Qian (2011) and interpret 1700 to be the date of the adoption of potatoes. That is, we interpret 1700 to be the date when potatoes began to be cultivated as a major staple crop within Europe.

Potatoes provide many more calories per acre of land than pre-existing staple crops such as wheat, rice or barley. They are also rich in micronutrients and lack only vitamins A and D. In fact, humans can have a healthy diet from consuming only potatoes, supplemented with only dairy, which contains the two vitamins not provided by potatoes (Connell, 1962, Cook, 2014, Davidson, Passmore, Brock and Eastwood, 1975). Potatoes are also more resistant to cold weather than existing staple crops. Thus, the availability of potatoes allowed Europeans to increase the productivity of existing agricultural land as well as to bring marginal pieces of land in colder climates into agricultural production (Davidson et al., 1975, Reader, 2008).

In support of the claim that the introduction of potatoes increased agricultural productivity, Nunn and Qian (2011) show that the introduction of potatoes substantially increased height, population size, and urbanization.

C. *The Link between Potatoes and Conflict*

There are various reasons why a rise in agricultural productivity could have reduced conflict historically and, in our appendix, we present a model which identifies the mechanism first articulated by Acemoglu et al. (2012). Accordingly, a positive productivity shock in agriculture can lead to a reduction in the value of land and an increase in the returns to labor. This occurs when the demand for food is sufficiently inelastic.[6] In that case, a positive shock to agricultural productivity increases the output of food, which causes the price of food to fall by more than the demand/output increase. This reduces the value of land. And regardless of the elasticity of demand, the positive shock also increases real wages.

The decline in the value of land then reduces the incentive to engage in conflict, the goal of which is often to take control of this valuable asset. In addition, the increases in real wages due to improvements in agricultural productivity could also reduce conflict by raising the outside option

[6]For example, one can assume a Cobb-Douglas production function and estimate the price elasticity of food demand. Studies that have done this have found the price elasticity of food demand to be between -0.80 and -0.20, which is inelastic (e.g., Tobin, 1950; Tolley, Wang and Fletcher, 1969; Van Driel, Nadall and Zeelenberg, 1997).

and opportunity costs of those who fight in the conflicts. Following a positive productivity shock, the wage received when not fighting is higher. Higher wages may also reduce conflict decided by rulers, who obtain revenues from taxing labor. In short, following a positive productivity shock to agriculture, conflict can decline since the value of the land being fought over declines or it becomes too costly to fight.[7]

Of course, it is possible that potatoes may have influenced conflict through other channels we do not highlight in our theoretical framework. For example, the introduction of potatoes may have loosened the Malthusian checks and balances. Increased productivity could have reduced the incidence of local rioting and peasant uprisings, which are induced by living close to subsistence. Since the introduction of potatoes occurred when Malthusian links were weakening in most of Europe, this mechanism is consistent with the persistent effects of the introduction of potatoes. If Malthusian links are strong such that productivity gains are soon offset by fertility increases, then the benefit of potatoes will be temporary.[8]

Because potatoes could be grown in small and marginal plots of land, including in garden plots in urban centers, they were particularly beneficial for the poorest classes in society. Thus, not only did they raise average living standards, but they also likely decreased overall inequality. To the extent that inequality was a source of conflicts, this is another channel through which the introduction of the potato would have affected conflict, particularly smaller-scale within-country conflict.

Potatoes, more than other crops, are particularly resistant to cold temperatures as well. Thus, their introduction may have reduced conflict by helping to increase consumption during particularly cold winters.[9]

Another way in which potatoes may have affected conflict is by providing a better and more stable supply of food to both soldiers and citizens during war. For example, Salaman (1949, pp. 573–574) and Reader (2008, p. 119) argue that potatoes provided a source of food for foraging soldiers during wartime. The 'Kartoffelkrieg' or the 'Potato War' of 1778 to 1779 is a salient example of how greater availability of potatoes could have instigated and prolonged conflicts.

[7]Please peruse the model in the first subsection of our appendix for further details.

[8]See, for example, Galor and Weil (2000) for a model of the Malthusian regime and the transition process when Malthusian links weaken.

[9]This mechanism is similar to that found by Jia (2014) for the introduction of the sweet potato in China. There, the introduction of the sweet potato, which was particularly drought resistant, led to a weaker link between drought and conflict.

Potato beds could have been dug up and eaten by soldiers on active duty in the battlefields. This may have helped to, at least partially, alleviate one of the primary obstacles during war: how to feed soldiers. Similarly, potatoes also provided food for citizens and populations that were displaced during war. In addition, they were also more difficult to expropriate (Scott, 2009). Thus, scholars such as McNeill (1999, pp. 71–72) and Scott (2009, pp. 187–207) have argued that potatoes may have decreased the destructive impact of warfare because potatoes, which grew beneath the ground, were more difficult for soldiers to appropriate than traditional staples such as wheat and rye which grew above the ground.

The above-summarized channels indicate that conflict propensity could have decreased or increased after a permanent and positive productivity shock to agricultural productivity. Hence, the net effects are ambiguous *ex ante* and, whether or not improved agricultural productivity reduces conflicts, ultimately, requires an empirical investigation to which we turn next.

3. Data and Empirical Strategy

A. *Conflict Data*

Our conflict dataset was constructed in the following manner: We began with the most comprehensive existing list of conflicts and battles at the time (approximately six years ago), which was Peter Brecke's *Conflict Catalog*. This is an annual record of all violent conflicts with 32 or more combat deaths, starting in 1400 CE. For each recorded conflict, the following information is reported when available: (*i*) the number and identities of the parties involved in the conflict; (*ii*) the common name for the confrontation, if it exists; and (*iii*) the date(s) of the conflict.

While the Brecke data is a natural basis for our dataset, it does have some shortcomings. First, it only records violent conflicts with 32 or more combat deaths. Second, the data reported are at a more aggregate war level rather than at a location and time-specific battle level, where a battle is defined as fighting that is part of a larger war and occurs in a particular location at a particular point in time. Thus, we supplemented the Brecke data by identifying and locating up to four battles per each war that is listed in the Brecke Dataset.

We then augmented the Brecke catalog with information from Michael Clodfelter's (2008) *Warfare and Armed Conflicts*, which is a statistical encyclopedia of global conflicts (recorded at the battle level) from 1494 to 2007. We first digitized this encyclopedic resource by hand before combining the information with that from Brecke's catalog which we also digitized.[10]

There is not a perfect overlap in the two sources in terms of temporal coverage, with Clodfelter's coverage starting 94 years later than Brecke's. As we will show in our analysis, our findings are robust if we restrict our analysis to the period for which there is coverage by both sources or if we only use data from Clodfelter.[11]

Having compiled a digitized list of all known battles and their characteristics from the two sources, we then geo-referenced (i.e., assigned geographic coordinates) to the reported location of each conflict. In many cases, the location of a reported name led to ambiguity about its specific location. In these instances, additional research was done using secondary sources to provide our best estimates of the exact location of a battle.

The geographic coverage of our data ranges from approximately eight to 78 degrees latitude and -61 to 96 degrees longitude. This includes North Africa, the Near East, Europe, Greenland, and Iceland. The region of interest is divided into equal-area square grid cells. The temporal coverage of our datasets is all battles that occurred from 1401 to 1900.[12]

Our final dataset includes 3,968 *battles* that occurred between 1400 and 1900. Our battles count includes 300 sea battles, 1040 colonial land battles, and 151 colonial sea battles, all of which we omitted from our analysis. Before dropping these battles, the data include 327 battles in the 15th Century, 570 battles in the 16th Century, 642 battles in the 17th Century, 1,016 battles in the 18th Century, and 1,413 battles in the 19th Century. After dropping the aforementioned types of battles, our dataset includes 323 battles in the 15th Century, 436 battles in the 16th Century, 468 battles in the 17th Century, 556 battles in the 18th Century, and 694 battles in the 19th Century.

Our final dataset includes 1,152 *wars* that occurred between 1400 and 1900. Before dropping colonial wars and wars fought exclusively in the sea, our dataset includes 267 wars in the 15th Century, 242 wars in the 16th Century, 209 wars in the 17th Century, 146 wars in the 18th Century,

[10]A number of other sources of data on conflict are available. However, we felt that Clodfelter (2008) provides better details on battles and their locations than other references that primarily provide information on wars only (e.g., Kohn, 2007), and relative to other resources that include detailed information on battles (e.g., Eggenberger, 1985, Dupuy and Dupuy, 1993), it has a more extensive coverage of battles. Gennaioli and Voth (2015) use data from Jaques (2007) to analyze 374 battles in Europe between 1500 and 1800. The quality and detail of the information provided by Jaques (2007) and Clodfelter (2008) are comparable, with Clodfelter being slightly more comprehensive. For example, for our geographic area and our period of interest (1400–1900), Clodfelter records 115 more battles than Jaques.

[11]See Appendix Table A.1 for results using the Clodfelter data exclusively. Results using the narrower time windows over which our two data sources overlap are available upon request.

[12]We exclude the 20th Century because agriculture was economically less important and conflicts were unlikely to be driven by agricultural productivity during that period.

and 299 wars in the 19th Century (note that this number is slightly larger than the total number of wars since some wars take place in more than one century). After dropping colonial wars and wars fought exclusively in the sea, our dataset includes 899 wars in total occurring between 1400 and 1900, with 265 wars in the 15th century, 209 wars in the 16th Century, 175 wars in the 17th Century, 91 wars in the 18th Century, and 164 wars in the 19th Century (again, note that this number is slightly larger than the total number of wars since some wars take place in more than one century).

The main analysis will focus on the aggregate number of battles/conflicts in a location and time period. These aggregate figures include all conflicts irrespective of type, e.g. both interstate wars and intra-state conflicts, such as peasant rebellions or uprisings; both religious and non-religious wars; etc.

Figure 1 maps the location of the battles in our dataset, with the century in which the battle occurred indicated by its shading/color. The figure shows that, consistent with the known history of conflicts in the regions of study, the majority of conflicts took place within the modern borders of Austria, France, Germany, Italy, Poland, Russia, Spain, and Turkey.

To get a better sense of how the location of conflicts changed over time, in Appendix Figure A.1, we report the location of the conflicts separately for each century. This figure shows that conflicts moved from northwest to southeast over time, which is a known pattern that was originally identified by Parker (1995).

Our baseline empirical analysis uses 400km$\times$400km cells as the spatial unit of observation. Prior to settling on our baseline grid cell size, we undertake a series of tests to estimate the presence of potential spillover effects using different cell sizes (50km, 100km, 150km, and 200km cells). We find that 400km$\times$400km cells are the smallest size for which we do estimate spillover effects. Appendix Figure A.2 displays the geographic coverage of the 400km$\times$ 400km grid cells. In places such as modern Italy, one grid cell spans roughly the entire width of the continental land. The baseline conflict incidence results use 50-year time intervals. As we show in our analysis, our findings are robust to the use of different time intervals and grid cell sizes.

Our primary outcome of interest is the total number of *conflict incidents* in grid cell i during time period t. We use the term conflict or conflict incidence synonymously with battle which is defined as an episode of fighting that occurs in a specific location during a specific period of time. As we have noted, typically, multiple battles comprise a war. An example is the Battle of Waterloo

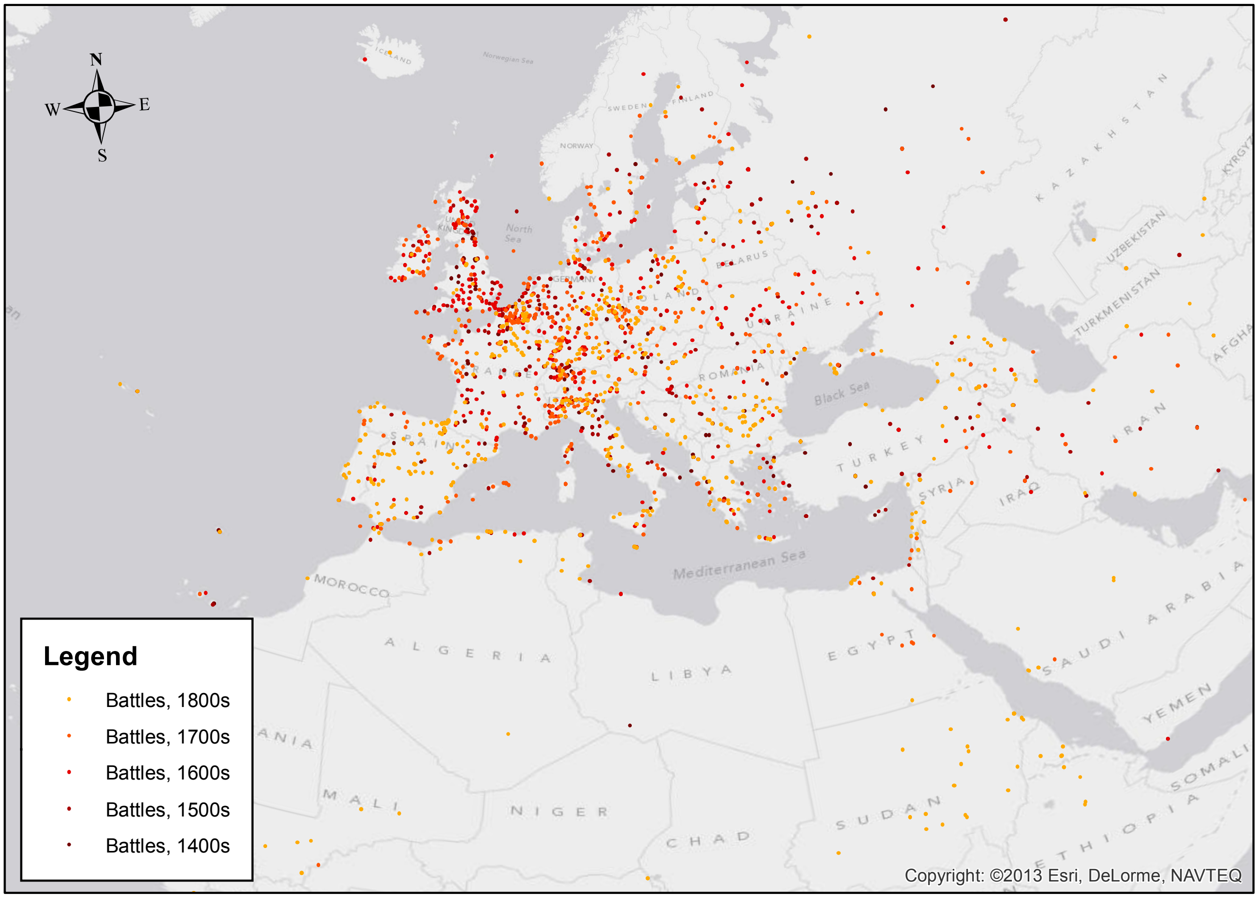

Figure 1: Conflicts, 1401-1900

in which a coalition of British and Prussian led forces dealt a heavy defeat to the French army on June 18th, 1815, thereby ending Napoleon's reign. This battle is recognized as the decisive conflict of the 12-year-long Napoleonic Wars, which pitted French forces under Napoleon I's command against an array of European countries in numerous smaller-scale wars and battles between May 1803 and November 1815.

To calculate the number of conflict incidences in a grid cell and time period, we first calculate the number of battles in our dataset in each grid cell and year. We then aggregate the number of battles across the time period of interest e.g., 50-years, 100-years, etc.

An important point to note is that if a battle takes place over multiple calendar years, it is counted as multiple battles. For example, if a battle occurs over two calendar years, it is counted as two incidents.[13] In our data, we find that about 75% of the battles lasted one year or less. Another consequence of our procedure is that if there are two separately listed battles that occur

[13]For example, a battle that lasts from 1401–1410 in location A will contribute ten conflict incidents to the grid cell which contains location A for the period 1401–1450. We count battles this way so that we capture not just the occurrence of a conflict but also the intensity (i.e., duration) of the conflict.

within the same grid cell (each within a calendar year), then these are counted as two conflict incidents.

Our baseline measure aggregates all battles that occur in a 400km×400km cell and over a 50-year period. Doing this results in 4,916 conflict incidents. On average, this comes out to 1.79 incidents per cell over a 50 year window, ranging from a low of zero to 105 incidents. Over time, the highest average number of incidents was 2.42 which occurred between 1801 and 1850 and the lowest was 0.86 which was recorded between 1851 and 1900.

B. *Potato Cultivation Suitability Data*

Our analysis follows Nunn and Qian (2011) and relies on a measure of the suitability of a location for potato cultivation, which is taken from the United Nations *Food and Agricultural Organization's* (*FAO*) Global Agro-Ecological Zones (*GAEZ*) database. We use the current version of the database, which is an updated version of the data used by Nunn and Qian (2011). The FAO database includes information on the suitability for the cultivation of 154 different crops across 2.2 million cells spanning the whole world, with each cell covering an area of 5 arc minutes by 5 arc minutes, or roughly 10km×10km. Using nine climate characteristics of each cell, such as frequency of wet days, precipitation, mean temperature, etc., the *FAO* calculated an estimate of the potential yield of each crop in each cell, given an assumed level of crop management and input use. With some additional data processing, the *FAO* then calculated the constraint-free crop yields and referenced the potential yield of each cell as a percent of this benchmark. The index ranges from 0 to 100.

The suitability measures across the land area of interest are shown in Figure 2. In the map, more suitable locations are represented by a lighter shade. The most suitable locations in our sample are in Northern and Eastern Europe. However, there is significant local variation within regions due to differences in elevation and microclimates.

Since the 10km×10km *GAEZ* cells are finer than the cells used in our analysis, we measure suitability at the cell level as the average suitability measure of all land within a grid cell. Other crop suitability measures used in our analysis come from the same source and are constructed in the same manner.

It is important for our study that the suitability measures that we use proxy for historical conditions. The FAO *GAEZ* database has several features that make this possible. In calculating suitability, the FAO's agro-climatic model explicitly avoids taking into account factors that are eas-

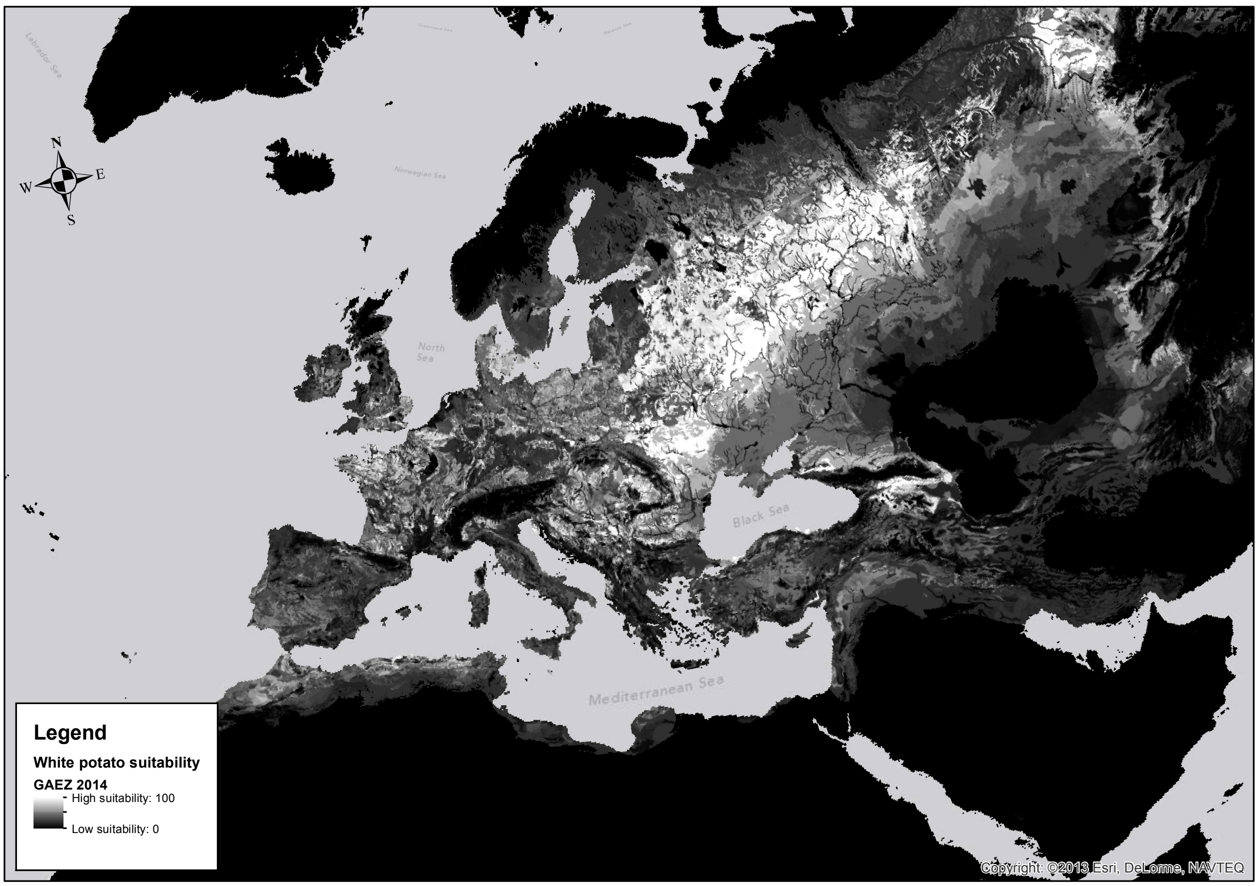

Figure 2: Suitability of Locations for Potato Cultivation

ily manipulated by human intervention. For example, the fact that Europe has been significantly de-forested over time does not affect the suitability measure because the number of forests does not factor into suitability. Instead, the model focuses on agricultural inputs that are difficult to manipulate such as climate and the average hours of sunshine in each season. Similarly, the GAEZ model allows us to choose inputs for factors such as mechanization and irrigation. We choose inputs to best approximate the historical conditions of the time. Thus, we measure suitability for cultivation when agriculture is rain-fed and there is low-input intensity.

C. *Empirical Strategy*

Our empirical strategy uses a generalized *differences-in-differences* (DD) regression equation where the measure of treatment (i.e., potato cultivation suitability) is continuous. The baseline equation is:

$$y_{it} = \beta \, Potato_i \times I_t^{Post} + \mathbf{X}_{it}\mathbf{\Gamma} + \delta_i + \rho_t + \varepsilon_{it} \ , \tag{1}$$

where i indexes 400-km grid cells and t a 50-year time interval.

When we discuss and present our results, the year t will indicate the end of the interval. For example, 1450 includes battles during 1401–1450 and 1900 includes battles during 1851–1900. Our outcome of interest, y_{it}, is the number of conflict incidents that occurred in cell i during time period t, where the measurement and counting of conflict incidents is as explained in the previous section. This outcome is a function of the interaction of suitability for potatoes, $Potato_i$, and an indicator variable that equals one for the years 1700 and afterward, I_t^{Post}. The specification also includes grid-cell fixed effects, δ_i, time-period fixed effects, ρ_t, and a vector of covariates, $\mathbf{X}_{it}$, that we describe in further detail below. We cluster the standard errors at the grid-cell level.

As in Nunn and Qian (2011), we use the agro-climatic suitability of a region for potato cultivation instead of actual potato cultivation as our main explanatory variable. This is done for two reasons. First, there is limited historical data on cultivation. Second, the level of cultivation is endogenous to a host of factors, including conflict itself (Reader, 2008, pp. 177–178). There are well-known examples of rulers discovering the benefits of the potato because of conflict. For instance, Frederick the Great of Prussia learned the value of the potato during the war of the Austrian Succession, which was from 1740 to 1748. He observed how potatoes kept peasants alive, despite the ravages of invading armies (Gentilcore, 2012, p. 43).

In equation (1), we compare conflict in cells that are suitable for cultivation to conflict in cells that are less suitable, before and after the introduction of potatoes. Cell fixed effects control for time-invariant differences across cells such as geography. Time-period fixed effects control for changes over time that affect all regions similarly, such as climate change or general improvements in military technology. If the introduction of potatoes reduced conflict, then the estimate of the coefficient of $Potato_i$ should be negative, i.e., $\hat{\beta} < 0$.

In addition, the baseline estimates control for the suitability of existing staple crops in the Old World. This is important since the benefit of the new crops, potatoes, will greatly depend on the productivity of alternatives. Since suitability is highly correlated across crops, we control for the first principal component of suitability for the five main pre-existing staples (wheat, wet rice, dry rice, barley, and rye), which accounts for approximately 60% of the variation in suitability.[14] To allow the effects to vary over time in a flexible way, we control for its interaction with time fixed effects.

The main concern about our identification strategy is that, conditional on the baseline controls, suitability for potato cultivation is correlated with factors that may also have reduced conflict over time. We address this in two ways. First, we directly control for the correlates of potato suitability that are most likely to also affect conflict, $\mathbf{X}_{it}$. We document and discuss these in the next section.

Second, we examine the timing of the impact of potatoes. If there is no pre-trend and the levels of conflict began to diverge between regions of varying suitability for potato cultivation around the time when potatoes first came to be cultivated in the regions of our study, then we will be less concerned about spurious correlations. We also present numerous additional robustness checks after we present the main results.

4. Empirical Results

A. *Baseline Estimates*

Panel A of Table 1 presents estimates of equation (1). Our baseline estimates using 400km×400km grid cells are reported in column 1. The baseline estimates show that potato-suitable locations witness a reduction in conflict after the diffusion of the crop to Europe. That is, that the

[14]Panel A of Appendix Table A.2 reports the factor loadings for the principal components. The eigenvalue for the first component is over three and it is slightly less than one for the second component. The standard rule-of-thumb is to use the principal components that have eigenvalues greater than one.

Table 1: The Effect of the Introduction of Potatoes on Conflict for Varying Grid Sizes, Spatial Spillover Effects

	Dependent Variable: Number of Conflicts				
	(1)	(2)	(3)	(4)	(5)
Grid Cell Size:	400km × 400km	50km × 50km	100km × 100km	200km × 200km	800km × 800km
	A. Baseline Specification				
Dependent Variable Mean	1.794	0.037	0.138	0.509	5.586
Potato Suitability × Post	-11.30	-0.105	-0.448	-2.035	-64.85
	(4.433)	(0.067)	(0.239)	(1.023)	(23.41)
Number of Observations	2,740	133,980	35,560	9,660	880
Number of Clusters	274	13,398	3,556	966	88
R-squared	0.484	0.164	0.194	0.302	0.595
	B. Control for Neighbor Suitability x Post				
Potato Suitability × Post	-9.028	0.083	0.461	-0.329	-67.42
	(5.517)	(0.133)	(0.445)	(1.598)	(23.23)
Neighboring Potato	-3.137	-0.214	-1.034	-2.078	-15.46
Suitability × Post	(4.752)	(0.136)	(0.489)	(1.454)	(8.721)
Number of Observations	2,740	133,950	35,550	9,660	870
Number of Clusters	274	13,395	3,555	966	87
R-squared	0.484	0.164	0.194	0.302	0.596

Notes : The table reports regressions where an observation is a 50-year time period and a grid cell. The sizes of the grid cells are in the column headings. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley, and rye). Standard errors are clustered at the grid-cell level.

introduction of the potato reduced conflicts. The estimate of β is -11.30, which is statistically different from zero at the 1% significance level. To assess the magnitude of the coefficient, consider that the standard deviation of the suitability measure is 0.154 and that the standard deviation of conflict incidence is 6.748. Thus, after the introduction of potatoes, a cell with a one standard deviation increase in the suitability for potato cultivation experienced 1.74 fewer conflict incidents ($-11.30 \times 0.154 = -1.74$), which is equal to 0.26 standard deviations of conflict ($-1.74/6.748 = -0.26$). This is a sizable and yet plausible effect. It shows that potatoes had a quantitatively important effect on reducing conflict.

B. ***Spatial Spillovers***

We next turn to a consideration of the potential for spatial spillovers. Conflicts that participants engage in do not always occur where they produce food. For example, potatoes may increase agricultural productivity in a given 400km$\times$400km grid, but the group which obtains food from that grid could engage in conflicts that are outside of the grid cell. If, for example, conflicts tended to occur as far as 500 kilometers away, then if we used grid cells that were 500km $\times$ 500km or larger, we would better capture the full effects of the agricultural productivity increase. In practice, the correct size will vary by conflict, actor, and time period.

The importance of spatial spillovers will vary depending on the size of the grid cells that we use as our unit of observation. Ideally, we would like the grid cells to be small so that we have more granularity and variation in the data. However, the smaller are the grid cells the more important is the issue of spillover effects. Thus, we would like the grid cell to be large enough to capture most spatial spillovers.

To make progress on the issue of spillovers and to understand the robustness of our estimates to variation in the size of the grid cells, we do two things. First, we re-estimate equation (1) using other grid cell sizes; namely, 50km $\times$ 50km, 100km $\times$ 100km, 200km $\times$ 200km, and 800km $\times$ 800km. These estimates are reported in columns 2–5 of Table 1. The estimates show that irrespective of the size of the grid cell, we continue to find a negative effect of potato suitability on conflict after the introduction of potatoes. This is true whether we consider grid cells smaller or larger than our baseline size.

The second exercise we undertake is to re-estimate equation (1) with the addition of the interaction of the post-1700 indicator variable with a measure of the average potato suitability in the eight grid cells that are adjacent to the observation. The specification produces estimates of how the incidence of conflict in a cell is affected by the cultivation of potatoes in that cell and how it is affected by the cultivation of potatoes in cells that are adjacent to it. The former is the direct effect and the latter is the spillover effects. If a cell is large enough to capture most of such spillovers, then we should find that the own-grid-cell effect is statistically significant while the adjacent-grid-cell effect is (statistically) zero.

The estimates are reported, for each size of grid cell, in Panel B of Table 1. We find that consistent with expectations, smaller grid cells tend to generate larger estimated spillover effects when compared either to the direct effect or the mean of the dependent variable which is reported at the top of Panel A. As reported in column 1 of Panel B, we do not find any meaningful spillover effects in our baseline specification. The spillover effect is one-third of the direct effect and is statistically insignificant. This is in contrast to the 200km$\times$200km grid cells (or smaller) which

Table 2: The Effect of the Introduction of Potatoes on Conflict: Various Time Intervals

	Dependent Variable: Number of Conflicts		
	(1)	(2)	(3)
Time Period Length:	50 years	25 years	100 years
Dependent Variable Mean	1.794	0.897	3.588
Potato Suitability x Post	-11.30	-5.652	-22.61
	(4.433)	(2.217)	(8.864)
Number of Observations	2,740	5,480	1,370
Number of Clusters	274	274	274
R-squared	0.484	0.333	0.661

Notes : Grid cells are 400km × 400km and the lengths of the time periods are reported in the panel headings. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley, and rye). Standard errors in parentheses are clustered at the grid-cell level.

have spillover effects that are much larger than the direct effect or much larger relative to the means of the dependent variable. For the larger 800km×800km grid cells, we also find fairly small spillover effects. Thus, 400km×400km cells are the smallest cells that allow us to capture spatial spillovers. This is the motivation for using 400km ×400km grid cells as our baseline unit of analysis.

C. *Robustness*

a. Different Time Periods

Table 2 investigates what happens with different time-periods: 50-years (baseline), 25-years and 100-years. The results are similar. The mean number of conflict incidents in a grid-cell-time-period observation doubles when the time-period increases from 25 to 50 years and from 50 to 100 years. As would be expected, this causes the interaction coefficient to also roughly double.

b. Pre-Trends and Timing

Next, we examine the timing of the effect of potato suitability on conflict. This is important for two reasons. First, to provide support for the parallel trends assumption, we would like to establish that there was no pre-trend. Second, we would like to see that the difference in conflict between potato-suitable and non-suitable locations began shortly after potatoes were first adopted as a field crop in Europe around 1690. Given that it took time for the technology to fully diffuse, we expect to see our differential effects emerge after about 1700.

With these objectives in mind, we estimate the following equation:

$$y_{it} = \sum_{j=1500}^{1900} \beta_j (Potato_i \times I_t^j) + \mathbf{X}_{it}\mathbf{\Gamma} + \delta_i + \rho_t + \varepsilon_{it}, \tag{2}$$

where, as before, i indexes cells and t indexes time periods. The dependent variable, y_{it}, is the number of conflict incidents in cell i during time period t. $Potato_i$ is the measure of the suitability of grid cell i for the cultivation of potatoes. I_t^j are indicator variables that equal one in time period j. As before, the specification includes grid-cell fixed effects, δ_i, and time-period fixed effects, ρ_t.

The estimated coefficients, $\hat{\beta}_j$'s, and their 90% confidence intervals are plotted in Figure 3. The coefficients and standard errors are reported in column 1 of Appendix Table A.3. There is no trend prior to 1700. Recall that 1700 measures conflicts from 1651–1700 and 1750 measures conflicts from 1701–1750. Prior to 1700, we see no evidence of a trend in the relationship between potato suitability and conflict. However, after 1700, the relationship (and the estimated coefficients) becomes gradually more negative over time.

Overall, the timing of the decrease in conflicts in places suitable for potato cultivation is consistent with a causal effect of the adoption of potato on conflict. As our DD estimates reported, the difference in the relationship between potato suitability and conflict before and after 1700 is statistically significant.

The estimates also show that our baseline differences-in-differences estimates are not driven by any one time period. There is a general negative relationship between potato suitability and conflict in all time periods after 1700. This addresses the concern that our results are due to particular wars, which causes a spurious correlation in the DD estimates. Figure 3 shows that our results would be qualitatively similar with the exclusion of any particular time period.

The analogous figure for alternative 800km$\times$800km grid cells produces a similar pattern. There is no relationship between potato suitability and conflict prior to 1700. After 1700, as potato cultivation diffuses, the negative relationship between potato suitability and conflict emerges. See column 2 of Appendix Table A.3 and Appendix Figure A.3.

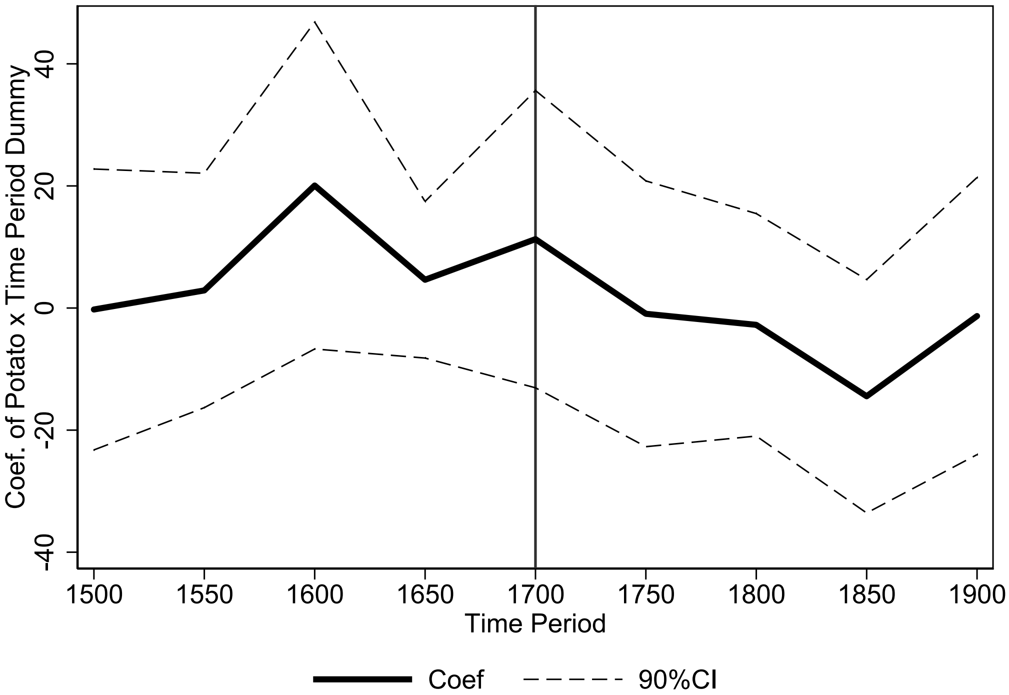

Figure 3: The Effect of Potatoes on Conflict for each 50-year Time Period, 400km × 400km Grid Cells

c. Controlling for Potential Correlates of Potato Suitability

A potential concern with our empirical strategy is the possibility that the suitability for cultivating potatoes is correlated with factors that affected conflict differentially after 1700. To address this, we first study the covariates that are potentially correlated with potato suitability and could have led to lower conflicts after 1700.

The first set of alternative factors that we consider is the suitability of land for the cultivation of other staple crops. These are taken from the same source and calculated in the same manner as our potato suitability measure. Table 3 presents pairwise correlation coefficients (and their corresponding p-values) for the relationship between potato suitability and the suitability for other crops. We begin first by examining crops that were indigenous to the Old World prior to our period of analysis; namely, dry rice, wet rice, wheat, barley, and rye. Across the sample of 400km × 400km grid cells, the suitability for cultivating potatoes is strongly correlated with the suitability for the cultivation of all of these Old World staple crops, except for dry rice. The positive association with the other crops is not surprising and reflects differences in suitability for agriculture in general. We also examine the correlation between potato suitability and the suitability of other New World crops that were introduced to the Old World at approximately the

Table 3: The Correlates of Suitability for Potato Cultivation

Correlation with Suitability for Potato Cultivation		
	Correlation Coefficient	*p*-value
Old World crop suitability		
Dry Rice	-0.074	0.22
Wet Rice	0.184	0.00
Wheat	0.958	0.00
Barley	0.939	0.00
Rye	0.941	0.00
New World crop suitability		
Sweet Potato	0.182	0.00
Maize	0.693	0.00
Cassava	0.018	0.77
Geographic characteristics		
Ruggedness	-0.076	0.21
Elevation	-0.179	0.00
Distance to Nearest Ice-Free Coast	0.202	0.00
Indicator for Presence of Navigable River	0.619	0.00
Latitude	0.298	0.00
Longitude	0.164	0.01
Base-period characteristics		
Distance to Nearest City in 1401-1450	-0.289	0.00
Number of Conflicts in 1401-1450	0.227	0.00

Notes: The table reports the correlation coefficients of the stated variables and the suitability for potato cultivation. The sample is a cross-section of 400km × 400km grid cells. There are 274 observations.

same time. These are sweet potato, maize, and cassava. We find that suitability for sweet potato and maize are positively correlated with potato suitability but not cassava which is uncorrelated.

We next examine the correlation between potato suitability and a range of geographic characteristics that could affect conflict differentially over time. The first geographic characteristics that we examine are elevation and ruggedness, since changes in military technology may have changed the cost of fighting relatively differently in uneven terrain and mountainous regions. The data show that rugged and high elevation grid cells tend to be less suitable for the cultivation of potatoes. We also consider distance to international trade, measured by (straight-line) distance from an ice-free coastline. This may have become a more important determinant of conflict over time as overseas trade grew in importance, particularly Atlantic trade. We find that locations further from the coast are also slightly more suitable for potato cultivation. We also consider the presence of a major navigable river in a grid cell. Rivers, in addition to being important for trade, tended to also be the locations of early industrialization. We find that grid cells with rivers tend to also be more suitable for potato cultivation. Lastly, we also consider the relationship between potato suitability and a grid cell's cardinal location, measured using both the latitude and longitude of the centroid of the grid cell. We find that more northern latitudes and more eastern longitudes are associated with greater suitability for potato cultivation. This reflects the fact that some of the most suitable regions shown in Figure 2 are in northeastern Europe.

Finally, we investigate the correlation between potato suitability and political and economic characteristics measured during the base period, 1401–1450. We find that areas suitable for cultivating potatoes were further away from urban areas and experienced more conflict during the 1401–1450 period. Thus, if the incidence of conflicts decreased more after 1700 in places with more conflicts or farther from urban centers in our baseline period, then our estimates will be confounded.

We find that the suitability for potato cultivation is correlated with several characteristics that could differentially affect conflicts over time. Thus, it is important for us to examine whether our baseline estimates are robust to controlling for these additional influences. To be as rigorous as possible, we will allow the influence of the time-invariant geographic characteristics to be as general as possible by flexibly interacting each with time-period fixed effects.

Estimates testing for the robustness of our baseline estimates to account for these additional covariates are reported in Tables 4 and 5. Column 1 of Table 4 reports our baseline specification for comparison. Recall that this includes the interaction of time-period fixed effects and the first principal component of the Old World Crops dry rice, wet rice, wheat, barley, and rye. In column 2 of Table 4, we show that our estimates are robust to also controlling for the second principal component.[15] In column 3 of Table 4, we control for the first principal component of Old World Crops and the first component of three New World staple crops that were introduced from the Americas: sweet potato, maize, and cassava. Column 4 measures the suitability to Old World Crops as the average across the crops rather than the first principal component. In column 5, we follow the more parsimonious specification of Nunn and Qian (2011), which controls for the average suitability of three Old World staple crops; namely wheat, dry rice, and wet rice. Across each of the five specifications, our estimated coefficient of interest remains negative, significant,

[15]Panel A of Appendix Table A.2 reports the factor loadings of the principal components.

Table 4: The Effect of Potatoes on Conflict: Robustness to Controlling for the Suitability for Other Staple Crops

	Dependent Variable: Number of Conflicts				
	(1) Baseline Specification	(2)	(3)	(4)	(5) Nunn-Qian (2011)
Potato Suitability × Post	-11.30	-11.34	-8.06	-10.02	-9.388
	(4.433)	(4.474)	(4.614)	(4.248)	(4.418)
Controls: Time FE ×					
Suitability of Old World Crops (1st Prin Comp)	Y	Y	Y	N	N
Suitability of Old World Crops (2nd Prin Comp)	N	Y	N	N	N
Suitability of New World Crops (1st Prin Comp)	N	N	Y	N	N
Old World Avg Suitability	N	N	N	Y	N
Old World (3 Crops) Avg Suitability	N	N	N	N	Y
Number of Observations	2,740	2,740	2,740	2,740	2,740
Number of Clusters	274	274	274	274	274
R-squared	0.484	0.484	0.489	0.483	0.483

Notes : The sample is a balanced panel from 1401-1900. The observations are at the 50-year and 400km × 400km grid-cell level. All regressions control for grid-cell fixed effects and time period fixed effects. In all specifications, the mean of the dependent variable is 1.794. The standard errors are clustered at the grid-cell level.

and very similar in magnitude. Thus, the finding of reduced conflict in potato-suitable locations following the introduction of the potato appears robust.

We next report estimates that flexibly control for additional geographic and baseline-period characteristics. Column 1 of Table 5 reproduces the baseline estimates for comparison. We then gradually introduce additional controls for geographic characteristics to illustrate their influence. In column 2, we add controls for ruggedness and elevation. In column 3, we introduce latitude, longitude, as well as latitude × longitude. In column 4, we control for an indicator variable for the presence of a navigable river, the distance to the nearest ice-free coastline, and the average distance to the nearest urban area during 1401–1450. In column 5, we control for the number of battles during 1401–1450. We interact each control with time fixed effects to allow conflict levels to evolve differentially over time according to each measure in a way that is flexible over time.

In all specifications, our coefficient of interest remains robust. The estimated effect of potatoes on conflict is always negative, statistically significant, with a magnitude that is quantitatively similar to that of the baseline estimate.

Table 5: The Effect of Potatoes on Conflict: Robustness to Controlling for Geographical Characteristics and the Lagged Dependent Variable

	Dependent Variable: Number of Conflicts					
	(1) Baseline	(2)	(3)	(4)	(5)	(6)
Potato Suitability × Post	-11.30	-10.99	-11.96	-12.95	-12.92	-12.57
	(4.433)	(4.210)	(4.556)	(4.763)	(3.881)	(4.416)
Number of Conflicts$_{t-50}$						0.003
						(0.068)
Controls:						
Time FE ×						
Ruggedness, Elevation	N	Y	N	N	N	N
Latitude, Longitude, Latitude x Longitude	N	N	Y	N	N	N
River, Coast, and Urbanization	N	N	N	Y	N	N
Number of Battles in 1401-1450	N	N	N	N	Y	N
Number of Observations	2740	2740	2740	2740	2740	2466
Number of Clusters	274	274	274	274	274	274
R-squared	0.484	0.491	0.489	0.492	0.581	0.487

Notes: The sample is a balanced panel from 1401-1900. The observations are at the 50-year and 400km × 400km grid-cell level. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley, and rye). The standard errors are clustered at the grid-cell level.

d. Additional Robustness Checks

We also undertake a number of additional robustness checks. The first tests the robustness of our estimates to allowing for dynamics and persistence of conflicts over time. Specifically, we check the sensitivity of our estimates to controlling for a one-period lag of conflict. We do not do this in our baseline specification because of well-known concerns due to the Nickell bias (Nickell, 1981). However, as the estimates reported in column 6 of Table 5 show, our findings are nearly identical if we control for the lagged dependent variable.

We next check the robustness of our findings to the omission of the largest wars historically. Because our analysis of conflict examines the incidence of battles, there is concern that our findings might be spuriously driven by a few very large wars that contain numerous battles. To test for this possibility, we omit battles belonging to each of the twenty-five largest wars and check the sensitivity of our results. We also omit the wars that are part of the larger "Napoleonic Wars". If we take these together and define them as one single war, then this is the largest war in our sample. Appendix Table A.4 reports the estimates. We find that our coefficient of interest is always negative and similar to the baseline estimate.

Another concern is the potential presence of spillovers that extend beyond our 400-kilometer grid cells. For example, if the introduction of potatoes in Russia caused Russia to relocate its conflicts to southern Spain, then our differences-in-differences strategy will show that potatoes reduced conflict. However, this will be due to a long-range relocation effect. It is unlikely that such an effect drives our results since there are very few conflicts in our sample where the parties involved are such a distance apart. However, to be as conservative as possible, we re-estimate our baseline specification after omitting conflicts where the two nearest actors were more than 1200 kilometers apart or more than 800 kilometers apart. The estimates, which are reported in Appendix Table A.5, show that our estimates are robust to this sensitivity check as well.

5. Better Understanding Mechanisms

A. *Onset vs. Duration*

Thus far, we have focused on the number of conflict incidents as the outcome variable. A greater prevalence of conflict incidents could occur both because more conflicts start or because the duration of a conflict is longer conditional on a conflict starting. In this section, we conduct a complementary analysis by examining whether our main results are driven by effects on the extensive margin (potatoes reduced the probability of any conflict) or the intensive margin (potatoes reduced the duration of conflict conditional on one starting).

We consider whether agricultural productivity reduced the start of new wars (conflict onset) or if it made wars shorter by increasing the likelihood of conflict offset conditional on a war occurring. For this analysis, we exploit the granularity of our data to construct an annual panel and estimate a hazard model. In the hazard model, the event of interest is either the onset of conflict during an episode of peace or the offset of conflict during an episode of war. Let t index years, i index periods of peace (or conflict), and $T_i \geq 0$ denote the duration, in years, of the episode of interest. The sample includes all grid cells and years that are "at risk" for transition into conflict or peace, e.g., for the onset regressions, all of the observations for which there was no conflict in the previous period. The estimation uses the discrete hazard $h_{it} = \Pr(T_i = t \mid T_i \geq t)$, where it is assumed that h_{it} follows a logistic distribution. Our regressions control for a third-order polynomial in the duration of the peace episode or conflict episode up until year $t - 1$. It also includes our interaction of interest, potato suitability interacted with the post-adoption indicator variable, as well as the following additional controls: the first principal component of Old World staple crops, the post-adoption indicator variable, and the interaction between the first principal component of Old World crops and the post-adoption indicator variable.

For the analysis of onset and duration, it is important to measure conflicts as precisely as possible. A conflict (i.e., a battle) will appear to continue in our data if it ends, but another begins within the same grid cell in the next calendar year. This false-continuation is more likely the larger is the grid cell. Therefore, for our onset and duration estimates, we use grid cells that are at a finer level than 400km×400km and check the robustness of our findings to the use of grid cells of different sizes. Thus, we report estimates where the analysis is at the 50km, 100km, and 200km grid cell levels.

The hazard model estimates are reported in Table 6. The coefficients report marginal effects evaluated at means. Our estimates provide suggestive evidence that the agricultural productivity increase from the introduction of potatoes reduced the onset of conflict. The coefficients from columns 1–3 are negative and statistically significant. By contrast, the interaction coefficients from the offset regressions, reported in columns 4–6, are insignificant. The interaction coefficients are negative, large in magnitude, and very imprecisely estimated. The lack of precision may be due

Table 6: The Effect of Potatoes on Conflict Onset and Duration

	Hazard Models. Dependent Variable:					
	Conflict Onset			Conflict Offset		
	(1)	(2)	(3)	(4)	(5)	(6)
	50km × 50km	100km × 100km	200km × 200km	50km × 50km	100km × 100km	200km × 200km
Dependent Variable Mean	0.000294	0.00100	0.00313	0.289	0.298	0.325
Potato Suitability × Post	-0.00026	-0.00100	-0.00280	-0.58890	-0.71533	-0.44662
	(0.00010)	(0.00034)	(0.00093)	(0.40235)	(0.48201)	(0.56302)
Duration (third order polynomial)	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y
Number of Observations	6,665,563	1,764,661	475,417	2,364	2,296	2,270
Number of Clusters	966	966	966	187	187	191

Notes : The table reports estimates from hazard models, where the unit of observation is a 50km × 50km, 100km × 100km and 200km × 200km grid cell and a calendar year. Columns 1-3 report estimates from a hazard model that estimates conflict onset. Columns 4-6 report estimates from a hazard model that estimates conflict offset. The reported coefficients are marginal effects evaluated at the means from a logit regression. These estimates control for: a third-order polynomial of duration (either conflict or peace), the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley, and rye), a post-potato-adoption indicator variable, and the interaction of the Old World Crop first principal component and the post-adoption indicator variable. All standard errors are clustered at the 200km × 200km grid-cell level.

to the much smaller sample size. Thus, the evidence indicates that the introduction of potatoes decreased the probability of conflict onset, but it did not increase the probability of conflict offset and the duration of conflicts once they started.

B. *Testing for an Insurance Mechanism*

We now turn to a mechanism that is motivated by existing findings in the literature. The introduction of potatoes may have improved peasants' ability to smooth consumption during adverse weather shocks. Jia (2014) shows that, within China, the introduction of sweet potatoes, which was also introduced from the Americas to the Old World, allowed peasants to better survive droughts due to their drought resistant properties. This, in turn, resulted in a reduction in peasant revolts during periods of drought. Along similar lines, potatoes are known to be particularly hardy through cold winters. Thus, in the European setting, it is natural to ask whether the introduction of potatoes reduced the incidence of conflict, especially during cold-weather shocks.

We investigate this possibility by using data on historical seasonal (winter, spring, summer, and autumn) temperatures reported by Luterbacher, Dietrich, Xoplaki, Grosjean and Wanner (2004). These data are at the annual and 0.5×0.5 degree levels for the years 1500–1900 and cover a geographic subsample of our main sample. The climate data are constructed using instrumental readings (when available), geological climate proxies (e.g., soil sediment, tree rings, ice cores, etc.)

as well as documentary evidence. See the data appendix provided by Luterbacher et al. (2004) for a detailed discussion.

Given the importance of the timing of conflicts relative to cold-weather shocks, we estimate a version of equation (1) that is at the year-level rather than 50-year level. Given the persistence of conflict at the annual resolution, the specification also includes a one-year lag of the dependent variable.[16] We then test for the heterogeneous effect of interest by embedding into equation (1) a triple interaction of potato suitability, a post-adoption indicator, and a cold-winter indicator variable. We also include the relevant double interactions. This allows us to test whether the impact of potatoes on conflict was greater when cold-weather shocks were experienced.

We construct three measures of the presence of a cold-weather shock in a grid cell and year. Each indicator variable equals one if the winter temperature in that grid cell and year was below a given percentile threshold of the winter temperature in the same grid cell over the full period spanning 1500–1900. Each measure uses a different threshold, either the 5th, 10th, or 20th percentile threshold.

The estimates are reported in Table 7. In columns 1–3, we first report estimates of equation (1) using the annual panel, including the cold-winter-shock indicator variable as a control variable. Column 1 uses the 5th, column 2 the 10th, and column 3 the 20th percentile thresholds. The coefficient for the cold shock (column 1) is negative and statistically significant. This suggests that severely cold-weather shocks reduced conflicts. By contrast, the coefficients for the less extreme, 10th and 20th-percentile shocks, are much smaller and not statistically different from zero. The estimates in columns 1–3 also show that our finding that potatoes reduce conflict is found when using annual data and account for dynamics by controlling for a one-year lag of the dependent variable.

In columns 4–6, we report estimates that include the triple interaction between the suitability for potato cultivation, an indicator variable for post-adoption, and an indicator for particularly-cold winters. If our main finding reflects the role of potatoes as an insurance mechanism, then the double interaction of suitability for potato cultivation and an indicator variable for post-adoption should be close to zero, since this coefficient captures the effects of the introduction of potatoes in years without a cold shock. In addition, the triple interaction should be large and negative

[16] As we stated earlier, the Nickell (1981) bias is very unlikely to be a problem given that we are using an annual panel with many time observations.

Table 7: The Effect of Potatoes on Conflict: Interaction with Annual Weather Shocks

	Dependent Variable: Number of Conflicts					
	(1)	(2)	(3)	(4)	(5)	(6)
	< 5th Percentile	< 10th Percentile	< 20th Percentile	< 5th Percentile	< 10th Percentile	< 20th Percentile
Potato Suitability × Post	-0.202	-0.201	-0.199	-0.202	-0.200	-0.189
	(0.079)	(0.079)	(0.079)	(0.079)	(0.080)	(0.081)
Cold Shock	-0.023	-0.005	0.003	0.025	0.021	-0.000
	(0.011)	(0.009)	(0.005)	(0.019)	(0.016)	(0.011)
Potato × Post × Cold Shock				-0.027	-0.028	-0.063
				(0.144)	(0.123)	(0.078)
One-Year Lag of Number of Conflicts	0.414	0.414	0.414	0.414	0.414	0.414
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Number of Observations	39200	39200	39200	39200	39200	39200
Number of Clusters	98	98	98	98	98	98
R-squared	0.271	0.271	0.271	0.271	0.271	0.271

Notes: An observation is a year and a 400km × 400km grid cell. The sample is a balanced panel from 1500-1900. The shocks used in columns 1 and 4 are defined as indicator variables that take the value of one if annual temperatures in grid cell i and year t are lower than the 5th percentile of temperature during the entire sample period for the grid cell. In columns 2 and 5, shocks are constructed using the 10th percentile, while in columns 3 and 6, they are constructed using the 20th percentile. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley, and rye). Columns 4-6 also control for all relevant double interactions from the triple interaction. Standard errors are clustered at the grid-cell level.

indicating that the conflict-reducing effects of potatoes are predominantly felt in years with cold-weather shocks.

We find that the double interaction of the suitability for the cultivation of potatoes and the post-adoption indicator variable is always statistically significant and similar in magnitude to those reported in columns 1–3. In addition, the triple interaction, although consistently negative, is always small and not statistically different from zero. Thus, the introduction of potatoes reduced conflict similarly during years with good and adverse weather. On this basis, we find no evidence that our results are driven by better insurance against cold winters.

6. Conclusion

This paper provides evidence of the long-run relationship between a permanent increase in agricultural productivity and conflict. We constructed a new comprehensive dataset, which digitizes the name, date, and location of battles, as well as the participants involved. We then exploited variation in agricultural productivity caused by the introduction of potatoes to obtain a causal estimate of the permanent increase in agricultural productivity due to the introduction of potatoes and conflict.

Our estimates show that the introduction of potatoes led to a significant reduction in the incidence of conflict. The finding is robust to the use of differently sized grid cells, different time periods, more or less flexible estimation strategies, and flexibly controlling for a host of observable grid-cell level characteristics. Hazard estimates indicate that the effects on conflict incidence are primarily due to a reduction in the probability of conflict onset rather than a decline in duration (i.e., the probability of conflict offset). We find no evidence that the estimated effects arise because potatoes provide insurance against cold winters.

These findings contribute to a deeper understanding of the determinants of conflict. We have provided evidence of the effects of the long-run effects of a permanent improvement in agricultural productivity, as opposed to transitory shocks. Having estimates of the effects of a permanent shock is important since responses to transitory shocks might reflect shifts in the timing of conflict and not changes in the equilibrium levels of conflict. By contrast, the finding that increased agricultural productivity from the introduction of potatoes reduced the levels of conflict for the subsequent two hundred years is likely to reflect a reduction in the equilibrium levels of conflict.

Our analysis shows that understanding the long-run effects of a permanent change in agricultural productivity and/or the determinants of persistent changes in conflict are important and feasible avenues of future empirical study. This is a small step forward in improving our understanding of the long-term co-evolution of economic growth and conflict. To this end, we hope that the conflict database that we have constructed will allow researchers to make more progress by conducting in-depth and rigorous quantitative analyses.

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ONLINE APPENDIX – Not for Publication

Appendix A. Simple Model

A.. Agricultural TFP and Land Values

The key mechanism is as follows: Suppose that (*i*) the demand for food is sufficiently inelastic, and (*ii*) the production function for food is Cobb-Douglas. A TFP shock in agriculture increases the output of food. From (*i*), we obtain that the price of food falls by more than output increases. Based on (*ii*), we obtain that the value of land is proportional to the market price of agricultural output. Since agricultural prices fall by more than the increases in agricultural product, this implies that the value of land declines.

Specifically, let there be two sectors, agriculture (A) and manufacturing (M). Production of both goods requires labor. We assume that land is in fixed supply and is only used in agriculture. Thus, because of the fixed factor land, agriculture has a decreasing marginal product of labor while, in manufacturing, the marginal product of labor is constant. More precisely, we assume the following production functions:

$$\begin{aligned} Y_A &= \widetilde{A_A} L_A^{\alpha} \qquad \text{where} \quad \widetilde{A_A} \equiv A_A N^{1-\alpha}, \\ Y_M &= A_M L_M, \end{aligned} \tag{A1}$$

L_A and L_M respectively denote labor allocated to agriculture and manufacturing. Total labor supply is normalized to one so that $L_A + L_M = 1$. We assume free mobility of labor across the two sectors.

By definition, A_A and A_M are productivity parameters for agriculture and manufacturing, and N is the total amount of arable land in the economy. $\widetilde{A_A}$ is aggregate productivity in agriculture taking into account not only the level of technology in this sector A_A, but also the amount of arable land available N. Historically, the introduction of the potato increased the productivity of arable land, since it had higher caloric yields per acre, and it increased the amount of arable land, due to the fact that potatoes could be cultivated on land that was not suitable for other crops.

The wage rate is denoted by w, the price of the manufacturing good is normalized to one, and the price of the agricultural good is given by p_A. We assume that all households hold equal shares of land (alternatively, we can assume that all land is being held by a landlord).

In the competitive equilibrium, the wage rate w is determined by the marginal productivity of labor in manufacturing:

$$w = A_M. \tag{A.2}$$

The value of land, which we denote by Π, is given by the solution to the following problem:

$$\Pi = \max_{L_A} p_A \widetilde{A_A} L_A^{\alpha} - w L_A \tag{A.3}$$

The first-order condition for L_A gives:

$$\alpha p_A \widetilde{A_A} L_A^{\alpha - 1} = w \tag{A.4}$$

Combining equations (A.2) and (A.4) gives equilibrium labor in agriculture as a function of the relative price of the agricultural commodity, $L_A(p_A)$:

$$L_A(p_A) = \left(\frac{\alpha p_A \widetilde{A_A}}{A_M} \right)^{\frac{1}{1-\alpha}} \tag{A.5}$$

And output as function of the agricultural-good price is:

$$Y_A(p_A) = \left[\left(\frac{\alpha p_A}{A_M} \right)^{\alpha} \widetilde{A_A} \right]^{\frac{1}{1-\alpha}} \tag{A.6}$$

We now consider consumer demand to derive equilibrium prices. The consumer's problem is given by:

$$\max_{c_A, c_M} c_A^{1-1/\sigma} + c_M \text{ subject to } p_A c_A + c_M = w + \Pi. \tag{A.7}$$

The first-order condition for c_A gives

$$c_A^{-1/\sigma} = p_A. \tag{A.8}$$

In the goods market equilibrium, aggregate production equals aggregate consumption:

$$c_A = Y_A. \tag{A.9}$$

Taken together, (A.6), (A.8), and (A.9) give the equilibrium price of the agricultural good, p_A^*:

$$p_A^* = \left[\left(\frac{A_M}{\alpha} \right)^{\alpha} \frac{1}{\widetilde{A_A}} \right]^{\frac{1}{\sigma(1-\alpha)+\alpha}}. \tag{A.10}$$

Using (A.3), (A.5), and (A.10), we can now derive the equilibrium value of land:

$$\Pi^* = (1-\alpha) A_M^{\frac{\alpha(1-\sigma)}{\sigma(1-\alpha)+\alpha}} \widetilde{A_A}^{\frac{-(1-\sigma)}{\sigma(1-\alpha)+\alpha}} \tag{A.11}$$

In our setting, the elasticity of demand for food with respect to price is $-\sigma$.[17] Therefore, as long as the demand for food is inelastic (i.e., $\sigma < 1$), increases in A_A lower land values, Π.

The existing empirical evidence finds that the demand for agricultural goods is indeed price inelastic. Studies typically estimate the price elasticity of food demand to be between -0.80 and -0.20 (e.g., Tobin, 1950; Tolley et al., 1969; Van Driel et al., 1997). We therefore take the case in which an increase in agricultural productivity $\widetilde{A_A}$ decreases the value of land to be the empirically relevant scenario.

B.. Land Values and Conflict

Assume that, in each period, each country draws a random fixed cost of fighting. Countries fight over land, so they start conflict if the fixed cost of aggression is less than Π. Obviously, if Π decreases, conflict occurs less frequently.

Following the recent work of Acemoglu et al. (2012), which focuses on the incentives to arm more explicitly, we make the following assumptions: there is an armament decision m, the cost of which is given by $l(m)$. The function $l(.)$ is an increasing and convex function and the probability of winning a violent contest is $p(m)$, which is also an increasing and concave function. The aggressor solves

$$\max_{m} p(m)\Pi - l(m). \tag{A.12}$$

In this model, the introduction of potatoes increases the cost of arming, m, because it increases real wages; and it lowers Π since it decreases the value of land. Both forces obviously reduce the probability of armed conflict.

[17] Note that $c_A = p_A^{-\sigma}$. Therefore, $\frac{\partial c_A}{\partial p_A} \cdot \frac{p_A}{c_A} = -\sigma$.

Appendix B. Empirical Results

Table A.1: The Effect of Potato Suitability on Conflict: Using only Clodfelter's data

Dependent Variable: Number of Conflicts		
	(1)	(2)
	Full Sample	Clodfelter Only
Dependent Variable Mean	1.794	0.713
Potato Suitability × Post	-11.30	-7.419
	(4.433)	(2.950)
Number of Observations	2740	2466
Number of Clusters	274	274
R-squared	0.484	0.399

Notes: The sample is a balanced panel for 1401-1900. The sample comprises only of conflicts reported by Clodfelter (2008). The observations are at the 50-year and 400km × 400km grid-cell level. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley and rye). Standard errors are clustered at the grid-cell level.

Table A.2: Factor Loading of Principal Components

A. Old World Staples: Dry Rice, Wet Rice, Wheat, Barley and Rye					
Component	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**	
Comp1	3.088	2.097	0.618	0.618	
Comp2	0.991	0.083	0.198	0.816	
Comp3	0.908	0.900	0.182	0.998	
Comp4	0.008	0.004	0.002	0.999	
Comp5	0.004	.	0.001	1.000	
Variable	**Comp1**	**Comp2**	**Comp3**	**Comp4**	**Comp5**
Dry Rice	-0.0639	0.9979	0.0085	0.0005	-0.0002
Wet Rice	0.2051	0.0048	0.9787	0.0026	0.0080
Wheat	0.5637	0.0375	-0.1214	-0.5903	0.5636
Barley	0.5646	0.0370	-0.1116	-0.1934	-0.7937
Rye	0.5633	0.0367	-0.1221	0.7836	0.2286
B. New World Staples: Sweet Potato, Maize and Cassava					
Component	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**	
Comp1	1.239	0.248	0.413	0.413	
Comp2	0.991	0.221	0.330	0.743	
Comp3	0.770	.	0.257	1.000	
Variable	**Comp1**	**Comp2**	**Comp3**		
Sweet Potato	0.6963	-0.1081	-0.7096		
Maize	0.6907	-0.1682	0.7034		
Cassava	0.1954	0.9798	0.0425		

Panel A reports the factor loadings for the principal components of suitability for the five Old World Crops (wheat, wet rice, dry rice, barley, and rye). Panel B reports the factor loadings for the principal components of suitability for the three New World Staples (sweet potato, maize, and cassava).

Table A.3: The Effect of Potato Suitability on Conflict for Each Year since Its Introduction

Dependent Variable: Number of Conflicts		
	(1)	(2)
Potato Suitability ×		
1500	-0.237	10.85
	(13.94)	(41.03)
1550	2.882	19.30
	(11.64)	(32.75)
1600	20.07	77.75
	(16.23)	(55.00)
1650	4.632	40.37
	(7.774)	(31.38)
1700	11.29	79.32
	(14.76)	(65.21)
1750	-0.941	9.058
	(13.19)	(33.97)
1800	-2.751	-34.77
	(11.05)	(52.64)
1850	-14.46	-65.47
	(11.59)	(41.88)
1900	-1.311	-16.50
	(13.76)	(35.70)
Number of Observations	2740	880
Number of Clusters	274	88
R-squared	0.487	0.602

Notes: The sample is a balanced panel for 1401-1900. The observations are at the 50-year and 400km × 400km (column 1) or 800km × 800km (column 2) grid-cell levels. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley and rye). The standard errors are clustered at the grid-cell level.

Table A.4: The Effect of Potato Suitability on Conflict, Omitting the Largest Wars

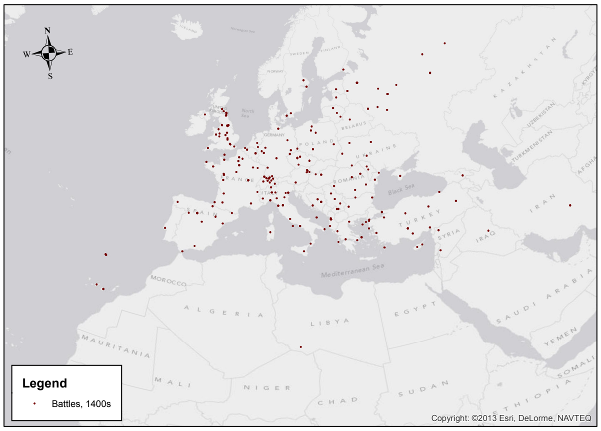
		Dependent Variable: # of Conflicts$_t$			
			Potato Suitability x Post		
Common Name of the Omitted War	Number of Battles in War	Dep. Var Mean	Coef.	Std. Err.	R-squared
Napoleonic War (Peninsular War)	73	1.638	-7.185	(3.666)	0.516
French Revolutionary War of the First Coalition	65	1.641	-7.480	(3.940)	0.498
Thirty Years' War	63	1.642	-8.163	(3.814)	0.506
Seven Years' War	60	1.643	-8.295	(4.166)	0.509
War of Spanish Succession	56	1.644	-7.525	(3.883)	0.495
War of the Second Coalition	54	1.645	-6.863	(3.677)	0.501
Napoleonic War of Liberation	42	1.649	-8.166	(3.806)	0.505
Napoleonic War of the Third Coalition	33	1.653	-8.220	(3.794)	0.511
Second Northern War/Great Northern War	32	1.653	-8.267	(3.819)	0.512
War of Austrian Succession	31	1.653	-7.733	(3.815)	0.508
Franco-Prussian War	31	1.653	-7.947	(3.816)	0.503
Egyptian and Syrian Campaign (Battle of the Pyram	27	1.655	-7.883	(3.739)	0.514
Crimean War	26	1.655	-7.580	(3.714)	0.513
Fourth Franco-Prussian War (Napoleonic Wars)	22	1.657	-7.808	(3.779)	0.512
Dutch War of Independence	22	1.657	-7.964	(3.908)	0.517
Napoleonic War (Russian Expedition)	20	1.657	-8.989	(3.728)	0.513
First English Civil War	17	1.658	-7.942	(3.733)	0.514
Dutch War of Louis XIV	16	1.659	-8.028	(3.726)	0.510
Russo-Turkish War	15	1.659	-7.715	(3.745)	0.514
Catherine the Great's First War with Turkey	14	1.659	-8.100	(3.722)	0.513
No common name	14	1.659	-8.242	(3.754)	0.514
No common name	14	1.659	-7.843	(3.773)	0.514
Habsburg-Ottoman War	14	1.659	-8.324	(3.759)	0.513
First Northern War	13	1.660	-7.807	(3.736)	0.513
United Irishmen Revolt (Wexford rebellion)	13	1.660	-7.949	(3.746)	0.513
All Napoleanic Wars	211	1.588	-8.296	(4.011)	0.497

Notes: Each row shows the estimate of the main coefficient of interest (Potato Suitability x Post) from the baseline specification, dropping battles belonging to each of the 25 largest wars in our sample one-by-one. The sample is a balanced panel for 1401-1900. The observations are at the 50-year and 400km × 400km grid-cell level. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley and rye). Standard errors are clustered at the grid-cell level.

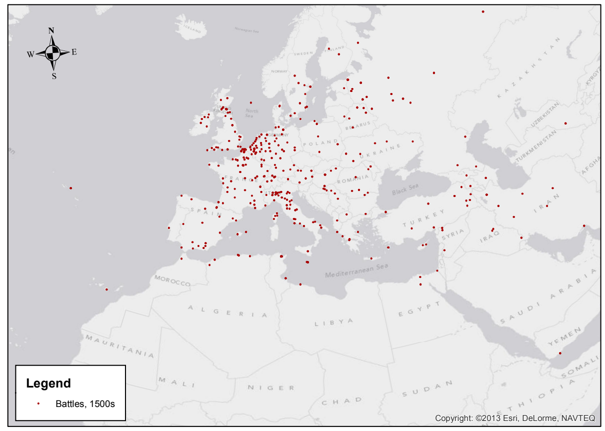
Table A.5: The Effect of the Introduction of Potatoes on Conflict: Excluding Conflicts (from Wars) with Distant Actors

Dependent Variable: Number of Conflicts			
		Exclude conflicts (wars) if nearest two actors are > X km apart	
	(1)	(2)	(3)
	All Conflicts	X=1200km	X=800km
Dependent Variable Mean	1.794	1.497	1.307
Potato Suitability × Post	-11.30	-10.73	-8.032
	(4.433)	(4.042)	(3.370)
Number of Observations	2740	2740	2740
Number of Clusters	274	274	274
R-squared	0.484	0.497	0.491

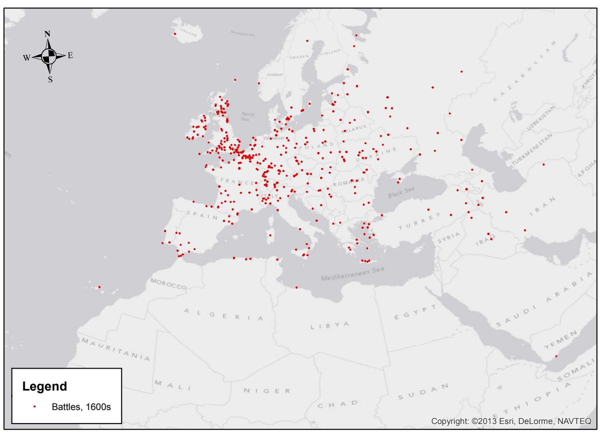
Notes: The sample is a balanced panel for 1401-1900. The observations are at the 50-year and 400km × 400km grid-cell level. All regressions control for the full set of baseline controls: grid-cell FE, year FE, and year FE x the first principal component of suitability for Old World Crops (wheat, wet rice, dry rice, barley and rye). The standard errors are clustered at the grid-cell level. The column headings state the sample restrictions.



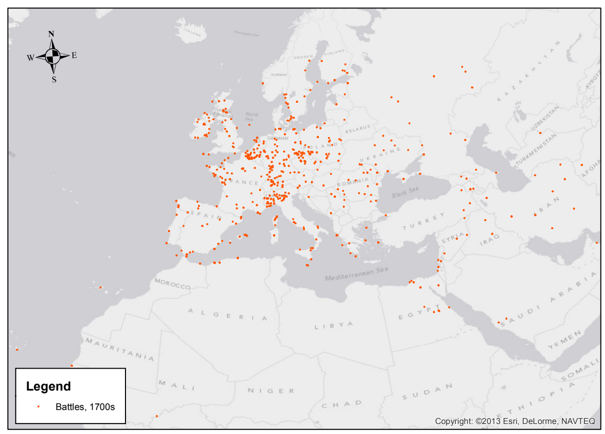
(a) 1401-1500



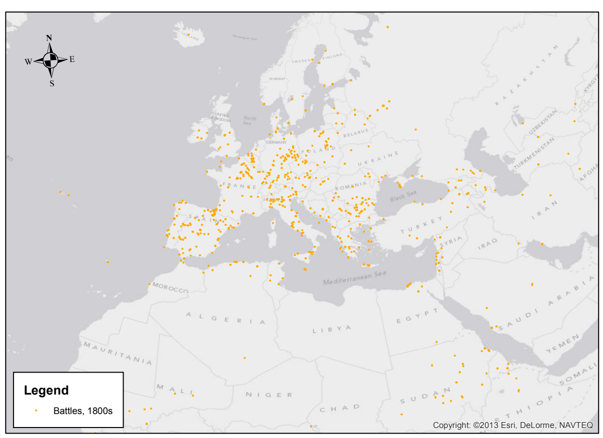
(b) 1501-1600



(c) 1601-1700



(d) 1701-1800



(e) 1801-1900

Figure A.1: Conflicts, 1401-1900 by Century

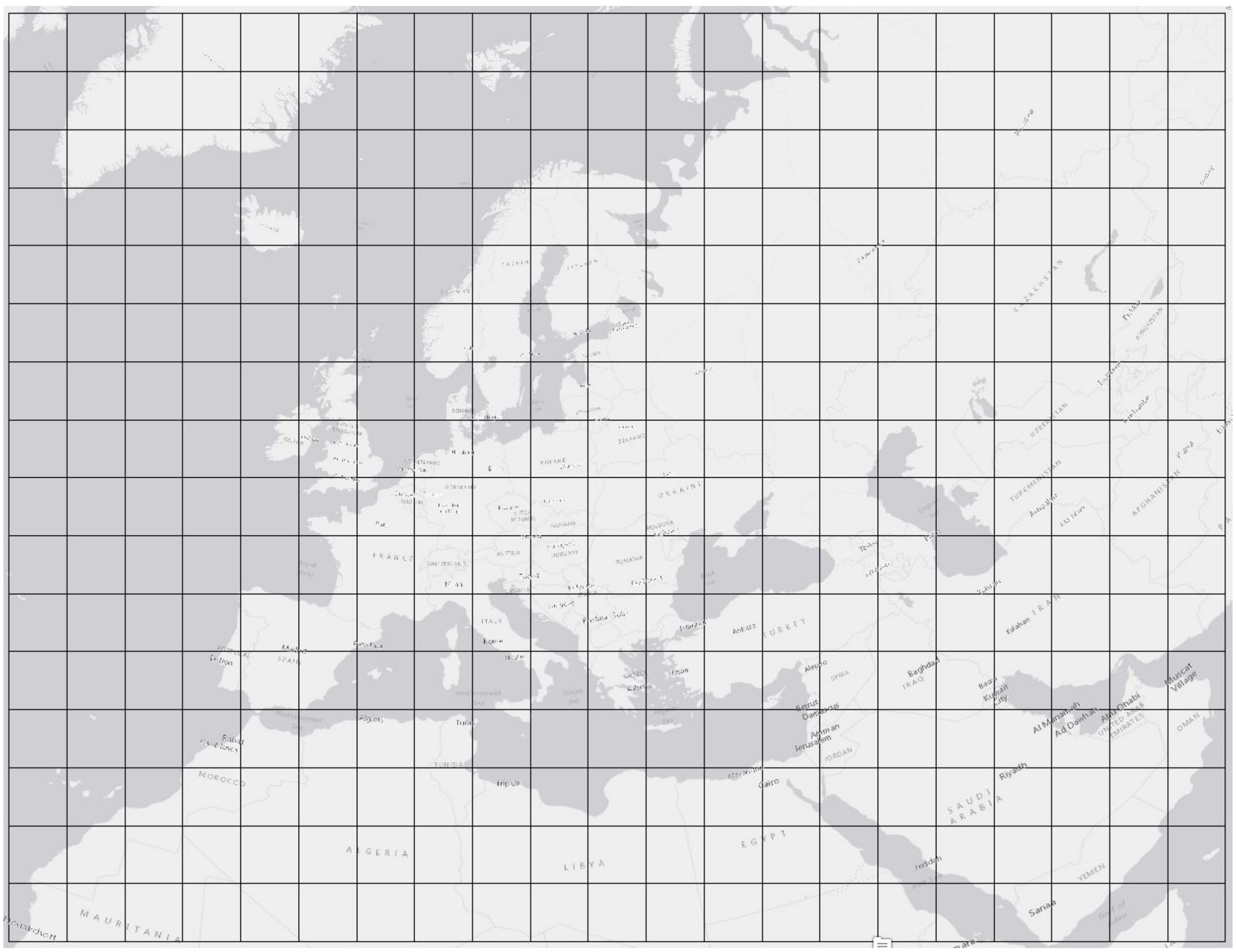


Figure A.2: 400km × 400km Grid Cells

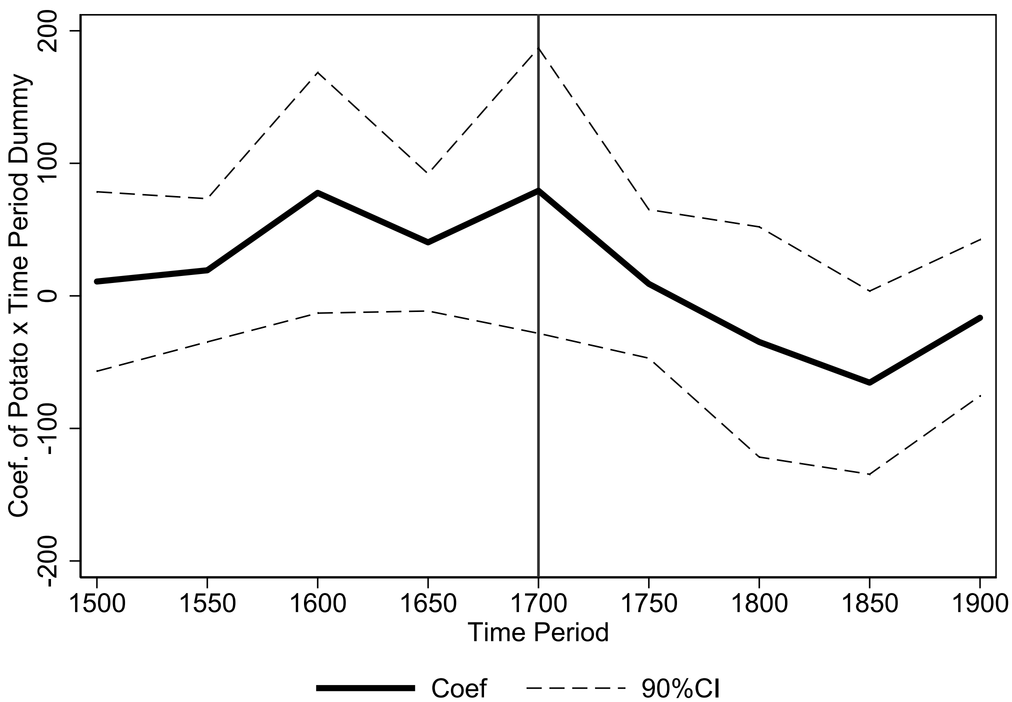


Figure A.3: The Effect of Potatoes on Conflict for each 50-year Time Period, 800km × 800km Grid Cells