UNIVERSITY OF HOHENHEIM

FACULTY OF BUSINESS, ECONOMICS AND SOCIAL SCIENCES

HOHENHEIM DISCUSSION PAPERS

IN BUSINESS, ECONOMICS AND SOCIAL SCIENCES

Institute of Economics

DISCUSSION PAPER 22-2017

LORD OF THE LEMONS:
ORIGIN AND DYNAMICS OF STATE CAPACITY

Thilo R. Huning

Humboldt-Universität zu Berlin

Fabian Wahl

University of Hohenheim

State · September 2017
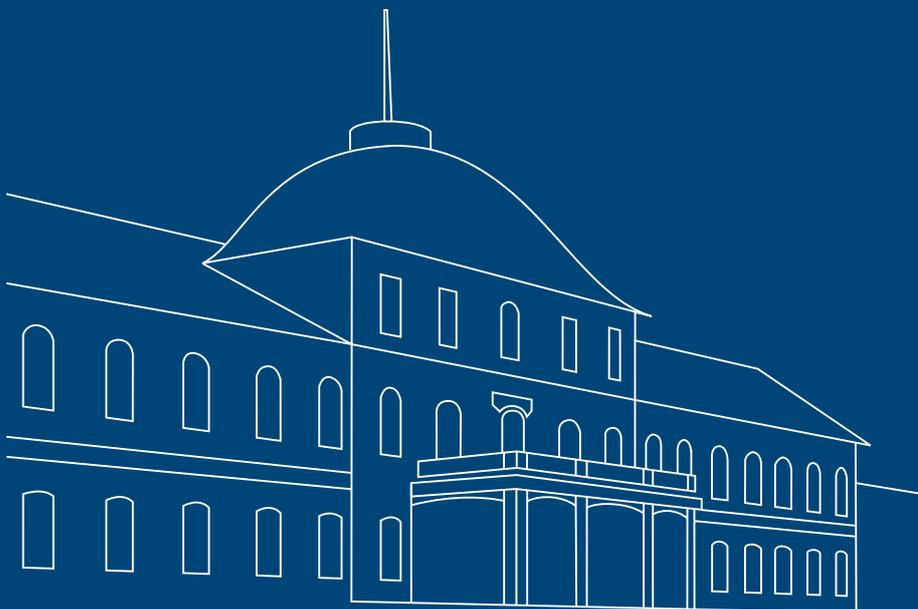
www.wiso.uni-hohenheim.de

Discussion Paper 22-2017

Lord of the Lemons: Origin and Dynamics of State Capacity

Thilo R. Huning, Fabian Wahl

Lord of the Lemons:
Origins and Dynamics of State Capacity[*]

THILO R. HUNING[†] AND FABIAN WAHL[‡]

Abstract

To better understand the role of taxation in the emergence of states, this article presents an incomplete contract model of an agricultural society in which information asymmetries cause inefficient taxation, and hence outmigration, uprisings, and rent-seeking, but also urbanization. We propose a geographic index of information costs, observability, to test our model. Our case study is the Holy Roman Empire, which had a relatively homogeneous institutional framework, state of technology, culture, and ethnic composition across hundreds of observed states, for over 500 years. We find a robust link between observability and states' tax capacity, their size, and their survival.

JEL Codes: *O42 · D73 · Q15 · N93 · D82*
Keywords: *State capacity · principal-agent problem · taxation · Holy Roman Empire*

What creates a successful state? Current economic debate has stressed the role of efficient taxation and administration.[1] Despite disagreements about the role of the state for economic development, there is consensus that some level of state capacity is essential to ensure basic public good provision

---

[†]Thilo R. Huning is doctoral candidate at the Institute for Economic History, Humboldt-Universität zu Berlin, School of Business and Economics, Spandauer Str. 1, 10997 Berlin, Germany; email: huningth at wiwi.hu-berlin.de.

[‡]Fabian Wahl is post doctoral researcher at the Institute for Economic and Social History with Agricultural History, University of Hohenheim, Wollgrasweg 49, 70599 Stuttgart, Germany; e-mail: fabian.wahl at uni-hohenheim.de

[1]For modern examples and literature review, see Olsson and Hansson (2011). For historical overviews, see Dincecco and Prado (2012); Johnson and Koyama (2017) and (Dincecco, 2015).

(Acemoglu, 2005). There is debate about what allowed some states to establish this capacity while others failed. Long-run studies point at the the self-reinforcing nature of state capacity[2], and have identified important structural changes around and after 1500, from the 'military revolution' to the Industrial Revolution until the emergence of the welfare state[3], all of which radically changed the rules of development. When searching for the optimal point in history to study the development of state finances, one has to study the period from just before until just after these structural changes, in order to avoid going back to far in time.[4] In this paper, we will trace hundreds of uniquely homogeneous states that were arranged in a federation, the Holy Roman Empire (HRE), through these radical changes, 1250–1789. We find evidence for a mechanism that links observability of (taxable) agricultural output to state capacity. This mechanism explains differences in state development during the medieval period, but not afterwards.

Our argument is based on the idea that states emerged when there was agricultural output that needed to be protected (see Bates et al. (2002); North et al. (2009) and more recently Dal Bó et al. (2015); Boix (2015); Mayshar et al. (2015)). Some believe states emerged from tribal societies realizing that security could be provided more efficiently in a central way (Bean, 1973). Tribal societies therefore set-up a voluntary 'social contract' (Rousseau, Hobbes) between the group and a 'violence specialist' (North et al., 2009, p. 20) who was granted the 'monopoly of violence' (Weber, 1919). Others do not believe in a voluntary contract, but in states emerging from coercion by a 'stationary bandit' (Olson, 1993) stealing from his subjects.[5]

---

[2]Examples include Allen (2009); Findlay and O'Rourke (2009); Mokyr (2011); Dincecco (2015); Karaman and Pamuk (2013); Ang (2015)

[3]These revolutions include the military revolution (Tilly, 1993; Diamond, 1999; Simms, 2013; Gennaioli and Voth, 2015; Boix, 2015), urban revolution (Allen, 2009; Bosker et al., 2013; Voigtländer and Voth, 2013; Karaman and Pamuk, 2013; Boix, 2015; Abramson, 2017), the discovery of the Americas (Hoffman, 2011; Nunn and Qian, 2011; Simms, 2013; Hoffman, 2015), the printing press (Rubin, 2014; Dittmar and Seabold, 2015), the Reformation (Cantoni, 2012; Cantoni et al., 2016; Dittmar and Meisenzahl, 2017), the Enlightment (Mokyr, 2011), the Financial Revolution (Neal, 2015), the French Revolution and its consequences (Acemoglu et al., 2011; Boix, 2015), nationalism (Anderson, 1983), and the expansion of public good provision in general (Alesina and Spolaore, 1997; Bolton and Roland, 1997; Alesina et al., 1999; Goldin and Katz, 2009).

[4]The few studies concerned with the determinants of state capacity prior to 1500 AD are primarily those examining, in the spirit of Diamond (1999) the impact of the different timing of the Neolithic revolution across the world on the development of statehood (Borcan et al., 2016; Ang, 2015) or those focusing on differences in transparency of agricultural output and the role of environmental circumscription in ancient states (Mayshar et al., 2017; Schönholzer, 2017). Fenske (2014) analyses the role of different gains from trade due to differences in ecological diversity for state capacity in pre-colonial Africa. Exceptions to this are Abramson (2017) and Ko et al. (2016). These papers analyze the determinants of political centralization and state formation for very early periods or over a very long time (e.g. from the Middle Ages until today) and, in this, are closely related to our paper in this.

[5]This view of an involuntary agreement is shared by figures as prominent as Marx and Engels, but also Tilly (1985). See Fukuyama (2011, Ch. 21) for an overview. An addition to this argument is the circumscription theory by Carneiro (1970). Carneiro noted that early states emerged predominantly in areas surrounded by infertile areas (such as deserts), and assumed this provided a natural barrier against fleeing from violent rulers.

What both agree on is that this 'contract', either voluntary or involuntary, exchanges violence (protective or coercive) in return for taxation. Many authors have therefore stressed the role of the former and view military technology as decisive for state development (see Tilly, 1993; Diamond, 1999; North et al., 2009; Gennaioli and Voth, 2015; Boix, 2015; Ko et al., 2016). Museums and arsenals of historic tools, weaponry, and war records from most of human history have guided the understanding of the role of the horse, the chariot, the canon, or general conscription for political order. The other side of the contract, efficient taxation, is less prominent, but understanding it is decisive for modern development economists. At its core aspect is the quality of information about taxable output. The weaker the information, the more our bandit would find himself between Scylla and Charybdis. Demanding an excess of taxes, he bites the hand that feeds him. Demanding too little, less modest rivaling bandits will take his place. Free-riding and false accusation of free-riding also threatens also the consent of those governed by a voluntary contract. Both the voluntary and the involuntary contract suffer from the problem of asymmetric information between the source of the taxes and the provider of 'security'. From the perspective of a peasant who is overtaxed due to false information, the distinction between these two origins of a state is, therefore, of purely theoretical nature.

In addition, overtaxation will lead rational agents to hide some parts of the harvest (and spend effort trying to avoid being caught), just to prevent starvation. States can try to reduce information asymmetries by creating a political order, a hierarchy, to collect data on agricultural output. This introduces multiple principal-agent problems and the problem of rent-seeking (Krueger, 1974; Olson, 2008; Acemoglu and Robinson, 2012). Therefore, imperfect information about taxable agricultural output translates to high information costs, undermines political institutions, may lead to conflict within a state, reduces state capacity, and in the end limits the states development in general—and precisely because of the information asymmetry, this is true even with the most benevolent ruler. Unlike winners of wars, rent-seeking tax collectors, lords, and officials did not boast about their successes. Their relics seldom survived in a form to anything that could be excavated today and analyzed in a structured fashion today. However, state capacity in an early agricultural society has to be viewed as an equilibrium solution between military technology *and* taxation.

To formalize this argument, we develop a macroeconomic model that links state capacity to geographic circumstances, namely a combination of the quality, and observability of agricultural output. This model is inspired by the study of Mayshar et al. (2017), who develop a principal–agent model of an agricultural state, in which state rulers maximize state revenue under information asymmetry about agricultural output, which is geographically determined. If output is perfectly predictable, rulers can extract full effort from their subjects. In a state with a high spatial variation of soil quality, for example, the actual quality of a single plot is hard to observe, meaning the ruler will have to estimate the endowment. The lower the observability of soil quality, the lower the state capacity. The more heterogeneous, and thus less observable the productive potential of each plot, the higher the costs of observation.[6]

Our theoretical model extends the work of Mayshar et al. (2017) in respect to respects. Their model is not empirically testable as they only distinguish between two types of soils, those with low and those with high observability and provide only two case studies from ancient times. We generalize their micro-level principal-agent model to a macro-level two-sector output model with a continuous observability measure. We also extend their model to explain the failure and survival of feudal states and the changing importance of agricultural and economic determinants of state capacity over time.

To test our theoretical propositions empirically, we compute a variable that proxies the observability of agricultural output (and thus the information costs in an agricultural society). This measure is based on spatial variation of the crop suitability within a region. Output is measured using the average caloric yield that can be obtained from harvesting crops. We base our measure of observability on the caloric suitability index developed by Galor and Özak (2014, 2015). This index denotes the amount of calories that can be produced in a given area, averaging over the individual caloric yields obtained from planting all suitable crops. This index covers the periods before and after the Columbian exchange. Based on this index we calculate our observability measure as a ruggedness index of caloric yields, i.e. we measure the variation in agricultural output as the variance between the caloric suitability of each cell and that of its neighboring fields. Thus, we

---

[6]Our reasoning is also based on the fact that medieval rulers, for example Charlemagne, were not only interested in increasing agricultural output, but also in increasing its observability, uniformity and comparability (Henning, 1994; Hermann, 1985)

capture to what extent the agricultural output of a grid cell diverges from perfect observability (all cells within a grid have the same caloric yield).

We link this observability measure to the states in the HRE at six points in time (1250, 1378, 1556, 1648 and 1789), which are all decisive moments in Central European history (see p. iii of the Appendix). This allows us to abstract from the role of military technology, as this is common across our sample and has been studied extensively. We obtain information and states and their size by digitizing historical maps of the HRE (without the Italian parts) by Wolff (1877). After digitizing these maps, we validated and, if necessary, corrected them using literature on the history of territorial states in the HRE, such as Köbler (1988) and Sante (1964). We also collected reasons for the failure of states.

Using this unbalanced, state-level panel data set, we first show a robust and both economically and statistically significant positive relationship between observability of agricultural output and taxation. We proxy the taxation by the tributes towards the Empire, the 'Reichsmatrikel'. We then investigate how differences in observability are related to the failure or survival of agricultural states. The results suggest that states with low observability are more likely to disappear because of bankruptcy or war and that observability is positively linked to the probability of state surviving in the Middle Ages. In the following, we find observability being positively related to state size when pooling over all states and periods. The relationship also holds when estimating separate cross sections for each of the six years and when considering the characteristics of neighboring states. It is also robust to controls for many alternative determinants of state capacity, such as access to trade routes and rivers; the availability of important natural resources such as iron, gold or salt; trade fairs; imperial cities; terrain features such as ruggedness and elevation, temperature, suitability for ploughing; the type of the state (i.e. kingdom, duchy, princedom, county, city etc.); the number of battles per state area; and the effect of differences in the appropriability of crops. Results pass various tests of robustness. We use the settled area of a state as dependent variable (the area that is not forested or marshland or the like). We take levels of agricultural observability and state area instead of natural logarithms. We employ an alternative version of the agricultural observability index (based on the assumption that only the crop with the highest caloric yield is planted), and another version of the index. The cross-sectional estimates, and alternative OLS

regressions in which the agricultural observability index is interacted with period dummies, are in line with our theoretical reasoning and historical evidence. Agricultural observability loses its significance as a determinant of state capacity in the early modern period, more specifically in the 16th century. As outlined earlier, this is the timing we would expect, when due to structural changes like the Reformation and technological progress in military technology made the scale effect the dominant factors in predicting state capacity.

Below we provide an overview of relevant historical features, such as the political and societal structure of the HRE. We continue by developing the theoretical model that connects the principal-agent problem to state capacity and size. We introduce the data and outline our empirical strategy to test the theoretical model. This includes a discussion of alternative influences on pre-modern state capacity, and also how we address them. We will discuss the empirical results, and then conclude

I. STATE SIZE IN AN AGRICULTURAL SOCIETY
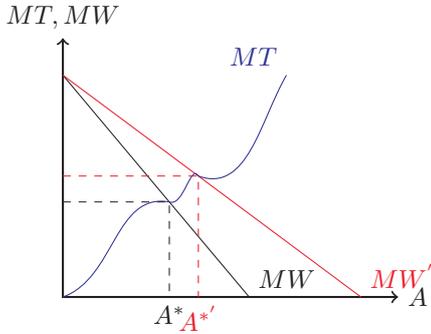
Figure 1: *Stylized equilibrium area (A^*) of a state in equilibrium between decreasing marginal costs of warfare, MW, and increasing, geographically induced and non-linear marginal cost of taxation MT, before and after the military revolution that shifts military costs to MW′ starting around 1500*

We define a state as a geographical unit that competes with fellow states over both territory and labor supply to generate taxes. We are therefore interested in the tax capacity of such a state, and its influence on geographic size and survival. Our model state is predominantly agricultural, as this was by far the leading occupation throughout human history (see Allen, 2000, for estimates). We assume that land rents are Ricardian, and that a state's tax revenue is a function of the available land area and labor force. The general idea that the geographic size of a state is at equilibrium between increasing returns to scale in providing public goods and increasing

obstacles to this provision [7] is well established (see Spolaore, 2014, for a recent overview). Consider Figure 1. Following Bean (1973), we view defense of the territory as the predominant public good, which is provided at decreasing costs per unit of land. During the High Middle Ages changes in technology amplified these decreasing returns to scale, in the 'Military Revolution' (Tilly, 1993; Gennaioli and Voth, 2015; Boix, 2015).

Already Adam Smith was concerned with obstacles to state size and capacity, and proposed a mix between geographic variables and administrative constraints

"In countries, such as Italy and Switzerland, in which, on account either of their distance from the principal seat of government, of the natural strength of the country itself, or of some other reason, the sovereign came to lose the whole of his authority. [...] This is the short history of the republic of Berne as well as of several other cities in Switzerland. If you except Venice, for of that city the history is somewhat different, it is the history of all the considerable Italian republics, of which so great a number arose and perished between the end of the twelfth and the beginning of the sixteenth century."[8]

Concerning distance, Olsson and Hansson (2011) have recently shown that across modern countries there is a robust negative relationship between country size and rule of law.[9] In theory, there can be three reasons for their finding. First, the complexity of the process upon which that information is collected (unrelated to distance). Second, the transfer of the information through the organizational structure of the state (weakly related to distance, depending on circumstances). Third, the loss of information due to the physical transport of the information, which we positively rule out for modern times given communication technology.

Regarding the first, more complex processes are harder to understand. Mayshar et al. (2017) show this with Egyptian agriculture, a fairly simple process. The Nile carried with it fertile soil and distributed it evenly across its banks. This means that a primitive tool, the Nilometer[10] was a reasonable indicator for harvest outcomes, in the form of a univariate relationship. By contrast, agricultural output in Mesopotamia depends on multiple variables, as irrigation was more complex.

---

[7]Both Alesina and Spolaore (1997) and Bolton and Roland (1997) view heterogeneous preferences as the obstacle for modern states

[8]Wealth of Nations, book III, ch. 3. Quoted edition Smith (1991)

[9]They also provide an overview of the history of this thought including prominent figures like Plato, Aristotle, Rousseau, and Montesquieu.

[10]A Nilometer is essentially a set of marks to measure the water level (see Mayshar et al., 2017).

The process of agriculture in Western and Central Europe was even more complex, and not well understood in the Middle Ages. There are some homogeneous landscapes, where properties of the soil are very uniform, the terrain is even, the wind blows all seeds in the same direction, etc., and other landscapes, where none of this is true. Taxation of output from these landscapes will naturally be based on estimates, and these can vary in their quality. Lacking an objective tool (like the Nilometer), these estimates relied on self-reporting (van Schaïk, 1993; Vogeler, 2005). We will outline how different levels of variation, which are geographically determined, yield different qualities of information, and induce information costs.

Information about agricultural output is necessary for taxing an agricultural society. Meteorology, the science of measuring and predicting weather and climate, was rediscovered during the Renaissance. Behringer (1999) goes as far as viewing the emergence of meterology to predict agricultural output as a counter-reaction to witch-hunting—the prevailing practice for overcoming harvest failures during 1300–1600. We can assume that the state of meteorology was so weak, and that investment into the understanding of factors that determine the harvest was so costly, that tax collection depended on adaptive expectations, and also local gentry and officials who were familiar with subjects and landscape. This explains hierarchies, such as the Chinese bureaucracy, the Mamluks in the Middle East, and also the feudal system in Western and Central Europe.[11]

Relying on local knowledge has downsides. In any such hierarchy there is loss of information, even if the incentives of all participants are aligned. In an analogy to the telephone game, there would be some loss of information, but driven more by the number of hierarchy levels than distance.[12] The levels of hierarchy in the HRE were however not dependent of its size, but mostly due to tradition. This could lead us to reject incentive-aligned tax officials if we observe variation in state capacity despite the same number of levels in the hierarchy. At any level in the hierarchy there is a principal-agent problem, and these problems combined limited the expansion of the

---

[11]It is important to note that the feudal system was not built from scratch, but relied on existing tribal hierarchies. The alternative, demonstrated by China, reveals however that these structures could be eroded, if the central power is strong enough. This in turn allows us to measure information costs half a millennium ago, unlike in other areas of the world. One can assume that asymmetric information in a bureaucracy would translate to e.g. corruption, which is hard to observe in a historical context. (see also Mitterauer, 2004; Fukuyama, 2011).

[12]Consider playing the telephone game. The quality of information is reduced slowly but continuously over time (as people forget) which would be analogous to the distance in our context. Much faster, and the core of the game, is the sharp drop in information quality between two players when one player has to listen and repeat the information.

state.[13] In the next section, we will trace these problems through the hierarchy of the HRE and show how we can measure them in aggregate.

II.   TAXATION IN THE MEDIEVAL HOLY ROMAN EMPIRE

We follow the literature in regarding the medieval Roman Empire as a chain of bilateral contracts (North and Thomas, 1971; Volckart, 2002), through which security is provided from the top down in exchange for goods and services (see Bean, 1973; North et al., 2009; Olson, 1993). In Figure 2, we see the ends of the chain of bilateral contracts held by the Emperor and the households. Our element of interest, the territorial states, contracts directly with the Emperor, but only connects to households through intermediaries. We will outline how the rents that gentry and officials gain from inter-mediating between state and household are a loss to the rulers, and how rents arise endogenously from the multi-layer principal-agent problem.

1.   Households and the Gentry

The lower end, and the smallest political unit of the HRE was the household (see (Wilson, 2016, p. 508) and (Volckart, 2002, p. 33)). Volckart (2002) distinguishes between three types of contracts that exchange either services or agricultural goods between the household and the low gentry and officials. The most prominent of these was the feudal contract, in which a lord (lat. vilicus) provides security in exchange for agricultural output and compulsory labor for the feudal lord (corvee). The households had the right to decide the use of the land and the yields of the land ("usus et usus fructus" (Volckart, 2002, p. 40)), but would never gain property over it. This system, developed by the Carolingians, had its origins in the Late Roman Empire, when formerly free peasants were obliged to fill military granaries, and diffused eastwards into the Germanic areas (Mitterauer, 2004, p. 42ff.). The lord maintains certain rights of deposition over the feudal state, but grants the household (its serfs) the right to work on the land and retain a portion of the harvest to feed themselves.

---

[13]The idea of non-aligned incentives in a company-like state, which is true both for a feudal society and a command economy, is taken from Harrison (2002).

Neither secular nor ecclesiastical states based their taxation upon tradition, but were flexible about the form and quantity of taxation. North and Thomas (1971) have argued that whether a lord would demand goods or services was a question of transaction costs, and depended on the lord's ability to market each of the products. We employ this idea in our model, since we identify all forms of taxation with their labor input. Inefficiency in acquiring information about the harvest posed a substantial risk to the lord. Tradition and written contracts certainly did not impose an upper bound for taxation, especially due to a very flexible and hence dynamic element: free provision of peasants' labor services. Labor services were not well codified (Volckart, 2002, p. 9), and allowed rulers to flexibly adjust the quantity of such services to circumstances. For example, a 1222 source from the Eiffel provides instructions on how to persuade peasants to take over new duties, selling them as old traditions (Epperlein, 2003, p. 76).[14]

One of the most important threats to tax capacity was outmigration. Depending on the demographic circumstances, but especially following the Black Death, outmigration to another feudal state or a Free or Imperial city made states compete for peasants (Volckart, 1997, 2002), and one element of this competition was costs created by incomplete information.[15] Rulers' ability to restrict this migration depended on features such as state capacity and the size of its territory—as it was easier to escape undetected from a small state than a large one (Blickle, 2006; Gerteis, 1997). Thus, some rulers were more
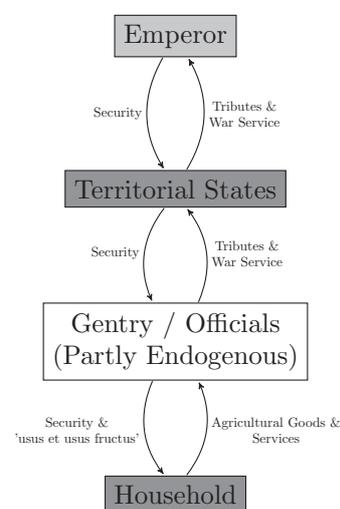
Note: This graph shows how agricultural output and security are exchanged via a chain of bilateral contracts between the household on the one side and the emperor on the other side. The box 'Gentry and officials' represents multiple layers of bilateral contracts exchanging tributes & war services against the promise of security

Figure 2: *Model of the political structure of the Holy Roman Empire*

---

[14]Large and extensive corvees were not unusual (see e.g., the discussion in Blickle (2006) on the particularly repressive feudal system in the Baltic Sea area).

[15]The migration from rural areas to cities is considered among German historians to be an important aspect in the demise of the feudal system. They provide a several detailed accounts about conflicts between rulers and city states about fleeing serfs. One of the most conflicted topics between territorial states and cities states was the so-called urban dwellers ("Pfahlbürger"): people who lived outside the area of the city in villages but were citizens of the city—and hence not part of the feudal system. Emperors forbade this type of citizenship several times during the 14th century but did not succeed in preventing it (Blickle, 1988). However, as emphasized by (Ogilvie, 2007, 2011) urban labor markets in pre modern times were highly regulated by guilds, and they often successfully limited immigration to cities. Thus, migration to a city state might not have been possible for everyone or at all times.

successful in preventing emigration than others.[16]

Another threat arising from information asymmetries and information costs was revolt. Peasant revolts were common in the HRE throughout the Middle Ages and increased in frequency and intensity in the early 16th century, culminating in the German Peasants' War in 1525.[17] Although their overall success (especially in the Peasants' War) was limited, there are numerous examples of peasant revolts against (perceived) overtaxation, restriction of free movement and inheritance rules that resulted in a compromise between the ruler and the peasants. These gradually improved the situation of the peasants and weakened the feudal system in the long-term.[18]

Incomplete information about agricultural output also explains a common phenomenon during the Middle Ages, tax avoidance. The Sachsenspiegel (around 1230)[19], a rich historical source of medieval life in Saxony, allows us to understand how peasants attempted to cheat their rulers. It explicitly states that the quality of the tithe (an in kind payment to the local church officials of ten percent of the agricultural harvest of the season) has to be exactly the same as the share the peasant keeps (2nd book, Art. 48 §6). Rulers had to be informed about the estimated quantity of the harvest in advance, otherwise they could make their own estimate of their subjects' dues.

2. Gentry and Nobility

The intermediate level of the feudal societal order there was the gentry, i.e. lower-ranked nobles like knights, officials ("Ministerialen") of the noble state ruler (like reeves) and also those counts and barons who ruled over a feudal estate that was not "reichsunmittelbar" (directly subordinate to the Emperor) but was given to them by a duke or prince. Those medium ranked nobles (the gentry) usually administered their territory under a higher-ranked noble. For example, counts originally served as vassals of dukes with responsibility for a particular county of the duchy.

---

[16]In the south west of the HRE, rulers found arrangements to deal with it, either by demanding several types of fees and compensation payments for permission to emigrate or by bilateral agreements with neighboring rulers that for each serf migrating to the territory of the neighbor they get one of the neighbor's serfs (Blickle, 2006). In the north, by contrast, they took measures to further punish migrants in order to restrict emigration, e.g. they made agreements with other rulers to send back strangers from other states who didn't have a an official dismissal allowance from their former ruler–but with apparently limited success (Blickle, 2006; Peters, 1995).

[17]The reader is referred to Blickle (2006) and Buszello et al. (1984) for detailed accounts of the Peasants' War.

[18]An overview of the history of German peasant revolts and uprisings in general, including several case studies is given by Blickle (1988, 2006) and Franz (1976).

[19]Cited after Epperlein (2003).

As such, they were responsible for the collection of dues and taxes in their feudal estate. These intermediaries could engage in rent-seeking (North and Thomas, 1971; North et al., 2009), keeping a certain amount for their own purposes and passing the rest to the overlord. They had to provide soldiers for the wars of the overlord in return for his protection. Hence, the principal-agent problem between them and the households discussed above, was relevant to the relationship between the overlords and the gentry. If the gentry could not appropriate enough taxes from the serfs (or overtaxed the households) the amount that the overlord received from the gentry was also reduced. Furthermore, as the local gentry had better information about the agricultural than the overlord, there is an additional principle-agent problem between gentry and nobility. The first has an incentive to cheat the nobility in order to retain a higher share of output for themselves. Of course, the incentive to conceal tax revenues increases as agricultural output, and the amount that is available for appropriation, decreases. This increases the severity of the principal-agent problem between the nobility and the gentry.

Territorial states saw these intermediaries as necessary to collect taxes, but also as a cost factor, aware that information asymmetries led to rent-seeking. As Bloch (1966, p. 134) wrote, the emergence of absolutism was "to protect rural communities, ripe material for taxation, from intemperate exploitation by their landlord".

3.   Emperor and Nobility

At the top of the feudal order was the Emperor of the HRE, who was usually also the king of Germany. He was the supreme overlord and granted feudal estates to his vassals, the "Fürstliche Häuser" (princely houses). This originally meant dukes, princes, bishops and archbishops. They also had the right to 'subcontract' parts of their estates to lower-ranked nobles for administration (subinfeudation).[20] The Emperor also granted city rights (making cities directly subordinate to the Emperor), and had the right to reallocate estates from disloyal or deceased vassals. In exchange for the feudal estate and troops for war and dues from the nobles (the 'Reichsmatrikel') he guaranteed security of their rights over the estate. The Emperor also had territories that he

---

[20]The fact that the vassals had the right to give away parts of their estates to lower-ranked nobles also led to a decrease in the power of the Emperor over time. This was because, within the feudal hierarchy, a noble was subordinate only to his immediate overlord and not to those at higher ranks.

ruled directly. In those territories, the Emperor usually installed officials like reeves to collect taxes, administer the law and uphold order. Here again, the relationship between nobility and Emperor was characterized by a principal-agent problem, and again, the initial information problem between gentry and serfs determined the amount of dues, taxes and troops the Emperor could extract from the nobility. Most of the time the nobility had a better bargaining position than the Emperor as, especially during the Middle Ages, the Emperors did not directly control a large area. Furthermore, the German king was traditionally elected by the leading princes (the electors). Hence, he depended on the loyalty and favor of the most powerful territorial rulers. This allocation of power between the princes and the Emperor lead to a decline in his power during the medieval period and a decentralized, highly fragmented political landscape.[21]

III. MODEL

The purpose of the model is to connect information costs in a completely coercive society to tax capacity, as in Mayshar et al. (2017), from there to connect the geographical size of rural states and migration to cities. We will employ a two-sector model of agriculture and proto-industry. To be consistent with the historical setting we will not allow for non-coercive institutions (see Acemoglu and Wolitzky, 2011; Boix, 2015), and only a negligible share of agricultural output is traded via markets (Ogilvie, 2001). We will outline a static analysis before turning to the system dynamics.

The optimization problem of our states is very complex, so that we constrain ourselves to the most simple notation, standard letters, omit explicit functional form, and explain our concepts mostly by comparative statics.[22] In general, states maximize tax revenue over an infinite time horizon. They aim to extract all of their subjects' output above subsistence.[23] They can do so by allowing their subjects to move to cities, adjusting their urbanization rate $u \in (0, 1)$. States can also conquer other

---

[21]The Golden Bull of 1356, the so-called constitution of the HRE, officially settled the election procedure of the king by the electoral college and confirmed the rights and privileges of the electors. This made those seven (and later up to nine) electors the most powerful rulers of the Empire.

[22]Consider any function $f(x)$ that is differentiable twice. We will use a shortcut to ease notation using $f(x \uparrow)$ if $\frac{\partial f}{\partial x} > 0$ and $f(x \downarrow)$ if $\frac{\partial f}{\partial x} < 0$.

[23]The idea that the taxes were so high that peasants were kept at subsistence can be found both in Smith (1776) and Malthus (1798), and is also a feature of Mayshar et al. (2017).

states' territories, which will affect their geographic size a, their average Ricardian land rent r, and the observability of their agricultural output N. Attacking other territories and defending against attacks come with adjustable costs V. States can also allocate parts of their budget to maintaining interior order G. These costs include tax administration, but also collecting information on tax cheaters, quelling uprisings, preventing subjects from fleeing the state or moving around the state against the state's interest, acquiring subjects from over states, and rudimentary poor relief. Decisions of state budgets and strategy are taken discretely for any year t. States have a common discount factor $\delta > 0$ so that the optimization is given by

$$\max_{u,a,r,N,V,G} \sum_{t=1}^{\infty} \left(\frac{T_t}{(1+\delta)^t} \right) \qquad \text{s.t. constraints}$$

which are described in more detail now.

1. General Model of the Economy

We will drop state and period subscripts for ease of notation, wherever possible. Consider any state that produces agricultural output R and output from proto-industry P, so that $Y = Y_P + Y_R$. The state is endowed with common labor L, which is split between rural L^R and urban L^P labor stock, depending on the urbanization rate u, $L_P = uL$ and $L_R = (1-u)L$. Agricultural output depends on common technology A_R, factor inputs L^R and soil S, which can be substituted at elasticity α, so that $Y_R = A_R L^{R^\alpha} S^{(1-\alpha)}$. Output of the proto-industry depends on common technology A_P and manual work L^P at diminishing returns $\beta < 1$, so that $Y_P = A_P L^{P^\beta}$. There is a common information technology $A_T \in (0,1)$ to collect taxes and assess agricultural output. States collect these taxes in the form of goods, or via direct labor services (North and Thomas, 1971; Volckart, 2002; Mitterauer, 2004). Subsistence in cities is higher than in the countryside as cities do not produce food and transport is costly, $s_P > s_R$. Therefore, tax income T is a function of $T^P(A_T \uparrow, Y_P \uparrow, s_P \downarrow)$. Subjects naturally prefer to live in cities (which we will show later). We can therefore solve for the urbanization rate that maximizes tariff revenue, which is found where the additional tax from a urban labor supply is offset by the loss from its higher costs of subsistence and the loss to the rural labor supply, $u(\frac{\partial Y_P}{\partial L^R} \uparrow, \frac{\partial Y_R}{\partial L^P} \downarrow, (s_P - s_R) \downarrow)$. States face costs

$V > 0$ to protect their borders using common military technology A_V.[24] These costs increase with geographic size a, but have decreasing marginal costs per area (Bean, 1973). The investment in one period has consequences for the following periods. Castles need to be maintained, and unemployed soldiers would find employment as rowing bandits, so that $V_t(A_V \downarrow, a \uparrow, V_{t-1})$ with $\frac{\partial^2 V}{\partial^2 a} < 0$ and $\frac{\partial V_t}{\partial V_{(t-1)}} \geq 0$. This explains that there will be some states which will maximize tax revenue by minimizing the costs of defense, e.g. by building a wall around the city itself, setting $u = 1$ and not having any endowment of soil S. These are city states.

2. The Problem of Agricultural Taxation

States having $u < 1$ use soil as an input factor. Following Mayshar et al. (2017), states have incomplete information about soil quality and depend on estimates of agricultural output. Therefore, the state will organize tax collection in its territory by building a hierarchy. This hierarchy features distinct groups of households, which are groups of individuals. Rural households are only connected to the state only via a set of individuals, the intermediaries. Any rural household h is part of a set of households H that owes taxes to the tax official, or lord, g_1 at the lowest level of intermediaries l_1, which contracts the land from. In this way, various layers on other layers $l_2,..$ various intermediaries $g_2,..$ are interposed between the state and all its rural households H, $h \in H_{g_1}^{l_1} \subset H_{g_2}^{l_2}... \subset H$. Using adaptive expectations about the quality of the soil, the lords or officials parcel this land and assign it to rural households. They can assess average Ricardian land rent r. However, the complexity of the weather affects fields in any period t in ways that are beyond their understanding[25], $S_{ht} = r_h + \omega_{ht}$ while $\lim_{t^* \to \infty} \sum_{t=0}^{t^*} \frac{\partial S_{ht}}{\partial \omega_{ht}} = 0$. Households naturally learn about their current soil endowment as they harvest. Anyone else has to rely on incomplete information about the soil quality. Using adaptive expectations[26], the most local intermediary

---

[24]This argument is in line with coercion, or violence as the source of states, as in Olson (1993). Tilly (1993), North et al. (2009), Gennaioli and Voth (2015) and Boix (2015) have based their arguments about the dynamics of state building on this aspect.

[25]Imagine two farms, one on the hill, and one in the valley, and strong rain for days. The hill farmer will find it sufficient to dig some temporary channels to help the excess water find its way downhill; the valley farmer will find his crops flooded.

[26]We can neglect Bayesian updating, mostly due to limitations on the tax collector's learning behavior. How do states learn about their subjects' soil quality in any period? A scientific model of the link between weather, landscape characteristics, and meteorology, was not available. States cannot learn from their subjects' words, but they can learn from what they observe, in the form of operant conditioning and social cognitive learning. If tax collectors observe an unexpected increase in some households' livestock, physical appearance, and living conditions in general, and increase the tax, this learning is part of natural human behavior, and therefore common technology. Learning from peers, e.g. if some

will allocate a plot of land to a household that maximizes tax revenue, depending on the average rent and the subsistence level, $a_h(r_h \downarrow, s_R \uparrow)$ as it cannot be optimal to keep the households below subsistence. This will not assure that households never starve, as the effects of the weather upon a specific plot are unobserved to the anybody but the household, which is not trusted to share the information. Generalizing this point, due to the principal-agent problem on each layer, all layers from the lowest gentry l_1 up to state level n depend on own estimates. We assume that any level's signal about soil quality S^* is normally distributed around the actual endowment of rural household h with soil S in period t. The shape parameter N represents noise (a decrease in the quality) of the signal. From standard reasoning about information asymmetries back to Akerlof (1970) it follows that the signal gets weaker the further up the hierarchy, so that for any level k it is $\forall_{k=\{,1...,n\}} : S_{ht}^{*l_k} \sim \mathcal{N}\left(S_{ht}, N_h^{l_i}\right)$ while $\forall_{k=\{1,...,(n-1)\}} : N_h^{l(k+1)} \geq N_h^{l_k}$. Any level k will however use this signal as the basis for taxation of household h and wish to leave all levels below it with subsistence only, $T_{ht}^{Rl_k}(Y_{ht}^{*l_k} \uparrow, s_R \downarrow)$.

What are the consequences of underestimating the soil endowment? Since $S_{ht}^* < S_{ht}$ it follows that some of the agricultural output cannot be taxed away. If the signal of the lowest level of intermediaries underestimates the soil endowment, this yields a potential rent y for the households, $y_{ht}^{l_1}(S_{ht}^{*l_1} - S_{ht})$ with $\frac{\partial y_{ht}^{l_1}}{\left(S_{ht}^{*l_1} - S_{ht}\right)} \geq 0$. This potential rent will be realized by rational agents depending on the probability of being caught cheating and the punishment (following the logic of Becker, 1968). Prosecution of households often ended with subjects being injured and dying, such that prosecution could reduce the supply of labor in the next period. If chances of being caught are high rural households will reduce their effort during the harvest, leading to a reduction in L. Lords also had the right to punish 'insubordination, persistent laziness, or deliberate neglect of their duties' (Whaley, 2012, p. 251), so that this labor reduction was also risky. In any layer, intermediaries therefore have the incentive to keep their agents from realizing rents, and hold on to them themselves. In the long run, it has different effects on the society who is the one extracting rents, but for the tax capacity of the state, it has only

---

intermediary finds out that another intermediary on the same level is richer than he is, the first intermediary might try to discover the reason. This might help to identify the households that cheat him based on shared characteristics with the households that his richer peer taxes more efficiently. He will do what his neighbor does, e.g. provide his tax collectors with better tools to assess, infiltrate his subjects with spies, etc. Soon, all intermediaries on this level will discover the trick, and the technology will become common. Tax collectors could try to learn by trial and error to retrieve a model on the effects of weather and taxation on what they can observe. As this is connected to starvation, out-migration, and uprising, these experiments would be very costly.

negative ones.[27]. The same principal-agent problem is repeated up to the level of the state n, which has the lowest quality of information $\left[I_{ht} \mid S_{ht}^{*l_n} < S_{ht}\right] = \left(y_{ht}^{l_1} + \sum_{k=1}^{(n-1)} y_{ht}^{l_k} (S_{ht}^{*l_{(k+1)}} - S_h^{*lt})\right)$. Knowing that on average any second period yields rents, long run rents in any state r relate to the information asymmetries of all rural households in $H = \{h, h_2, ...\}$ on all layers $l_1, ..l_2, .., n$, yielding $\lim_{t^* \to \infty} \sum_{t=0}^{t^*} I_{rt} \sim \{N_h^{l_1}, N_h^{l_2}, .., N_h^n, N_{h_2}^{l_1}, N_{h_2}^{l_2}, .., N_{h_2}^n, ...\}$. We can conclude that underestimation of harvests limits the tax capacity of a state by reducing taxes that could be gained from the potential output of household h in period t under perfect information Y_R by the rents $I\left[T_{ht} \mid S_{ht}^{*l_n} < S_{ht}\right] = T\left(A_T, Y_{Rt}, s_t\right) - I_{ht}$.

Now turn to the case of an overestimation of soil quality, which at any point in time t can leave any other element of the chain with agricultural output below subsistence after tax collection. In the end, this was mostly true for the households. First, assume that households did not want or could not leave the state—as we will focus on emigration later—so they decided to pay the taxes. One option would have been working on the side to get the taxes from other sources. This was dangerous, as it was highly illegal. Lords often sold households' extra labor supply to urban traders in form of monopsonies (Ogilvie, 2001). This included many forms of agricultural goods, and also intermediaries, such as yarn. To uphold Lords' income from these contracts with traders, the informal labor market was illegal. The illegal labor market can be characterized as an exchange of jobs undertaken by desperate households that often came with a health hazard plus a high risk of capital punishment in case of being caught. Second, households could also resort to violence, e.g. looting granaries. Third, households could starve. All three options had negative effects on households' ability to provide labor, which we will circumscribe with Q. Households could try to move to a city, or another state. Given that cities also allow their citizens to subsist, due to complete information on output, subjects living in a city cannot be overtaxed. If we imagine our medieval households to be disutility minimizing, they would naturally prefer to live in the town. However, as states use u as one of their decision variables to maximize taxes, they will only allow this up to the point at which it reduces overall tax revenues. This can render within state urbanization impossible.

---

[27] Arguing with Malthus, rents sought by households can lead to a higher population, until the returns to the factor of labor diminish, and emphasize the effect of bad harvests (see also Mayshar et al., 2017, 2015; Voigtländer and Voth, 2013). In case gentry and nobility realize the rents, this can undermine the political stability of the state, and also lead to a decrease in households' fertility due to rising prices for staple food following Engel's Law (Engel, 1857).

Concerning migration to other states, we assume that all states are alike in their aim of extracting all of their subjects' taxable output, so that we can neglect tax competition between states. Consider migration from any state i to the rural area of another state j, which households perceive to be the most attractive due to its soil endowment and allows immigration due to its marginal product of labor $\frac{\partial Y_j}{\partial L_j}$. Migration of households to closer states is more probable than long-distance migration for two reasons. First, households need to collect information about the state they contemplate moving to (see Bursztyn and Cantoni, 2016). Second, their disappearance is less likely to be noted if it only takes some hours to reach the border (Volckart, 1997, 2002; Blickle, 2006). Therefore, fleeing time d, the probability and severity of the punishment when caught, and the perceived information asymmetries explain why migration from the household to the safe border of the destination state is central[28]. The net migration X from any territorial state i to any other territorial state j can be spelled out as $X_{ijt}^R = \sum_{h \in i \mapsto h_2 \in j} \left(N_h^{l_1} \uparrow, N_{h_2}^{l_1}, \left(\frac{\partial R_j}{\partial L_j} - \frac{\partial Y_i}{\partial L_i} \right) \uparrow, d_{hd} \downarrow, G_i, G_j \right)$ with $\frac{\partial X_{rit}^R}{\partial G_i} \lesseqgtr 0$ and $\frac{\partial X_{rjt}^R}{\partial G_j} \lesseqgtr 0$. Destination states could find it either beneficial to stop peasants from immigrating, depending on their marginal product of labor, by investing in G, but could also welcome the arriving migrants by investing in G and allocating them to a field to harvest for future seasons.[29] In the absence of labor market regulations, this would only depend on immigrants' marginal product and their subsistence needs. The most recorded form of outmigration was fleeing to cities, especially Imperial cities. As cities produce use proto-industry technology A_P and have perfect information about their citizens, migration to any city j depends on technologies, marginal product of labor in the city compared to rural areas[30], and observability $h \in i \mapsto h_2 \in j : X_{hjt}^P = \left(N_h^{l_1} \uparrow, \left(\frac{\partial P_j}{\partial L_j^P} - \frac{\partial P_i}{\partial L_i^P} \right) \uparrow, G_{it}, G_{jt} \right)$ while $\frac{\partial X_{rit}^P}{\partial G_{it}} \lesseqgtr 0$ and $\frac{\partial X_{rjt}^P}{\partial G_{jt}} \lesseqgtr 0$.

3. Government Under Information Asymmetry

We established that states have room to reduce, or avoid, negative effects of asymmetric information by spending on interior order G. This would deliver better information on tax cheaters, leading

---

[28]Carneiro (1970) and more recently Schönholzer (2017) go as far as viewing this mechanism as the nucleus of state formation. They claim that the impossibility of fleeing allowed coercive government.

[29]What we would today understand as poor relief was not established in German lands before the mid 17th century, nor was the problem of migrant poverty seen as a field of government action (Whaley, 2012, p. 261).

[30]Historic literature following Abel (1943, 1953) has focused on these factors, viewing the process of abandoning areas in Central Germany solely as an outcome of wage differentials induced by the Black Death.

to a reduction in households shirking, but it could also just lead to more innovation in tax avoidance. States could also spy on subjects planning to flee the country, or deport unwanted immigrants. They could use police to suppress uprisings. It has also been recorded that agents were sent to collect anyone without a master from neighbouring territories (Whaley, 2012, p. 252), which is essentially another form of investing in G. 'Peuplierungspolitik' (populationist policies) (Whaley, 2012, p. 263), most prominently affecting religious minorities (see e.g., Hornung, 2014, for a later example), were an outcome of this problem. These costs G are the sum of the costs for all households, $G_{rt} = \sum_{h \in H} G_{rht}$. For any household h, these costs are given by the characteristics of the household itself, but also all possible migration targets $h2, ...$, so that $G_{iht}\left(A_V, A_R, A_C, N_{h_2}^{l_1}, ..., z_{hj}, ..., G_j, ..., N_h^{l_1}, N_h^{l_2}, .., N_h^n, N_{h_2}^{l_1}, N_{h_2}^{l_2}, .., N_{h_2}^n, ..., z_{hj_2}, ...\right)$. These costs are aggregated on a state level. Similar to V, investment in one period creates maintenance costs for future periods. Collecting information on emigration and tax avoidance builds on established networks of trustworthy spies, so that aggregate G is given by $G_t(\sum_{h \in H} G_{ht} \uparrow, G_{t-1})$ while $\frac{\partial G_t}{\partial G_{(t-1)}} \geq 0$.

The overall effect of overestimating the soil quality for any household h in period t can be given by the possible tax under perfect information from which is deducted the negative impacts on the households that stay and the effects of emigration to all other countries J, so that $\left[T_{ht} \mid S_{ht}^{*l_n} > S_{ht}\right] = T\left(A_{Tt}, R_t, s_t\right) - \frac{\partial R_t}{\partial Q} - \sum_{j \in J} X_{jt}^R$. The two losses to tax revenue due to information asymmetries are costly, and if these costs are ignored, they can undermine the state's existence. The two types of government spending we identified, V and G both have to be financed by taxes. If they cannot be financed, states are bankrupt, iff $T_t < V + G \Rightarrow \sum_{t^*=(t+1)}^{\infty} T_t^* = 0$.

This yields that

Proposition 1. *States with lower observability of agricultural output are left with a lower amount of taxes, ceteris paribus.*

and also due to the properties of the normally distributed signal that

Proposition 2. *States with a lower observability of agricultural output face a higher risk of bankruptcy.*

Now turn to the long run implications of this problem. Imagine the survival of a feudal state as a continuous struggle of the ruling family to raise an heir to marriage age, and to find an adequate

match (Stone, 1961). In the tradition of Gale and Shapley (1962), this matching process requires a certain number of possible partners, and an ordered list of preferences for all partners. The German high nobility was relatively closed, which allowed marriage market participants to be well informed about what is on offer (Spieß (1993) and Hurwich (1998)). This gives us the proposition that other participants on the marriage market would notice their problems with efficiently taxing their subjects, moving them down their preference list on the marriage market, so that

Proposition 3. *States with lower observability of agricultural output are inferior on the marriage market*

4. War Over Territories With Information Costs
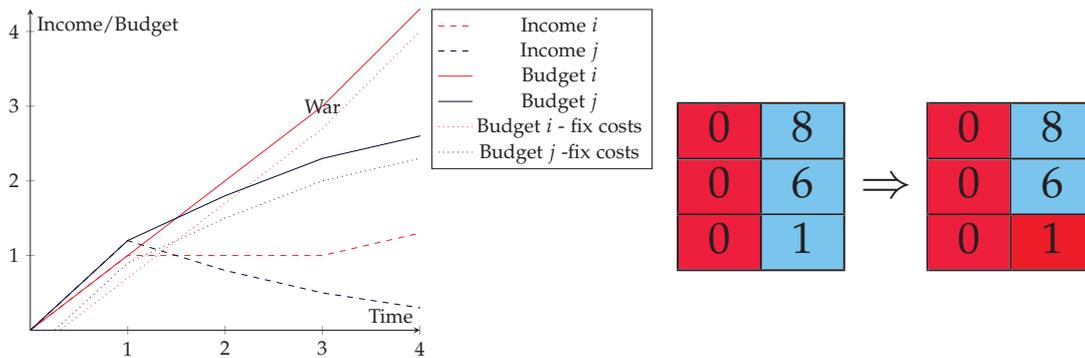
Note: At equal soil quality, state i's aggregated output from agriculture is perfectly observable, while state j's signal is distorted. Therefore i's aggregated income varies significantly between periods, which allows i to pay for the fixed costs of war and overcome j's defense to conquer territory from j after harvest in period 3. State i would do so conditional on the observability of the conquerable plots, and take over the best plots (indicated in dark red). After war, this would cause i to be larger compared to state i. Both states face a decrease in their average observability. Also, i faces a trade-off between the potential income, and the added variation of income between periods. If the conquest of one of the remaining plots would allow i to be attacked by another state (not in the picture), the visualized 'after war'-state is a new equilibrium.

Figure 3: *Stylized example of two states competing for territory. The plot on the left shows the income/budget of the states over time. The right visualization displays the observability of soil quality in two states, before and after i's attack on the southeastern plot.*

What explains war? Consider state budget, and keep in mind that V comes with increasing returns to scale. As outlined in fig. 3, under certain conditions, state i will find it profitable to conquer territory from i. He would invest in V above the budget the defendant would have to invest in keeping the territory. If successful, the aggresor would increase its size a, which would also affect its average Ricardian land rent r. The aggressor would choose exactly the territory that yields the best combination of land rent, and observability, deduced by the one time costs of the attack

and the recurring costs of defense. Depending on the magnitude of the increasing returns, a geographically larger state might maximize its long-run tax revenue by taking over territory that reduces its average land rent, and also its average observability. The higher the information costs of i, the less funds can be raised for defense. If increasing returns to scale become very large in magnitude, as implied by (Tilly, 1975; Gennaioli and Voth, 2015) for 16th century onwards, this allows geographically larger and less observable states to overtake even more observable territories. In the long run, this yields

Proposition 4. *States with poor observability of agricultural output are geographically smaller, ceteris paribus.*

This shows that there are many channels via which information costs affect states, including the risk of rent seeking intermediaries, mass starvation, outmigration, civil unrest, urbanization, and war. We have linked this to geographical variables and the state of technology, which we assumed to be common across states. The central outcome of this model is that it is costly to states to solve problems caused by asymmetric information, and that in the long run this affects the survival of the state.

Proposition 5. *Any state with a higher observability of agricultural output than any other state also has a higher probability of survival*

Finally, it is well established that asymmetric technological and institutional changes in favor of proto-industrial technology, accompanied by a period of wars, flight to cities (Dincecco and Gaetano Onorato, 2016), and also the 'military revolution' lead to an unprecedented urbanization after 1500 (Tilly, 1993; Voigtländer and Voth, 2013; Dittmar and Meisenzahl, 2017; Bosker et al., 2013; Boix, 2015). This hints at a reduction in the diminishing returns to labor in cities, $\beta \downarrow$, and also in the relative defense costs V for cities vs. territorial states. Territorial states would therefore increase u (reducing the role of soil, and reducing the need for hierarchy as population decreases), and city states would allow more immigration.

Proposition 6. *The predictive power of agricultural observability diminishes over time, especially after the structural changes around 1500.*

IV. DATA

1. Dependent Variable: State Size

To calculate the size of a state, we digitized maps of the "reichsunmittelbare Territorien" (territories directly subordinate to the Emperor) of the HRE (without its Italian parts) as provided in the school atlas by Wolff (1877).[31] These were the most detailed maps we could find. Furthermore, Wolff drew maps for the periods of decisive historical events of the HRE. These dates are 1250 (collapse of the Staufer dynasty) 1378 (peak of political fragmentation), 1477 (Peace of Nancy), 1556 (Peace of Augsburg), 1648 (Peace of Westphalia), and 1789 (outbreak of the French Revolution)[32].

The maps contain the names of the territories, and their borders. It includes all types of states in the Empire, i.e., city states (Imperial cities), large territorial states (kingdoms, duchies, principalities, margraviates, counties etc.) and ecclesiastical states (bishoprics, archbishoprics and monastic territories). However, each map contains white and unnamed territories (either because the name of the territory was not certain or because the territory or territories were too small to be included in the map). We tried to populate these white areas by comparing the different maps (as sometimes a territory is included in one map but not in another one) and we also overlaid the maps with Google maps. This enabled us to identify the territories based on the cities located within them. We were also able to considerably reduce the white areas in the maps but still, especially in 1477—when the map is less detailed than in the other years—some white areas containing very small states or that were divided between several states in a complex manner, remain. Nevertheless, as far as we are aware, ours are the most detailed and comprehensive digitized maps of the states of the HRE currently available.

To validate and cross-check the maps and the included territories, we compared them to several

---

[31] To define only territories that were directly subordinate to the Emperor as states seems to be the consensus among German historians the reason is that only those states had a degree of independence somehow similar to modern sovereign state. States not directly subordinate to the Emperor were subordinate to a higher ranked ruler of another state (e.g. a duchy), and the rulers of those state received them as a feudal estate ("feud"). However, their power over the territory was limited. Another concern with the maps is whether the de jure situation was consistent with the de facto situation. There could for example be territories that were not directly subordinate to the Emperor but nevertheless were de facto independent. In Appendix A.1.4. we describe in detail who we decided when this was the case and also discuss some examples of states where this was an issue.

[32] A detailed historical overview of these critical points of Central European history is given in section A.1.3. of the Appendix.

other maps of historical states in the HRE, including those of Darby and Fullard (1978); Stier et al. (1956); Andree (1886), or Baldamus et al. (1914). Furthermore, we consulted the "Historisches Lexikon der deutschen Länder" (Historical Encyclopedia of German States) (Köbler, 1988), a comprehensive and reliable source that provides a historical overview of each German state from the Middle Ages until the late 20th century, including their inception and downfall, the reasons they disappeared, their legal status and name changes. We also consulted the first volume of the "Geschichte der deutschen Länder" Sante (1964), a monograph about the history of the German states during the medieval and early modern period, that also names and gives detailed histories of all territories that existed during that period. We used these publications to identify every state on the map, verfiy that they actually existed that they existed in this period and that their location was correctly identified. We further checked that they were correctly classified by type, e.g. as a duchy or county.[33]

Errors as to name, type of state or omission of an existing state occurred sometimes. Such problems mostly arose in the case of small states on which information is limited even today (typically some "Herrschaften", states ruled by a baron or an imperial knight), when there were several territories with the same name (e.g. "Limburg") or for a few of Imperial cities in the Alsac-Lorrain region which Wolff forgot.[34] However, we were able to resolve almost all of these issues, sometimes by consulting additional sources such as books by local historians.

Another difficulty was determining the start and end point of a states' independence. The latte was problematic, when, for example, a states was split up between the sons of a ruler and three family lines ruled over three different parts of the former territory. Here, Wolff did not always correctly recognize the division of the state, but we did so we found information about the shape of the new territories or if the separated territories are included in later maps. Another issues was that sometimes, after a ruling dynasty died out due to a lack of a male heir (or after a war

---

[33]To validate the city states drawn in the maps we also consulted Cantoni (2012) and the "Deutsche Städtebuch" (Handbook of German cities) (Keyser and Stoob, 1939–1974) an encyclopaedia containing information on the history of each German city from its foundation/ first mentioning until the 20th century.

[34]Another case was that of the Imperial city of Friedberg and the burgraviate of Friedberg, located around a castle next to the city. The latter was a very small county around the castle of Friedberg that was involved in various conflicts with the nearby Imperial city. Wolff does not include both territories before the 1789 map, where he drew a territory called Friedberg and marked it as an Imperial city. We split this territory between the Imperial city and the burgraviate from 1250 to 1378. In 1477 the Imperial city lost its independence (it was under the control of the burgraviate then for most of the time) and thus, we assigned the whole territory to the burgraviate in the later maps—the burgraviate existed until 1806.

about its heritage) a territory was partitioned between several other rulers. Here, we decided on a case-by-case basis whether to assign the territory to the state that had the majority of rights or whether it remained an independent state (when there was no clearly dominant party).[35][36]

Overall, we identified 730 independent states, including 81 city states, 89 ecclesiastical territories (bishoprics, archbishoprics and monastic states), and 560 secular territorial states. The latter group consists of two kingdoms, Bohemia and Prussia, 48 duchies, 80 principalities [37], 16 republics (all of them in today's Switzerland), 217 counties[38] and 180 "Herrschaften" (territories ruled by "Freiherren" (barons)). Furthermore, there were seven Imperial territories (directly controlled by the Emperor), among them were six "Landvogteien" (Grand Bailiffs) and one territory, the Staufian lands, controlled by the Staufian Emperors during the 11th to 13th century. There are also four territories that were occupied by the Swedes after the Thirty Years' War. Finally, there are nine electorates (among them three archbishoprics already counted above), which are considered to be the most powerful states of the HRE and are hence considered an own category.[39]

Figure A.2 provides an overview of the HRE and its territorial and city states in each of the six years for which we have a map from Wolff (1877).

---

[35] This was the case, for example, for the county of Sponheim which had a constantly changing political history. Details on this case and how we solved it can be found in Appendix A.1.2.

[36] A lack of clarity about when a territory ceased to be an independent state typically arose also because Wolff (and other historians) followed a tradition of drawing important states (like e.g., the duchy of Berg) as independent ("reichsunmittelbare") states even when they were de facto ruled by other nobles, as was the case for the united duchy of Kleve-Jülich-Berg which was split up again after armed hostilities over the different parts, with one part (the duchy of Kleve and the counties of Mark and Ravensberg) falling in the hands of the margrave of Brandenburg and another part (the duchies of Berg and Jülich) coming under the control of the duchy of Pfalz-Neuburg. In these cases we diverge from the map and make these territories part of Brandenburg or Pfalz-Neuburg, respectively.

[37] Apart from principalities, we also classify the following states into this category: Nine "Landgrafschaften" (landgraviates), 17 "Markgrafschaften" (margraviates) and two Princely counties (the Princely county of Burgundy and the Princely County of Tyrol). The reason for this is that the rulers of those states (the margrave, the landgrave etc.) were considered to have the same rank as princes (although their names refer to their origins as counties).

[38] The 226 counties subsume the following territories with "county" in the name: Four "Pfalzgrafschaften" (county palatinates). In general, the rulers of those territories (the palatinates) were considered to be of a higher rank than ordinary counts (in the case of a "Pfalzgraf" (Palatinate)). One of these county palatinates, the "Pfalzgrafschaft bei Rhein" (County Palatinate of the Rhine) had the status of an electorate from the middle of the 13th century (and was thereafter called "Kurfürstentum Pfalz" (Electorate of the Palatinate)). Thus, it still was called a county palatinate but actually was one of the most influential and powerful states within the Empire. Then, there are also six burgraviates and 207 ordinary "counties". It is important to note that counties were fairly heterogeneous regarding their size, and political importance. The county of Württemberg, for example, for a long time the largest county of the Empire (before it became a duchy in 1495), was larger than some of the principalities or duchies of the time and also had higher tax revenues than some of those higher-ranked territories. Hence, one should not assume counties to be less important or smaller than duchies or principalities.

[39] The official title of those states differed. Some of them were called "Kurfürstentümer" (electoral principalities) some are margraviates or county palatinates and the Habsburg monarchy called itself "Archduchy of Austria".

2.   Main Explanatory Variable: Caloric Observability Index

To proxy observability, we propose an index that measures divergence from perfect observability as proposed in the theoretical framework. This measure of observability of agricultural output is based on the caloric suitability index developed in Galor and Özak (2014) and Galor and Özak (2015).[40] This index provides the average caloric yield per hectare per year for each grid cell on a resolution of 300 arc seconds (0.083 degrees or around 85 km^2).[41] The average is derived from the caloric suitability of all 49 crops for which the Global Agro-Ecological Zones (GAEZ) project of the Food and Agriculture Organization (FAO) provides global crop yield estimates and that can be grown in the area of a state (caloric yields>0). Those estimated crop yields (given in annual tons per hectare) are converted into calories using information on the caloric content of the respective crops, available from the United States Department of Agriculture Nutrient Database for Standard Reference. The commonly used agricultural suitability measures of Ramankutty et al. (2002), or Zabel et al. (2014), report the fraction of each grid cell that is suitable for agriculture in terms of probability. Compared to those standard indexes, the caloric suitability index has several advantages. First, equally suitable land can have very different caloric yields, as land that is suitable for agriculture will not necessarily be suitable for the crops with the highest caloric yields. In a Malthusian subsistence society, the main purpose of agriculture is to feed the population, so the caloric yield is central. Second, the caloric suitability index accounts for the fact that prior to the Columbian Exchange not all of the 49 crops incorporated in the GAEZ database were actually available (e.g. potatoes were not available in Europe). Finally, the index is not endogenous to human activities, since Galor and Özak (2014) calculate the potential caloric yields assuming low level of inputs and rain-fed agriculture (it abstracts from irrigation methods) and agro-climatic constraints exogenous to human activities.

Our proxy for information cost, *CNoise*, is based upon the ruggedness index by Riley et al. (1999) that is applied to data on the caloric suitability index CSI[42] (not elevation). It is therefore

---

[40]The caloric suitability index can be downloaded here: `http://ozak.github.io/Caloric-Suitability-Index/`, accessed on April, 24th 2016.

[41]We use the version of the index that does not include crops with zero productivity in the respective grid cell for the calculation of the average caloric yields.

[42]This allows the usage of tools already implemented in QGIS or other GIS software and makes our results easy to reproduce.

defined for raster data, holding data for row-column-coordinates (r, c). *CNoise* of any state s is the average of all *CNoise* raster values in the state.[43] We construct *Caloric Observability Index* by linear transformation using the maximum over all states. This transformation has two semantic advantages. First, it is a positive index that translates to lower information costs, the higher the index. Second, it captures the idea that observability is a relative measure of comparable states that compete with each other; the state with the weakest observability serves as a benchmark.

$$CNoise(r, c) = \sqrt{\sum_{i=(r-1)}^{(r+1)} \sum_{j=(c-1)}^{(c+1)} \left[CSI_{(i,j)} - CSI_{(r,c)}\right]^2}$$

$$CNoise_s = \frac{1}{|(r, c) \in s|} \sum_{(r,c) \in s} CNoise_{(r,c)})$$

$$Caloric\,Observability\,Index_s = -1(\max_{t \in States} (CNoise_t) - CNoise_s)$$

For each column c and each row r, we derive the variance between the caloric suitability *CSI* and that of its neighboring fields. If this variance is zero, measuring caloric suitability of one field would perfectly predict the suitability of neighboring fields, and caloric observability is zero. With an increase in between-neighbor differences, the relationship between factor input and output becomes less observable, and the households' effort harder to observe. Hence, high values of the COI correspond to low observability and vice versa. To ease the interpretation of the COI, we transform it for the empirical analysis to ensure higher values correspond to higher observability.

Figure 4 provides an overview of the average observability of the caloric yiles of each state of the HRE in each of our six sampling years.

3. Other Explanatory Variables & Controls

To limit concerns about omitted variables bias, we include a number of variables to our data set that should capture potentially relevant confounders of state capacity and size. Those are:

Agricultural conditions. A vast body of literature has pointed at soil quality as an indicator for

---

[43]This can be retrieved using the summary statistics tool in QGIS and ArcGIS, given the raster data and polygons on the states

(a) *HRE 1250*

(b) *HRE 1378*

(c) *HRE 1477*

(d) *HRE 1556*

(e) *HRE 1648*

(f) *HRE 1789*
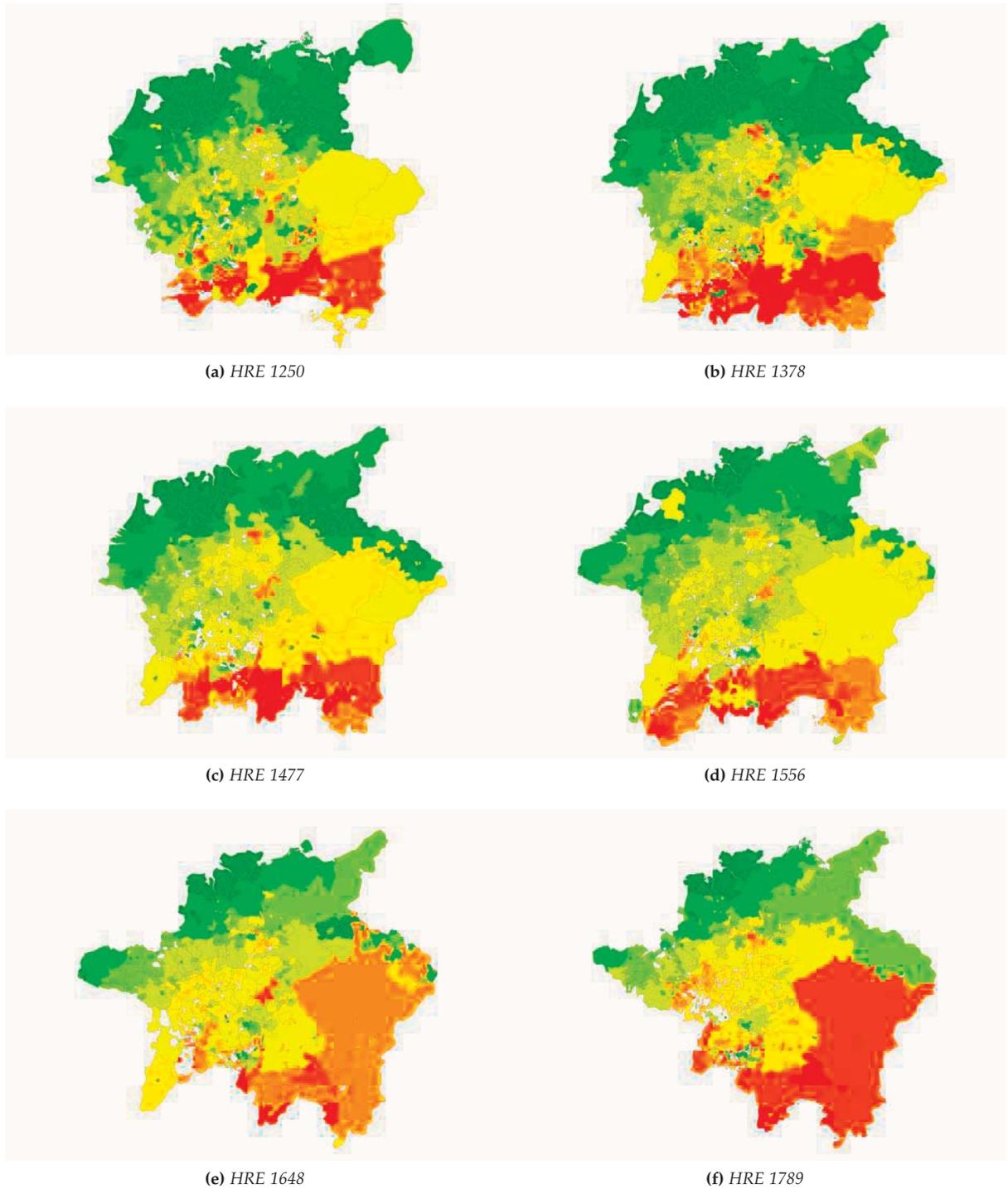
Note: These figures shows the average Caloric Observability Index in each of the territories of the HRE at the different sampling years. After 1500 New World crops become available due to the Columbian exchange and are included in the calculation of the COI. Increasing caloric observability corresponds to increasingly darker shades of green; increasing shades of red denote decreasing caloric suitability.

Figure 4: *Observability of Agricultural Output in the States of the HRE*

development (e.g., Diamond, 1999; Olsson and Hibbs, 2005). For example, von Thünen (1826) and more recently Lindert (1999) and Kopsidis and Wolf (2012) have pointed at the link between urban development and soil quality. Furthermore, the vast majority of the population was employed in agriculture and had to feed the growing urban population which produced all the innovations and proto-industrial activity. Thus, to account for the effect of the level of soil quality on state development, we use the caloric suitability index by Galor and Özak (2014, 2015) that we already have used to construct the observability index. A necessary prerequisite for crop farming was *deforestation*, which was mostly finished by the 12th century (Wilson, 2016). We digitized data on areas still forested (or otherwse non-arable, for example, marsh land) during the Middle Ages, which is available for modern Germany from Schlüter (1952). With this variable we control for the share of a territory's area that was not deforested by the early Middle Ages. Finally, a growing body of literature is concerned with the *effects of specific crops*, such as the potato, on various economic outcomes (Nunn and Qian, 2011) and more recently Berger (2017). We therefore employ both the pre-1500 and post-1500 specification of the caloric suitability index. The fact that cereals, which can be stored and transported, are easier for rulers to appropriate could also be a factor (Mayshar et al., 2015). We control for this aspect with a variable measuring how the productivity advantage of cereals over roots and tubers in a respective state. Finally, we include the *average temperature* to account for climatic variations over time that could affect the agricultural output in each state.

Border States. Recently, economic research has found evidence that state capacity within historical and contemporary developing countries varies depending on the remoteness of a region (Olsson and Hansson, 2011; Michalopoulos and Papaioannou, 2014). Thus, in peripheral areas state capacity might be weaker. Looking at the HRE, it is evident that many of the border states were politically unstable and conflict-prone, and eventually gained independence from the Emperor (e.g. the Dutch Republic, Switzerland, the northern Italian cities etc.). Thus, we created a variable to identify countries that are located on the *outer border of the HRE* in each of our sampling years, to account for this. This also takes into account spatial effects of outward threats, especially the expansion of France and the Ottoman Empire (see (Iyigun, 2008)).

Disease environment. Acemoglu and Robinson (2001) and Acemoglu and Johnson (2007) pro-

posed that diseases affect outcomes via political institutions. This makes diseases potentially relevant for our study. We collected data on the location of medieval *swamp areas* as well as proximity to *rivers, trade routes, and Imperial cities*, which could have spread germs in the Middle Ages as outlined in Börner and Severgnini (2014) and Voigtländer and Voth (2013). (Diamond, 1999) has argued that everyday *contact between humans and livestock* creates resistance against diseases. This was predominant in all regions of Central Europe (Mitterauer, 2004), but shows some variation depending on the ruggedness of the terrain. We also include a variable measuring the average temperature of each state, as it is well known that germs favor higher temperatures.

Heavy Plough. Alesina et al. (2013) and Anderson et al. (2016) document a profound impact of the introduction of the heavy plough on gender inequality and city development. Thus, it is very likely that it could also have affected state capacity, e.g. due to significantly increasing the productivity of agriculture within a state that adopted the plough (or adopted it earlier). Higher productivity of agriculture increased agricultural output and therefore the absolute tax basis of a state. We account for the effect of the heavy plough by a variable measuring the fraction of a states' area that was endowed with *luvisol soils*, a type of soil that particularly benefited from ploughing.

Natural Resources. It is well established that the availability of natural resources such as gold, silver, salt and copper was a decisive factor determining a country's state capacity and tax revenues. Where minerals could have been exploited, mining was an alternative to agriculture, and rulers could generate high revenues from mining activities (historically particularly true for the Harz area and Saxony). To account for differences in natural resource endowments, we digitized maps of the geographic location of *copper, gold, lead, salt (rock salt and potassium salt) and silver*. Based on these maps we calculated a variable giving the average distance from 1,000 randomly generated points within a state to the next deposit of those resources. Additionally, we have data on areas within contemporary Germany that were still forested in the Middle Ages and hence provided a supply of wood—one of the most important raw materials in the pre-modern economy.

Outmigration. As discussed above, outmigration to Imperial cities posed a vital threat to the financial base of medieval and early-modern states. Thus, we compute a variable that proxies the outmigration opportunities by the average distance from 1000 randomly generated points within

a state to the next Imperial city.

Pre-Existing Cultural and Historical Differences. We can account for the effect of a priori cultural differences in the HRE by assigning each of its later states to one of the states existing in 1150 using, again, a map of European states in 1150 AD by Wolff (1877). The states in 1150 largely reflected old, traditional borders of the territories of *Germanic tribes* (like the stem duchies, which reflected the territories of the Germanic tribes of the Bavarians, Franks, Swabians and Saxons).[44] To address the possibility of pre-existing, deeply rooted factors influencing state capacity in medieval Europe, we include a variable for the area of each state that was already settled in pre-historic times. These areas might have a longer history of statehood or other positive characteristics making them attractive for settlement.[45]

Terrain Characteristics. We also control for the *maximum elevation* above sea level and average ruggedness of a states' territory, using the digital elevation model provided by thee U.S. Geological Survey's Center for Earth Resources Observation and Science (EROS). Both factors could affect state capacity because they have an influence on the defensibility of the area of a state.

Trade and Tariff Income. Trade affects our analysis in many different ways. First, trade was a source of revenue, as trading cities were usually wealthy and generated large tax revenues. Furthermore, trade took place along *trade routes, rivers and Roman roads* therefore rulers could impose tolls on trade routes and navigable rivers within their territories (Heckscher, 1994).[46] Tariff income from such road tolls could be significant and made some territories e.g., those straddling both sides of the Rhine, very wealthy.[47] Finally, if a lot of rivers or trade routes were located within a state, it was easier for its citizens (and the ruler) to access commercial centers. Therefore, these states profited from better market access and lower transaction costs. We proxy for these

---

[44]After the Migration Period more than four centuries before, the areas in which different Germanic tribes settled have been relatively stable.

[45]We can also rule out nationalism as a unifying element within the HRE and a dividing element between different sub areas that would not be captured by tribal areas in 1150. There is wide consensus that nationalism cannot be attributed to Central Europe before the 18th century, if not the French Revolution (Weber, 1976; Anderson, 1983). We conclude from this that the sizes of states were too small for heterogeneous preferences in the spirit of Alesina and Spolaore (1997) or Bolton and Roland (1997) to limit the growth of states.

[46]There is a growing literature documenting the importance of the Roman road network for the long-run development of Europe (e.g.Wahl (2017)). This makes it even more important to account for the Roman road network and its possible effects.

[47]The small sizes of states introduce competition between them over trade routes, so that any single state can only raise its overall revenues from tariffs to the level that drives traders to change their routes (Huning and Wolf, 2016).

advantages with variables measuring the average distance from 1000 randomly generated points within a state to the next Roman road, trade route or major navigable river. We also control for *trade fairs*, which were identified by Milgrom et al. (1990), and more recently Edwards and Ogilvie (2012) as classic example of medieval trade institutions. With respect to access to *financial markets*, the results of Volckart and Wolf (2006) suggest that there is a strong correlation between the spatial pattern of the integration of commodity markets on the one side, and financial markets on the other. We therefore assume to have controlled for spatial variation of financial integration with the above.

War and Conflicts. Several authors have argued that war and conflicts were a driver for state capacity in Europe, e.g. because of competition between states fostering technological and organizational innovations (e.g. in taxation technologies) (Hoffman, 2011; Karaman and Pamuk, 2013; Tilly, 1975). We construct a variable measuring the *number of battles* that had taken place within a state between 800 and 1378 AD, normalized by a state's area. Romer (2009) and Acemoglu et al. (2011) have pointed to the benefits of importing efficient political institutions, which in our historical setting is captured either via trade as a market for ideas, or conflicts. Radical modernization occurs well after the period in our study (also see Mokyr (2011)).

A descriptive overview of the variables in the data set can be found in Table A.1. Definitions and the sources of all the variables can be found in the Online Data Appendix (Appendix A.2). The maps on which we base our geographic variables are in section A.4 of the Appendix.

V. Empirical Analysis and Results

1. Caloric Observability and the Financial Capacity of States

We expect a significant and positive statistical relationship between caloric observability and the financial capacity of a state (proposition 1) and test this empirically. Following Cantoni (2012) we proxy the financial capacity and economic and military power of a state by its contribution (in guilder) to the Imperial war tax ("Reichsmatrikel") in 1521.[48] The Reichsmatrikel contributions

---

[48]There are three types of contributions: states had to contribute mounted and foot soldiers as well as a certain contribution in guilders. To monetize the whole contribution we follow Cantoni (2012) and assume—in line with the

are taken from Zeumer (1913). We have matched the territories mentioned in the Reichsmatrikel with the states in our data set.[49] If a state existed in 1521 and 1556, we assigned its Reichsmatrikel contribution to the year 1556 in our data set. If a state existed in 1521 but not in 1556, we assigned its contribution to the year 1477 in our data set. Overall, we could match 236 states.[50]

We then run a cross-sectional regression where each state's Reichsmatrikel contribution is explained by its caloric observability and different sets of control variables. Thus, we estimate the following equation using OLS:

$$ln(IMPERIAL\_TAX)_{ic} = \alpha + \beta ln(COI_i) + \gamma' \mathbf{X_i} + \lambda_c + \epsilon_i \tag{1}$$

Where $ln(IMPERIAL\_TAX)_{ic}$ is the natural logarithm Reichsmatrikel contribution of state i of type c in the Reichsmatrikel of 1521. $ln(COI_i)$ is the natural logarithm of caloric observability of a states' agricultural output. X_{ic} is a vector of different set of controls comprising of the variables introduced above. The set of basic geographic controls is made up of: of the following variables: average distance to a major river, maximum elevation, average terrain ruggedness and a dummy for states located on the outer border of the HRE in that year. Variables controlling for soils and climate are caloric suitability, average temperature, share of luvisol soils, and the productivity advantage of growing cereals instead of roots and tubers. The set of "Economic Factors and Resources" variables includes the average distance to the closest trade route, trade fair, Roman road, Imperial city, copper, gold, iron, lead, potassium salt, rock salt or silver deposit. λ_c are state type dummies (for kingdoms, electoral states, ecclesiastical territories, duchies, princedoms, margraviates, counties, republics and "Herrschaften"), capturing unobserved shocks that might have affected different types of states in a different way and also unobserved historical factors making a certain state a kingdom and another one only a county.[51] ϵ_{ic} is the error term.

---

historical literature—that the pay of a mounted soldier was 12 guilders and that for foot soldiers was 4 guilders and multiply for the number of each type of soldier.

[49]It is known that the Reichsmatrikel list has errors, i.e. it contains states that were not or no longer independent ("reichsunmittelbar") or for which this status is doubtful. Furthermore, our maps give us information about the states in 1477 and 1556 but not for 1521. Thus, we have to rely on information from Köbler (1988) and other sources to match the states in our maps to those of the Reichsmatrikel.

[50]The average Reichsmatrikel contribution was 629.4 guilders with the minimum being zero and the largest contribution being 11,940 guilders (from the states controlled by the Habsburgs).

[51]The base category remaining are states occupied by the Swedish after the Thirty Year's War and Imperial territories directly controlled by the Emperor (i.e., bailiffs and Staufian territories). The electoral states are not double counted as they are not coded as e.g., duchy, margraviate, kingdom or county palatinate.

Results are shown in Table 1.[52] They show that, reassuringly, there is statistically and economically significant positive relationship between the Reichsmatrikel contributions and caloric observability. This relationship—while being marginally statistically significant— is almost unaffected by the inclusion of different sets of control variables and implies that, on average, a one percent increase in observability increases the Reichsmatrikel contribution by about 0.17 percent. This positive relationship is presented in Figure 5, showing a partial regression plot of ln(Caloric Observability) for the regression in Table 1, column (4).

Table 1: *Caloric Observability and Financial Capacity of States*

Dependent Variable	ln(Reichsmatrikel Contribution)			
	(1)	(2)	(3)	(4)
ln(Caloric Observability)	0.173*	0.168*	0.187*	0.185*
	(0.0949)	(0.0971)	(0.0999)	(0.100)
State Type Dummies	✓	✓	✓	✓
Caloric Suitability	✓	✓	✓	✓
Basic Geographic Variables	✓	✓	✓	✓
Caloric Suitability	✓	✓	✓	✓
Soils and Climate	–	✓	✓	✓
Economic Factors and Resources	–	–	✓	✓
Battles per Area	–	–	–	✓
Observations	235	235	235	235
R^2	0.518	0.526	0.560	0.563

Notes. Heteroskedasdicity robust standard errors are reported in parentheses. Coefficient is statistically different from zero at the *10 % level. The unit of observation is a state. All regressions include a constant not reported. State Dummies are dummy variables indicating electoral states ("Kurfürstentümer"), kingdoms, margraviates, duchy, princedoms, counties, republics, "Herrschaften" and ecclesiastical states. The set of basic geographic controls comprises a variable measuring the average distance of 1,000 randomly distributed points within a state to the closest major river, its maximum elevation above sea-level, its average ruggedness and a dummy for states adjacent to the boundary of the HRE. Soil and climate controls include the natural logarithm of a state's average caloric suitability index, the average caloric suitability for growing cereals relative to grow roots and tubers, the fraction of a state's area with luvisol soil that benefits most from plowing and a measure for the average temperature in a state. The control variables in "Economic Factors and Resources" include variables measuring the average distance of 1,000 randomly distributed points within a state to the closest Roman road, major medieval trade route, trade fair, gold, copper, silver, iron, lead, potassium salt or rock salt deposit.

---

[52]By taking the natural logarithm we lose one observation (Gr. Saarwerden) which has a recorded contribution of zero.

Figure 5: *The Relationship between Caloric Observability and Financial Capacity of States*

2.   Caloric Observability and the Failure and Survival of States

To investigate our theoretical propositions 2, 3, and 5, regarding the relationship of observability and the fate of states, i.e. whether and how a state disappeared, we were able to collect data on 367 events leading to the failure (dissolution/ disappearance) of states, mostly from Köbler (1988) and other sources on regional history.[53] To provide descriptive statistics of the link between observability and state failure, we provide box plots separated box plots of the COI for different categories of reasons for failure. They are shown in Figure 6.

In general, the most frequent—and probably most unsystematic—reason for state failure was the death of a ruler without a male heir. This is not surprising, given that fertility of the nobility was generally low.[54] The probability of anybody dying of an accident or a common infection was high.[55] Adam Smith was right that the geography of Switzerland set it on a different path. Consider Figure 6a on the period before 1500 (reasons of state failure in 1250, 1378 and 1477). Most prominently, bankruptcy is the leading reason for failure of states with bad observability, which

---

[53]The territories that are lost in each of the maps as well as the reason for their disappearance are shown in Appendix Figure A.3.

[54]See e.g., Schröter (2007) for an overview.

[55]Cummins (2017) shows that during the Middle Ages, nobles regularly died on the battle field and their life expectancy was about 50 years.

is in line with proposition 2 from the model. When the ruling family of a state ended without a single male heir, partition or inheritance by other states/noble families could be the consequence, which also includes inheritance by the first daughter's husband (in the plot: in family). States that were sold or given away, leading to the departure of the ruling dynasty (plot: ex family), were associated with about the same observability, with a few outliers displaying low observability. States that were conquered in wars were on average endowed with lower observability, which points towards the role of the decreasing marginal cost of protection on the victorious side.

Federal rule leading to the end of a state was rare, and so was secularization before the Reformation. After 1500 (Figure 6b), sorting by observability becomes more prominent, distinguishing within and out-of-the-family inheritance. Furthermore, bankruptcy is even more prominently associated with bad observability. However, those states that were conquered show a high observability pointing towards the direction of a regime change, which is a puzzle we will investigate further.
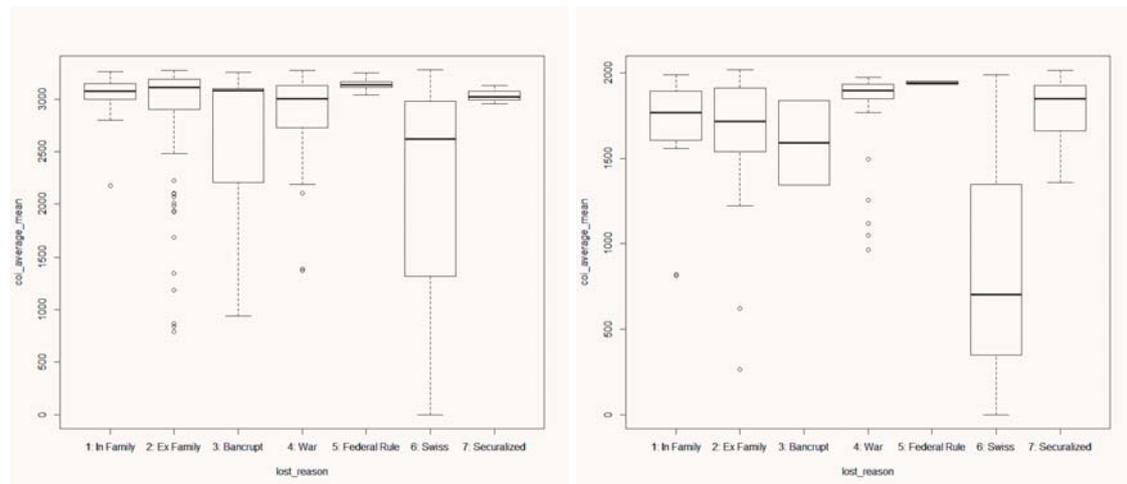
(a) *Before 1500 (N=257)*   **(b)** *After 1500 (N=110)*

Note: This figure distinguishes different reasons for failure of a medieval state. From left to right these are that a single heir was not present, and another branch of the family took over via marriage, partition, or inheritance rules (in family). If this was not the case, the territory was sold, given away, or left the dynasty (ex family). Bankruptcy was a reason for a living dynasty to loose their territory, war was another. Federal ruling leading to the loss of a territory was rare. The states to form the Swiss Confederation left the Empire. Some territories were secularized, mostly after 1556.

Figure 6: *Descriptive statistics of observability by different reasons states failed*

Is observability of agricultural output significantly positively associated with the survival of states during the Middle Ages? States with a high observability of agricultural output should be capable

of remaining independent for a longer time due to better defensive capacities, more effective abilities to restrict outmigration, etc. To test this empirically, we run Cox proportional hazard models including all the baseline control variables (but, of course, no year dummies).[56] The results are in Table 2 and suggest that, indeed, caloric observability was significantly positively related to state survival during the Middle Ages, but in the 17th and 18th century. To be precise, during the medieval period a ten percent increase in caloric observability raised the probability of a state surviving by around 0.6 percent.

Table 2: *Observability and the Survival of States*

Dependent Variable	Periods a State Exist		
	(1)	(2)	(3)
	All Periods	Until 1477	After 1477
ln(Caloric Observability)	1.424***	0.94**	1.026
	(0.0563)	(0.0237)	(0.0371)
Baseline Controls	✓	✓	✓
Observations	1,925	1,083	842
Wald *Chi*^{2}	961.82	1183.61	2523.85

Notes. Standard errors clustered on state-level are reported in parentheses. The tables reports hazard ratios obtained from running a Cox proportional hazard model using Breslow method for ties. Hazard ratio is statistically different from zero at the ***1 %, **5 % and *10 % level. The unit of observation is a state.

3. Caloric Observability, the Size of a States and the Dynamics of Statehood

We now test our theoretical proposition about the relationship between state size (proposition 4) and observability and the temporal evolution of this relationship (proposition 6). We run pooled OLS regressions using the unbalanced panel data set of states in the HRE as explained above. Our data set includes information on 730 states and for six points in time amounting to 1,925 state-year pairs being our observations. As observability of agricultural output is orthogonal to economic activities, political institutions and human activity—at least in the period studied—

---

[56]We estimate the Cox proportional hazard model using the Breslow method for ties. Other methods to handle tied failures like those proposed by Efron would yield very similar results. Those estimations are not reported but available uponn request. The results would also hold if we exclude the states who exit the data set because they left the Empire and became part of another state entity (like Switzerland) and because their ruling family extinguished (what arguably should be a random event in most cases). Results are available upon request.

reverse causality should not be a very critical issue. Nonetheless, there still could be a third (and unobserved) factor positively correlated with both caloric observability and political fragmentation. We address this potential bias by including several control variables, which were introduced in the previous section, in the regression specification. In addition to the control variables, we include year fixed effects to account for temporal shocks that affect all of the HRE equally, and we also include eight state type dummies. Thus, to identify our effect we only exploit variation in observability and state size within the same year and within the same types of states. To be precise, we estimate variants of the following regression equation:

$$ln(STATEAREA)_{ic,t} = \alpha + \beta ln(COI_{i,t}) + \gamma' \mathbf{X_{i,t}} + \delta_t + \lambda_c + \epsilon_{i,t} \tag{2}$$

Where $ln(STATEAREA)_{ic,t}$ is the natural logarithm of the area in km^2 of state i of type c in year t. δ_t are year dummies. The rest of the equation is defined as in equation 1 In robustness checks, we include dummy variables for the states to which a certain territory belonged in 1150 AD, dummy variables assigning each historical state to its modern-day equivalent, and variables reporting certain characteristics (e.g., area, soil quality or observability of agricultural output) of neighboring states.[57]

Later in the empirical analysis, we want to identify the temporal evolution of the effect of observability of agricultural output on state size. We estimate equation 2 as cross-sectional equation, separately for each year. Furthermore, we interact the caloric observability with the year dummies and estimate equation 3:

$$ln(STATEAREA)_{ic,t} = \alpha + \sum_{t \in \Gamma} \beta'_t ln(COI_{i,t}) \cdot \delta_t + \gamma' \mathbf{X_{i,t}} + \delta_t + \lambda_c + \epsilon_{i,t} \tag{3}$$

Where $ln(COI_{i,t}) \cdot \delta_t$ is the interaction of the COI with year dummies, and all other variables match those in equation 2.

First, we estimate equation 2 to statistically test the relationship between observability of agricultural output and state size. Results of the estimations are reported in Table 3. We start with a simple baseline specification only including year fixed effects and basic geographic control variables.

---

[57]We assigned a state to those state in 1150 or contemporary country in which the majority of its area is located.

Caloric observability is highly statistically and economically significant with a one percent increase in observability increasing state size by around 0.5 percent. From columns (2) to (6) we add progressively more sets of control variables, to look how the coefficient reacts to the inclusion of covariates. In column (2) we add soil and climate controls, and the coefficient only decreases slightly. In column (3) we add variables proxying economic factors and resources. These variables decrease the coefficient of observability, but it remains economically and statistically significant. The inclusion of battles per state area in column (4) has virtually no effect on the results and the battles themselves are not significant. In column (5), nine state type dummies are added to further reduce unobserved heterogeneity.

Table 3: *Observability of Agricultural Output and State Size*

Dependent Variable	ln(Area)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Caloric Observability)	0.529***	0.500***	0.286***	0.287***	0.259***	0.141**	0.27***
	(0.0740)	(0.0727)	(0.0665)	(0.0665)	(0.0532)	(0.0527)	(0.068)
Year Dummies	✓	✓	✓	✓	✓	✓	✓
State Type Dummies	–	–	–	–	✓	✓	✓
1150 State Dummy	–	–	–	–	–	✓	–
Basic Geographic Variables	✓	✓	✓	✓	✓	✓	✓
Soils and Climate	–	✓	✓	✓	✓	✓	✓
Economic Factors and Resources	–	–	✓	✓	✓	✓	✓
Battles per Area	–	–	–	✓	✓	✓	✓
Early Settled, Forest & Swamp Area	–	–	–	–	–	–	✓
Observations	1,925	1,925	1,925	1,925	1,925	1,866	990
R^2	0.329	0.386	0.522	0.522	0.682	0.709	0.67

Notes. Standard errors clustered on state-level are reported in parentheses. Coefficient is statistically different from zero at the ***1 %, **5 % and *10 % level. The unit of observation is a state. All regressions include a constant not reported. State Dummies are dummy variable indicating electoral states ("Kurfürstentümer"), kingdoms, margraviates, duchy, princedoms, counties, republics, "Herrschaften" and ecclesiastical states. The set of basic geographic controls comprises of a variable measuring the average distance of 1,000 randomly distributed points within a state to the closest major river and city state, its maximum elevation above sea-level, its average ruggedness and a dummy for states adjacent to the boundary of the HRE. Soil and Climate controls include the natural logarithm of a state's average caloric suitability index, the average caloric suitability to grow cereals relative to grow roots and tubers, the fraction of a states area with luvisol soil that benefits most from plowing and a measure for the average temperature in a state.The control variables in "Economic Factors and Resources" include variables measuring the average distance of 1,000 randomly distributed points within a state to the closest Roman road, major medieval trade route, trade fair, gold, copper, silver, iron, lead, potassium salt or rock salt deposit.

However, this again leaves the coefficient of caloric observability almost unchanged.[58] In columns

---

[58]With regard to the control variables, several interesting results emerge from this specification. For example, distance to the closest Imperial city is significantly positively associated with state size, pointing to the fact that outmigration may indeed have played an important role for the tax capacity of feudal states. Another interesting result is the significant positive effect of battles per state area and the negative and significant coefficient of distance to copper, iron, lead and potassium salt deposits. These indicate the importance of natural resources and war for the capacity of states. The

(7) and (8), we lose some observations, as we restrict the sampling area to the extent of the HRE in 1150. We do this, by including dummy variables that assign the territories of the HRE to the state to which they belonged in 1150 AD. As explained in the previous section, this is to account for pre-existing cultural differences, as the states in 1150 largely reflected the traditional territories of Germanic tribes. The coefficient of caloric suitability further decreases but remains significant suggesting that a one percent increase in observability raises state size by around 0.13 percent. Finally, in column (7), the sample is restricted further to historical states within the borders of contemporary Germany, as we control for the area (in m^2) within a state that was already settled in pre-historic times (and hence, might have a longer history of statehood) that was still forested or consisted of swamps and flood plains in the Middle Ages. None of these variables stop caloric observability from being significant, although both forest areas and early settled areas show a significant positive effect. The coefficient remains about 0.25, and hence, increases again, when compared to column (6).

We then conduct checks to ensure that our baseline results are sufficiently robust. The results are in Table 4. First, we investigate the effect of modern country dummies on the preferred baseline specification (Table 3, column (5)).[59] The estimated coefficient, including those contemporary countries is reported in Table 4, column (1) and shows that the coefficient of observability only decreases slightly when these dummies are included. This suggests that unobserved heterogeneity connected to larger political entities (some of which were created during the existence of HRE e.g., Switzerland) does not decisively influence the effect of caloric observability.

Second, in column (2), we account for the fact that not all land in a state was either settled or suitable for agriculture, so considering the whole area of a state might introduce bias. Thus, we subtract from the overall area of each state those areas with forests, swamps, flood plains, lakes, estuaries and coastal marsh, to use this variable "Settled area" as dependent variable. As information on these areas is only available for contemporary Germany, the sample is again

---

significantly positive effect of maximum elevation also points towards defensibility of the area as an important factor. Finally, caloric suitability itself is positively related to state size, although the estimated coefficient (0.091) is much smaller than that of observability. Thus, it is not only the observability of agricultural output, but also the productivity of agriculture that matters, but observability seems to be much more important.

[59]The HRE spanned 13 contemporary countries. These are Austria, Belgium, Switzerland, Czech Republic, Germany, France, Hungary, Italy, Lithuania, Lichtenstein, the Netherlands, Poland and Slovenia. In the regression we include 12 modern country dummies, with Austria being the omitted country.

reduced to historical states within modern Germany. Again, the coefficient becomes smaller in magnitude but remains significant.

Third, in column (3) we show what happens if we take into account that, due to the different size of the states, some variables, like ruggedness, or caloric observability, that are calculated based on differences between the data points of the underlying raster data, could be mechanically higher in larger states.

Table 4: *Observability of Agricultural Output and State Size—Robustness*

Dependent Variable	ln(Area)	ln(Settled Area)	ln(Area)	ln(Area)	Area	Area	ln(Area)	ln(Area)
Robustness Check			Inversely Weighted by Ruggedness Count					Difference between post-1500 and pre-1500 COI for years<1556
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Caloric Observability)	0.2307*** (0.0522)	0.1974** (0.0863)	0.2711*** (0.0879)	0.2253*** (0.0511)				
Caloric Observability					1481615** (699871.9)			
ln(Caloric Observability Post-1500)						0.296*** (0.06)		
ln(Optimal Caloric Observability)							0.3126*** (0.065)	
COI Post-1500-COI Pre-1500								0.0004 (0.0002)
Baseline Controls	✓	✓	✓	✓	✓	✓	✓	✓
Modern Country Dummies	✓	–	–	–	–	–	–	–
Number of Territories	–	–	–	✓	–	–	–	–
Observations	1,925	827	1,925	1,925	1,925	1,925	1,925	1,450
R²	0.692	0.591	0.857	0.703	0.4782	0.683	0.693	0.664

Notes. Standard errors clustered on state-level are reported in parentheses. Coefficient is statistically different from zero at the ***1 %, **5 % and *10 % level. The unit of observation is a state. All regressions include a constant not reported. Baseline controls include year and state type dummies, the basic geographic, soil and climate, economic factors and resources controls as well as battles per area.

Thus, we inversely weight each observation by the number of ruggedness data points that are located within the state. Results are virtually identical.

Fourth, in column (4) we include a variable measuring the number of separated territories that make up a state. The medieval HRE was made up of non-contiguous areas. States with highly fragmented territory will have higher tax collection costs, information and defense costs might be larger, and it could be less susceptible to take over. However, this does not change the resulting coefficient estimate a lot. The next three columns (5-7) show what happens if one estimates the preferred baseline specification using different variants of the caloric observability and state size measure. In column (5), we employ caloric observability and state area in levels instead of natural logarithms. The resulting coefficient is statistically and economically significant. Therefore, the results are not driven by taking the natural logarithms of both variables.

In column (6) we estimate the baseline regression using a caloric observability index also taking into account plants that become available only after the Columbian Exchange. In column (7) we use a version of the caloric observability index computed under the assumption that only the crop giving the highest caloric yield is actually planted. This is winter barley in all states. Both times, the estimated coefficient is similar to that obtained in Table 3, column (5).

Finally, in column (8) we conduct a placebo-test. We only consider the years prior to 1556 (that is 1250, 1378 and 1477) and test if the difference in caloric observability before and after the Columbian exchange has explanatory power—which should not be the case. Reassuringly, these differences do not explain state size prior to 1500, making it unlikely that our results emerged by chance.

Another concern with the baseline estimates could be that not only characteristics of a certain state itself matter for its capacity. As states compete for labor and territory, characteristics of surrounding states are relevant. Thus, we take the baseline regression specification and add variables capturing relevant characteristics of a state's neighbors. Results are reported in Table 5, where we add an additional set of neighbor characteristics to the baseline specification in each column. All in all, while neighbor characteristics somehow reduce the size of the coefficient of caloric observability to about 0.16, this is still a large and economically and statistically significant

effect. Interestingly, the results imply that neither the caloric suitability nor the caloric observability of the neighbor states has a significant impact.

However, states surrounded by small states are significantly larger than states surrounded by large states (as shown by the negative and significant estimate of the neighbor states area and the positive coefficient of the number of neighbor states). It also seems to be the case that states were larger when their neighbors did not have access to nearby major rivers while the opposite is true for access to resources. Thus, states have profited from having resource-rich states as neighbors, but were better off if their neighbors were further away from important transportation networks.

One important implication of our theoretical argument is that caloric observability should only matter for state size during the medieval period as later on, the scale effect becomes more and more important. To see whether this is the case, we run two types of regressions. First, we interact the caloric suitability index with year dummies and look at how the effect of caloric observability develops over time (Table 6). We find that, while the interaction terms are predominantly significant (apart from column (2) where the coefficient loses significance for 1648 and 1789), in line with our expectations, the coefficient notably declines after 1556.

Second, we run separate cross-section regressions for each of the six years in our data set (Table 7). Here, the coefficients of caloric observability are highly statistically significant and vary between 0.2 and 0.33. Again confirming our theoretical reasoning, in 1648 and 1789 the coefficient of caloric observability is not significant and is notably smaller in size.

Table 5: *Observability of Agricultural Output and State Size—Controlling for Neighbor Characteristics*

Dependent Variable	ln(Area)			
	(1)	(2)	(3)	(4)
ln(Caloric Observability)	0.238***	0.204***	0.194***	0.171***
	(0.0564)	(0.0527)	(0.0518)	(0.0504)
ln(Neighbor Caloric Observability)	-0.0561	0.0304	-0.0169	0.0722
	(0.0758)	(0.0684)	(0.0708)	(0.0791)
ln(Neighbor Caloric Suitability)	0.409***	0.182	0.208	-0.357
	(0.145)	(0.135)	(0.135)	(0.251)
ln(Neighbor Area)		-0.0592***	-0.0468**	-0.00534
		(0.0220)	(0.0213)	(0.0235)
Number of Neighbor States		0.114***	0.115***	0.110***
		(0.0240)	(0.0240)	(0.0240)
Neighbor Mean Distance to Trade Routes			-0.00377*	-0.00242
			(0.00201)	(0.00231)
Neighbor Mean Distance to Roman Road			-0.00294***	-0.00184
			(0.00110)	(0.00185)
Neighbor Mean Distance to Large River			0.00559*	0.00575*
			(0.00291)	(0.00293)
Neighbor Mean Distance to Gold				4.37e-06
				(2.69e-06)
Neighbor Mean Distance to Silver				-1.19e-06
				(1.33e-06)
Neighbor Mean Distance to Copper				-4.53e-06**
				(2.28e-06)
Neighbor Mean Distance to Iron				-2.96e-06
				(2.02e-06)
Neighbor Mean Distance to Pottasium Salt				-3.11e-06**
				(1.27e-06)
Neighbor Mean Distance to Rock Salt				-2.26e-06
				(1.39e-06)
Neighbor Mean Distance to Lead Resev				7.48e-07
				(2.16e-06)
Neighbor Mean Relative Cereals Suitability				9.97e-05***
				(3.45e-05)
Neighbor Share of Luvisol Soils				-0.110***
				(0.0415)
Baseline Controls	✓	✓	✓	✓
Observations	1,842	1,842	1,842	1,842
R^2	0.679	0.735	0.738	0.746

Notes. Standard errors clustered on state-level are reported in parentheses. Coefficient is statistically different from zero at the ***1 %, **5 % and *10 % level. The unit of observation is a state. All regressions include a constant not reported. Baseline controls include year and state type dummies, the basic geography, soil and climate, economic factors and resources controls as well as battles per area.

Table 6: *Temporal Evolution of the Effect of Observability on State Size*

Dependent Variable	ln(Area)			
	(1)	(2)	(3)	(4)
COI*1250	0.256***	0.144**	0.179**	0.232***
	(0.0598)	(0.0598)	(0.0824)	(0.0593)
COI*1378	0.250***	0.153**	0.317***	0.226***
	(0.0626)	(0.0620)	(0.0751)	(0.0608)
COI*1477	0.319***	0.192***	0.327***	0.297***
	(0.0668)	(0.0649)	(0.0947)	(0.0663)
COI*1556	0.293***	0.149**	0.322***	0.238***
	(0.0639)	(0.0668)	(0.0921)	(0.0634)
COI*1648	0.187**	0.0692	0.253**	0.176**
	(0.0767)	(0.0777)	(0.104)	(0.0768)
COI*1789	0.201**	0.0484	0.225**	0.166**
	(0.0846)	(0.0838)	(0.100)	(0.0832)
Baseline Controls	Yes	Yes	Yes	Yes
1150 State Dummies	No	Yes	No	No
Share Early Settled & Forest Area	No	No	Yes	No
Modern Country Dummies	No	No	No	Yes
Observations	1,925	1,866	990	1,925
R^2	0.683	0.709	0.671	0.693

Notes. Standard errors clustered on state-level are reported in parentheses. Coefficient is statistically different from zero at the ***1 %, **5 % and *10 % level. The unit of observation is a state. All regressions include a constant not reported. Baseline controls include year and state type dummies, the basic geography, soil and climate, economic factors and resources controls as well as battles per area.

Table 7: *Observability of Agricultural Output and State Size—Cross Sections*

Dependent Variable	ln(Area)					
	(1)	(2)	(3)	(4)	(5)	(6)
Year	1250	1378	1477	1556	1648	1789
ln(Caloric Observability)	0.209***	0.213***	0.252**	0.358***	0.120	0.104
	(0.0763)	(0.0737)	(0.106)	(0.0811)	(0.118)	(0.135)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
State Type Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	368	402	313	367	255	220
R^2	0.665	0.688	0.704	0.698	0.736	0.751

Notes. Standard errors clustered on state-level are reported in parentheses. Coefficient is statistically different from zero at the ***1 %, **5 % and *10 % level. The unit of observation is a state. All regressions include a constant not reported. Baseline controls include state type dummies, the basic geography, soil and climate, economic factors and resources controls as well as battles per area.

VI. Conclusion

This paper has studied the determinants of tax capacity in medieval Central Europe. Because the HRE was a federation of states for hundreds of years, we have been able to connect the location, history and geographic circumstances of hundreds of states via our model. We have shown theoretically and empirically that the observability of agricultural output, via its impact on taxation capacity and the political structure of states, was a primary determinant of state size and survival in medieval Central Europe. We employed the theory of incomplete contracts to shed light on the dynamics of state capacity, before revolutionary social and economic events, from 1496 onwards, changed the game.

Our results provide evidence for the interaction of agriculture, climate, and geography in explaining political outcomes such as state capacity or regime. This adds a new perspective to the existing large and influential literature that links geography, climate and agriculture to long-run differences in economic outcomes (Diamond, 1999; Olsson and Hibbs, 2005). We have proposed a GIS measurement of observability of agricultural output that actually measures the degree of information asymmetry in an early society. As this index is well grounded in theoretical economic reasoning, it is potentially useful for other research endeavors in economic history, and long-run development.

This paper is a starting point for important further analyses—for example, why agricultural observability lost its explanatory power for state capacity during the early-modern period. This step would improve our understanding of the dynamics of state capacity in Europe over the last 1000 years. Potential factors to examine are the increased impact of technological innovations (e.g, de la Croix et al., 2017), or advances in education during the Reformation (Dittmar and Meisenzahl, 2017), 2017), which lead to increased urbanization and reduced a state's dependence on agricultural output for revenue. There are also opportunities for further study of the role of this observability mechanism in single states and other regions of the world.

References

Abel, Wilhelm. 1943. *Die Wüstungen des ausgehenden Mittelalters: ein Beitrag zur Siedlungs- und Agrargeschichte Deutschlands*. Stuttgart: Fischer Verlag.

Abel, Wilhelm. 1953. "Wüstungen und Preisfall im spätmittelalterlichen Europa." *Jahrbücher für Nationalökonomie und Statistik / Journal of Economics and Statistics*, 165(5/6): 380–427.

Abramson, Scott F. 2017. "The Economic Origins of the Territorial State." *International Organization*, 71 97–130.

Acemoglu, Daron. 2005. "Politics and economics in weak and strong states." *Journal of monetary Economics*, 52(7): 1199–1226.

Acemoglu, Daron, Davide Cantoni, Simon Johnson, and James A. Robinson. 2011. "The Consequences of Radical Reform: The French Revolution." *American Economic Review*, 101(7): 3286–3307.

Acemoglu, Daron, and Simon Johnson. 2007. "Disease and development: the effect of life expectancy on economic growth." *Journal of Political Economy*, 115(6): 925–985.

Acemoglu, Daron, and J. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *The American Economic Review*, 91(5): 1369–1401.

Acemoglu, Daron, and James A. Robinson. 2012. *Why nations fail: the origins of power, prosperity, and poverty*. New York, NY: Crown Publishing Group.

Acemoglu, Daron, and Alexander Wolitzky. 2011. "The Economics of Labor Coercion." *Econometrica*, 79(2): 555–600.

Akerlof, George A. 1970. "The Market for "Lemons": Quality Uncertainty and the Market Mechanism." *The Quarterly Journal of Economics*, 84(3): 488–500.

Alesina, Alberto, Reza Baqir, and William Easterly. 1999. "Public Goods and Ethnic Divisions." *The Quarterly Journal of Economics*, 114(4): , p. 1243.

Alesina, Alberto, Paola Giuliano, and Nathan Nunn. 2013. "On the origins of gender roles: Women and the plough." *The Quarterly Journal of Economics*, 128(2): 469–530.

Alesina, Alberto, and Enrico Spolaore. 1997. "On the Number and Size of Nations." *Quarterly Journal of Economics*, 112(4): 1027–1056.

Allen, Robert C. 2000. "Economic structure and agricultural productivity in Europe,

1300–1800." *European Review of Economic History*, 4(1): 1–25.

Allen, Robert C. 2009. *The British Industrial Revolution in Global Perspective*. New Approaches to Economic and Social History, Cambridge, UK: Cambridge University Press.

Andersen, Thomas Barnebeck, Peter Sandholt Jensen, and Christian Volmar Skovsgaard. 2016. "The heavy plow and the agricultural revolution in Medieval Europe." *Journal of Development Economics*, 118 133–149.

Anderson, Benedict. 1983. *Imagined communities: Reflections on the growth and spread of nationalism*. New York and London: Verso.

Anderson, Robert Warren, Noel D. Johnson, and Mark Koyama. 2016. "Jewish Persecutions and Weather Shocks: 1100–1800." *Economic Journal, forthcoming*.

Andree, Richard. 1886. *Professor G. Droysens Allgemeiner Historischer Handatlas*. Leipzig: Velhagen & Klasing.

Ang, James B. 2015. "What Drives the Historical Formation and Persistent Development of Territorial States." *Scandinavian Journal of Economics*, 117(4): 1134–1175.

Baldamus, Alfred, Ernst Schwabe, and Julius

Koch. 1914. *F.W. Putzgers Historischer Schulatlas zur alten, mittleren und neuen Geschichte*. Leipzig: Velhagen & Klasing.

Bates, Robert, Avner Greif, and Smita Singh. 2002. "Organizing violence." *Journal of Conflict Resolution*, 46(5): 599–628.

Bean, Richard. 1973. "War and the Birth of the Nation State." *The Journal of Economic History*, 33(01): 203–221.

Becker, Gary S. 1968. "Crime and Punishment: An Economic Approach." *Journal of Political Economy*, 76(2): 169–217.

Behringer, Wolfgang. 1999. *Climatic Change and Witch-Hunting: The Impact of the Little Ice Age on Mentalities*. 335–351, Dordrecht: Springer Netherlands.

Berger, Thor. 2017. "Adopting a New Technology: Potatoes and Population Growth in the Periphery." *Economic History Review, forthcoming*.

Blickle, Peter. 1988. *Unruhen in der Ständischen Gesellschaft 1300–1800*. Munich: R. Oldenbourg Verlag.

Blickle, Peter. 2006. *Von der Leibeigenschaft zu den Menschenrechten. Eine Geschichte der Freiheit in Deutschland*. Munich: C.H. Beck Verlag.

Bloch, Marc L.B. 1966. *French Rural History: An Essay on Its Basic Characteristics*. Campus (Berkeley), Berkeley, CA: University of California Press.

Boix, Carles. 2015. *Political order and inequality*. Cambridge, UK: Cambridge University Press.

Bolton, Patrick, and Gerard Roland. 1997. "The breakup of nations: a political economy analysis." *Quarterly Journal of Economics*, 112 1057–1090.

Borcan, Oana, Ola Olsson, and Luis Putterman. 2016. "State History and Economic Development. Evidence from Six Millenia." *Mimeo*.

Börner, Lars, and Battista Severgnini. 2014. "Epidemic trade." *LSE Economic History Working Papers, No. 212/2014*.

Bosker, M., E. Buringh, and J. L. Van Zanden. 2013. "From Baghdad to London. Unraveling Urban Development in Europe, the Middle East, and North Africa, 800–1800." *Review of Economics and Statistics*, 95(4): 1418–1437.

Bradbury, Jim. 2004. *The Routledge Companion to Medieval Warfare*. London: Routledge.

Bursztyn, Leonardo, and Davide Cantoni. 2016. "A tear in the iron curtain: The impact of Western television on consumption behavior." *Review of Economics and Statistics*, 98(1): 25–41.

Buszello, Horst, Peter Blickle, and Rudolf Endres. eds. 1984. *Der deutsche Bauernkrieg*. Paderborn: Ferdinand Schöningh Verlag.

Cantoni, Davide. 2012. "Adopting a New Religion: the Case of Protestantism in 16th Century Germany." *The Economic Journal*, 122(560): 502–531.

Cantoni, Davide, Jeremiah Dittmar, and Noam Yuchtman. 2016. "Reformation and Reallocation: Religious and Secular Economic Activity in Early Modern Germany." CESifo Working Paper Series 6218, CESifo Group Munich.

Carneiro, Robert L. 1970. *A Theory of the Origin of the State*. Studies in social theory, London: Macmillan.

Clodfelter, Michael. 1992. *Warfare and Armed Conflicts. A Statistical Reference to Casualty and Other Figures, 1500–2000*. Jefferson, NC: McFarland & Company.

Cummins, Neil. 2017. "Lifespans of the European Elite, 800–1800." *Journal of Economic History*, 77(2): 406–439.

Dal Bó, Ernesto, Pablo Hernández, and Se-

bastián Mazzuca. 2015. "The paradox of civilization: Pre-institutional sources of security and prosperity." *NBER Working Paper No. 21829*.

Darby, Henry C., and Harold Fullard. eds. 1978. *The New Cambrigde Economic History Atlas*. Cambridge, UK: Cambridge University Press.

de la Croix, David, Matthias Doepke, and Joel Mokyr. 2017. "Clans, Guilds, and Markets: Apprenticeship Institutions and Growth in Pre-Industrial Europe." *The Quarterly Journal of Economics, forthcoming*.

Diamond, Jared. 1999. *Guns, Germs and Steel: The Fates of Human Societies*. New York, NY: W.W. Norton.

Dincecco, M., and M. Gaetano Onorato. 2016. "Military Conflict and the Rise of Urban Europe." *Journal of Economic Growth, forthcoming*.

Dincecco, Mark. 2015. "The Rise of Effective States in Europe." *Journal of Economic History*, 75(3): 901–918.

Dincecco, Mark, and Mauricio Prado. 2012. "Warfare, fiscal capacity, and performance." *Journal of Economic Growth*, 17(3): 171–203.

Ditchburn, David, and Angus Mackay. 2002.

Atlas of Medieval Europe. London: Routledge.

Dittmar, Jeremiah, and Ralf R. Meisenzahl. 2017. "State Capacity and Public Goods: Institutional Change, Human Capital, and Growth in Historic Germany." *Mimeo*.

Dittmar, Jeremiah, and Skipper Seabold. 2015. "Media, markets and institutional change: evidence from the Protestant Reformation."

Edwards, Jeremy, and Sheilagh Ogilvie. 2012. "What lessons for economic development can we draw from the Champagne fairs?" *Explorations in Economic History*, 49(2): 131–148.

Elsner, Harald. 2009. "Goldgewinnung in Deutschland. Historie und Potenzial." *Commodity Top News*, 30.

Engel, Ernst. 1857. "Die Productions-und Consumtionsverhältnisse des Königreichs Sachsen." *Zeitschrift des statistischen Bureaus des Königlich Sächsischen Ministerium des Inneren*.

Epperlein, Siegfried. 2003. *Bäuerliches Leben im Mittelalter: Schriftquellen und Bildzeugnisse*. Cologne: Böhlau Verlag.

Fenske, James. 2014. "Ecology, Trade and States in Pre-Colonial Africa." *Journal of the European Economic Association*, 12(3): 612–640.

Findlay, Ronald, and Kevin H. O'Rourke.

2009. *Power and plenty: trade, war, and the world economy in the second millennium*. Princeton NJ: Princeton University Press.

Franz, Günther. ed. 1976. *Geschichte des deutschen Bauernaufstandes vom frühen Mittelalter bis zum 19. Jahrhundert*. Stuttgart: Eugen Ulmer Verlag.

Frenzel, Konrad. ed. 1938. *Velhagen & Klasings Grosser Wehratlas*. Biefeled and Leipzig: Velhagen & Klasing.

Fukuyama, Francis. 2011. *The Origins of Political Order: From Prehuman Times to the French Revolution*. New York, NY: Farrar, Straus and Giroux.

Gale, David, and Lloyd S. Shapley. 1962. "College Admissions and the Stability of Marriage." *The American Mathematical Monthly*, 69(1): 9–15.

Galor, Oded, and Ömer Özak. 2014. "The Agricultural Origins of Time Preference." *The American Economic Review*, 106 3064–3103.

Galor, Oded, and Ömer Özak. 2015. "Land Productivity and Economic Development: Caloric Suitability vs. Agricultural Suitability." *Brown University Working Paper*.

Gennaioli, Nicola, and Hans-Joachim Voth.

2015. "State Capacity and Military Conflict." *Review of Economic Studies*, 82(4): 1409–1448.

Gerteis, Klaus. 1997. "Auswanderungsfreiheit und Freizügigkeit in ihrem Verhältnis zur Agrarverfassung: Deutschland, England, Frankreich im Vergleich." In *Frühneuzeitliche Obrigkeiten im Wettbewerb: institutioneller und wirtschaftlicher Wandel zwischen dem 16. und 18. Jahrhundert*. ed. by Oliver Volckart, Baden-Baden: NOMOS Verlagsgesellschaft, 82–98.

Goldin, Claudia Dale, and Lawrence F Katz. 2009. *The race between education and technology*. Cambridge MA: Harvard University Press.

Guiot, Joel, and Christophe Corona. 2010. "Growing Season Temperatures in Europe and Climate Forcings Over the Past 1400 Years." *PLOS One*, 5(4): 1–15.

Harrison, Mark. 2002. "Coercion, compliance, and the collapse of the Soviet command economy." *Economic History Review*, 55(3): 397–433.

Heckscher, Eli F. 1994. "Mercantilism, vol 1." *New York, NY: Routledge* 33–78.

Henning, Friedrich-Wilhelm. 1994. *Deutsche Agrargeschichte des Mittelalters: 9. bis 15. Jahrhundert*. Stuttgart: Eugen Ulmer Verlag.

Hermann, Klaus. 1985. *Pflügen, Säen, Ernten.*

Landarbeit und Landtechnik in der Geschichte. Reinbek: Rowohlt Taschenbuch Verlag.

Hoffman, Philip T. 2011. "Prices, the military revolution, and western Europe's comparative advantage in violence." *The Economic History Review*, 64(s1): 39–59.

Hoffman, Philip T. 2015. *Why Did Europe Conquer the World?*.: Princeton University Press, Princeton NJ.

Hornung, Erik. 2014. "Immigration and the Diffusion of Technology: The Huguenot Diaspora in Prussia." *The American Economic Review*, 104(1): 84–122.

Huning, Thilo R., and Nikolaus Wolf. 2016. "How Britain Unified Germany: Endogenous Trade Costs and the Formation of a Customs Union." *Mimeo*.

Hurwich, Judith J. 1998. "Marriage strategy among the German nobility, 1400–1699." *The Journal of Interdisciplinary History*, 29(2): 169–195.

Iyigun, Murat. 2008. "Luther and suleyman." *The Quarterly Journal of Economics*, 123(4): 1465–1494.

Jacob, Marcus. 2010. "Long-Term Persistence: The Free and Imperial City Experience in Germany." *Mimeo*.

Johnson, Noel D., and Mark Koyama. 2017. "States and Economic Growth: Capacity and Constraints." *Explorations in Economic History*, 64 1–20.

Karaman, K. Kivanç, and Şevket Pamuk. 2013. "Different Paths to the Modern State in Europe: The Interaction Between Warfare, Economic Structure, and Political Regime." *American Political Science Review*, 7(03): 603–626.

Keyser, Erich, and Heinz Stoob. eds. 1939–1974. *Deutsches Städtebuch. Handbuch städtischer Geschichte*. 1–11, Stuttgart: W. Kohlhammer Verlag.

Ko, Chiu Yu, Mark Koyama, and Sng Tuan-Hwee. 2016. "Unified China and Divided Europe." *International Economic Review, forthcoming*.

Köbler, Gerhard. 1988. *Historisches Lexikon der deuschen Länder. Die deutschen Territorien und reichsunmittelbaren Geschlechter vom Mittelalter bis zur Gegenwart*. Munich: C.H. Beck.

Kopsidis, Michael, and Nikolaus Wolf. 2012. "Agricultural productivity across Prussia during the industrial revolution: a Thünen perspective." *Journal of Economic History*, 72(03): 634–670.

Krueger, Anne O. 1974. "The political econ-

omy of the rent-seeking society." *The American economic review*, 64(3): 291–303.

Lindert, Peter H. 1999. "The Bad Earth? China's Soils and Agricultural Development since the 1930s." *Economic Development and Cultural Change*, 47(4): 701–736.

Malthus, Thomas R. 1798. *An Essay on the Principle of Population*. London: J. Johnson.

Mayshar, Joram, Omer Moav, and Zvika Neeman. 2017. "Geography, Transparency, and Institutions." *American Political Science Review (forthcoming)*.

Mayshar, Joram, Omer Moav, Zvika Neeman, and Luigi Pascali. 2015. "Cereals, Appropriability and Hierarchy." *CEPR Discussion Paper No. 10742.*

McCormick, Michael, Guoping Huang, Zambotti Giovanni, and Jessica Lavash. 2013. "Roman Road Network (version 2008)." *DARMC Scholarly Data Series. Data Contribution Series No. 2013-5.*

Michalopoulos, Stelios, and Elias Papaioannou. 2014. "National institutions and subnational development in Africa." *The Quarterly Journal of Economics*, 129(1): 151–213.

Milgrom, Paul R., Douglass C. North, and Barry R. Weingast. 1990. "The role of insti-

tutions in the revival of trade: The law merchant, private judges, and the champagne fairs." *Economics & Politics*, 2(1): 1–23.

Mitterauer, Michael. 2004. *Warum Europa? Mittelalterliche Grundlagen eines Sonderwegs.*: C.H. Beck, Munich.

Mokyr, Joel. 2011. *The Enlightened Economy: Britain and the Industrial Revolution, 1700-1850*. London: Penguin Books.

Neal, Larry. 2015. *A Concise History of International Finance: From Babylon to Bernanke.*: Cambridge University Press.

North, Douglass C, and Robert Paul Thomas. 1971. "The rise and fall of the manorial system: A theoretical model." *The Journal of Economic History*, 31(04): 777–803.

North, Douglass C, John J Wallis, and Barry R Weingast. 2009. *Violence and social orders: a conceptual framework for interpreting recorded human history*. Cambridge MA: Cambridge University Press, Cambridge, UK.

Nunn, Nathan, and Diego Puga. 2012. "Ruggedness: The blessing of bad geography in Africa." *Review of Economics and Statistics*, 94(1): 20–36.

Nunn, Nathan, and Nancy Qian. 2011. "The potato's contribution to population and ur-

banization: evidence from a historical experiment." *The Quarterly Journal of Economics*, 126(2): 593–650.

Ogilvie, Sheilagh. 2001. "The Economic World of the Bohemian Serf: Economic Concepts, Preferences, and Constraints on the Estate of Friedland, 1583–1692." *The Economic History Review*, 54(3): 430–453.

Ogilvie, Sheilagh. 2007. "Can We Rehabilitate the Guilds? A Sceptical Re-Appraisal." *Cambridge Working Papers in Economics, No. 745*.

Ogilvie, Sheilagh. 2011. *Institutions and European Trade: Merchant Guilds, 1000–1800*. Cambridge Studies in Economic History - Second Series, Cambridge, UK: Cambridge University Press.

Olson, Mancur. 1993. "Dictatorship, Democracy, and Development." *The American Political Science Review*, 87(3): 567–576.

Olson, Mancur. 2008. *The rise and decline of nations: Economic growth, stagflation, and social rigidities*. Yale, NH: Yale University Press.

Olsson, Ola, and Gustab Hansson. 2011. "Country Size and the Rule of Law: Resuscitating Montesquieu." *European Economic Review*, 55(5): 613–629.

Olsson, Ola, and Douglas A. Hibbs. 2005.

"Biogeography and Long-Run Economic Development." *European Economic Review*, 49(4): 909–938.

Panagos, Panos. 2006. "The European soil database." *GEO: connexion*, 5(7): 32–33.

Peters, Jan. ed. 1995. *Konflikt und Kontrolle in Gutsgesellschaften*. Göttingen: Vandenhoeck & Ruprecht.

Ramankutty, Navin, Jonathan A. Foley, John Norman, and Kevin McSweeney. 2002. "The Global Distribution of Cultivable Lands: Current Patterns and Sensitivity to Possible Climate Change." *Global Ecology and Biogeography. A Journal of Macroecology*, 11(3): 377–392.

Riley, Shawn J., Stephen D. DeGloria, and Robert Elliot. 1999. "A Terrain Ruggedness Index that Quantifies Topographic Heterogeneity.." *Intermountain Journal of Sciences*, 5 23–27.

Romer, Paul. 2009. "Why the World Needs Charter Cities." *TED: Ideas worth Spreading*.

Rubin, J. 2014. "Printing and Protestants: An Empirical Test of the Role of Printing in the Reformation." *Review of Economics and Statistics*, 96(2): 270–286.

Sante, Georg Wilhelm. ed. 1964. *Geschichte der*

deutschen Länder. Territorien-Ploetz. Band 1: Die Territorien bis zum Ende des alten Reiches. Würzburg: A.G. Ploetz Verlag.

van Schaïk, Remi. 1993. "Taxation, public finances and the state-making process in the late Middle Ages: the case of the duchy of Guelders." *Journal of Medieval History*, 19(3): 251 – 271.

Schlüter, Otto. 1952. "Die Siedlungsräume Mitteleuropas in frühgeschichtlicher Zeit." *Deutsche Landeskunde*, 63.

Schönholzer, David. 2017. "The Origins of the State: Extraction, Environmental Circumscription, and Protection." *BEHL Working Paper 2017-01.*

Schröter, Wilko. 2007. "Vergleich der Fertilität im deutschen Hochadel ab 1600 mit der 'Natural Fertility'." *Historical Social Research/Historische Sozialforschung*, 32 68–90.

Shepherd, William R. 1923. *Historical Atlas*. New York, NY: Henry Holt and Company.

Simms, Brendan. 2013. *Europe: The Struggle for Supremacy, from 1453 to the Present*. London: Penguin Books.

Smith, Adam. 1776. *An inquiry into the nature and causes of the wealth of nations*. London: Routledge and Sons.

Smith, Adam. 1991. *An inquiry into the nature and causes of the wealth of nations*. London: Everyman's Library.

Spieß, Karl-Heinz. 1993. *Familie und Verwandschaft im deutschen Hochadel des Spätmittelalters: 13. bis Anfang des 16. Jahrhunderts*. Vierteljahrschrift für Sozial-und Wirtschaftsgeschichte, Stuttgart: Franz Steiner Verlag.

Spolaore, Enrico. 2014. "The Economics of Political Borders." *Mimeo.*

Stier, Hans-Erich, Ernst Kirsten, Wilhelm Wühr, Heinz Quirin, Werner Trillmich, Gerhard Czybulka, Hermann Pinnow, and Hans Ebeling. eds. 1956. *Westermanns Atlas zur Weltgeschichte*. Vorzeit/ Altertum, Mittelalter, Neuzeit, Brunswick: Georg Westermann Verlag.

Stone, Lawrence. 1961. "Marriage among the English Nobility in the 16th and 17th Centuries." *Comparative Studies in Society and History*, 3(2): , p. 182–206.

Talbert, Richard J.A. ed. 2000. *Barrington Atlas of the Greek and Roman World*. Princeton, NJ: Princeton University Press.

Tilly, Charles. ed. 1975. *The Formation of National States in Western Europe*. Princeton, NJ: Princeton University Press.

Tilly, Charles. 1985. "War making and state making as organized crime." In *Bringing the state back in*. eds. by Theda Skocpol, Peter Evans, and Dietrich Rueschemeyer, London: Routledge, 35–60.

Tilly, Charles. 1993. *Coercion, Capital and European States: AD 990 - 1992*. Studies in Social Discontinuity, Hoboken NJ: Wiley.

Van Liedekerke, Marc H., Arwyn Jones, and Panos Panagos. 2006. "ESDBv2 Raster Library-a set of rasters derived from the European Soil Database distribution v2.0." *European Commission and the European Soil Bureau Network, CDROM, EUR*, 19945.

Vogeler, Georg. 2005. "Tax accounting in the late medieval German territorial states." *Accounting, Business & Financial History*, 15(3): 235–254.

Voigtländer, Nico, and Hans-Joachim Voth. 2013. "The three horsemen of riches: Plague, war, and urbanization in early modern Europe." *The Review of Economic Studies*, 80 774–811.

Volckart, Oliver. 1997. *Frühneuzeitliche Obrigkeiten im Wettbewerb: institutioneller und wirtschaftlicher Wandel zwischen dem 16. und 18. Jahrhundert*. 5, Baden-Baden: NOMOS Verlagsgesellschaft.

Volckart, Oliver. 2002. *Wettbewerb und Wettbewerbsbeschränkung im vormodernen Deutschland 1000-1800*. Einheit der Gesellschaftswissenschaften, Tübingen: Mohr Siebeck.

Volckart, Oliver, and Nikolaus Wolf. 2006. "Estimating Financial Integration in the Middle Ages: What Can We Learn from a TAR Model?" *The Journal of Economic History*, 66(1): , p. 122–139.

von Thünen, Johann H. 1826. *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie, oder, Untersuchungen über den Einfluss, den die Getreidepreise, der Reichthum des bodens und die Abgaben auf den Ackerbau ausüben*. Hamburg: Friedrich Perthes Verlag.

Wahl, Fabian. 2017. "Does European Development Have Roman Roots? Evidence from the German Limes." *Journal of Economic Growth (forthcoming)*.

Weber, Eugene. 1976. *Peasants Into Frenchmen: The Modernization of Rural France, 1870-1914*. Stanford, CA: Stanford University Press.

Weber, Max. 1919. *Politik als Beruf*. Berlin: Duncker & Humblot.

Whaley, Joachim. 2012. *Germany and the Holy Roman Empire: Volume II: The Peace of Westphalia to the Dissolution of the Reich, 1648-1806*.

Germany and the Holy Roman Empire, Oxford: Oxford University Press.

Wilson, Peter H. 2016. *The Holy Roman Empire: A Thousand Years of Europe's History*. London: Allan Lane.

Wolff, Carl. 1877. *Carl Wolff's historischer Atlas*. Berlin: Reimer Verlag.

Zabel, Florian, Brigitta Putzenlechner, and Wolfram Mauser. 2014. "Global Agricultural Land Resources. A High Resolution Suitability Evaluation and Its Perspectives until 2100 under Climate Change Conditions." *PLOS One*, 9(9): 1–12.

Zeumer, Karl. ed. 1913. *Quellensammlung zur Geschichte der deutschen Reichsverfassung in Mittelalter und Neuzeit*. 2, Tübingen: Mohr Verlag.

DATA APPENDIX

A.1. Dependent Variable

A.1.1. The Underlying Maps

The area of a state ("reichsunmittelbares Territorium") is calculated based on shapefiles created from maps of the non-Italian parts of the Holy Roman Empire printed in Wolff (1877). One of those maps, "Deutschland beim Tode Karl des IV. im Jahre 1378" ("Germany at the death of Charles IV. in the year 1378") is shown below in Figure A.1. Note that this map incorrectly includes the state of the Teutonic Order, so when digitizing the map we excluded this area. The maps are available here: `http://gei-digital.gei.de/viewer/javax.faces.resource/pdf-icon32.png.xhtml?ln=images/` (accessed on January 22, 2016).
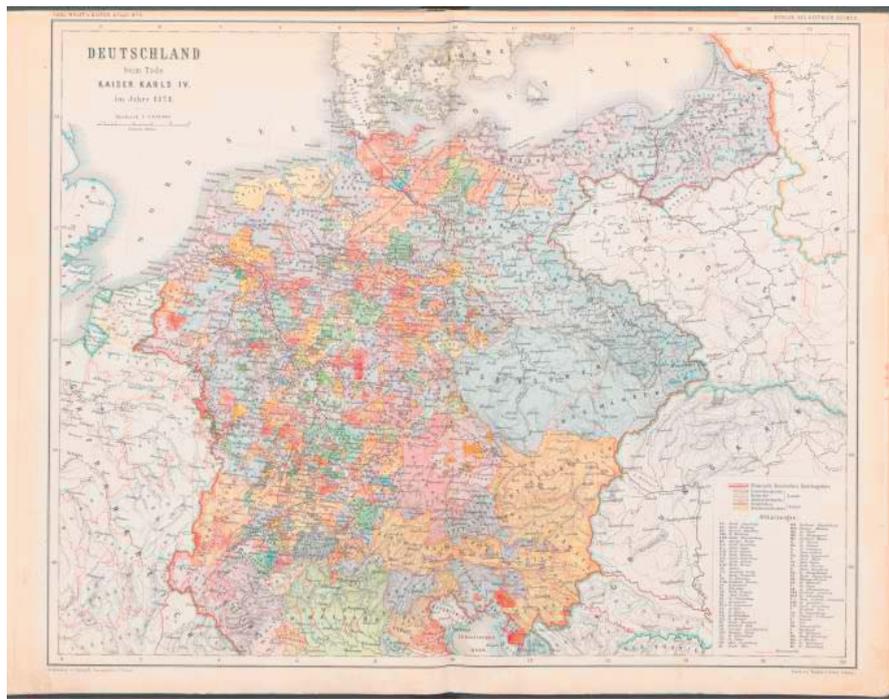
Note: This figure shows the original map of the HRE as printed in Wolff (1877). For our empirical analysis we digitized this map using GIS software.

Figure A.1: *Germany at the Death of Charles IV. in the Year 1378 (Wolff, 1877)*

A.1.2. States in the Holy Roman Empire 1250–1789

(a) *HRE 1250*

(b) *HRE 1378*

(c) *HRE 1477*

(d) *HRE 1556*

(e) *HRE 1648*

(f) *HRE 1789*
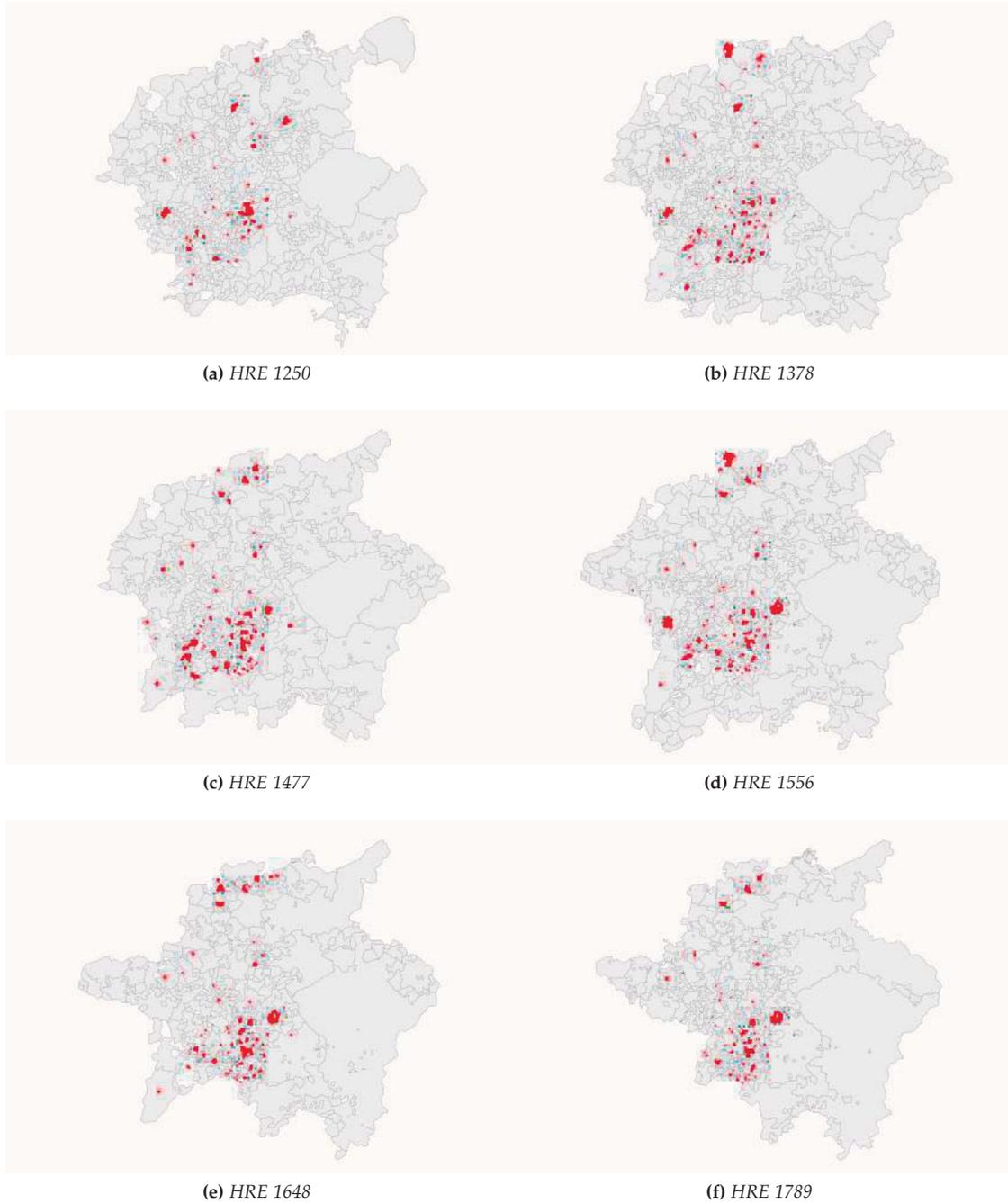
Figure A.2: *The Holy Roman Empire and its territorial states (gray) and city states (red) at our sampling years*

A.1.3.   Historical Background of the Sampling Years

(i) 1250 was the year of the death of Frederick II., the last Emperor of the Staufer dynasty. The Staufer dynasty had ruled the Empire as kings and emperors for more than 110 years. The whole dynasty (and with them central power) collapsed soon after, in 1254, when his only son Konrad IV., who was King of Germany but never Emperor, died. Following the collapse of the Staufer dynasty, a 20 year period called the "Great Interregnum" began, in which there was no elected Emperor but four elected kings. The kings were not universally accepted by the powerful princes, and so did not rule the Empire. In this period, known as an age of insecurity, violence and anarchy, many of the numerous city state (free and imperial cities) emerged and political fragmentation increased further[60].

(ii) 1378 was the year Emperor Charles IV died. This year marks the peak of the political fragmentation of the Empire—a situation that was made permanent by the Golden Bull of 1356. Furthermore, while considered by some as one of the greatest and most influential medieval German Emperors, he failed to preserve the powerful position of his dynasty, the Luxembourgians, as he pledged away a lot of the territories under his control, in order to pay his large debts. This further weakened central authority and helped to increase the political fragmentation of the Empire.

(iii) 1477 was the year in which Charles the Bold, Duke of Burgundy died. With his death, the Duchy of Burgund, one of the largest states in Europe, which could be considered an independent, middle-sized power (although de jure part of the HRE), collapsed and was split after violent hostilities. Some parts of the Duchy fell to France and the remainder was integrated into the HRE as smaller political entities (like the Duchy of Brabant). Furthermore, through marriage, the Habsburgs gained control over the remaining parts of Burgundy and thus, the death of Charles the Bold was the decisive event in the ascent of the House of Habsburg to world power. A period with slowly declining political fragmentation began.

---

[60]Political fragmentation in the 13th century was already much higher than during the 12th century. This was due to the fact that, as a consequence of the struggle between Henry the Lion, Duke of Saxony and Emperor Frederick I., the old and quite large stem duchies ("Stammesherzogtümer") were dissolved and partitioned into smaller (and even further divisible) territories. This should have weakened the position of dukes and princes towards the Emperor and hence strengthen central power, but in the long-run, had the opposite effect.

(iv) 1556, the year after the peace of Augsburg settled the confessional division of Germany for the next decades and ended the first wave of religious wars in the Holy Roman Empire. However, it also was the year when Charles V, probably the most powerful European monarch after the fall of Rome, abdicated from the throne due to his setback against the protestant princes and his lack of loyal vassals within the Empire. His reign marked the peak and turning point of the power of the House of Habsburg as his resignation from the throne and its defeat by the princes of the Empire was the starting point of the slow decline of the Habsburg's power.

(v) 1648, the year when the Thirty Years War ended, with the Peace Treaties of Westphalia. This lead to notable territorial changes, as some large and powerful states like Brandenburg or Hesse integrated smaller territories into their states. Furthermore, several imperial cities disappeared, becoming part of France or of Switzerland (whose independence was officially acknowledged). Finally, it settled the confessional question within the Empire.

(vi) (vi) 1789, the year when the French Revolution began and triggered a series of events and wars, resulting in the demise of the HRE and the most significant reshaping of the landscape of states in Central Europe since the dissolution of the stem duchies in the 12$^{\text{th}}$ century.

A.1.4. De Facto vs. de Jure Independence of States in the Maps

City states are often among those territories for which it was not absolutely clear what degree of independence they had, regardless of their de jure status. It is well known that some cities had gained certain independence from their rulers, while never being officially considered as imperial cities. By the same measure, there were imperial cities that were never truly independent of their former ruler although they were granted "Reichsunmittelbarkeit" by the Emperor. We consulted standard sources on the history of German cities such as Köbler (1988) or Keyser and Stoob (1939–1974) and other studies on imperial cities, including Cantoni (2012) and followed their judgement about whether a city was de facto, and not just de jure, an imperial city. This is also an issue for several territories that were ruled by the Emperor or another high-ranked noble (like an elector) but where never part of their core territory. Two of these territories were the magraviates of Ober- and Niederlausitz (Upper and Lower Lusatia). Hence, some historians argue that the

power of those rulers over the territory was limited if non-existent. Therefore, we decided to treat the Lausitz territories as independent states.

A.1.5. Coding Example of a Difficult Case

A difficult of a different case to code is the county of Sponheim which consisted at the beginning of the 14th century, of two separated territories, the "Vordere" and "Hintere" Grafschaft of Sponhein. When the dynasty ruling the "Vordere Grafschaft" (the front county) died out, one fifth of the County went to the Electoral Palatinate and four fifth to the Count controlling the "Hintere Grafschaft" (the back county). After 1437, the Margrave of Baden and the Count of Veldenz inherited both parts of the County. Both rulers decided not to split the County but to rule it together as a condominium. Another change occurred in 1559, when the Princedom of Pfalz-Simmern (who had inherited the part of the County of Veldenz) bought the Electoral Palatinate's shares in the "Vordere Grafschaft". Simultaneously, it decided to give away the half of the "Hintere Grafschaft" to the Duchy of Pfalz-Zweibrücken. This resulted in the following situation: the "Vordere Grafschaft" belonged three fifths to Pfalz-Simmern (since 1559 Electoral Palatinate) and two fiftha to Baden. The "Hintere Grafschaft" belonged half to Baden and half to Zweibrücken. Finally, in 1707, the Margraviate of Baden-Baden and Electoral Palatinate split up the "Vordere Grafschaft" and in 1776, the "Hintere Grafschaft" was split in half by the Margrave of Baden and the duke of Pfalz-Zweibrücken. After 1815 the territory was integrated into Prussia and disappeared. In 1477 and 1555, i.e. during the condominium, we decided to consider the whole territory as county of Sponheim. Wolff, in his 1556 map has assigned the four separate territories of the county to either Pfalz-Simmern or Baden-Baden, Pfalz-Zweibrücken and the Electoral Palatinate. One cannot be sure whether he has assigned it to Pfalz-Simmern or Baden-Baden as both have the same color. In addition, this does not reflect the actual situation in 1556 (according to our sources), rather this is the situation in 1559 (when one assumes that he has assigned the "Vordere Grafschaft" to Baden and not to Pfalz-Simmern). For 1648 and 1789 we follow Wolff, who no longer included the county of Sponheim but assigned its territory to Pfalz-Zweibrücken, Electoral Palatinate and Baden-Baden (or Baden, respectively).

A.2.   Control Variables

The spatial datasets were each converted into WGS 1984 UTM 32N projection. State type and "State in 1150" dummies are calculated from the shapefiles of Wolff's maps (1877). This is also the case for the variable "Outer Boundary" reporting the share of a states' border that is an outer boundary of the HRE.

Area Types. We have computed the (natural logarithm of the) area within each state that consisted of forests, swamps and floodplains (in m^2) in the pre-modern period and hence was very likely not settled or used for agricultural purposes. Floodplains and swamps might also have played a role as source of germs and diseases. Data is taken from a map by Schlüter (1952) that we have digitized. His map only covers the area of contemporary Germany.

Average Terrain Ruggedness. Following Riley et al. (1999) average ruggedness of a states' territory is calculated as the negative value of the derivative of the ruggedness index of a digital elevation model. The calculations are based on the elevation raster of Nunn and Puga (2012) (see above). Terrain ruggedness was calculated using QGIS.

Average Temperature. Historical average temperature for a state is taken from the data set of Guiot and Corona (2010). They constructed a grid cell database of historical European temperatures and their deviations from the average temperature in 1960–1990. We use this data set to calculate, for each state, the average temperature deviation in the period from 800 to 1378. To calculate the average temperature deviations for each grid we follow the interpolation procedure of Anderson et al. (2016) by filling in missing values with the inverse distance weighted average temperature of the twenty-four nearest neighbor grid points.

Battles. Number of battles per km^2 that have taken place in a state in the period between two of our maps (e.g. between 800 and 1250 between 1250 and 1378, between 1378 and 1477 etc.). Information of the date and location of the battles is taken from Bradbury (2004), Clodfelter (1992) and Darby and Fullard (1978).

Distance to City State. Distance to city states is calculated as follows: Points with random location were generated until 1,000 points fell in into each state. In a second step, the Euclidean distance

from each of the 1,000 points per state to the closest Imperial city was calculated. In a last step, these distances were aggregated by state. The location of city states follows the maps of Wolff (1877) but we have corrected/ supplemented them—if necessary—with information from Köbler (1988), Keyser and Stoob (1939–1974) and Jacob (2010).

Distance to Major Rivers. Distance to major rivers is calculated as follows: Points with random location were generated until 1,000 points fell in into each state. In a second step, the Euclidean distance from each of the 1,000 points per state to the to the closest major river (see Figure A.5) was calculated. In a last step, these distances were aggregated by state. For the location of the rivers, we used the dataset for 'WISE large rivers' shapefile, which can be downloaded here: `http://www.eea.europa.eu/data-and-maps/data/wise-large-rivers-and-large-lakes` (last accessed May, 30th 2016).

Distance to Natural Resources. We have calculated seven variables reporting the distance to natural resources (copper, gold, iron, lead, potassium salt, rock salt and silver). Distance to natural resources is calculated as follows: Points with random location were generated until 1,000 points fell in into each state. In a second step, the Euklidean distance from each of the 1,000 points per state to the closest deposit of the respective natural resource was calculated. In a last step, these distances were aggregated by state. The location of natural resource deposits is taken from Frenzel (1938) and Elsner (2009).

Distance to Roman Roads. Distance to (minor and major) Roman roads is calculated as follows: Points with random location were generated until 1,000 points fell in into each state. In a second step, the Euclidean distance from each of the 1,000 points per state to the to the closest Roman road was calculated. These distances were aggregated by state. Locations of Roman roads (minor and major) originate from a shapefile included in the "Digital Atlas of Roman and Medieval Civilizations" (McCormick et al., 2013). The shapefile is based on the map of Roman roads in the Barrington Atlas of the Greek and Roman World (Talbert, 2000). It can be downloaded here: `http://darmc.harvard.edu/icb/icb.do?keyword=k40248&pageid=icb.page601659` (last accessed September, 24th 2015).

Distance to Medieval Trade Road. Distance to medieval trade routes is calculated as follows: Points with random location were generated until 1,000 points fell in into each state. The Euklidean distance from each of the 1,000 points per state to the to the closest medieval trade route was calculated. In a last step, these distances were aggregated by state. Location of trade routes are obtained by digitizing a map on "Medieval Commerce" from Shepherd (1923). The map can be downloaded as pdf from here: `https://www.lib.utexas.edu/maps/historical/shepherd/europe_mediaeval_commerce.jpg` (last accessed July, 10th 2017).

Distance to Trade Fairs. Distance to trade fair is calculated as follows: Points with random location were generated until 1,000 points fell in into each state. The Euclidean distance from each of the 1,000 points per state to the to the closest trade fair city was calculated. These distances were aggregated by state. The locations of the fairs were taken from Ditchburn and Mackay (2002).

Maximum Elevation. Maximum elevation of each state in meters. Data is based on the Digital Elevation Model (DEM) of the U.S. Geological Survey's Center for Earth Resources Observation and Science (EROS), namely the GTOPO30 dataset, which can be downloaded here `https://lta.cr.usgs.gov/GTOPO30` (last accessed May, 30th 2016). The GTOPO30 has a spatial resolution of 30 arc seconds.

Plough Suitability. Plough suitability of a states' soils are measured by the share of its area which has luvisol soils. Data on location of luvisol soils is taken from the European Soil Database version 2 provided by the European Soil Data Center (ESDAC). We used the 1km*1km raster data set downloadable here (upon request): `http://esdac.jrc.ec.europa.eu/content/european-soil-database-v2-raster-library-1kmx1km` (last accessed June, 20th 2017).

Pre-Historic Settlement Area. We have computed the (natural logarithm of the) area within each state that was already settled in pre-historic times (in m^2). This information stems from Schlüter (1952).

Latitude. Minimum longitudinal coordinates a states' centroid (mid-point) in meters. Calculated

using QGIS.

Longitude. Minimum longitudinal coordinates of a states' centroid (mid-point) in meters. Calculated using QGIS.

Relative Cereals Suitability. An index of caloric suitability of cereals relative to roots and tubers for each states was generated according to the logic of Mayshar et al. (2015) using data from Galor and Özak (2015). This index measures the difference between the maximum yield from plants that are appropriable, and the maximum yield from roots and tubers. Appropriable plants ("cereals") included alfalfa, banana, barley, buckwheat, cabbage, canary grass, chickpea, citrus, coconut, cow pea, dry pea, flax, foxtail millet, greengram, indigo rice, jatropha, miscanthus, oat, oil palm, olive, pasture grass, pasture legumes, pearl millet, pigeon pea, pulses, rape, rye, sorghum (subtropical), sorghum (tropical highland), sorghum (tropical lowland), soybean, spring barley, spring wheat, sugar cane, tea, wetland rice, wheat, winter barley, winter rye, and winter wheat. Roots and tubers were carrot, groundnut, onion, yams, and white yam.

Table A.1: *Descriptive Overview of the Data Set*

Variable	Obs	Mean	Std. Dev.	Min	Max
Area	1,925	2250000000.000	8470000000.000	4948171.000	193000000000.000
Average Temperature	1,925	0.150	0.054	-0.011	0.355
Battles per km^2	1,925	0.000	0.000	0.000	0.015
Belgium	1,925	0.040	0.196	0.000	1.000
Caloric Observability	1,925	399.880	475.622	0.000	4160.717
COI Post-1500-COI Pre-1500	1,925	3619.769	181.221	2145.383	4284.983
County	1,925	0.265	0.442	0.000	1.000
CSI Post-1500-CSI Pre-1500	1,925	1474.386	181.221	0.000	2139.601
Czech Republic	1,925	0.010	0.101	0.000	1.000
Distance to Copper Deposit	1,925	136088.000	62582.970	8989.408	394265.800
Distance to Gold Deposit	1,925	93655.510	70641.920	0.000	457256.300
Distance to Imperial City	1,925	65288.080	93232.030	0.000	509783.900
Distance to Iron Deposit	1,925	79611.300	54619.310	0.000	377603.900
Distance to Large River	1,925	33.660	23.005	0.888	143.924
Distance to Lead Deposit	1,925	116992.100	63723.760	8277.119	441320.800
Distance to Potassium Salt Deposit	1,925	121460.000	96965.100	0.000	597686.800
Distance to Rock Salt Deposit	1,925	130085.100	86606.360	18.912	376318.100
Distance to Roman Road	1,925	81.126	118.883	0.650	656.984
Distance to Silver Deposit	1,925	397472.600	140633.700	18386.710	810327.000
Distance to Trade Fair	1,925	231385.200	131436.600	3159.897	843413.800
Distance to Trade Route	1,925	45.722	37.628	1.169	236.214
Duchy	1,925	0.063	0.244	0.000	1.000
Ecclesiastical State	1,925	0.202	0.401	0.000	1.000
Electorate	1,925	0.025	0.158	0.000	1.000
France	1,925	0.081	0.272	0.000	1.000
Germany	1,925	0.707	0.455	0.000	1.000
Herrschaft	1,925	0.161	0.368	0.000	1.000
Hungary	1,925	0.001	0.032	0.000	1.000
Italy	1,925	0.008	0.088	0.000	1.000
Kindom	1,925	0.002	0.046	0.000	1.000
Lithuania	1,925	0.001	0.023	0.000	1.000
ln(Area)	1,925	20.067	1.650	15.415	25.988
ln(Caloric Observability Post-1500)	1,925	5.768	0.885	0.000	8.078
ln(Caloric Observability)	1,925	2.832	1.007	0.000	8.334
ln(Caloric Suitability Post-1500)	1,925	7.266	0.637	0.000	7.786
ln(Caloric Suitability)	1,925	7.431	0.679	0.000	7.897
ln(Floodplains)	990	2.069	6.712	0.000	23.821
ln(Forest Area)	990	6.220	8.415	0.000	17.594
ln(Optimal Caloric Observability)	1,924	6.662	0.975	0.000	9.716
ln(Optimal Caloric Suitability)	1,925	8.947	0.638	0.000	9.430
ln(Pre-Historic Settlement)	990	9.092	8.736	0.000	17.477
ln(Settled Area)	827	19.122	1.313	12.666	22.857
ln(Swamp Area)	990	2.145	6.666	0.000	22.836
Luxemburg	1,925	0.002	0.046	0.000	1.000
Margraviate	1,925	0.017	0.128	0.000	1.000
Maximum Elevation	1,925	767.721	766.672	5.000	4366.000
Netherlands	1,925	0.020	0.139	0.000	1.000
Outer Boundary	1,925	0.047	0.137	0.000	0.890
Poland	1,925	0.034	0.181	0.000	1.000
Princedom	1,925	0.054	0.225	0.000	1.000
Relative Cereals Suitability	1,925	17279.220	3039.148	0.000	20795.540
Republic	1,925	0.018	0.134	0.000	1.000
Share of Luvisol Soils	1,925	4.085	2.577	0.027	16.823
Slovenia	1,925	0.009	0.096	0.000	1.000
Switzerland	1,925	0.067	0.250	0.000	1.000
Terrain Ruggedness	1,925	112.777	141.549	2.212	858.629
Territories	1,925	1.722	1.755	1.000	21.000

A.3. Failure of States

(a) *Territories missing in 1378*

(b) *Territories missing in 1477*

(c) *Territories missing in 1556*

(d) *Territories missing in 1648*

(e) *Territories missing in 1789*

Note: The data on the failure of the states was collected from Köbler (1988) and completed from other sources on regional history

Figure A.3: *Failed states*

A.4. Geographic Controls
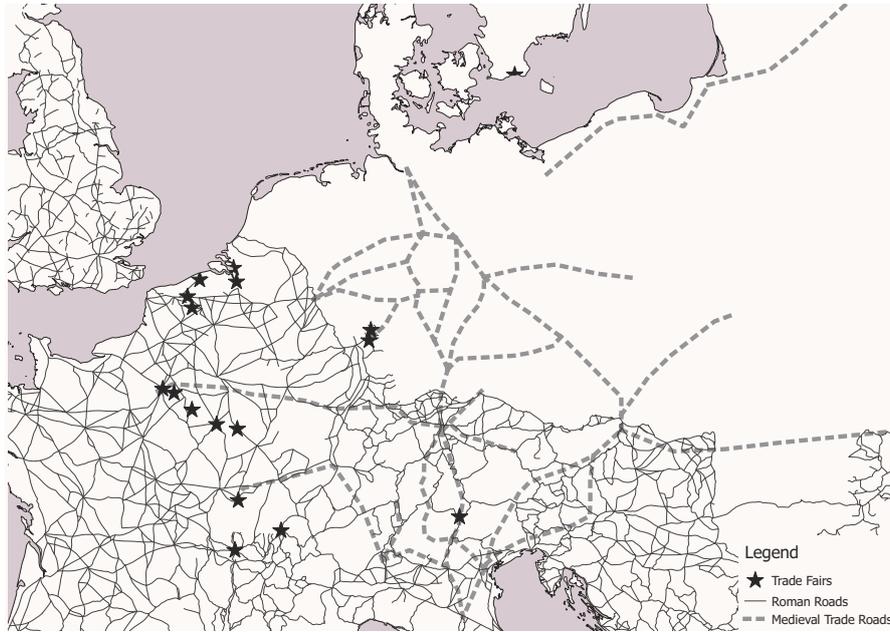
Note: Data on Roman Road was taken from McCormick et al. (2013), medeval trade routes were digitztized from Shepherd (1923). Trade fairs were digitized using modern positions and the towns from Ditchburn and Mackay (2002).

Figure A.4: *Roman & Medieval Roads, Trade Fairs, and Hanseatic Towns*

Table A.2: *Inclusion of the trade fairs*

Name	1250	1378	1477	1555	1648	1789
Antwerp	–	✓	✓	✓	✓	✓
Bar sur Aube	✓	✓	–	–	–	–
Bergen ob Zoom	–	✓	–	–	–	–
Bozen	–	–	✓	✓	✓	✓
Bruges	✓	✓	✓	✓	✓	✓
Chalons sur Saone	✓	✓	–	–	–	–
Frankfurt	–	✓	✓	✓	✓	✓
Friedberg	–	✓	–	–	–	–
Geneva	–	✓	✓	✓	✓	✓
Lagny	✓	✓	–	–	–	–
Leipzig	–	–	✓	✓	✓	✓
Lille	✓	✓	✓	✓	✓	✓
Lyon	–	✓	✓	✓	✓	✓
Provins	✓	✓	–	–	–	–
Skanes	✓	✓	✓	✓	✓	✓
St. Denis	✓	✓	✓	✓	✓	✓
Troyes	✓	✓	–	–	–	–
Ypres	✓	✓	✓	✓	✓	✓
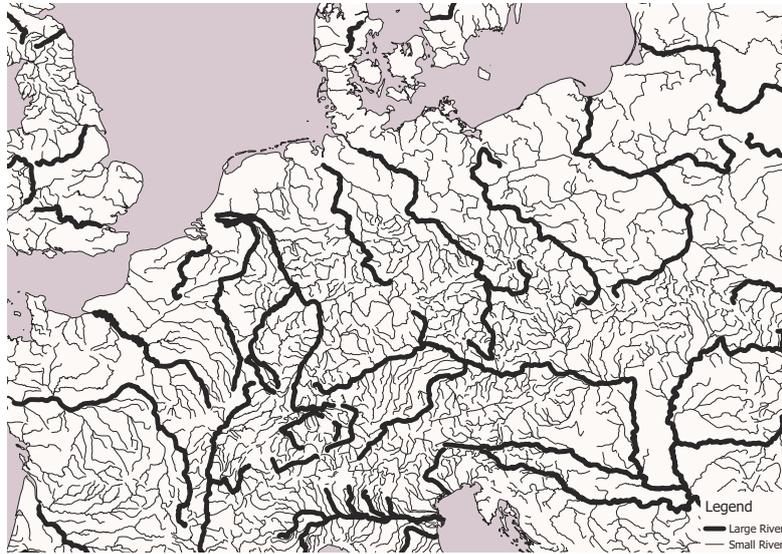
Figure A.5: *Large and Small Rivers*
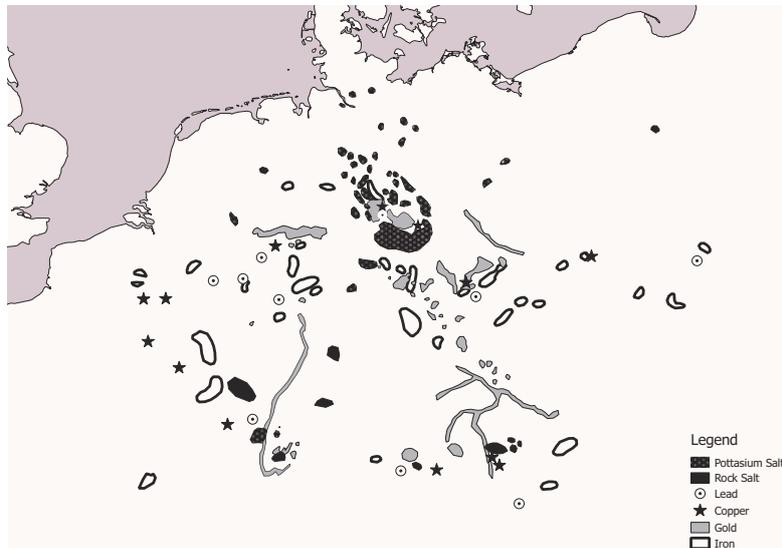
Note: These data were digitized from Frenzel (1938) and Elsner (2009)

Figure A.6: *Mineral Resources*
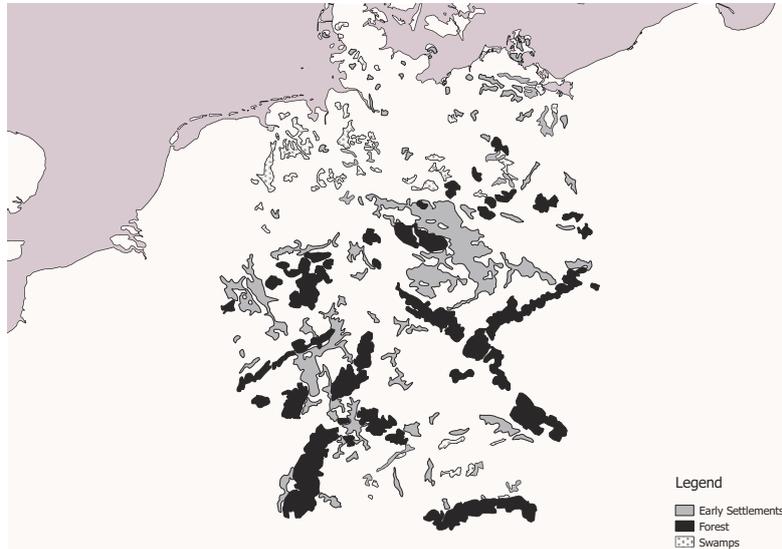
Note: Areas were digitized from Schlüter (1952).

Figure A.7: *Settlement in the Early Middle Ages*
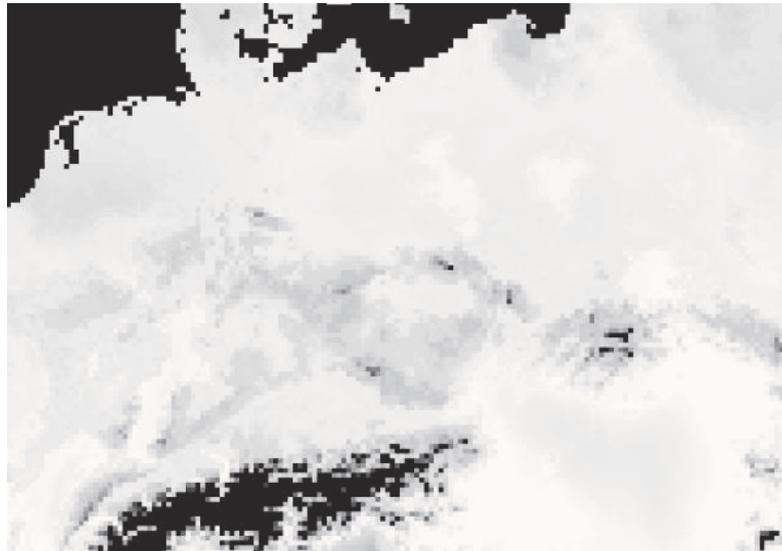
Note: Own calculation on the basis of Mayshar et al. (2015) and data from Galor and Özak (2014, 2015). The lighter the colors, the higher is suitability for growing cereals relative to growing roots and tubers.

Figure A.8: *Cereals vs. Roots and Tubers*

Note: The instrument from Alesina et al. (2013) shows only minor variation within our sample. We employ the idea by Andersen et al. (2016) based on data from Panagos (2006) and Van Liedekerke et al. (2006).

Figure A.9: *Usage of the Heavy Plough Alesina et al. (2013); Andersen et al. (2016)*
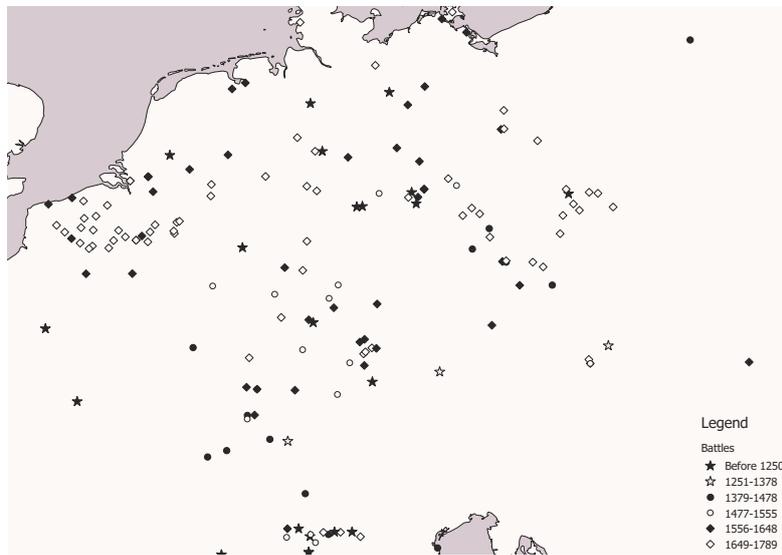
Note: Information of the date and location of the battles is taken from Bradbury (2004), Clodfelter (1992) and Darby and Fullard (1978).

Figure A.10: *Battles*
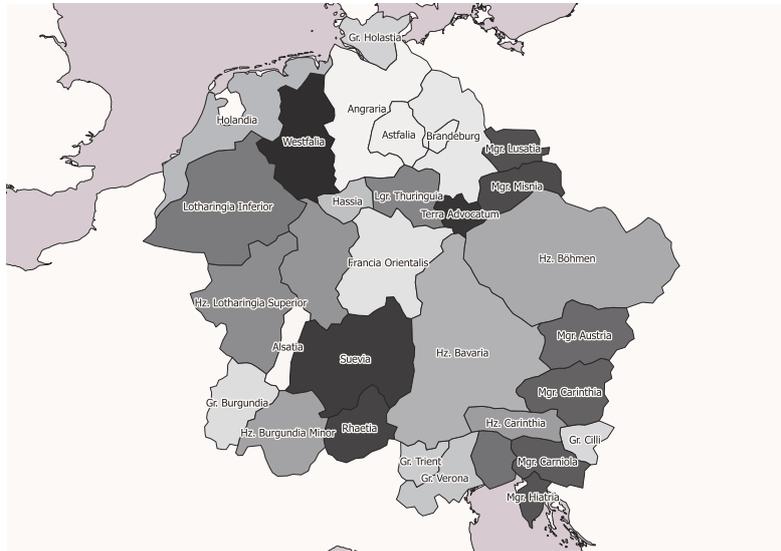
Note: Digitized from Wolff (1877)

Figure A.11: *Regions of the HRE in 1150*

Hohenheim Discussion Papers in Business, Economics and Social Sciences

The Faculty of Business, Economics and Social Sciences continues since 2015 the established "FZID Discussion Paper Series" of the "Centre for Research on Innovation and Services (FZID)" under the name "Hohenheim Discussion Papers in Business, Economics and Social Sciences".

Institutes

510	Institute of Financial Management
520	Institute of Economics
530	Institute of Health Care & Public Management
540	Institute of Communication Science
550	Institute of Law and Social Sciences
560	Institute of Economic and Business Education
570	Institute of Marketing & Management
580	Institute of Interorganisational Management & Performance

Research Areas (since 2017)

INEPA	"Inequality and Economic Policy Analysis"
TKID	"Transformation der Kommunikation – Integration und Desintegration"
NegoTrans	"Negotiation Research – Transformation, Technology, Media and Costs"
INEF	"Innovation, Entrepreneurship and Finance"

Download Hohenheim Discussion Papers in Business, Economics and Social Sciences
from our homepage: https://wiso.uni-hohenheim.de/papers

No.	Author	Title	Inst
01-2015	Thomas Beissinger, Philipp Baudy	THE IMPACT OF TEMPORARY AGENCY WORK ON TRADE UNION WAGE SETTING: A Theoretical Analysis	520
02-2015	Fabian Wahl	PARTICIPATIVE POLITICAL INSTITUTIONS AND CITY DEVELOPMENT 800-1800	520
03-2015	Tommaso Proietti, Martyna Marczak, Gianluigi Mazzi	EuroMind-D: A DENSITY ESTIMATE OF MONTHLY GROSS DOMESTIC PRODUCT FOR THE EURO AREA	520
04-2015	Thomas Beissinger, Nathalie Chusseau, Joël Hellier	OFFSHORING AND LABOUR MARKET REFORMS: MODELLING THE GERMAN EXPERIENCE	520
05-2015	Matthias Mueller, Kristina Bogner, Tobias Buchmann, Muhamed Kudic	SIMULATING KNOWLEDGE DIFFUSION IN FOUR STRUCTURALLY DISTINCT NETWORKS – AN AGENT-BASED SIMULATION MODEL	520
06-2015	Martyna Marczak, Thomas Beissinger	BIDIRECTIONAL RELATIONSHIP BETWEEN INVESTOR SENTIMENT AND EXCESS RETURNS: NEW EVIDENCE FROM THE WAVELET PERSPECTIVE	520
07-2015	Peng Nie, Galit Nimrod, Alfonso Sousa-Poza	INTERNET USE AND SUBJECTIVE WELL-BEING IN CHINA	530

No.	Author	Title	Inst
08-2015	Fabian Wahl	THE LONG SHADOW OF HISTORY ROMAN LEGACY AND ECONOMIC DEVELOPMENT – EVIDENCE FROM THE GERMAN LIMES	520
09-2015	Peng Nie, Alfonso Sousa-Poza	COMMUTE TIME AND SUBJECTIVE WELL-BEING IN URBAN CHINA	530
10-2015	Kristina Bogner	THE EFFECT OF PROJECT FUNDING ON INNOVATIVE PERFORMANCE AN AGENT-BASED SIMULATION MODEL	520
11-2015	Bogang Jun, Tai-Yoo Kim	A NEO-SCHUMPETERIAN PERSPECTIVE ON THE ANALYTICAL MACROECONOMIC FRAMEWORK: THE EXPANDED REPRODUCTION SYSTEM	520
12-2015	Volker Grossmann Aderonke Osikominu Marius Osterfeld	ARE SOCIOCULTURAL FACTORS IMPORTANT FOR STUDYING A SCIENCE UNIVERSITY MAJOR?	520
13-2015	Martyna Marczak Tommaso Proietti Stefano Grassi	A DATA–CLEANING AUGMENTED KALMAN FILTER FOR ROBUST ESTIMATION OF STATE SPACE MODELS	520
14-2015	Carolina Castagnetti Luisa Rosti Marina Töpfer	THE REVERSAL OF THE GENDER PAY GAP AMONG PUBLIC-CONTEST SELECTED YOUNG EMPLOYEES	520
15-2015	Alexander Opitz	DEMOCRATIC PROSPECTS IN IMPERIAL RUSSIA: THE REVOLUTION OF 1905 AND THE POLITICAL STOCK MARKET	520
01-2016	Michael Ahlheim, Jan Neidhardt	NON-TRADING BEHAVIOUR IN CHOICE EXPERIMENTS	520
02-2016	Bogang Jun, Alexander Gerybadze, Tai-Yoo Kim	THE LEGACY OF FRIEDRICH LIST: THE EXPANSIVE REPRODUCTION SYSTEM AND THE KOREAN HISTORY OF INDUSTRIALIZATION	520
03-2016	Peng Nie, Alfonso Sousa-Poza	FOOD INSECURITY AMONG OLDER EUROPEANS: EVIDENCE FROM THE SURVEY OF HEALTH, AGEING, AND RETIREMENT IN EUROPE	530
04-2016	Peter Spahn	POPULATION GROWTH, SAVING, INTEREST RATES AND STAGNATION. DISCUSSING THE EGGERTSSON-MEHROTRA-MODEL	520
05-2016	Vincent Dekker, Kristina Strohmaier, Nicole Bosch	A DATA-DRIVEN PROCEDURE TO DETERMINE THE BUNCHING WINDOW – AN APPLICATION TO THE NETHERLANDS	520
06-2016	Philipp Baudy, Dario Cords	DEREGULATION OF TEMPORARY AGENCY EMPLOYMENT IN A UNIONIZED ECONOMY: DOES THIS REALLY LEAD TO A SUBSTITUTION OF REGULAR EMPLOYMENT?	520

No.	Author	Title	Inst
07-2016	Robin Jessen, Davud Rostam-Afschar, Sebastian Schmitz	HOW IMPORTANT IS PRECAUTIONARY LABOR SUPPLY?	520
08-2016	Peng Nie, Alfonso Sousa-Poza, Jianhong Xue	FUEL FOR LIFE: DOMESTIC COOKING FUELS AND WOMEN'S HEALTH IN RURAL CHINA	530
09-2016	Bogang Jun, Seung Kyu-Yi, Tobias Buchmann, Matthias Müller	THE CO-EVOLUTION OF INNOVATION NETWORKS: COLLABORATION BETWEEN WEST AND EAST GERMANY FROM 1972 TO 2014	520
10-2016	Vladan Ivanovic, Vadim Kufenko, Boris Begovic Nenad Stanisic, Vincent Geloso	CONTINUITY UNDER A DIFFERENT NAME. THE OUTCOME OF PRIVATISATION IN SERBIA	520
11-2016	David E. Bloom Michael Kuhn Klaus Prettner	THE CONTRIBUTION OF FEMALE HEALTH TO ECONOMIC DEVELOPMENT	520
12-2016	Franz X. Hof Klaus Prettner	THE QUEST FOR STATUS AND R&D-BASED GROWTH	520
13-2016	Jung-In Yeon Andreas Pyka Tai-Yoo Kim	STRUCTURAL SHIFT AND INCREASING VARIETY IN KOREA, 1960–2010: EMPIRICAL EVIDENCE OF THE ECONOMIC DEVELOPMENT MODEL BY THE CREATION OF NEW SECTORS	520
14-2016	Benjamin Fuchs	THE EFFECT OF TEENAGE EMPLOYMENT ON CHARACTER SKILLS, EXPECTATIONS AND OCCUPATIONAL CHOICE STRATEGIES	520
15-2016	Seung-Kyu Yi Bogang Jun	HAS THE GERMAN REUNIFICATION STRENGTHENED GERMANY'S NATIONAL INNOVATION SYSTEM? TRIPLE HELIX DYNAMICS OF GERMANY'S INNOVATION SYSTEM	520
16-2016	Gregor Pfeifer Fabian Wahl Martyna Marczak	ILLUMINATING THE WORLD CUP EFFECT: NIGHT LIGHTS EVIDENCE FROM SOUTH AFRICA	520
17-2016	Malte Klein Andreas Sauer	CELEBRATING 30 YEARS OF INNOVATION SYSTEM RESEARCH: WHAT YOU NEED TO KNOW ABOUT INNOVATION SYSTEMS	570
18-2016	Klaus Prettner	THE IMPLICATIONS OF AUTOMATION FOR ECONOMIC GROWTH AND THE LABOR SHARE	520
19-2016	Klaus Prettner Andreas Schaefer	HIGHER EDUCATION AND THE FALL AND RISE OF INEQUALITY	520
20-2016	Vadim Kufenko Klaus Prettner	YOU CAN'T ALWAYS GET WHAT YOU WANT? ESTIMATOR CHOICE AND THE SPEED OF CONVERGENCE	520

No.	Author	Title	Inst
01-2017	Annarita Baldanzi Alberto Bucci Klaus Prettner	CHILDRENS HEALTH, HUMAN CAPITAL ACCUMULATION, AND R&D-BASED ECONOMIC GROWTH	INEPA
02-2017	Julius Tennert Marie Lambert Hans-Peter Burghof	MORAL HAZARD IN VC-FINANCE: MORE EXPENSIVE THAN YOU THOUGHT	INEF
03-2017	Michael Ahlheim Oliver Frör Nguyen Minh Duc Antonia Rehl Ute Siepmann Pham Van Dinh	LABOUR AS A UTILITY MEASURE RECONSIDERED	520
04-2017	Bohdan Kukharskyy Sebastian Seiffert	GUN VIOLENCE IN THE U.S.: CORRELATES AND CAUSES	520
05-2017	Ana Abeliansky Klaus Prettner	AUTOMATION AND DEMOGRAPHIC CHANGE	520
06-2017	Vincent Geloso Vadim Kufenko	INEQUALITY AND GUARD LABOR, OR PROHIBITION AND GUARD LABOR?	INEPA
07-2017	Emanuel Gasteiger Klaus Prettner	ON THE POSSIBILITY OF AUTOMATION-INDUCED STAGNATION	520
08-2017	Klaus Prettner Holger Strulik	THE LOST RACE AGAINST THE MACHINE: AUTOMATION, EDUCATION, AND INEQUALITY IN AN R&D-BASED GROWTH MODEL	INEPA
09-2017	David E. Bloom Simiao Chen Michael Kuhn Mark E. McGovern Les Oxley Klaus Prettner	THE ECONOMIC BURDEN OF CHRONIC DISEASES: ESTIMATES AND PROJECTIONS FOR CHINA, JAPAN, AND SOUTH KOREA	520
10-2017	Sebastian Till Braun Nadja Dwenger	THE LOCAL ENVIRONMENT SHAPES REFUGEE INTEGRATION: EVIDENCE FROM POST-WAR GERMANY	INEPA
11-2017	Vadim Kufenko Klaus Prettner Vincent Geloso	DIVERGENCE, CONVERGENCE, AND THE HISTORY-AUGMENTED SOLOW MODEL	INEPA
12-2017	Frank M. Fossen Ray Rees Davud Rostam-Afschar Viktor Steiner	HOW DO ENTREPRENEURIAL PORTFOLIOS RESPOND TO INCOME TAXATION?	520
13-2017	Steffen Otterbach Michael Rogan	SPATIAL DIFFERENCES IN STUNTING AND HOUSEHOLD AGRICULTURAL PRODUCTION IN SOUTH AFRICA: (RE-) EXAMINING THE LINKS USING NATIONAL PANEL SURVEY DATA	INEPA
14-2017	Carolina Castagnetti Luisa Rosti Marina Töpfer	THE CONVERGENCE OF THE GENDER PAY GAP – AN ALTERNATIVE ESTIMATION APPROACH	INEPA

No.	Author	Title	Inst
15-2017	Andreas Hecht	ON THE DETERMINANTS OF SPECULATION – A CASE FOR EXTENDED DISCLOSURES IN CORPORATE RISK MANAGEMENT	510
16-2017	Mareike Schoop D. Marc Kilgour (Editors)	PROCEEDINGS OF THE 17TH INTERNATIONAL CONFERENCE ON GROUP DECISION AND NEGOTIATION	NegoTrans
17-2017	Mareike Schoop D. Marc Kilgour (Editors)	DOCTORAL CONSORTIUM OF THE 17TH INTERNATIONAL CONFERENCE ON GROUP DECISION AND NEGOTIATION	NegoTrans
18-2017	Sibylle Lehmann-Hasemeyer Fabian Wahl	SAVING BANKS AND THE INDUSTRIAL REVOLUTION IN PRUSSIA SUPPORTING REGIONAL DEVELOPMENT WITH PUBLIC FINANCIAL INSTITUTIONS	520
19-2017	Stephanie Glaser	A REVIEW OF SPATIAL ECONOMETRIC MODELS FOR COUNT DATA	520
20-2017	Dario Cords	ENDOGENOUS TECHNOLOGY, MATCHING, AND LABOUR UNIONS: DOES LOW-SKILLED IMMIGRATION AFFECT THE TECHNOLOGICAL ALIGNMENT OF THE HOST COUNTRY?	INEPA
21-2017	Micha Kaiser Jan M. Bauer	PRESCHOOL CHILD CARE AND CHILD WELL-BEING IN GERMANY: DOES THE MIGRANT EXPERIENCE DIFFER?	INEPA
22-2017	Thilo R. Huning Fabian Wahl	LORD OF THE LEMONS: ORIGIN AND DYNAMICS OF STATE CAPACITY	520

FZID Discussion Papers

(published 2009-2014)

Competence Centers

IK	Innovation and Knowledge
ICT	Information Systems and Communication Systems
CRFM	Corporate Finance and Risk Management
HCM	Health Care Management
CM	Communication Management
MM	Marketing Management
ECO	Economics

Download FZID Discussion Papers from our homepage: https://wiso.uni-hohenheim.de/archiv_fzid_papers

Nr.	Autor	Titel	CC
01-2009	Julian P. Christ	NEW ECONOMIC GEOGRAPHY RELOADED: Localized Knowledge Spillovers and the Geography of Innovation	IK
02-2009	André P. Slowak	MARKET FIELD STRUCTURE & DYNAMICS IN INDUSTRIAL AUTOMATION	IK
03-2009	Pier Paolo Saviotti, Andreas Pyka	GENERALIZED BARRIERS TO ENTRY AND ECONOMIC DEVELOPMENT	IK
04-2009	Uwe Focht, Andreas Richter and Jörg Schiller	INTERMEDIATION AND MATCHING IN INSURANCE MARKETS	HCM
05-2009	Julian P. Christ, André P. Slowak	WHY BLU-RAY VS. HD-DVD IS NOT VHS VS. BETAMAX: THE CO-EVOLUTION OF STANDARD-SETTING CONSORTIA	IK
06-2009	Gabriel Felbermayr, Mario Larch and Wolfgang Lechthaler	UNEMPLOYMENT IN AN INTERDEPENDENT WORLD	ECO
07-2009	Steffen Otterbach	MISMATCHES BETWEEN ACTUAL AND PREFERRED WORK TIME: Empirical Evidence of Hours Constraints in 21 Countries	HCM
08-2009	Sven Wydra	PRODUCTION AND EMPLOYMENT IMPACTS OF NEW TECHNOLOGIES – ANALYSIS FOR BIOTECHNOLOGY	IK
09-2009	Ralf Richter, Jochen Streb	CATCHING-UP AND FALLING BEHIND KNOWLEDGE SPILLOVER FROM AMERICAN TO GERMAN MACHINE TOOL MAKERS	IK

Nr.	Autor	Titel	CC
10-2010	Rahel Aichele, Gabriel Felbermayr	KYOTO AND THE CARBON CONTENT OF TRADE	ECO
11-2010	David E. Bloom, Alfonso Sousa-Poza	ECONOMIC CONSEQUENCES OF LOW FERTILITY IN EUROPE	HCM
12-2010	Michael Ahlheim, Oliver Frör	DRINKING AND PROTECTING – A MARKET APPROACH TO THE PRESERVATION OF CORK OAK LANDSCAPES	ECO
13-2010	Michael Ahlheim, Oliver Frör, Antonia Heinke, Nguyen Minh Duc, and Pham Van Dinh	LABOUR AS A UTILITY MEASURE IN CONTINGENT VALUATION STUDIES – HOW GOOD IS IT REALLY?	ECO
14-2010	Julian P. Christ	THE GEOGRAPHY AND CO-LOCATION OF EUROPEAN TECHNOLOGY-SPECIFIC CO-INVENTORSHIP NETWORKS	IK
15-2010	Harald Degner	WINDOWS OF TECHNOLOGICAL OPPORTUNITY DO TECHNOLOGICAL BOOMS INFLUENCE THE RELATIONSHIP BETWEEN FIRM SIZE AND INNOVATIVENESS?	IK
16-2010	Tobias A. Jopp	THE WELFARE STATE EVOLVES: GERMAN KNAPPSCHAFTEN, 1854-1923	HCM
17-2010	Stefan Kirn (Ed.)	PROCESS OF CHANGE IN ORGANISATIONS THROUGH eHEALTH	ICT
18-2010	Jörg Schiller	ÖKONOMISCHE ASPEKTE DER ENTLOHNUNG UND REGULIERUNG UNABHÄNGIGER VERSICHERUNGSVERMITTLER	HCM
19-2010	Frauke Lammers, Jörg Schiller	CONTRACT DESIGN AND INSURANCE FRAUD: AN EXPERIMENTAL INVESTIGATION	HCM
20-2010	Martyna Marczak, Thomas Beissinger	REAL WAGES AND THE BUSINESS CYCLE IN GERMANY	ECO
21-2010	Harald Degner, Jochen Streb	FOREIGN PATENTING IN GERMANY, 1877-1932	IK
22-2010	Heiko Stüber, Thomas Beissinger	DOES DOWNWARD NOMINAL WAGE RIGIDITY DAMPEN WAGE INCREASES?	ECO
23-2010	Mark Spoerer, Jochen Streb	GUNS AND BUTTER – BUT NO MARGARINE: THE IMPACT OF NAZI ECONOMIC POLICIES ON GERMAN FOOD CONSUMPTION, 1933-38	ECO

Nr.	Autor	Titel	CC
24-2011	Dhammika Dharmapala, Nadine Riedel	EARNINGS SHOCKS AND TAX-MOTIVATED INCOME-SHIFTING: EVIDENCE FROM EUROPEAN MULTINATIONALS	ECO
25-2011	Michael Schuele, Stefan Kirn	QUALITATIVES, RÄUMLICHES SCHLIEßEN ZUR KOLLISIONSERKENNUNG UND KOLLISIONSVERMEIDUNG AUTONOMER BDI-AGENTEN	ICT
26-2011	Marcus Müller, Guillaume Stern, Ansger Jacob and Stefan Kirn	VERHALTENSMODELLE FÜR SOFTWAREAGENTEN IM PUBLIC GOODS GAME	ICT
27-2011	Monnet Benoit, Patrick Gbakoua and Alfonso Sousa-Poza	ENGEL CURVES, SPATIAL VARIATION IN PRICES AND DEMAND FOR COMMODITIES IN CÔTE D'IVOIRE	ECO
28-2011	Nadine Riedel, Hannah Schildberg-Hörisch	ASYMMETRIC OBLIGATIONS	ECO
29-2011	Nicole Waidlein	CAUSES OF PERSISTENT PRODUCTIVITY DIFFERENCES IN THE WEST GERMAN STATES IN THE PERIOD FROM 1950 TO 1990	IK
30-2011	Dominik Hartmann, Atilio Arata	MEASURING SOCIAL CAPITAL AND INNOVATION IN POOR AGRICULTURAL COMMUNITIES. THE CASE OF CHÁPARRA - PERU	IK
31-2011	Peter Spahn	DIE WÄHRUNGSKRISENUNION DIE EURO-VERSCHULDUNG DER NATIONALSTAATEN ALS SCHWACHSTELLE DER EWU	ECO
32-2011	Fabian Wahl	DIE ENTWICKLUNG DES LEBENSSTANDARDS IM DRITTEN REICH – EINE GLÜCKSÖKONOMISCHE PERSPEKTIVE	ECO
33-2011	Giorgio Triulzi, Ramon Scholz and Andreas Pyka	R&D AND KNOWLEDGE DYNAMICS IN UNIVERSITY-INDUSTRY RELATIONSHIPS IN BIOTECH AND PHARMACEUTICALS: AN AGENT-BASED MODEL	IK
34-2011	Claus D. Müller-Hengstenberg, Stefan Kirn	ANWENDUNG DES ÖFFENTLICHEN VERGABERECHTS AUF MODERNE IT SOFTWAREENTWICKLUNGSVERFAHREN	ICT
35-2011	Andreas Pyka	AVOIDING EVOLUTIONARY INEFFICIENCIES IN INNOVATION NETWORKS	IK
36-2011	David Bell, Steffen Otterbach and Alfonso Sousa-Poza	WORK HOURS CONSTRAINTS AND HEALTH	HCM
37-2011	Lukas Scheffknecht, Felix Geiger	A BEHAVIORAL MACROECONOMIC MODEL WITH ENDOGENOUS BOOM-BUST CYCLES AND LEVERAGE DYNAMICS	ECO
38-2011	Yin Krogmann, Ulrich Schwalbe	INTER-FIRM R&D NETWORKS IN THE GLOBAL PHARMACEUTICAL BIOTECHNOLOGY INDUSTRY DURING 1985–1998: A CONCEPTUAL AND EMPIRICAL ANALYSIS	IK

Nr.	Autor	Titel	CC
39-2011	Michael Ahlheim, Tobias Börger and Oliver Frör	RESPONDENT INCENTIVES IN CONTINGENT VALUATION: THE ROLE OF RECIPROCITY	ECO
40-2011	Tobias Börger	A DIRECT TEST OF SOCIALLY DESIRABLE RESPONDING IN CONTINGENT VALUATION INTERVIEWS	ECO
41-2011	Ralf Rukwid, Julian P. Christ	QUANTITATIVE CLUSTERIDENTIFIKATION AUF EBENE DER DEUTSCHEN STADT- UND LANDKREISE (1999-2008)	IK

Nr.	Autor	Titel	CC
42-2012	Benjamin Schön, Andreas Pyka	A TAXONOMY OF INNOVATION NETWORKS	IK
43-2012	Dirk Foremny, Nadine Riedel	BUSINESS TAXES AND THE ELECTORAL CYCLE	ECO
44-2012	Gisela Di Meglio, Andreas Pyka and Luis Rubalcaba	VARIETIES OF SERVICE ECONOMIES IN EUROPE	IK
45-2012	Ralf Rukwid, Julian P. Christ	INNOVATIONSPOTENTIALE IN BADEN-WÜRTTEMBERG: PRODUKTIONSCLUSTER IM BEREICH „METALL, ELEKTRO, IKT" UND REGIONALE VERFÜGBARKEIT AKADEMISCHER FACHKRÄFTE IN DEN MINT-FÄCHERN	IK
46-2012	Julian P. Christ, Ralf Rukwid	INNOVATIONSPOTENTIALE IN BADEN-WÜRTTEMBERG: BRANCHENSPEZIFISCHE FORSCHUNGS- UND ENTWICKLUNGSAKTIVITÄT, REGIONALES PATENTAUFKOMMEN UND BESCHÄFTIGUNGSSTRUKTUR	IK
47-2012	Oliver Sauter	ASSESSING UNCERTAINTY IN EUROPE AND THE US - IS THERE A COMMON FACTOR?	ECO
48-2012	Dominik Hartmann	SEN MEETS SCHUMPETER. INTRODUCING STRUCTURAL AND DYNAMIC ELEMENTS INTO THE HUMAN CAPABILITY APPROACH	IK
49-2012	Harold Paredes-Frigolett, Andreas Pyka	DISTAL EMBEDDING AS A TECHNOLOGY INNOVATION NETWORK FORMATION STRATEGY	IK
50-2012	Martyna Marczak, Víctor Gómez	CYCLICALITY OF REAL WAGES IN THE USA AND GERMANY: NEW INSIGHTS FROM WAVELET ANALYSIS	ECO
51-2012	André P. Slowak	DIE DURCHSETZUNG VON SCHNITTSTELLEN IN DER STANDARDSETZUNG: FALLBEISPIEL LADESYSTEM ELEKTROMOBILITÄT	IK
52-2012	Fabian Wahl	WHY IT MATTERS WHAT PEOPLE THINK - BELIEFS, LEGAL ORIGINS AND THE DEEP ROOTS OF TRUST	ECO
53-2012	Dominik Hartmann, Micha Kaiser	STATISTISCHER ÜBERBLICK DER TÜRKISCHEN MIGRATION IN BADEN-WÜRTTEMBERG UND DEUTSCHLAND	IK
54-2012	Dominik Hartmann, Andreas Pyka, Seda Aydin, Lena Klauß, Fabian Stahl, Ali Santircioglu, Silvia Oberegelsbacher, Sheida Rashidi, Gaye Onan and Suna Erginkoç	IDENTIFIZIERUNG UND ANALYSE DEUTSCH-TÜRKISCHER INNOVATIONSNETZWERKE. ERSTE ERGEBNISSE DES TGIN-PROJEKTES	IK
55-2012	Michael Ahlheim, Tobias Börger and Oliver Frör	THE ECOLOGICAL PRICE OF GETTING RICH IN A GREEN DESERT: A CONTINGENT VALUATION STUDY IN RURAL SOUTHWEST CHINA	ECO

Nr.	Autor	Titel	CC
56-2012	Matthias Strifler Thomas Beissinger	FAIRNESS CONSIDERATIONS IN LABOR UNION WAGE SETTING – A THEORETICAL ANALYSIS	ECO
57-2012	Peter Spahn	INTEGRATION DURCH WÄHRUNGSUNION? DER FALL DER EURO-ZONE	ECO
58-2012	Sibylle H. Lehmann	TAKING FIRMS TO THE STOCK MARKET: IPOS AND THE IMPORTANCE OF LARGE BANKS IN IMPERIAL GERMANY 1896-1913	ECO
59-2012	Sibylle H. Lehmann, Philipp Hauber and Alexander Opitz	POLITICAL RIGHTS, TAXATION, AND FIRM VALUATION – EVIDENCE FROM SAXONY AROUND 1900	ECO
60-2012	Martyna Marczak, Víctor Gómez	SPECTRAN, A SET OF MATLAB PROGRAMS FOR SPECTRAL ANALYSIS	ECO
61-2012	Theresa Lohse, Nadine Riedel	THE IMPACT OF TRANSFER PRICING REGULATIONS ON PROFIT SHIFTING WITHIN EUROPEAN MULTINATIONALS	ECO

Nr.	Autor	Titel	CC
62-2013	Heiko Stüber	REAL WAGE CYCLICALITY OF NEWLY HIRED WORKERS	ECO
63-2013	David E. Bloom, Alfonso Sousa-Poza	AGEING AND PRODUCTIVITY	HCM
64-2013	Martyna Marczak, Víctor Gómez	MONTHLY US BUSINESS CYCLE INDICATORS: A NEW MULTIVARIATE APPROACH BASED ON A BAND-PASS FILTER	ECO
65-2013	Dominik Hartmann, Andreas Pyka	INNOVATION, ECONOMIC DIVERSIFICATION AND HUMAN DEVELOPMENT	IK
66-2013	Christof Ernst, Katharina Richter and Nadine Riedel	CORPORATE TAXATION AND THE QUALITY OF RESEARCH AND DEVELOPMENT	ECO
67-2013	Michael Ahlheim, Oliver Frör, Jiang Tong, Luo Jing and Sonna Pelz	NONUSE VALUES OF CLIMATE POLICY - AN EMPIRICAL STUDY IN XINJIANG AND BEIJING	ECO
68-2013	Michael Ahlheim, Friedrich Schneider	CONSIDERING HOUSEHOLD SIZE IN CONTINGENT VALUATION STUDIES	ECO
69-2013	Fabio Bertoni, Tereza Tykvová	WHICH FORM OF VENTURE CAPITAL IS MOST SUPPORTIVE OF INNOVATION? EVIDENCE FROM EUROPEAN BIOTECHNOLOGY COMPANIES	CFRM
70-2013	Tobias Buchmann, Andreas Pyka	THE EVOLUTION OF INNOVATION NETWORKS: THE CASE OF A GERMAN AUTOMOTIVE NETWORK	IK
71-2013	B. Vermeulen, A. Pyka, J. A. La Poutré and A. G. de Kok	CAPABILITY-BASED GOVERNANCE PATTERNS OVER THE PRODUCT LIFE-CYCLE	IK
72-2013	Beatriz Fabiola López Ulloa, Valerie Møller and Alfonso Sousa-Poza	HOW DOES SUBJECTIVE WELL-BEING EVOLVE WITH AGE? A LITERATURE REVIEW	HCM
73-2013	Wencke Gwozdz, Alfonso Sousa-Poza, Lucia A. Reisch, Wolfgang Ahrens, Stefaan De Henauw, Gabriele Eiben, Juan M. Fernández-Alvira, Charalampos Hadjigeorgiou, Eva Kovács, Fabio Lauria, Toomas Veidebaum, Garrath Williams, Karin Bammann	MATERNAL EMPLOYMENT AND CHILDHOOD OBESITY – A EUROPEAN PERSPECTIVE	HCM

Nr.	Autor	Titel	CC
74-2013	Andreas Haas, Annette Hofmann	RISIKEN AUS CLOUD-COMPUTING-SERVICES: FRAGEN DES RISIKOMANAGEMENTS UND ASPEKTE DER VERSICHERBARKEIT	HCM
75-2013	Yin Krogmann, Nadine Riedel and Ulrich Schwalbe	INTER-FIRM R&D NETWORKS IN PHARMACEUTICAL BIOTECHNOLOGY: WHAT DETERMINES FIRM'S CENTRALITY-BASED PARTNERING CAPABILITY?	ECO, IK
76-2013	Peter Spahn	MACROECONOMIC STABILISATION AND BANK LENDING: A SIMPLE WORKHORSE MODEL	ECO
77-2013	Sheida Rashidi, Andreas Pyka	MIGRATION AND INNOVATION – A SURVEY	IK
78-2013	Benjamin Schön, Andreas Pyka	THE SUCCESS FACTORS OF TECHNOLOGY-SOURCING THROUGH MERGERS & ACQUISITIONS – AN INTUITIVE META-ANALYSIS	IK
79-2013	Irene Prostolupow, Andreas Pyka and Barbara Heller-Schuh	TURKISH-GERMAN INNOVATION NETWORKS IN THE EUROPEAN RESEARCH LANDSCAPE	IK
80-2013	Eva Schlenker, Kai D. Schmid	CAPITAL INCOME SHARES AND INCOME INEQUALITY IN THE EUROPEAN UNION	ECO
81-2013	Michael Ahlheim, Tobias Börger and Oliver Frör	THE INFLUENCE OF ETHNICITY AND CULTURE ON THE VALUATION OF ENVIRONMENTAL IMPROVEMENTS – RESULTS FROM A CVM STUDY IN SOUTHWEST CHINA –	ECO
82-2013	Fabian Wahl	DOES MEDIEVAL TRADE STILL MATTER? HISTORICAL TRADE CENTERS, AGGLOMERATION AND CONTEMPORARY ECONOMIC DEVELOPMENT	ECO
83-2013	Peter Spahn	SUBPRIME AND EURO CRISIS: SHOULD WE BLAME THE ECONOMISTS?	ECO
84-2013	Daniel Guffarth, Michael J. Barber	THE EUROPEAN AEROSPACE R&D COLLABORATION NETWORK	IK
85-2013	Athanasios Saitis	KARTELLBEKÄMPFUNG UND INTERNE KARTELLSTRUKTUREN: EIN NETZWERKTHEORETISCHER ANSATZ	IK

Nr.	Autor	Titel	CC
86-2014	Stefan Kirn, Claus D. Müller-Hengstenberg	INTELLIGENTE (SOFTWARE-)AGENTEN: EINE NEUE HERAUSFORDERUNG FÜR DIE GESELLSCHAFT UND UNSER RECHTSSYSTEM?	ICT
87-2014	Peng Nie, Alfonso Sousa-Poza	MATERNAL EMPLOYMENT AND CHILDHOOD OBESITY IN CHINA: EVIDENCE FROM THE CHINA HEALTH AND NUTRITION SURVEY	HCM
88-2014	Steffen Otterbach, Alfonso Sousa-Poza	JOB INSECURITY, EMPLOYABILITY, AND HEALTH: AN ANALYSIS FOR GERMANY ACROSS GENERATIONS	HCM
89-2014	Carsten Burhop, Sibylle H. Lehmann-Hasemeyer	THE GEOGRAPHY OF STOCK EXCHANGES IN IMPERIAL GERMANY	ECO
90-2014	Martyna Marczak, Tommaso Proietti	OUTLIER DETECTION IN STRUCTURAL TIME SERIES MODELS: THE INDICATOR SATURATION APPROACH	ECO
91-2014	Sophie Urmetzer, Andreas Pyka	VARIETIES OF KNOWLEDGE-BASED BIOECONOMIES	IK
92-2014	Bogang Jun, Joongho Lee	THE TRADEOFF BETWEEN FERTILITY AND EDUCATION: EVIDENCE FROM THE KOREAN DEVELOPMENT PATH	IK
93-2014	Bogang Jun, Tai-Yoo Kim	NON-FINANCIAL HURDLES FOR HUMAN CAPITAL ACCUMULATION: LANDOWNERSHIP IN KOREA UNDER JAPANESE RULE	IK
94-2014	Michael Ahlheim, Oliver Frör, Gerhard Langenberger and Sonna Pelz	CHINESE URBANITES AND THE PRESERVATION OF RARE SPECIES IN REMOTE PARTS OF THE COUNTRY – THE EXAMPLE OF EAGLEWOOD	ECO
95-2014	Harold Paredes-Frigolett, Andreas Pyka, Javier Pereira and Luiz Flávio Autran Monteiro Gomes	RANKING THE PERFORMANCE OF NATIONAL INNOVATION SYSTEMS IN THE IBERIAN PENINSULA AND LATIN AMERICA FROM A NEO-SCHUMPETERIAN ECONOMICS PERSPECTIVE	IK
96-2014	Daniel Guffarth, Michael J. Barber	NETWORK EVOLUTION, SUCCESS, AND REGIONAL DEVELOPMENT IN THE EUROPEAN AEROSPACE INDUSTRY	IK