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You reap what you know: Appropriability and the origin of European states[☆]

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ABSTRACT

Geography provides some states with a higher level of soil quality than others, and in addition has allowed some historical states to appropriate agricultural output at lower costs. To test this empirically, we propose a new measure of appropriability: caloric observability. The idea behind this measure is that geography induces variation between states because their signals about agricultural output differ in precision. Caloric observability is robustly and significantly correlated with proxies of government success on three levels: Data on all European states 1300–1700, our new data set on the Holy Roman Empire 1150–1789, and a municipality-level data set of 1545 Duchy of Württemberg.

> *"Nobody is qualified to become a statesman who is entirely ignorant of the problem of wheat".*
>
> [Socrates (470 BC–399 BC)]

Why have some historical states prospered, while others failed? Different parts of the literature have sought the answer to this question in understanding the origins of statehood itself, as far back as the Neolithic Revolution (see Galor, 2022, for example). Economists have studied technical, administrative, anthropological and cultural differences, and highlighted events ranging from Roman times, via the European Middle Ages, the military and commercial revolutions of the Early Modern Period, and the foundation of our modern nation states during the Industrial Revolutions for the role and nature of our modern states.[1] Above all, however,

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[1] See Scheidel (2019) for an discussion of the Roman inheritance. Gennaioli and Voth (2015) study state capacity in pre-modern Europe. The institutional developments in the medieval Holy Roman Empire is the subject of Cantoni (2012), Cantoni et al. (2019), Wahl (2015) and Johnson and Koyama (2019), to name a few.

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geography has been highlighted as a main divider between the have and the have-nots, in terms of economic development as well as for state capacity.[2] Geography has provided some areas with more fertile lands, made it easier for some to grow the right crops, presented them domesticable animals, gave nations easier access to new shores, and finally the energy that fueled the Industrial Revolution.[3] In this paper, we argue that the local heterogeneity of soil quality mattered for the establishment of states' ability to tax agricultural outcome. We draw on a large literature on appropriability and extend this literature by providing a new geographic index, *observability*, a measure of local soil heterogeneity, an aspect of geography that contributes to the appropriability of agricultural output. We then present empirical evidence that our index is related to outcomes of tax capacity in medieval Europe.

We build on two inspirational contributions that formulate the concept of appropriability: Mayshar et al. (2017) and Mayshar et al. (2022). The central theory in Mayshar et al. (2022) is that a main condition for the development of a state is that agricultural output can be appropriated. If it is hard for anyone to take away agricultural output from those who planted the seed, then there is no one who specializes in stealing (a 'bandit', Olson (1993)), nor protection, nor in administering the fair contribution to all these protective efforts. In the empirical part of this paper, the authors show that the decision on whether early farmers would have been more likely to grow roots (which are not appropriable) or cereals (highly appropriable) depends essentially on the geographic circumstances: Cereals would only be planted where they provide enough calories to compensate for the expected loss through appropriation; states only emerged in areas were geography made cereals pay off. Mayshar et al. (2017) then provide us with a slightly different focus on this concept, and present information costs as an important aspect of states' ability to tax efficiently, and explain how geography is the main cause of these information costs. The authors argue that early governments with better knowledge about their means of income established stronger and more centralized states because the process through which this income was generated was more transparent. They contrast ancient Egypt with ancient Babylon. Egypt, so they argue, gained its income from a highly transparent process, the annual Nile flooding. This flooding could be precisely measured with a simple tool that predicted the harvest well enough to have served the Egyptian government as a base for the tax assessment. Egypt in consequence became a strong and centralized state. In contrast, Babylon's agriculture depended on private irrigation, which was rather intransparent. To the Babylonian government, it was intractable how much water any farmer received, and the tax base depended on more guess work. In consequence, Babylon became a more decentralized state with strong rivalling elites, and a weaker state than Egypt.

This paper extends this literature by introducing our measure of information costs, observability, and providing first tests that show correlations with outcomes of the capacity of medieval European states to collect taxes. The idea of the measure is quite simple. If the quality of the soil in a country is completely uniform, information costs are, ceteris paribus, smaller than if it was completely randomly distributed. This is the case because rulers, or their administrators, cannot move from one farm to another and assume the tax base of the first was the same as the latter. As such, the degree to which between-neighbors variation matters for early states' ability to tax an agricultural society. The concept of between-neighbors variation is ubiquitous in papers that rely on geographic variation since Nunn and Puga (2012): Ruggedness. Ruggedness is calculated by comparing the elevation of neighboring data points in raster data with each other. The main advantages of this measure are that it is quick to understand, easily generated with standard GIS software for any data set for which soil quality data is available, and is intuitively connected to information costs in a society in which little was known about the predictors of agricultural outputs. This general observability measure can be calculated from any soil quality data or measure of agricultural output. In this paper however we rely on the caloric suitability data by Galor and Özak (2014, 2015), and will use the term caloric observability whenever we refer to these specific observability data.[4]

We introduce three different data sets on fiscal and administrative capacity of European states of increasingly smaller geographic regions. We first focus on Europe and extend the established data set on European states by Nüssli (2008). Second, we create a novel data set for this paper, which provides us with the most detailed geographic information on the states of the Holy Roman Empire. This historic area is ideal to test that soil heterogeneity helped governments *ceteris paribus*: It spans over several modern-day countries, providing plenty of variation in soil heterogeneity. It also consisted of hundreds of different states which differed along several dimensions; there were secular and ecclesiastical ones, territorial ones based on an agricultural economy, but also small city states engaging in trade and proto-industrial activities. Here we also draw on a large literature with a multitude of plausibly important control variables. Third, our idea about the relationship between soil heterogeneity and fiscal capacity applies across states and within states. We therefore end with a case study of the municipalities in the early-modern Duchy of Württemberg. This has the additional advantage that a lot of potentially important confounding factors in relation to state capacity can be considered constant within such a territory. Fig. 1 shows the borders of the Holy Roman Empire in 1400 and of the contemporary German federal state of Baden-Württemberg which includes the area of the historical Duchy of Württemberg.

The remainder of the paper is structured as follows. Section 1 is a review of the literature on appropriability. Here, we define a framework in which we explain how (caloric) observability relates to other aspects that have been discussed as determinants of the appropriability of agricultural output. In Section 2, we then explain how this concept of appropriability and our observability index can be applied to the concept of Medieval Europe, especially the Holy Roman Empire.

In Section 4, we present partial correlations between different measures of fiscal and administrative capacity, and caloric observability. For the European data set, our outcome variable is the most abstract measure of government success, the geographic

[2] The landmark paper on the state capacity in economic history is Karaman and Pamuk (2013). We rely on their agnostic concept of state capacity as the share of a state's national income that is collected in tax. Recent empirical papers into state in the spirit of Diamond (1999), that study the origin of our modern states are Ang (2015), Ko et al. (2019), Abramson (2017), Schönholzer (2017) and Mayshar et al. (2022).

[3] Central references here are Acemoglu and Robinson (2001), Alesina et al. (2013), Nunn and Qian (2011), Acemoglu et al. (2005) and Allen (2009). See Rodrik (2003) for a conceptual framework.

[4] A discussion of these data is provided in our data section.

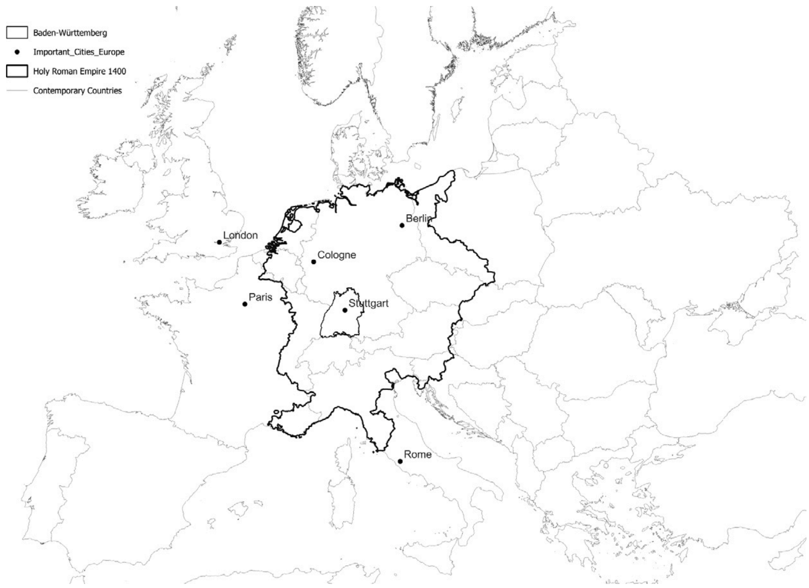


Fig. 1. Borders of Contemporary European Countries, the Holy Roman Empire and Baden-Württemberg. *Note: The borders of the HRE in 1400 originate form Nüssli (2008), borders of contemporary countries are from the Eurostat GISCO database, and the borders of Baden-Württemberg come from Federal Agency of Cartography and Geodesy*.

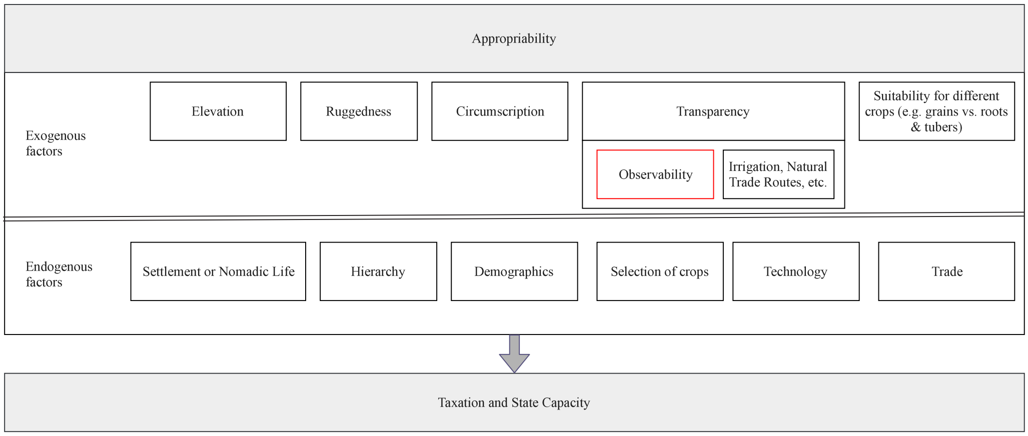


Fig. 2. Aspects of appropriability and its influence on taxation and state capacity.

size of the state. For the Holy Roman Empire, we have data on the number of administrative buildings in cities. This acts as a proxy for administrative capacity and local presence of the state. The latter aspect is also connected to the degree of control the state could exert over a particular region. We also rely on the 1545 collection of the Imperial war tax (''Reichsmatrikel'') as collected by Zeumer (1913), as a more direct measure and established measure of fiscal capacity (Cantoni, 2012). For the Duchy of Württemberg in 1545 we collected actual wealth tax contributions on the municipality level, normalized per capita. All these cross-sectional regressions show a robust and significant link between caloric observability and our outcomes. This supports our notion that European governments have faced the problem of relative soil heterogeneity. We conclude the paper in Section 5.

1. Appropriability, transparency, and caloric observability

We contribute to a rapidly growing literature linking appropriability and fiscal capacity. Appropriability describes the degree to which a government can extract resources from its subjects. A low appropriability means that a government is restricted to extracting a small share of the revenues of its subject as taxes, tariffs, and other levies. The literature has explored many dimensions of appropriability, as can be seen from an overview diagram of this literature, Fig. 2. The diagram shows that appropriability is an abstract concept. Parts of it can be explored empirically using exogenous variation (especially geography). Appropriability however also consists of a complex endogenous component, notably since it can be self-reinforcing. On the one hand, a government can find itself in geographic circumstances that ease the appropriation from its subjects, and can use these revenues to fund good institutions (for example a highly trained bureaucracy). Because of this, appropriability feeds into the related concept of state capacity.[5]

Some parts of appropriability have been studied empirically. Mayshar et al. (2022) provide an empirical study in which they show that a high soil suitability for roots and tubers relative to the suitability for grains determines appropriation. Grain-growing villagers who are raided right after the harvest could be left with nothing; their attackers can simply carry away the content of the granary. Those who grow roots and tubers harvest only what they plan to consume on the next days, so they are in parts assured against complete loss. The relative suitability of roots and tubers vs. grains cannot explain European divergences. There is hardly any variation. A historical overview of other exogenous factors is provided by Scott (2009) and Scott (2017)—the latter can be called a human history of appropriation. From these studies, we learn that elevation and ruggedness are also important control variables, for example because subjects might be able to hide themselves or valuables in caves, or escape tax collectors by ascending to altitudes that cannot be passed on horseback (compare Nunn and Puga, 2012).

In this paper, we operationalize a part of what Mayshar et al. (2017) coined as 'transparency'. According to their paper, the most crucial difference between ancient Egypt and Mesopotamia is exogenous: The Nile. Their verbal argument talks a lot of the consequences of its flood, and how the Nile irrigated with a higher level of transparency that Mesopotamia. In Western Europe, our case study, irrigation is not a crucial problem, so that our concept of caloric observability is distinct from these other factors. An important control variable coming from Mayshar et al. (2017) however is that the city network, and hence also trade, might be shaped by the geographically induced possibility for trade. Since we will be looking at very small areas, we will also consider trade routes as an important control.

Fig. 2 shows the complex changes a society can undergo due to variation in appropriability. Scott (2017), concerned with earliest states, explains how the distribution of humans today, the grains they grow, and the location of ethnic minorities today can be explained by appropriability. Mayshar et al. (2017) argue that ancient states' city networks, degree of centralization, bureaucracy, political and social organization, are shaped by appropriability. To distinguish these endogenous factors of appropriability from other factors (unrelated to appropriability), we rely on two strategies. First, we provide an overview of historical literature to gain insights into which other factors this could be, and how we could potentially control for them, in the next section. Second, our three data sets allow us to move from a European data set (which pledges external validity but might be confounded by unobserved variation in factors that determine governments' fortunes which are unrelated to appropriability) to our small-scale municipality data set (where unobserved variation is expected to be lower). An empirical study which is close to ours is Ahmed and Stasavage (2020). Their study is also motivated by Mayshar et al. (2017), relies on the standard deviation of soil quality as a measure of transparency, and provides evidence for a link to modern representation in a global anthropological data set.

2. Appropriability in the European Middle Ages

The European governments of the Middle Ages found themselves in vastly different geographic circumstances. These provided them with different means to appropriate, and they also tried different ways to increase the share of their subjects' revenues they could collect from them. In his landmark book, Jones (1981) explains how "core regions offered the largest tax base" (Jones, 1981, p. 105), pointing at geography as a determinant for governments' success. Some regions were more remote from the trade routes that re-emerged after around 1000 AD (Wickham, 2016), and had to rely more on their own agricultural base for income than others. However, given the size of this agricultural sector, as put by Wickham (2016, p. 14), "The wealth of lords, whether royal, ecclesiastical, or aristocratic [...] came from what they could extract from the peasantry [...] by force, or by the threat of force". As such, our study focuses on the agricultural sector and controls for other possible sources of government revenue.

The most widespread agricultural institution in Europe was the manorial system (North and Thomas, 1973; Wickham, 2016). Manors were "never universal, but they represented a state-of-the-art management of an estate for profit" (Wickham, 2016, p. 126). The profit relies on a highly dynamic system of contributions, taxes, and labor services. The most important part of the tax base of territorial states came from agricultural goods of a grain based agriculture (also including livestock) and was paid in kind, primarily via the ubiquitous crops rye and oat (Mitterauer, 2010; Henning, 1994). If peasants failed to provide their in-kind taxes they had to provide corvée (a form of forced labor). Forced 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).[6] This highlights that the medieval tax system in Europe was not a static customs-based order, but a highly dynamic negotiation process between those who were taxed, and those who wished to collect taxes. Appropriability is at the center of this problem, and the success of medieval lords to convince their peasants to comply with their wish of ever increasing revenues was dependent on subjects' environmental circumstances.

Medieval governments aimed to overcome the problem of tax collection with hierarchy. Based on a chain of bilateral relationships – between peasants and tax collectors, between tax collectors and lower gentry, between lower gentry and higher lords, and between lords and the king or emperor – were the backbone of the feudal society (Bloch, 1961), "no institution or method could take the place of personal contact between human beings" (Bloch, 1961, p. 62). In this chain, the peasants knew most about their soil's actual abilities in a given year. The lower lords who they interacted with already knew much less. It was also prohibitively expensive to

[5] Karaman and Pamuk (2013) measure state capacity by dividing states' tax revenues by their estimated GDP figures.

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

increase this knowledge, given the basic state of understanding of agriculture at the time. In the early Middle Ages, as put by North and Thomas (1971) "the institution of serfdom gained efficiency and avoided the need for much enforcement and supervision, since in exchange for a fixed amount of labor services to the lord to perform the variety of activities involved in the self-sufficient manorial economy, the serf was granted the rest of the time to produce for himself" (p. 20). In order to circumvent the information costs, the lord appropriated only a small share of the peasants' labor potential, often only a couple of hours per week, but also did not have to – and in effect was not able to – institutionalize the collection of a larger share of the potential tax base. Lords gave up on solving the problem until the inflation of agricultural goods after the 13th century hit. This excluded lords from the benefits of surging land prices and serfs' rising wages, so that the costs of this resignation became more severe. To again quote (North and Thomas, 1971), "it was often less expensive for the lord to exercise his acknowledged right by returning the demesne to his own direct cultivation [...] despite the notorious shirking problems encountered with forced labor" (North and Thomas, 1971, p. 60). This exemplifies how—across Europe—feudal lords were struggling to appropriate income from their peasants, who could engage in the most passive resistance—shirking (Bloch, 1961, see also). Where they tried to overcome this with more bureaucracy, they also experienced a rise in rent-seeking. As such, the problem of appropriating from their peasants was shifted to trying to appropriate from their lower lords (North and Thomas, 1973).

To summarize, imagine tax collection in the Duchy of Württemberg in the 16th century—a case that we study later. In this Duchy (a typical feudal state of that time), the tax base consisted predominantly of real estate, farm buildings, and agricultural land, wood, stored crops, natural interest from all kinds of agricultural goods, livestock, and wine barrels. Our hypothesis is that the Duke's administration was unable to appropriate as much from municipalities with a heterogeneous and complicated geography than from areas with a plane and more observable agricultural base. This could be either because the lower lords shirked the Duke, because the lower lords themselves were tricked by their farmers, or a combination of both.

3. Data

3.1. Main explanatory variable: Caloric observability

Our measure of observability proxies the degree to which governments can infer the soil quality of a plot from the quality of the plots adjacent to it. This would allow officials to identify peasants (or subordinates in general) who lie about their actual (or potential) harvest, and their effort. If a government was able to find something close to an optimal tax rate of a single plot of land, an area with a high observability would mean that this government to scale up this increased understanding, and increase its taxation also for the surrounding fields. In an area of a large between-neighbor variation observability, knowledge gained from one plot cannot be transferred to others, which – if our theory is correct – limits the capacity of its government.

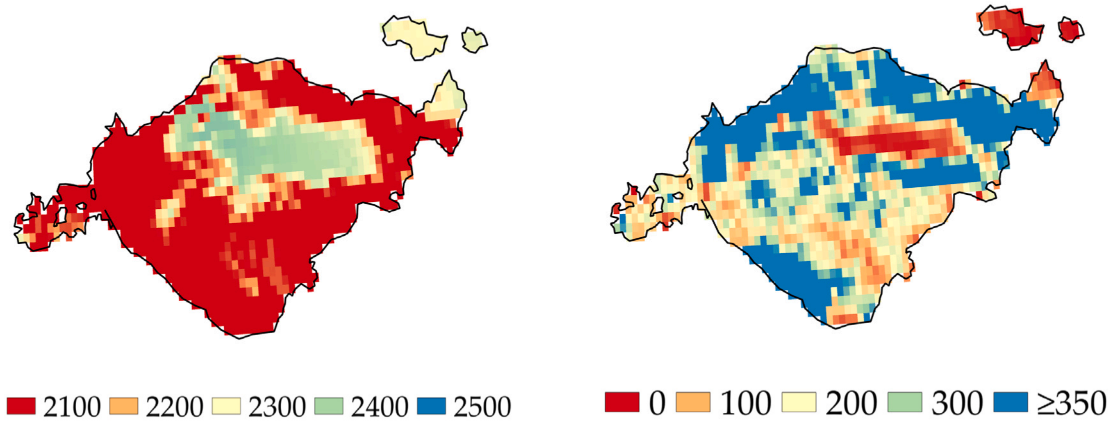
To construct our proxy for observability we employ GIS software tools. We first use raster data on soil suitability to calculate a new raster containing the variation in soil suitability between adjacent grid cells. In a last step aggregate the data from this second raster for any political unit of interest. As displayed in Fig. 3 (with the example of 1378 Bohemia), we can transform any soil suitability raster to a raster with its between-neighbor variation using the same process that converts a digital elevation model (DEM) to a ruggedness raster. The generation of the between-neighbor variation raster itself is independent of political borders, it is simply a transformation of a suitability raster. The observability of a grid cell at the border is calculated using grid cells on the other side of the border. There are two advantages of this process. First, a theoretical one. Our measure of observability is designed to capture local irregularities in the soil quality, for example a break in the composition of the soil, geological consequences of the Ice Age, or local weather conditions. Second, an econometric advantage arising from the fact that this is the same process through which ruggedness data is created. This is important if ruggedness is one of the controls. Panel (a) of Fig. 3 shows how the center of Bohemia has a higher soil quality, and Panel (b) shows that this varies little. As such, the government of Bohemia could expect a high agricultural productivity and in addition could also appropriate this product relatively well. In the Southern areas of Bohemia, the between-neighbor variation of the caloric suitability differs; if or hypothesis is true, in some regions (i.e. the Southwest) appropriation should have been easier than in the Northwest.

We rely on Galor and Özak (2014, 2015) as our suitability data. Since they provide caloric suitability (expressed in calories per hectare and year), we name the result caloric observability. This suitability data has important advantages. First, Galor and Özak (2014, 2015) provide data that is averaged for $10\,\text{km} \cdot 10\,\text{km}$ grid cells. This is large enough to believe that we are not measuring variation that affects the production capacity of agriculture itself. For example, if we had a measure of $1\,\text{m} \cdot 1\,\text{m}$ resolution, the resulting between-neighbor variation could also indicate that agriculture itself is less productive, already at small scale (because there would be a variation in a given field of rye, for example, and the farmers would have to plant a different fruit per small parcels of land to cater to the local conditions on each square meter). 10 km is roughly the distance an observer at a slightly elevated position can see until the horizon.[7] As such, members of the lower gentry observing the work of their peasants around their castle can, if this between-neighbor variation is low, transfer the information also to plots behind the horizon. This is exactly what designed this measure for.

To associate a single number to each territory, we average this between-neighbor variation per state.[8] Then, since between-neighbor variation is a higher number for less observable areas (and it is inconvenient to interpret a higher number as a lower

[7] See http://www.ringbell.co.uk/info/hdist.htm for a distance to the horizon calculator.

[8] Since the observability of any raster field depends on the suitability of the eight raster fields surrounding it, caloric observability of a state depends also on the suitability which lie directly adjacent, but outside of this state's borders. This captures the idea that governments cannot transfer ideas and innovations archived in a bordering states if the suitability variation is high.



(a) 1378 Bohemia overlaid with pre-1500 caloric suitability, per hectare and year, taken from Galor and Özak (2014, 2015)

(b) 1378 Bohemia overlaid with between-neighbor variation of calories pre-1500. This is generated in GIS by calculating the terrain ruggedness index of a caloric suitability layer

Fig. 3. The calculation of between-neighbor variation of caloric suitability, the basis of our measure of caloric observability.

observability) we define caloric observability for a territory x as a linear transformation of between-neighbor variation BNV that relies on subtracting the maximum between-neighbor variation in the sample of $Territories$, as follows.

(r-1,c-1)	(r-1,c)	(r-1,c+1)
(r,c-1)	(r,c)	(r,c+1)
(r+1,c-1)	(r+1,c)	(r+1,c+1)

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

$$BNV_x = \frac{1}{|(r,c) \in s|} \sum_{(r,c)\in s} BNV_{(r,c)}) \tag{1b}$$

$$Observability\ Index_x = -1(BNV_x - \max_{t\in Territories}(BNV_t)). \tag{1c}$$

Here, (r, c) denote coordinates of the raster cells. Eq. (1a) creates a raster data with cell coordinates (r, c) that are calculated from the between-neighbor variation in the underlying caloric suitability raster CSI. Eq. (1b) averages this measure over any territory x. Eq. (1c) transforms this measure linearly, using the data from all $Territories$, to express a higher observability with a larger value of caloric observability. This eases interpretation.

3.2. Dependent variables

3.2.1. Data on states and state size in medieval Europe

The part of our empirical analysis that is focused on cross-sections of historical European states, is based on shapefiles of historical territories in Europe from Nüssli (2008). He provides shapefiles of territories for every 100 year period from year 1 to year 2000. For our analysis we use medieval state borders of the years 1200, 1300, 1400, and 1500. From these maps, we compute state size (in km^2) as proxy for fiscal capacity. On European level, we have to resort to state size as proxy for the fiscal capacity of a state as we lack any more direct measure for the Middle Ages. We argue that historically state size is a valid proxy for fiscal capacity and tax revenues. The economies of feudal states were based on agriculture, hence their tax systems relied primarily on in-kind taxes. In consequence, land was the tax-base and more land meant – ceteris paribus – a higher tax basis. It goes back to Aristotle that geographically small states can be governed with less effort than larger states (Olsson and Hansson, 2011). We use this idea to argue that large states were only able to survive if they were efficiently governed and fiscally healthy.

We also derive dummy variables for state types according to the names of the territories (e.g., the Flanders is coded as county). We consider all historical states of which over 50% were located within the borders of modern countries completely covered by Nüssli's shapefiles.[9] We also restrict our sample to countries that have adopted the NUTS classification. The level of the analysis

[9] For example, only a small part of Sweden is included and Norway and Finland are entirely missing.

is what Nüssli calls "2nd order administrative divisions", a layer of his shapefile into which he has drawn the border of French counties, duchies, English counties, Spanish kingdoms etc. We remove what Nüssli calls "Small states of the Holy Roman Empire", a very large polygon in the shapefile containing hundreds of small states in the Holy Roman Empire for which he was not able to find reliable border information. We lose variation in state size and types (especially small and city states) and exclude large parts of today's Germany, Austria and Switzerland. This is a major shortcoming of the Nüssli maps, which we overcome with our new data set on the Holy Roman Empire introduced below.

3.2.2. Fiscal and administrative capacity in the Holy Roman Empire

Data on the States of the Holy Roman Empire. A large part of our empirical analysis focuses on variation in tax revenues and state presence within the Holy Roman Empire. The basis of this data set are shapefiles containing information on the location and shape of the territories of the Holy Roman Empire for several points in time. To obtain this information, we digitize maps of the "reichsunmittelbare Territorien" (territories directly subordinate to the Emperor) of the Holy Roman Empire (without its Italian parts) by Wolff (1877).[10] Wolff drew these maps for years in which important events for the development of statehood in the Holy Roman Empire took place. These are the (i) collapse of the Staufer dynasty in 1250, (ii) the Western schism around the peak of political fragmentation in 1378, (iii) the Peace of Nancy in 1477, (iv) the Peaces of Augsburg (1556) and (v) Westphalia (1648), and (vi) the outbreak of the French Revolution in 1789.[11] Because our measures of tax returns and administrative presence are from the 15th and 16th centuries, we focus on the territories of the Holy Roman Empire in 1477 and 1556. The maps illustrate territories and their borders and include all types of states. These are city states (Imperial cities), large territorial states (kingdoms, duchies, principalities, margraviates, counties, etc.) and ecclesiastical states (bishoprics, archbishoprics, and monastic territories). We use this information to code state type dummies, which can act as important control variables.

To validate the maps and the included territories, we compare them to several other maps of historical states in the Holy Roman Empire (listed in the Appendix section A.1.1.).[12] Examples of coding decisions and other procedural issues are discussed in the Appendix section A.1.5. Overall, we identified 730 independent states. More detailed information on the type and frequency of the included territories is given in Appendix A.1.2.

Data on Administrative Capacity. Cantoni et al. (2018) established administrative buildings as a measure of administrative capacity and local presence of the state. To get information about the number of administrative buildings present in a city, they rely on information on construction activities in cities from the "Deutsches Städtebuch" (Handbook of German cities) Keyser and Stoob (1939–1974).[13] Following this idea, we use their data set and create a variable reporting the number of administrative buildings in the cities of each state of the Holy Roman Empire as the sum of the constructed administrative buildings between 1400 and 1477 and between 1400 and 1556. Thus we have administrative buildings in a respective state for two points in time, 1477 and 1556. From these data, we also compute a variable containing the overall number of cities in a state which we will use as control variable for differences in the degree of urbanization among the states of the Holy Roman Empire.

Data on Fiscal Capacity. To have a measure for differences in fiscal capacity among the states of the Holy Roman Empire, we follow Cantoni (2012) and use states' contributions to the Imperial war tax ("Reichsmatrikel") in 1521 as collected by Zeumer (1913).[14] The "Reichsmatrikel" is one of the few source on empire-wide taxes available. These taxes were raised by the Emperor to finance the defense against the Ottoman invasion.

A state's contribution depended on its rank in the imperial hierarchy (e.g. electoral states paid more than others, duchies paid more than counties),[15] its estimated wealth, and its population. We match the territories mentioned in the Reichsmatrikel with the states in our data using their names and consulting historical literature.[16] Whenever we find a matching state in our data set in 1556, we assume that its geography was unchanged between 1521 and 1556. If a state ceased to exist between 1521 and 1556, we match it with the 1477 state from our data set, assuming it did not change in between.

Overall, we match 236 states (which is around 80% of the 305 states that existed in the Holy Roman Empire in 1477).[17]

[10] Figure A.1 in the Appendix shows the original map from Wolff (1877) for 1378.

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

[12] To verify the existence of a territory included in the maps, 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. To validate the city states drawn in the maps we also consulted the "Deutsches Städtebuch" (Handbook of German cities) by Keyser and Stoob (1939–1974), an encyclopedia containing information on the history of each German city.

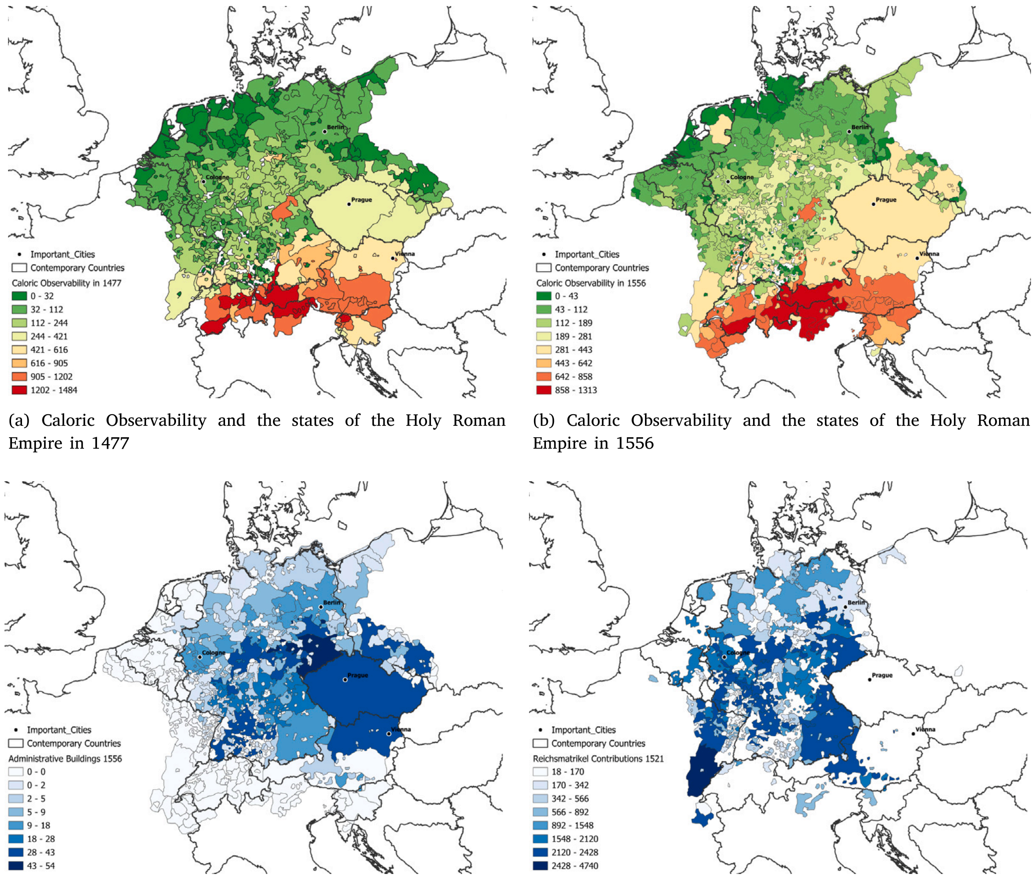
[13] The Handbook contains information for each of the 2,390 places that had city-rights at one point in their history and that are located within the borders of the German Empire as of 1937—which implies that not all the states of the Holy Roman Empire are covered (overall 362 of the 411 different states that existed in 1477 and 1556 are located within these boundaries).

[14] There are Holy Roman Empire types of contributions: states had to contribute mounted and foot soldiers, and also a certain contribution in guilders. To monetize the whole contribution we also follow Cantoni (2012) and the historical literature and assume that a mounted soldier was paid 12 guilders and a foot soldiers were paid four guilders and multiply for the number of each type of soldier. Typically, not the population of the state was a restriction for the contribution of soldiers but rather its ability to pay them. This can also be seen by the fact that the average contribution was 70 soldiers on foot and just 15 on horse.

[15] The electoral states on average paid 3465 guilder, duchies 2427, counties 252 and "Herrschaften" 147 guilders.

[16] 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. Our maps also provide information on the states in 1477 and 1556, but not on 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.

[17] 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).



(a) Caloric Observability and the states of the Holy Roman Empire in 1477

(b) Caloric Observability and the states of the Holy Roman Empire in 1556

(c) Administrative Buildings 1556

(d) Reichsmatrikel Contributions 1521

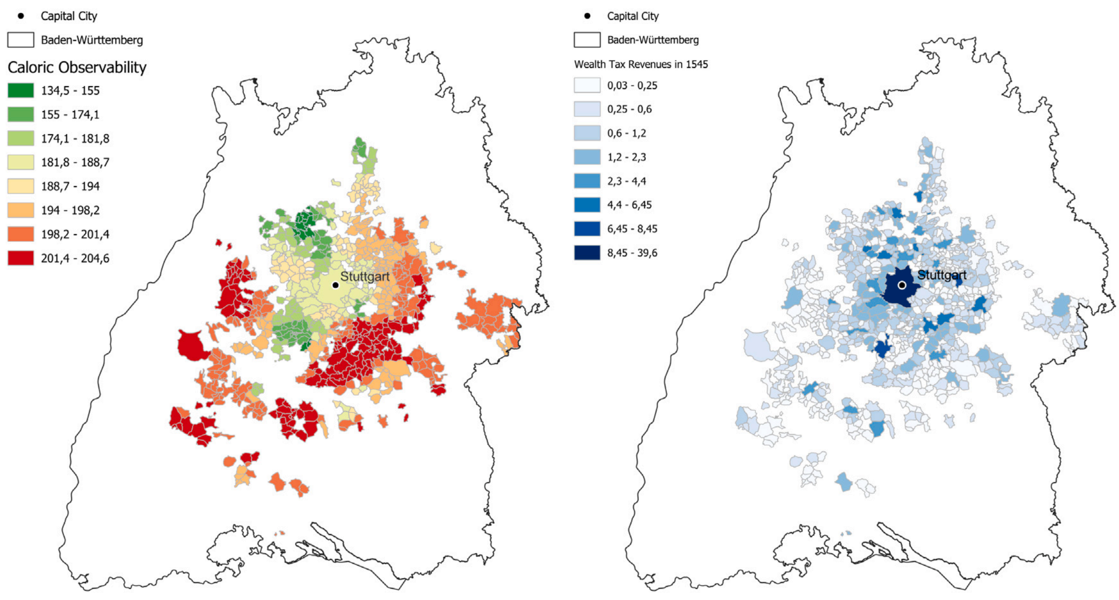
Fig. 4. Observability, state presence and tax revenues in the Holy Roman Empire.
Note: Panel (a) shows the Caloric Observability Index in each of the territories of the Holy Roman Empire in 1556 alongside modern country borders and the location of important cities. Panel (b) shows the number of administrative buildings in each state of the Holy Roman Empire in 1556. Panel (c) shows the Reichsmatrikel (Imperial Tax) contribution of each state in 1521 (in guilder).

Fig. 4, Panels (a) and (b) provides an overview of the caloric observability of each state of the Holy Roman Empire in 1477 and 1556. Panels (b) and (c) show the distribution of number of administrative buildings and the Reichsmatrikel contributions per state, respectively.

3.2.3. Wealth taxation in the 1545 Duchy of Württemberg

We consider differences in tax revenues within one particular state of the Holy Roman Empire, namely the Duchy of Württemberg as another way to test our hypotheses. The Duchy of Württemberg was located in the southwest of the Holy Roman Empire and was among the largest duchies of the Empire, as such it was homogeneous with respect to the political and institutional environment, but characterized by a relatively heterogeneous geography. As such it provides us with sufficient within-state variation in observability to conduct an empirical analysis. Württemberg was a large territorial state, very rural, with a predominantly agricultural economy (There was a single major urban center, its capital Stuttgart).

We collect municipality-level information on tax revenues from the imperial tax raised for the defense against the Turkish invasion 1545 ("Reichstürkenhilfe")—a tax similar to the Reichsmatrikel contribution introduced above. The tax had to be paid by the duke to the Emperor, and he advised his administration to collect taxes from the municipalities in his realm (Bull, 1980). The tax rate was 0.5% of taxable wealth. This consisted of real estate property, farm buildings and agricultural land (distinguished between fief and allodium), wood, stored crops, natural interest from all kinds of agricultural goods, money interest, livestock, and wine barrels. The tax had to be paid in coin rather than in kind, so the value of all taxable goods was monetized. A list with the taxable wealth of each municipality is available from the state archives and is printed in Bull (1980) alongside a map contained in the publication "Historischer Atlas von Baden-Württemberg" (Kommission für geschichtliche Landeskunde in Baden-Württemberg, 1988), a series of maps on the history of the contemporary German state Baden-Württemberg (of which the historical duchy is part of) edited by an official, state-financed commission of historians. Bull aggregated the historical municipalities (so called "Ämter") to municipalities of the state of Baden-Württemberg in 1957. This allows us to connect the information on taxable wealth (and tax



(a) Observability in the Duchy of Württemberg (b) Wealth Tax Revenues in 1545

Fig. 5. Observability and Wealth Taxation ("Türkensteuer") in the Duchy of Württemberg in 1545.
Note: Panel (a) shows the Caloric Observability Index in those municipalities of Baden-Württemberg as of 195 which belonged to the Duchy of Württemberg in 1545 ("Altwürttemberg"). Panel (b) shows the wealth tax revenue per municipality (in 1000 guilders).

revenue as 0.5% of it) with our data set on municipality level variables for Baden-Württemberg in the 1950s from our studies on the origins and economic effects of agricultural inheritance traditions (Huning and Wahl, 2021a,b). This contributes a host of relevant historical control variables.

Fig. 5(a) shows caloric observability among the municipalities that were part of the Duchy of Württemberg in 1545.

Panel (b) indicates the wealth tax revenue in each municipality. With respect to observability we see that it is the highest in the southwest and north of the capital city Stuttgart and decreases towards the periphery. The pattern of wealth tax revenues appears similar.

4. Empirical analysis and results

In this section we introduce the empirical tests of our argument for medieval European states, the Holy Roman Empire, and the Duchy of Württemberg. We also present the results of the regressions and discuss their implications.

4.1. Observability and European states' sizes

We start our analysis by looking at the relationship between state size and observability in cross-sections of historical European territories.

In line with our argument, we expect a significant and positive relationship between state size and observability of agricultural output across historical European states. To empirically test this, we calculated the caloric observability of each 2nd order administrative division included in the maps of historical European states by Nüssli (2008). Then, we estimate the relationship between caloric observability and the area of these territories—also calculated from the maps. We separately look a this relationship for the years 1200, 1300, 1400 and 1500. This is, we run the following cross-sectional OLS regressions for each of these years:

$$ln(STATEAREA)_i = \alpha + \beta ln(COI_i) + \gamma' \mathbf{X_i} + \epsilon_i, \tag{2}$$

where $ln(STATEAREA)_i$ is the natural logarithm of the area in km^2 of state i. $ln(COI_i)$ is the natural logarithm of a territory's caloric observability index as defined in Eq. (1c). $\mathbf{X_i}$ is a vector of basic control variables to account for factors that might have influenced both state size and observability. Among those variables is the maximum elevation of each territory. As suggested by Scott (2009, 2017), maximum elevation is highly positively correlated with state size. The rationale behind this is that states with high mountains (like Bohemia, or the Habsburg Lands) are harder to conquer.

On the other hand, elevation is negatively correlated with observability. As such, our argument only works when accounting for the effect of mountains on state capacity.

Table 1
Observability of agricultural output and state size in Europe 1200–1500.

Dependent variable	ln(Area)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1200		1300		1400		1500	
ln(Caloric observability)	0.356***	0.211*	0.387***	0.205**	0.580***	0.346***	0.510***	0.367***
	(0.122)	(0.111)	(0.0966)	(0.0932)	(0.0867)	(0.108)	(0.110)	(0.0714)
ln(Caloric suitability)		−0.0601		0.200		0.0734		0.321**
		(0.424)		(0.188)		(0.196)		(0.139)
Control variables	–	✓	–	✓	–	✓	–	✓
State type dummies	–	✓	–	✓	–	✓	–	✓
Observations	238	238	398	398	430	430	512	511
R^2	0.229	0.566	0.204	0.574	0.258	0.547	0.179	0.518

Notes. Standard errors clustered on the level of 2nd order administrative divisions are reported in parentheses. All regressions include a constant not reported. Control variables are a territory's average terrain ruggedness and maximum elevation, its average latitude and longitude, market potential, and a dummy equal two one if the territory was an island.

*Coefficient is statistically different from zero at the 10% level.

**Coefficient is statistically different from zero at the 5% level.

***Coefficient is statistically different from zero at the 1% level.

Our idea holds for states that differ in observability but are similar with respect to their maximum elevation. Other covariates include the average ruggedness of a territory's terrain, and the average caloric suitability of its soils. Both are related to agricultural productivity. Terrain ruggedness also serves as a proxy for the difficulty of defending the territory against foreign enemies and exerting control over it. To consider possible geographic patterns in state development and caloric observability, we also include the latitude and longitude of a territory's centroid.

To account for the extend of commercial activities as potential alternative source of state income and general measure of economic prosperity we include a territory's average market potential.[18] To capture the particularities of islands with respect to natural conditions but also sources of fiscal income, we include a dummy for island territories (like Sicily).

Finally, we add a set of state type dummies accounting for possible existing differences in unobserved factors connected to observability and state size.[19] ϵ_i is the error term.

Table 1 shows the results of the OLS regressions. For each of the respective years, the odd-numbered columns report the results of baseline regressions where we explain the natural logarithm of a state's area just by the logarithm of caloric observability and maximum elevation of each state. We find a highly statistically and economically significant positive coefficient of observability.

In the regressions in the even-number columns, the other covariates area added. The covariates reduce the estimated elasticity of state size with respect to observability to 0.20–0.35. The results show a statistically significant and qualitatively important relationship between both variables.

4.2. Observability and state development in the states of the Holy Roman Empire

In this subsection we analyze the relationship between caloric observability, fiscal capacity and state presence among the states of the Holy Roman Empire in the 15th and 16th century.

4.2.1. Observability and administrative capacity in the cities of the Holy Roman Empire

As a first step, we test whether caloric observability is significantly and positively related to the number of administrative buildings in cities of each state of the Holy Roman Empire in 1477 and 1556. Formally we estimate the following regression equation using OLS:

$$ln(BUILDINGS)_{i,t} = \alpha + \beta ln(COI_{i,t}) + \gamma' \mathbf{X_{i,t}} + \delta_t + \epsilon_{i,t}, \quad (3)$$

where $ln(BUILDINGS)_{i,t}$ is the number of buildings in the cities of state i, in period t (and $t = 1477, 1556$). $X_{i,t}$ is a vector of different sets of controls. The motivation for including these control variables is to limit concerns about omitted variables bias. Therefore, we include a number of variables in our data set that should capture relevant historical and geographical confounders of fiscal and administrative capacity as well as observability as identified in the literature.

The set "Basic Geographic Controls" includes average distance to a major river, maximum elevation, and average terrain ruggedness. Variables controlling for soils and climate are caloric suitability, average temperature, and share of luvisol soils (the latter control for the effect of early plough adoption, see Alesina et al. (2013) and Andersen et al. (2016)). Because of its prominence in the literature on state capacity we include soil suitability in all regressions, and discuss it.

[18] We calculate the market potential based on the Bairoch et al. (1988) data set of historical city populations. We follow the approach of Crafts (2005). Market potential basically captures a state's market access and size (from a demand but also a supply perspective).

[19] A descriptive overview of the different cross-sectional data sets is presented in Table A.1 in the Appendix.

Table 2
Caloric observability and the number of administrative buildings in cities.

Dependent variable	ln(Number of administrative buildings)					
	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All states		Without city states	All states		Without city states
ln(Caloric observability)	0.136**	0.0980*	0.122*	0.131**	0.121**	0.133**
	(0.0534)	(0.0512)	(0.0725)	(0.0510)	(0.0497)	(0.0660)
ln(Caloric suitability)	1.108***	1.146***	1.448***	1.154***	1.150***	1.315***
	(0.361)	(0.359)	(0.423)	(0.316)	(0.316)	(0.370)
1556 dummy	✓	✓	✓	✓	✓	✓
State type dummies	–	–	–	✓	✓	✓
Basic geographic controls	✓	✓	✓	✓	✓	✓
Climate	–	–	–	✓	✓	✓
Economic factors and resources	–	–	–	✓	✓	✓
Battles per area	–	–	–	✓	✓	✓
Cities per area	–	✓	✓	–	✓	✓
Boundary location	–	–		✓	✓	✓
Observations	362	362	269	362	362	269
R^2	0.162	0.196	0.218	0.439	0.442	0.508

Notes. Heteroskedasdicity robust standard errors are reported in parentheses. 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 1000 randomly distributed points within a state to the closest major river, its maximum elevation above sea-level, and its average ruggedness. Climate controls include 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 1000 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.

*Coefficient is statistically different from zero at the 10% level.

**Coefficient is statistically different from zero at the 5% level.

***Coefficient is statistically different from zero at the 1% level.

The set "Economic Factors and Resources" 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. Several authors have argued that military conflicts were a driver for state capacity in Europe, 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 our sampling years (i.e., between 1250 and 1378 or between 1556 and 1648), normalized by the area of the state. Additionally, a dummy variable "Boundary Location" measuring the share of a states' border that is an outer boundary of the Holy Roman Empire is also included to proxy for the more likely exposure of these regions to military conflicts or a higher presence of military there.

We also include a set of 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 differently and also unobserved historical factors that caused a certain state to become a kingdom and another one a county.[20] Finally, we add the number of cities per km^2 in a state as a control.δ_t is a 1556 dummy, and ϵ_{ic} is the error term.

The rationale for including each of these variables is explained in more detail in the Online Data Appendix (Appendix A.2.1). Exact definitions and sources of all the variables are given in Appendix section A.2.2. A descriptive overview of the variables in the data set can be found in Table A.2. The maps on which we base our geographic and historical variables are shown in section A.3 of the Appendix.

Table 2 reports the results. In columns (1) to (3), we include the basic geographic controls alongside a 1556 dummy, and cities per area as control variables. In column (3), we exclude city states as our argument, which is based on the taxation of agricultural output, might not apply to them. Finally, in columns (4) to (6) we add additional controls. The results imply a statistically and economically significant positive relationship between the observability of a state's agricultural output and the number of administrative buildings in its cities. The coefficients suggest that a 1% increase in caloric observability increases the number of administrative buildings by around 0.10%, which is sizable, but within a reasonable range. Caloric suitability is always positively and significantly associated with the number of administrative buildings, once again giving credit to the importance of soil quality itself.

4.2.2. Observability and imperial taxation in 1521

We continue with the evidence for a positive relationship between the fiscal capacity of states as measured by their contribution to the Imperial War Tax ("Reichsmatrikel") of 1521 and caloric observability. To do so, we estimate the following, cross-sectional OLS regression:

$$ln(IMPERIALTAX_i) = \alpha + \beta ln(COI_i) + \gamma' \mathbf{X_i} + \epsilon_i, \quad (4)$$

[20] The base category remaining are states occupied by the Swedish after the Thirty Year's War, Imperial territories directly controlled by the Emperor (i.e., bailiffs and Staufian territories) and Imperial cities.

Table 3
Caloric observability and financial capacity of states in the Holy Roman Empire.

Dependent variable	ln(Reichsmatrikel contribution)					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Caloric observability)	0.253***	0.265***	0.237***	0.212**	0.210**	0.174*
	(0.0969)	(0.0922)	(0.0913)	(0.102)	(0.102)	(0.101)
ln(Caloric suitability)	0.366***	0.303***	0.272***	0.261**	0.254**	0.253**
	(0.140)	(0.0747)	(0.0892)	(0.109)	(0.108)	(0.111)
Basic geographic controls	✓	✓	✓	✓	✓	✓
State type dummies	–	✓	✓	✓	✓	✓
Soil and climate	–	–	✓	✓	✓	✓
Economic factors and resources	–	–	–	✓	✓	✓
Battles per area	–	–	–	–	✓	✓
Boundary location	–	–	–	–	–	✓
Observations	235	235	235	235	235	235
R^2	0.163	0.494	0.512	0.546	0.549	0.558

Notes. Heteroskedasdicity robust standard errors are reported in parentheses. 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 1000 randomly distributed points within a state to the closest major river, its maximum elevation above sea-level, and its average ruggedness. Climate controls include the fraction of a state’s area with luvisol soil that benefits most from plowing and measure for the average temperature in a state. The control variables in “Economic Factors and Resources” include variables measuring the average distance of 1000 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.

*Coefficient is statistically different from zero at the 10% level.

**Coefficient is statistically different from zero at the 5% level.

***Coefficient is statistically different from zero at the 1% level.

where $\ln(IMPERIAL\_TAX_i)$ is the natural logarithm of the contribution of state i in the Reichsmatrikel of 1521. $ln(COI_i)$ is the natural logarithm of caloric observability of a state’s agricultural output. X_{ic} is a vector of different sets of controls, identical to those used in Table 2.[21]

Table 3 reports the results of the regressions. As before, column (1) shows baseline regressions in which we include only a set of basic geographic controls and caloric suitability.

The results are in line with our expectations. There is an economically sizable and statistically at least marginally significant relationship between caloric observability and the Reichsmatrikel contributions of each state. The most conservative estimate from column (6) implies that a one percent increase in caloric observability is associated with an increase in the Reichsmatrikel contribution of 0.17 percent, which is not only statistically significant but sizable from an economic point of view too. The results on soil suitability (not observability) suggest that it is relevant to the Reichsmatrikel contributions as well.

4.3. Observability and taxation in 1545 Württemberg

We conclude the empirical analysis by exploring the association between caloric observability and (wealth) tax revenues in the 16th century Duchy of Württemberg by estimating the following OLS equation:

$$ln(TAX)_i = \alpha + \beta ln(COI_i) + \gamma' \mathbf{X_i} + \epsilon_i, \tag{5}$$

where $ln(TAX)_i$ is the natural logarithm of tax revenue of municipality i in 1545, or of the tax revenue per capita (taxable wealth per capita). $ln(COI_i)$ is the natural logarithm of a municipality’s caloric observability, and $\mathbf{X_i}$ is a vector of control variables. These variables include distance to the Rhine and Neckar (the major rivers in the area), and to the capital city Stuttgart, maximum elevation and average terrain ruggedness of each municipality, its average caloric suitability, Roman road density, foreign market potential in 1500, the length of trade roads through it, the share of a municipality’s area settled already during Neolithic times, its exposure to the Black Death (calculated as distance-weighted average of the mortality rates of the cities around it during the Black Death epidemic in 1347/48), a dummy variable equal to one if historically equal partition was the dominant mode of inheriting agricultural property in the municipality and the number of water mills active during the 16th century in a municipality. These variables account for relevant differences in geography, economic prosperity – and thus, potentially alternative sources of taxable wealth – and settlement history of each of the municipalities.

Huning and Wahl (2021a) as well as the Data Appendix provide detailed information on all the variables and their sources. ϵ_i is the error term.

Table A.4 in the Appendix reports descriptive statistics of the variables included in the regressions, and Table A.5 provides bivariate correlations. Figures A.8 and A.9 in the Appendix show scatter plots of the bivariate relationship between the natural logarithm of caloric observability, tax revenue, and tax revenue per capita. They show a clearly positive and statistically significant relationship to caloric observability for both variables. This is not driven by outliers.

[21] Table A.3 in the Appendix provides a descriptive overview of this data set and all the variables included in the regressions.

Table 4
Caloric observability and municipal tax revenues in Württemberg in 1545.

Dependent variable	ln(Tax revenue)						ln(Tax revenue per capita)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(Caloric observability)	0.443***	0.304***	0.316***	0.315***	0.271***	0.258***	0.0840**
	(0.0652)	(0.0729)	(0.0707)	(0.0722)	(0.0725)	(0.0715)	(0.0335)
ln(Caloric suitability)		0.856***	0.919***	0.773***	0.668***	0.709***	0.106*
		(0.109)	(0.108)	(0.116)	(0.120)	(0.118)	(0.0550)
Basic geographic controls	–	✓	✓	✓	✓	✓	✓
Economic factors	–	–	✓	✓	✓	✓	✓
Settlement history & Black death	–	–	–	✓	✓	✓	✓
Equal partition	–	–	–	–	✓	✓	✓
Distance to stuttgart	–	–	–	–	–	✓	✓
Observations	662	660	660	660	660	660	660
R^2	0.069	0.168	0.228	0.255	0.268	0.280	0.151

Notes. Heteroskedasdicity robust standard errors are reported in parentheses. The unit of observation is a municipality in Baden-Württemberg in 1953. All regressions include a constant not reported. The set of basic geographic controls includes a variable measuring the average distance of 1000 randomly distributed points within a municipality to the Rhine or Neckar, its maximum elevation above sea level, its average terrain ruggedness and caloric suitability. "Economic Factors" are a set of variables comprising Roman road density (km Roman Roads per area (km^2)), the number of water mills, foreign market potential and km of medieval trade routes. Settlement history is measured by the share of a municipality's total area that was settled during the Neolithic period. The impact of the Black death is covered by Black Death potential. Equal partition is accounted for by a dummy variable equal to one if a municipality was located in the historical area where equal partition was the predominant form of inheritance. Distance to Stuttgart is the distance of 1000 randomly distributed points within a municipality to Stuttgart in kilometers.

*Coefficient is statistically different from zero at the 10% level.

**Coefficient is statistically different from zero at the 5% level.

***Coefficient is statistically different from zero at the 1% level.

Table 4 reports the results of the regressions. They suggest a robust and positive relationship between caloric observability and tax revenues within the Duchy of Württemberg. Reassuringly the estimated elasticity with all controls included is similar to the other estimates, suggesting that a one percent increase in observability increases tax revenues by around 0.25 percent.

These results confirm the relationship between financial capacity and caloric observability, also within large territorial states.

5. Conclusion

This paper studies the determinants of fiscal capacity in medieval Europe, the Holy Roman Empire and the Duchy of Württemberg. We are among the first to study the role of appropriability within the context of Europe. We present a theoretical argument linking observability of agricultural output to administrative and fiscal capacity. We provide empirical support for this idea using different data sets and by introducing a new, uniquely detailed data set on the states of the Holy Roman Empire. We conclude that observability of agricultural output, specifically via its impact on fiscal capacity was an important determinant of state capacity.

Our results provide evidence for the interaction of agriculture, climate, and geography in explaining political outcomes, such as fiscal capacity. This adds a new perspective to the influential literature that links geography, climate and agriculture to long-run differences in economic outcomes (Diamond, 1999; Olsson and Hibbs, 2005). We introduce a GIS measure of observability of agricultural output which calculates the degree of information asymmetry in an early society. As this index is well grounded in theoretical economic reasoning, it can be applied to other research in political and economic history, and long-run development.

The evidence suggests that our story holds across historical European states. Further exploration of this will require more detailed data, or different avenues of exploitable exogenous variation in observability. An especially interesting question is which specific historical developments link geography, observability, and the development of state capacity. Studying other European regions, focusing on the mechanisms, and the discovery of exogenous variation are promising avenues for future research. With this paper, we introduce a new, more comprehensive and detailed database on the states of the Holy Roman Empire from the Middle Ages until the French Revolution. It contains data on the location and borders of the historical states as well as the evolution of their status, and the reasons for their disappearance. We hope that this database can be used for a variety of future research in this and adjacent areas, for example for research concerned with the causes and consequences of political fragmentation and instability, or the location of borders.

Declaration of competing interest

The authors report there are no competing interests to declare.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.ejpoleco.2023.102432.

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