Ancient Colonialism and the Economic Geography of the Mediterranean

Abstract

This paper investigates the legacy of ancient Phoenician, Greek and Etruscan colonialism in shaping the economic geography of the Mediterranean region. Utilising historical data on ancient colonies and current data on population density and night light emissions (as a proxy for economic activity), we find that geographic areas colonised by these ancient civilisations have higher population density and economic activity in the present day. We also find that ancient colonialism affected the origin and evolution of the urban system of cities and settlements prevalent in the Mediterranean region.

Keywords: Economic Geography, Economic Development, Ancient Colonialism, History, Mediterranean, Cities

JEL Classification: C21, N93, O1

1. Introduction

This paper examines the long-term legacy of ancient colonialism in shaping the economic geography of the Mediterranean region. During the period spanning the 11th to the 6th centuries before the common era (BCE), the Phoenician, Greek and Etruscan civilisations spread around the Mediterranean region via a process of colonisation. This colonisation was characterised by the founding of urban-style settlements. These ancient civilisations, which achieved remarkable prosperity by pre-modern standards, transferred their respective institutions, culture, technology and human capital to colonised areas.[1] This was a positive shock for the locations affected directly by the founding of new colonies as well as the immediate surrounding geographic areas. As this shock is likely to generate dynamics that persist over time (in terms, for instance, of agglomeration economies and institutional persistence), it would appear plausible ex ante that there is a link between ancient colonialism and modern population density and economic activity.[2]

Our main hypothesis is that ancient colonialism, by geographically spreading urban settlements and more advanced civilisations, had a positive impact on long-term population density and economic activity. In order to test this hypothesis, we divide the territory surrounding the Mediterranean and Black Sea into a large number of grid cells (geographic areas), each measuring 100 kilometres squared, and then compare geographic areas that were subject to ancient colonisation with similar counterparts where no colonisation took place.

We collect data on the location of Phoenician, Greek, and Etruscan colonies, and augment this with information regarding the various geographic and climatic characteristics of all countries around the Mediterranean and Black Sea. As a proxy for the concentration of economic activity at the sub-national level, we use fine grained spatial resolution light density data. Our choice is guided by prior evidence that suggests that light data is highly correlated with GDP per capita (Henderson et al., 2011, 2012; Pinkovskiy, 2017).[3] We complement this light density indicator with a measure of population density at a high (1 km^2) spatial resolution.

In our baseline regression model, the main independent variable of interest is a binary indicator that captures whether there is at least one ancient colony in a grid cell (geographic area). Our baseline regression model also includes country fixed effects, which control for any

[1] Regarding Ancient Greece prosperity, Morris (2004) estimates an annual rate of aggregate consumption growth of 0.6% to 0.9% over the period 800 to 300 BCE. This growth rate is smaller than that experienced by Great Britain after the Industrial Revolution, but higher than that experienced by many pre-industrial economies (including Holland which grew at 0.5% between 1580 and 1820).

[2] Recent research suggests that economic prosperity perpetuates over time (Comin et al., 2010; Chanda, et al., 2014; Maloney and Caicedo, 2016).

[3] Chen and Nordhaus (2014), Donaldson and Storeyguard (2016) and Michalopoulos and Papaioannou (2018) provide extensive reviews of the use of light data in economic analyses.

systematic differences in economic activity across countries. In order to focus on homogenous geographic areas, we restrict the sample to coastal grid cells. The results of the empirical analysis indicate that geographic areas that are subject to ancient colonisation (i.e. grid cells where ancient colonies were located) have higher levels of economic activity (light density) and population density relative to areas where no colonisation took place.

The results of further extensive analyses suggest that differences between geographic areas that were subject to ancient colonisation relative to areas where no colonisation took place are driven by man-made consequences of colonisation rather than naturally occurring advantages specific to a given geographic area. More specifically, we include a large set of covariates in our estimations which control for: the attributes of coastal areas; the position of a grid cell within the overall network of established colonies; and the availability of important natural resources for human activity. We also use propensity score matching as an alternative means of estimation as well as a finer (sub-national) fixed effects in order to ensure that we compare similar observations. Other robustness checks include: the use of alternative indicators and sources of ancient colonisation; a wide array of control variables related to pre-existing and contemporary conditions; the use of a larger grid cell size measuring 50x50 km; spatial autocorrelation tests; analysis of heterogeneity across continents (in order to test whether the estimated results are similar across Europe, Asia and Africa); investigating any differential impact of colonisation on economic outcomes by coloniser identity; and the exclusion of grid cells where luminosity or population density is zero.

We forward two complementary mechanisms driving the impact of ancient colonialism on modern day economic activity and population density. These comprise institutions and culture, and the persistence of urban settlements. The institutions, culture, human capital and technology brought with colonisation represented a major shock to colonised areas. The Phoenicians, Greeks, and Etruscans were urban-centred societies with more sophisticated economies, a higher standard of living and more inclusive institutions than the rest of their Mediterranean neighbours. It is likely that these elements were transferred (at least to some degree) to colonised areas, with resultant positive consequences for economic development. In regard to urban persistence, once a settlement is founded, agglomeration economies reinforce any dynamics driving the concentration of economic activity and development over the long-run. Indeed prior evidence suggests that cities are persistent, even following negative shocks (Davis and Weinstein, 2002; Bleakley and Lin, 2012). We test for the importance of institutions and culture, and urban persistence by comparing ancient colonies with settlements of other cultures from the same era. If urban persistence were the only relevant mechanism, we should not observe differences between ancient colonies and other settlements. However, we observe differences: ancient colonies had more urban-related features in ancient times (330 BCE -300 CE), were closer to ancient trading routes (c. 150-200 CE), and exhibit higher levels of economic activity (light density) today. Thus, our findings suggest that both of these aforementioned channels play a role, albeit based upon available data, urban persistence appears to have been relatively more important than institutions and culture in driving the observed link between colonisation and economic outcomes.

We further analyse the role of ancient colonialism in the origin and development of the urban system in the Mediterranean region. In doing so, we posit that ancient colonisers distributed around the Mediterranean a major innovation in the form of urban settlements or cities. The results of this analysis suggest that areas colonised by Phoenicians, Greeks and Etruscans were more likely to have ancient settlements, Roman cities and roads, and (later) modern cities. For instance, the percentage of grid cells which had a city at some point in time from 800 to 1800 is approximately 14 percentage points (pp.) higher for those with ancient colonies (being the sample average of only 4.4%). Nowadays, cells with ancient colonies are 30 pp. more likely to have towns larger than 10,000 inhabitants, and 10 pp. more likely to have large urban centres (relative to average values of 19.7% and 5.4%, respectively). Thus, the evidence of a positive effect of ancient colonialism can be traced through more than two millennia until the present day.

Our findings contribute to several strands of literature. First, we contribute to the growing literature regarding the importance of historical events in shaping economic development (Nunn, 2014, 2020). More specifically, we contribute to the literature which suggests that colonialism had an important and long-lasting impact on the current economic activity of colonised areas (Acemoglu and Robinson, 2017; Michalopoulos and Papaioannou, 2020). For the most part, this literature focuses on episodes of modern colonisation associated with the colonial rule of several major European powers. Differences in the style of rule, and the institutions established by colonisers appear to explain much of the variation observed in current economic activity across former colonies.[4] We augment this literature on modern colonisation by assessing, for the first time, whether ancient colonisation had a similar long-lasting impact on economic outcomes.

Similar to their modern counterparts, ancient colonisers settled in new places by establishing colonies along the Mediterranean. However, in contrast to their modern counterparts, ancient colonies were smaller, more localised and located typically along the coast. The territorial control of these ancient colonies was limited. Control extended typically beyond the walls of the urban

[4] A non-exhaustive list of contributions to this literature include Engerman and Sokoloff (2000), Banerjee and Iyer (2005), Angeles (2007), Feyrer and Sacerdote (2009), Dell (2010), Iyer (2010), Acemoglu and Robinson (2012), Bruhn and Gallego (2012), Spolaore and Wacziarg (2013), Easterly and Levine (2016), Oto-Peralías and Romero-Ávila (2014, 2016, 2017), Michalopoulos and Papaioannou (2016), Droller (2018), and Kampanelis (2019).

centres, but the average colony had a size that did not exceed 200 km^2 (Hansen and Nielsen, 2004).[5] In common with modern instances of colonialism, ancient colonisers transferred political and cultural institutions to new settlements, but also organised these settlements in a manner similar to their metropolis (Garnand 2020). For example, urban characteristics such as a marketplace (known as the agora), temples, burial grounds and walls or fortifications surrounding the urban space found in the home country (motherland) were also evident in the colonies. In some instances, newly founded colonies exhibited signs of urban planning evidenced by rectangular street networks, and specific sites allocated to public or private use (McCredie 1971).

The nature of ancient colonisation is somewhat contested. Similar to modern colonisation, traditional views suggest that ancient colonisers were involved in the violent displacement of indigenous populations and the seizure and control of natural and economic resources (Wilson, 2006). However, more recent research suggests that in fact ancient colonisers were less violent and involved in a level of reciprocity with the indigenous population (Webster 1996; Osborne 1998; Babic 2002; Dietler 2010; van Dommellen 2012). Regardless of the nature of ancient colonisation, evidence on the extent to which ancient colonisation had a long-lasting impact is rather scarce. Our findings document a positive economic legacy of Phoenician, Greek and Etruscan colonies, evidenced by more economic activity and population density along with a greater incidence of cities.

Second, our study contributes to the literature regarding the spatial distribution of population and economic activity (Ottaviano and Thisse, 2004), and more specifically to the location of cities and persistence of urban networks (Bleakley and Lin, 2012; Michaels and Rauch, 2018; Bosker and Buringh, 2017; Barjamovic et al., 2019). It also contributes to the ongoing debate over whether geographic characteristics or historical events determine the spatial distribution of population density and economic activity (Davis and Weinstein, 2002; Redding et al., 2011; Nunn and Puga, 2012; Allen and Donaldson, 2019). The results of our empirical analysis suggest that the establishment of colonies led to greater prosperity over time, and the creation of modern cities where significant economic activity took place. This suggests that a particular man-made intervention in the form of the founding of a colony in a foreign land has a significant impact, which persists to the modern day.

Third, our work also contributes to the literature on the economic and social legacy of the classical world, which has recently attracted interest among economists and other social scientists (Scheidel et al., 2008; Ober, 2015; Wahl, 2017; Dalgaard et al. 2018; Bakker et al., 2020; Michaels

[5] Given the simple means of transportation in ancient times this was smaller than the ideal size of a city state, approximated to be 3000 km^2. Inhabitants could travel from the urban centre to city boundaries within a day's march.

and Rauch, 2018). While it is generally acknowledged that the influence of classical Greece is widespread in Western culture, we document a direct and local impact of the Phoenician, Greek and Etruscan civilisations on modern day economic outcomes. Our findings suggest that the benefit for colonised areas of having contact with more advanced cultures in the long-run exceeded any short-term costs (associated with conflict).

Our results also augment recent literature which examines the impact of coastal connectivity on the evolution of ancient settlements. Bakker et al. (2020) find that maritime connectivity is positively associated with the presence of ancient archaeological sites dating back to the Iron Age, when open water sailing throughout the Mediterranean became widespread. In contrast to Bakker et al. (2020), who focus on the link between the geographic attributes of coastal areas and the prevalence of archaeological sites, we investigate the consequences of a man-made intervention in the form of founding ancient colonies. Our results (derived from several tests) suggest that maritime connectivity did not exert any influence on modern day economic outcomes of geographic areas colonised by the Phoenicians, Greeks and Etruscans.[6] As such, the results of our study complement prior understanding of the evolution of the economic geography of the Mediterranean region. Specifically, coastal connectivity influenced the growth of settlements during the Iron Age period, while ancient colonisation (of the form investigated in the current study) affected economic activity and urbanisation from that period onwards, with its effect being visible today.

The rest of the paper is structured as follows. Section 2 provides a brief historical background of ancient colonialism in the Mediterranean and Black Sea region. In Section 3, we discuss the empirical strategy and provide a preliminary analysis of the data. Section 4 presents our main results, and augments this with a discussion of the results derived from a battery of robustness checks. Section 5 investigates possible underlying mechanisms driving the relationship between ancient colonisation and population density and economic activity, while Section 6 analyses the impact of ancient colonialism on the development of the system of urban settlements in the Mediterranean. In Section 7 we provide concluding remarks.

2. Historical background

The Phoenicians, Greeks and Etruscans developed and settled around the Mediterranean and the Black sea coasts from the 11th to the 6th century BCE. During this period, these civilisations

[6] Ancient colonies are not systematically located in grid cells with higher connectivity. The lack of relationship between ancient colonies and maritime connectivity may be due to the fact that ancient colonies are special settlements and coast connectivity might weigh less than for other settlements. For instance, the strong ties with the metropolis and other colonies might reduce the importance of coast connectivity for ancient colonisers.

experienced significant economic and cultural progress, which has often been attributed to developed institutions, high levels of social capital and technological innovation. Describing the Greeks (but largely applicable to Etruscans and Phoenicians as well), Ober (2015) argues that 'citizen-centred' institutions and competitiveness were the main drivers of prosperity. In this section, we discuss selective characteristics of these aforementioned civilisations and their respective expansion overseas. Figure 1 represents the geographical distribution of ancient colonies in the Mediterranean area.

2.1 The Greek Colonisation

The most active period of Greek colonisation took place between the 11th and the 5th century BCE, when numerous settlements were established around the southern European coastline and the Black sea. This colonisation was prompted, in part by the social and political instability prevalent in Greece during this period. At the beginning of the archaic period (8th century BCE), the socioeconomic power of existing aristocracies was based on their birth and wealth. However, the lack of primogeniture rights resulted in a wider dispersion of land rights among siblings, thus undermining previous predominant power and generating political instability (White, 1961). Higher life expectancy, overpopulation, limited arable land, finite natural resources, climatic disasters, and political instability were all factors that led Greeks to search for new territories to settle (White, 1961; Austin and Vidal-Naquet, 1980; Cawkwell, 1992).[7]

The first wave of Greek colonisation spanned the period from the 11th until the 8th century BCE. A second wave of colonisation took place between the 8th to end of the 6th century BCE. By the end of the second wave, approximately 400,000 Greeks (a third of the total population) lived outside the Aegean Sea (Morris, 2005). Religious beliefs and institutional arrangements of the ancient poleis (city-states) had a significant influence on the form of newly founded colonies. New areas for colonisation were chosen via a specific ritual related to religious customs, which involved seeking guidance from several oracles within the Greek territory. Evidence from the locations of Greek poleis reflect a preference for settling in coastal areas. This is evidenced by Plato's analogy '[Greeks live] like ants or frogs around a pond' (Plato's dialogue *Phaedo*, in Ober, 2015, p. 21). The colonial enterprise was organised by the mother city or metropolis, which maintained strong cultural ties with any new colonised area.

The Greeks spread the idea of urbanism as a settlement form throughout the Mediterranean basin. This was a novel concept in the newly colonised areas, and particularly so in the western

[7] Naval technology played an important role in the foundation of new colonies. The design and construction of a new type of ship, the trireme, permitted safer and more efficient transportation along the Mediterranean coast (Davison, 1947).

Mediterranean (Pounds, 1969). The colonisers also disseminated the Greek culture to neighbouring indigenous communities (White, 1961). Colonies (in line with established standards of the mother city) developed their own laws, cults, foreign relations and arts. An increasing number of towns and small settlements, which were embedded within larger regions progressively adopted social norms and formal rules, and influenced by the Greeks became similar to poleis (Ober, 2015). The Greek alphabet (a conversion of Phoenician primitive symbols) and Greek coins had great influence throughout the Mediterranean region (Culican, 1992; Schoenberger and Walker, 2017).

2.2 The Phoenician Colonisation

The Phoenicians played a major role in establishing settlements on the Mediterranean coast from the end of the second millennium until the 7th century BCE. Among the most important Phoenician cities were Byblos, Sidon, Tyrus, Citium, Utica, Gades and Lixus (Bryce, 2012). The overall expansion of colonies around the Mediterranean took place mainly in North Africa and Western Europe. Phoenicians were also a prosperous civilisation of small-states, with a commercial orientation and relatively open political institutions (Ober, 2015). The Phoenician colonisations were similar to Greek counterparts, but were organised in a different way. With the exception of Carthage (which was founded as a colony in 814 BCE by Tyrians), every other Phoenician settlement was initially a trading post (Whittaker, 1974). Promontories and small islands close to the mainland were preferred.

The Phoenician colonial expansion and economic development was based on a large trade network. Luxurious and prestigious goods enhanced the Phoenician trading reputation. The search for purple shells (which were a key input in the production of dyed cloth) led the Phoenicians to expand in many places including Cyprus, Rhodes and Crete. Since dye factories were a significant source of wealth, Phoenicians established treatment plants and settlements not only in places with profitable trading ties to native populations, but also in regions with rich coral and shell deposits (Jensen, 1963). In doing so, the Phoenicians contributed to the creation of cities in the newly colonised areas, and in some instances played an important role in the subsequent evolution of the indigenous societies (Bierling, 2002; Osborne and Cunliffe, 2005).[8]

Prior evidence suggests that significant (bi-directional) relationships existed with Phoenicians and neighbouring civilisations. Phoenician temples devoted to Asherah goddess indicate religious influence on the indigenous population in modern day Israel. Egyptian talismans, medallions and

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[8] In the case of Iberia, interactions of the indigenous societies with the Phoenicians helped locals transition from a proto-urban state to an urbanized era and also ushered the emergence of centralised states in the peninsula (Scott, 2018).

scarabs were found in the surrounding area of Phoenicia suggesting an exchange of cults and norms between the two civilisations. Black-on-red vessels (related to the Phoenician style of pottery) appear at Tarsus in Cecilia around 1000 BCE (Culican, 1992). Overall, the Phoenicians had a pervasive influence and close relationships with indigenous populations of North Africa and Western Europe. The established colonies soon became vibrant trading posts. Given the importance of trading by that time, Phoenicians as a naval nation were able to diffuse their civilisation to the coastal areas around the Mediterranean Sea.

2.3 The Etruscan Colonisation

In common with the Greeks and Phoenicians, the Etruscans were a prosperous commercially oriented city-state civilisation with a citizen-centred political regime. However, in contrast to Greeks and Phoenicians, the Etruscans settled in a limited geographic area confined to modern-day northern Italy, where there was an abundance of natural and agricultural resources. The fertile land combined with large forests provided them with a wide range of agricultural products and wood, which was a crucial raw material input for the construction of ships (Haynes, 2005). The plentiful supply of mineral deposits such as iron, copper, zinc, tin and lead enabled the Etruscans to form profitable trading relationships with the Greeks and the Phoenicians. Moreover, salt mines in Volterra, salt works along the Tyrrhenian, and wool processing stations all helped boost economic output (Wittke, 2011).

In the first half of the sixth century, the Etruscan trading network extended to northern Europe, Phoenicia, Sardinia and Euboea. This led not only to the exchange of goods, but also to new institutions, culture and customs. Trade relationships with Euboeans inspired Etruscans to adopt new drinking practices, new ceremonies and the Greek alphabet. Imports of amber from northern Europe, perfume and ornamental objects and other luxurious products from Corinth indicate a high standard of living among the Etruscans (Bernardini and Camporeale, 2004). Despite their relatively limited territorial expansion, by the end of the 6th century, Etruscans had established a distinctive cultural stamp on many of the geographic areas around the Mediterranean Sea.

3. Data and empirical strategy

3.1 Data

In order to investigate whether there is a link between ancient colonialism and modern-day economic activity and population concentration, we compare geographic areas with and without ancient colonies. For that purpose, we divide the territory surrounding the Mediterranean and Black Sea into a large number of grid cells (geographic areas), each measuring 100 kilometres squared (Bakker et al, 2020; Jedwab and Moradi, 2016). For brevity, we refer to this area as

Mediterranean Sea or simply Mediterranean. The analysis is conducted restricting the sample to coastal grid cells, as most of ancient colonies where located on the coast or very near of it.[9]

3.1.1 Main independent variables

We collect data on ancient Phoenician, Greek and Etruscan colonies from the *Historical Atlas of the Ancient World* (Brill's New Pauly Supplements I, Volume 3, Wittke, 2011). Figure 1 illustrates the colonies of these three ancient civilisations circa 11th to 6th centuries BCE. There are 144 colonies around the Mediterranean along with 34 metropoleis.[10] Of these 178 settlements, 14 were Etruscan (8 colonies and 6 metropoleis), 134 were Greek (111 colonies and 23 metropoleis), and 30 were Phoenician (25 colonies and 5 metropoleis).

Our main independent variable is a binary indicator which takes the value of 1 if there is at least one ancient colony in the grid cell and 0 otherwise. As an alternative to this indicator, we generate 1km and 5km buffers around the coordinates of each colony and consider treated those grid cells overlapping with these buffers. We also calculate the distance to the nearest colony. For completeness, we also use other historical information sources on the location of ancient colonies. For the location of Greek colonies we utilise Osborne (1996), while for Etruscans and Phoenicians we exploit a variety of electronic sources (see Table A1 for more details). We augment this by utilising an extensive dataset on Greek poleis compiled by Ober (2015).

3.1.2 Main outcome variables

In order to construct our main outcome variable, we use night light emission data produced by the National Oceanic and Atmospheric Association (NOAA) National Centers for Environmental Information.[11] This satellite data reports images of the Earth between 2030 and 2200 hours local time. The satellite detects light from any human and natural activity including ephemeral light, sunlight, glares, moonlight, aurora, blooming areas (areas that reflect light due to snow) and cloud observations. Light data is then purged from all the non-permanent luminosity sources and converted into an index that takes a value ranging between 0 and 63 for approximately each square kilometre of surface. To mitigate problems derived from top-coding, which are particularly

[9] Our focus on coastal cells means that most grid cells are actually smaller than 100 km^2. This is because our sample is the result of the intersection between the 10×10 km grid and the Mediterranean coastline. We control for the grid cell surface area to take this into account.

[10] Metropoleis refer to settlements in the homeland of these civilisations.

[11] Night light emission has been widely used as an indicator of economic development (Michalopoulos and Papaioannou, 2013; Alesina et al., 2016; Fafchamps, Koelle and Shilpi, 2017). Moreover, Chen and Nordhaus (2011, 2014) argue that light density is likely to add value as a proxy for economic activity in cases where data is not available at sub-national level.

pervasive in urban agglomerations, we use corrected light data provided by Bluhm and Krause (2020), and used by Pinkovskiy and Sala-i-Martin (2020).[12] We use these data to calculate the average light density for each grid cell over a six year period spanning 2000 to 2005.

We complement the night light density indicator with a measure of population density using data from the Global Population of the World (GTW v4, Columbia University, 2018). This dataset provides population data at a very high (1km^2) spatial resolution. We take the average of the years 2000 and 2005 (albeit the results are very similar using the most recent available year of 2015, given that the correlation between both is 0.99). The correlation between our indicators of population density and night light density is 0.49, suggesting that these variables capture slightly different aspects of economic activity.

3.1.3 Other variables

We also collect data on a wide array of historic, geographic and climatic variables, including: ancient settlements and cities; distance to the former metropoleis; temperature; rainfall; altitude; ruggedness; agricultural suitability; types of rocks; and presence of rivers among others. Selected variables are described below as we introduce them into the analysis. More standard variables are defined in Appendix 1 in the Supplementary Material. Descriptive statistics are provided in Appendix 2.

3.1.4 Baseline sample

As mentioned above, we focus on coastal observations and remove small grid cells (smaller than 1km^2) yielding 4,306 observations. We further exclude geographic areas corresponding to the ancient homelands of Phoenicians, Greeks and Etruscans. This is because, by definition, colonies were located outside their homelands and consequently grid cells located there are not an appropriate comparison group. Moreover, we only keep observations with non-missing data for the main variables of the analysis. This applies to: the two dependent variables; the ancient colony indicator; and the set of control variables. This leads to a sample of 3,234 grid cells, of which 113 have ancient colonies. From the latter, 91 are Greek, 21 Phoenician and only one Etruscan.

[12] Bluhm and Krause (2020) correct top-coding by combining the so-called stable lights data with radiance calibrated night light data (which are less affected by the censoring problem). As the radiance calibrated light data have higher volatility and less time coverage, Bluhm and Krause (2020) do not use them directly. Rather, they argue that top lights follow a Pareto distribution and apply its properties to the data correction procedure. They show that corrected light data are a better proxy for economic activity than the uncorrected version, particularly when conducting the analysis at the city level. The latter is important given that our units of observation are small (≤ 10x10 km). Our results are robust using both stable lights and Bluhm and Krause (2020) data. This is unsurprising given that both variables are strongly correlated. The difference between both is only noticeable in the right tail of the distribution.

Therefore, the results are, in practice, based upon Greek and Phoenician colonies.

3.2 Empirical approach and methodological issues

Grid cells with ancient colonies have on average 353% higher night light density and 128% higher population density than corresponding grid cells without colonies. Focusing on within country variation, the difference is also large with values of 268% and 130%, respectively. The reason why grid cells with ancient colonies feature more economic activity today is arguably because ancient colonisers established settlements with urban features with some surviving as modern cities today. The key question is whether the observed difference is attributable to advantages derived from colonisation or simply due to inherent geographic differences. The latter implies that places with ancient colonies would have evolved similarly even if they had not been colonised. That is, due to their (supposedly) attractive geographic features, cities would have flourished anyway.

Our approach to identify any impact of ancient colonialism on modern day economic outcomes is to control for any relevant geographic and climatic attributes such that grid cells with and without ancient colonies are comparable.[13] We argue that, although ancient colonisers may have selected places to colonise with specific (attractive) features, there were many equally attractive areas around the Mediterranean that were not colonised. As a consequence, it is possible to compare similar areas that were subject to colonisation with counterparts where no colonisation took place.

This approach involves collecting a large set of control variables. Some of the variables such as temperature, rainfall, elevation, ruggedness, soil quality, being an island, latitude, and longitude are standard in the economic geography literature. Other variables are less common and merit a brief description. First, there is a group of variables related to the attributes of the coast. *Coast length over surface area* controls for heterogeneity in terms of the length of the coast. *Depth of the sea* measures the average depth of the sea within a distance of 10 nautical miles from the coast. *Port excellent shelter* is a dummy variable indicating whether a grid cell contains an ancient port classified as excellent shelter by modern nautical guides.[14] *Access to mainland* captures how

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[13] We also conduct below a propensity score matching analysis as an alternative estimation method (see Section 4.5).

[14] de Graauw (2017) provides a list of ancient harbours and ports based on documents produced by 79 ancient and modern authors and incorporating information from the Barrington Atlas (Bagnall and Talbert, 2000). This yields a list of around 4,400 ancient ports. de Graauw (2017) identifies as a port or harbour 'a place where ships can seek shelter. In the concept of 'shelter' must be included anchorages, landing places on beaches and ports'. Shelters of interest in de Graauw's (2017) catalogue include 'all places which may have been used by seafarers sailing over long distances'. Figure A1 in the Supplementary Material shows the geographic distribution of ancient ports.

accessible the mainland is from each point on the coast taking into account the slope of the surface.[15] *Coast connectedness* is a measure of how many coastal grid cells are within a distance of 500 km from each point on the coast moving only through water (following Bakker et al., 2020).

Second, there is another group of variables related to the position of the grid cell within the network of colonies and metropoleis. *Distance to Ancient Greece homeland* and *to Ancient Phoenician homeland* refer to the sea-distance from each grid cell to the average location of the metropoleis of these civilisations.[16] *Number of colonies within 200 km* measures the number of colonies and metropoleis within this distance in order to capture the potential advantages of being located close to other Phoenician, Greek and Etruscan settlements.

The third group of variables includes factors related to the availability of natural resources important for human activity. *River* is a dummy variable indicating whether a river at least 50 metre width passes through the grid cell. *Distance to ancient lake* measures the proximity to a lake as another source of drinkable water. *Marble* and *limestone* capture the availability of these types of rocks that were important construction materials for Greek (and Roman) architecture (Tucci, 2014). *Original forest* reflects whether the place was a forest area before the impact of human activity and, therefore, whether wood was available (UNEP-WCMC, 1998). We also include country-fixed effects to capture any unobserved country-wide characteristics (such as national institutions or common historical shocks).

In Table 1, we examine the relationship between our colony dummy and all the aforementioned control variables, after partialling out country-fixed effects. This is a helpful exercise to guide our empirical analysis and gauge the likely importance of certain covariates. Ancient colonies appear to have been associated with less rainfall, located at higher altitude, and more likely to have a port labelled as excellent shelter. Moreover, ancient colonies were in closer proximity to Greek metropoleis and located in grid cells that cover larger surface area. The correlation of our colony dummy indicator with the other 17 variables is statistically insignificant.

Regarding the correlations that turn out to be significant, less rainfall is a negative characteristic for a location in the Mediterranean. As a consequence, this feature does not create an upward bias in the estimated impact of ancient colonies on economic outcomes. Higher altitude could have been an attractive feature in the past, for defensive reasons, but ceased to be an advantage a long time ago. The same applies to proximity to Greek metropoleis, which also ceased

[15] More specifically, it measures the number (in hundreds) of 10x10 km grid cells located in the mainland that are within a distance of 250 km from the coast moving only through land and taking into account the slope of the surface (for instance, passing through a cell with a slope of 5% is twice as costly as passing through a flat cell). Figure A2 in the Supplementary Material illustrates the construction of this indicator.

[16] Distance to the Etruscan homeland is not included because, as mentioned above, the sample only contains one Etruscan colony.

to be important when the centre of gravity in the Mediterranean moved to the West. The positive association with surface area simply reflects that the likelihood of observing a colony is greater within larger grid cells. More concerning is the extent of the correlation with ports labelled as excellent shelters, which suggests that ancient colonisers selected coastal locations to colonise that have good shelters. We tackle this issue in several ways. First, we include *port excellent shelter* in our set of control variables in the baseline regression model. Second, we show that, when focusing on the non-European sample, where ports labelled as excellent shelters are balanced across treated and control grid cells, the effect of ancient colonialism is also large and significant. Third, we show that excluding cells containing ports labelled as excellent shelters does not change our main results. Fourth, we conduct a matching exercise in which we ensure that treated and control grid-cells are indistinguishable based upon observables and, particularly, on excellent shelters. The results are consistent, and show that the impact of ancient colonies on modern day economic outcomes is not driven by different locational (geographic) characteristics, but instead by genuine man-made interventions that led to long-lasting advantages accruing to colonised areas.

Another concern with the empirical strategy is the possible presence of survivorship bias in the ancient colonies observed. There exists the possibility that we are more likely to observe colonies that have succeeded and have survived over time to become cities. This would inflate the observed impact of ancient colonialism on economic outcomes. We address this concern through several avenues. First, we argue that there are several sources of information from which historians can reliably collect evidence on former colonies. The available data is not only based on archaeological evidence *in situ* (the source arguably most affected by the survivorship bias), but also on historical writings and testimonies left in the metropolis and other places, which help identify and locate ancient colonies. Second, we include country fixed effects to control for the fact that some (richer) countries can afford more archaeological exploration than others. This could also bias our coefficient of interest upwards. Third, we use several alternative data sources in order to measure the extent of ancient colonialism. In particular, we use a rich dataset that contains a comprehensive list of Greek poleis for which survivorship bias should not be a concern (Ober, 2015). Fourth, we also control for distance to archaeological departments and modern cities to take into account the possibility that more excavations may have taken place in areas nearby.

We also acknowledge that our main dependent variable, light data, is known to be affected by measurement problems, such as blooming and overglow (Pinkovskiy, 2017; Michalopoulos and Papaioannou, 2018). The former refers to the fact that lights are magnified over some covers such as snow and water. The measurement error introduced by blooming is unlikely to be a significant problem given that we focus on a homogeneous coastal sample and control for altitude and ruggedness. Overglow relates to light spillovers between neighbouring grid cells. Such light spillovers could introduce a downward bias in the coefficient on ancient colonies and therefore work against finding an effect. To further test whether imprecision in the compilation of light data are affecting our results, we use additional data collected from the Visible Infrared Imaging Radiometer Suite (VIIRS). This data is compiled using sensors with higher spatial resolution, but is not available until 2015 (Bluhm and Krause, 2020). The results are robust to the use of this alternative light data source.

Finally, it is worth discussing the relative merits of using 100 km^2 grid cells for the purposes of our empirical analysis. On the one hand, analytical regions (grid cells) are not affected by administrative boundaries that may evolve endogenously. As a consequence, they do not capture any functional aspects of these regions and potential spillovers to neighbouring cells, which were also arguably affected by ancient colonies. This may create a downward bias in the coefficient of ancient colonies, thereby working against finding an effect. On the other hand, the small grid cell area selected increases the precision of any empirical analysis, and allows us to more accurately measure the variables used. However, the downside of a small cell area is that also increases the likelihood of observing spillovers between neighbouring grid cells. As a robustness check, we also repeat our analysis using larger 50x50 km grid cells. The results (which confirm our baseline findings) are reported in the Appendix.

4. Main results: The effect of ancient colonialism on modern-day economic outcomes

4.1 Baseline results

To investigate the possible link between ancient colonialism and modern-day population density and economic activity, we estimate the following equation via Ordinary Least Squares (OLS), with standard errors clustered at the country level.

$$Y_{ic} = \alpha * Ancient\ colonies_{ic} + \beta * X_{ic} + \eta_c + \varepsilon_{ic}, \quad (1)$$

where i denotes grid cells and c denotes countries. Y_{ic} is our dependent variable and represents the logarithm of night light density or the logarithm of population density. $Ancient\ colonies_{ic}$ is a binary variable, which takes the value 1 if there is at least one ancient (Phoenician, Greek or Etruscan) colony in grid cell i of country c, and 0 otherwise. X_{ic} is a vector of geographic, topographic and climatic characteristics that includes the twenty two variables used in Table 1. Our model also includes country fixed effects, η_c. ε_{ic} is a stochastic error term. The coefficient of interest, α, captures any impact of ancient colonies on current economic outcomes.

Tables 2 and 3 present the baseline results. Column 1 in Table 2 shows the impact of ancient colonies on light density conditional on country fixed effects. The coefficient on $ancient\ colonies_{ic}$ is positive and highly statistically significant. This suggests that ancient colonialism has a positive impact on the concentration of economic activity. Columns 2 through 12 augment the specification used in Column 1, by introducing various geographic and climatic control variables. Column 13 reports the results of estimating a saturated model, which includes a full set of control variables along with country fixed effects. Despite the large number of variables included, the coefficient on $ancient\ colonies_{ic}$ is only slightly smaller than in column 1, remaining both statistically and economically significant. Grid cells with ancient colonies have a level of light density that is 180% higher than counterparts without colonies ($e^{1.031}-1$). Regarding the effect on population density, column 13 in Table 3 indicates that areas where ancient colonisers settled are 99% more densely populated today.

A few issues regarding our baseline results are worthy of note. First, it appears that ancient colonialism has impacted the level of economic activity more than population density. We explore this issue further in Section 5.1 below. Second, the size of the coefficients is large, but similar to estimates presented in other related studies. Although our results are not directly comparable with those of modern colonialism, recent related evidence finds similar (or larger) effects to that presented in the current study.[17]

Third, the fact that the coefficient on $ancient\ colonies_{ic}$ is stable across various model specifications suggests that unobservables are not driving the effect of ancient colonialism on modern day economic outcomes. Nevertheless, in order to address this issue more formally we follow Oster (2019), who builds on Altonji et al. (2005)'s insight that selection on observables can assist in estimating the potential bias arising from selection on unobservables. This approach is based upon the assumption that selection on observables is proportional to selection on unobservables, and thus offers upper and lower bounds for any omitted variable bias. The upper bound is given by $\tilde{\alpha}$, while the lower bound is equal to $\tilde{\alpha}-(\acute{\alpha}-\tilde{\alpha})\left[\left(R_{max}-\tilde{R}\right)/\left(\tilde{R}-\acute{R}\right)\right]$. $\tilde{\alpha}$ is the coefficient on ancient colonies when a full set of (observable) controls is included in Equation (1). $\acute{\alpha}$ is the coefficient on ancient colonies when no controls other than the treatment are included in the model specification. $\tilde{R}$ and $\acute{R}$ denote the respective R^2 in the two regression specifications, while R_{max} is the R^2 in a hypothetical regression when all (observable and unobservable)

[17] For instance, Bleakley and Lin (2012) examine the role of historical portage sites on current economic activity. The findings of the authors suggest that the existence of a historical portage site in U.S. census tracts, is related to 204% higher current population density. Moreover, Jedwab and Moradi (2016) partition Ghana to 0.1 × 0.1 degrees cells and find that those which have a colonial railroad from 1918, experience 415% higher light density today. Other research which finds similar effects of historical events on economic activity indexes (such as population density, light density, etc.) include Michalopoulos and Papaioannou (2011), Bertazzini (2018), Dalgaard et al. (2018), Büchel and Kyburz (2020).

variables are controlled for. A bound on the treatment effect that excludes zero suggests that the coefficient is robust to omitted variables bias. We set $R_{max} = 1.3 * \tilde{R}$, and obtain [0.875, 1.031] and [0.642, 0.687] as bounds for the effect of ancient colonies on log night light density and log population density, respectively. These estimated intervals suggest that the coefficients on ancient colonies are unlikely to be confounded by selection on unobservables.

4.2. Additional control variables

4.2.1 Pre-colonisation controls

The results presented in the previous section suggest that the impact of ancient colonies on modern day economic outcomes is robust after controlling for a myriad of geographic and climatic factors. Yet, one could argue that ancient colonisers could have selected places to colonise that were close to areas already populated. As a consequence, any observed relationship between colonisation and economic activity might simply reflect the persistence over time of very early population settlements. In order to address this concern, we collect data that measures (directly or indirectly) the existence of settlements before the commencement of our observed period of colonisation. First, we calculate the land-distance from the centroid of each grid cell to the Fertile Crescent and Jericho, where agriculture originated about 10,000 years ago (Olsson and Paik 2020). The rationale is that agriculture steadily spread across space from the Fertile Crescent, and that the timing of transition to agriculture is an effective predictor of later development (Bakker et al., 2020). Second, using spatial interpolation we calculate the time since the Neolithic revolution (Pinhasi et al., 2005; Olsson and Paik 2020). Third, using previously published sources, we measure the presence of ancient cities prior to 1000 BCE (Reba et al. 2016), Bronze age sites (Whitehouse and Whitehouse, 1975, digitized by Bakker et al., 2020) and ancient settlements prior to 1000 BCE (Pleiades, 2017). Given the very low number of coastal 100 km^2 grid cells containing ancient cities and settlements, we construct binary indicators measuring whether an ancient city or settlement is present within a distance of x km, where x ranges from 10 to 200. Columns 1 to 6 of Table 4 (Panels A and B) show that the inclusion of these variables does not alter our baseline results, with the coefficient on ancient colonies remaining stable across specifications.

4.2.2 Proximity to important cities and archaeological departments

Another source of concern is related to selection in areas where excavations have been carried out that resulted in discoveries of archaeological remains. For example, having a university with a department of archaeology increases the chances of having comprehensive archaeological research in a given geographic area. Similarly, archaeological finds are also more likely to happen around major cities, while preparing land for new urban development. To assess any potential bias arising from this issue, we construct variables that measure the distance of each cell to its nearest: major city; major or secondary city; and archaeological department. Regarding the first two variables, we use the Natural Earth's Populated Places. This dataset provides information regarding all major and secondary cities around the world. We extract information on all universities with archaeological departments from the IAU WHED Portal (a global reference tool constructed in collaboration with UNESCO), and the Times Higher Education (THE) newspaper. The results, reported in columns 7 to 10 of Table 4 (Panels A and B), are robust and indicate that proximity to cities and universities with archaeological departments does not affect the coefficient on ancient colonies.[18]

4.3 Dealing with spatial autocorrelation

Regressions of the form estimated above are likely to produce inflated *t*-statistics when observations are spatially autocorrelated (Kelly, 2019). Following Kelly (2019, 2020), we test for this possibility. First, we estimate Moran *I* statistics followed by simulation exercises with a spatially autocorrelated noise variable. The results of the analysis (which are reported in full in Appendix 3), indicate the presence of spatial autocorrelation in our dependent variables. The results of the simulation exercise suggest that the structure of the spatial autocorrelation in our data has only a mild effect on the *t*-statistic of the variable of interest. This is considerably smaller than those documented in Kelly (2019).[19] Second, in line with Kelly (2020), we employ two different variance-covariance estimators to account for spatially autocorrelated residuals. The first estimator is due to Kelly (2020) and imposes a parametric structure on the spatial autocorrelation of the residuals by means of the Matérn correlation function. The second estimator is the large cluster approach implemented with three large clusters (Bester et al., 2011). Prior (Monte Carlo) evidence suggests that the large cluster approach with three clusters produces rather conservative estimates, and is robust to varying patterns of spatial autocorrelation (Kelly 2020). The results of this analysis, which are presented in Table 5, suggest that our findings are not driven by spatial autocorrelation.

4.4 Maritime connectivity

In a recent paper, Bakker et al. (2020) contend that certain coastal locations were advantaged by

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[18] The magnitude of the coefficient decreases when including distance to major and secondary cities (column 8), which is constructed using a large dataset of 7,343 cities worldwide (361 within 100 km of the Mediterranean coastline). The decrease in the coefficient is expected as urban persistence is part of the mechanism accounting for the effect of ancient colonies.

[19] Appendix 3 provides a more detailed discussion of the simulation results.

coastal geography, which enabled better connectivity with trading partners located further afield during the Iron Age. We examine whether our findings could be driven by colonies located in areas that exhibit maritime connectivity advantages over their non-colonised counterparts. In other words, we consider the possibility that the Phoenicians, Greeks and Etruscans settled in places with superior maritime connectivity, which provided settlements with a better chance of survival. To alleviate such concerns, we follow Bakker et al. (2020) and include this connectivity measure in our control set of variables. To further assess whether maritime connectivity is driving our findings, we restrict our sample to grid cells with similar levels of connectivity. Specifically, we construct several different restricted samples by setting the cut-off point at different levels of maritime connectivity. That is, by excluding observations with least and most (10%, 20%, 30%, 40% and 50%) values of maritime connectedness. Table 6 presents the results of this analysis. Overall, the results suggest that the positive and significant relationship between ancient colonies and current economic activity reported in our main findings is not driven by different levels of maritime connectedness among Mediterranean coastal locations.[20]

4.5 Location in excellent shelters

Table 1 suggests that ancient colonies tend to be located in grid cells containing ports labelled as excellent shelters by modern nautical guides. This lack of balance is a source of potential concern. However, this can be addressed in several ways (besides simply including in the baseline specification a variable capturing whether a given port provided excellent shelter to ships). There is arguably a selection bias in the construction of our excellent shelter variable given that areas on the coast where ancient colonisers settled and created ports are more likely to be classified as excellent shelters relative to similar, but lesser known locations on the coast where colonisation did not take place. Moreover, the Mediterranean coastline has an abundance of natural harbours with many classified as excellent shelters. As such, the correlation with ancient colonies is low. Only 10.6% of colonies are in grid cells with excellent shelter ports, while only 7.9% of grid cells with excellent shelters contain colonies.[21]

Second, Table 7 shows that when all grid cells containing ports (columns 1 and 4) or excellent shelter ports (columns 2 and 5) are omitted, the results hold. This is also the case when using a non-European sample (columns 3 and 6), where the excellent shelter variable is highly balanced between locations that were colonised and those where colonisation did not take place (column

[20] Section 4.5 includes an analysis based on a matched sample, which is obtained on several observables including maritime connectivity. The results of this matching exercise further alleviate any concerns that different levels of connectedness among coastal grid cells could be driving our findings.

[21] Figure A1 in the Supplementary Material provides a map with the distribution of natural harbours around the Mediterranean.

7). Third, we conduct a matching exercise in which we ensure that treated and control grid cells are indistinguishable based on the presence of excellent shelters. In order to do so, we construct matched samples using two different methods, while ensuring an exact matching on excellent shelter ports. First, we employ a nearest neighbour approach which matches each grid cell with a colony to its nearest neighbouring grid cell without a colony. This matching is performed with replacement such that one grid cell without a colony could act as the closest match for multiple grid cells with a colony. This matching results in a sample of 406 grid cells (113 with a colony and 293 without). Nevertheless, this matching method faces the risk of bad matches if the nearest neighbour is far away in terms of propensity score. In order to ensure the robustness of our results to the matching method, we also perform a radius matching procedure, which matches each grid cell with a colony with all grid cells without a colony that lie within a pre-determined propensity score distance level, i.e. a small caliper of 0.0001 (Dehejia and Wahba, 2002). Table 8 presents OLS estimates of our baseline model using the aforementioned matched samples. The results are qualitatively similar to those obtained from the unmatched sample, and thus lend support to our baseline results and primary conclusions.

4.6 Distinguishing among colonisers and continents

In order to investigate whether the economic impact of ancient colonialism depends on the identity of the coloniser, we create three dummy variables to distinguish between colonies based on coloniser identity. There are 91 grid cells with Greek colonies, 21 with Phoenician colonies, and one with an Etruscan colony. Columns 1 and 3 in Table 9 show that the positive relationship of ancient colonies with light and population density holds across Greek and Phoenician colonies.[22] According to column 1, the size of the coefficient is very similar in both cases for light density, while in column 3, the effect of Greek colonisation on population density is larger, albeit one must exercise caution when interpreting these results given the relatively low number of Phoenician colonies relative to Greek counterparts. The similar coefficients on Greek and Phoenician colonies are not necessarily surprising as in both cases the type of colonisation and coloniser was similar, although Phoenicians arrived earlier. Greeks and Phoenicians were largely urban societies, with inclusive institutions and diversified and commercial oriented economies.

Both Greek and Phoenician colonies were characterised by an urban model. Greek poleis and colonies were mostly uphill wall-enclosured cities with a fortress or acropolis in the middle. Marketplaces (agora) and sanctuaries were among the most important places of a Greek colony (Pounds, 1969). In the case of Phoenician colonies, recent research suggests that these developed

[22] Naturally, no inference can be done from Etruscan colonies as there is only one in our coastal sample.

Greek-like cities and trading posts (emporia). They were also constructed within fortified hilltops accompanied by markets, roads, and city gates, thus forming urban-style settlements (Garnand 2020). Besides the urban landscape, Greek and Phoenician cities shared similar market and social institutions. Greek market participants (e.g., producers, landowners…) had rights to engage in the market freely, with laws in place establishing market rules. Such rules included maximum hours of a working day, price controls, contracts and oligopolistic practices (Bresson 2015). The Phoenician economy, which was largely based on trade and commercial relations, benefited from institutions that promoted trust and punished misbehaviour. In common with the Greeks, magistrates, city councils and assemblies were key parts of the Phoenician city structure (Terpstra 2019). Overall, despite some distinctive features, Greek and Phoenician city states were characterised by similar urban governments with complex political and economic institutions. Our results showing similar impacts to Greek and Phoenician colonisations on economic outcomes are consistent with this.

It is also informative to assess whether the economic impacts of ancient colonialism are similar across continents, or whether one continent is driving the results. For this purpose, we create three dummy variables, one for each continent, and interact these with our ancient colony dummy. This allows us to differentiate the impact of ancient colonialism across continents. The results, reported in columns 2 of Table 9, show that the impact of colonisation on light density is the strongest for Africa, followed by Asia and Europe. In all cases our coefficient of interest remains economically and statistically significant. The lower coefficient for Europe is possibly attributable to the widespread development that has affected a large swathe of this territory. For this continent, the imprint of ancient colonialism is slightly less visible than for areas such as northern Africa, which have not witnessed similar development. Column 4 shows that the effect on population density is relatively similar across continents, although slightly higher for Europe.[23]

4.7 Alternative indicators and sources for ancient colonialism

Table 10 uses alternative indicators and sources to measure the presence of ancient colonies. Columns 1, 2, 6 and 7 employ a variable similar to the baseline indicator, but now the grid cell is considered treated (*ancient colony* equal to 1) if it is within a distance of 1 km or 5 km from the location of a colony. In this way, we take into account any potential measurement errors in the

[23] The relatively similar effect across continents suggests that, despite different local conditions and subsequent country-level development, the local effect of ancient colonies (i.e., of establishing an urban-style settlement) has been similar. This may be due to the homogeneity of our coastal sample. Shared characteristics across coastal locations may explain the relatively homogeneous effect of ancient colonies on economic outcomes across continents.

exact location of ancient colonies. Columns 3 and 8 employ distance from the nearest colony (in log) as an alternative indicator to measure the influence of ancient colonialism. While the variable *ancient colonies* assumes a discrete and discontinuous effect of ancient colonialism, the variable distance to the nearest colony assumes the existence of a continuous relationship between the geographic distance to an ancient colony and economic outcomes. We expect that the positive influence of ancient colonies diminishes as distance from the colony increases. In all cases the indicator carries the expected sign.[24]

In addressing concerns that our results hinge upon a singular source of information regarding the location of ancient colonies, we repeat the analysis in columns 4 and 9 using an indicator of ancient colonies based on alternative sources. In both specifications, the alternative colony dummy variable enters into the regression with a statistically significant positive coefficient, indicating that our findings are robust to alternative data sources regarding the location of ancient colonies. As an additional exercise, we use Ober's (2015) dataset on Greek poleis. This source contains a comprehensive list of all Greek poleis known to have existed in the Antiquity, from 800 BCE up to 323 BCE, and covering the archaic as well as the classical period of ancient Greece. We consider as colonies all those Greek poleis outside the Greek homeland. While this source has the obvious disadvantage of covering Greek colonies only, it has the important advantage of being very comprehensive, and thus mitigates possible survivorship bias of the form discussed in Section 3.2.[25] The results, which are reported in columns 5 and 10, show a positive and statistically significant effect of Greek colonies on the concentration of economic activity and population density. This suggests that the survivorship bias does not drive our results.

4.8 Additional robustness checks

This subsection conducts further robustness checks. First, we exclude dark grid cells (with an average value of light density equal to zero), and grid cells that are unpopulated. Second, we

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[24] To further study the effect of distance to the nearest colony, we interact it with the continent dummies. Appendix 4 shows that, when light density is the dependent variable, the coefficient is the strongest in Asia, smaller in Europe and insignificant in Africa. When the dependent variable is population density, it is statistically significant in the three cases, being smaller for Europe. Moreover, we split the indicator of distance to the nearest colony depending on whether the nearest colony is Phoenician, Greek or Etruscan. There are 976 grid cells whose closest colony is Phoenician, 2074 whose closest one is Greek, and 184 Etruscan. The results reported in Appendix 4 show that the strongest negative relationship of light and population density is with distance to Phoenician colonies, although the difference with Greek colonies is not large. This suggests that spillovers of Phoenician colonies were more important, that is, that these colonies had a greater impact on their neighbours than other colonisers. This is consistent with the fact, mentioned in Section 2, that Phoenicians held closer relations with indigenous societies in the areas where they expanded.

[25] Ober's (2015) dataset is based largely on the *Inventory of Archaic and Classical Poleis* (Hansen and Nielsen, 2004). The *Inventory* is a monumental work by the Copenhagen Polis Centre that contains information on more than 1,000 Greek city-states known to have existed during the period c. 800-323 BCE.

include more demanding fixed effects consisting of grids of 400x400 km and 200x200 km. This produces 45 and 110 dummy variables respectively. In this way, we ensure that the comparison is made among cells in close geographic proximity. Third, we run our baseline model specification deleting countries one by one. This allows us to check whether any individual country exerts an undue influence on the coefficient of interest. The positive coefficient on the colony dummy remains robust and statistically significant in all cases. Fourth, we repeat the main analysis using a cell size of 50x50 km. This allows us to better capture any spillovers of ancient colonies to neighbouring areas. Fifth, we use light data from the Visible Infrared Imaging Radiometer Suite (VIIRS), which while not available until 2015 is less affected by measurement problems as mentioned above. Our main results hold in all cases and are reported in Appendix 5.

5 Explaining the long-term effects of ancient colonialism

The results so far establish a robust reduced-form effect of ancient colonies on population density and economic activity. This section tries to elucidate the nature of this effect and the mechanisms that account for it.

5.1 More economic activity or simply more population density?

If ancient colonisation affects economic activity beyond its effect on population density, this would suggest that the legacy of ancient colonisers is not only having founded settlements that persist over time, but also providing the basis for a more dynamic economic environment. To investigate this issue, we use lights per capita as the dependent variable in Table 11. Column 1 shows that cells with ancient colonies have on average a level of lights per capita that is 59% higher than non-colonised counterparts.

Column 2 includes population density. While population density is a “bad control” in the sense that it can also be considered an outcome of ancient colonies, it allows to mitigate the fact that lights do not accumulate linearly (Angrist and Pischke, 2008). The ‘digital number’ reflecting light intensity ‘is not exactly proportional to the physical amount of light received (called true radiance)’ (Henderson et al., 2012, p. 999), which is due to sensor saturation and the scaling factor. This generates a bias when using the indicator in per capita terms. Thus, when light intensity is sufficiently high, increases in population (the denominator in lights per capita) leads to small or absence of increases in light intensity (the numerator). Controlling for population density partially alleviates this.[26] The coefficient is now larger and more precisely estimated. Columns 3 and 4 use the more advanced VIIRS data, which is not available until 2015. The results are qualitatively

[26] Appendix 6 further discusses the limitations of lights per capita as an income indicator.

similar.

5.2 Institutional-cultural transfer or urban persistence?

There are two complementary mechanisms that could explain the positive impact of ancient colonialism on modern day economic outcomes. One mechanism is couched in terms of institutions and culture. Ancient colonialism was a major positive shock in terms of institutions, culture, human capital and technology. The Phoenicians, Greeks, and Etruscans enjoyed a much higher standard of living than the rest of their Mediterranean neighbours. They operated largely urban societies, and had more inclusive institutions, a high level of civic capital and more diversified and sophisticated economies. All these elements were transferred to the new colonies, with positive consequences for economic development. Another related mechanism is urban persistence, which contends that once a town or settlement is founded, the forces of agglomeration can reinforce the dynamics of the concentration of economic activity over the long-run. Prior evidence suggests that cities are persistent and resilient to major negative shocks (Davis and Weinstein, 2002; Bleakley and Lin, 2012).

We investigate the relative importance of the institutions and culture and the urban persistence mechanisms by comparing settlements of Phoenician-Greek-Etruscan origins to settlements of other cultures of similar age. We use the gazetteer of ancient places *Pleiades* (2017) to collect information on settlements existing in 750-250 BCE. A dummy variable *other ancient settlements* is created which takes the value of 1 if the grid cell contains at least one ancient place classified as a city, urban, town, village or settlement, and 0 otherwise. The variable also equals 0 if the grid cell contains an ancient colony. If the coefficient on the ancient colony dummy is larger than the coefficient on *other ancient settlements*, this would imply that the underlying mechanism driving our observed results is not only urban persistence, but also the transfer of institutions and culture.

Columns 1, 3 and 5 in Table 12 include the variable *other ancient settlements* measured in 750, 500 and 250 BCE, respectively. The coefficients on these variables are positive, thereby indicating that there is a long-term persistence in the settlement structure of the territory. However, interestingly the size of the coefficients on ancient colonies is larger. This result suggests that both the 'urban persistence' and the 'institutions-culture' transmission mechanisms help explain the positive impact of ancient colonies on current economic outcomes, although the small difference between the coefficients suggests that the former is the most important channel.

It could be argued that the coefficient on ancient colonies is larger because measurement errors are more pervasive for *Other ancient settlements*. We acknowledge this potential criticism and have only used those places with a precise location to create our 'other ancient settlements' variable.[27] Moreover, we also construct a more restricted measure of settlements that focuses exclusively on places classified as city, town or urban area. Arguably, this indicator captures important and well-studied ancient places. The results reported in columns 2, 4 and 6 are largely consistent to those presented previously.

Columns 7 to 12 in Table 12 use population density as the dependent variable. The coefficient on ancient colonies is more precisely estimated, but not always larger (particularly in column 7). This suggests that urban persistence is the relevant channel with respect to population density. To some extent, it makes sense that the institutional-cultural mechanism does more to explain economic activity than to explain population density given the examples of very large agglomerations in places with poor institutions we observe around the world today.

Overall, the evidence provided by this section suggests that urban persistence is not the only factor responsible for explaining the long-term impacts of ancient colonies on modern day economic outcomes. Arguably, some kind of institutional-cultural transfer has affected the subsequent development of these settlements. Naturally, not all the elements or factors involved in this process have persisted over time. Nevertheless, some factors such as urban-style and commercial networks may continue to be relevant.

5.3 Did ancient colonies differ from other ancient settlements?

We now turn to analyse whether ancient colonies were any different from other ancient settlements. If there was some institutional-cultural transfer, we should observe some differences among them. We first assess the urban characteristics of both types of settlements. As we have argued previously, the Greeks and Phoenicians exported an urban model when founding colonies, following the example of their homelands. As a consequence, one might expect these colonies to have more urban related architectural features. Columns 1 to 5 in Panel A of Table 13 compare ancient colonies with other ancient settlements (that existed before 330 BCE) in terms of their urban archaeological characteristics. For each ancient colony and settlement, we count the archaeological sites with urban-related features within 1, 2, 3, 4, and 5 km distance (from its coordinates).[28] We transform this measure into a dummy variable capturing whether there is at least one urban-related feature within these distances. This is a convenient transformation given the low proportion of non-zero observations. We regress this indicator on the ancient colony

[27] Pleiades (2017) classifies the precision of a location as either unlocated, rough, related or precise.

[28] We consider with urban-related features those sites containing the following words in the "feature type" field of Pleiades' dataset: acropolis, theatre, aqueduct, architecturalcomplex, basilica, bath, cemetery, church, circus, cistern, ekklesiasterion, fountain, gymnasium, lighthouse, monastery, monument, palaistra, plaza, port, pyramid, sanctuary, shrine, stadion, station, stoa, taberna-shop, temple, townhouse, treasury, city, urban, and vicus (note that amphitheatre is contained in "theatre" and city-gate and city-wall in "city").

dummy and the baseline set of controls. Both the dependent variable and the ancient colony dummy are included at the archaeological-site level, which constitutes the unit of observation. The control variables are included at the grid cell level. Column 1 shows that ancient colonies were more likely to have urban characteristics than other ancient settlements. The difference is large as reflected by a coefficient of 0.24 for an average value of 0.16. The results do not change if we consider sites within 2, 3, 4 or 5 km from each settlement (rather than just 1 km). Moreover, the results do not change if we compare ancient colonies with sites existing before 550 BCE (rather than 330 BCE), as shown in columns 6 to 10.[29] Appendix 7 shows that ancient colonies had more urban-related features not only before 330 BCE or 550 BCE, but also later during the Roman period.

In addition to the urban model, we also investigate whether ancient colonies are related to better institutions. This would cast further light on whether an institutional-cultural transfer is taking place. Unfortunately, it is virtually impossible to collect data in a systematic way on local level institutions for all Mediterranean countries. Instead we adopt an indirect approach by leveraging the POLIS dataset and comparing colonies according to their degree of democracy (Ober, 2015). More specifically, we focus only on poleis outside the Greek homeland where a history of their regime is available. This yields a small dataset of 59 observations. We then compare poleis with evidence for democracy with those without evidence for democracy. If the type of institutions transferred to the new locations matters for the long-run effect of ancient colonialism, we should observe differences between colonies with evidence for democratic institutions and those without it. Columns 1 and 2 in Panel B of Table 13 show that poleis with evidence of democracy have today more light density and population density (albeit in the latter case this is not statistically significant).

Finally, another piece of evidence showing that ancient colonies were different than other settlements comes from their location with regard to ancient trading routes. Using data from the Old World Trade Routes (OWTRAD) project, there were 47 maritime trade routes in the Mediterranean c. 150-200 CE, based on 33 trading nodes (Ciolek, 2000). More than half of these nodes (18) were located either in ancient colonies (15) or in metropoleis (3). Moreover, 24 trading nodes were no further than 50 km from ancient colonies. This indicates that ancient colonies differed from other settlements in their strong commercial orientation. To analyse this point more formally, we use distance to trading nodes as a dependent variable in columns 3 to 5 of Panel B (Table 13) and compare the coefficient on ancient colonies to that estimated for other ancient

[29] According to Pleiades, the Archaic period refers to 1000-550 BCE and the Classical period to 550-330 BC. Later periods are the Hellenistic-republican (330-30 BCE), Roman (30–300 CE), and Late-antique (300–640 CE).

settlements. The results confirm that trading nodes are closer to ancient colonies, suggesting that the latter actively contributed to the development of the Mediterranean trade routes.

6. The effect of ancient colonialism on the development of the urban system

In this section we focus on the idea that ancient colonisers distributed a major innovation around the Mediterranean in the shape of urban settlements or cities. The evidence provided in the previous section supports this point given that urban-related features were more common in ancient colonies than in other settlements of similar periods. This is an important part of the explanation for the positive impact that ancient colonisation appears to have on economic activity and population density. Ancient colonists exported an urban lifestyle that went hand in hand with their institutional and cultural influence. By founding cities, they were offering a model which natives could copy. Therefore, both directly (by establishing urban settlements themselves), and indirectly (by offering a model that others could follow), ancient colonialism has potentially played a relevant role in the origin and evolution of the urban system in the Mediterranean (Osborne and Cunliffe, 2005; Scott, 2018).

Table 14 tackles this question by analysing the relationship between ancient colonies and the urbanisation process of the Mediterranean coast from 1000 BCE until today. For the period before 800 CE, there is no systematic urban data available. Therefore, we use the gazetteer of ancient places *Pleiades* (2017) to collect information on settlements existing at different points in time. We create dummy variables indicating whether the grid cell contains at least one ancient place classified as a city, urban, town, village or settlement. We also create a dummy variable capturing the presence of Roman cities during the period 100 BCE to 300 CE. In addition, we construct another dummy variable which captures the existence of Roman roads (under the assumption that Roman roads and ancient urban development are correlated).[30] For the period 800-1800, we use the urban dataset collected by Bosker et al. (2013) from Bairoch et al. (1988) and several other sources, while for modern-day cities we use data from Geonames (2020) and the Urban Centre Database (UCDB, European Commission, Florczyk et al., 2020). To ensure sample consistency across columns, we exclude countries not covered by Bosker et al. (2013). These comprise Russia, Ukraine, Moldova, and Georgia.[31]

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[30] Indeed, there is a strong correlation between the presence of Roman roads and these settlements indicators. Thus, the percentage of grid cells with ancient settlements (in year 0) is 19.5 percentage points higher for those cells with Roman roads –conditional on country fixed-effects and the full control set of geographic and climatic variables.

[31] With respect to ancient settlements collected from Pleiades (2017), this dataset provides for each archaeological site an estimation of the start and end dates. We use this information to create our measure of settlements for each period. For instance, a settlement existing in 500 BCE has a start date equal to or earlier than 500 BCE and an end date equal to or later than 500. The same settlement may count several

Columns 1 to 7 use the presence of settlements from 1000 BCE to 500 CE as dependent variables. The coefficient on ancient colonies is always positive and statistically significant from 750 BCE onwards.[32] These results suggest that ancient colonialism created a persistent pattern of settlement (urbanisation) from the very beginning of the Mediterranean urban system. For instance, the coefficient in column 5 indicates that the percentage of grid cells with settlements is about 60 percentage points higher for those grid cells with ancient colonies. This is a large effect given that the percentage of observations with settlements in 0 CE is 28%. Columns 8 and 9 further show that the percentage of grid cells with Roman cities and Roman roads is 47 and 20 percentage points higher, respectively, for those with ancient colonies.

Columns 10 to 15 use dummy variables that capture the presence of urban settlements where the population exceeds 10,000 inhabitants. We also observe that the probability of having a city from 1200 CE onwards is significantly larger in areas that had ancient colonies. Column 16 shows that the percentage of grid cells that have had a city at some point in time from 800 to 1800 is 14 percentage points larger for those with ancient colonies.[33] Columns 17 and 18 use two measures of modern-day cities from two sources, Geonames and the UCDB. In both cases, cities are much more likely to exist where ancient colonisers established their colonies. More specifically and according to column 18, the likelihood of finding a city is three times higher in grid cells with ancient colonies (as reflected by a coefficient of 0.103 relative to a mean value of 0.054). Figure 2 depicts the effect of ancient colonialism on the presence of settlements and cities at different points in time, as in Table 1. The figure clearly illustrates a positive contribution of ancient colonialism to the development of the urban system in the Mediterranean.

A question worth asking regarding these results is whether the effect of ancient colonialism is linked to the urban character of settlements or to the mere establishment of a settlement. This is relevant to shedding light on whether the urban blueprint exported by ancient colonisers is

times as it may persist over centuries. Regarding cities collected from Bosker et al. (2013), we only count cities which in the specified period pass the threshold of 10,000 inhabitants. Thus, if a city founded -say- in 500 CE only exceeds 10,000 inhabitants in the year 1800, it is only counted in 1800. By the same token, the same city can switch being in the sample or not depending on this population criterion. While we stick to this 10,000-threshold based on data availability, one must bear in mind that this makes the number of cells with cities to be very low.

[32] The lower and insignificant coefficient in column 1 is consistent with our hypothesis since by that time ancient colonialism had hardly began, with the exception of the Phoenicians. Another complementary explanation is that for this early period, measurement errors are more pervasive, creating a downward bias in the coefficient.

[33] When interpreting the insignificant coefficients in columns 10 and 11, it is important to bear in mind the very low number of non-zero observations. For these periods, our coastal sample only contains 8 and 20 cities, respectively. Besides this, one may wonder whether the coefficient becomes significant from 1200 onwards due to the foundation of new cities (in cells with ancient colonies) or because already existing cities passed the threshold of 10,000 inhabitants after this date. The latter appears to be true as almost all the cities in cells with ancient colonies were founded in times of ancient colonisation.

responsible for the observed effect, or whether the latter is simply related to agglomeration effects from establishing a settlement. Although we lack precise information regarding the type of settlement created by colonisers, we can classify ancient colonies depending on whether there were sites with urban-related features (dated before 300 BCE) within the same grid cell. Accordingly, columns 19 to 27 split the ancient colony indicator based on this criterion. Interestingly, ancient colonies with urban features were much more likely to lead to cities in a later time period. This provides some support to the view that it is not simply a case of establishing a settlement, but rather the type of settlement established that leads to desirable economic outcomes.[34]

Overall, this section provides evidence which suggests that ancient colonialism played an important role in the origin and development of the Mediterranean urban system. Areas colonised by Phoenicians, Greeks and Etruscans were more likely to have settlements, Roman roads and cities. This analysis of the development of the urban system also helps explain the very long-term effect of ancient colonialism on current economic outcomes reported in Section 4. The evidence of a positive effect of ancient colonies can be traced throughout more than two millennia until today.

7. Conclusions

This paper investigates the long-term impact of ancient colonialism on the modern-day population density and economic activity of the Mediterranean region. Using data on the location of Phoenician, Greek and Etruscan colonies and using night light density as a proxy for economic activity at the sub-national level, we document that geographic areas that were ancient colonies exhibit greater economic activity today than areas not subject to such colonisation. We show through an exhaustive empirical analysis that this effect is due to a man-made intervention via colonisation rather than to the physical attributes of the geographic areas where colonies are located.

Two complementary underlying mechanisms appear to explain the long-run impact of ancient colonialism. On the one hand, colonisers transferred advanced institutions, culture, human capital and technologies to new locations. On the other hand, colonisers also founded settlements, with the resultant advantages of agglomeration which reinforced the concentration of economic activity in existing places. By comparing ancient colonies to other settlements from the same time period, we provide evidence that both underlying mechanisms played a relevant role, albeit the

[34] If we replace these dependent variables with our baseline variables, that is, light and population density, both coefficients are statistically significant but the one on ancient colonies with urban features is significantly larger.

latter appears to be more important.

The results of this study contribute to the literature on the economic legacy of colonialism by focusing, for the first time, on the very early experience of colonisation undertaken by the Phoenicians, Greeks and Etruscans. In doing so, we also contribute to improving understanding of the causes of the spatial distribution of economic activity in the Mediterranean region. In contrast to its modern counterpart, ancient colonialism was much local in nature (confined merely to the territory surrounding a city) and as a consequence did not lead to vast overseas dominions (with the exception of Carthage). Regions in which ancient colonisers established their colonies have belonged to different empires and countries, and have been subjected to very different historical paths during the ensuing period exceeding two millennia. We observe consistently across continents that areas with ancient colonies exhibit more economic activity and are more densely populated today. Given that we control for country fixed effects, the positive legacy of ancient colonialism documented here has been working at the local level.

We further show that the effect of ancient colonialism can be traced back more than two millennia since the origin of the Mediterranean urban system. Areas colonised by Phoenicians, Greeks and Etruscans were more likely to have ancient settlements, Roman roads and cities. This evidence suggests that ancient colonisers diffused a major innovation in the form of urban settlements or cities around the Mediterranean. Thus, our work also informs the literature regarding the location of cities and the persistence of the urban network (Bleakley and Lin, 2012; Bosker and Buringh, 2017; Michaels and Rauch, 2018). We show that a particular man-made intervention, via the founding of a colony in a foreign land, can have a large and persistent effect.

The evidence presented in this paper is appealing, as the impact of ancient colonialism on economic outcomes is remarkably robust. However, our analysis has limitations. There are inherent measurement errors when attempting to observe and quantify phenomena, which took place in the remote past. Another possible limitation relates to a potential problem of endogeneity in the location of ancient colonies. While we conduct a large battery of robustness checks in an attempt to address this concern, we acknowledge that it is impossible to completely dispel all doubts.

To conclude, our paper reinforces the idea that historical shocks play a significant role in the structure of regional and local economies. Ancient colonialism, by geographically spreading urban settlements and more advanced civilisations had a positive legacy on population density and economic activity in the Mediterranean. The Greeks, Phoenicians and Etruscans not only influenced modern Western culture in general, these civilisations have also left an economic legacy at the local level.

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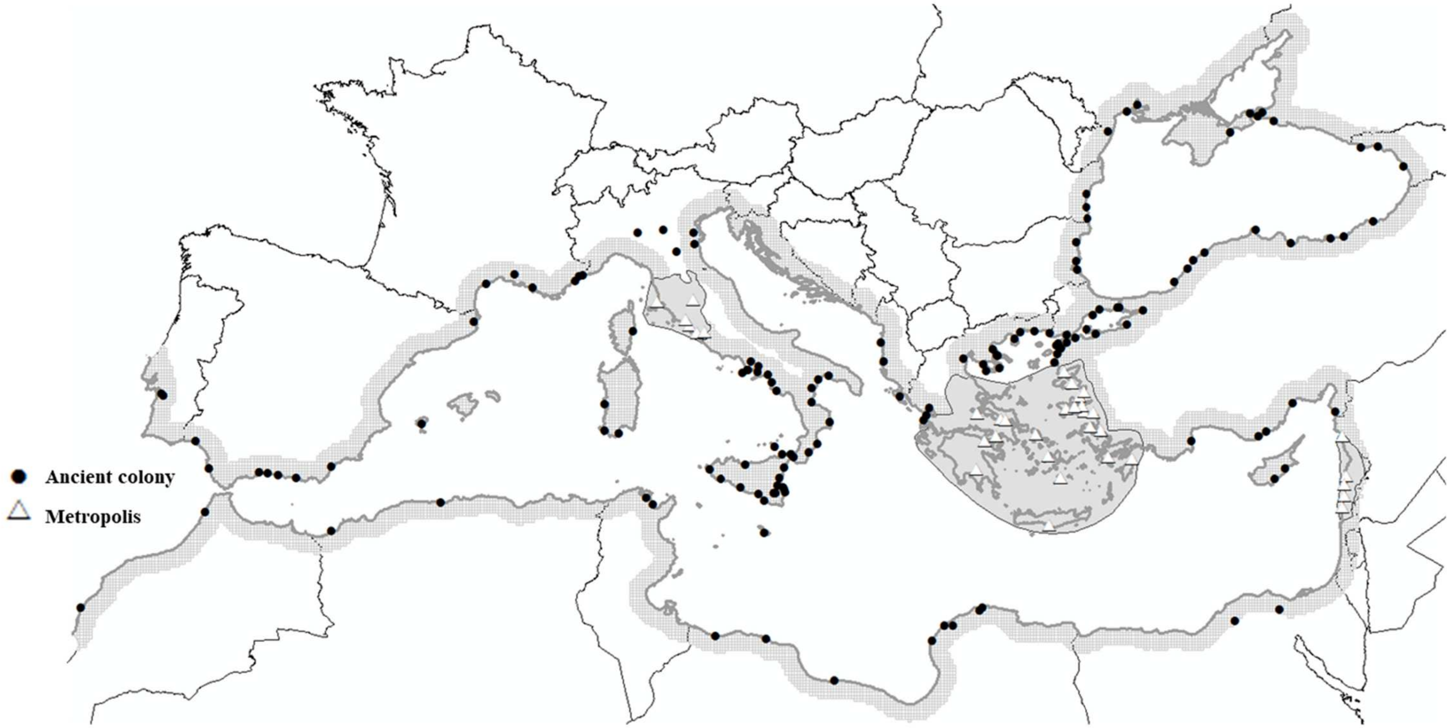
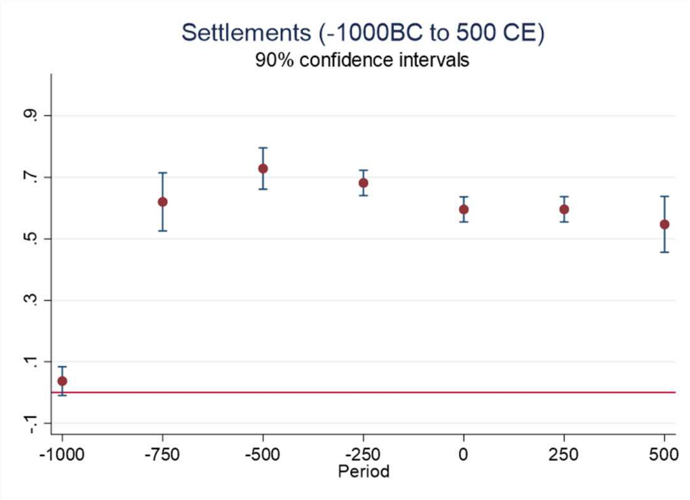
FIGURES AND TABLES

FIGURE 1. MAP OF ANCIENT COLONIES IN THE MEDITERRANEAN AREA



Notes: This map shows the geographic distribution of ancient colonies along with their metropolis, c. 11th-6th cents. BCE (Wittke, 2011b). The map also represents 10x10km grid cells around the Mediterranean coast as well as the delimitation of the homeland of Phoenicians, Greeks and Etruscans.

FIGURE 2. THE EFFECT OF ANCIENT COLONIALISM ON THE EVOLUTION OF THE URBAN SYSTEM



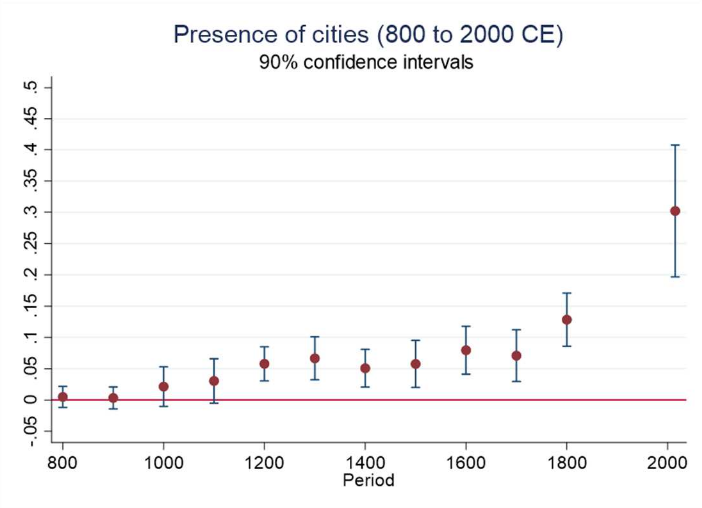


Table 1

Balancedness table

	The dependent variable is:										
	Temperature	Rainfall	Elevation (log)	Ruggedness	Island	Coast length/surface (log)	Depth of the sea (log)	Soil quality	Longitude	Latitude	Port excellent shelter
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Ancient colonies	0.212	-50.007***	0.204***	-0.187	-0.014	-0.072	0.061	0.066	-0.201	-0.372	0.069**
	(0.299)	(13.556)	(0.066)	(0.141)	(0.058)	(0.103)	(0.054)	(0.144)	(0.421)	(0.46)	(0.03)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Standard. coef.	0.014	-0.029	0.025	-0.015	-0.006	-0.010	0.023	0.006	-0.003	-0.016	0.060
R-sq	0.81	0.70	0.22	0.20	0.32	0.04	0.30	0.75	0.96	0.88	0.1
Observations	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234
	River	Dist. ancient lake (log)	Coast connected-ness	# colonies within 200 km	Access to mainland	Dist. Ancient Greece Homeland	Dist. Ancient Phoenician Homeland	Marble	Limestone	Original forest	Surface area
	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Ancient colonies	-0.006	-0.059	0.002	1.038	0.000	-0.066**	0.002	0.007	0.07	0.017	5.909**
	(0.025)	(0.092)	(0.002)	(0.683)	(0.003)	(0.024)	(0.032)	(0.028)	(0.047)	(0.025)	(2.701)
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Standard. coef.	-0.004	-0.006	0.019	0.036	-0.001	-0.021	0.001	0.007	0.027	0.007	0.033
R-sq	0.03	0.16	0.60	0.44	0.66	0.81	0.81	0.09	0.45	0.7	0.02
Observations	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2

Ancient colonialism and the spatial concentration of economic activity: Baseline results (I)

	The dependent variable is Log night light density												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Ancient colonies	1.304***	1.369***	1.191***	1.273***	1.289***	1.353***	1.241***	1.305***	1.351***	1.347***	1.198***	1.222***	1.031***
	(0.237)	(0.23)	(0.225)	(0.198)	(0.212)	(0.227)	(0.23)	(0.234)	(0.225)	(0.233)	(0.2)	(0.213)	(0.165)
Temperature		-0.007											0.321**
		(0.036)											(0.12)
Rainfall		0.001**											0
		(0.001)											(0.001)
Elevation (log)			0.348*										0.225*
			(0.176)										(0.111)
Ruggedness			-0.224***										-0.163***
			(0.065)										(0.051)
Island				-1.444***									-1.217***
				(0.355)									(0.423)
Coast length/surface (log)				-0.256***									-0.044
				(0.074)									(0.1)
Depth of the sea (log)				-0.128									-0.02
				(0.199)									(0.234)
Soil quality					0.227**								0.173**
					(0.095)								(0.084)
Longitude						0.02							-0.003
						(0.041)							(0.035)
Latitude						0.123***							0.104
						(0.042)							(0.104)
Port excellent shelter							0.912***						0.912***
							(0.165)						(0.168)
River								0.445**					-0.007
								(0.2)					(0.23)
Dist. Ancient lake (log)								-0.03					0.024
								(0.091)					(0.081)
Coast connectedness									-6.97				-1.046
									(14.657)				(20.525)
# colonies within 200 km									-0.033				-0.022
									(0.037)				(0.03)
Access to mainland									6.942				4.303
									(5.772)				(5.82)
Dist. Ancient Greece Homeland										0.672**			0.406
										(0.254)			(0.877)
Dist. Ancient Phoenician										0.118			0.41
										(0.188)			(0.377)
Marble											0.637***		0.634**
											(0.19)		(0.284)
Limestone											1.18***		0.849***
											(0.286)		(0.25)
Original forest											1.089***		0.958**
											(0.301)		(0.359)
Surface area												0.014***	0.009**
												(0.003)	(0.004)
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.23	0.24	0.25	0.29	0.24	0.24	0.24	0.24	0.24	0.24	0.27	0.26	0.34
Observations	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 3

Ancient colonialism and the spatial concentration of economic activity: Baseline results (II)

	The dependent variable is Log population density												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Ancient colonies	0.832***	0.91***	0.808***	0.809***	0.813***	0.882***	0.788***	0.833***	0.833***	0.866***	0.75***	0.803***	0.687***
	(0.239)	(0.243)	(0.248)	(0.272)	(0.253)	(0.289)	(0.228)	(0.246)	(0.186)	(0.225)	(0.208)	(0.24)	(0.185)
Temperature		0.038											0.323***
		(0.035)											(0.102)
Rainfall		0.002**											0.001*
		(0.001)											(0)
Elevation (log)			0.049										0.002
			(0.075)										(0.052)
Ruggedness			-0.073										-0.072*
			(0.045)										(0.04)
Island				-1.155***									-0.866***
				(0.255)									(0.178)
Coast length/surface (log)				-0.067*									-0.015
				(0.039)									(0.041)
Depth of the sea (log)				0.036									-0.009
				(0.138)									(0.085)
Soil quality					0.29***								0.218***
					(0.102)								(0.07)
Longitude						0.024							-0.051
						(0.06)							(0.031)
Latitude						0.122**							0.222**
						(0.046)							(0.093)
Port excellent shelter							0.632***						0.67**
							(0.224)						(0.254)
River								0.419***					0.089
								(0.105)					(0.106)
Dist. Ancient lake (log)								-0.025					0.044
								(0.064)					(0.061)
Coast connectedness									-26.191**				-26.052*
									(9.381)				(14.856)
# colonies within 200 km									0.044**				0.065***
									(0.021)				(0.02)
Access to mainland									-2.166				-7.413
									(5.459)				(4.667)
Dist. Ancient Greece Homeland										0.516			0.16
										(0.332)			(0.634)
Dist. Ancient Phoenician										-0.155			-0.221
										(0.236)			(0.273)
Marble											0.544*		0.49***
											(0.29)		(0.148)
Limestone											0.957**		0.737***
											(0.37)		(0.193)
Original forest											0.656***		0.315
											(0.167)		(0.29)
Surface area												0.005***	0.004*
												(0.002)	(0.002)
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.2	0.22	0.2	0.24	0.22	0.21	0.2	0.2	0.21	0.2	0.24	0.21	0.33
Observations	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 4

Additional control variables

Panel A: The dependent variable is Log night light density

	Land-distance to Fertile Crescent (log)	Land-distance to Jericho (log)	Time since agricultural transition	Ancient cities (1000 BCE) (+)	Bronze age sites (+)	Ancient settlements (1000 BCE) (+)	Distance to major cities (log)	Distance to major and secondary cities (log)	Distance to archaeological dep. IAU WHED (log)	Distance to archaeological dep. THE (log)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ancient colonies	1.038***	1.03***	0.94***	1.064***	0.989***	0.988***	0.919***	0.636***	0.913***	0.968***
	(0.168)	(0.17)	(0.164)	(0.17)	(0.16)	(0.153)	(0.133)	(0.114)	(0.178)	(0.154)
Control variables (see columns headings)	0.585	-0.111	-0.025	Included	Included	Included	-0.762***	-1.045***	-0.827***	-0.658***
	(1.036)	(0.792)	(0.241)				(0.098)	(0.147)	(0.128)	(0.141)
Geo-climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.34	0.34	0.36	0.35	0.34	0.34	0.38	0.42	0.38	0.36
Observations	3234	3234	2200	3234	3234	3234	3234	3234	3234	3234

Panel B: The dependent variable is Log population density

	Land-distance to Fertile Crescent (log)	Land-distance to Jericho (log)	Time since agricultural transition	Ancient cities (1000 BCE) (+)	Bronze age sites (+)	Ancient settlements (1000 BCE) (+)	Distance to major cities (log)	Distance to major and secondary cities (log)	Distance to archaeological dep. IAU WHED (log)	Distance to archaeological dep. THE (log)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ancient colonies	0.671***	0.672***	0.699***	0.683***	0.692***	0.677***	0.567***	0.392**	0.578***	0.62***
	(0.186)	(0.187)	(0.201)	(0.171)	(0.193)	(0.169)	(0.15)	(0.163)	(0.203)	(0.156)
Control variables (see columns headings)	-1.409*	-1.121*	0.334	Included	Included	Included	-0.814***	-0.78***	-0.758***	-0.703***
	(0.729)	(0.619)	(0.245)				(0.07)	(0.055)	(0.076)	(0.094)
Geo-climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.33	0.33	0.26	0.33	0.34	0.33	0.42	0.43	0.4	0.38
Observations	3234	3234	2200	3234	3234	3234	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. (+) Six dummy variables are included to capture the presence of cities, settlements or sites: i) within 10 km of the grid cell, ii) between 10 and 25 km, iii) between 25 and 50 km, iv) between 50 and 100 km, v) between 100 and 150 km, vi) between 150 and 200 km. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 5
The role of spatial autocorrelation

	The dependent variable is:			
	Log night light density		Log population density	
	Kelly's adjustment	Large clusters	Kelly's adjustment	Large clusters
	(1)	(2)	(3)	(4)
Ancient colonies	1.031***	1.031***	0.686***	0.686**
	(0.220)	(0.104)	(0.158)	(0.116)
Geo-climatic controls	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
R-sq	0.33	0.33	0.32	0.32
Observations	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors for models (1) and (3) are adjusted for spatial autocorrelation based on Kelly's (2020) adjustment, while for models (2) and (4) the adjustment is based on three large clusters following Bester, Conley and Hansen (2011), and are reported in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 6
Restricted samples based on levels of connectedness

	Panel A: The dependent variable is Log night light density					
Cut-off point	>10% & <90%	>20% & <80%	>30% & <70%	>40% & <60%	>=50%	<50%
	(1)	(2)	(3)	(4)	(5)	(6)
Ancient colonies	1.0994***	1.0156***	1.0635***	1.0662***	0.7827***	1.2061***
	(0.1893)	(0.1954)	(0.2363)	(0.2462)	(0.1343)	(0.257)
Geo-climatic controls	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES
R-sq	0.37	0.40	0.42	0.47	0.36	0.39
Observations	2616	1971	1326	678	1644	1590
	Panel B: The dependent variable is Log population density					
Cut-off point	>10% & <90%	>20% & <80%	>30% & <70%	>40% & <60%	>=50%	<50%
	(1)	(2)	(3)	(4)	(5)	(6)
Ancient colonies	1.1170***	1.0311***	0.9991***	1.0624***	0.8813**	0.5348**
	(0.1816)	(0.2344)	(0.2562)	(0.2978)	(0.3633)	(0.1873)
Geo-climatic controls	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES
R-sq	0.16	0.18	0.20	0.21	0.07	0.41
Observations	2616	1971	1326	678	1644	1590

Notes: The units of analysis are 10x10 km grid-cells. Different restricted samples are used to estimate Equation (1). The restriction is based on the distribution of the connectedness variable. Observations falling outside of specified cut-off points are omitted from the sample. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 7

Ports excellent shelters

	The dependent variable is:						
	Log night light density			Log population density			Port excellent shelter
	Cells with ports omitted	Cells with ports excellent shelters omitted	Europe omitted	Cells with ports omitted	Cells with ports excellent shelters omitted	Europe omitted	Europe omitted
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ancient colonies	1.068***	1.084***	1.066***	0.671**	0.663***	0.502***	-0.001
	(0.279)	(0.174)	(0.251)	(0.254)	(0.167)	(0.1)	(0.006)
Geo-climatic controls	YES	YES	YES	YES	YES	YES	NO
Country fixed effects	YES	YES	YES	YES	YES	YES	YES
R-sq	0.33	0.34	0.15	0.31	0.32	0.52	0.02
Observations	2447	3082	1296	2447	3082	1296	1296

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 8

Matched samples

	Log night light density		Log population density	
	Nearest neighbour matching	Radius matching	Nearest neighbour matching	Radius matching
	(1)	(2)	(3)	(4)
Ancient colonies	0.9494***	1.1518***	0.7593***	0.7699***
	(0.1661)	(0.2073)	(0.2317)	(0.1645)
Control variables	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
R-sq	0.38	0.33	0.38	0.37
Observations	406	559	406	559

Note: This table presents estimates of Equation (1) using matched samples. Matching is performed with two methods. The nearest matching method with oversampling (n=3) and the radius method with a calliper of 0.0001. The units of analysis are 10x10 km grid-cells. All control variables included in the baseline regression as well as country fixed effects are accounted for in these estimations. Variables descriptions are provided in Table A1. Standard errors clustered at the country level are reported in parentheses. *, **, and *** indicates significance at 10%, 5%, and 1% level, respectively.

Table 9

Distinguishing among colonisers and continents

	The dependent variable is:			
	Log night light density		Log population density	
	(1)	(2)	(3)	(4)
Greek colony	1.046***		0.75***	
	(0.179)		(0.246)	
Phoenician colony	1.011***		0.431***	
	(0.275)		(0.136)	
Etruscan colony	0.166		0.594**	
	(0.233)		(0.246)	
Ancient col. x Africa		1.572***		0.526**
		(0.351)		(0.245)
Ancient col. x Asia		1.085***		0.557***
		(0.239)		(0.146)
Ancient col. x Europe		0.915***		0.776***
		(0.224)		(0.274)
Geo-climatic controls	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
R-sq	0.34	0.34	0.33	0.33
Observations	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 10

Alternative indicators and sources for ancient colonialism

	The dependent variable is Log night light density					The dependent variable is Log population density				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ancient colonies: 1-km buffer	1.003***					0.711***				
	(0.169)					(0.141)				
Ancient colonies: 5-km buffer		0.865***					0.604***			
		(0.127)					(0.129)			
Distance to the nearest colony			-0.275**					-0.179***		
			(0.1)					(0.049)		
Ancient colonies (alternative sources)				1.05***					0.842***	
				(0.201)					(0.162)	
Ober (2015)'s poleis dataset					0.768***					0.397**
					(0.169)					(0.156)
Geo-climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33	0.33	0.33
Observations	3232	3232	3232	3232	3232	3232	3232	3232	3232	3232

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. The sample is homogeneous across columns to facilitate comparison. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 11

Log night light emission per capita

	Corrected lights (2000-2005)		VIIRS DNB Lights (2015)	
	(1)	(2)	(3)	(4)
Ancient colonies	0.463**	0.578***	0.713***	0.701***
	(0.17)	(0.121)	(0.209)	(0.177)
Log population density (average 2000 and 2005)		-0.183		
		(0.125)		
Log population density (2015)				0.018
				(0.11)
Geo-climatic controls	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
R-sq	0.24	0.25	0.21	0.21
Observations	3224	3224	3224	3224

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. The sample is homogeneous across columns to facilitate comparison. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 12

Institutional-cultural transfer or urban persistence

	The dependent variable is Log night light density						The dependent variable is Log population density					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ancient colonies	1.115***	1.034***	1.152***	1.034***	1.24***	1.037***	0.761***	0.69***	0.786***	0.692***	0.82***	0.693***
	(0.158)	(0.164)	(0.156)	(0.164)	(0.171)	(0.164)	(0.197)	(0.187)	(0.206)	(0.189)	(0.222)	(0.19)
Other ancient settlements 750BC	0.837***						0.74***					
	(0.277)						(0.105)					
Other ancient settlements 750BC (only town, city or urban)		0.549***						0.759				
		(0.15)						(0.449)				
Other ancient settlements 500BC			0.617***						0.506***			
			(0.138)						(0.176)			
Other ancient settlements 500BC (only town, city or urban)				0.392*						0.678		
				(0.213)						(0.58)		
Other ancient settlements 250BC					0.8***						0.509**	
					(0.133)						(0.183)	
Other ancient settlements 250BC (only town, city or urban)						0.637***						0.679
						(0.172)						(0.472)
Geo-climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.34	0.34	0.34	0.34	0.35	0.34	0.34	0.33	0.34	0.33	0.34	0.33
Observations	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234	3234

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 13

Ancient colonies vs. other settlements of similar age

Panel A: urban-related features

	Settlement existing before 330 BC					Settlement existing before 550 BC				
	Urban-features within a distance of …					Urban-features within a distance of …				
	1 km	2 km	3 km	4 km	5 km	1 km	2 km	3 km	4 km	5 km
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ancient colonies	0.238***	0.233***	0.227***	0.21***	0.178**	0.232***	0.214***	0.218***	0.215***	0.194**
	(0.058)	(0.054)	(0.057)	(0.059)	(0.064)	(0.059)	(0.053)	(0.054)	(0.064)	(0.074)
Geo-climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.15	0.14	0.14	0.15	0.15	0.22	0.2	0.21	0.23	0.21
Observations	986	986	986	986	986	601	601	601	601	601

Panel B: Political regime and trade

	Political regimes and modern-day outcomes:		Maritime trade routes in the Mediterranean c. 150-200 CE		
	Log night light density	Log population density	Distance to the nearest trade node		
	(1)	(2)	(3)	(4)	(5)
Evidence for democracy in the regime history	0.828*	0.351			
	(0.378)	(0.482)			
Ancient colonies			-0.38***	-0.409***	-0.398***
			(0.086)	(0.091)	(0.093)
Other ancient settlements 750BC			-0.187***		
			(0.066)		
Other ancient settlements 500BC				-0.246***	
				(0.07)	
Other ancient settlements 250BC					-0.142**
					(0.052)
Geo-climatic controls	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
R-sq	0.71	0.67	0.42	0.43	0.42
Observations	59	59	3234	3234	3234

Notes: The units of analysis in Panel A are archeological sites attested before either 330BCE or 550 BCE; in columns 1 and 2 of Panel B they are 10x10 km grid-cells containing Greek poleis with known regime history; and in columns 3 to 5 of Panel B they are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 14

Ancient colonialism and the evolution of the urban system

	Ancient settlements							Roman cities (100 BCE - 300 CE)	Presence of Roman Roads
	1000 BCE	750 BCE	500 BCE	250 BCE	0 CE	250 CE	500 CE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ancient colonies	0.037	0.62***	0.728***	0.682***	0.596***	0.596***	0.547***	0.469***	0.201***
	(0.027)	(0.055)	(0.039)	(0.024)	(0.024)	(0.024)	(0.053)	(0.056)	(0.049)
Geographic and climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.07	0.28	0.31	0.22	0.21	0.21	0.19	0.15	0.38
Observations	2800	2800	2800	2800	2800	2800	2800	2737	2737

	Cities 800 -1800						City at some point in time (800-1800)	Modern-day cities	
	800	1000	1200	1400	1600	1800		Cities ≥ 10k	UCDB
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Ancient colonies	0.005	0.022	0.058***	0.051***	0.08***	0.128***	0.144***	0.302***	0.103***
	(0.01)	(0.018)	(0.016)	(0.018)	(0.022)	(0.025)	(0.023)	(0.061)	(0.029)
Geographic and climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.01	0.02	0.03	0.03	0.04	0.06	0.06	0.19	0.09
Observations	2800	2800	2800	2800	2800	2800	2800	2800	2800

	Roman cities (100 BCE - 300 CE)	Cities 800 -1800						Modern-day cities	
		800	1000	1200	1400	1600	1800	Cities ≥ 10k	UCDB
	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
Ancient colonies - Urban features by 300 BCE	0.657***	-0.005*	0.014	0.078**	0.059*	0.112**	0.153***	0.387***	0.198***
	(0.062)	(0.002)	(0.022)	(0.029)	(0.03)	(0.048)	(0.036)	(0.048)	(0.038)
Ancient colonies - No evidence for urban features by 300BCE	0.324***	0.012	0.027	0.043	0.044	0.055	0.11***	0.238**	0.032
	(0.065)	(0.014)	(0.027)	(0.029)	(0.028)	(0.033)	(0.028)	(0.093)	(0.026)
Geographic and climatic controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.16	0.02	0.02	0.04	0.03	0.05	0.06	0.19	0.1
Observations	2737	2800	2800	2800	2800	2800	2800	2800	2800

Notes: The units of analysis are 10x10 km grid-cells. Sample restricted to coastal observations around the Mediterranean. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.