The Bounty of the Sea and Long-Run Development*

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Abstract

We document that a high level of natural productivity of the ocean – a rich *bounty of the sea* – has had a persistently positive impact on economic development: societies inhabited by people who descend from regions with eco-climatic conditions supporting a highly productive ocean are more prosperous today. We argue that an explanation is that a rich bounty of the sea facilitated early coastal settlements, which ultimately created a pre-industrial occupational structure that benefitted long term economic development. Specifically, we propose that societies that were more coastally oriented during the pre-industrial era were characterized by a less agrarian occupational structure, and thereby gained more experience in non-agricultural production. In the long run, this produced capabilities that were complementary to industrialization, and allowed for an early take-off to growth.

Keywords: Comparative development; coastal orientation; industrialization.

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1 Introduction

The earth's surface consists of roughly 30% land mass and 70% water surface of which about 97% is oceans. While the natural productivity of land, in the sense of its potential nutritional benefits, has received ample attention in the literature on comparative development, it is surprising to observe that the role played by the natural productivity of oceans has been ignored. Below we take a first step in the direction of changing this state of affairs.[1]

In this study we ask whether a rich *bounty of the sea* has supported long-run development. Our core finding is that the answer is in the affirmative: high productivity of the ocean stimulated economic development in the past, and societies with access to productive oceans are also richer today than societies with access to less productive oceans. More specifically, we document that countries where the current inhabitants *descend* from regions featuring highly productive oceans, have prospered relative to nations inhabited by descendants from regions without a rich bounty of the sea.

As a point of departure we propose a new measure: the Bounty of the Sea (BoS) index. Conceptually, the index is similar in spirit to indices speaking to the suitability of land for agriculture. The underlying data we use derive from georeferenced information about the habitat suitability of most species of marine fish in the world. Hence, these data speak to the *potential* presence of specific species, not whether they are actually found in a particular location.

We carefully validate the index by asking if it: (*i*) predicts historical landings; (*ii*) holds relevant explanatory power vis-á-vis the occupational structure during historical times; and, (*iii*) predicts what people subside on, in a pre-industrial setting. Overall, the tests paint a coherent picture, consistently supporting the relevance of the developed index for the purpose at hand.

In the second part of the analysis we explore the explanatory power of the BoS index, vis-á-vis economic development. Conditional on an extensive set of controls, such as the natural level of productivity in agriculture and geographic access to the ocean, we find that countries that could benefit from a rich bounty of the sea attained a higher level of pre-industrial development. Moreover, in order to mitigate potential concerns regarding omitted variable bias we also explore sub-national data, which allows us to control for coastal proximity in a more detailed way as well as for country fixed effects. Across the universe of coastal areas, defined as grid cells of one degree latitude by one degree longitude that are located within 100 km of the coast, we document that a more productive adjacent ocean served to stimulate population density on the eve of the Age of Discovery.

[1] By "natural" productivity we refer to eco-climatic factors that impinge on the productivity of agriculture or of the ocean. In the former case that chiefly involves soil conditions, temperature and precipitation, whereas it in the latter case involves sea temperature, salinity, sea depth and more. We return to the definition of the natural productivity of the ocean below.

In the current era, the BoS index remains positively correlated with economic development. Similarly to our findings regarding pre-industrial development, we obtain this result across countries as well as within countries. However, the cross-country results are substantially strengthened, statistically and economically, when we "ancestor adjust" the natural productivity level of the ocean using Putterman and Weil's (2010) historical migration matrix; i.e., when we study the impact from a BoS index reflecting the natural productivity of the ocean in the locations from which the ancestors of the current population originate. Naturally, if the productivity measure exerts its contemporary influence via factors that are embodied in individuals and transmitted through generations (such as e.g. cultural values), we would expect to see an economically and statistically more significant link emerge when we invoke the ancestry adjusted index, than when we rely on its unadjusted counterpart. Accordingly, our findings suggest that the bounty of the sea mainly is exerting its influence on contemporary comparative development through indirect channels, such as formal and informal institutions. Quantitatively, the impact from the BoS is economically significant: an increase in the BoS index by one standard deviation increases contemporary income per capita by 0.2 standard deviations.

In the third part of the study we propose, and explore empirically, a possible explanation for these findings. Our theory relies on three elements. The first element links the natural productivity of the ocean to spatial settlement patterns: Conditional on natural productivity inland, we propose that a rich bounty of the sea allowed for more coastal settlements, historically. As a result, economic activity became more coastally oriented early on, in societies with a greater natural productivity of the ocean.

The second element concerns the ensuing occupational structure. With a greater concentration of the population along the coast, we hypothesize that non-agricultural occupations, perhaps especially those related to long distance trade, would gain importance to the economy. Put differently, nations adjacent to highly productive oceans became somewhat less reliant on agriculture early on, compared with regions offering a low natural productivity of the ocean. With time, therefore, societies with a rich bounty of the sea gained more experience with non-agricultural production, thus gaining capabilities – skills as well as formal and informal institutions – that support industry and services.[2] Many of such capabilities are portable, for which reason they would diffuse to other locations due to international migration during the Age of Discovery.

The third element involves the speed of adoption of industrialization. In light of the two first

[2]For example, Acemoglu et al. (2005) argue that Atlantic traders were more likely to adopt institutions which ultimately stimulated economic development. If indeed a rich bounty of the sea generated more coastal settlements and a greater reliance on non-agricultural occupations, such as long-distance trade, one might hypothesize a reduced form link between the natural productivity of the ocean and property rights supporting institutions.

elements we propose that regions with a high natural productivity level of the ocean – or more generally nations inhabited by citizens descending from such regions – were better positioned to exploit the new opportunities offered by the arrival of industrialization. Consequently, such societies therefore experienced an earlier take-off to growth.

In the analysis below, we provide corroborating evidence in favor of each of the three elements of the theory, and we document that the theory in totality can account for the lion's share of the reduced form impact from the bounty on the sea on current comparative economic development. Moreover, the theory is consistent with a well known fact, which we re-confirm below: high natural productivity in agriculture is a characteristic of poor countries today, although the opposite was the case historically. While high natural productivity of the ocean drew people to the coast, according to the proposed theory, high inland productivity would do the opposite leading to a more agrarian occupational structure and capabilities to match. As a consequence, in regions (inhabited by ancestors of places) featuring high natural productivity of agriculture, industrialization should be comparatively delayed, leading to the contemporary negative cross-country correlation with prosperity.

The present study is the first to examine the long-run impact from the natural productivity of the ocean, and to demonstrate its significance to economic development. By thus focusing on the benefits of the sea, our study is related to an existing literature that emphasizes the advantages of coastal proximity. To be sure, at least since the time of Adam Smith it has been well known that economic activity tends to cluster near oceans, or sea navigable rivers, due to the advantages offered by such locations in terms of trade and market access.[3]

In the present study, however, we argue that access to the ocean was necessary but not sufficient to ensure that a nation would benefit from the sea historically. A decisive additional factor, we believe, is a high natural productivity of the ocean in nutritional terms, since it allows for early coastal settlements, which makes it much more likely that a nation can benefit economically from the sea more broadly. Indeed, our analysis documents an impact from the natural productivity of the ocean on economic development, conditional on a variety of measures of sea access. Moreover, as mentioned above, we also show that the bounty of the sea is positively correlated with economic activity *within* coastal areas, defined as pixels of size one degree latitude by one degree longitude that all are within 100 km of the coast.

By implication, our analysis indirectly draws attention to the vast differences in prosperity that exist within coastal locations. Figure 1 shows global inequality across the world at large, and

[3]"*As by means of water-carriage a more extensive market is opened to every sort of industry than what land-carriage alone can afford it, so it is upon the sea-coast, and along the banks of navigable rivers, that industry of every kind naturally begins to subdivide and improve itself, and it is frequently not till a long time after that those improvements extend themselves to the inland parts of the country*." (Adam Smith, 1776, Ch. 3). More direct evidence of the benefits of access to the sea is provided e.g. by Rappaport and Sachs (2003).

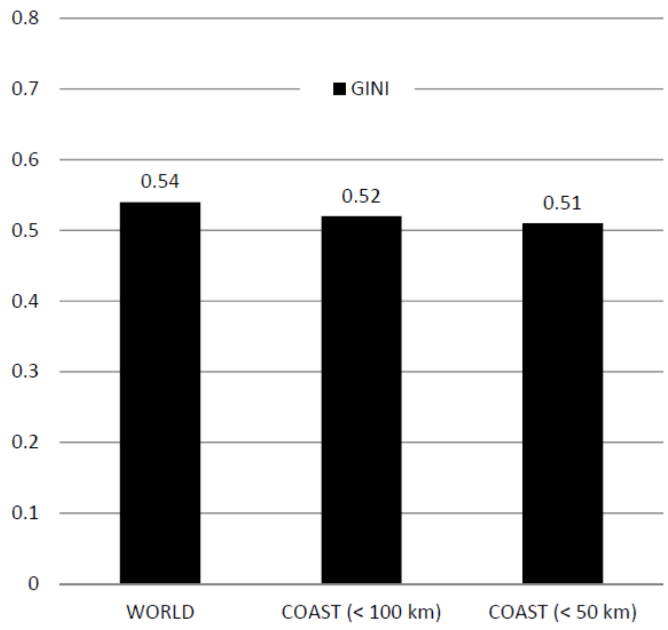

Figure 1: Inequality in GDP per capita across the World and across selected regions. Notes: Each unit of observation is a pixel of size 1 degree latitude by 1 degree longitude. The bar labelled "World" includes all available data. The bar labelled "Coast (< 100 km)" only includes pixels located less than 100 km from the ocean. The final bar focuses on data for pixels within 50 km of the coast. The observation year for per capita income is 2005. Data Source: Yale GECON project.

within coastal regions. Remarkably, inequalities within coastal areas is very nearly as great as those across the world in totality (cf. Figure 1).[4] Our analysis provides a simple explanation for this fact: If a society is to benefit economically from its coastal access people need to be located in coastal areas, and the bounty of the sea importantly influenced whether people would be located in coastal areas historically.

In contrasting the impact of natural productivity in the ocean with that of agriculture, our study is related to an extensive literature, which explores the impact from the historical legacy of agriculture. There are two strands of literature that can be distinguished. The first studies the influence from the emergence of agriculture, and its productivity.[5] The second, more recent, strand of literature argues that agriculture may have helped shape non-geographical fundamental determinants of productivity.[6] In this literature the above mentioned "reversal" of the impact

[4]To get a sense of how just how close these numbers are, note that the Gini coefficient can be interpreted as the expected income difference between two randomly selected observations, normalized to the overall average (Pyatt, 1976). Hence, the expected income difference between two randomly selected areas across the world is 54% relative to mean income, whereas it is 51% across (very) coastal areas (<50 km). While average income rises when moving to coastal areas, income differences evidently rise almost proportionally.

[5]On the timing of the Neolithic and (early) development, see Diamond (1997); Olsson and Hibbs (2005); Putterman (2008), Ashraf and Galor (2011) and Chanda et al. (2014). The land suitability for agriculture and its impact on development has been examined by Gallup and Sachs (2000) and Masters and McMillan (2001).

[6]Key contributions include Engermann and Sokoloff (2002); Easterly (2001); Durante (2010); Michalopoulos (2012); Alesina et al. (2013); Galor and Özak (2014); Michalopoulos et al. (2014); Talhelm et al. (2014); Olsson and Paik (2014); Bentzen et al. (2015) and Litina (2015).

from agriculture on economic development is well known. Olsson and Paik (2014) document that an early transition to agriculture supported economic development early on, but not today. Litina (2015) documents a similar reversal in terms of natural productivity in agriculture. Both studies propose explanations for the reversal that rely on cultural change. Other theories of how comparative advantages in agriculture can be a benefit in one stage of development but a disadvantage in another are found in Matsuyama (1992) and Galor and Mountford (2008). We believe the proposed mechanism behind our results is consistent with these existing contributions, while it at the same time accounts for a persistently positive impact from the natural productivity of the ocean.[7]

Finally, and more broadly, by emphasizing a persistent positive impact on development from the bounty of the sea the present study contributes to the literature on long-run persistence in comparative development. Important contributions include Acemoglu et al. (2001, 2002), Brockstette et al (2002), Olsson and Hibbs (2005); Comin et al (2010); Ashraf and Galor (2011, 2013); and, Chanda et al. (2014). Recent surveys are found in Spolaore and Wacziarg (2013) and Nunn (2014).

The remainder of the paper is organized as follows. In Section 2 we describe the construction of the Bounty of the Sea index, and provide validation tests. Section 3 presents the main findings of the paper, which pertain to the relationship between the bounty of the sea and economic development during pre-industrial times as well as in the industrial era. Subsequently, in Section 4 we propose a potential underlying mechanism that can account for the results obtained in Section 3, and explores its empirical relevance. Finally, Section 5 concludes.

2 The Bounty of the Sea index

2.1 Constructing the index

Assessing how reliant societies potentially could have been on the exploitation of marine resources is associated with several obstacles. Obtaining global historical data on marine fish landings and fishing activities is difficult – and even if such data were easy to collect, its usefulness for a study like this would be limited by the fact that actual landings of fish would likely be endogenous to regional productivity levels. We therefore construct the Bounty of the Sea (BoS)

[7] For example, consider the Matsuyama (1992) model, which is a standard two sector model featuring learning-by-doing driven endogenous growth (only manufacturing productivity grows), and non-homothetic preferences that generate Engel's law. In autarky higher productivity in agriculture increases income and ultimately shift labor into the dynamic sector to the benefit of growth. In an open economy setting however, a sufficiently high level of agricultural productivity causes the economy to specialize in agriculture, choking off growth. If natural productivity of the ocean raises manufacturing productivity it would have a persistent positive impact on growth, whereas land productivity would start to decrease growth once globalization emerges, as it arguably did during the second half of the 19th century (e.g. Galor and Mountford, 2008).

index as a measure of the *potential* abundance of exploitable marine fish resources in the oceans. The informational content of our index rests, then, on the assumption that societies adjacent to oceans richer in marine fish resources were more likely to exploit said resources. We test this assumption in a variety of ways in the next subsection.

Underlying the construction of the BoS index is the well established marine biological fact that differences in oceanographic and climatic conditions are key drivers of the abundance as well as the composition of marine resources in the global oceans, thus shaping the productivity of marine fisheries (Cheung et al., 2010). While the total of all marine resources are limited in abundance by requirements for nutrition and space, individual species exhibit distinctive preference profiles with relevant ocean conditions. Empirical tests show that the most favorable combination of such conditions tend to coincide with the midpoint of a species' actual geographical range (Jennings et al., 2009). On top of that, migratory species migrate along their calculated areas of habitat suitability (Cheung et al., 2010).

Following these insights, we exploit the georeferenced database constructed by *AquaMaps*, which predicts the global habitat suitability of most marine fish species, by matching knowledge of their preference profiles with local environmental conditions. Specifically, based on the environmental parameters of sea depth, seawater temperature, salinity, primary production, and ice cover, the survival probability of individual species is calculated at a 0.5 by 0.5 decimal degree pixel size. Accordingly, these data speak to whether a particular species of fish *could* be observed in a particular location, not to whether the species in actual fact *is* observed in that location.[8] With the *AquaMaps* database in hand, we calculate the BoS index as the composite habitat suitability of marine fish species that are identified as carrying substantial weight in the global fisheries.

For the baseline BoS index we selected 15 species, which together made up a majority of the global marine fish landings in the 1950s according to FAO.[9] Naturally, the more abundant, accessible and (nutritionally) valuable a species is, the more likely it is to be associated with large fishery catches.[10] By focusing on such species, the BoS index will not only reflect the general productivity level of the oceans, but also ocean conditions that support species that share the characteristics of being particularly exploitable. Furthermore, limiting our attention to important species of the 1950s, which is the earliest period for which global landings statistics at the species level exist, is important: since the 1970s, modern fishing technology has developed rapidly (McGoodwin, 1990) and a more pronounced targeting of smaller species of lower trophic

[8]In the Supplementary Appendix we provide further details on the raw data from *AquaMaps*.

[9]A list of these species are reported in Table A1 in the Supplementary Appendix. The 15 species accounted for 52% of the global marine fish catch according to the FAO FIGIS database, which reports the catch volume (tons) of fish landed by individual countries, by species or higher taxonomic levels, for the period 1950-2012.

[10]See the discussion and evidence by Sethi et al. (2010), Branch et al. (2010), and Pauly et al. (2013).

levels has been documented (Pauly et al., 1998). By focusing on an earlier period then, we hope to ensure that the BoS index is a sensible proxy of potential marine resource abundance historically.

Several arguments can be made in favor of the usefulness of the index for a historical analysis. First, a majority of the species included in the baseline BoS Index are continuously found to be among the most important species before 1950, as evidenced by archeological studies of fish bones. Codfish (cod, haddock, and pollack among others) were for instance among the most commonly caught marine fish species during the Stone Age in Denmark (Enghoff et al. 2007). In England, the cod and herring dominated the expansion of capture fisheries around the year 1000 C.E. (Barrett et al. 2004a, Barrett et al. 2008). Before this period and dating back to 3500 BCE, codfish have consistently made up the majority of bone assemblages found in Northern Scotland (Barrett et al. 1999). On other continents, remains of the Peruvian anchovy have been detected in the coastal parts of the Incan Empire for the years 1100-1450 C.E. (Marcus 1987) and in ancient settlements on the Peruvian coast dating back to 10,000 BP (Keefer et al. 1998).

Second, evidence of historical fishing activities like those mentioned above are found in the regions that today, according to our index, are still blessed with oceans rich in marine resources. Furthermore, it seems that pressure caused by human fishing activity on local availability of marine resources does not cause long term differences in the global pattern of oceanic productivity. As Huston and Wolverton (2009) explain, when some species tend to be depleted in a region: "they are typically replaced by a fishery based on a lower trophic level that is often more productive than the original fishery, consistent with ecological theories of trophic dynamics" (p. 344). In other words, the relatively more productive oceans today are likely to have been the relatively more productive ones in the past as well, even if the nature of the exact target species changed over time. It is therefore plausible that areas judged as most productive based on relatively contemporary landings, were also the most productive areas in the past.

Our baseline BoS index is calculated as an unweighted average of the habitat suitability of the 15 species identified as being most important to the global fisheries in the 1950s. The index is aggregated to country level using each nations exclusive economic zone (EEZ).[11] Landlocked countries are assigned a BoS value of zero. Figure 2 illustrates our baseline BoS index for the world's oceans.

Several observations are worth making in light of the revealed worldwide distribution of exploitable marine fish. First, one observes a higher potential abundance along the coasts and

[11] The EEZs are prescribed areas by the United Nations and represent territories over which coastal countries have exclusive fishing rights and jurisdiction over natural resources, and that stretch up to 200 nautical miles from each individual country's coastline. A shapefile for exclusive economic zones is found at http://www.marineregions.org/downloads.php

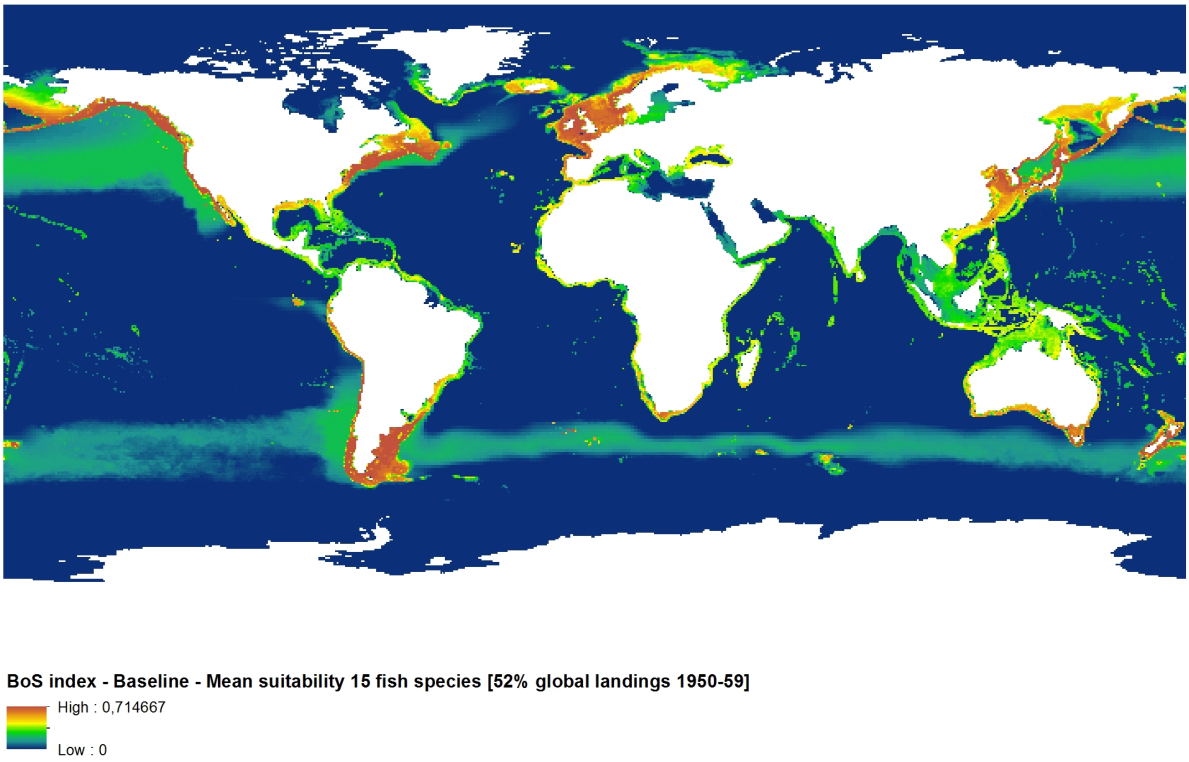

Figure 2: Figure 2: The Bounty of the Sea index, baseline measure. Notes: The index captures the (unweighted) average survival probability for 15 major fish species.

in particular associated with the continental shelf.[12] This is in accordance with the marine biological literature as shelf waters are characterized by a high content of nutrients that are derived from the continental landmasses and released by coastal upwelling effects.[13] Combined with the accessibility of its shallow waters and proximity to land, the continental shelf is the most exploited and productive ocean area in terms of fishing globally (Watson et al., 2004, King, 2013). The width of the shelf varies considerably from being very narrow around the African continent to stretching the entire North Sea in Europe. Second, there appears to be a latitude gradient in the BoS index: places further away from the equator are associated with having access to relatively richer maritime environments. This resonates with marine biological insights on the impact of temperature. Warmer waters tend to be less productive due to wider vertical sea temperature differences, which prevents nutritious bottom layers from mixing with surface layers (Valavanis et al., 2004). Moreover, it has been observed that temperate and colder waters generally host larger aggregations of single species, which naturally are more easily exploitable (King, 2013).[14]

[12]The continental shelves are underwater landmasses that extend from the continents and end with a steep slope towards the deep ocean floor. The shelf is characterized by being relatively flat and located at depths no larger than 150 meters.

[13]"Upwelling" is an oceanographic phenomenon that involves wind or current driven motion of dense, cooler, and usually nutrient-rich water towards the ocean surface, replacing the warmer, usually nutrient depleted surface water.

[14]Research has even documented how marine fish in higher latitudes are more mobile as they respond to seasonal changes in temperature, making them more likely to form tight shoals and thereby become easier targets for fisheries (Floeter et al., 2004).

This corresponds with the fact that species diversity declines with increasing latitude and distance from southeast Asia and the Caribbean (Tittensor et al., 2010).[15] Finally, regional hotspots of marine productivity identified by the literature are reflected in the BoS index. Such hotspots are the outcome of strong upwelling effects, nutrient terrestrial runoff, and the redistribution of nutrients by ocean currents.[16] These processes also produce regional spots of relatively low productivity like the Mediterranean Sea, where nutrient depleted Atlantic surface waters flow in through the Strait of Gibraltar in exchange for deep and more nutritious Mediterranean waters (Estrada, 1996). Overall, there appears to be substantial variation in the BoS index across and within continents and these patterns are in accordance with key marine biological principles.

Naturally, concerns may be raised in the context of our baseline measure. First, one may worry about selection bias: if the most technologically sophisticated nations in the world (in the 1950s) also were the most productive in fishing, the species found in these regions might well end up dominating global landings and therefore our BoS index.[17] To address this concern, we identify the most caught fish in every country around the world in the 1950s, thus avoiding a potential "technology bias" in the selection of species. The downside of this measure is, of course, that this alternative index may involve species that only to a very limited extent are exploitable, as reflected in a potentially very low number of global landings. Consequently, this measure may be somewhat noisy, making the regression results sensitive to measurement error. This procedure leads to an alternative list of 41 different species (cf. Table A1 in the Supplementary Appendix). Hence, our first alternative BoS index is the unweighted average habitat suitability index of these 41 species.

Second, one may worry that the size of the EEZ is endogenous (just like country borders usually are). To be sure, the extent of the EEZ is at times the source of conflict – the "cod-wars" between Iceland and England during the 1960s being a case in point.[18] To address this concern our second alternative BoS index aggregates the average survival probability of the top 15 fish during the 1950s using a 10 km buffer zone around countries' coastlines. This reduction in the area considered relevant for fishing also works to diminish the concern that, in historical times, exploitation of marine resources occurred probably closer to the coast than what is implied by the current EEZ areas.

[15]South East Asia has especially been identified as a centre of evolution and specification of marine resources as it is home to some of the oldest marine ecosystems of the world (Ursin, 1984).

[16]Major upwelling area are associated with the Canary (off Northwest Africa), Benguela (off Sourthern Africa), California (off California and Oregon), and Humboldt (off Peru and Chile) currents (King, 2013). Nutrient terrestrial runoff is particularly associated with glaciated, high-latitude soils and, globally, the outflow of major rivers including the Ob, Mackenzie, Mississippi, Amazon, Parana, Congo, Tigris and Euphrates, Indus, Ganges, Irrawaddy, Yangtze, and Huang (Huston and Wolverton, 2009).

[17]Note that similar concerns might be raised in the context of the selection of key crops for indices involving land suitability, see Nunn (2014, p. 370).

[18]See Kurlansky (1997, Ch. 10) for a vivid account.

Finally, one may wonder if "all fish are equally important"? That is, perhaps a superior index would weigh the individual survival probabilities in some way? To address this issue we also construct nutrition-weighted BoS indices. The nutritional value of commercially important fish species are reported by FAO (1989) in a comparable manner. These values are used to weigh the baseline Bounty of the Sea index according to calorie content, fat content, and protein content of each species, respectively.[19]

In sum, in addition to our baseline measure, we construct five alternatives, which differ in terms of: (*i*) the selection of relevant species; (*ii*) how we aggregate average survival probabilities to the country level, and, (*iii*) the weighting scheme involved in calculating the average survival probability (fats, protein, calories, respectively). Importantly, each of these indices involve changes in assumptions in one dimension at a time, compared with the baseline index. By comparing regression results when alternative indices are invoked, we are thereby able to gauge which of our baseline assumptions (if any) may seem critical.

2.2 Validating the BoS Index

The BoS index is by construction developed to capture the potential for marine exploitation. A natural question to ask is whether this potential seems to have been borne out?

To address this question, we begin by exploring the predictive power of the BoS index visá-vis actual landings during the 20th century. Subsequently, we explore whether the BoS index predicts the allocation of labor during the 19th century – with available data for the North Atlantic region; and whether the index predicts the contribution from fishing to subsistence in traditional societies recorded in Murdock's (1967) Ethnographic Atlas.

2.2.1 The harvest of marine resources

Comparable data on total marine fish landings across countries can be obtained back to the year 1900. For the period from 1950 the source is the FAOs FIGIS database, and for the period before 1950 two historical collections are available: *ICES Historical Landings 1903-1949* (ICES dataset) for 17 European countries and *Mitchell's International Historical Statistics* (IHS dataset) for 48 countries across the globe.[20]

Table 1 reports the results of regressing the log of yearly marine fish landings in tons on the Bounty of the Sea index, controlling for the log of the sea area within which the BoS index is aggregated (EEZ or buffer area). In columns 1 and 2 the outcome variables are historical

[19]Of the 15 marine fish species in the original Bounty of the Sea Index only 12 are associated with nutritional values in FAO (1989). The species not included are the Gulf menhaden, Atlantic menhaden, and Alaska pollock.

[20]See the appendix for a description of these data collections.

landings during the period prior to the 1950s.[21]

Table 1

As seen the BoS index indeed predicts yearly landings during the period from 1900-1940; along with the EEZ area the BoS index accounts for in between 25% and 40% of the variation. This is reassuring in that the species included in our index were not selected on the basis of actual landings during this period. Naturally, the sample sizes are somewhat modest.

Column 3 confirms that the BoS index exhibits a positive correlation with landings during the 1950s, as expected; this remains the case when we explore within continent variation (column 5). Along with sea area, the BoS index accounts for about 1/3 of the variation in the global data set on actual landings.

As a second out-of-sample check, we explore whether the BoS index remains significantly correlated with observed landings after the 1950s; see columns 4 and 6. Once again the answer is in the affirmative, and the R^2 even increases to about 0.5. As can be seen from Table A1 the most important species for worldwide fisheries diversified considerably after the 1950s. Hence, the significant explanatory power of the BoS index during this period both supports the prior that data on the potential abundance of marine resources carry predicting power of actual marine fish landings, and the prior that the index most likely proxies the riches of local oceans more broadly than what pertains to the exact species selected for the index.

2.2.2 Labor force allocation

Besides predicting marine fish landings across countries throughout the 20th century, the Bounty of the Sea index can be contrasted with data going further back in time and reflecting the allocation of societies' labor resources to activities related to the harvest of marine fish. Using historical survey data from the North Atlantic Population Project[22], we compute the number of people engaged in fishing across regions within six North Atlantic countries (Norway, Sweden, Iceland, United Kingdom, United States, and Canada), for different years within the period 1801-1910.[23] Disregarding landlocked regions, we aggregate the Bounty of the Sea index within a 100 km buffer zone from each region, and proceed to test how well the Bounty of the Sea index explains variation in the employment share of fishermen across 80 regions within these 6 countries.

[21]We disregard the 1940s in order to avoid how the Second World War hampered landings in an asymmetric manner.

[22]Collected by the Minnesota Population Center, this data contains census microdata from Canada, Great Britain, Germany, Iceland, Norway, Sweden, and the United States from 1801 to 1910. Important for this study is the reporting of individual occupation codes. Germany, which is actually just the region Mecklenburg-Schwerin, is left out in the present analysis.

[23]The subnational regions in the data set compare to the present day first-level divisions of these countries.

Conditioning on the buffer area of the sea, survey year fixed effects, country fixed effects, and total population or total employment in each regions, the results in Table 2 document that the BoS index is positively correlated with the number of fishermen, the number of ship workers, and the number of boat makers across regions in the six North Atlantic countries mentioned, throughout the 19th century and during the beginning of the 20th century.

Table 2

2.2.3 Food supply in traditional ethnic societies

In the checks above we have focused on whether the BoS index appears to carry explanatory power vis-á-vis the actual bounty of the sea, measured by observed landings, and if the BoS index seems to correlate in the expected way with what occupation people hold; i.e., whether areas adjacent to rich maritime waters also seem to be characterized by more people preoccupied with exploiting them. Another issue is whether the BoS index also predicts the extent to which societies have relied on fishing for subsistence.

To explore this issue we turn to data on traditional societies recorded in Murdock's (1967) Ethnographic Atlas (EA) and Standard Cross Cultural Sample (SCCS), respectively, and identify those located within 200 km from the coast.[24] We find the appropriate value of the Bounty of the Sea index for all these coastal traditional societies, by computing the average BoS within a 100 km buffer from the point on the coastline which is nearest to the centroid of each respective society. With this procedure we obtain data for 100 traditional societies in the SCCS, and 546 in the EA, which we can use to test whether the potential abundance of marine resources is correlated with the extent to which traditional and ethnic societies across the globe rely on fishing relative to agriculture. This is feasible as both data sets provide information on the contribution of fishing, animal husbandry, and agriculture to the total food supply.[25]

Table 3

Table 3 shows a clear pattern: controlling for the area of the BoS buffer, distance from the centroid of each society to the coastline, and the year in which data for each respective society was collected (which ranges from 800 BCE to 1960 C.E.), the BoS index is negatively associated with the contribution of animal husbandry and agriculture to the food supply, but positively correlated with the contribution from fishing.

[24]The geographical coordinates of the ethnic group centroids are reported in the SCCS. From this point we calculate the distance to the nearest coast and disregard those with a distance of more than 200 km. The use of 200 km as the radius within which the ethnic groups have been likely to move around follows Alesina et al. (2013).

[25]Specifically, the indices range from 0-9, where 0 represents 0-5% dependence, 1 represents 6-15%, 2 represents 16-25%, so on up to 8, which represents 76-85% dependence, and 9, which represents 86-100% dependence.

For the group of traditional societies included in the Ethnographic Atlas, which involves a larger selection of societies, we find the same pattern (cf columns 6-10): the potential abundance of marine resources is positively correlated with fishing, and negatively correlated with animal husbandry and agriculture.

Overall, these results suggest that in areas characterized by a greater BoS index it would be more likely to see societies that relied on the exploitation of marine resources for subsistence to a significant extent, albeit not necessarily exclusively.

3 The Bounty of the Sea and Economic Development

3.1 Empirical Strategy

In this study we explore the links between the BoS index and various outcomes at the country level (y_i): population density, GDP per capita and a range of measures pertaining to the proposed mechanism linking the BoS index to current economic development.

Formally, the regression model that we take to the data can be written

$$y_i = \beta_1 \mathrm{BoS}_i + \beta_2 \mathrm{AG}_i + \mathbf{X}_i' \gamma + \varepsilon_i, \tag{1}$$

where y_i is the outcome of interest, "AG" is a measure of agricultural land productivity, whereas the vector $\mathbf{X}_i$ comprises a set of control variables and a constant term.

In the main body of the analysis we restrict $\mathbf{X}_i$ to comprise a relatively limited set of covariates; in the appendix we extend it considerably, as explained below. Accordingly, our baseline controls include, in addition to land productivity and the BoS index: the timing of the Neolithic revolution; sea area and land area; a full set of continental fixed effects; the distance to the equator; a dummy variable which takes on the value one if the country is landlocked, and finally, the fraction of land area within 100 km of the ocean or navigable river.

Land productivity is included in all specifications, alongside the BoS index since we are interested in comparing the long-run impact from natural productivity of the ocean and inland; i.e., the relative size and sign of β_1 and β_2. Similarly, we control for both sea area and land area in all cases, since we are interested in the importance of greater "quality" of the environment, for its size given. The timing of the Neolithic Revolution is added since it allows us to assess the importance of sea and land productivity, conditional on the time at which agriculture entered the scene. Distance to the equator (absolute latitude) is in the control set to capture in a parsimonious way climatic conditions that may (through a variety of mechanisms) have influenced productivity in the past, as well as exerted an impact on outcomes today. Moreover, since there appears to be something of a latitude gradient in our baseline BoS index, the omission of absolute latitude would increase the risk that our results become tainted by omitted variable bias. In light of the discernible continental-wide differences in marine productivity, continental fixed effects are included to capture unobserved heterogeneity. Finally, in order to control for the potential access to the sea we include the percentage of land within 100 km of coasts and waterways and a dummy variable which takes on the value of 1 if the country is landlocked. Data description, summary statistics, and sources for our control variables are found in the Supplementary Appendix.

3.2 Pre-Industrial Development

3.2.1 Country level evidence

In Table 4 we report the results from estimating equation (1) when log population density in 1500 C.E. is the outcome of interest. The regression parameters are standardized throughout. Accordingly, the individual regression coefficient speaks to the change in the left hand side variable, measured in standard deviations, that results from a change in the right hand side variable by one standard deviation. This facilitates a simple comparison of the economic significance of the individual controls. Statistical significance are reported in parenthesis (p-values).

Table 4

In the first five columns we add the auxiliary controls sequentially, and then collectively (column 5). The BoS index is in all settings significant at the five percent level, or better, and carries a positive point estimate. The same is true both for our measure of soil suitability for agriculture, and for the timing of the Neolithic. Hence, these results suggest that, for given land productivity and length of agrarian history, countries that could rely on a relatively richer Bounty of the Sea were more densely settled in 1500 C.E.[26] Economically, the influence from the timing of the Neolithic is greater than both that of the BoS index and the agricultural counterpart. Conditional on the timing of the Neolithic, the impact from soil conditions is greater than that of the BoS, though the point estimates are of similar order of magnitude.

In column 6 we restrict the sample by excluding all landlocked countries. Naturally, being landlocked may have hampered development in its own right, for which reason it is of interest to inquire whether the BoS index contains explanatory power only between countries that have

[26] It is interesting to note that the parameter estimate for absolute latitude is *negative*, suggesting greater economic development close to the equator in 1500 C.E.. This finding, suggestive of a climatic reversal in economic activity during the last half millennium, was first noticed in Ashraf and Galor (2011). See Dalgaard and Strulik (2014) for a possible explanation for the reversal, and discussion of alternative accounts.

access to the ocean. Interestingly, the point estimate for the BoS index does not seem to be much affected, statistically and economically.[27]

In columns 7-10 we employ our alternative BoS indices, with and without landlocked nations being present in the sample. The results are very similar. This is reassuring in that it indicates that our BoS index probably is not haunted by selection bias in any substantial way via of the selection of species, nor by a potential endogeneity bias due to the geographical unit we aggregate to.

In the Supplementary Appendix we explore the robustness of these results in several ways. First, we examine if the results hold up if we solely focus on Europe and Asia, respectively. This check is motivated by the potential concern that the quality of the data on population density in 1500 C.E. may be lower outside these areas. Reassuringly, however, the size and significance of the BoS indices is very similar, albeit more economically significant (Tables A3-A4).[28]

Second, we study whether the results change if we rely on alternative BoS indices, which weigh individual species by their calorie content, their fat content, or their protein content. As documented in the Supplementary Appendix, the results are qualitatively and quantitatively similar to those reported above (Table A5).

Third, we examine the consequence of expanding the set of controls. In order to tie our own hands in the context of choosing specifications, we opted for those invoked by Ashraf and Galor (2013) in the context of their study of pre-industrial development. That is, we simply add the BoS index (along with EEZ area) on top of their controls. As in Table 4, we also explore the consequences of omitting landlocked nations. The message from Table 4 carries over (see Table A6).[29]

Finally, we revert to our full specification and explore the influence from additional controls with direct bearing on marine conditions: an island dummy; average distance to coast or rivers; ocean biodiversity; the extent of tidal movements; the length of coastline and inland waterways to land area, respectively; the number of natural harbours relative to land area; and the share of the EEZ area which constitutes shelf area or is covered by estuaries, respectively. The BoS index remains significantly correlated with population density in 1500 C.E. despite the inclusion

[27]Throughout we include a control for being landlocked, which means we partial out the *average* difference in population density between coastal and non-coastal nations. When we exclude landlocked nations entirely we push matters a bit further by exploring the impact from the BoS index solely *within* coastal countries.

[28]If the measurement error (in the dependent variable) is classical, one would only expect to see more imprecisely estimated parameters, not changes in point estimates (in contrast to measurement error on the independent variables). *A priori*, however, the measurement error could be non-classical. Our results can therefore be interpreted as indicating that the measurement error on population density in 1500 C.E. is approximately classical in nature.

[29]To be clear, this approach is not to meant to suggest that we believe the specifications chosen by Ashraf and Galor (2011, 2013) necessarily are the "specifications to end all specifications", in the context of understanding population density in 1500 C.E. What this approach does demonstrate, however, is that our novel results are robust to the inclusion of the most commonly agreed upon determinants of pre-industrial development, at present.

of these additional controls (See Table A7).[30]

3.2.2 Within country evidence

While the cross-country results appear robust, concerns regarding omitted variable bias may linger. As a consequence we explore, as a further step, within country variations. For these tests we have obtained data on population density for the year 1500 C.E. from the HYDE database, version 3.1, which contains grid-level estimates of population size (Klein Goldewijk et al., 2010, 2011). In order to rigorously control for coastal access we focus on the universe of pixels worldwide that are located within 100 km from the coast. In order to assign a BoS value to a pixel, we calculate the shortest distance to the coast from the center of each pixel, and from this coastal location calculate the BoS value using a 100 km buffer zone.

Our control strategy is similar to the one invoked in the last section with a couple of modifications. We do not have pixel level data on the timing of the Neolithic, for which reason this control is not included. Moreover, since we only focus on coastal areas we introduce distance measures and control for geographical characteristics of the nearby ocean: distance to the ocean and natural habour, respectively, as well as the extent of tidal movements, and shelf and estuary area. Finally, continental fixed effects are omitted and replaced by country fixed effects.

The results are reported in Table 5.

Table 5

In column 1 we only control for the BoS index along with land productivity, aside from pixel and buffer zone area; both productivity measures are positively correlated with population density. This remains true when we control for country fixed effects (column 2). In the remaining columns we sequentially add controls for: the distance to the coast and natural habour, repectivtly (column 3); geographic features of the coast such as the extent of tidal movements (column 4); absolute latitude and elevation (column 5); and all of the controls collectively (column 6). In terms of the economic impact of the BoS index it is worth noting that the standardized parameter estimates are very similar to those obtained in the cross-country context.

In the two final columns we check the robustness of our within country results to the use of alternative BoS indices: a version where we limit the buffer zone to 10 km rather than 100 km (column 7) and the "technology adjusted" version of the BoS index (column 8). While the economic significance shrinks in the latter case, compared with the results from our cross-country sample, the BoS index remains significant at conventional levels. Overall, the pixel-level results

[30]Estuaries are places where rivers run into the ocean and thus produce brackish water. In this empirical specification, the "shelf" area constitutes the relatively shallow waters of up to 200 meters in depth.

support the cross-country results: more productive oceans stimulated pre-industrial development.

3.3 Contemporary Development

3.3.1 Country level evidence

Table 6 report the results from exchanging log population density in 1500 C.E. for log real GDP per capita in 2005 as the dependent variable. The specifications are, to begin, exactly the same as those invoked in Table 4.

Table 6

The link between the BoS index and economic development is rather similar to that detected for the pre-industrial period: a positive correlation emerges. In contrast, the sign of the correlation involving agricultural productivity has reversed, whereas the timing of the Neolithic no longer carries any significant explanatory power, statistically speaking.

In comparison with the pre-industrial setting, however, the estimates appear more sensitive to the chosen specification, and in some instances statistical significance is not attained. This finding raises the question of whether, in the 21st century, the local environment is really what matters to economic activity.

Alternatively, relative natural endowments may influence economic development today via more indirect channels like cultural values and preferred institutions, which are embodied in people. The past 500 years has witnessed a considerable amount of international migration so that the current inhabitants of many countries have ancestry from elsewhere. As a result, a purely geographic variable may be a poor indicator of the environment within which the ancestors of the current population were found. This may explain why the BoS index seems less robustly correlated with economic outcomes today than what is the case for 1500 C.E.

Accordingly, Table 7 examines the consequences of ancestry adjusting the BoS index using the population migration matrix constructed by Putterman and Weil (2010). The ancestry adjusted BoS index thus reflects the bounty of the sea of the countries from which the ancestors of the populations of today's countries have migrated during the past 500 years.[31] We also ancestry adjust variables that relate to agriculture, for the same reason.

Table 7

[31]Suppose the fraction π_{ij} of the population in country i descends from country j, the ancestor adjusted BoS index is calculated as $\sum_j \pi_{ij} BoS_j$, where $\sum_j \pi_j = 1$.

The change in the nature of the results is noticeable. In particular, the estimates become more stable, and increase in size. Moreover, whereas land productivity continues to enter with a negative sign after the migration adjustment, the ancestry adjusted timing of the Neolithic now also carries explanatory power and enters with a positive sign. Overall, these results suggest that the positive correlation detected in Table 5 largely reflect the influence from the historical legacy of the people of the country rather than the place itself.

To follow up, Table 8 reports the results from "horse-race" regressions where we simultaneously control for the environment, and the environment of the ancestors of the current population.

Table 8

Intriguingly, the point estimate for the ancestral BoS index maintains its statistical and economic significance whereas the purely geographical indicator ceases to be statistically significant. These results suggest that the importance of the BoS index today is not mainly driven by local geographic conditions per se.

In the Supplementary Appendix we explore the robustness of these results in various ways. First, we study if the impact from the ancestry adjusted BoS index changes if we employ indices where individual species are weighted by their nutritional value. This is not the case (cf Table A8).

Second, we include controls for additional marine conditions, as in the previous section. The impact from the ancestral BoS index is unaffected by augmenting the control set this way (Table A9).

Third, we experiment with a different specification. Again, we chose to follow the specifications adopted in Ashraf and Galor (2013), in the context of their analysis of contemporary development, to limit our degrees of freedom, and to ensure that we capture the most commonly agreed upon (fundamental) determinants of development (tables A10-A11). Broadly speaking, the results are similar to the ones reported above, with an important corollary. In some specifications Ashraf and Galor (2013) include a measure of institutional quality: the Social Infrastructure index, due to Hall and Jones (1999). In these settings, the ancestry adjusted BoS index (with or without the simultaneous inclusion of the unadjusted BoS index) tends to loose significance. This result need not be surprising, as a manifestation of differences in relative endowments may be differences in the institutional infrastructure.

If we thus take the estimates at face value there are two ways in which one may gauge their economic significance. First, one may observe that the standardized regression coefficient for the ancestral BoS index is of the same order of magnitude (in absolute terms) as that of land

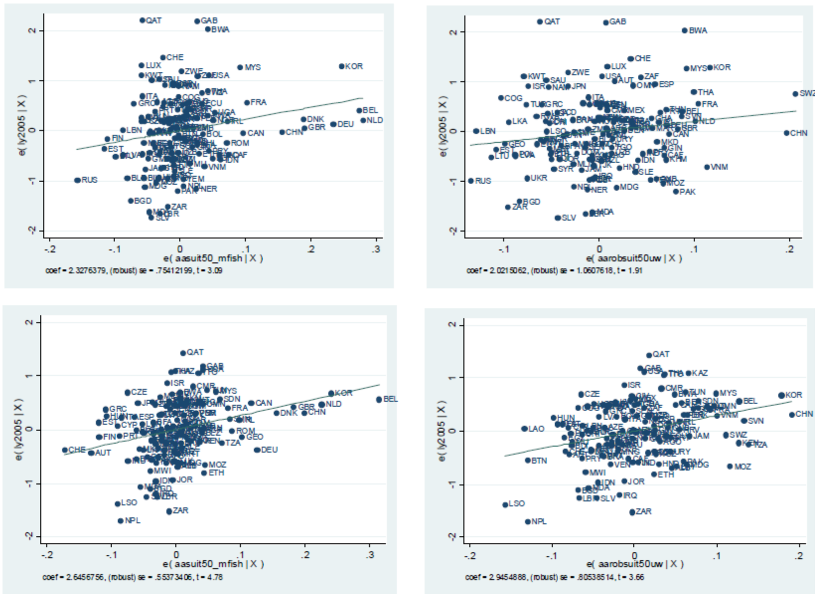

Figure 3: The partial correlation between ancestral BoS index and GDP per capita. Notes: Top left hand side (LHS) picture depicts the baseline full specification and baseline measure whereas the top right hand side (RHS) figure shows the baseline full specification where the "top fish" BoS index is employed (Table 6, cls 5 & 7). Lower LHS shows the result when we employ the baseline measure and controls from Ashraf and Galor (2013) short of Social infrastructure; the lower RHS figure shows the same though employing the "top fish" BoS index (cf Table A9, cls 8 & 10).

productivity, and the ancestral timing of the Neolithic. In light of the importance of agriculture in human history this in itself suggests the impact from the bounty of the sea is substantial.

Second, one may ask how big of an impact the BoS index can create in terms of income per capita. In the specification reported on in column 6 of Table 7, the basic point estimate is 2.78 (not reported), which means that an increase in the ancestral BoS index of one standard deviation (0.1) increases current income per capita by about 28 % (=0,1x2,78). Alternatively, the range of the BoS index in the relevant sample is 0.43, which means that the maximal income difference that can be generated by differences in the natural level of productivity of the ocean is about 112% (0,4x2,78).

In way of concluding this section, Figure 3 depicts the partial correlation between the ancestry adjusted BoS index (baseline measure, as well as the indicator involving the top fish in each country), in both our full basic specification and when we employ the Ashraf and Galor (2013) specification omitting the social infrastructure variable. As is visually clear, the results do not seem fragile to any particular influential observation.

3.3.2 Within country evidence

As in the pre-industrial setting we have also explored the consequences of limiting attention to within country, near coast, locations. As measures of economic activity we employ either population density or earthlights. The control strategy is identical to the one adopted in Section 3.2.2. In the modern setting we would ideally like to ancestor adjust the BoS index. This is not feasible unfortunately. However, observe that insofar as the post 1500 immigrants are reasonably evenly distributed within the coastal areas (and potentially within the country in general), the influence from international migration would be picked up by the country fixed effects. In all settings the BoS index is significantly and positively correlated with economic activity, as expected. This demonstrates that variations in the bounty of the sea contributes with an explanation of the substantial inequality within coastal locations (cf. Figure 1). In the interest of brevity the results are relegated to the supplementary appendix (Table A12).

4 A Mechanism

4.1 The theory

The empirical analysis in Section 3 documents three salient facts. First, the bounty of the sea is positively correlated with measures of economic development, both during pre-industrial times and today. Second, the contemporary links are strengthened if we focus on ancestral productivity levels, rather than their place- specific counterparts. Third, the natural level of productivity in agriculture is positively correlated with economic development in the past, but negatively correlated with prosperity today. The goal of the theory developed in this section is to provide a mechanism, which can potentially account for these regularities.

The theory that we propose rests on three elements. The first element concerns the degree of coastal orientation of the economy, or the spatial distribution of economic activity. In pre-industrial times the existence of adequate food resources was a natural pre-condition for urban centers to emerge. For instance, according to the influential work of Jared Diamond (1997), the emergence of cities had to await the arrival of the Neolithic revolution, and even today natural productivity in agriculture is a strong predictor of the spatial distribution of economic activity (Henderson et al., 2016; Motamed et al, 2014). This is no mystery. In historical and pre-historical times, the ability to transport food over land was limited, implying that the emergence of a population center usually required sufficiently rich agricultural hinterlands to provide sustenance for the population. By the same token, limited inland transport capabilities may have constrained the emergence of early population centers in coastal areas, absent nearby rich agricultural hinterlands. However, a rich marine environment would have helped overcome such constraints, due to the availability of an alternative (or complementary) source of food. Consequently, in regions featuring a highly productive ocean a greater proportion of the population would be able to settle in close proximity to the ocean early on. Since settlement patterns tend to be very persistent, this pattern might well be discernible today (e.g., Bleakley and Linn, 2012). In sum:

Prediction 1: The BoS index should predict a greater fraction of total population living near the coast, historically as well as today.

The second element of the theory is that the location of economic activity influenced the occupational structure of the economy, prior to industrialization. More specifically, in coastal communities a range of non-agricultural occupations would be observed. Perhaps most obviously long distance traders and merchants. But the list would likely also involve proto-industrial occupations related to shipbuilding.[32] Due to a differential degree of coastal orientation across societies heterogeneity in the experience with non-agricultural endeavours would arise with the passing of time.

In the supplementary appendix we provide historical case studies concerning the rise of cities and markets, which were deeply connected to the bounty of the sea. The "old world" example concerns the capital of Denmark, Copenhagen. However, during the period after 1000 C.E. cities and markets all over Europe seems to have been stimulated by the bounty of the sea, even in a rather direct way. As observed by Hoffman (2005, p. 23-4)

> In about the tenth century, records from several European regions show people catching fish for sale to nearby consumers... Local markets for fish were an integral, indeed often precocious, element in the early rise of an exchange sector, i.e. the start of what historians call the 'Commercial Revolution of the Middle Ages' which became fully visible as it grew during the eleventh and twelfth centuries. Artisan fishers first appeared at inland and coastal sites with access to consuming centres, especially emerging towns such as Ravenna, Gdansk, Dieppe, Lincoln or Worms, and such people 'who make their living from fishing' spread and multiplied from there.

A "new world" example, discussed in the supplementary appendix, is the city of Boston, which arguably was similarly stimulated early on. As observed by Adam Smith (1776, Chapter 7, part II: *Causes of the Prosperity of New Colonies*):

> To increase the shipping and naval power of Great Britain by the extension of the fisheries of our colonies, is an object which the legislature seems to have had almost constantly in view. Those fisheries, upon this account, have had all the encouragement which freedom can give them, and they have flourished accordingly. The New

[32]In the validation tests (Section 2.2.2) we documented that the employment rate of boat makers and ship workers is higher in coastal regions featuring a high bounty of the sea (cf Table 2).

England fishery, in particular, was, before the late disturbances, one of the most important, perhaps, in the world. ... Fish is one of the principal articles with which the North Americans trade to Spain, Portugal, and the Mediterranean.

Hence, whereas early coastal settlements quite likely were connected to the bounty of the sea for sustenance, a high natural level of productivity of the ocean arguably also helped the settlements grow, and formed the foundations for markets and trade, with implications for the occupational structure to follow. Namely, a greater proportion of people working outside agriculture. These considerations motivate the second prediction:

Prediction 2: The (ancestrally adjusted) BoS index should predict a more non-agrarian employment structure, *prior* to industrialization.

P2 follows since many of the capabilities attained via non-agricultural endeavors should be portable; this would be the case for the job specific skills themselves, but also for cultural values and preferences for formal institutions which would develop over time in light of the occupational structure. For example, Acemoglu et al. (2005) argue that the emergence of the Atlantic trade enriched long-distance traders favouring property rights supporting institutions. If the natural productivity of the ocean helps explain at which locations long-distance merchants would be observed at greater frequency one might thus anticipate a reduced form link between the bounty of the sea and institutions that are complementary to industrialization. When the Age of Discovery is ushered in, these capabilities are diffused around the world via migration, thereby impacting on the host country's occupational structure. Naturally, in the pre-Columbian era the purely geographic BoS measure should carry significant explanatory power vis-a-vis the non-agrarian employment share.

The third element of the theory is that the adoption of industrialization would be greatly facilitated by a historical experience with non-agricultural activities. Such experience would be found, according to the proposed hypothesis, in greater measure in locations featuring relatively high natural productivity levels in the oceans. Taken together we have

Prediction 3: The ancestral BoS index should predict an earlier timing of Industrialization and take-off to growth.

By combining these three elements we can provide an account for the reduced form results above. The theory suggests a persistently positive impact from the BoS on development, whereas the influence from natural inland productivity is reversed in the course of development due to an adverse impact on the timing of Industrialization. It also motivates why these regu-

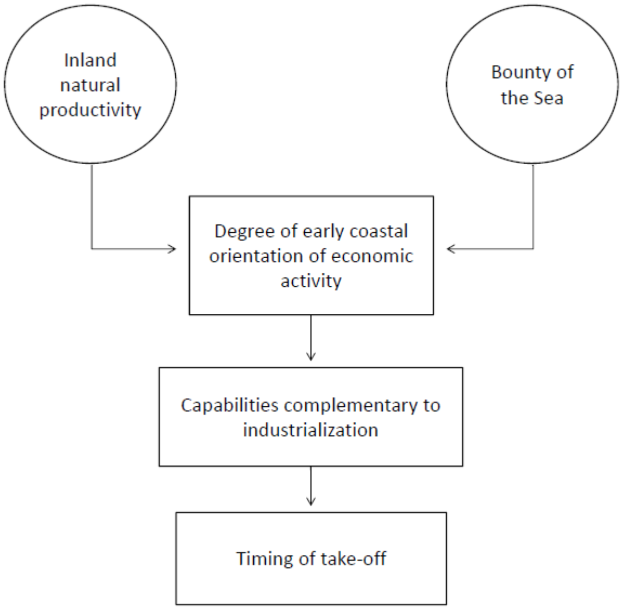

Figure 4: Overview of the hypothesis.

larities should be more salient when the ancestral natural productivities are invoked. Figure 4 provides a schematic overview of the proposed theory.

A final prediction, concerning the theory in its totality, is as follows:

Prediction 4: The ancestral BoS index should have a quantitative impact on the timing of the take-off so as to plausibly account for its reduced form impact on current income per capita.

Prediction 4 follows as the proposed mechanism motivates an impact from the ancestral BoS index on current prosperity through a differentiated timing of the take-off. Andersen et al. (2016) show how this sort of a proposed mechanism allows for a simple consistency check.

The check works as follows. Imagine that some underlying characteristic (here it is the BoS index) influenced the timing of the take-off, and therefore current income differences. Prior to the take-off per capita income is assumed to stagnate for Malthusian reasons. Ignore convergence effects after the take-off for simplicity. Then the reduced form OLS estimate of the BoS index on income per capita can be interpreted, in the limit where all countries in the sample have emerged from stagnation, as reflecting the marginal impact from the BoS index on the timing of the take-off, multiplied by the average growth rate since the take-off. Hence, if the estimated quantitative impact on the timing of the take-off is either much to large, or much to small, it sheds doubt on the hypothesis in question. In the next sections we examine P1-P4 empirically.

4.2 Testing Prediction 1: Coastal orientation

In testing P1 we rely on several databases. For the year 1500 C.E. we draw on the HYDE database, version 3.1, which contains grid-level estimates of population size historically (Klein Goldewijk et al., 2010, 2011). For the contemporary era we invoke the Gridded Population of the World database, version 4.0. As a matter of robustness we additionally employ earthlights as a proxy for current economic activity (Henderson et al., 2012, 2016). The coastal orientation of a country is defined as the fraction of the total population (or total lights) that is located within 100 km of the coast.

Table 9

Panel A of Table 9 focuses on 1500 C.E., whereas Panel B examines the determinants of coastal orientation today. The model specification is our baseline specification from the last section, with a minor adjustment: instead of the dummy variable for landlocked nations we instead control for the fraction of a country's territory that falls within 100 km of the coast. Naturally, the shape of a country mechanically influences the spatial distribution of the population for which reason it seems prudent to include it as a control when testing P1. Note that landlocked nations are implicitly controlled via this variable, motivating the exclusion of the dummy variable from the model.

Turning to the results we observe that the baseline BoS index is significant in all cases, typically at the one percent level of significance. This continues to hold when we employ our alternative BoS indices (cf column 6 and 7 in Panel A and B). It is also noteworthy that our measure of land productivity is negatively correlated with the fraction of the population living near the coast, suggesting that the levels of natural productivity impact on the distribution of the population in opposite directions.

As alluded to above, the contemporary results are very similar if we employ earthlights rather than population levels (see Table A13 in the Supplementary Appendix). Moreover, as also documented in the Supplementary Appendix (Table A14), the results for 1500 C.E. and today are very similar if we define coastal orientation as the fraction of population within 50 km of the coast. Overall, we find that these results are consistent with our findings in Section 3 where we document that within coastal areas adjacent to productive oceans, population density and economic activity is higher both in 1500 C.E. and today.

If we assume the estimates reported in Table 9 reflect a causal impact, it becomes possible to gauge the quantitative significance of the bounty of the sea for the spatial distribution of the population. In particular, in Panel B column 5 we find that a reduction in the BoS index by one standard deviation reduces the fraction of the population near the coast today by about

0.15 standard deviations. In the sample one standard deviation of our left hand side variable is very close to 1. Accordingly, if one reduces the BoS index by one standard deviation it should reduce the population near the coast today by roughly 15 %. In 1500 the corresponding estimate is smaller; a similar calculation leads to an estimated reduction of roughly 2.5%. Accordingly, to square these estimates agglomeration effects playing out over the last half millennium must have served to elevate initial differences in coastal orientation initially caused by differences in the natural productivity of the ocean.

4.3 Testing Prediction 2: Occupational Structure

In testing P2 we rely on two measures of the pre-industrial occupational structure. The first is the urbanization rate in 1500 C.E., which is thought to proxy the employment rate in non-agricultural enterprises during the Pre-Colombian period; arguably, most service and proto-industrial jobs were found in cities, at the time. The second measure is more direct, namely the employment share in agriculture. This measure is not available in 1500 C.E., but it is feasible to obtain it for 1900 C.E. While this obviously is too late to capture the pre-industrial occupational structure in a few Western European countries, England first and foremost, it should be a sensible measure for most of the countries around the world. Note that, formally, fisheries would serve to increase the employment share in agriculture by national accounts conventions.

Table 10

Panel A from Table 10 focuses on 1500 C.E., whereas Panel B examines the determinants of the agricultural employment rate in 1900 C.E. The model specification is our baseline specification from Section 3. When we focus on the occupational structure in 1500, we invoke the baseline BoS index, whereas we employ the ancestral counterpart for the analysis pertaining to 1900, motivated by the migration flows over the intervening period.

As seen from Panel A, the BoS index is strongly positively correlated with the urbanization rate; typically at the one percent level or better. The parameter estimate appears relatively stable when additional controls are added, as long as the continental FE's are included in the model. In contrast, higher land productivity is found to be negatively correlated with urbanization in 1500 C.E.

In 1900, as seen from Panel B, the results are similar. That is, the ancestor adjusted productivity level of the ocean is negatively correlated with the employment share in agriculture, whereas land productivity is positively correlated with reliance on agriculture. Hence, consistent with the proposed hypothesis we in fact observe that the structure of employment appears to have been influenced by natural productivities. Figure 5 depicts the partial correlation between the

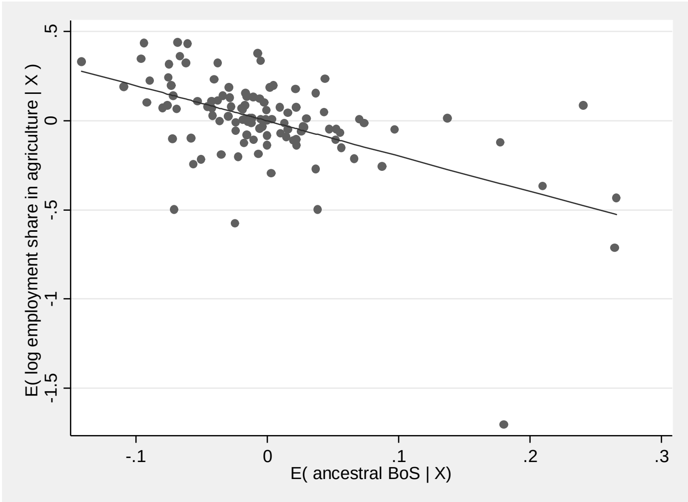

Figure 5: The partial correlation between BoS (ancestor adj) and employment share in agriculture, 1900 C.E. Notes: The figure is based on the results reported in Table 10, column 5.

(ancestor adjusted) BoS index, and the employment share in agriculture; the obvious outlier, featuring low employment in agriculture and high natural productivity of the ocean is England.[33]

A potential concern with these results, however, is the risk of reverse causality in the context of the ancestor adjustment. The reason is that the migration matrix involves migration flows that in part takes place during the 20th century, which is after the year in which the employment rates are measured. In order to check if the concern is of substantial importance we have rerun the specifications in Table 10 using the pure geography measure but limiting the sample to countries where more than 90% of the population is native. The results are similar to those reported above (see the supplementary appendix, Table A15, columns 1-3)

In way of concluding we turn to the economic significance of the findings. In our full specification our point estimate implies that a reduction in the BoS index by one standard deviation increases the (log) employment share in agriculture by roughly 0.5 standard deviations. In the sample underlying the regression the standard deviation of the left hand side variable is about 0.36 implying an impact of ca. 18%.

4.4 Testing Prediction 3 and 4: Industrialization and the take-off

In order to examine the last two predictions we rely on two measures. The first is labeled the "timing of industrialization", which is proxied as the year in which the employment in industry exceeds that of agriculture. The second measure is the year of the fertility decline.[34] The data

[33] This does not mean that the theory is inconsistent with the experiences of England. But by 1900 C.E. industrialization in England has had time to progress much further than in the remaining countries in the sample, for which reason it presents itself as an outlier.

[34] According to unified growth theory, the onset of the fertility transition marks the onset of modern growth, which thus represents our motivation for using this measure as a marker for the take-off to growth (see Galor and Weil,

sources are provided in the Supplementary appendix.

Table 11

In Table 11, panel A and B, we ask if the BoS is a predictor of either measure of the take-off. In compliance with P3 we find the answer to be affirmative: higher values of the BoS index are associated with an early onset of industrialization as well as of the fertility decline. Moreover, the parameter estimates appear to be stable when additional controls are added.

Once again one may be concerned with the risk of reverse causality due to the ancestor adjustment. We have re-run the specifications in Table 11 using the pure geography measure but limiting the sample to countries where more than 90% of the population is native. The results are similar to those reported above (see the supplementary appendix, Table A15, column 4-9).

In Table 12 we ask if the timing of industrialization and the fertility decline seems to reduce the impact from the bounty of the sea in explaining current income per capita. If the influence from the BoS index on prosperity is channeled through the take-off we would expect to see a reduction in the impact from the former on GDP per capita.

Table 12.

In the first three columns of Table 12 Panel A and B, we estimate the reduced form impact, controlling for the sample available to us in the present setting; in the subsequent columns we add either the timing of industrialization (Panel A) or of the fertility decline (Panel B). Generally, the BoS index remains significant. But the point estimate is visibly reduced, and in some instances it does loose significance (column 4, panel B). These finding suggest that a significant part of the reduced form impact from the bounty of the sea involves a differential timing of industrialization and the take-off to growth. This issue can also be approached from a more quantitative angle.

Turning to P4, we observe that the impact of the BoS index on industrialization is roughly 0.5 standard deviations (Table 11, column 5). This means that a reduction in the BoS index of one standard deviation delays industrialization by about (0.5 x 37 =) 18.5 years, since the standard deviation of the timing of industrialization in the sample is ca. 37 years. In terms of the fertility decline, we find an impact of 0.3 x 34.5, or 10.3 years. As seen from Table 12 a delay in either the fertility decline or the timing of industrialization comes at a cost to observed income per capita in 2005; quantitatively each year either transition is delayed reduces income per capita in

2000; Galor and Moav, 2002; Cervellati and Sunde, 2005; Galor 2011 for an overview).

2005 by about 1% (not shown).[35] These estimates are probably underestimating the true costs due to measurement error, but if we use them nevertheless we can calibrate an income loss from one standard deviation reduction in the BoS index of between 11% (using a delay of 10.3 years and an annual cost of one percent) and 20% (delay of 18.5 years). Our reduced form estimate, discussed in section 3.3.1 is 28%, which is a bit larger than our calibrated estimate, though clearly in the same ball park.

Overall, the conservative conclusion is that the proposed mechanism can account for a large share of the reduced form estimate, under plausible assumptions. Yet, the mechanism involving a differentiated timing of the take-off does not seem to fully account for our reduced form estimates; the BoS index often remains significant (albeit the parameter estimate shrinks markedly) when either measure of the take-off is introduced into the model, and the internal consistency check also suggests the mechanism does not fully account for the reduced form impact of the BoS index on current income differences. The remainder of the effect must then either be attributed to another mechanism, or to post-take off influences from the bounty of the sea. If the BoS has served to influence fundamental determinants of productivity, such as formal and informal institutions, it would seem likely that the BoS could be convoluting the effect from factors that impinge on growth after the process has begun. Inquiring into which formal and informal institutions the bounty of the sea has influenced is an interesting topic for further research, but well beyond the scope of the present paper.

5 Conclusions

In the present study we have taken a first pass at examining the long-term economic consequences of having access to a rich Bounty of the Sea. We find that maritime resources positively influenced countries' development in the past, and that they still seem to do so today. In the latter respect, however, it appears that it is the bounty of the sea of the ancestors of the current populations which drives the link, not geography per se. This suggests that the impact from the productivity of the ocean on current economic activity is likely indirect, involving an intermediate impact on formal and informal institutions.

We believe an important explanation for these reduced form findings is a mechanism which involves early coastal orientation, the ensuring occupational structure, and the timing of the take-off to growth. In societies with access to a rich bounty of the sea coastal areas featured more economic activity early on; that is, the productivity of the nearby ocean influenced the

[35] This is consistent with, though on the low side of, estimates found in Dalgaard and Strulik (2013) and Andersen et al. (2016).

spatial distribution of the population. We argue that a greater concentration of the overall population near coastal areas subsequently influenced the occupational structure, which became less agrarian in nature. Ultimately, a longer experience with non-agricultural occupations became advantageous when the Industrial Revolution emerges. Simply put, countries characterized by a greater bounty of the sea – or more generally a population descending from such areas – were faster to benefit from the new opportunities that industrialization offered, facilitating an early take-off to growth. Our tests suggest that this mechanism, which involves a differential timing of the take-off, can account for a large share of the reduced form result.

The present study may form the basis for future research in a number of directions. First, in the analysis above we have focused on marine resources, though fishing naturally also may attract people to rivers and lakes. It would clearly be interesting to extend the analysis of the present study in the direction of the bounty of rivers and lakes.

Second, while our results suggests that the bounty of the sea influenced coastal orientation and the occupational structure of individual nations, they do not explicitly speak to what sort of capabilities that were accumulated within coastally oriented urban societies. Hence, more work is required in order to understand the potential impact from the bounty on the sea on formal and informal institutions, which likely have been shaped in these locations. Knudsen (2015) takes a step in this direction, documenting an impact on individualism. Yet more research seems to be called for.

Third, one may hypothesize that having had access to a rich bounty of the sea may have influenced the diet and dietary traditions of different societies, which could impact on health – and economic outcomes today. This too seems well worth exploring in future research. ■

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Table 1. Validation of BoS: Harvesting marine resources

	1	2	3	4	5	6
Dependent variable: (log)	Fish landings (tons/year)					
Dataset:	ICES	IHS	FAO			
Period:	1903-1939	1900-1939	1950s	1960-2009	1950s	1960-2009
BoS index	0.665	0.443	0.35	0.412	0.302	0.282
	(0.001)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)
(log) EEZ area (sq km)	0.49	0.401	0.446	0.566	0.56	0.728
	(0.095)	(0.019)	(0.000)	(0.000)	(0.000)	(0.000)
Continent FE's	No	No	No	No	Yes	Yes
Observations	17	36	162	162	162	162
R-squared	0.38	0.25	0.31	0.47	0.42	0.63

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant.

Table 2. Validation of BoS: Labor force allocation

	1	2	3	4	5	6
Dependent variable: log (1+)	Fishermen		Boat makers		Ship workers	
BoS index (100 km buffer)	0.33	0.346	0.136	0.112	0.275	0.345
	(0.000)	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)
(log) 100 km buffer area (sq km)	0.299	0.339	-0.1	-0.023	0.106	0.175
	(0.000)	(0.000)	(0.023)	(0.412)	(0.038)	(0.000)
(log) Employment	0.347	0.615	-0.056	0.269	0.581	0.837
	(0.000)	(0.000)	(0.437)	(0.000)	(0.000)	(0.000)
Country FE's	No	Yes	No	Yes	No	Yes
Survey year FE's	Yes	Yes	Yes	Yes	Yes	Yes
Number of regions	80	80	80	80	80	80
Observations	309	309	309	309	309	309
R-squared	0.570	0.607	0.617	0.867	0.544	0.683

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant.

Table 3. Validating the BoS Index: Food supply in traditional ethnic societies

	1	2	3	4	5	6
Dataset:		Standard Cross Cultural Sample			Ethnographic Atlas	
Dep. Var:	Fishing	Animal Husbandry	Agriculture	Fishing	Animal Husbandry	Agriculture
BoS index, 100 km buffer	0.205	-0.175	-0.286	0.083	-0.132	-0.329
	(0.024)	(0.052)	(0.003)	(0.083)	(0.000)	(0.000)
(log) Buffer ocean area	0.008	-0.012	-0.007	-0.02	0.063	0.051
	(0.921)	(0.908)	(0.954)	(0.598)	(0.109)	(0.243)
(log) Distance to coast	-0.557	0.259	0.189	-0.483	0.182	0.159
	(0.000)	(0.030)	(0.116)	(0.000)	(0.000)	(0.000)
Continent FEs	No	No	No	Yes	Yes	Yes
Survey year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	100	100	100	545	545	545
R-squared	0.35	0.10	0.12	0.42	0.36	0.35

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant.

Table 4. The Bounty of the Sea and Pre-industrial Development - Country level data

	1	2	3	4	5	6	7	8	9	10
Dependent variable: (log)					Population density 1500 CE					
BoS index	0.204	0.137	0.154	0.154	0.187	0.183				
	(0.029)	(0.051)	(0.040)	(0.012)	(0.004)	(0.010)				
Bos index, top fish							0.214	0.208		
							(0.010)	(0.002)		
Bos index, 10km buffer									0.263	0.235
									(0.000)	(0.000)
Soil suitability	0.239	0.225	0.238	0.251	0.247	0.304	0.236	0.284	0.239	0.292
	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
EEZ area	-0.084	0.098	0.206	0.017	0.133	0.103	0.119	0.089		
	(0.553)	(0.405)	(0.077)	(0.895)	(0.274)	(0.403)	(0.317)	(0.447)		
Buffer area									0.032	-0.014
									(0.599)	(0.816)
Land area	-0.304	-0.335	-0.402	-0.139	-0.197	-0.209	-0.193	-0.209	-0.120	-0.118
	(0.064)	(0.004)	(0.000)	(0.209)	(0.061)	(0.068)	(0.060)	(0.051)	(0.114)	(0.163)
Latitude (abs)				-0.525	-0.525	-0.385	-0.372	-0.190	-0.540	-0.389
				(0.000)	(0.000)	(0.000)	(0.000)	(0.082)	(0.000)	(0.000)
Landlocked				0.016	0.074		0.129		0.127	
				(0.829)	(0.278)		(0.092)		(0.076)	
Land near waterways (%)				0.174	0.215	0.184	0.209	0.186	0.227	0.198
				(0.042)	(0.014)	(0.040)	(0.014)	(0.031)	(0.007)	(0.019)
Yrs since Neolithic			0.336		0.351	0.296	0.373	0.336	0.355	0.299
			(0.000)		(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	No landlock	Full	No landlock	Full	No landlock
Observations	150	150	150	150	150	113	150	113	150	113
R-squared	0.255	0.511	0.549	0.622	0.661	0.702	0.654	0.704	0.678	0.723

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.

Table 5. The Bounty of the Sea and Pre-industrial Development - Pixel level data

	1	2	3	4	5	6	7	8
Dependent variable: (log)	Population density in 1500 CE							
BoS index	0.111	0.157	0.129	0.167	0.139	0.124		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
	[0.031]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		
Bos index, 10 km buffer							0.119	
							(0.000)	
							[0.000]	
Bos index, top fish								0.090
								(0.000)
								[0.067]
Soil suitability	0.551	0.305	0.298	0.285	0.252	0.23	0.229	0.229
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pixel area	0.078	0.057	0.045	0.058	0.04	0.032	0.035	0.032
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Buffer area (100 km buffer)	-0.172	-0.021	-0.06	-0.02	0.035	-0.003		-0.018
	(0.000)	(0.00145)	(0.000)	(0.000)	(0.000)	(0.679)		(0.0159)
Buffer area (10 km buffer)							0.002	
							(0.733)	
Distance to coast			-0.096			-0.087	-0.085	-0.094
			(0.000)			(0.000)	(0.000)	(0.000)
Distance to natural harbors			-0.065			-0.061	-0.065	-0.074
			(0.000)			(0.000)	(0.000)	(0.000)
Estuary (200 km buffer)				0.058		0.046	0.046	0.046
				(0.000)		(0.000)	(0.000)	(0.000)
Shelf (200 km buffer)				-0.026		-0.015	-0.004	-0.036
				(0.0114)		(0.127)	(0.707)	(0.000155)
Tidal movements (200 km buffer)				-0.032		-0.054	-0.049	-0.025
				(0.000281)		(0.000)	(0.000)	(0.00315)
Latitude (abs)					-0.43	-0.422	-0.428	-0.396
					(0.000)	(0.000)	(0.000)	(0.000)
Elevation					-0.06	-0.029	-0.025	-0.018
					(0.000)	(0.00113)	(0.00327)	(0.0293)
Country FEs	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5892	5892	5892	5892	5892	5892	5892	5892
R-squared	0.477	0.787	0.797	0.789	0.803	0.813	0.813	0.809

Notes: OLS regressions. Each column displays standardized beta coefficients, p-values based on robust standard errors in parentheses, and p-values based on Conley standard errors (robust to spatial interdependence in a radius of 400 km) in brackets. All regressions include a constant.

Table 6. Bounty of the Sea and Contemporary Development

	1	2	3	4	5	6	7	8	9	10
Dependent variable: (log)	GDP per capita, 2005									
BoS index	0.381	0.176	0.178	0.088	0.092	0.136				
	(0.000)	(0.000)	(0.000)	(0.038)	(0.026)	(0.005)				
BoS index, top fish							0.074	0.077		
							(0.357)	(0.294)		
BoS index, 10km buffer									0.111	0.139
									(0.023)	(0.007)
Soil suitability	0.020	-0.205	-0.206	-0.256	-0.259	-0.313	-0.262	-0.314	-0.259	-0.312
	(0.819)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EEZ area	0.282	0.118	0.129	0.058	0.071	0.093	0.061	0.070		
	(0.011)	(0.337)	(0.309)	(0.491)	(0.435)	(0.441)	(0.500)	(0.542)		
Buffer area									0.033	0.042
									(0.603)	(0.626)
Land area	-0.116	-0.042	-0.048	0.014	0.008	-0.000	0.014	0.015	0.038	0.039
	(0.232)	(0.661)	(0.621)	(0.858)	(0.923)	(0.999)	(0.869)	(0.891)	(0.577)	(0.649)
Latitude (abs)				0.411	0.409	0.395	0.471	0.495	0.408	0.402
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Landlocked				-0.010	-0.002		0.006		0.016	
				(0.866)	(0.972)		(0.941)		(0.807)	
Land near waterways (%)				0.238	0.243	0.215	0.245	0.228	0.249	0.225
				(0.010)	(0.008)	(0.019)	(0.009)	(0.015)	(0.006)	(0.012)
Yrs since Neolithic			0.036		0.041	0.097	0.044	0.096	0.041	0.097
			(0.733)		(0.652)	(0.361)	(0.644)	(0.383)	(0.654)	(0.352)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	No landlocked	Full	No landlocked	Full	No landlocked
Observations	140	140	140	140	140	103	140	103	140	103
R-squared	0.203	0.627	0.628	0.692	0.692	0.686	0.689	0.676	0.694	0.688

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.

Table 7. Ancestral Bounty of the Sea and Contemporary Development

	1	2	3	4	5	6	7	8	9	10
Dependent variable: (log)					GDP per capita, 2005					
BoS index (ancestry adj)	0.428	0.235	0.243	0.135	0.158	0.208				
	(0.000)	(0.000)	(0.000)	(0.009)	(0.002)	(0.001)				
BoS index, top fish (ancestry adj)							0.144	0.088		
							(0.059)	(0.228)		
Bos Index, 10 km buffer (ancestry adj)									0.225	0.222
									(0.000)	(0.000)
Soil suitability (ancestry adj)	0.120	-0.167	-0.179	-0.194	-0.213	-0.261	-0.218	-0.256	-0.220	-0.267
	(0.174)	(0.008)	(0.005)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
EEZ area	0.182	0.112	0.166	0.081	0.137	0.175	0.115	0.134		
	(0.048)	(0.344)	(0.163)	(0.331)	(0.109)	(0.131)	(0.170)	(0.211)		
Buffer area									0.035	0.045
									(0.406)	(0.441)
Land area	-0.085	-0.044	-0.087	-0.016	-0.053	-0.084	-0.034	-0.037	0.019	0.015
	(0.359)	(0.627)	(0.346)	(0.843)	(0.512)	(0.426)	(0.689)	(0.729)	(0.769)	(0.852)
Latitude (abs)				0.406	0.390	0.354	0.489	0.485	0.379	0.373
				(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
landlocked				-0.026	0.013		0.040		0.054	
				(0.672)	(0.833)		(0.586)		(0.410)	
Land near waterways (%)				0.169	0.182	0.149	0.182	0.182	0.189	0.169
				(0.086)	(0.058)	(0.132)	(0.068)	(0.067)	(0.043)	(0.074)
Yrs since Neolithic (ancestry adj)			0.180		0.169	0.232	0.177	0.215	0.184	0.231
			(0.031)		(0.021)	(0.009)	(0.020)	(0.026)	(0.008)	(0.007)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	No landlock	Full	No landlock	Full	No landlock
Observations	139	139	139	139	139	102	139	102	139	102
R-squared	0.262	0.641	0.652	0.693	0.702	0.700	0.696	0.679	0.710	0.703

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.

Table 8. Bounty of the Sea and Contemporary Development: Place or People?

	1	2	3	4	5	6	7	8	9	10
Dependent variable: (log)					GDP per capita, 2005					
Bos Index (ancestry adj)	0.479	0.379	0.431	0.260	0.304	0.311				
	(0.000)	(0.020)	(0.008)	(0.052)	(0.026)	(0.010)				
BoS index	-0.055	-0.150	-0.194	-0.133	-0.154	-0.107				
	(0.579)	(0.359)	(0.230)	(0.294)	(0.231)	(0.313)				
Bos Index, top fish (ancestry adj)							0.274	0.146		
							(0.027)	(0.306)		
Bos index, top fish							-0.173	-0.065		
							(0.231)	(0.681)		
Bos index, 10 km buffer (ancestry adj)									0.370	0.262
									(0.004)	(0.007)
Bos Index, 10 km buffer									0.014	0.038
									(0.772)	(0.539)
Soil suitability (ancestry adj)	0.122	-0.164	-0.176	-0.187	-0.206	-0.254	-0.207	-0.253	-0.214	-0.265
	(0.174)	(0.010)	(0.006)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
EEZ area	0.170	0.105	0.162	0.074	0.132	0.171	0.098	0.126		
	(0.090)	(0.373)	(0.166)	(0.375)	(0.127)	(0.140)	(0.274)	(0.274)		
Buffer area									-0.154	-0.041
									(0.184)	(0.625)
Land ara	-0.082	-0.046	-0.095	-0.023	-0.063	-0.092	-0.025	-0.034	0.019	0.015
	(0.389)	(0.603)	(0.293)	(0.770)	(0.424)	(0.374)	(0.775)	(0.756)	(0.781)	(0.855)
Latitude (abs)				0.406	0.389	0.354	0.461	0.477	0.378	0.374
				(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
landlocked				-0.042	-0.004		0.000		0.033	
				(0.490)	(0.948)		(0.999)		(0.614)	
Land near waterways (%)				0.154	0.166	0.138	0.175	0.178	0.173	0.164
				(0.119)	(0.086)	(0.170)	(0.067)	(0.063)	(0.065)	(0.086)
Yrs since Neolithic (ancestry adj)			0.198		0.177	0.236	0.170	0.213	0.188	0.231
			(0.016)		(0.017)	(0.008)	(0.028)	(0.027)	(0.007)	(0.007)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	No landlock	Full	No landlock	Full	No landlock
Observations	139	139	139	139	139	102	139	102	139	102
R-squared	0.263	0.644	0.658	0.695	0.705	0.702	0.700	0.680	0.714	0.703

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.

Table 9: Coastal orientation in preindustrial and modern times

Panel A: Coastal orientation and the Bounty of the Sea in 1500 CE

	1	2	3	4	5	6	7
Dependent variable: (log)	Fraction of total population near coast in 1500 CE (<100 km)						
BoS index	0.348	0.341	0.342	0.082	0.086		
	(0.000)	(0.000)	(0.000)	(0.008)	(0.008)		
BoS index, top fish						0.240	
						(0.000)	
BoS index, 10km buffer							0.103
							(0.002)
Soil suitability	-0.100	-0.155	-0.155	-0.122	-0.119	-0.122	-0.119
	(0.224)	(0.042)	(0.045)	(0.007)	(0.009)	(0.004)	(0.008)
EEZ area	0.485	0.443	0.447	-0.023	0.009	0.007	
	(0.000)	(0.000)	(0.000)	(0.601)	(0.852)	(0.880)	
Buffer area							-0.006
							(0.892)
Land area	-0.531	-0.543	-0.546	0.009	-0.010	-0.050	-0.000
	(0.000)	(0.000)	(0.000)	(0.838)	(0.825)	(0.214)	(0.991)
Yrs since Neolithic			0.013		0.115	0.128	0.116
			(0.926)		(0.053)	(0.030)	(0.048)
Latitude (abs)				-0.040	-0.039	0.107	-0.034
				(0.553)	(0.548)	(0.053)	(0.610)
% land near coast (<100 km)				0.931	0.937	0.892	0.917
				(0.000)	(0.000)	(0.000)	(0.000)
Land near waterways (%)				-0.053	-0.052	-0.100	-0.042
				(0.417)	(0.434)	(0.111)	(0.530)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152	152	152	152	152	152	152
R-squared	0.265	0.345	0.345	0.845	0.850	0.878	0.852

Panel B: Coastal orientation and the Bounty of the Sea in 2005

	1	2	3	4	5	6	7
Dependent variable: (log)	Fraction of total population near coast in 2005 (<100 km)						
BoS index	0.331	0.369	0.370	0.126	0.129		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
BoS index, top fish						0.300	
						(0.000)	
BoS index, 10km buffer							0.159
							(0.000)
Soil suitability		-0.175	-0.174	-0.140	-0.137	-0.140	-0.137
		(0.017)	(0.018)	(0.002)	(0.002)	(0.001)	(0.002)
EEZ area	0.170	0.446	0.453	0.004	0.037	0.031	
	(0.035)	(0.000)	(0.000)	(0.927)	(0.470)	(0.564)	
Buffer area							-0.025
							(0.575)
Land area		-0.493	-0.497	0.029	0.010	-0.033	0.052
		(0.000)	(0.000)	(0.542)	(0.841)	(0.509)	(0.335)
Yrs since Neolithic			0.021		0.118	0.133	0.110
			(0.875)		(0.052)	(0.028)	(0.070)
Latitude (abs)				-0.053	-0.052	0.136	-0.045
				(0.456)	(0.453)	(0.022)	(0.516)
% land near coast (<100 km)				0.899	0.905	0.856	0.883
				(0.000)	(0.000)	(0.000)	(0.000)
Land near waterways (%)				-0.076	-0.075	-0.133	-0.063
				(0.275)	(0.291)	(0.040)	(0.368)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152	152	152	152	152	152	152
R-squared	0.147	0.362	0.362	0.812	0.817	0.856	0.824

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant.

Table 10: Occupational structure in preindustrial and modern times

Panel A: Occupational structure and the Bounty of the Sea in 1500 CE

	1	2	3	4	5	6	7
Dependent variable: (log)				Urbanization rate in 1500 CE			
BoS index	0.262	0.366	0.399	0.430	0.442		
	(0.039)	(0.007)	(0.003)	(0.011)	(0.007)		
BoS index, top fish						0.343	
						(0.057)	
BoS index, 10km buffer							0.450
							(0.001)
Soil suitability		-0.158	-0.237	-0.048	-0.182	-0.080	-0.233
		(0.157)	(0.020)	(0.718)	(0.160)	(0.571)	(0.076)
Land area		-0.060	-0.198	-0.177	-0.230	-0.153	-0.061
		(0.439)	(0.013)	(0.108)	(0.028)	(0.137)	(0.645)
EEZ area	-0.118	-0.034	0.153	0.013	0.153	-0.039	
	(0.187)	(0.736)	(0.091)	(0.901)	(0.103)	(0.694)	
Buffer area							-0.050
							(0.707)
Yrs since Neolithic			0.522		0.470		0.460
			(0.000)		(0.002)		(0.001)
Latitude (abs)				-0.254	-0.181	0.044	-0.129
				(0.210)	(0.293)	(0.838)	(0.438)
Landlocked (=1)				-0.079	-0.011	-0.097	0.023
				(0.525)	(0.924)	(0.480)	(0.841)
Land near waterways (%)				-0.300	-0.141	-0.257	-0.029
				(0.098)	(0.393)	(0.150)	(0.848)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	71	71	71	71	71	71	71
R-squared	0.084	0.323	0.440	0.369	0.452	0.300	0.461

Panel B: Occupational structure and ancestral bounty of the sea in 1900

	1	2	3	4	5	6	7
Dependent variable: (log)				Employment share in agriculture in 1900			
BoS index (ancestry adj)	-0.597	-0.452	-0.452	-0.510	-0.525		
	(0.000)	(0.003)	(0.002)	(0.002)	(0.001)		
BoS index, top fish (ancestry adj)						-0.383	
						(0.017)	
Bos Index, 10 km buffer (ancestry adj)							-0.540
							(0.004)
Soil suitability (ancestry adj)	-0.072	0.091	0.104	0.096	0.134	0.141	0.141
	(0.286)	(0.164)	(0.103)	(0.163)	(0.052)	(0.082)	(0.058)
EEZ area	-0.200	-0.121	-0.216	-0.209	-0.312	-0.244	
	(0.068)	(0.196)	(0.021)	(0.021)	(0.002)	(0.012)	
Buffer area							-0.138
							(0.093)
Land area	0.180	0.146	0.233	0.261	0.327	0.247	0.168
	(0.174)	(0.201)	(0.042)	(0.029)	(0.009)	(0.063)	(0.115)
Yrs since Neolithic (ancestry adj)			-0.285		-0.324	-0.326	-0.348
			(0.001)		(0.000)	(0.000)	(0.000)
Latitude (abs)				-0.207	-0.168	-0.484	-0.220
				(0.037)	(0.074)	(0.001)	(0.035)
Landlocked (=1)				-0.122	-0.194	-0.282	-0.280
				(0.123)	(0.008)	(0.027)	(0.006)
Land near waterways (%)				0.090	0.027	-0.034	-0.037
				(0.367)	(0.776)	(0.756)	(0.706)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	111	111	111	111	111	111	111
R-squared	0.416	0.551	0.582	0.588	0.625	0.521	0.610

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.

Table 11: Industrialization and demographic transition

Panel A: Timing of Industrialization and the ancestral bounty of the sea

	1	2	3	4	5	6	7
Dependent variable:				Year of Industrialization			
BoS index (ancestry adj)	-0.598	-0.408	-0.422	-0.423	-0.457		
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)		
BoS index, top fish (ancestry adj)						-0.329	
						(0.008)	
Bos Index, 10 km buffer (ancestry adj)							-0.395
							(0.026)
Soil suitability (ancestry adj)	-0.024	0.117	0.121	0.140	0.163	0.169	0.178
	(0.757)	(0.066)	(0.048)	(0.058)	(0.022)	(0.024)	(0.036)
Land area	0.085	0.036	0.088	0.158	0.194	0.118	0.018
	(0.574)	(0.770)	(0.476)	(0.194)	(0.125)	(0.368)	(0.874)
EEZ area	-0.165	-0.104	-0.165	-0.182	-0.249	-0.168	
	(0.217)	(0.381)	(0.164)	(0.078)	(0.029)	(0.110)	
Buffer area							-0.039
							(0.601)
Yrs since Neolithic (ancestry adj)			-0.162		-0.177	-0.165	-0.177
			(0.053)		(0.027)	(0.090)	(0.040)
Latitude (abs)				-0.294	-0.255	-0.540	-0.304
				(0.001)	(0.002)	(0.000)	(0.001)
Landlocked (=1)				-0.093	-0.146	-0.193	-0.170
				(0.235)	(0.064)	(0.077)	(0.112)
Land near waterways (%)				0.057	0.024	-0.034	-0.044
				(0.552)	(0.807)	(0.751)	(0.653)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	101	101	101	101	101	101	101
R-squared	0.405	0.601	0.612	0.649	0.660	0.594	0.619

Panel B: Timing of the Fertility Decline and ancestral bounty of the sea

	1	2	3	4	5	6	7
Dependent variable:				Year of the fertility decline			
BoS index (ancestry adj)	-0.521	-0.258	-0.277	-0.233	-0.271		
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)		
BoS index, top fish (ancestry adj)						-0.244	
						(0.018)	
Bos Index, 10 km buffer (ancestry adj)							-0.303
							(0.003)
Soil suitability (ancestry adj)	-0.153	-0.050	-0.050	-0.048	-0.031	-0.031	-0.015
	(0.131)	(0.326)	(0.343)	(0.431)	(0.591)	(0.546)	(0.788)
EEZ area	-0.202	-0.173	-0.231	-0.197	-0.258	-0.229	
	(0.088)	(0.073)	(0.031)	(0.028)	(0.016)	(0.033)	
Buffer area							-0.093
							(0.150)
Land area	0.098	0.094	0.138	0.119	0.152	0.129	0.042
	(0.444)	(0.157)	(0.049)	(0.092)	(0.049)	(0.125)	(0.558)
Yrs since Neolithic (ancestry adj)			-0.143		-0.147	-0.163	-0.169
			(0.091)		(0.092)	(0.096)	(0.098)
Latitude (abs)				-0.215	-0.171	-0.370	-0.174
				(0.041)	(0.106)	(0.002)	(0.141)
Landlocked (=1)				-0.016	-0.069	-0.104	-0.102
				(0.759)	(0.207)	(0.129)	(0.126)
Land near waterways (%)				-0.008	-0.025	-0.055	-0.060
				(0.899)	(0.659)	(0.360)	(0.315)
Continent FE's	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	92	92	92	92	92	92	92
R-squared	0.371	0.728	0.738	0.746	0.755	0.743	0.752

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.

Table 12: Testing the proposed mechanism

Panel A: Channeling the influence from ancestral bounty of the sea via industrialization

	1	2	3	4	5	6
Dependent variable: (log)	PPP GDP per capita, 2005					
Year of industrialization				-0.233	-0.247	-0.216
				(0.058)	(0.030)	(0.070)
BoS index (ancestry adj)	0.248			0.139		
	(0.001)			(0.108)		
BoS index, top fish (ancestry adj)		0.301			0.217	
		(0.003)			(0.030)	
Bos Index, 10 km buffer (ancestry adj)			0.336			0.250
			(0.000)			(0.002)
Soil suitability (ancestry adj)	-0.148	-0.164	-0.167	-0.115	-0.125	-0.132
	(0.038)	(0.021)	(0.021)	(0.105)	(0.078)	(0.061)
Land area	-0.150	-0.138	-0.046	-0.102	-0.106	-0.040
	(0.171)	(0.233)	(0.582)	(0.296)	(0.264)	(0.549)
EEZ area	0.214	0.187		0.155	0.146	
	(0.069)	(0.120)		(0.143)	(0.168)	
Buffer area			0.076			0.066
			(0.178)			(0.175)
Yrs since Neolithic (ancestry adj)	0.079	0.112	0.111	0.040	0.074	0.075
	(0.344)	(0.196)	(0.159)	(0.656)	(0.414)	(0.374)
Latitude (abs)	0.296	0.476	0.267	0.244	0.348	0.206
	(0.004)	(0.000)	(0.005)	(0.014)	(0.001)	(0.037)
Landlocked (=1)	-0.032	0.068	0.036	-0.065	0.020	-0.001
	(0.677)	(0.480)	(0.658)	(0.352)	(0.828)	(0.993)
Land near waterways (%)	-0.042	-0.046	-0.028	-0.031	-0.049	-0.035
	(0.685)	(0.666)	(0.774)	(0.755)	(0.622)	(0.711)
Continent FE's	Yes	Yes	Yes	Yes	Yes	Yes
Observations	96	96	96	96	96	96
R-squared	0.721	0.723	0.735	0.739	0.747	0.753

Panel B: Channeling the influence from ancestral bounty of the sea via fertility decline

	1	2	3	4	5	6
Dependent variable: (log)	PPP GDP per capita, 2005					
Year of fertility decline				-0.307	-0.315	-0.252
				(0.033)	(0.037)	(0.072)
BoS index (ancestry adj)	0.169			0.103		
	(0.071)			(0.282)		
BoS index, top fish (ancestry adj)		0.162			0.097	
		(0.107)			(0.340)	
Bos Index, 10 km buffer (ancestry adj)			0.283			0.218
			(0.003)			(0.024)
Soil suitability (ancestry adj)	-0.276	-0.281	-0.290	-0.293	-0.297	-0.303
	(0.006)	(0.006)	(0.003)	(0.004)	(0.003)	(0.003)
Land area	-0.063	-0.050	0.028	-0.026	-0.017	0.043
	(0.598)	(0.673)	(0.773)	(0.822)	(0.881)	(0.646)
EEZ area	0.194	0.174		0.142	0.128	
	(0.228)	(0.264)		(0.357)	(0.392)	
Buffer area			0.052			0.032
			(0.597)			(0.745)
Yrs since Neolithic (ancestry adj)	0.220	0.238	0.255	0.195	0.205	0.228
	(0.043)	(0.039)	(0.015)	(0.073)	(0.074)	(0.030)
Latitude (abs)	0.294	0.405	0.269	0.249	0.314	0.231
	(0.012)	(0.000)	(0.008)	(0.031)	(0.009)	(0.026)
Landlocked (=1)	0.146	0.176	0.200	0.137	0.155	0.184
	(0.123)	(0.079)	(0.037)	(0.136)	(0.106)	(0.048)
Land near waterways (%)	0.301	0.316	0.312	0.294	0.303	0.302
	(0.037)	(0.027)	(0.026)	(0.041)	(0.034)	(0.031)
Continent FE's	Yes	Yes	Yes	Yes	Yes	Yes
Observations	84	84	84	84	84	84
R-squared	0.649	0.646	0.669	0.670	0.669	0.682

Notes: OLS regressions. Each column displays standardized beta coefficients, and p-values based on robust standard errors in parentheses. All regressions include a constant. Columns marked "No Landlock" exclude landlocked nations from the sample.