Institutional Development, Capital Accumulation, and the Emergence of Civilizations

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Abstract

This paper examines the hypothesis that institutional development, in the form of property rights, may have played a key role in facilitating agricultural capital accumulation, which in turn promoted the emergence of early civilizations. We rely on a falsification approach to examine Neolithic settlements in riverine environments along major ancient trade routes, and argue that neither geography nor trade—two main fundamental determinants of growth—were not sufficient to ensure the emergence of civilizations between 4500 and 1600 BCE. We go on to show that a distinguishing feature of these early civilizations was the development of institutional regimes that offered either actual or notional respect for property rights, and the importance of the development of writing in supporting such regimes.

KEYWORDS: Fundamental determinants of growth, property rights, capital accumulation, civilizational formation
JEL CLASSIFICATION: N10, O33, O43

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> All civilizations have up to now been based on private ownership of the means of production. In the past civilization and private property have been linked together... [i]f historical experience could teach us anything, it would be that private property is inextricably linked with civilization.
>
> Ludwig von Mises (1998, p. 264)

1 Introduction

Since the seminal work of Solow (1956), economists have recognized the central role of capital accumulation in the process of economic growth. Capital (along with labor) inputs are, however, typically regarded only as proximate drivers of economic performance; recent research has identified more fundamental factors—such as the geographical environment (Davis & Weinstein 2002; Diamond 1997; Gallup, Sachs & Mellinger 1999), economic integration through trading relations (Dollar & Kraay 2003; Frankel & Romer 1999), and the operation of political-economic institutions (Acemoğlu, Johnson & Robinson 2001; North, Wallis & Weingast 2009)—as the underlying basis for growth.

If these fundamental determinants of economic growth do indeed condition the development of societies, then they should matter over the long span of human history: geography, trade, and institutions should have played a role in shaping the initial emergence of civilizations at its dawn. Specifically, these factors may have impacted the accumulation of capital—especially in terms of agricultural tools and techniques used in irrigation and drainage—which then enabled early sedentary human settlements to generate the kinds of food surpluses necessary to support continued economic specialization and development beyond the subsistence level.

In this paper, we explore the relative contributions of geography, trade, and institutions to supporting agricultural capital accumulation in four ancient river valley societies—Mesopotamian, Egyptian, Harappan, and Sinic—which enabled them to make the transition from disparate settlements into nascent civilizations. In particular, we will consider manner by which river access, trading activity, and property rights supported the broad-based adoption of region-specific agricultural capital in Mesopotamia during the late Ubaid and early Uruk (4500–3100 BCE), Egypt during the early Dynastic through Old Kingdom (3150–2181 BCE), the Indus Valley during the early Harappan (2100–1600 BCE), and the Yellow River Valley during the Xia and early Shang (2000–1400 BCE) periods. Our analysis draws on diverse sources of (qualitative) evidence: textual, artifactual, and archeological.

The central argument of this paper is that institutional advances through the medium of reasonably well-defined property rights were crucial in spurring peasant incentives to exploit newly-developed hydraulic tools and technologies, resulting in their widespread adoption. The accumulation of such agricultural capital subsequently enabled substantially increased food output and supported

surpluses, contributing to the consolidation of hitherto disparate settlements into nascent civilizations. As property rights regimes coalesced, writing emerged in these civilizations, potentially as a response to recording needs.

The contributions of this paper are threefold. First, by returning to the dawn of history, we are able to draw inferences regarding the initial conditions that favored the emergence of civilizations. The payoff to this strategy is that the fundamental drivers of growth—as proxied by civilizational formation—can be more cleanly analyzed by a relatively simple qualitative research design (comparing the development of settlements in geographically-similar regions along major ancient trade routes), while (mostly) limiting the complicating effects of confounding factors that often come into play in societies that develop under later, more complex global settings (factors such as, for example, human or social capital).[1] Second, the approach offers additional support for the insight that independently-developed writing systems were central for early civilizations, although not so much from the perspective of technological transfer *per se* (as important as that could have been) (Doheny-Farina 1992), but from its role in facilitating the formalization of existing property rights institutions. Third, we provide an explanation of economic growth in ancient civilizations that unbundles property rights institutions from contracting institutions, an approach advocated by Acemoğlu & Johnson (2005) (and whose findings we are consistent with).

1.1 Related Literature

This paper speaks to existing work in several distinct literatures. It falls most clearly in line with papers that have sought to empirically disentangle the fundamental determinants of growth (Acemoğlu, Johnson & Robinson 2005a; Ashraf & Galor 2013; Decker & Lim 2008; Galor & Moav 2002; Glaeser, La Porta, López-de Silanes & Shleifer 2004; Rodrik, Subramanian & Trebbi 2004). However, empirical explorations undertaken by this body of work relies on econometric analysis of cross-country data from 20th-century economic history or, at best, patchy data from the middle ages onward. While framing our study period at the dawn of history necessarily rules out data-driven quantitative analysis, doing so offers us both the ability to isolate the effects of various key drivers, as well as a novel lens with which to examine an aspect of economic history that remains understudied.

There are also a small number of papers that examine economic growth over the very long run, both from primarily empirical (Ashraf & Galor 2011; Kremer 1993; Maddison 2001) or theoretical (Galor & Weil 2000; Hansen & Prescott 2002; Jones 2001) perspectives. The present paper is consistent with some of the central findings emerging from the theoretical treatments—in particular the

[1] This does not deny that elements in these other factors could come into play as fundamental determinants of growth, merely that these other factors exhibit less cross-regional variation during ancient times. For example, with subsistence consumption as the binding constraint during the the pre-Malthusian epoch (Galor & Moav 2002), the effect of human capital accumulation is unlikely to be a dominant differentiating factor between ancient settlements.

stress on property rights (Jones 2001) and the important role of widespread adoption of technology in exiting Malthusian stagnation (Galor & Weil 2000; Hansen & Prescott 2002)—but our contribution here is that we offer additional, albeit qualitative, evidence that bears out the result that institutions are a central part of the story.

Our paper is also relevant to a number of papers that explore the coevolution of political and economic transitions (Acemoğlu, Johnson, Robinson & Yared 2009; Acemoğlu & Robinson 2001; Huang 2012; Lagerlöf 2009). The difficulty with this family of papers is that they often stress the linear nature of political transition, for example from monarchy to oligarchy to democracy (Huang 2012). While we are sympathetic to some of the mechanisms these models rely on, especially that of property rights (Lagerlöf 2009), we divorce our approach from the almost dialectic emphasis adopted by many of these papers, where political-economic development is a linear progression toward ever more decentralized forms of economic and political organization. Instead, we stress the sufficiency of property rights as a precursor to bottom-up economic growth, with the possibility of either more or less centralized forms of political organization potentially emerging.

Finally, there is a voluminous literature in political science and political economics that has sought to explain state formation. Such theories include those that adopt a primarily militaristic (Mann 1986; Tilly 1992), economic (Alesina & Spolaore 2003; Besley & Persson 2009; Levi 1986; Spruyt 1994), political (Jessop 1990; Putnam 1993), or cultural (Steinmetz 1999) lens to explain the development of states in history. Our work here clearly adopts a more rationalist-economistic motivation for state formation, and in particular the institution of property rights (à la Besley & Persson (2009)). Of course, we acknowledge that the early emergence of civilizations almost certainly involves a multidimensional set of drivers. We regard our preferred mechanism, which leans heavily on the interaction between institutions and capital accumulation, as a central one. This perspective means that we willingly acknowledge that our paper abstracts from the roles that religion, slavery, and warfare played in the development of ancient societies.

The rest of this paper is organized as follows. In Section 2, we examine the phenomenon where other major civilizations did not arise in riverine environments along the ancient trade routes between the civilizations of interest. This is followed, in Section 3, with a discussion of how trade was, at best, secondary as a medium of technology transfer and growth. Section 4 provides historical evidence on the pervasiveness of *de facto* or *de jure* property rights regimes in ancient civilizations, and Section 5 considers how the coincident emergence of independently-developed writing systems may have facilitated the establishment of such rudimentary property rights. A penultimate section offers a simple model that rationalizes our results, while the final section concludes with reflections on implications for growth in modern societies.

2 The Absence of Other River Valley Civilizations Along Ancient Trade Routes

In this section, we offer evidence, by falsification, of why geography and trade were not sufficient explanations for the early emergence of civilizations. Before we proceed, however, it is valuable to establish a concrete definition of our central ontological unit and outcome of interest, that of a civilization.

Definition 1 (Civilization)**.** A *civilization* is an independently-emergent sedentary human society or culture that has attained a high relative level of technological advancement and capital accumulation, broad-based specialization in intra-civilizational production capable of generating a *food surplus*, S, enabling concentrated (typically urban) settlement patterns, and possessing institutions of political organization.

We note that this definition is consonant with those adopted by scholars engaged in the comparative study of civilizations. The emphasis on specialization, urbanization, and technology is fairly typical; Krejči (2004, p. 9), for example, characterizes civilizations as demonstrating "division of labor, city life, [and] some knowledge of how to make metal tools," while agricultural capital is central for Melko (1969, p. 8), who distinguished civilizations from simpler cultures by their "greater control of environment, including the practice of agriculture on a large scale and the domestication of animals." Some authors do go further in stressing the importance of technology for knowledge transmission, a feature that Bosworth (2003, p. 9) terms a "cultural infrastructure of information and knowledge," although it is often the communication aspects of technology that is often emphasized (Targowski 2004), and how information technologies ultimately facilitate large-scale political organization (McGaughey 2000). Of course, the focus on understanding political structures in civilizations is not unique; Wilkinson (2005), for instance, traces the fluctuations in political institutions over the long span of history.

Regardless of the broad-ranging approaches to defining civilization, there is fair amount of consensus in both the historical and archaeological literature on ancient societies that independent civilizations first emerged during the Neolithic period in six distinct regions, all associated with river valleys: the Indus Valley (Harappan), Mesopotamia (Sumerian/Akkadian), Nile River Valley (Egyptian), Yellow River Valley (Sinic), the Coatzacoalcos River basin (Olmec/Mesoamerican), and the Norte Chico valley system (Andean).

For this study, we will concentrate on the four non-American civilizations situated in the Old World, and limit our historical scope to the late Ubaid (4500–3800 BCE) and early Uruk (3800–3100 BCE) periods in Mesopotamia, the early Dynastic (3150–2686 BCE) and Old Kingdom (2686–2181 BCE) periods in ancient Egypt, the early Harappan (2100–1600 BCE) period in ancient India, and the Xia[2] (2000–1600 BCE) and early Shang (1600–1400 BCE) periods in

[2]There has been, to date, no archeological evidence attesting to the existence of this dynasty. In this paper, we will accept the veracity of Chinese tradition that maintains the

ancient China.[3]

We further limit the discussion of non-civilizational societies to the larger Neolithic settlements that were established during this period along ancient trade routes, and displaying geographic features—principally a riverine environment[4]—that were comparable to those of our ancient civilizations of interest. These routes are illustrated in Figure 1. We consider routes from three distinct periods, of which there is substantial overlap: ancient urban supply routes existing around 3000 BCE, the loose network of intra- and inter-civilization transit routes—such as Indias Grand Trunk Road, the Persian Royal Road, and Chinas Yellow River system—that existed around 500 BCE, and the interconnection of the ancient Silk Routes first established around 206 BCE, expanded around 114 BCE, and reached its fruition during the middle of the Han dynasty, around the turn of the millennium. The first period considered highlights the fact that interconnections between Egypt, Mesopotamia, and Harappa were already established at the dawn of these respective civilizations; the second illustrates these expanding linkages, especially within civilizational units; and the third is demonstrates fullest articulation of trading linkages between civilizations during the pre-Classical era.[5]

There is substantial historical evidence that non-civilizational societies existed along these trade routes, sometimes contemporaneously, during the period that our civilizations of interest became established. However, despite similar geographical conditions—approximated by river valley environments and fertile plains—these cultures did not resolve into more advanced civilizations.

Consider first the route between Mesopotamia and the Indus Valley. Settlements have existed in the northern foothill oases of the Kopet Dag since the Neolithic period (around 6000 BCE), as well as in Mehrgarh. By the Eneolithic there was substantial population growth, with evidence of farming of wheat and barley, and animal husbandry with domesticated pigs, sheep, and goats. Geographical conditions in Mehrgarh were exceedingly similar to those of the

historicity of the Xia, although much of the argument that follows will continue to hold as long as the record from the early Shang period is broadly reflective of late Xia developments as well.

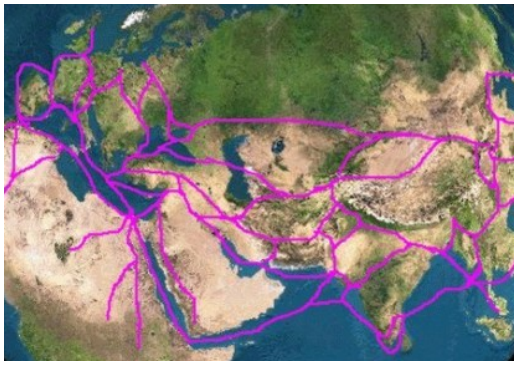
[3]Although the focus is on the respective founding periods of these civilizations, we will occasionally bring to bear evidence from later periods if the subsequent historical record is superior, so long as there is sufficient reason to believe that the evidence presented in these more recent sources apply to the preceding period as well.

[4]Of course, climatic changes since the ancient period means that geographic features in these regions today are potentially different—and in some cases, such as for the Indus Valley or Bactria-Margiana complex—substantially so. Nevertheless, the existence of settlements and, more crucially, the emergence of extensive urbanization in these areas in later periods together suggest that, to the extent that geography may have been a constraint to the development of ancient civilizations in these regions, it was likely to have been relatively mild.

[5]Although it may appear somewhat discordant that we choose to incorporate into the analysis trade routes that were established well after the formation of these civilizations, this approach actually affords two significant advantages: first, it ensures that our sample does not place the onus of proving causality on the nonexistence of a route, since our knowledge of ancient routes may be imperfect; second—and related to the first—including more potential locations for civilizational formation renders the falsification exercise more robust to the possibility of this imperfect knowledge.

(a) Urban supply routes, 3000 BCE

(b) Urban supply routes, 500 BCE



(c) Urban supply routes, 0 CE

Figure 1: Major trading routes between Sinic, Harappan, Mesopotamian, and Egyptian civilizations, 3000 BCE to 0 CE. These urban supply routes connected major civilizations, and expanded considerably between 500 and 250 BCE. Goods trade was typically inter-industry in nature, with imports of finished products and intermediates not found in the importing economy. Source: Sherratt (2004).

Indus valley; indeed, there is speculation that wild wheat varieties, subsequently cultivated in the Indus Valley, may have originated there (Costantini & Biasini 1985). But settlements in Mehrgarh remained largely confined to the Kachi plain (modern-day Balochistan), and ultimately became absorbed into greater Harappan civilization (Kenoyer & Heuston 2005). And although settlements at Kopet Dag did expand further—into the Murghab valley delta (modern-day Afghanistan) and the Zerafshan Valley in Transoxonia (modern-day Tajikistan), before eventually coalescing into Oxus culture with major settlements in Altyn-Depe, Kara-Depe, and Namazga-Depe—the culture never developed much beyond proto-urban societal organization, even at the peak of its development in the Bronze age around 2300 BCE. Excavations in the Bactria-Margiana archeological complex, corresponding to level V at Namazga-Depe, attests to settlements having practiced some basic irrigation agriculture (Masson 1992), but there is little evidence of more sophisticated hydraulic methods.

Similarly, specialization into professions appears to have been limited to sedentary farming, livestock breeding, and craftsmanship, with no evidence of more sophisticated social and political organization, for example specialization into administrative bureaucracies or more service-oriented professions, such as teachers or scribes (although differentiation into social classes undoubtedly existed).[6] Even the discovery of the Anau seal, which hints at the possibility that a system of writing existed in the Oxus culture, has largely been regarded as anomalous, and when placed in context it may potentially be of Chinese origin, comparable to a seal unearthed in Niyä, a relic of the Western Han dynasty (Colarusso 2002).

Trade routes in the second millennium BCE between Mesopotamia and the Indus also included maritime trade between societies in the central Gulf (Barbar culture, in modern-day Bahrain) and southeastern Arabia (Makkan culture, in modern-day Oman). Although relatively little is known of these settlements, the available evidence suggests that trade was definitely not fundamentally transformational for the social structures of these societies (Edens 1992). For example, scattered oasis settlements in the interior and on the coastal regions of southeast Arabia—notably the Bronze-Age cultures at Hafi, Hili, Umm an-Nar, and Wadi Suq—indicate that agricultural activity involved rudimentary water management and double cropping, but techniques did not progress far beyond that (Berthoud & Cleuziou 1983). Specialization was also limited, with evidence of earthenware and weapons production, but none with regard to tertiary (service) activities (Frifelt 1985). Moreover, political organization was fairly loose, with semi-autonomous polities weakly centralized along kinship groups, but little suggestion of more advanced structures.

Perhaps the most puzzling example of the absence of civilizational evolution in South Asia lies along the Grand Trunk Road, along which lies the Ganges river delta. This is peculiar, especially given the centrality of the river in subsequent agricultural advancement in the Ganges-Yamuna Doab and Ganges valley,

[6] On the basis of, for example, historical linguistics, which offers no indication that words associated with such specialization existed (Witzel 2005).

and the fertility of the alluvial plains for agriculture in general. It is clear from the historical record that the area only developed in the late Harappan period, starting in 2500 BCE, and excavations of copper artifacts suggest that interactions between the Indus and Ganges valleys most likely occurred in the direction of the former to the latter, rather than the other way round (Allchin & Allchin 1982).

Along Mediterranean trade routes, there is no sign that the ancient Aegean settlements—notably the Minoan and early Mycenaean societies, but also the relatively less developed Cycladic and Helladic ones—blossomed into large, complex societies until its evolution into ancient Greek Civilization during the Hellenic Age, around 800 BCE. Aegean culture, prior to its emergence as Greek civilization, experienced its achievements primarily in terms of art and architecture. Early Minoan culture appears to have imported elements of agricultural practices from the Fertile Crescent (Zeder 2008) and (hieroglyphic) writing appears to have diffused from Egypt, rather than developing independently (Bengtson 2002). In Minoan society, specialization in production was fairly limited; even among the elite, consumption was distinguished more by quantity than quality or variety (Schoep 2010). And for all their artistic and architectural achievements, alongside a clear aristocratic class, Mycenaean societies appear to have lacked a highly-educated and sophisticated bureaucracy (Steele 2009),[7] an important precondition for the more advanced political institutions associated with complex civilizations. Moreover, these early Aegean societies were mostly geographically confined to the islands of the Cyclades, Crete, and the Peloponnesian peninsula, which meant that they remained limited in scope and influence, and were more likely to be technological recipients rather than innovators. Finally, and most controversially, the independent origins of Aegean civilization have also been questioned (Bernal 1987).

Routes connecting ancient China to other civilizations similarly point to the absence of civilizations emerging in Southern China. The archeological record suggests that settlements in the Xia era (around 3000 BCE) were not limited to the (Northern) Ordos bulge region of the Yellow River, but also included proto-states along the Middle and Lower Yangtze (at Qujialing and Liangzhu, respectively) (Lin & Cao 2010; Liu 2009). But these settlements never coalesced sufficiently, both economically and politically, into civilizations. This is in spite of geographical conditions that were not unfavorable to population expansion and economic development. Indeed, cultivable rice—which very quickly established itself as the primary agricultural staple across China—likely originated in Southern China around the Yangtze valley (Zhang & Hung 2013), although the climatology of the North at the time was probably milder, and hence could as easily have afforded the possibility of rice cultivation in the presence of irrigation (Creel 1937). Furthermore, the geography of south-eastern China on the banks of the Yangtze was, if anything, more favorable to large-scale rice

[7] This was certainly the case when compared to bureaucracies in the Near East; for example, bureaucratic records in Near Eastern civilizations employed "bilateral" documentation (records that provide legal evidence of liability for transactions), which are absent in Mycenaean Linear B archives (Steele 2009).

cultivation (Murphey 1973). Subsequent patterns of agriculture by the time of the late Shang and early Zhou (around 1045 BCE), with rice production spread extensively across the South, further testify to the suitability of the region for rice.

Many such riverine environments could be found along the Southern Silk Road, which passed through Yunnan and Sichuan before traversing westward toward India (Wilkinson 1998). Yet the South only became integrated into greater Sinic civilization in the late Shang and Zhou periods, and it was only hence that there was significant expansion of settlements beyond the immediate proximity of the Yangtze (Chang 1973). Similarly, more sophisticated agricultural tools and techniques appear to have been deployed in the south after assimilation into Sinic civilization. The *Tribute to Yü* in the *Shangshu* documents that significant large-scale damming and irrigation projects beyond the Yangtze and other river systems only began during that period (Chen & Williams 1977).

Finally, consider Southern and Eastern routes emanating from the Egyptian civilizational core, namely, the Nubian region of the middle and upper Nile, and the largely (geographically indeterminate) land of Punt.[8] Egyptian civilization was founded in the relatively poorer agricultural conditions of the lower Nile. This is in spite of evidence that farming existed in the middle Nile basin since Neolithic times (Krzyżaniak 1991). Available historical evidence also indicates that the independent Kush kingdom only emerged in Middle Nile in 10th century BCE, following the disintegration of the New Kingdom in Egypt, and significantly after Egyptian civilization had formed and consolidated. This occurred in spite of reasonably favorable geography in the Nubia—Kush was situated at the confluence of the Blue Nile, White Nile, and River Atbara—for flood irrigation-based crop cultivation (Török 1997). Kushian political organization was simple and small in scale (O'Connor 1993). Even when the kingdom ultimately established a sophisticated mode of political organization, this was primarily modeled on existing Egyptian structures. Writing also did not appear to have developed independently in the kingdom, and the Meroïtic writing system, although applied to a language unrelated to ancient Egyptian, was likely derivative from the Semitic or Greek alphabet, along with Egyptian scripts (Houston, Baines & Cooper 2003; Leclant 2000).[9] Thus, while the kingdom did subsequently attain dynastic status in Greater Egypt following a series of successful conquests beginning in 760 BCE, this was already the 25th dynasty of Egypt, long after the initial founding of the civilization.

Even taking the existence of Punt as given, the available historical evidence indicates that the culture did not evolve into a complex society. Traded goods

[8]Current archeology has not established the definitive location (or existence) of Punt, and the culture is almost entirely known to us only through Egyptian records from the Old Kingdom through Second Intermediate period (2498–1549 BCE). However, scholars have generally placed the region within the Horn of Africa, around modern-day Eritrea and Ethiopia, southeast of Egypt.

[9]Meroïtic script comprised an administrative and everyday form, which was alphabetic and inspired by Semitic or Greek alphabets, and a monumental script, which was modeled on either Egyptian hieroglyphs or hieratic script.

from Punt were fairly simple primary products, such as precious metals, ebony, incense, and wild animals (although these were undeniably exotic, and desirable, from the point of view of the ancient Egyptians) (Bradbury 1996). Puntites "were described as 'cattle-herding pastoralists'... [who lived in] round hut 'pile-dwellings' woven as basketwork" (Phillips 1997, pp. 430–431). There is no evidence of more organized political frameworks developing, and even in later periods (1st millennium BCE) —when the D'MT kingdom emerged in the proximate geographic area of Punt—the society did not display a much more complex production structure or political organization, other than being in likely possession of a written language (Phillips 1997).

3 The Secondary Role of Trade in the Transfer of Agricultural Capital

Although the previous section has highlighted the fact that economic integration through trading linkages was unlikely to have been a direct mechanism for civilizational emergence, there is a second, indirect channel by which trade could potentially harness growth and development: economic exchange may give rise to technological diffusion and adoption, leading eventually to greater capital accumulation and growth. There is in fact a substantial literature that supports the notion that such exchange relationships may support technology transfer and hence growth. Trade in goods may occur through enabling knowledge spillovers via technology diffusion (Grossman & Helpman 1991b) or through the importation of intermediate goods that embody technologies (Eaton & Kortum 2002; Grossman & Helpman 1991a). Cross-border capital—especially through foreign direct investment—may also give rise to technological knowledge transfer (Ethier 1986; Markusen 2002), labor turnover (Fosfuri, Motta & Rønde 2001), or technology embodied in intermediate goods and services (Rodríguez-Clare 1996). Migratory flows can also promote knowledge spillovers (Arrow 1962), knowledge transfer (Kerr 2008), or network effects (Rauch 2001).

Before we proceed further, especially given the centrality of capital, it is useful to circumscribe the form of capital with which we are concerned with in our discussion that follows.

Definition 2 (Capital)**.** Ancient agricultural *capital*, $k > 0$, are the structures, tools, and machinery employed for the purposes of controlling natural water supply systems and effecting either small- or large-scale irrigation and drainage associated with the growth of food crops.

Note that our definition of agricultural capital is somewhat narrower than that which is conventionally regarded as physical capital in contemporary terms (which treats all forms of capital as substitutable), but is broader in that our definition of capital embodies existing hydraulic engineering knowledge and technology embedded in capital. Thus, Nubian *sakias* as well as *norias* (different forms of irrigation waterwheels) fall within our definition agricultural capital,

as do the Chinese *sanguoche* and *longguche* (distinct types of chain irrigation pumps).

The transfer of agricultural capital between the major civilizations, via the medium of trade, appears to have been reasonably limited during the periods concerned. In spite of the flourishing overseas trade between Harappa and Mesopotamia, especially in terms of goods exchange (Allchin & Allchin 1982), trade between the two did not appear to have effected much transfer of capital goods. Indeed, the nature of goods traded appears to suggest that trading patterns were more reflective of Heckscher-Ohlin-type relative factor abundance, rather than comparative advantage derived from Ricardian productivity differentials. For instance, copper—one of the major imports into Mesopotamia via the Gulf—was primarily a luxury good in the mid-3rd millennium BCE, and even when its use became much more widespread as an intermediate good to production around 2200 BCE, there is little evidence that trade was sufficiently intra-industry to offer much potential for technological spillovers (Edens 1992). Moreover, evidence on the actual form of irrigation techniques deployed in Harappa appear to have been distinct from those employed in Mesopotamia, which would have further limited the possibility of direct transfer: in contrast to the channel-based irrigation methodologies common across Mesopotamia, Harappan agriculture was reliant on land inundation as the Indus flooded due to the monsoon (Giosan *et al.* 2012).

Trade between Egypt and Mesopotamia likewise did not appear to have been accompanied by broad-based capital transfer. For starters, trading relations between the two civilizations were only first established significantly after their respective civilizations had taken root, during the reign of Assyrian ruler Sargon II (between 721–705 BCE), with Egypt having maintained an isolationist stance until then (Oppenheim 1964). Even after trading took off between Egypt and Mesopotamia—largely along the ancient route of Wadi Hammamat—this trade did not involve the transfer of irrigation capital or technology, at least in the earlier periods (Rice 2003).[10] By and large, trading caravans across the Eastern Desert carried natural resources (such as gold or precious stones) or aromatic resins (such as myrrh) (Bradbury 1988). Furthermore, while the two civilizations were engaged in hydraulic engineering, the more unpredictable nature of the Tigris and Euphrates dictated irrigation practices that were distinct from those involving the Nile, with its cyclical floodwaters. Mesopotamian irrigation tended to favor the abandonment of irrigation canals (due to silting) (Tamburrino 2010), as opposed to the larger-scale hydrology projects that were deployed to continuously sustain the irrigation channels of the Nile (Singer, Hall & Holmyard 1954). While some learning probably did occur—the design of the *shaduf*, for example, was likely a technological import from Mesopotamia

[10] Rice (2003, p. 37) does speculate that the more or less simultaneous development of hydraulic engineering by the two civilizations could be due to more than chance and instead be attributable to the exchange of ideas. However, the available archeological evidence from the Eastern Desert indicate that goods exchange involved ornamental stone tools associated with religious ceremonies or funerary rites (Hobbs 2002), and not tools and implements related hydraulic tools and technology.

(Stroubal 1992)—capital transfers were not systematic and ongoing. More generally, traces of Sumerian practices on Egyptian culture in predynastic and early dynastic times appears to be very minute (King 1910), which casts doubt on how much in influence either civilization had on the other, insofar as the exchange of agricultural capital and technology via trade was concerned.

Although there is some historical evidence of hydraulic engineering as far back as the Shang dynasty, larger-scale irrigation and damming projects in ancient China only began in earnest in the Zhou period (around 4th century BCE) (Creel 1937), and by that period Sinic civilization had probably advanced furthest among ancient civilizations in hydraulic tools and technology. The existing historical record provides little reason to believe, however, that such engineering knowledge for large-scale technologies were routinely exchanged with other civilizations via movements of goods or factors, at least in ancient times (Biswas 1970).[11] The major hydraulic engineering projects of the ancient world—such as the diversion of the Nile by King Menes, the Indus river drainage systems, and flood control of the Yellow River by the "Great Yu"—all appear to have been undertaken independently with available technologies in their respective civilizations.

4 Property Rights Regimes in Ancient Civilizations

The insufficiency of economic integration and geographic conditions by themselves to ensure the widespread adoption of agricultural tools and technologies suggests that institutional factors—in particular, either a *de jure* or *de facto* respect for property rights—may have played a crucial role in supporting the emergence of civilizations. Our definition of property rights regimes follows.

Definition 3 (Property rights)**.** A regime of *property rights* is a *de jure* or *de facto* system of rules or laws delineating the ability of an individual (or small group of close-knit individuals) to appropriate gains from the ownership and use of a given (agricultural) resource, the strength of which is measured by a parameter $\theta \in (0, 1)$.

Note that while the definition above constrains itself to agricultural (typically land) resources, it is consistent with the more general definition of property rights commonly employed in the literature. The definition encompasses, for example, the right to exclude (North 1981), and conveys the ability to benefit from such rights (Demsetz 1967). Given the historical context, however, the definition does not insist on such rights being bound by a formal legal code;[12] an

[11] This was not necessarily the case by the Classical period. For example, Muslim engineers adopted *saqiyas* from Ptolemaic Greece (Stroubal 1992), while *norias* were adapted and improved by engineers in Song China, who subsequently actively spread the technology (Elvin 1973).

[12] This is because the rule of law is a distinct institutional concept, and systematic legal codes may or may not have been established in the societies in question during the periods considered.

approach that has also been embraced by authors adopting a more archeologically or anthropologically-centered perspective (Castillo Butters, DeMarrais & Earle 1996; Earle 2000).[13] For analogous reasons, our definition blurs the distinction between institutional and private property that is occasionally made by some authors (Hunt & Gilman 1998).

It has long been accepted that a nominal recognition of land tenure can help promote greater investment in agricultural capital and technology. Indeed, Coase (1960) framed his seminal "problem of social cost" in the context of rights over agricultural use of land, and development economists have elaborated on the various channels, such as security-induced investment demand and collateral availability, by which more secure property rights over land can accelerate the adoption of farming technology and improve agricultural productivity (see Besley & Ghatak (2010) for a recent survey).[14,15]

The historical evidence in favor of property rights in ancient civilizations is probably strongest in Mesopotamian civilization. The *Code of Hammurabi* includes a section that explicitly spells out the rights accruing to agricultural land ownership (albeit applying primarily to fiefs and nobility), which includes rights of ownership, transfer, and contractual gains from ownership (Harper 1904, §27, §39, §46):

> If an officer or constable... be captured, and afterward they give his field and garden to another... if the former return[s]... they shall restore to him his field and garden.... He may deed to his wife or daughter the field, garden or house which he has purchased and (hence) possesses, or he may assign them for debt.... [If an owner has] rented the field... the tenant and the owner of the field shall divide the grain which is in the field according to agreement.

The *Code* goes on further to expound on obligations regarding irrigation practices, and how these were governed by the prevailing regime of property

[13] By this somewhat more expansive definition—where codification is entire unnecessary—property rights to land may even be traced back even further, to prehistory (Earle 2000). The difficulty of a sole reliance on archeological evidence of this nature is that one is led almost to a tautological notion of property: if property rights can be inferred by labor investment, warfare, and patterns of migration and settlement alone, without regard to some nominal degree of codification, then it becomes difficult to identify the cases where property rights might be deemed not to exist. Accordingly, the approach used here draws on not just indirect evidence of this form, but also direct evidence of some limited codification based on the written record.

[14] We note that our expanded definition of property to include *de facto* ownership is also consistent with the argument, forwarded by Firmin-Sellers (1995), that property rights *enforcement*, as opposed to land *tenure*, *per se*, was central to encouraging productive land investment in colonial Ghana.

[15] Some authors (Comin, Easterly & Gong 2010) have argued that the persistence of technological differences suggests that the existing stock of earlier technologies is a major determinant of adoption, which they demonstrate most convincingly for technology from 1500 CE onward. While we accept their argument that adoption differentials may have already been observed as far back as 1000 BCE, this result does not invalidate our own argument that property rights played an important role in agricultural capital accumulation for the even earlier period that we study.

rights. For example, the law waives contractual interest for a farmer if weather conditions (attributed to the god of storms, Adad) lead to the "inundat[ion of] his field... or, through lack of water, grain have not grown in the field" (Harper 1904, §48), and also stipulates that "if a man open [sic] his canal for irrigation and neglect [sic] it... and the water carry [sic] away improvements of an adjacent field, he shall measure out [compensation]" (Harper 1904, §§55–57). Moreover, legal recognition of property was not confined to the Hammurabic code; similar, albeit less comprehensive, collections of Mesopotamian laws include those of Eshunna, Ur-Nammu, and Lipit-Ishtar, and Sumerian tablets etched with maps and plans clearly indicate ownership rights (Figure 2). Nor did was such a regime likely to have emerged only in the Old Babylonian period: the ubiquitous recognition of private property, and prevalence of respect for it, was likely a feature of the social and religious fabric long before its formal codification (Speiser 1953). This latter point is further underscored by the fact that the binding nature of contracts was not limited to written form in ancient Mesopotamia, where oral contracts were often recognized as equally valid (Charpin 2010).[16]

Figure 2: A Sumerian clay tablet with a map of Nippur and its environs, with distinct property boundaries and ownership rights (marked in cuneiform), 14th–13th century BCE. These properties were owned by royalty and temple households, and corresponded to cultivated land. The map also marks irrigation canals (the narrow parallel bars), as well as unassigned property (the broad parallel bar at bottom left). Source: University of Pennsylvania Museum of Archeology and Anthropology.

Other agricultural practices also reflected the importance of property rights

[16]Oral traditions have typically preceded written records in history, and the pervasiveness of oral contracts in ancient Mesopotamia lends credence to the notion that such regimes were in existence before the Akkadian period.

in Mesopotamia. While specific farming arrangements differed, especially between the northern rain-fed hills and the southern dry plains,[17] hydrologic engineering was important for agricultural productivity. The adoption of irrigation, in turn, was closely tied to property rights over agricultural land (Gruber 1948). Yields were often highest in the large holdings of irrigated arable land owned by temple households and the palace (Postgate 1984), where property rights were well-demarcated.[18] Other land with assigned tenure—either as grants to important officials, held by small kinship collectives, or rented on a commercial basis to tenant farmers via sharecropping—also appear to have benefited from the autonomous adoption of irrigation tools and technology (Steinkeller 1981). It was the buffer land between settled enclaves—unassigned land known as the *edin*—that lay unirrigated (Crawford 2004).[19]

Because of the cyclical inundations of the Indus river, agriculturalists in the Indus valley had little need for large-scale canal irrigation of the rich alluvial land. However, the more decentralized, small-plot agricultural practices of Harappan farmers (Possehl 2002) meant that they were freed from the need to maintain the more sophisticated basin irrigation techniques of the Egyptians (who also enjoyed regular flood cycles) (Singer *et al.* 1954). The absence of systematic regulation of irrigation in turn would have encouraged individual land ownership.[20] The pervasiveness of small stone seals (Figure 3), and substantial stylistic variation in discovered pieces across Harappan archeological sites, also speaks to the likelihood that respect for property rights was reasonably broad-based in Harappan society (McIntosh 2008), since such seals were probably used in commerce to connote individual ownership.

Textual analysis of the Indus inscriptions[21] suggests that agricultural output likely accrued, in part at least, to owners of land: diacritic modifiers (the "upper," denoted by ⅄) to the likely symbol for crops (ψ, for the compound

[17] In the north, violent surges in the flow of the Tigris and Euphrates due to snowmelt in the spring meant the need for damming or diversion to protect the ripening harvest; in the south, the challenge was one of adequate irrigation, both in the autumn where softened land facilitated plowing, and in the summer to supplement the meager rainfall.

[18] There is the possibility that priests and royalty simply chose the most productive land, and that higher productivity reflects a selection effect, rather than superior agricultural techniques. Given the proximity of the landholdings, and the state of pedology at the time, it is unlikely that this outperformance would be due primarily to selection.

[19] Incidentally, the property rights argument lends an additional reason to believe why sharecropping may be an optimal institutional arrangement, no only because of efficient risk-sharing contract (Stiglitz 1974), but also as a means of encouraging capital accumulation.

[20] Ironically, this decision may have been at least partially responsible for the decline and ultimate collapse of Harappan civilization. Recent research has speculated that climatic changes between 1800 and 1700 BCE disrupted the regularity of the monsoon; without control over its agricultural landscape, these changes eventually eroded the agricultural surpluses necessary for supporting the civilization's predominantly urban civilization (Giosan *et al.* 2012).

[21] Harappan inscriptions remain undeciphered, and while some have questioned whether these markings constitute an actual writing system (Farmer, Witzel & Sproat 2004), the preponderance of Indologists are of the view that Harappan inscriptions can be regarded as proper script (Parpola, Pande, Koskikallio, Meadow & Kenoyer 2010; Rao, Yadav, Vahia, Joglekar, Adhikari & Mahadevan 2009). In any case, even *if* the inscriptions were simply nonlinguistic symbols or emblems, they could still potentially have been used as personal or official identifiers to denote property.

Figure 3: A Harappan steatite seal discovered during initial excavations at Mohenjo-Daro (modern-day Pakistan), dated approximately 20th century BCE. The seal displays the classic features of such seals: an icon, usually of an animal (in this case, a unicorn), often interpreted as representing either a city or social group, and pictographic inscriptions that may have been related to the owner of the seal. Such seals, when used to create sealings, would have marked the ownership of goods or materials. Source: Department of Archaeology and Museums, Government of Pakistan.

symbol ψ̂) can be interpreted to mean "the 'upper share of the produce (due to the landlord)'... suggested by the Tamil literary and inscriptional usage" (Mahadevan 2006, p. 70). Other compound signs, with a harrow modifier (ᚳᚳᚳ), may have indicated the equivalent share of the crop belonging to the tenant-farmer (Mahadevan 2006). Given the relative abundance of water, the key form of agricultural capital would have taken the form of proper drainage systems, rather than irrigation mechanisms. While there is little archeological evidence of agricultural drainage systems, the evidence supporting sophisticated urban drainage systems is extensive (Meadow & Kenoyer 1997, 2005). To the extent that such urban systems are reflective of the general level of technological advancement in hydraulic engineering, we would expect in rural agricultural drainage systems to have been sophisticated and widely adopted as well. Taken together, therefore, the textual, artifactual, and archeological evidence lends supports the notion that property was important for agricultural capital accumulation in Harappan civilization.

In principle, all property in ancient Egypt and China was centralized, and belonged to the Pharaoh and Emperor, respectively. However, in practice, there was substantial scope for deviation from this ideal, which meant that property rights would have accrued to specialized groups or individuals.[22]

[22]This is not to say that the notional sense of property rights granted by the centralized systems of ancient China and Egypt were particularly supportive of growth. Indeed, if anything, centralization may have inhibited more rapid technological innovation and capital adoption

In Egyptian civilization, respect for property rights was most prominent in the domain of land. Land transfers from pharaonic holdings to temples were routinely recorded in documents and inscriptions (Johnson 1978), and there is both textual and archeological evidence dating to 2600 BCE from the pyramid at Meidum that indicates the ability of elites to independently hold property and render inheritance (Romer 2012). Furthermore, and textual evidence attesting to land conveyancing from the later Ptolemaic period in Egypt (332–30 BCE) strongly suggest that the use of demotic contracts was merely a continuation of ancient practices of land tenure within the civilization (Manning 2004).

Importantly, the temple-based landholding system was not closed: a sharecropping arrangement was available in Pharaonic Egypt, and in fact was a crucial mechanism for development, especially in absence of labor surplus (Eyre 1997, pp. 368–369, *emphasis* added):

> Modernisation of the countryside has arisen from changes to the water regime and associated farming technology, *mediated by traditional patterns of land tenure*, and commercial imperative.... The development of tracts of "new" land was a normal feature of the ancient regime, in reaction to local fluctuation in the valley profile and in the flood patterns. However it also involved the extension of arable cultivation to previously wild areas, whenever the necessary "colonising" population was available: native, immigrant or prisoners of war. Such development came in cycles... [but] it is likely that internal colonisation in the Old Kingdom at least was characterised by extension of flood-basin control to new areas.... Perennial irrigation doubtless expanded slowly but continuously from a very small base in the earliest period.

It is thus clear that the extension of nominal property rights was not accidental, but rather a conscious strategy to encourage the adoption of agricultural capital by peasant labor. The actual mechanism employed was typically an agreement by the "tenant" to purchase crop in advance at an agreed (low) price, which would then free him or her to exploit irrigation and other agricultural productivity techniques to maximize the yield from the land (Eyre 1997). While, unlike Mesopotamia, there was no explicit complementary institution of the rule of law, this was not an intractable problem; the prevalence of a strong social customs and adherence to precedent (Brewer & Teeter 2007) meant that the indiscriminate expropriation of property was unlikely, even with the absence of contract. Subsequent developments also attest to the fact that *de facto* property rights were prevalent in Egypt: given the gradual diminution of Pharaoh's landholdings over time, with traditionally-ceded titles upheld in

in agriculture. In Egypt, the *shaduf* only arrived in the New Kingdom period—more than six centuries after the end of the Old Kingdom—and this was not a native innovation but a technological adaptation from Mesopotamia (Stroubal 1992). In China, the taming of the middle Yangtze with flood control projects only began a half-century later during the Western Zhou era, and control of Yangtze riverland during the Xia dynasty was far more limited (Chen & Williams 1977).

courts, the Pharaonic state eventually resorted to levying taxation as a means to extract some surplus from former royal landholdings (Brier & Hobbs 1999), which began as early as the 1st dynasty of the Early Dynastic period (between 3000–2800 BCE).

In much the same manner, there was a clear sense of private property rights—especially regarding land ownership—in ancient Sinic civilization. In spite of theoretical ownership by the king (or emperor), land holdings accrued, *de facto*, to the vassal (Hou 1973). The *Chijangkou* ("Song of Mud Balls"), which by tradition dates to the earliest times, exemplifies this individualism in farming practices: "I dig a well for my drink, I till the fields for my food. What has the power of the emperor to do with me?" (Wu 1977, p. 86). But while the textual record in favor of this argument is strongest for the Zhou period[23]—and we will thus draw heavily on this record—it should nevertheless be noted that up till at least 600 BCE, practices in the Zhou dynasty was essentially a continuation and propagation of its Shang precedent (Chang 1973). Moreover, an acceleration of agricultural productivity, and by extension economic growth, only really took hold in Sinic civilization during the Zhou (although there was undoubtedly substantial territorial expansion during the Shang).

Possibly the earliest (verifiable) textual evidence of individual property rights comes to us from the *Daya* and the *Xiaoya* of the *Shijing* (Classics of Poetry).[24] In the fifth stanza of *Jianghan* (Poem 262), the king confers "hills and streams. . . in K'e-chow" to a loyal subject (Legge 1876, p. 344), a clear indication that ownership could indeed be held privately. Indeed, the *Datian* (Poem 212) not only explicitly delineates agricultural property between public and private ownership, it also attributes a significant degree of agency in farming practices to peasants (Legge 1876, p. 258):

> Various are the toils which fields so large demand!
> We choose the seed; we take our tools in hand.
> . . .
> The clouds o'erspread the sky in masses dense,
> And gentle rain down to the earth dispense.
> First may the public fields the blessings get,
> And then with it our private fields we wet!

The well-field system (*jingtian zhidu*) that was prevalent in the 9th century BCE clearly demarcated private ownership; the system involved eight outer sections that were privately cultivated (the *sitian*), with a center section held in common (the *gongtian*). Indeed, the Chinese character used to describe the system, "well" (*jing*), is similar in form to the # symbol and represents this form

[23] It is well-known that the major challenge for documenting and analyzing pre-Zhou historical developments is that popular writing media—bamboo and silk—were highly perishable, and so much of that early record has been lost (Wilkinson 1998).

[24] Dobson (1964) relies on linguistic innovations to date the written form of the *Daya* and the *Xiaoya* to around the 10th and 9th century BCE, respectively, corresponding to the early Zhou period, although the poems may have passed on as oral traditions from earlier eras.

of land division (the center of the symbol corresponding to the public plot) (Fu 1981).

By the time of the Chunqiu (Spring and Autumn, 722-476 BCE) and Zhanguo (Warring States, 476-221 BCE) eras of the late Zhou dynasty, *de facto* land ownership had been accompanied by substantial increases in agricultural productivity, with irrigation facilities having been expanded considerably as technological advances were extensively adopted by the peasantry; indeed, the prosperity that followed large agricultural surpluses probably contributed to the eventual formal recognition of private land ownership in 4th century BCE (Hou 1973). This was accompanied by the arrival of the rule of law late in the Zhou dynasty, around 536 BCE (Bodde 1963), although—similar to the case of Egypt—the prevalence of a strong social order likely limited indiscriminate expropriation of property in earlier periods, even in the absence of formal enforcement.

5 The Role of Writing in Reinforcing Property Rights

One important piece of corroborating evidence for the thesis that property rights were central for civilizational formation is the coincident development of independent writing systems in many of these civilizations as property rights became gradually more established. The fact that writing systems did *not* develop in the other non-civilizational settlements also provides additional indirect evidence against the possibility that property rights were a feature of those societies, which is difficult to definitively verify due to the paucity of the historical record.

In Mesopotamia, cuneiform writing was invented in the Uruk period, having built on proto-script in the Ubaid period (Pollock 1999). Archaic Chinese writing, as recorded on the oracle bones at Anyang, corresponds to the period of the early Shang dynasty (Creel 1937; Wilkinson 1998). Hieroglyphic symbols were already foreshadowed in predynastic Egypt, as civilization was only just taking hold in the Nile River delta, and indigenous invention of the hieroglyphic and hieratic scripts occurred in the Early Dynastic period (Baines 1983; Shaw 2003; Wilkinson 2010). And rudimentary signs began to appear on pottery dated to the early Harappan, with prototypical logographic inscriptions found on square stamp seals associated with a Transitional Stage (2600–2500 BCE) level of a Harappan mound at Kunal (Khatri & Acharya 2005).

As these civilizations became gradually more sophisticated, there would have been increased demand for a method for recording the myriad transactions that occurred, mainly within their civilizational borders, but also between different civilizations. It is in this sense that commerce and trade was important for the early development of civilizational entities.[25] Of course, inasmuch as writing

[25] In this, we see a parallel to the argument raised by Acemoğlu, Johnson & Robinson (2005b) that commercial trade was central to strengthening the position of the merchant class and spurring the development of property rights institutions, several millennia later.

was critical for meeting the needs of economic exchange, it was also important in several other aspects. First, production technologies could be documented and transmitted across time and space, which further stimulated capital accumulation. Second, property rights—which were likely enforced informally through social sanction—could now be formally codified, and as we have seen, such property rights were central to the adoption of new capital. Independent writing systems also eventually underpinned the codification of the rule of law, which is yet another cornerstone in the political-economic development of civilizations.

Would the ancient civilizations have emerged even in the absence of a writing system? There is a profound endogeneity issue here, since both civilizations and their writing systems probably coevolved, and in some cases scholars have even defined civilizations in terms of whether they possessed a writing system. While resolving the direction of causality is beyond the scope of this paper, it is clear that there were important feedback effects between the development of the two, and we can only conjecture as to whether writing was a sufficient condition for property rights to become entrenched, and in turn spark the development of civilizations. At the very least, it would appear to be a necessary one.

This is verified in part by examining the timing in which writing systems subsequently developed independently in later civilizations that emerged around the Bronze Age. We examine two other major groups of writing systems: other Near Eastern protohistoric scripts (Proto-Elamite, Proto-Sinaitic, and Proto-Canaanite), and Cretan protohistoric writing (Cretan Hieroglyphic, Minoan Linear A, and Mycenaean Linear B).

The group of Near Eastern scripts under consideration can be further classified into Proto-Sinaitic (Proto-Canaanite was almost certainly an antecedent of Proto-Sinaitic), and Proto-Elamite. Although not widely used in its times, Proto-Sinaitic is the likely parent script for the Phoenician alphabet, which in turn was adopted for the Greek alphabet. Proto-Sinaitic probably emerged as an intermediate step from Egyptian hieroglyphs (Hamilton 2006), rather than as an independent creation; consequently, the script was securely entrenched by the mid-11th century BCE,[26] and hence would have been available for recording purposes by the time of the rise of Archaic Greek civilization in the 8th century BCE.

In contrast, Proto-Elamite script is probably best viewed as a script associated with broader Mesopotamian civilization. Although Proto-Elamite is distinct from the cuneiform script prevalent in other parts of Mesopotamia—being composed of both lines and circles, rather than wedged markings alone—the geographic location of the Proto-Elamite and Elamite kingdoms, just east of the Tigris on the Iranian plateau, suggests that it is best regarded not as a distinct civilization but rather as part of the broader urban civilization that we have designated in this paper as Mesopotamian. Moreover, Proto-Elamite appears to have been in use concurrently with Sumerian cuneiform by settlements in

[26] Indeed, it is conventional to refer to Phoenician inscriptions dated prior to 1050 BCE as Proto-Canaanite (Healey 1990).

Elam (Walker 1987).

The other major class of script we consider are those of the Cretan family. Cretan protohistoric writing systems developed sequentially, beginning with Cretan Hieroglyphic—which dates back to the third millennium BCE—and was followed by Minoan Linear A and Mycenaean Linear B.[27] Although the development of these writing systems were likely in response to economic needs, it is unlikely that writing was independently discovered without knowledge of Mesopotamian or Egyptian systems (Olivier 1986). The innovativeness of the script notwithstanding—Cretan writing introduced a remarkably uncomplicated syllabulary—the Cretan writing family disappeared with the decline of Mycenaean society (ancient Greek civilization ultimately adopted the Phoenician alphabet).

6 A Simple Model of Property Rights and Capital Accumulation

In this section we introduce a simple model of property rights and technological adoption that captures the salient features of the evidence that we have documented in the previous section.

Consider society populated by $N > 0$ yeoman agricultural producers, each faced with the possibility of investing in irrigation. To survive during the production year, each individual must consume at least $\underline{z} \leq z$. Period optimization involves maximizing their respective (indirect) utility functions given by

$$v = z + \theta \left[af\left(k\left(i + i_0\right), l\right) - z \right] - c\left(i + l\right), \tag{1}$$

where $z > 0$ is the quantity of output that the farmer is able to retain prior to any appropriation of production (for survival), a is (disembodied) technology used in the production process, $f(\cdot)$, which uses agricultural capital k and (optimal) labor l as inputs, and $c(i + l)$ is the effort cost of devoting i labor units to initial needs i_0 for maintaining an irrigation system of size k, and another l labor units to production. $\theta \in (0, 1)$ represents the share that is retained from production income following appropriation.

The broad level of technology given by a includes knowledge generated within the agents community or settlement, that learned from other settlements (for example via goods trade), and geographical determinants of productivity. Institutional determinants of income, however, are distinct and captured with the parameter θ; we accordingly interpret θ as a measure of the security of property rights.

The strength of property rights captured by θ, while exogenous for agricultural producers, is in fact chosen by elites, who possess objective functions given

[27] Although the invention of Linear A and Linear B is attributed to the Minoans and Mycenaeans, respectively, their use was more widespread across the Bronze Age Aegean, with evidence of Linear A found on the Greek mainland, and large archives of Linear B found in Knossos, on Crete.

by

$$w = (1-\theta)\left[af\left(k\left(i+i_0\right),l\right)-z\right]. \tag{2}$$

A settlement's food surplus aggregates that of all agricultural producers:

$$S \equiv N\left[af\left(k\left(i\right),l\right)-z\right]. \tag{3}$$

We define the probability that a civilization emerges, μ, as an increasing function of per capita food surplus; that is,

$$\mu \equiv \left[af\left(k\left(i\right),l\right)-z\right],$$

with $g' > 0$. Finally, we make a number of standard assumptions: $f'_k, f'_l > 0, f''_{kk}, f''_{ll} < 0,\ f''_{kl} > 0,\ k'_i > 0,\ k''_{ii} \leq 0,\ c'_i, c'_l > 0,\ c''_{ii}, c''_{ll}, c''_{il} > 0$, where for ease of notation, partial derivatives are denoted with a prime superscript.

Civilizational emergence is the result of a simple two-stage game, where elites first establish the property rights regime by selecting θ, followed by producers making their agricultural capital accumulation decisions. The formal definition of equilibrium in this game follows.

Definition 4 (Civilizational emergence equilibrium)**.** The (pure strategy) subgame perfect Nash equilibrium in the civilizational emergence game is a pair $\{\theta^*, i^*\}$ such that: (a) $\nexists\ \tilde{\theta} \neq \theta^*$ such that $w\left(\theta^*\right) \leq w\left(\tilde{\theta}\right)$; (b) $\nexists\ \tilde{i} \neq i^*$ such that $v\left(i^*\right) \leq v\left(\tilde{i}\right)$.

This equilibrium is solved by backward induction. Our first proposition obtains from optimizing (1) in the second stage, and states that after controlling for the overall technological level inherent in both the trading regime and geographical landscape, more secure property rights promote greater investment in irrigation capital. For simplicity of exposition, we consider the special case where there are negligible initial irrigation needs.

Proposition 1 (Property rights promote capital investment)**.** *Let there be no initial irrigation needs ($i_0 = 0$). In any interior optimum, more secure property rights promotes greater investment in agricultural capital, as well as greater labor input. That is, $\frac{dk}{d\theta} > 0$ and $\frac{dl}{d\theta} > 0$.*

Proof. We first show that $\frac{dk}{d\theta} = k'_\theta = k'_i i'_\theta > 0$. We first maximize (1):

$$\max_{i,l}\left\{k+\theta\left[af\left(k\left(i\right),l\right)-z\right]-c\left(i+l\right)\right\},$$

which yields the following first order conditions for an interior optimum:

$$\theta a f'_k k'_i = c'_i, \tag{4a}$$

$$\theta a f'_l = c'_l, \tag{4b}$$

which implies $f'_k k'_i = f'_l$ since $c'_i = c'_l$ (due to our assumption that i and l are perfect substitutes). For (4) to define an optimum, two second order conditions for optimality must hold:

$$\theta a\left(f''_{kk}k'_i k'_i + f'_k k''_{ii}\right) - c''_{ii} < 0, \tag{5a}$$

$$D \equiv \begin{vmatrix} \theta a\left(f''_{kk}k'_i k'_i + f'_k k''_{ii}\right) - c''_{ii} & \theta a f''_{kl}k'_i - c''_{il} \\ \theta a f''_{lk}k'_i - c''_{li} & \theta a f''_{ll} - c''_{ll} \end{vmatrix} \tag{5b}$$
$$= \left[\theta a\left(f''_{kk}k'_i k'_i + f'_k k''_{ii}\right) - c''_{ii}\right]\left(\theta a f''_{ll} - c''\right) - \left(\theta a f''_{kl}k'_i - c''_{il}\right)^2 > 0.$$

Now, differentiating (5) with respect to θ implies

$$\begin{bmatrix} \theta a\left(f''_{kk}k'_i k'_i + f'_k k''_{ii}\right) - c''_{ii} & \theta a f''_{kl}k'_i - c''_{il} \\ \theta a f''_{lk}k'_i - c''_{li} & \theta a f''_{ll} - c''_{ll} \end{bmatrix}\begin{bmatrix} i'_\theta \\ l'_\theta \end{bmatrix} = \begin{bmatrix} -a f'_k k'_i \\ -a f'_l \end{bmatrix}.$$

Applying Cramer's rule yields, respectively,

$$i'_\theta = \frac{\begin{vmatrix} -a f'_k k'_i & \theta a f''_{kl}k'_i - c''_{il} \\ -a f'_l & \theta a f''_{ll} - c''_{ll} \end{vmatrix}}{D}, \tag{6a}$$

$$l'_\theta = \frac{\begin{vmatrix} \theta a\left(f''_{kk}k'_i k'_i + f'_k k''_{ii}\right) - c''_{ii} & -a f'_k k'_i \\ \theta a f''_{lk}k'_i - c''_{li} & -a f'_l \end{vmatrix}}{D}. \tag{6b}$$

From (5b), the denominator of (6a) is positive. The numerator of (6a) is

$$\begin{aligned} &-a f'_k k'_i\left(\theta a f''_{ll} - c''_{ll}\right) - \left(-a f'_l\right)\left(\theta a f''_{kl}k'_i - c''_{il}\right) > 0 \\ &\Leftrightarrow \left(\theta a f''_{ll} - c''_{ll}\right) - \left(\theta a f''_{kl}k'_i - c''_{il}\right) < 0 \\ &\Leftrightarrow f''_{ll} < f''_{kl}k'_i, \end{aligned}$$

where we have used the result that $f'_k k'_i = f'_l$ from (4) in the second line. The final line is true by the assumptions $f''_{ll} < 0 < f''_{kl}$ and $k'_i > 0$, so $i'_\theta > 0$. Finally, since $k'_i > 0$ by assumption, $k'_\theta > 0$, as required.

Repeating the procedure for the numerator of (6b) yields

$$\begin{aligned} &\left[\theta a\left(f''_{kk}k'_i k'_i + f'_k k''_{ii}\right) - c''_{ii}\right] - \left(\theta a f''_{lk}k'_i - c''_{li}\right)\left(-a f'_k k'_i\right) > 0 \\ &\Leftrightarrow f''_{kk}k'_i k'_i + f'_k k''_{ii} < f''_{lk}k'_i, \end{aligned}$$

which together with the assumptions $f''_{kk} < 0 < f''_{lk}$, $k'_i > 0$, and k''_{ii} imply that $l'_\theta > 0 \Rightarrow l'_\theta > 0$ as well. □

This result, although straightforward, is nontrivial; this is because the optimum calls for yeoman farmers to balance the marginal benefit of higher output resulting from greater deployment of agricultural capital, against the marginal (effort) cost of allocating labor toward accumulating such capital. This will only be the case if the relationship between changes in irrigation-directed labor vis-à-vis changes in the security of property rights is positive (rather than, as may initially appear, the relationship between *output* and property rights). Ultimately, as detailed in the proof, this condition is satisfied because of the diminishing marginal product of labor and the (partial) complementarity of capital and labor.

Proposition 1 also rationalizes the broad thrust of the empirical evidence presented in Sections 2–4 for Ancient China, Egypt, Harappa, and Mesopotamia:

that even when we allow for a role for a broad level of other fundamental factors that affect technology—as captured by a—property rights retain a distinct role. In particular, the presence of other dimensions of institutional quality need not diminish the catalytic role of property rights; for instance, improved control of corruption or the enhanced political stability—as important as they might be independently—would not override the necessity of secure property rights in promoting capital accumulation and hence growth. Consequently, when we control for geographical determinants of productivity as well as the possibility of technology transfer through trade (as we have via our research design), we can concentrate on the independent importance of property rights institutions as a determinant of agricultural capital accumulation.

One key feature of the empirical evidence presented earlier is that the early Harappan and Mesopotamian civilizations exhibited more distinct individual property rights than the Egyptian or Sinic civilizations. These, in turn, would have emerged from greater initial levels of hydraulic management that prevailed in the Nile and Yellow River valleys. We thus optimize (2) in the first stage, taking optimal investment in the second stage as given, to obtain the following proposition on how differences in initial irrigation needs might give rise to variations in the strength of property rights chosen.

Proposition 2 (Higher initial irrigation needs leads to weaker property rights regimes)**.** *Let the initial level of irrigation needs be given by $i_0 > 0$. If i and l are linear in θ, the property rights regime will be weaker if this initial level is greater as long as the response of labor with respect to property rights is sufficiently elastic. More precisely, $\frac{d\theta}{di_0} < 0$ if*

$$l'_\theta > \frac{2}{1-\theta}.$$

Proof. We first note that the interior optimum is now given by

$$\arg\max_{i,l} \left\{k + \theta\left[af\left(k\left(i_0+i\right),l\right) - k\right] - c\left(i+l\right)\right\},$$

which yields interior optima given by

$$\theta a f'_k\left(i_0+i\right)k'_i = c'_i, \tag{7a}$$

$$\theta a f'_l\left(i_0+i\right) = c'_l, \tag{7b}$$

which implies $f'_k\left(i_0+i\right)k'_i = f'_l\left(i_0+i\right)$. Since i_0 and i are separable, the result from the proof of Proposition 1 that $i'_\theta > 0$ and $l'_\theta > 0$ continue to hold.

Now maximizing (2):

$$\max_\theta w = \left(1-\theta\right)\left[af\left(k\left(i_0+i\right),l\right) - z\right],$$

yields the first order condition

$$-af\left(k\left(i_0+i\right),l\right) + \left(1-\theta\right)\left(af'_k\left(i_0+i\right)k'_i i'_\theta + af'_l\left(i_0+i\right)l'_\theta\right) = -z, \tag{8}$$

which applying (7) simplifies to

$$-af\left(k\left(i_0+i\right),l\right)+\left(1-\theta\right)\left[af_l'\left(i_0+i\right)\left(i_\theta'+l_\theta'\right)\right]+z=0,$$

Applying the implicit function theorem, obtain (after some algebra)

$$\frac{d\theta}{di_0}=\frac{-\left(af_k'k_{i_0}'+af_l'l_{i_0}'+\left(1-\theta\right)af_l'l_{i_0}'\right)}{-2af_l'\left(i_\theta'+l_\theta'\right)+\left(1-\theta\right)a\left[f_l'l_\theta'\left(i_\theta'+l_\theta'\right)+f_l'\left(i_{\theta\theta}''+l_{\theta\theta}''\right)\right]}, \tag{9}$$

where we have omitted the arguments for $f_k'\left(i_0+i\right)$ and $f_l'\left(i_0+i\right)$ to conserve space.

The numerator of (9) is negative as long as $f_l'l_{i_0}'$ is positive, which is the case since $f_l'>0$ by assumption, and $l_{i_0}'>0$ [to be proven]. By the assumption of linearity of i and l in θ, $i_{\theta\theta}''=l_{\theta\theta}''=0$, and so the denominator is positive if

$$\begin{aligned}&\left(1-\theta\right)af_l'l_\theta'\left(i_\theta'+l_\theta'\right)>2af_l'\left(i_\theta'+l_\theta'\right)\\&\Leftrightarrow\left(1-\theta\right)l_\theta'>2,\end{aligned}$$

which is the condition required in the proposition. □

Proposition 2 implies that the greater initial water management facing farmers in Egypt and China should therefore result in weaker property rights, relative to Harappa and Mesopotamia. The intuition is that the larger initial water management needs i_0, the higher will be final agricultural output. Because $z$output units are not subject to appropriation, the effective "tax base" is small and highly elastic in response to appropriation (tax changes) when i_0 and production are low. As output grows further, the percentage response of the tax base to tax cuts increases; indeed, the larger is i_0, the larger and less elastic is the tax base. As a result the ruler, whose optimality condition sets the elasticity of the tax base to unity, prefers a higher tax rate (weaker property rights) $1-\theta$.[28]

We are now in a position to offer the central proposition of the paper.

Proposition 3 (Property rights support civilizational emergence)**.** *In any interior optimum, more secure property rights increases investment in agricultural capital and labor input, resulting in greater food production and surplus, and enhances the likelihood of civilizational emergence. That is,* $\frac{d\mu}{d\theta}>0$.

Proof. The relationship of the surplus to property rights is given by

$$af_\theta'\left(k\left(i\right),l\right)=a\left(f_k'k_i'i_\theta'+f_l'l_\theta'\right),$$

which is positive in an interior optimum since, by Proposition 1, $k_i'i_\theta'>0$ and $l_\theta'>0$, and $f_k',f_l'>0$ by assumption. Then the likelihood of civilization arising increases since

$$\mu_\theta'=g'af_\theta'>0.$$

□

[28] More formally, $\arg\max_\theta w=\left(1-\theta\right)\left[af\left(k\left(i_0+i\right),l\right)-z\right]\Rightarrow\frac{(1-\theta)\partial(af(i,l))/\partial\theta}{af(k(i),l)-z}$.

7 Conclusion

In this paper, we have explored the manner by which institutional mechanisms—in particular, property rights—were central in the early evolution of settlements into full-fledged civilizations. By examining other Neolithic settlements possessing riverine environments along ancient trade routes, we have sought to exclude geographic and trade-based explanations for civilizational emergence, while demonstrating that *de jure* or *de facto* regimes of property rights over agricultural land were operative in all the ancient civilizations. We have also offered corroborative evidence based on the coincident development of writing systems—which enabled these nascent property rights regimes to become formally entrenched—in these early civilizations.

Although this paper has relied on available qualitative data from the dawn of civilization, the findings speak to both an academic and policy debate that continues to this day. On the academic front, it contributes to the burgeoning literature that has established the important, and often causal, role of institutions as a fundamental determinant of economic growth (see Acemoğlu *et al.* (2005a) for a survey). In terms of policy, this paper has shown that relatively simple institutional mechanisms—such as a formal or informal property rights regime—can make a big difference to countries seeking to improve their long-run economic performance. This straightforward advice is especially relevant for developing countries, where institutional environments are often weak, and policymakers are left with a huge checklist of potentially significant candidate policy fixes. Our paper suggests that a respect for property rights can be of first-order importance.

Future research in this vein can seek to further examine the relevance of property rights regimes for economic outcomes. While some work in this area has already been undertaken (Acemoğlu & Johnson 2005), there is substantial scope for additional research, especially in the realm of economic history; greater insight into the relative importance of property rights mechanisms in high-income countries in the early stages of their development, vis-à-vis other institutional mechanisms, can be especially valuable for developing nations currently debating the relative merits of these distinct political-economic institutions.

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