State Capacity and Organizational Learning in Classical Greece

Federica Carugati
King's College London

Mark Pyzyk
Princeton University

ABSTRACT: State capacity is critical for development. But how do states become capacious? The literature defines state capacity in a variety of ways and identifies war and bargains as its primary drivers. In this paper, we borrow from the literature on organizations to explore the role of the state as an epistemic agent and to highlight the importance of learning processes for the development of state capacity. Our focus is on ancient Greece, and particularly on Athens, Sparta, and Macedon. Focusing on three well-documented historical cases allows us to identify the factors that facilitate or prevent learning and how those factors affect state capacity in a comparative perspective. We identify three such factors: the willingness of states to invest in research; the ability to direct resources toward projects; and "tolerance for disruption," which enables states to incorporate innovation into existing institutional structures.

ACKNOWLEDGMENTS: World Politics seminar at Indiana University, LSE economic history seminar, and David Chilosi for their comments on earlier drafts; Josh Ober for comments and help with epistemic democracy literature; Bob Gibbons and Tiantian Yang for comments and help with organizational behavior literature; Jenna Bednar for sharing her work in progress on federalism.

1. Introduction

State capacity is critical for development. But how do states become capacious? The literature—which spans the fields of sociology, history, economics and political science—focuses on the roles of war and bargains among societal groups as drivers of capacity (Huntington 1968; Hintze 1975; Mann 1984; Tilly 1990; North Wallis and Weingast 2009; Besley and Persson 2009; 2011; Fukuyama 2011; 2014; Acemoglu et al. 2004; 2011; 2015; Dincecco and Katz 2016; Spruyt 2017; see also Grzymala-Busse 2020 on the role of religion, with bibliography). Definitions of this complex concept have varied across fields. For example, while the sociological approaches emphasize territorial centralization and rule-making and enforcement (see especially Tilly 1990, Herbst 2000, Spruyt 2017, Mann 1984), economic approaches emphasize fiscal and market structures (e.g., Besley and Persson 2009, 2011; Acemoglu et al. 2004, 2011, 2015; Dincecco and Katz 2016; Koyama and Johnson 2017). State capacity has also been approached from more multidimensional perspectives that encompass military/coercive, administrative, as well as economic functions (see, for example, Hendricks 2010; Knutsen 2013; Andersen et al. 2014;

Acemoglu and Robinson 2016, 2019, 2020; and Hanson and Sigman 2019; see also the seminal work of Skocpol 1985).

In this paper, we contribute to this literature by conceptualizing the state as an epistemic agent and highlighting the role of learning. We treat state capacity as a process of innovation or stagnation: that is, as the ability or inability of states to adopt novel solutions—be they institutional or technological—to their changing problems.[1] Drawing on the literature on organizational behavior and performance (which we discuss below), we flesh out two relevant dimensions of learning for state capacity: first, the importance of processes of routinization and innovation; second, the relevance of social and technological components.

We study learning processes in the states of ancient Greece, and particularly in Athens, Sparta, and Macedon.[2] The classical Greek world provides a coherent ecology in terms of geography, climate, and resources, allowing us to keep these variables constant. Greece affords three additional advantages: first, the city-states were neither large empires, nor face-to-face societies (even classical Macedon was, at most, a regional power). Such mid-range states, we contend, is where much of the action—at least in terms of institutional innovation—occurs (Scheidel 2019). Second, state formation in ancient Greece was intensive, owing both to the prevalence of totalizing forms of war and to citizen-centered political regimes, which were able to mobilize large portions of the population effectively and with relatively little resistance (unlike later conscript states, whose soldiers—whether citizens or not—had little choice in the decision to mobilize). Third, because premodern states are comparatively smaller and simpler than modern ones, they afford a clearer look into complex institutional dynamics, including those that underlie learning. The institutional and political history of the Greek city-states is well documented compared to other pre-modern societies. And the history of Athens, Sparta and Macedon is comparatively better documented than that of other Greek states. Moreover, in the period under consideration, these three states were meaningfully engaged with one another: in fact, the 4th century was a time of particularly intense institutional development and state competition (see Section 2). Finally, Athens, Sparta, and Macedon are emblematic of different approaches to organizational learning, which manifests in different outcomes for state capacity.

In exploring the role of learning for state capacity, we note its absence from the existing literature.[3] We therefore turn to other fields where the connection between knowledge, expertise, and learning

[1] As such, we are agnostic as to a specific definition of state capacity, or what features of state capacity are more important for development. The underlying methodological assumption is that a rigorous understanding of state capacity rejects its modern embodiment as a definitional requirement (Scheidel 2013).

[2] On the polis as a state: Hansen 2002; 2006.

[3] Joel Mokyr's work focuses on the link between knowledge and economic growth, but no reference is made to state capacity (Mokyr 2002). John Nagl (2002) discusses learning and the armed forces of several countries, but confines himself to matters of military doctrine and cultures of learning, rather than state learning, more broadly. Learning also plays a role in the literature on federalism as the outcome of processes of experimentation: see Bednar (in progress); Callander and Harstad (2015).

on one hand, and organizational and institutional performance on the other, has been more widely studied.

Learning dynamics and the role of knowledge figure prominently in the literature on epistemic democracy, both in its normative/philosophical and positive/social scientific approaches.[4] But because this literature focuses uniquely on democracy, its findings do not lend themselves to a comparative study of learning processes and how they contribute to capacity across regime types.

More useful for our purposes is the literature on organizational behavior and performance, which spans the fields of business, economics, and sociology. This literature focuses primarily on the role of learning—within or across firms—in improving productivity gains: in other words, learning is the process of producing something faster over a period of time. Particularly useful for our purposes is the iterative nature of the learning process and its relation to the broader work environment (Argote 2013, ch. 2). Work on the social and cultural embeddedness of organizational learning—a topic especially prominent in debates over virtual and remote work environments versus traditional, face-to-face workplaces—is highly relevant (see especially Brown and Duguid 2017). We draw upon the organizational literature on core capabilities of firms, covering the pay-offs, conditions, and dynamics by which technologies (or other innovative core capabilities) are developed and incorporated into organizational routines (Amit and Shoemaker 1993; Andreu and Ciborra 1996). We also draw on the seminal distinction between innovation and learning and the importance of processes of routinization for organizational performance (Nelson and Winter 1982; March 1991; see also, Ober 2008). Although processes of routinization of knowledge play a role in our story, we concentrate primarily on the dynamics that allow states to make risky investments in producing, deploying, and institutionalizing new knowledge.[5] These dynamics are particularly relevant today as we grapple with the role of the state in fostering innovation in a competitive environment, and with the relative advantages of autocracies and democracies (cf. Farrell and Schneier 2018; Harari 2018).

Our investigation highlights three factors that facilitate or prevent learning and suggests how those factors affect state capacity in a comparative perspective. The first factor is the willingness of states to invest in epistemic, or research, capacity. The second is the ability to direct resources (including money and infrastructural support) toward projects. The third is what we call "tolerance

[4] The philosophical approach highlights principles such as individual intelligence (or competence) and cognitive diversity, and mechanisms such as deliberation and aggregation (Landemore and Elster 2012; Goodin and Spiekermann 2018); the approach from political science highlights diversity, networks, competition, and power asymmetries (Page 2007; Hirsch and Shotts 2013; Allen, Farrell and Shalizi 2019).

[5] We are not concerned here with how (what kind of people, groups and structures) useful knowledge is produced (on this topic, see Page 2007, Ober 2008, Farrell and Shalizi 2011, cf. Allen, Farrell and Shalizi 2019). By focusing on the technical case of the catapult, we skip this step, postulating the existence of expertise and experts that can, at some cost, be hired/used. Our argument is compatible with Farrell and Shalizi on the dynamics of contagion and power asymmetries in selecting for change, but our results point to a less optimistic outcome for epistemic democracy.

for disruption," which enables states to incorporate innovation into existing institutional structures. Our analysis shows that tolerance for disruption is critical to the development of state capacity and that autocratic states might have a comparative advantage in this respect, other things being equal. In our analysis, Macedon won over Sparta and Athens—both capable of investing in research and directing resources toward large projects—because Macedon was better positioned to incorporate new technologies and new political stakeholders into its pre-existing institutional structure.

While we highlight the role of learning, we also recognize the importance of other forces shaping state capacity—forces that have been extensively analyzed in previous scholarship. More explicitly, we study learning processes that occur as states experience exogenous shocks (particularly war) and in the context of existing institutional structures (see figure 1). Our contribution emphasizes the dynamic, iterative aspect of learning, suggesting how these processes ultimately change the state itself, producing conditions for significant gains (and sometimes significant losses) in capacity. In this respect, we contribute to Douglass North's project of studying institutions' adaptive efficiency (North 2005).

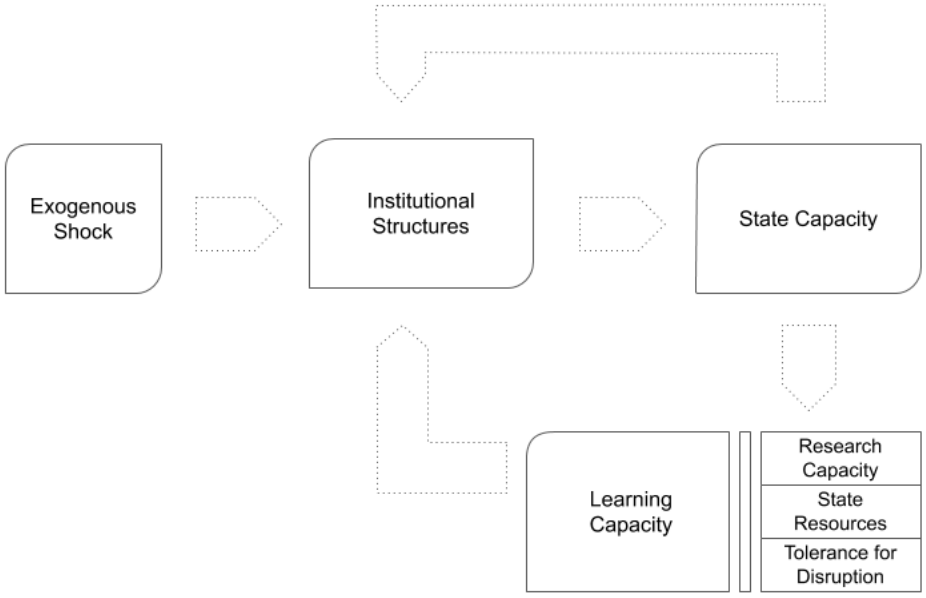

FIG 1. An epistemic theory of state capacity

But our account also puts pressure on several claims in the literature. First, we problematize the emphasis on the role of inclusion for development (Acemoglu and Robinson 2012; 2016; 2019). We see processes of inclusion occurring both in autocracies (Macedon) and in democracies (Athens). In both cases, inclusion is gradual, instrumental, and limited, falling far short of universal political inclusion. Yet, inclusive processes arguably increased both the wellbeing of the recipients and overall state capacity. These conclusions suggest that inclusion does not need to be particularly broad to effectively contribute to state development. Moreover, inclusion may enable states to increase their tolerance for disruption, but does not necessarily lead to gains in fundamental rights.

Second, Greece provides an exception to the conclusion that state capacity is maximized when the powers of state and society are evenly matched (Acemoglu and Robinson 2019; 2020). As we suggested above, inclusive processes played a role in increasing capacity in Macedon, but Macedonian society as a whole does not seem to have acquired a stronger bargaining position either leading up to those changes or on account of them. Finally, our story challenges the notion, common in longue-durée accounts of political history, that democracy wins out in the end (Fukuyama 2011; 2014). A non-teleological reading of history teaches us instead how fragile and uncommon our modern achievements are and that, more often than not, when democracies fight autocracies, the latter tend to come up on top.[6]

The paper proceeds as follows: section 2 provides some background on the world of the Greek city-states. Section 3 presents our theory of innovation and state learning, illustrated through the development of catapult technology. Sections 4, 5, and 6 analyze the factors that facilitated or prevented learning in Athens, Sparta, and Macedon, respectively. Our conclusions follow.

2. The Greek World

The world of the Greeks consisted of more than 1000 city-states spread around the Mediterranean and Black Seas (*poleis,* sing. *polis*: Hansen and Nielsen 2004). These city-states shared a common geographic, climatic, and natural resource environment (Braudel 1972; Morton 2001). By the 4th century, Greece was densely populated and highly urbanized. The total population has been estimated between 7 and 10 million people, with at least 30% of Greeks living in towns of 5000 people or more, yielding a population density of about 44 persons per km^2 (Hansen 2006; 2008; Milanovic, Lindert and Williamson 2011).[7] T he relatively dense and urbanized population was made possible by 500 years (ca. 800-300 BCE) of sustained economic growth.[8]

The Greek states had broadly egalitarian political institutions: government types ranged from democracies—where the franchise was extended to the entire adult male population, as in Athens—to oligarchies—where the franchise was limited through property requirements, as in Sparta (Hansen and Nielsen 2004; Robinson 2011; Simonton 2017). At the most radical democratic end, citizens made critical decisions about state spending, the decision to go to war, and building projects undertaken by the state. At the most radical oligarchic end, decisions were

[6] This claim is not meant as an analytical counterpoint to the narrative of democracy's military prowess (see e.g., Reiter and Stamm 2002), but as a simple observation borne out by the history of conflict before the 20th century, a period in which democracy did not fare very well. Our case studies are an instance of a broader historical pattern.
[7] Compare with 45.3 in Holland in 1561, and 44 in England and Wales in 1688 (cf. Ober 2015: 22-3).
[8] Population growth measured at 0.4% per annum; aggregate consumption measured at 0.6-0.9% per annum (as compared to Holland's 0.5%); per capita consumption measured at 0.1% per annum (as compared to Holland's 0.2% and Rome's 0.1%): Ober 2015.

in the hands of a small elite of wealth representing ca. 10% of the entire male population. More rare were forms of sole rule, as in Macedon. But even Macedon, as we will see, was not a centralized territorial state in the mold of, say, 19th-century Prussia. It was, rather, a loose federation of semi-feudal, aristocratic, and urban interests around a royal court, with limited power to intervene in the everyday lives of subjects.

War and trade tied the Greek city-states together (war: van Wees 2009; trade: Bresson 2016). In a rapidly expanding, yet close-knit and highly competitive world, the stakes to capture gains from trade for each individual city-state were high. As Bresson (2016: 416) argues, "the prosperity of the Greek Aegean world...was based first on the ability to control a vast, trans-Mediterranean trade network that allowed it to supply itself with massive amounts of grain, metal, slaves and other unprocessed commodities brought in from peripheral region, and to which it supplied in return a series of high-value products (oil, fine wines, artisanal products)." But if the stakes to capture gains from trade were high, so was the possibility of violent conflict.

The 5th century opened with two Persian invasions (490 and 480-79 BCE), which the Greeks famously (and surprisingly) repelled. After the Persian Wars, Athens replaced Sparta at the head of the alliance that defeated the Persians and began to transform it into the coercive structure known as the Athenian Empire.[9] Tensions between Athens and Sparta began to simmer as early as the 460s. As the historian Thucydides suggests, "the growth of the Athenian empire and the fear which this generated in Sparta, made war [between the two *poleis*] inevitable." The Peloponnesian War began in 431 BCE and lasted for 27 years, mobilizing almost the entire Greek world (Thuc. 1.1). In 404 BCE, Sparta defeated Athens, taking over her empire and the mantle of sole hegemon of the Greek world.[10]

One might have imagined the 4th century BCE would bring peace, but the Greeks were back at war within ten years. The Corinthian War (395–387 BCE) was the first major challenge to Sparta's hegemony, in which they faced down an alliance of Corinth, Argos, Athens, and Thebes, all of whom were funded with Persian gold. The war ended in the so-called King's Peace, which was guaranteed by the Great King of Persia and enforced by Sparta as its champion. The Peace did not hold. The Athenians sought to recover their position of primacy through a new confederacy that revived some elements of the 5th century naval empire. In the meantime, Thebes emerged as a force to be reckoned with, rivaling Sparta in land warfare. The antagonism between Thebes and Sparta culminated at the Battle of Leuctra in 371 BCE, where the Theban army defeated Sparta's. As hostilities continued, the Greek powers met again in

[9] We note here, but only in passing, that Morris (2009) challenged this label, suggesting that we should instead refer to this structure as a greater state, not as an empire, on account of the substantial differences with other pre-modern empires.
[10] For an in-depth account of state formation in the 5th century, see Morris 2009.

battle at Mantinea in 362 BCE. This battle produced no clear victor, with each side—Athenian, Theban, and Spartan—coming out slightly weaker.

It was in this vacuum that a new power emerged. Far to the north, loosely organized around the Argead dynasty, Macedon had been a third-rate power in the Greek world up to that point. Starting in 359 BCE, however, with the accession of Philip II (r. 359–336 BCE), Macedon first began to compete with, and then entirely master, the Greek cities to the south. This took roughly twenty years, as Philip alternately fought and cooperated with various Greek powers. Step by step, Macedon expanded its leadership in the northern Aegean. First, they participated in the Third Sacred War (356–346 BCE), siding with Thebes to defeat an alliance of Phocis, Athens, and Sparta. But the war put them at loggerheads with Thebes, too. Athens and Thebes then allied to fight Macedon in one of the decisive battles of antiquity, at Chaeronea in 338 BCE. Macedon won, projecting Philip to the head of the Greek world. His dominance did not last long, since he was assassinated in 336 BCE. But the state apparatus he left behind proved enduring and powerful, enabling his son Alexander to conquer Persia.

3. Innovation and State Learning

The Greek states in the 4th century faced severe competitive pressures, which prompted them to experiment and innovate in a number of spheres. This included administrative practices, shipbuilding, fortifications, and infantry tactics and equipment, to mention a few. One of the most striking of these innovations was in siege engineering, of which the iconic development was the catapult.

The introduction of the catapult well illustrates the elements and dynamics of state learning in 4th century Greece, as the technology is emblematic of the kind of innovations that could give states an edge over competitors. In the following sections, we use this case study to flesh out three factors critical to state learning. First, states must be able to build and sustain significant research capacity. Second, states need considerable material resources. Third, states require a significant tolerance for disruption of existing routines. States that effectively combined the three were most likely to prosper among other learning organizations.

a. The catapult in ancient Greece

Between 430 BCE and 330 BCE, the Mediterranean saw a sea change in states' ability to hurl large objects. While Pericles and the Athenians of the 5th century had to content themselves with building long counter-walls around fortified cities to starve out opponents, a century later Alexander and his corps of engineers were launching boulders at the walls of Halicarnassus and Tyre. Catapults were also used, more and more over time, as field artillery in battle, providing cover for advancing and retreating troops (Marsden 1969, 164 ff.; Ober 1987, 598–599; Keyser

1994, 33). The introduction of such devices fundamentally changed the calculus around defense priorities.

Faced with the challenge of high-speed ballistic weaponry, states had a number of options. One was to do nothing, which had the advantage of costing very little. The downside was that it left troops and walls vulnerable to severe attacks to which they could not respond. The second option was to keep up with existing technology, trying to hire specialists where possible and maintain stocks of standard equipment. This would allow states to respond to artillery with their own engines, usually from protected turrets on advantageous terrain. States were also forced to build and maintain increasingly large fortifications, which were extremely expensive and, at best, yielded parity with the enemy (Ober 2015, 57). Finally, if states were particularly ambitious, they could invest massively in new and advanced technologies, enjoying a first-move advantage. Anyone aware of technological competition in, say, 20th and 21st century military aviation, will be broadly aware of the advantages this path can yield, and also of the enormous costs of exploratory technological research.

The expenses involved in building catapults was vast, ranging from facilities, to building materials, to expertise. Hiring experts was particularly tricky. While even minimally ambitious projects required them, such specialists were free to move around and work for the highest bidder. Moreover, expertise was critical, since the slightest mistake would not only render a machine useless, but—given the tremendous tensile forces at play—potentially deadly to technicians in its vicinity. Materials could also be particularly hard to obtain. Early engines were essentially large composite bows. A mixture of wood, animal horn, and sinew were needed to provide the enormous tension that, when released, would send a bronze missile 250–300 yards (Marsden 1969, 15). Later machines required large stocks of horse hair or sinew rope (more on this below), and without it, the elastic cords that powered engines could not be made.

The early catapult was likely invented in 399 BCE in Syracuse (Marsden 1969; Rossi et al. 2015; Cuomo 2007). This device was called a *gastraphetes* because of its loading mechanism, which required the artilleryman to lean his full body weight onto his belly to mechanically notch a bow string. The occasion for its invention was war between Syracuse and Carthage following the conclusion of the Peloponnesian War. With every intention of attacking first, Syracuse's new tyrant—Dionysius I (r. 405-367 BCE)—undertook a crash building and armament program that produced enormous numbers of basic arms, innovative ships, and critically, "every kind of missile" (Diodorus Siculus 14.41–42). This "great gathering" at Syracuse arguably became an aspirational model for the autocratic research workshop. Subsequently, other tyrants across the Mediterranean hosted philosophers and scientists with the aim of stimulating research.

In the years after 399 BCE, advances in catapult technology came at a steady pace, increasing in strength, range, and size. However, these were quantitative increases, based on incremental improvements in frames, materials, and projectiles. The introduction of the torsion catapult,

which, rather than relying on an enlarged composite design, introduced a wholly new mechanism of coiled, fiber-based springs, was a fundamental technological leap. Such engines, which could hurl boulders across great distances, were invented in Macedon in the 340s. Instead of composite bow arms, torsion engines used thick coils of sinew or horse-hair rope as springs, producing sufficient force to hurl a 40kg stone up to 400 yards. This came on the heels of a long term Macedonian research effort. In the 350s, Philip first tangled with non-torsion stone throwers, suffering a humiliating defeat against the Phocians in 353 BCE.[11] Soon after, he undertook a research program meant to catch up and surpass the capacities of his neighbors. These efforts centered on a man named Polyides—along with a circle of subordinate engineers—who built novel and remarkable engines with which Philip besieged large cities like Byzantium and Perinthus.[12] Besides physical engines, these efforts produced a permanent research and engineering capacity in the Macedonian state: when Alexander conquered the Persian empire, he did so with the help of engineers who were products of this program.

b. Why Macedon? The Role of Learning

Why was Macedon better suited to develop the torsion catapult than Athens, Sparta, or any of their neighbors? The existing literature on Macedon's ascent highlights the advantages of cheap centralized structures capable of outperforming more expensive decentralized ones. In a famous, if now outdated, essay, W.G. Runciman (1990) suggested that the polis was "doomed to extinction" because it was "far too democratic." As such, the polis could not concentrate economic, ideological, and coercive power in the hands of "a compact, self-reproducing elite," as happened in Rome or Venice (1990: 364). Responding directly to Runciman's theory, Davies denied that any fatal flaw existed with the Greek city-states. The problem was, instead, the rise of innovative, autocratic regimes like Philip's Macedon. Faced with bigger and more nimble autocratic competitors, the Greeks were simply unable to respond to this challenge in time (Davies 1978, 228 ff.; 1995, 34–35). Ober (2015) has built on this story, suggesting that Macedon's autocratic state was capable of more easily scaling the learning processes that made the Greek poleis so successful.

We agree with the conclusion that autocracies are able to build capacity quickly and effectively and can, under the right circumstances, learn just as well as democracies. This conclusion, it is worth keeping in mind, supports a striking empirical regularity in world history—the prevalence of autocracy. We also agree with the important role that knowledge, expertise, and learning play

[11] Onomarchus the Phocian is supposed to have employed men who were "expert in throwing stones" (trans. Shepherd). See: Polyaenus 2.38.2.

[12] It is unknown whether torsion devices were ever deployed by Philip against Thebes or Athens. Arguably, the system of towers constructed by Athens after the Peloponnesian War was designed to respond to the earlier *gastraphetes* catapult. See: Ober 1987, 596. An Athenian inscription, however, indicates that when, in 340 BCE, the Athenians expelled the Macedonian-backed tyrant of Eretria, they captured a number of torsion siege engines. So even if Philip did not deploy them in his armies *en masse*, by 338 BCE he was very close. See: *IG*² II 1627, B, 328–41; Marsden 1969, 58.

in building state capacity (Ober 2008). We build on these insights to elucidate the factors that favored or impeded learning in Athens, Macedon, and Sparta. In so doing, we challenge the simple dichotomy between autocracy and democracy posited by previous scholarship.

The story of the catapult reveals three factors critical to state learning. First, states must build and sustain significant research, or epistemic, capacity. This includes access to experts and a learning culture that enables them to do their work. Such access is not always guaranteed. While the engineers in the ancient Greek Mediterranean were free to sell their services to the highest bidder, other historical ecosystems have not been as permissive. Instead, the historical norm has tilted toward economies that applied considerable coercion to capture and keep specialist knowledge. Consider Soviet efforts to keep pace with American technological innovation in the postwar period—coerced labor was common, with research sometimes undertaken, quite literally, in the gulag (Siddiqi 2015; Alexopoulos 2016). Such tactics are old by world historical standards, echoing those of ancient Near Eastern states, which often simply enslaved and coerced experts in medicine, magic, and handicrafts (Zaccagnini 1983). However it was arranged, access to stocks of knowledge and expertise is a prerequisite for building research capacity.

Such capacity could also be built through intensive research efforts, which might produce crucial innovations. In the modern world this might mean a major endeavor such as the Manhattan Project or Enigma code breaking operation at Bletchley Park. In the ancient world, the Syracusan and Macedonian armament workshops were similar, bringing together craftsmen and engineers from all over the Mediterranean. Research capacity might also derive from states' ability to foster decentralized, organic learning through institutions that encourage the aggregation, sorting, and diffusion of knowledge among participants. As we discuss in the next section, Ober (2008) has argued that Athens was such a state, designing its various institutional organs to produce broad and dynamic organizational learning. The Spartan army—which relied on an integral system of formal education and socialization—served to generate a deep pool of expertise. In Sparta's case, as we will see, the lessons were over-rehearsed and too narrowly tailored—when the time came to adapt, the Spartans were unable to broaden their knowledge base.

Second, states need significant resources to facilitate learning, either money or materials. In the case of Athens, this could mean paying citizens to participate in the various organs of government, where actual learning took place. In Macedon, it could mean paying highly specialized engineers, buying quality timber, horse hair, sinew springs, or other specialized equipment ranging from catapult bolts to metal washers. In Sparta, lacking much in the way of a monetized economy, it meant marshalling resources in kind, directing agricultural surpluses toward supporting elite hoplite warriors. States that lacked this resource capacity could not sustain state learning.

Third, state learning rewards tolerance for disruption of existing routines. This usually has little to do with the explicit desires of states or their leaders—that is, while states usually recognize the benefit of reform, implementing it may be beyond their grasp. This is because the process of reform itself imposes (upfront) costs on states, for example material costs. Another major hurdle is the anxiety of social actors who stand to be functionally replaced by innovation—be it technological or organizational. This process is common in the history of states. Peter the Great, for instance, is famous for his military and naval reforms in late 17th century Russia. It is no coincidence, however, that he had to put down significant rebellions by elite units like the *streltsy*, whom he was replacing (Paul 2004). Given resistance to such reform, it is understandable that most states—like most businesses—simply maintain the status quo. Such resistance, moreover, can become embedded in cultural narratives, which makes overcoming it even more difficult (Weick 1995, 153). Countervailing narratives stifle reform, whether it is the adoption of advanced statistics in sports (like baseball) or the adoption of modern tactical doctrine in the Soviet or American armies.[13] A clear recognition that new institutions, technologies, or methods have superseded old ones only emerges in the long term (or after outright disaster).

We must also add that such innovations can involve considerable uncertainty. The hefty bill for the Manhattan Project, for instance—at $2 billion in 1945, the equivalent of $28.5 billion today—becomes astronomical when we reflect on the fact that its principal architects did not even know if success was possible in practice (though they were fairly certain of it, in theory).[14] The decision to go forward, therefore, required not only conspicuous resources, but also substantial risk tolerance on the part of laypersons like FDR, who approved the project personally. Thus, between the socially destabilizing effects of some innovations and the high-risk factor inherent in others, *intolerance* for disruption may be entirely rational on the part of states. Nevertheless, pay-offs for early investments in innovation and learning can be sufficiently high that some organizations willingly accept the risk, and thus organizations with the ability to mollify or coerce stakeholders into tolerating such disruption are more likely to succeed in high-risk, high-payoff learning.

In what follows, we illustrate how these factors facilitated or prevented learning in Sparta, Athens, and Macedon, and we suggest how they affected state capacity in each case.

[13] For Soviet failure to adopt cutting edge signals coordination, combined air and tank warfare, and "deep warfare" designed to disrupt internal lines of communication and logistics primarily on ideological grounds (their proponent—Mikhail Tukhashevsky—was proscribed as counter-revolutionary), see Hill 2017. For American failure to adopt the lessons of the British in Malaya, or its own experience in Vietnam, with respect to fighting a guerilla war, see Nagl 2002. For failures in sports to adopt statistical "Sabermetric" performance measurement in baseball, see Lewis 2003.

[14] While Einstein's famous letter to Roosevelt in 1939 was a seminal moment in the history of the Manhattan Project, others were unconvinced such a weapon was possible. Enrico Fermi, a major contributor to the Project, in 1939 suggested there was "little proof that we are not pursuing a chimera." See: Gosling 2005, 6.

4. State Development in Sparta

When the 4th century rolled around, Sparta occupied an enviable position. Success in the Peloponnesian War had vaulted the city to the head of the Greek world. Its tenure there, however, was brief. Throughout this period, Sparta failed again and again to adapt to new circumstances. To the extent that it did adapt (for instance, by incorporating new social actors into the state), these changes were incompatible with Sparta's conservative civic culture, and were either resisted or reversed. As a learning organization then, the Spartan state was ineffective, despite its wealth and population of expert soldiers.

When the Peloponnesian War ended in 404 BCE, Sparta did what imperial successors often do in such situations—it took over Athens' machinery of empire, simply diverting tribute from one capital to another. This provided new capacity for certain kinds of activities: for example, Sparta's fleet was expensive, and her allied troops in the Peloponnese and abroad required payment. With Athens' imperial resources, the Spartans could sustainably fund their empire.

But their new position created as many problems as it solved. Sparta suffered from three factors above all others—lack of manpower and an inability incorporate new social actors, failure to adapt to the challenges of empire, and inability to adapt to innovations (like siege technology) in 4th century warfare. These challenges were not insuperable. As we will see, Sparta could have replaced the citizens they lost over a century of war—they chose not to. They also had the resources to undertake technological and organizational reform—but, again, they chose not to. In each case, a deeply conservative tendency stood in the way of change.

Let us begin with the Spartan approach to population decline. Because of its extremely restrictive citizenship criteria, Sparta had a relatively small, and ever shrinking, population of citizen hoplites (Doran 2018). Aristotle called it *oliganthropia*—literally, "fewness of men." Strains on the population had already begun to show in the course of the Peloponnesian War, which had demanded constant mobilization of Sparta's citizen hoplites. At the Battle of Sphacteria (425 BCE), for instance, 120 Spartan citizens were taken prisoner by the Athenians, which amounted to between 5–10% of the total population. It was a substantial enough loss that Sparta sued for peace.

Sparta did supplement its citizens hoplites in battle with men from subservient classes (like, for instance, the well known class of helots—serf-like populations in Laconia and Messenia) . However, such soldiers never earned a permanent place in the Spartan state. During the Peloponnesian War, some helots, for instance, were armed and sent to the front, and in so doing, took on a new social status: they were called *neodamodeis* (i.e., new people). This allowed the Spartan army to grow far beyond its citizen-only ranks. The *neodamodeis* were clearly a useful addition . But they were tolerated, at best—more than helots, less than citizens (a status that caused severe resentment). No regular process was ever created to replenish Sparta's

citizen ranks, and the creation of new *neodamodeis* was discontinued entirely after the Battle of Mantinea in 362 BCE. Significantly, this occurred just when Sparta most needed manpower (Cartledge 1987, 328).

The same resistance to opening access to new citizens applied to new leaders. But the Peloponnesian War allowed innovative, unorthodox leaders to emerge. Commanders like Brasidas, Gylippus, and Lysander could never have risen through the traditional Spartiate chain of command for two reasons. First, Sparta's command structure narrowly favored the kings and their immediate supporters. Second, many of these upstarts came from families of uncertain or inferior status: the so-called *mothakes*, for example, whose families were Spartiate but required sponsorship to stay in good standing (Cartledge 2002; Hodkinson 2015; Doran 2018). The most prominent of these was Lysander, who won a major naval victory over Athens at Notium, off the coast of western Anatolia, in 406 BCE. As a personal friend of Cyrus II, son of the Persian king, he was able to procure a steady flow of resources to pay Sparta's navy. Desperate to win the war against Athens, the Spartans allowed Lysander to skirt the navarch's one year term limit . And at war's end, he was instrumental in constructing the basis for Sparta's brief imperial experiment: Spartan governors, Spartan garrisons, and loyal oligarchic juntas (Cartledge 1987, 91). But Lysander's rise invited a conservative reaction, and his plans to entrench and expand Sparta's empire were blocked in 403 BCE by an alliance between the two kings and the ephors, who recalled him to Sparta and nixed many of his imperial designs (Cartledge 1987, XXXXXX; Runciman 1990, 366). Sparta's empire, rather than emerge as a cohesive whole, instead became a poorly governed hodge-podge .

Several other factors hastened Sparta's imperial collapse. The first was its inability to govern other Greeks. While Sparta cared very much about collecting tribute, they did not provide much in return to subjects.[15] Add to this the fact that Spartan governors were themselves savage in enforcing their control over cities, and it was not long before Sparta faced serious problems among subject-states (Hornblower 2000). The second was the continued hostility of Sparta's rivals, which included the states that participated in the Corinthian War, starting in 395 BCE (especially Argos, Athens, Corinth, and Thebes). Thebes especially was a problem for Sparta in the long run (as we noted earlier), both because—as Xenophon claims explicitly—it learned lessons from fighting the Spartans so often, and also because it was flexible enough to combine a durable and populous confederation of Boeotian allies with strong, innovative Theban leadership (Plutarch Pelopidas, 15.2). By the 360s, Thebes was arguably better at hoplite warfare than the Spartans, but with a capacity for other kinds of learning, to boot.[16]

[15] By comparison, Athens provided economic and civil functions, such as the mediation of disputes and regulation of coinage, in addition to providing security through its fleet. See: Morris 2009, 132, 139.
[16] For fortification building, see: Luraghi 2008; Roy 2014. For Thebes' naval program, see: MacKill 2008, 186-7.

Sparta's problems can be attributed to many causes—oliganthropia, the challenges of running an empire, even chance. But a critical factor that is often ignored was their failure as a learning organization. This failure took two forms. First, Sparta learned too well in one particular sphere, hoplite warfare, to the detriment of others. From childhood, Spartan males were educated in the so-called *agoge*, a brutal education system that instilled discipline, physical toughness, and fighting skill—with little capacity for much else. Such overcommitment is a common risk for learning organizations. Because competitive equilibria often reward organizations that cultivate extensive core competencies in particular fields, many persist in such expertise long past their shelf lives (Levitt & March 1988, 323). In the archaic (700–490 BCE) and early classical periods (490–400 BCE), hoplites dominated the Mediterranean battlefield. The Persians, especially, were unable to counter them (Davies 1983, 199). But by the 4th century, the Greeks themselves had developed several counter-hoplite solutions (e.g., light-armed specialist troops, artillery missiles), which meant that Sparta's elite troops were exposed to ever-increasing danger abroad. Organizations can and do adapt to such circumstances. But often, finding their critical strengths outmatched, they instead obfuscate cause and effect, moralizing failure, and ignoring historical lessons (Weick 1995, 153). This was the case in Sparta, which would continue to cultivate strength in infantry warfare for another century and a half—only now by selling command expertise to other, larger powers (Cartledge 1987).

Second, Sparta failed as a learning organization in other fields. One obvious example was naval warfare, where the Spartans—even when they produced successful admirals like Lysander—never attempted to institutionalize their expertise. Another example was siege weaponry: while innovations in catapult technology were taking root in cities like Syracuse, Athens, and Thebes, no such efforts were ever made in Sparta. When Thebes built the city of Messene in 370 BCE (a capital for the newly free Messenians), they did so with the newest advances in siege fortification building, which were meant to stand up to precisely these sorts of weapons (Luraghi 2008). Given Sparta's deficit in this field, this made the loss of Messenia more likely to remain permanent.

Sparta's failure to learn and innovate cannot be attributed to a lack of state resources—certainly not at first, when Sparta inherited Athens' tribute empire. It is true that Sparta lost its empire quickly, and that this presented problems for generating the cash required to hire experts. Absent the empire, Sparta had to rely on its internal economy to supply resources, which meant that hard silver currency was hard to come by. Sparta was unique among major cities in not minting its own coins, and this might have impeded their ability to hire experts. As the ancient historian Polybius (6.49.8-9, trans. Paton) noted, "once they began to undertake naval expeditions and to make military campaigns outside the Peloponnese, it was evident that neither their iron currency nor the exchange of their crops for commodities which they lacked… would suffice for their needs, since these enterprises demanded a currency in universal circulation and supplies drawn from abroad." Nevertheless, this does not fully explain their failure to attract relevant technical

experts, either in siege technology, fortification building, or other fields. Sparta was never a poor state, and if they had chosen to, they could have found the money to pay them. In the end, hiring such experts was simply never a priority for the Spartans.

The problem, rather, lay in Sparta's cultural and social life—anti-cosmopolitan and anti-intellectual—which could find no place for experts who were not traditional military figures. In many cases, ancient evidence requires us to infer such cultural disapproval, but Sparta provides us with an explicit example of a state that reacted with horror to the new siege technology emerging in the 4th century. Consider, for instance, the reaction of the Spartan king Archidamus to an early catapult imported from Sicily. Horrified, he is said to have cried out "By Herakles, they've destroyed manly valor!" (Plutarch *Sayings of Kings and Commanders*, 191e). This is not absolute proof, but can reasonably be seen as representative of Sparta's military elite. Not only did catapult tactics require a deviation from those of hoplites—involving a set of skills Spartans had no hope of mastering, or even understanding—they replaced the valor and courage of battle with mechanical and cowardly projectile weapons. Indeed, the historical record bears this out. While Spartans were, on the whole, good at adapting novel infantry approaches—e.g., using peltasts and mercenaries, which complemented their existing specialization—we hear nothing of their use of catapults until 204 BCE (almost two centuries after their adoption by other cities: Marsden 1969, 167).

5. State Development in Athens

Athens presents the case for a successful learning organization which was exceptionally good at institutional innovation, but not as good at pursuing high-risk technological research. The evidence suggests that its citizen-centered rule-making institutions with multiple veto points may have hindered high-risk/high-payoff investments in learning and expertise. And while this meant that Athens displayed considerable robustness in state capacity and performance in the long run, it also meant that they were unable to compete against a nimble and centralized learning organization like Macedon (see Section 6).

Unlike Sparta, Athens was not in good shape at the beginning of the 4th century. The defeat in the Peloponnesian War deprived the polis of its empire, walls, and fleet. Twenty-seven years of war and the plague of 431-429 BCE had decimated the adult male population. Within a year of the defeat, Athens devolved into civil war.

Within a decade, however, Athens managed to rebuild both its democracy and economy on new bases. Key to the recovery were constitutional and institutional reforms (Carugati 2019). The reforms imposed checks on the previously unrestrained decision-making power of the Assembly, enhancing the democracy's stability. The economy was also rebuilt through innovative institutional reforms that expanded institutional access to new actors. To incentivize non-

citizens to become involved in maritime trade and silver mining, Athens' most lucrative economic resources, the Athenians extended to them rights to access the courts, to own land, lease silver mines, and form and participate in cultic associations (Ismard 2010; Taylor and Vlassopoulos 2015). Recipients included public and private slaves, resident aliens (*metics*), and foreigners.[17]

By the middle of the 4th century, Athens could once again muster both conspicuous financial and natural resources and the research capacity for both institutional and technological innovation. Indeed, we have evidence for substantial technological development both in mining technology (van Liefferinge et al. 2014) and, indeed, catapults (Cuomo 2007: 46, 63). In the case of the catapult, we see the Athenians' capacity for routinizing new knowledge and expertise in the incorporation of catapult training into the ephebic curriculum (Cuomo 2007, 63).[18] Nevertheless, Athens remained a follower in the development of catapult technology, keeping up with innovations developed elsewhere.

Athens, then, was a pioneer when it came to institutional innovation and could certainly invest in technological development. Moreover, as Ober (2008) has argued, the polis' democratic institutions effectively encouraged the aggregation, alignment, and codification of knowledge. However, the polis seems to have had a harder time with the high-stakes investments in learning and expertise required to develop new, expensive technologies. The reason, we suggest, lay at least in part in its decision-making structure, which limited the polis' tolerance for disruption by imposing many veto points that thwarted its ability to pivot very quickly into risky investment in innovation.

Because Athens' institutional history is comparatively well documented, we can reconstruct how the decision-making process influenced the incorporation of new technology and institutions within pre-existing structures. Critical to our account are the constitutional reforms of the late 5th century, which imposed a number of veto points in the decision-making process, slowing down the legislative process and encouraging innovation and change as long as it was compatible with the expectations of the average Athenian.

The process of decision-making followed three stages.[19] First, the Boule of 500 drafted an agenda to discuss new policies in the popular Assembly. The Boule was a deliberative institution and its members (who were paid to attend) were selected by lot annually through a mechanism that ensured participation of ordinary Athenians, drawn evenly from across the whole citizen

[17] Among these, *choris oikountes* (lit. [slaves] living apart [from their masters]), slave bankers, and public slaves (*demosioi hyperetai*) stand out. All these categories of slaves performed either economically productive or important administrative functions.
[18] The *ephebeia* was a two-year program of military service for eighteen and nineteen year old Athenian citizens.
[19] We focus here on policy-making. For laws: Canevaro (2019). The conclusions reached here extend to that process as well.

population. As Ober suggests, the Boule was an extraordinary tool to efficiently aggregate dispersed knowledge and promote learning (Ober 2008: Ch. 4). The agenda produced for each Assembly meeting was a mix of routine items that required little or no discussion, explicit policy recommendations (closed *probouleumata*), and requests to discuss and decide on a particular topic (open *probouleumata*).

Second, the Assembly met to discuss the agenda prepared by the Boule. The Assembly was a deliberative body of 6,000-8,000 citizens that met 40 times a year. Participation was also remunerated in the 4th century, and selection occurred on a first-come, first-served basis. The Assembly voted on routine procedures and Boule recommendations (the closed *probouleumata,* which could also spur further debate), and actively debated the other issues placed on the agenda (the open *probouleumata*). Decisions were made by show of hands and aimed toward consensus (Canevaro forthcoming).

Accepted proposals were implemented through Athens' bureaucracy, where officials worked in boards and were subject to scrutiny at the beginning and end of their mandate. If a proposal was deemed unsuitable or illegal, the decision-making process entered a third stage, which took place in the courts. The courts were made up of large panels of citizens selected by lot on the morning of the court case. The procedure to review a policy proposal, the so-called *graphe paranomon*, was usually adjudicated by 501 jurors. At this stage, the court setting encouraged innovation (departures from the status quo) only if it was compatible with the preferences of the median juror (Carugati 2019; Carugati Calvert and Weingast 2020).

This decision-making structure shaped policy-making toward both political stability and economic growth: according to the sources, the 4th century economy matched the growth levels reached during the apogee of the empire (Ober 2015). However, it may have been an obstacle to some types of innovation. The three-stage system offered a chance to reflect on whether a new proposal was in the interests of the Athenians. The fact that we see a great deal of institutional and technological innovation in the 4th century indicates that the process was not systematically prone to capture by anti-innovation advocates: as we mentioned earlier, innovation occurred both in terms of expanding institutional access and in developing or adopting new technologies in mining and catapults. These were incremental and opportunistic improvements upon existing technologies. But proposers of new measures that were hugely costly and/or whose results were uncertain—say, a proposal to direct state finances to developing a new catapult (the outcome of which was unknown)—would have had a harder time persuading the demos.[20] As we argued above, developing the torsion catapult required an enormous amount of political and material capital, and would have presented significant problems of epistemic uncertainty. Thus the

[20] External conditions may have also played a role. In the 4th century, Athens lacked a clear existential threat. There was plenty of warfare and certainly some Athenians became extremely vocal about the threat posed by Philip.

proposal became doubly expensive, requiring not only resources, but also significant political capital in order to convince stakeholders to commit to undertaking the research.

In sum, Athens had ample access to resources and significant research capacity. In addition, Athenian institutions could effectively foster decentralized, organic learning by encouraging the aggregation, sorting, and diffusion of knowledge. Athens was particularly effective at routinizing learning in function-specific institutions. For example, the fleet was a significant learning institution, with Athenian officers and sailors building unmatched organizational knowledge of naval warfare (Morrison 1984). Moreover, the ability of the Athenians to incorporate new actors and new expertise seems beyond doubt. We have already discussed the reforms that extended access to institutions to non-citizens. In addition, we see Athens' attitude toward experts and expertise emerge most clearly in the careers of the statesmen Eubulus and Lycurgus, who led the polis in the second half of the century. They were responsible for a number of fiscal reforms which included more explicit accounting practices, monetization of state assets, rental of public lands, and taxation of increasingly specific parts of the economy. As Davies (2004) suggests, this approach to state finances was cutting-edge in the classical world. Lycurgus was a son of the Athenian elite. We don't know about Eubulus' background. However, we do know (albeit from evidence) that their decision-making structure made it possible for lower-class Athenians—people without political pedigree but with good ideas—to propose new and innovative policies (Carugati 2019). What mattered for all these actors was not their aristocratic connections or family lineages, but the fact that they had functionally specific skills. Contra Runciman, then, the fact that Athens did not have a "compact, self-reproducing elite" lent it an epistemic advantage. On the other hand, Athens may have been less effective at incorporating the kind of disruption that required projecting resources onto projects quickly, at great expense, and in the face of epistemic uncertainty. Faced with a resource-rich, epistemically-dynamic foe that was willing to implement risky and innovative reforms and technologies, Athens was at a disadvantage.

5. State Development in Macedon

Unlike the previous examples, Macedon seems to have been good not only at technological and social innovation—stimulating new development via research investment—but also at emulating successful innovations via hired experts. We suggest that these traits played a role in Macedon' success over the other Greek poleis.

Like Athens, Macedon began the 4th century in bad shape. While resource-rich, the Macedonian state had always been weak compared to southern Greek poleis—some of the region's richest mines, sea ports, and timber sources were monopolized by far-off states like Athens and Sparta.[21]

[21] The Macedonian crown still controlled significant supplies of timber, iron, copper, and other minerals. See: Hammond 1994, 19.

After the collapse of the Athenian empire in 404 BCE, other Greek poleis began to compete for Macedon's resources. This was especially the case with Thebes which, after 371 BCE, took Sparta's place as the Greek world's leading land power. Philip II (r. 392–370 BCE) spent his youth in Thebes, largely as the result of Theban hegemony (Plutarch, *Life of Pelopidas* 26.4). Thebes required the assurance of peripheral states to the north (Macedon included) that they would recognize Theban leadership. Taking the Macedonian elites' sons as hostages was their method of ensuring this loyalty.

In competing with southern Greek states, Macedon was disadvantaged in several ways. One was its status, not as polis, but as *ethnos* (i.e., a regional confederation of tribal, civic, and social groupings). Besides basic religious and linguistic ties, these groups were united primarily by the Macedonian crown, which wielded significant ideological authority. This unity was achieved also through strategic ties of marriage to the king (polygamy was a Macedonian royal custom). This created as many problems as it solved. By balancing Macedon's regional and factional interests on a personal basis, through marriage to the king, the system created bitter rivalries among heirs (and by extension among their factions at court). This situation was exacerbated by unclear succession rules and an uncertain role for the army, which often played kingmaker (Mari 2011, 88). Successions could therefore get quite gruesome, with rival children and wives slaughtered to secure royal power.

Macedon's capacity to pursue its own foreign and domestic policy began to change when Philip took the throne in 359 BCE. He succeeded his brother Perdiccas III (r. 365–360 BCE), killed in a disastrous invasion of the northwestern kingdom of Illyria (Macedon's inland periphery could be as much a problem as Greek cities of the coast). Indeed, Perdiccas' campaign was an existential disaster and national embarrassment, with 4,000 Macedonians killed (a very high body count for an ancient battle), and "the remainder, panic-stricken … exceedingly afraid of the Illyrian armies and [having] lost heart for continuing the war." (Diod. Sic. 16.2.5, trans. Oldfather) The ease that Philip experienced in reforming the army and introducing a large class of new stakeholders in the affairs of state—the Macedonian *phalangites*, who were drawn from the lower strata—must be explained in part through the hole left by Perdiccas' defeat.

In 359 BCE, Philip was left with a state on the brink of collapse, with foes on every side. Under his leadership, however, a remarkable reform effort was undertaken, which quickly yielded dividends. In less than four decades, Philip transformed the state from regional power on the Greek periphery to one capable of toppling the mighty Persian empire. To understand how, we must follow Philip as he pursued reforms from the very earliest stages of his career, which combined changes in Macedon's military, fiscal apparatus, and state structures.

After his release as a Theban hostage in 365 BCE, Philip took up the governorship of one of Macedon's districts, a post he gained through his brother, Perdiccas. While there, he used his

time wisely, experimenting with a new model army (Hammond 1992, 18). The invention of the Macedonian phalanx, a mutation of the Greek hoplite phalanx, would be one of the most important innovations in military history. Philip made a critical decision in rooting his new military not in the Macedonian aristocratic stratum, but rather much more broadly. The new institution—the "foot companions"— allowed shepherds and other non-elites (who could not afford the elite's warhorse) to become warriors. The historian Arrian puts this process into plain language, recounting a speech of Alexander the Great (Philip's son):

> "Philip took you over when you were helpless vagabonds, mostly clothed in skins, feeding a few animals on the mountains and engaged in their defence in unsuccessful fighting with [tribes in the north]. He gave you cloaks to wear instead of skins, he brought you down from the mountains to the plains; he made you a match in battle for the barbarians on your borders, so that you no longer trusted for your safety to the strength of your positions so much as to your natural courage. He made you city dwellers and established the order that comes from good laws and customs." (Arrian, *Anabasis* 7.9.2 ff.)

Here, Arrian captures the process by which Philip folded a large, previously peripheral population into the Macedonian state. For the next two centuries, the phalanx infantry would be central to the Macedonian army, alongside its aristocratic cavalry and other supporting units. As such, its elevation directly impinged on the prerogatives of other groups—a dynamic that often hinders social reform in other states, as we saw at Sparta. This was not merely a matter of informal involvement, since the new soldiers were enfranchised as *Makedones*—full citizens of the Macedonian kingdom—which brought with it the right to participate in citizen assemblies.[22] A willingness to tolerate such newcomers was central to upgrading Macedonian state capacity.

Ancient sources imply that Philip observed and learned from the most advanced Greek infantry techniques in Thebes, while he was a hostage (Plutarch, *Life of Pelopidas* 26.4–5). This is surely mythologized, but probably contains a kernel of truth. Philip was a keen observer of what worked best among the Greeks, implementing tweaks that, ultimately, proved revolutionary. Take, for example, the Macedonian phalanx. In the Greek phalanx, hoplites were heavily armored with shields, medium-length spears (c. 8 feet long), and short machetes. They fought in long lines—usually 8 ranks deep, but sometimes as much as 20—using their bulk to overpower opposing armies. Hoplites relied on cohesion and discipline to defeat looser, more lightly-armed opponents. The Macedonian variant did several things differently. It too relied on long, deep lines of infantry. But Philip lengthened the spear (*sarissa*) to almost 20 feet and lightened soldiers' armor. A spear so long required two hands, and so—as opposed to the heavy hoplite

[22] How influential such gatherings were remains uncertain. Certainly, the king remained in charge. For soldiers' enfranchisement and discussion of citizenship in Macedon, see: Hammond 1994, 25–26; Hatzopoulous 2011, 72–73. The formal status of such "citizenship" is not above question, and Fox sees Hammond's assertion as overreach. See: Fox 2011, 360. For our purposes, whatever its constitutional character, entry into the charmed circle of Macedon's warrior elite is the key. Ober (2015) notes the instrumental nature of inclusion in Macedon, produced by the alignment between Philips' state building goals and the Macedonians' desire to live better lives.

shield—Macedonians carried only a small shield slung over the shoulder. The resulting formation was like a bristling hedgehog whose quills were simply too long for a predator to get past. Because they were vulnerable to missiles, the Macedonian phalanx relied on tremendous discipline and a willingness to hold together in spite of losses. This, in turn, required professional drilling and significant experience to withstand battle. Such an army required an enormous pool of disposable manpower, something that Macedon had, and that Greek poleis—with their strictly policed citizen bodies, from which they drew their heavy infantry—did not.

Philip's reform efforts were not limited to the army, however. A professional army requires money as well as manpower. Philip therefore had to figure out how to make revenue collection more effective. We have only a very small window onto his reform program, but what we see is significant. In addition to cultivating resources judiciously, Philip was keen to bring in experts from the Greek world. For example, he hired an Athenian named Callistratus to advise on better tax collection practices. Of these, we have one extant example (Aristotle *Economics*, 1350a 16-22). In the harbor city of Methone, Callistratus advised lowering the up-front cost of bidding on the right to collect the harbor tax of Methone (a Greek city on the southern coast of Macedon). From a talent of silver (roughly 6,000 silver drachmas), he dropped the cost to 2,000.[23] This had the effect of almost immediately doubling harbor revenues, since bidders from a wider circle, requiring less ready cash, were able to participate in the auction for tax-collecting privileges. We must understand this as part of a general program to disrupt entrenched elites, who kept bidding artificially low—a scheme that only worked if ambitious, but poorer, individuals were kept out of the bidding process (Ober 2015, 284-85).

In his reform efforts, Philip could boast a number of other advantages that were crucial to state innovation and learning. First, he had the material resources to carry out his projects. As he racked up victories, Philip's growing resource base allowed him to broaden and intensify reforms further. Thus, while the Macedonian crown was never poor, the capture of resource centers like the Pangaion gold mines, as well as continued implementation of fiscal and tax reforms, helped to fund a professional army, effective cavalry, and active siege engineering cluster.

Second, Philip was able to build significant research capacity in several fields. One was catapult research, which he institutionalized at the Macedonian capital, Pella, in a workshop headed by Polyides and his students. This was the clearest example of Macedon's capacity to seek out innovation, hire the right experts, and then internalize that knowledge into the state apparatus. Philip saw what was happening in the world of ballistics and hired experts to help solve a deficiency in his army. His efforts were more substantial than this, however. By the 340s, there was a significant, self-reproducing workshop of Macedonian engineers within the Macedonian

[23] A drachma of silver weighed c. 4.3 g., and was worth approximately a day's labor for an unskilled workman in the 5th century BCE. A talent could therefore employ a man for more than 15 years.

state (Marsden 1977). That this work would result in the torsion catapult cannot have been known in advance, but was an invaluable reward for the risk and material that had been spent.

Macedon was blessed, moreover, with a tolerance for disruption far beyond that of either Athens or Sparta. This had as much to do with its previous low level of state capacity as it did with its disastrous defeat leading up to the accession of Philip in 359 BCE. This left the new king—who wielded considerable ideological power—with the scope to implement far-reaching reforms. Far from ruling with despotic ambitions, Macedon's royal government consisted of a fairly thin layer of court, bureaucracy, and elites who administered several crucial institutions, most notably the army, royal treasury, resource monopolies, and research workshops. Other functions were left to local authorities. Enacting reform at the level of the Macedonian state, then, was simpler than at Athens or Sparta, where civic and social commitments were far thicker and less easily changed.[24]

7. Conclusion

How do states develop the capacity critical for development? In this paper, we contribute to the literature on state capacity by highlighting the critical role of learning. In particular, we suggest that key drivers of capacity-qua-learning are the ability to generate new or improved knowledge , the availability of resources, and their tolerance for disruption. These drivers encompass the substance of state learning, the conditions that facilitate its accretion, and the determinants of its institutionalization. More explicitly, research or epistemic capacity is the *substance* of state learning, and includes the people who develop expertise, as well as their epistemic networks. Resources *facilitate* the accretion of knowledge and expertise. Finally, tolerance for disruption *enables* their institutionalization and therefore their sustainability over time.

We explored these learning processes in ancient Greece—namely, in Macedon, Athens and Sparta—an ecology that enables us to keep a number of structural factors explored in the literature on state capacity constant (for example, characteristics of the natural environment or the pressure of war). We followed the Greek states as they grappled with the development of the 4th century BCE's equivalent of AI—a paradigm-shifting technological development—the torsion catapult. The example of the catapult allowed us to explore learning processes along two relevant axes: the interplay between innovation and learning and between social and technological components of learning. We find that Athens was very good at some kinds of institutional innovation, but not so much technological breakthroughs; Sparta was great at

[24] It remains an open question whether Macedon is an apt autocratic model. In particular, Macedon's success seems to be a combination of a system of government with few veto points and the lucky accident of a catastrophe that disrupts the capacity of incumbents (the "feudal aristocracy", horse-guards etc.) to veto major innovation in form of a combined social (foot companions) and technological (sarissa, catapult) revolution. As the literature on authoritarian states suggests, however, that more often autocracies are marred by the role that incumbent elites play in vetoing "opening of access" (North, Wallis and Weingast 2009, BDM 2003) of the kind we see in Macedon (i.e. enrolling shepherds into the infantry).

learning-as-expert-routine, but only within a very narrow domain; finally, Macedon was good both at technological and social innovation, as well as at emulating successful innovations (via hired experts) and stimulating new development (via research investments).

Our findings contribute to a number of literatures. First, we contribute to the literature on state capacity by highlighting the importance of learning processes alongside other factors, like war, geography or institutional structures. Second, we challenge some claims in the literature: most notably, the role of political inclusion and the notion that state capacity is maximized when the powers of state and society are evenly matched. We show that inclusion does not need to be particularly broad to effectively contribute to state development. Moreover, inclusion may enable states to increase their tolerance for disruption, but does not necessarily lead to gains in fundamental rights among the broader populace. Finally, Greece provides an exception to the argument that state capacity is maximized when the powers of state and society are evenly matched. Macedon's success over Athens, Sparta and other Greek states was due, at least in part, to its superior performance as a learning organization. As Macedonian state capacity increased, however, it does not appear to have been matched by a concomitant increase in the power of Macedonian society. Through the creation of the new army, some previously disenfranchised people acquired a position of influence within the state and many more improved their condition thanks to the proceeds of war and conquest. However, Macedon shows that massive gains in state capacity can be obtained with only very limited forms of inclusion.

Our account also adds to the existing literature in ancient history by fleshing out three mechanisms of state learning and by suggesting that regime type is less relevant than the combination of social, institutional, and technological variables. Moreover, we contribute to the literature on organizational behavior and state capacity by combining their insights into a new epistemic theory of state capacity. Finally, our account suggests a broader theoretical point: as we reckon with the importance of state-driven innovation (see, e.g., O'Mara 2019; Mazzuccato 2013), democracy and other citizen-centered states—with citizens-as-incumbents and rule-makers, and multiple veto points on potentially risky decisions—might be less able to embark on some kinds of high-risk/high payoff research/learning projects. They are thus vulnerable to autocracies that are more willing to take the relevant risks. The historian Yuval Noah Harari (2018) has recently made a similar argument about the development of AI as favoring tyrants by enabling them to "process enormous amounts of information centrally." Our story offers an additional window into these dynamics, but no easy fix.

Bibliography

Acemoglu, D., & Robinson, J. A. (2019). *The narrow corridor: States, societies, and the fate of liberty*. New York: Penguin Press.

Acemoglu, D., and J. Robinson. 2012. *Why Nations Fail.* New York: Crown Publishers.

Acemoglu, D., and J. Robinson. 2016. "Paths to Inclusive Political Institutions." In *Economic History of Warfare and State Formation*, edited by Jari Eloranta, Eric Golson, Andrei Markevich, and Nikolaus Wolf. Springer.

Acemoglu, D., C. García-Jimeno, and J. A. Robinson, 2015. State Capacity and Economic Development: A Network Approach, *American Economic Review 2015, 105(8): 2364–2409 http://dx.doi.org/10.1257/aer.20140044*

Acemoglu, D., T. Verdier, and J. A. Robinson, 2004. **Kleptocracy and Divide-and-Rule: A Model of Personal Rule**, *Journal of the European Economic Association*, Volume 2, Issue 2-3, 1 May 2004, Pages 162–192, https://doi.org/10.1162/154247604323067916

Acemoglu, D., Ticchi, D. and Vindigni, A. (2011), Emergence and Persistence of Inefficient States. Journal of the European Economic Association, 9: 177-208. doi:10.1111/j.1542-4774.2010.01008.x

Alexopoulos, Golfo. 2016. "Medical Research in Stalin's Gulag." Bulletin of Medical History 90 (3): 363–3932.

Allen, D. H. Farrell and C. Shalizi. 2019. Evolutionary Theory and Endogenous Institutional Change. Available at http://henryfarrell.net/wp/wp-content/uploads/2019/09/evol-inst-draft-missing-appendix.pdf. [See also Farrell H. and C. Shalizi 2011. Evolutionary Theory and the Dynamics of Institutional Change. Available at https://pdfs.semanticscholar.org/89ab/c4f91372a04ebe2c7e5840874af6a88ede00.pdf.]

Andersen, D., J. Møller, L. Lykke Rørbæk & S. Skaaning (2014) State capacity and political regime stability, Democratization, 21:7, 1305-1325, DOI: 10.1080/13510347.2014.960204

Argote, Linda. 2005. *Organizational learning: creating, retaining and transferring knowledge*. New York: Springer.

Besley, T. and Persson, T. 2009. The origins of state capacity: property rights, taxation, and politics. Am. Econ. Rev. 99 (4), 1218–1244.

Besley, T. and Persson, T. 2011. Pillars of Prosperity. Princeton University Press, Princeton, New Jersey.

Braudel, Fernand. 1972. The Mediterrranean and the Mediterranean World in the Age of Philip II. Translated by Sian Reynolds. 2 vols. New York: Harper & Row.

Bresson, A. 2016. *The Making of the Ancient Greek Economy: Institutions, Markets, and Growth in the City-States*. Princeton: Princeton University Press.

Bueno de Mesquita, Bruce. 2003. *The logic of political survival*. Cambridge, Mass. : MIT Press

Callander, Steven and Bard Harstad. 2015. Experimentation in Federal Systems. The Quarterly Journal of Economics (2015), 951–1002.

Canevaro Mirko. 2019. 'Athenian constitutionalism: nomothesia and the graphe nomon me epitedeion theinai', in Symposion 2017: Vortrage Zur Griechischen Und Hellenistischen Rechtsgeschichte (Tel Aviv, 20.-23. August 2017), eds. Thür, G. & Yiftach-Firanko, U. Vienna.

Canevaro, M. (forthcoming) Democratic deliberation in the Athenian Assembly: Procedures and behaviours towards legitimacy. *Annales. Histoire, Sciences Sociales.*

Carugati, F., R. Calvert and B.R.Weingast. 2020. Judicial Review by the People Themselves: Democracy and the Rule of Law in Ancient Athens. Working Paper.

Carugati, F. 2019. Creating a Constitution. Princeton: Princeton University Press.

Cuomo, Serafina. 2007. Technology and Culture in Greek and Roman Antiquity. New York: Cambridge University Press.

Davies, John K. 1978. *Democracy and Classical Greece*. Brighton: Humanities Press.

Davies, J.K. 1995. "The Fourth Century Crisis: What Crisis?" In Die Athenische Demokratie Im 4. Jahrhundert v. Chr.: Vollendung Oder Verfall Einer Verfassungsform?: Akten Eines Symposims 3.-7. August 1992, Bellagio, edited by W. Eder and C. Auffarth. Stuttgart: F. Steiner.

Davies, J.K. 2004. "Athenian Fiscal Expertise and Its Influence." Mediterraneo Antico 7 (2): 491–512.

Dincecco M. and G. Katz. 2012 State Capacity and Long-Run Economic Performance The Economic Journal, Volume 126, Issue 590, February 2016, Pages 189–218.

Farrell, Henry John and Schneier, Bruce, 2018. Common-Knowledge Attacks on Democracy. Berkman Klein Center Research Publication No. 2018-7. Available at SSRN: https://ssrn.com/abstract=3273111 or http://dx.doi.org/10.2139/ssrn.3273111.

Fox, Robin J. Lane. 2011. "Philip of Macedon: Accession, Ambitions, and Self-Presentation." In Brill's Companion to Ancient Macedon, edited by Robin J. Lane Fox, 335–366. Leiden: Brill.

Fukuyama, F. 2011. *The Origins of Political Order*. New York: Farrar, Strauss, and Giroux.

Fukuyama, F. 2014. *Political Order and Political Decay: From the Industrial Revolution to the*

Goodin, Robert E. and Kai Spiekermann. 2018. *An epistemic theory of democracy*. Oxford: Oxford University Press.

Grzymala-Busse, A. 2020. Beyond War and Contracts: The Medieval and Religious Roots of the European State, Annual Review of Political Science 2020 23:1, 19-36

Hammond, N.G.L. 1994. Philip of Macedon. Baltimore: The Johns Hopkins University Press.

Hansen, M. H. 2002. "Was the Polis a State or a Stateless Society?" In *Even More Studies in the Ancient Greek Polis*, edited by Thomas H. Nielsen. Acts of the Copenhagen Polis Centre [CPC] 6, 17–47.

Hansen, M. H. 2006. *The Shotgun Method: The Demography of the Ancient Greek City-State Culture*. Columbia: University of Missouri Press.

Hansen, M. H. 2008. "An Update on the Shotgun Method." *Greek, Roman, and Byzantine Studies* 48, 259–86.

Hansen, M. Herman, and T. Heine Nielsen. 2004. *An Inventory of Archaic and Classical Poleis.* Oxford: Oxford University Press.

Hanson and Sigman 2019; https://qog.pol.gu.se/digitalAssets/1733/1733772_hansonsigman_lld_20190605.pdf

Harari, Y.N. 2018. Why Technology Favors Tyranny. The Atlantic. https://www.theatlantic.com/magazine/archive/2018/10/yuval-noah-harari-technology-tyranny/568330/

Hatzopoulos, M.B. 2011. "Macedonians and Others Greeks." In Brill's Companion to Ancient Macedon, edited by Robin J. Lane Fox, 51–78. Leiden: Brill.

Hendrix, C. S. 2010. Measuring state capacity: Theoretical and empirical implications for the study of civil conflict. *Journal of Peace Research*, *47*(3), 273–285. https://doi.org/10.1177/0022343310361838

Herbst, J. 2000. *States and Power in Africa: Comparative Lessons in Authority and Control*, Princeton University Press.

Hill, Alexander. 2017. The Red Army and the Second World War. Cambridge: Cambridge University Press.

Hintze, O. 1975. The historical essays of Otto Hintze, edited with an introd. by Felix Gilbert, with the assistance of Robert M. Berdahl, New York: Oxford University Press.

Hirsch, Alexander V. and Kenneth W. Shotts. 2013. "Competitive policy entrepreneurship." *SU GSB Research Paper Series.* 2137.

Huntington, S. P. 1968. *Political Order in Changing Societies.* New Haven: Yale University Press.

Ismard, P. 2010. *La cité des réseaux. Athènes et ses associations, vie-ier siècle av. J.-C.* Paris: Publications de la Sorbonne.

Jenna Bednar (in progress). Federalism as a Mechanism of Collective Problem Solving: How States Improve National Policymaking.

Johnson, N.D. and M. Koyama, 2017. States and economic growth: Capacity and constraints, Explorations in Economic History, Volume 64, Pages 1-20.

Knutsen, C.H. 2013. Democracy, State Capacity, and Economic Growth, World Development, Volume 43, Pages 1-18.

Landemore, Hèléne and Jon Elster, ed. 2012. *Collective Wisdom: Principles and Mechanisms*. Cambridge: Cambridge University Press.

Levitt, Barbara, and James G. March. 1988. "Organizational Learning." Annual Review of Sociology 14: 319–340.

Luraghi, Nino. 2008. The Ancient Messenians: Constructions of Ethnicity and Memory. Cambridge: Cambridge University Press.

Mann, M. 1984. The autonomous power of the state : its origins, mechanisms and results. European Journal of Sociology / Archives Européennes de Sociologie / Europäisches Archiv für Soziologie, Vol. 25, No. 2, Tending the roots : nationalism and populism (1984), pp. 185-213.

Mazzuccato, M. 2013. The Entrepreneurial State. London : Anthem Press.

Marsden, E.W. 1969. Greek and Roman Artillery: Historical Development. Clarendon Press.

Milanovic, Lindert and Williamson 2011

Mokyr, J. 2002. The Gifts of Athena: Historical Origins of the Knowledge Economy. Princeton, N.J.: Princeton University Press.

Morris, I. 2009. *The Greater Athenian State*. In Morris and Scheidel, *The Dynamics of Ancient Empires.* Oxford, 99–177.

Morrison, J.S. 1984. "Hyperesia in Naval Contexts in the Fifth and Fourth Centuries BC." The Journal of Hellenic Studies 104: 48–59.

Morton, J. 2001. *The Role of the Physical Environment in Ancient Greek Seafaring*. Leiden, Netherlands; Boston: Brill.

Nelson and Winter 1982;

North, D. 2005. Understanding the Process of Economic Change. Princeton University Press.

North, D., B. Wallis, and J. Weingast. 2009. *Violence and Social Orders*. Cambridge: Cambridge University Press.

Ober, J. 1987. "Early Artillery Towers: Messenia, Boiotia, Attica, Megarid." American Journal of Archaeology, 569–604.

Ober, J. 2008. *Democracy and Knowledge.* Princeton: Princeton University Press.

Ober, J. 2015 . *The Rise and Fall of Classical Greece*. Princeton: Princeton University Press.

O'Mara, Margaret Pugh. 2019. *The code: Silicon Valley and the remaking of America*. New York : Penguin Press.

Page, Scott E. 2007. *The difference: how the power of diversity creates better groups, firms, schools, and societies*.

Reiter, Dan, and Allan C. Stam. 2002. *Democracies at war*. Princeton, N.J.: Princeton University Press.

Robinson, E. W. 2011. *Democracy beyond Athens: Popular Government in Greek Classical Age.* Cambridge: Cambridge University Press.

Rossi, Cesare, Serge Savino, Arcangelo Messina, and Giulio Reina. 2015. "Performance of Greek-Roman Artillery." Arms & Armour 12 (1): 67–89.

Runciman, W.G. 1990. Doomed to Extinction: The Polis as an Evolutionary Dead-End. In Murray and Price, *The Greek City from Homer to Alexander*. Oxford Clarendon Press.

Scheidel 2013,

Scheidel, Walter. 2019. Escape from Rome: The Failure of Empire and the Road to Prosperity. Princeton, N.J.: Princeton University Press.

Saddiqi, Asif. 2015. "Scientists and Specialists in the Gulag: Life and Death in Stalin's Shrashka." Kritika: Explorations in Russian and Eurasian History 16 (3): 557–588.

Simonton, M. S. 2017. *Classical Greek Oligarchy: A Political History*. Princeton: Princeton University Press.

Skocpol, Theda. 1985. "Bringing the State Back In: Strategies of Analysis in Current Research." In Evans et al. (1985), chap. 1, pp. 3–37.

Spruyt, H. 2017. War and state formation: Amending the bellicist theory of state making. In *Does War make States?: Investigations of Charles Tilly's Historical Sociology* (pp. 73-97). Cambridge University Press. https://doi.org/10.1017/9781316493694.004

Steinberg, J., C. Loyle, and F. Carugati (in progress). State Capacity and Digital Repression.

Taylor, C., and Vlassopoulos, K., eds. 2015. *Communities and Networks in the Ancient Greek World*. Oxford University Press.

Tilly, C. 1990. *Coercion, Capital and European States*. Blackwell.

van Liefferinge, K., et al. 2014. "Reconsidering the Role of Thorikos within the Laurion Silver Mining Area (Attica, Greece) through Hydrological Analyses." *Journal of Archaeological Science* 41.

van Wees 2009

Vlassopoulos, K. 2007. "Beyond and Below the Polis." *Mediterranean Historical Review* 22(1).

Weick, Karl E. 1995. Sensemaking in Organizations. Foundations for Organizational Sciences. Thousand Oaks: SAGE Publications.

Zaccagnini, C. 1983. "Patterns of Mobility Among Ancient Near Eastern Craftsmen." Journal of Near Eastern Studies, 245–264.