Can Marshall plus Malthus explain the evolution of ancient societies? A review of *Economic Prehistory* by Dow and Reed

Samuel Bowles and Amy Bogaard
23 April 2023

Abstract. In a work of extraordinary scope and scholarship Dow and Reed deploy conventional microeconomic theory to explain "six transitions that shaped the world", namely, the transitions to sedentism, farming, inequality, war, cities, and states. The models they offer provide a level of clarity about potential causal mechanisms that is unusual in the archaeological literature. But we are not convinced by some of their key empirical claims in light of current archaeological evidence, and we think that contemporary economics—including evolutionary game theory—has more appropriate models to offer than the Marshallian approach taken by the authors.

Affiliations: Bogaard, Institute of Archaeology, University of Oxford, and Santa Fe Institute; Bowles, Behavioral Sciences Program, Santa Fe Institute and CORE Econ. Thanks to the Behavioral Sciences Program of the Santa Fe Institute and Caroline Seigel of the Santa Fe Institute Library for support of this work.

1. Introduction.

Gregory Dow and Clyde Reed write that the six transitions referred to in their subtitle to *Economic Prehistory* – sedentism, farming, inequality, war, cities, and states – were all in play by 5000 years ago: that is, before the beginning of human 'history' as conventionally defined (Dow and Reed 2023). These six features of our current brief historical epoch, they maintain, were rare or absent prior to the warming episode near the end of the Last Glacial Period around 15,000 years ago. But they had all become ascendant features of human society by the time written histories began.

Given that "global revolutions are best explained by global causes," they reason, "the prime mover for the revolutionary social transformations of 15,000 to 5,000 BP was climate change" (486). They thus have placed themselves at the center of an established debate framed by the rhetorical question put by Richerson, Boyd and Bettinger: "Was agriculture impossible during the Pleistocene [before 11,700 years ago] but mandatory during the Holocene [the current geological epoch, since the end of the Pleistocene]?" (Richerson, Boyd and Bettinger 2001).

Dow and Reed ask what it was about climate that prompted hunter-gatherers to take up farming. Was it warming and greater stability of climate from the beginning of the Holocene (as Richerson and his co-authors propose), or instead the preceding colder and drier millennium (termed the Younger Dryas) at the end of the Last Glacial Period, as initially proposed by Ofer Bar-Yosef and other archaeologists?[1] Dow and Reed favor the climate adversity explanation, at least for the well-studied case of south-west Asia.

Here is their account in a nutshell: "the recovery from the Last Glacial Maximum, followed by the abrupt shock of the Younger Dryas and the arrival of the Holocene, were the triggers for sedentary lifestyles among foragers and later for village agriculture. Domestication of plants and animals set off a process of technological innovation … [and] rising agricultural productivities resulted in rising population densities ... population growth led to class stratification between elites and commoners at particularly attractive sites, and that stratification laid the foundations

[1] Exemplary are Bar-Yosef (1998), Munro (2004), but see also Bar Yosef (2014)

for chronic warfare over land among rival elites. … [T]hese processes ultimately led to cities and states"(486).

The scope and ambition of their work recalls Jared Diamond's *Guns, Germs and Steel* and *The Dawn of Everything* by David Graeber and David Wengrow (Diamond 1997, Graeber and Wengrow 2021).[2] But Dow and Reed differ from these works in that they propose precise causal mechanisms based on economic models. While the applications of their workhorse models to prehistory are for the most part novel, the models themselves will be familiar to economists: Malthusian population dynamics, the dual economy model of Arthur Lewis, and conventional Marshallian marginal analysis of the type used by Douglass North and Robert Thomas and Vernon Smith in their 1970s accounts of what the former called the "first economic revolution" (Lewis 1954, North and Thomas 1977, Smith 1975).

Drawing on their previous more technical papers – they are, respectively, an applied microeconomist/theorist and an economic historian – Dow and Reed provide a stimulating account of how their major revolutions in human society were over before history began (Dow, Mitchell and Reed 2017, Dow and Reed 2011, Dow, Olewiler and Reed 2009, Dow and Reed 2013, 2015)). Unlike many "have model, will travel" forays by economists into new fields, Dow and Reed have taken the time over the past decade and a half to read widely in the related archaeological and climate literature. Their review of the now-substantial work on prehistory by economists will also be welcomed by archaeologists. Through the application of mathematical models to archaeological data, they hope that the reader "has been persuaded that economics can be a fruitful source of research ideas about prehistory" "even if the reader is skeptical about … our hypotheses". (487)

We count ourselves among the persuaded about the value of economics while being skeptical about some of their empirical claims. We are not convinced by their dating of initial cultivation in south-west Asia to a period of climate adversity, nor by their assessment that warfare emerged well into the Holocene from an earlier (for the most part) peaceful prehistory. We would replace their putative peace-to-war transition with the transition from a common property regime to one in which private property eventually covered most inputs to people's livelihoods other than labor

[2] On the latter see Bowles (2023).

itself, that appears to have occurred during the same ten millennia that witnessed their other transitions. Finally, their model of what are termed the first Mesopotamian states appears to be inconsistent with what is now known about the structure of political power during this period.

In the next sections we present their narrative of the six transitions, pointing out the distinctive character of each of their accounts with respect to the literature. We feature the insights made possible by the models they provide, focusing on their case that it was climate adversity, not amelioration, that explains the advent of farming, and their reasoning that warfare would have been absent or rare among egalitarian hunter-gatherers or early farmers. We also explain our skepticism about aspects of their empirical account.

We then ask: are the models they use appropriate for explaining these transitions? As economists, have they put their best foot forward to persuade archaeologists and others that economics has important insights to offer about prehistory? (Though Dow and Reed treat other cases, we focus for the most part on the prehistory of south-west Asia, so as to exploit the richness of its archaeological record.)

2. Sedentism and farming: A model of adverse climate as the stimulus for farming.

In light of the substantial evidence that Dow and Reed cite to the effect that "early farmers were worse off than their foraging ancestors…" they pose a good question, which is why would people "voluntarily adopt a technology that made them worse off?" [3](195) Their resolution of the puzzle is that colder and dryer climate (of the Younger Dryas) triggered the emergence of farming and "people will become worse off when climate becomes worse." (195)

This is not a satisfactory answer because it seems likely that the oft-cited shorter stature and poorer health of the first farmers was neither universal (Larsen, Hillson, Boz et al. 2015) nor entirely due to the putative coincidence of early farming and adverse climate. It could also be a consequence of the lower average productivity (calories per hour of labor) in farming relative to

[3] Annual cultivation of the land and crop is the defining characteristic of farming, not domestication of the plant species, which typically occurred only after a considerable period of cultivation (see below). Early evidence on the inferior stature and health status of early farmers has been affirmed in more recent surveys. Cohen and Armelagos (1984), Mummert, Esche, Robinson, et al. (2011).

hunting and gathering. Because this finding is both surprising and critical for what follows, we will consider the evidence with some care.

A comparison of 5 hunter-gatherer and 15 horticultural (farmers lacking ploughs and draft animals) populations in the 20th century (and earlier) historical and ethnographic record found that as measured by calories per hour (including processing as well as acquiring food) the hunter-gatherers were on average 60 percent more productive (Bowles 2011). Taking account of the delayed return nature of agricultural production and the greater risk due to reliance on a more restricted set of species further widens the estimated productivity deficit of farming.

The transition from hunting and gathering to farming in south-west Asia included cultivation of previously harvested wild grasses, on which there are further data. An early study based on limited data is consistent with somewhat lesser productivity of cultivating wild grasses (Bowles 2011, Harlan 1967). Recent estimates of the caloric returns per hour of labor to harvesting as opposed to cultivating wild grasses under conditions similar to the early Holocene in the Fertile Crescent suggest a substantial productivity shortfall for cultivation similar in magnitude to that reported above.[4]

Dow and Reed resolve the puzzle they have raised, providing an ingenious mechanism by which farming might have been taken up even if it were to have been less productive. They model the advent of this new technology by combining two ideas. The first, originating with the archaeologist Raphael Pumpelly over a century ago, is that adverse climate concentrated plants and animals (including humans) at a few "oases" of favorable habitat, which could have prompted cultivation (Pumpelly 1908).

The second idea (originating with Smith and North and Thomas in the 1970s) provides a mechanism by which Pumpelly's conjecture might have worked. This is based on the supposition that foraging populations *collectively* allocated their labor so as to maximize the total output of the *group* (an assumption to which we will return). Assuming this to be the case, then, Dow and Reed explain that as the population grew "eventually the marginal product of gathering declines to a point where it is below the marginal and average product of the first worker who could

[4] Using the data compiled by Russell, Robert Allen's estimates of the hourly caloric returns to harvesting uncultivated wild grasses (1088) and cultivated wild grasses (677) imply that the uncultivated rate is 60 percent greater than the cultivated. Allen (2022), Russell (1988).

potentially be employed in cultivation" (159-160). At that point the average product of labor in hunting or gathering (what they term gathering) would exceed the marginal product, and so would also exceed the marginal (and average) product of the first farmer. So, taking up farming would not be inconsistent with the calories per hour data just cited (which, of course, are average, not marginal productivities).

While population would not necessarily grow at a regional level under the adverse climate of the Younger Dryas (there is regional variation – Roberts et al. 2018), Dow and Reed offer the explanation that the Younger Dryas made some sites of sedentary hunter-gatherer populations uninhabitable, prompting migration to the remaining superior sites: "[t]he resulting spike in local populations at these sites drove down the marginal product of labor in foraging and triggered reallocation of some labor toward cultivation. ... There is strong evidence for this explanation in the case of southwest Asia, and similar processes could have been at work for other cases of pristine agriculture (for example, China and sub-Saharan Africa)." (35-36)

As presented so far, the Dow-Reed explanation of the advent of farming is incomplete, because, if true, it would also predict that the first farmers would return to hunting and gathering when the population spikes at the limited number of good sites dissipated. This would have occurred when climate ameliorated at the onset of the Holocene, allowing some of the concentrated populations of the good sites to migrate back to the sites that had become temporarily uninhabitable during the Younger Dryas.

To explain why the first farmers would have persisted with cultivation despite the restoration of a higher marginal productivity of hunting and gathering, Dow and Reed posit that "learning by doing" and presumed productivity improvements associated with domestication occurred in farming in the few centuries between the advent of farming and the Holocene climate amelioration. They believe that this could have been sufficient to make cultivation and animal raising an attractive option even under the higher marginal productivity of foraging after the dispersal of populations after the end of the population spike.

If this occurred, it completes the Dow-Reed interpretation. But their scenario would require very rapid learning by doing and productivity increases immediately following initial cultivation.

More important, there is reason to doubt the postulated productivity increases in farming would have been sufficient given that the calories per hour of labor data cited above pertain to farming in recent centuries (with many millennia of learning by doing already having occurred). A more empirically grounded explanation for the persistence of farming under Holocene conditions is that the reduced climate volatility favored farming relative to hunting and gathering (Richerson, Boyd and Bettinger 2001). But Dow and Reed curiously do not take this course, instead positing that climate amelioration was technology-neutral rather than farming-friendly.

In their account of the advent of farming, Dow and Reed provide a valuable empirical critique of an alternative view of the role of collective action in the origin of farming offered by Daron Acemoglu and James Robinson. This is the following:

> In order for sedentary life to emerge, it … seems plausible that hunter gatherers would have had to be forced to settle down and this would have to have been preceded by an institutional innovation concentrating power in the hands of a group that would become the political elite, enforce property rights, maintain order and also benefit from their status by extracting resources from the rest of society. … The emergence of political elites most likely created the transition first to sedentary life and then to farming. (Acemoglu and Robinson 2012):p.139-140

The archaeology of the late Pleistocene-early Holocene in south-west Asia provides support for collective action and decision-making, consistent with the assumption by Dow and Reed (and Smith and North and Thomas) that populations made joint decisions about the allocation of their labor. By the early Holocene the evidence for collective action culminates in a series of 'communal' buildings of different forms across the region. Large-scale collective action is reflected in communal processing and storage prior to full blown farming (Willcox and Stordeur 2012) and building projects ranging from the tower at Jericho to the monumental enclosures at Göbekli Tepe (Celik 2015, Dietrich, Heun, Notroff et al. 2012, Kuijt and Goring-Morris 2002).

But Dow and Reed point out that there is no contemporary evidence that when farming first was practiced political elites had anything like the extractive powers entailed by the Acemoglu and Robinson account. The lag between the first farming and the first states, averaged across the regions where both occurred and using the archaeologist Bruce Trigger's dating of the first

states, is 4.8 millennia (Bowles and Choi 2019 , Trigger 2003).[5] Even for a broader category of political elites including what Borcan and his coauthors term "chiefdoms" (exercising leadership but lacking a monopoly on coercive powers), the lag between the first farmers and the emergence of a political elite is 3.1 millennia (Borcan, Olsson and Putterman 2021).

The Dow-Reed interpretation of the advent of farming shares with the Richerson, Boyd, and Bettinger view a key role of climate amelioration. But for Richerson et al, it is not the harsh Younger Dryas, but instead the warmer, wetter, and less volatile farming-favorable climate after 11,700 years ago that provided conditions favorable for people to take up producing food rather than hunting or gathering it. To Dow and Reed, climate amelioration contributed to the advent of farming only indirectly, by promoting sedentism during the warming Bølling-Allerød period from 14,700 to 12,700 years before the present, that is, before the Younger Dryas. The difference between Dow and Reed and Richerson et al is thus an empirical question – when did hunter gatherers first take up farming in a sustained way? This is a question on which there are some new data, to which we now turn.

3. Dating the agricultural revolution.

Because dating the first farmers is critical to evaluating the contribution by Dow and Reed, we will consider the evidence in some detail. As Dow and Reed point out, for any causal account of agricultural origins "it is essential to distinguish dates for initial cultivation from dates for full domestication" since there may be a significant time lag between the two. Archaeological views of the extent of this lag have changed in recent decades, as they also note, from as little as a few centuries (Hillman and Davies 1990) to a millennium or more (Tanno and Willcox 2006, Willcox, Fornite and Herveux 2008). Dow and Reed rightly view cultivation (not domestication *per se*) as the "critical puzzle to be solved" for advancing an explanation of agricultural origins. (158)

Dow and Reed provide some detail on how initial cultivation is diagnosed archaeobotanically. Cultivation is not "simply harvesting the plants supplied by nature" but rather involves practices such as "planting, weeding, and otherwise tending plants prior to harvest…" (158) They explain

[5] The earliest forms of political centralization in Mesopotamia – often termed states in the literature – such as Late Uruk about 5,500 years ago might better be termed archaic proto states (see Bowles and Fochesato (2023)

that archaeologists have identified the association of ancient weed flora with potential crops as the key archaeobotanical index of cultivation. This is the case because the occurrence of weeds reflects soil disturbance caused by preparation of soil for planting through tillage and subsequent weeding. But there are problems with their interpretation of these established methods to date the first farming.

Dow and Reed depend on a single archaeobotanical assemblage, from the site of Abu Hureyra in the Middle Euphrates valley of Syria, as representative of the wider region. And for this instance, they accept a contested case for cultivation during the cold and dry period of the Younger Dryas. This is the archaeobotanical evidence, including a weed flora presumed to be associated with cultivation, as interpreted by Hillman and is coauthors in their pioneering study of the site (Hillman, Hedges, Moore et al. 2001).

Subsequent reinterpretation of the data by Sue Colledge and James Connolly showed that the case for cultivation at Abu Hureyra was open to question (Colledge and Conolly 2010). They reinterpreted the potential arable weeds of cultivation as plant foods that were gathered as part of a widening human diet in response to the Younger Dryas. This alternative interpretation is particularly compelling in that some of the supposed weeds of cultivation actually decline in a subsequent phase of occupation at Abu Hureyra when agriculture is beyond doubt. Moreover, the Colledge-Connolly alternative interpretation of Abu Hureyra brings the assemblage into line with archaeobotanical data from the wider region of south-west Asia, which clearly points to intensified exploitation of wild cereals not during the Younger Dryas but later, in the early Holocene (Willcox et al., 2008).

A recent study (which Dow and Reed cite, and was co-written by one of the coauthors of this paper) points out a more fundamental flaw in the ‘weeds automatically signify cultivation’ approach cited by Dow and Reed. This arises because the potential weeds recognized until recently by archaeobotanists as evidence of cultivation are shown to also occur naturally in unmanaged stands of wild cereals (Weide, Hodgson, Leschner et al. 2021). A follow up study shows that it is necessary to distinguish between weeds that are particularly adapted to disturbance from those which are less well adapted, in order to distinguish gathering of wild

stands from annual tillage regimes (Weide, Green, Hodgson et al. 2022). Application of this revised method to archaeobotanical assemblages shows that, even in the early Holocene, annual tillage as part of a cultivation regime did not begin until *after* around 8500 BCE, during what archaeologists term the Pre-Pottery Neolithic B period (PPNB, *c.* 8500-6500 BCE). This is also when key morphological signs of domestication (loss of natural seed dispersal through ear shattering) begin to appear (Weide, Green, Hodgson, et al. 2022). The weed flora associated with intensified exploitation of wild cereals, as widely documented in south-west Asia during the preceding Pre-Pottery Neolithic A (mid 10th-mid 9th millennium BCE), instead resembles untilled, 'natural' wild cereal stands. Thus, *even if* cultivation had been practiced locally at Abu Hureyra or elsewhere during the Younger Dryas (for which there is no convincing evidence, as discussed above), the wider pattern in the PPNA was intensive gathering of untilled cereal stands rather than cultivation.

It is unfortunately the case that the Abu Hureyra archaeobotanical assemblage was not published in sufficient detail to enable the kind of re-analysis conducted by Weide et al at other sites (Weide, Green, Hodgson, et al. 2022). It is worth noting, however, that an archaeobotanical claim for cultivation at a much earlier site, Ohalo II, dating to the Late Glacial maximum, 23 thousand years before the present (Snir, Nadel, Groan-Yaroslavski et al. 2015), is overturned by Weide et al., since the weed flora there instead resembles that associated with untilled wild cereal stands. The same is the case for well-known PPNA sites of the early Holocene, such as Jerf al Ahmar (Weide, Green, Hodgson, et al. 2022, Willcox and Stordeur 2012).

Thus, the earliest cultivation – in the sense of annual tillage – emerges during the mid-later Pre-Pottery Neolithic (*c*. 8500-6500 BCE) over a millennium after the end of the Younger Dryas, and was widespread by the end of this period (Weide, Green, Hodgson, et al. 2022). In this timeframe annual cultivation coincides with dramatic societal changes including large, aggregated communities of up to 10 hectares or more ('megasites') featuring modular households with internal (and presumably private) storage (Weide, Green, Hodgson, et al. 2022).

This evidence on these megasites during the PPNB may be inconsistent with the resolution that Dow and Reed offer for the puzzle that hunter gatherers adopted cultivation even though it was

(on average) less productive. It appears that settlements with populations sufficiently large to depress the marginal productivity of hunting-gathering below the average product of farming did not emerge as a prior cause inducing the take up of cultivation but instead *along with and in part as the result of cultivation itself*.

The latest evidence for the timeframe in which cultivation began ((Weide, Green, Hodgson, et al. 2022)), sketched above, not only makes clear that Dow's and Reed's 'negative climate shock' of the Younger Dryas significantly *predates* agricultural origins, but also that the time lag between initial crop cultivation and morphological domestication needs to be recalculated. Crop domestication is primarily identified through the loss of natural seed dispersal. This occurs in the wild form through 'shattering' of the cereal ear (that is, grains fall from the plant as they ripen, from the top of the ear to the base). Archaeobotanically, the shattering habit leaves a characteristic smooth scar on the cereal rachis (the segmented 'stem' that holds the unripe ear together), while the non-shattering, domestic type ear leaves a rough scar. On current evidence, it appears that the shift from shattering to non-shattering ear began and developed during the PPNB, and that this incipient domestication thus coincided with the beginnings of annual cultivation (Weide, Green, Hodgson, et al. 2022), possibly accelerated by private storage, which could heighten selection pressures for domestication traits by sustaining genetic differentiation between the crops grown by different households (Weide 2021).

Ongoing work by Weide and colleagues will seek to establish a more precise timeframe for initial cultivation within the PPNB. But it is already clear that the 'origins of agriculture' in south-west Asia in the sense of annual cultivation (as well as eventual domestication) should be relocated to the Pre-Pottery Neolithic B, when a whole cascade of features come together including large settlements, standard household units, internal private storage, cultivation, and herding, leading eventually to morphological domestication. All of these features appear to have arisen more or less in tandem, though quite possibly in somewhat different ways in different regions of south-west Asia during the PPNB. A co-evolutionary scenario involving greater labour investment in plant and animal management alongside modular co-residential units with internal, apparently private storage is needed to account for this evidence (Bogaard, Charles, Twiss et al. 2009, Wright 2000). We return to this below, suggesting the co-evolutionary

dynamics of private property (initially in dwellings and storage, then animals, eventually in land) along with cultivation (Bowles and Choi 2013, 2019).

4. *Inequality and warfare*.

The second set of empirical claims advanced by Dow and Reed about which we are skeptical concerns warfare. Dow and Reed reason that during what they consider to be the egalitarian Late Pleistocene there was nothing for war to be about. The transition from a peaceful distant past to warfare occurred, they propose, when some people became sedentary and developed the capacity to exclude others, thereby sustaining high levels of consumption at good sites, providing a motive for territorial aggrandizement.

In their model, during the Late Pleistocene people could freely migrate to better sites, which along with Malthusian population growth, tended to equalize average consumption levels across sites in the long run. "The equalization of average products [across sites]… is the condition that ensures peace." "Groups at open sites … will not engage in warfare." (302)

They explain that sedentism and "the creation of group property rights over land," (269) whether among farmers or hunter gatherers, provided the initial basis for both inequality and warfare between groups. But "even when individual mobility among sites is restricted, long run Malthusian dynamics still tend to forestall warfare [because] better sites have larger populations and this deters attack." (354) They recognize that what they term "shocks from nature" could dominate these Malthusian war-deterring effects so as to create and sustain between group differences in consumption providing incentives for group conflict. But they regard these conditions as "narrow." (273)

According to Dow and Reed class inequality within a population provides the basis for more frequent warfare when an elite is able to monopolize ownership of the resource base and engage others as renters or wage workers. The consumption level of these "commoners" is given by their reservation option, which is the average productivity in the remaining open sites, the

"commons."[6] Subject to this constraint, the elite choose the level of outsiders to engage so as jointly to maximize their profits. The setup is similar to models that Dow has developed in which worker-owners of a cooperative collectively decide how many non-owner-members to employ for wages (Dow 2002).

From this model Dow and Reed derive a novel reason why warfare would be common among elite-dominated groups but not among egalitarian groups. For the members of an egalitarian group who evenly share their total output, the size of the territory they exploit will be subject to diminishing marginal returns, given the size of their group. Thus, the additional consumption made possible by incorporating the site from which a defeated group has been evicted is diminishing with the size of the group's resource base, limiting the incentive to acquire additional amounts of land. This is not the case for an elite that can increase the number of subordinated outsiders it engages as its resource base increases, so that profits scale proportionally with the size of the total resource base.

This completes the Dow Reed explanation of why war would be absent or rare prior to the Holocene, present among sedentary groups thereafter, and endemic following the emergence of class inequalities within groups. The models clearly illuminate the ways that Malthusian population dynamics coupled with open access among foragers (mobile hunter-gatherers) as well as the diminishing marginal value of additional land to a given population might result in war being rare or absent prior to the Holocene.

Dow and Reed recognize that the extent of warfare among hunter gatherer groups in the past is difficult to determine and remains a matter of debate ((Fry 2013, Leblanc 2020)). As the peace to war transition is one of their six occurring after 15kya, Dow and Reed have clearly concluded that warfare was not characteristic of earlier prehistory. But neither the model nor their interpretation of the available data is entirely convincing.

[6] This is recognizable to economists as the Arthur Lewis model of "economic development with unlimited supplies of labour" fruitfully applied to prehistory Lewis (1954)

First, sedentism is the key development in their transition from peace to war; but we know that some, perhaps many populations were sedentary well before 15 thousand years ago. Dow and Reed mention the Ohalo II settlement that we cited above. Other examples in south-west Asia include sites in the Azraq basin, a former wetland region of eastern Jordan (Maher, Richter, Macdonald et al. 2012).

Second, it difficult to think that groups were incapable of excluding outsiders prior to the advent of farming. Recall that according to Dow and Reed sedentary hunter-gatherer groups made a collective decision to take up cultivation (they allocated labor between hunting-gathering and farming, jointly maximizing the total output of the group). If they were able to coordinate to this extent when taking up farming, then it seems inconsistent to assume that those occupying a particularly good site would be unable to collaborate to exclude outsiders. In many cases, given the uncertainty of hunting and hence the need for a means of consumption smoothing which Dow and Reed assume, excluding outsiders could be accomplished by preventing them from the common sharing of the food supplies of the group (a far less challenging requirement than monitoring the perimeter of a site).

Third, warfare could have been common during the Late Pleistocene for other reasons. A study of lethal intergroup conflict among hunter horticulturalists in lowland South America found that material motives played a minor role: “Motives of killings … in order of importance, reportedly include revenge for previous killings and other wrong-doings like sorcery, jealousy over women, gain of captive women and children, fear or deterrence of impending attack, and occasionally the theft of material goods” (Walker and Bailey 2013).

Fourth, there is some evidence that warfare is associated with periodic resource scarcity and natural disasters, which would have been recurrent under the volatile climatic conditions of the Late Pleistocene (Allen, Bettinger, Codding et al. 2016, Ember and Ember 1992, Lambert 1997). As we noted above, Dow and Reed do recognize that climate shocks could sustain between group inequalities that might foster inter group warfare by overwhelming the Malthusian pressures that would otherwise lead groups to converge to the same level of average consumption. The between-group differences in resources induced by climate shocks are likely

to have been frequent and severe enough, and the Malthusian population growth dynamics slow enough, to motivate our conjecture that these "narrow" conditions might have been quite common, especially in light of what we now know about Late Pleistocene climate.

By comparison to the Holocene, climate variability during the Late Pleistocene was extraordinary (GRIP 2005). Between 40 and 15 thousand years ago, differences between the maximum and minimum average surface temperatures recorded within a moving 100 year window often exceeded 3^{o} C, averaging 2.15^{o} C (CI: 0.43, 3.88). The comparable average for the Holocene is 0.84^{o} C (CI: 0.10, 1.57).[7] Major temperature and other climate changes on these short time scales could have forced frequent moves and occasions for conflict over the shifting set of desirable sites.

Exemplary of this is burial evidence (which Dow and Reed cite) from between 18.2 and 13.4 years ago at Jebel Sahaba on the upper Nile, where well over half of those buried died violently. A recent reanalysis of the data suggests that the deaths occurred in "inter-group attacks, rather than intra-group or domestic conflicts" arising from "severe territorial competition between the region's hunter-fisher-gatherer groups is likely to have occurred when forced to adapt to the drastic environmental changes recorded at the end of the Last Glacial Maximum" (Crevecoeur, Dias-Meirinho, Zazzo et al. 2021). This is consistent with the much earlier assessment of the evidence, namely, that "with the deterioration of Late Pleistocene climate ... a few localities which were particularly favorable for fishing would have been repeatedly fought over as sources of food became increasingly scarce" (Wendorf 1968).

Thus, the climate shocks that Dow and Reed agree would promote frequent warfare even among egalitarian groups cannot be dismissed as unlikely "narrow conditions"; they appear to have been the norm during the Late Pleistocene. Further recent work on a "past foraging people" in West Turkana, Kenya provides "evidence that warfare was part of the repertoire of inter-group relations among prehistoric hunter-gatherers" (Mirazon Lahr, Rivera, Power et al. -2016).

[7] These calculations and alternative measures of surface temperatures and other indicators of Pleistocene and Holocene climate volatility are presented in Bowles and Choi (2013)

Fifth, there is additional more systematic evidence that warfare may well have been frequent during the Late Pleistocene based on estimates of the fraction of deaths likely to have resulted from intergroup conflict, for both sedentary and mobile hunter gatherer populations (Bowles 2009). The distributions of the estimates based on (n=15) archaeological and (n=8) 20th century ethnographic evidence are very similar, with a grand mean of 0.14 [CI: 0.18, 0.09]. These estimates exceed the comparable magnitudes for Europe during the 20th century, and even the more "warlike" 17th century. Because most of the estimates are for sedentary or semi-sedentary populations, the question of the frequency of between group conflict prior to 15 thousand years ago may hinge critically on the extent of sedentism. But in any case, it appears unlikely that warfare was rare or absent.

5. *Cities and states*.

Like their model of the advent of farming and warfare, the Dow-Reed interpretation of the origin of states is novel and clearly identifies the sequence of sufficient causal mechanisms involved Here is a summary of the Dow-Reed narrative of the origin of the first states, in southern Mesopotamia.

> … regional climate change in the form of increasing aridity [resulted in] a region-wide decrease in living standards for commoners. Simultaneously commoners migrated toward the south where food production was less dependent on rainfall. Local elites in the south could pay lower wages … which made urban manufacturing attractive. … manufacturing activities were more easily taxed than agriculture and .. this provided the fiscal foundation for the city states of southern Mesopotamia. (368)

Cities provided the setting for the emergence of states because of two characteristics that Dow and Reed associate with manufacturing: "aggregate increasing returns to scale as long as the workshops were in close spatial proximity" giving rise to urban agglomeration (387) and the idea that manufactured goods are more easily taxed than grain ("perhaps because workshops are highly visible and cities are physically compact"(364). This combination accounts for the first emergence of states in cities.

In their model "the wage is determined by labor market clearing, the price of manufactured goods is determined by product market clearing, and the scale of urban manufacturing is determined by a zero-profit condition." (388) The economic elite (including the owners of the

manufacturing workshops) function as a cartel, using the tax rate to regulate the size of the manufacturing sector. “Though individual elite entrepreneurs are price lakers, the elite as a whole has both monopoly and monopsony power [using] the tax rate to limit the size of the urban sector both driving up the output price and driving down the wage. The resulting profit is appropriated through the tax system and rebated to individual elite agents.”(388) In their view states were based on “a technology of confiscation” and they arose when this cartel-with-taxation-powers arrangement yielded higher profits than the pre-state system of agricultural land rents based on “a technology of exclusion.” (362)

The level of political centralization and control assumed in the model appears unlikely to have been characteristic of any of the Mesopotamian cities and archaic proto states that they are describing. Gil Stein, one of the preeminent scholars of early political formations in Mesopotamia, writes: “when Mesopotamian states pursued maximizing strategies aimed at extracting large consistent surpluses from the countryside, these attempts tended to be short-lived, unstable, and vulnerable to collapse” (Stein 1994):13.

Dow and Reed cite evidence that textile and other forms of non-agricultural production were part of the urban economies in Mesopotamia in the 3rd and 2nd millennia BCE, and Augusta McMahon suggests that manufacturing may have emerged earlier (McMahon 2020). But Jason Ur reports that there is as yet no unambiguous evidence for manufacturing during the 4th millennium BCE when states first emerged (Ur 2014). The central role in the formation of states and cities the Dow and Reed propose was played by an elite using taxation to reap both monopsony and monopoly rents from a de facto manufacturing cartel remains an interesting conjecture with little empirical support.

This overall account – the characteristic Dow-Reed combination of adverse climate change, the exercise of power, and a simple economic model – provides a coherent and for the most part new explanation of the first states awaiting empirical exploration. It may be contrasted with standard interpretations stressing the ancient state and its public goods as functional in addressing societal problems including defense (Flannery and Marcus 2012):458-459. Other recent archaeological work, in contrast to both sets of authors, rejects the view that “state-like organizations [in ancient

Mesopotamia] were deliberate functional adaptations to meet the goals of elite members of society, or society as a whole" (Ur 2014).[8]

This points to a more general concern: the lack of a sustained explanation of the origins of the collective action that play such an important role in the Dow-Reed account.

6. *Missing elements: the basis of collective action and why farming mattered.*

In a work distinctive for its thoroughness, we would have liked a more searching account of the basis of the collective action that (rightly we think) plays such an important role in their models, and of the role of private property, which plays almost no role at all.

The basis of collective action. Dow and Reed call the organization of the state "the victory of the organized over the unorganized." (480) In their model the state elite is represented as a single actor. They go on: "Our argument is fundamentally about the manner in which elite groups arise and how they pursue their joint interests." They immediately add: "This takes for granted that such elite groups are organized enough to overcome the coordination and free rider problems bedeviling all forms of collective action." (479-80) Their explanation of hunter-gatherer groups taking up farming similarly posits a strong form of collective action: the group acts as a single individual and like a centralized economic planner allocates the labor of all of its members across various activities; and under some conditions will find that doing a little farming will maximize total output.

By assuming entirely self-interested preferences and recognizing that the groups involved might be large (100 or more people), Dow and Reed make it difficult to explain the assumed collective action by hunter-gatherers. They refer to repeated interactions as a possible underpinning for cooperation among self-regarding actors, but for groups of any substantial size, game repetition is unlikely to be sufficient if there is any significant amount of error or private information (Bowles and Gintis 2012). Similar concerns arise for the assumed collective action by members of economic elites prior to states, unless they are very few in number. The result is that this

[8] The absence of an effective monopoly on the use of coercion in what they term the archaic proto states in Mesopotamia is further explored in Bowles and Fochesato (2023).

important part of their modeling setup – collective action – appears to be something of a *Deus ex machina*.

Farming and private property. An alternative to the Dow-Reed account is illustrated by the Batek people, foragers in Malaysia half a century ago. (Endicott 1988). Two Batek men had discovered cultivated rice nearby and tried planting some in their group's territory. But their fellow Batek simply harvested it and, given their norms governing any food acquired in large quantities, felt obliged to share the harvest with the entire group. The two gave up their attempt at farming.

Thus, sedentism among hunter-gatherers may contributed to the advent of farming by facilitating the development of private property (initially in dwellings and stored goods). According to this view (developed by, among others, one of the coauthors of this paper), when a farming-friendly climate emerged at the beginning of the Holocene, sedentary hunter-gatherers already had a pre-existing institutional template that could be deployed in farming. The institution of private property provided the necessary incentives entailed by the novel characterizes of the new technology: delayed production and long-term investments of labor entailed by cultivating crops and raising animals (Bowles and Choi 2013, 2019).

Dow-Reed and Bowles-Choi differ concerning what they stress about prehistoric farming that mattered for the evolutionary processes under study. For Dow and Reed, farming is important for two reasons. First, while not initially raising labor productivity it did substantially raise the productivity of land, allowing for greater population densities. Greater density in turn is the basis for the technology of exclusion and the resulting emergence of between group inequality as well as somewhat later the technology of confiscation and the rise of states. Second, they assume that cumulative learning by doing raises the labor productivity of farming but not hunting and gathering.

In the Bowles and Choi account, farming is important because it both requires family-held private property rights (to provide incentives for the labor devoted to cultivation) and facilitates the application of property rights to the full range of inputs required for one's livelihood, other

than labor itself. This occurred because the products of farming – cereals and pulses – could be stored in the household interior as private property more easily demarcated and defended than the mobile and diffuse resources of the hunter gatherer economy. There is evidence that a shift towards internal household storage accompanies the emergence of annual cultivation and selection for domestication traits (Weide 2021; Weide et al. 2022), suggesting that farming and a more extensive application of private property rights may have co-evolved. Though Dow and Reed do not think that farming required private property (165) their assessments about why farming mattered is not otherwise contradictory to the Bowles-Choi interpretation; the two accounts could be complementary.

7. The right models?

The economics introduced by Dow and Reed is for the most part Marshallian comparative static analysis with unique equilibria and entirely self-interested and risk-neutral actors. This conventional benchmark is enriched by making both population and technology endogenous. We have pointed to the valuable insights and crisp hypotheses that their models have generated. But in closing we wonder if these are the right models for the study of transitions in economic prehistory.[9]

To model the highly politicized and seemingly chaotic conflicts over resources in the emerging Mesopotamian cities, including the widespread exercise of private power over bonded labor (Diakonoff 1969, Gelb, Steiinkeller and Whitting 1991, Yoffee and Seri 2019), Dow and Reed assume clearing markets (including for labor), price taking, and a zero profit condition. This seems a needless handicap when game theoretic models of incomplete contracts, equilibrium non-clearing labor markets, bargaining over rents, and limited state enforcement capacities are available and provide the basis for the private exercise of power by principles over agents.

[9] We have already noted the difficulty one encounters seeking to explain the level and types of collective action that are essential to the Dow and Reed interpretation resulting from their adopting the conventional *Homo economicus* representation of actors.

In clarifying their own approach Dow and Reed point to an alternative modeling strategy in which institutional and technological arrangements are represented as conventions (mutual best responses) and transitions between them are represented in a stochastic dynamical system as the bottom-up movement from one convention to another:

> …how would it be possible to have two stable equilibria [and then ask] what would trigger a transition from one to the other. In contrast we … have unique equilibria… Our central question is how a climate shock could move the system from a corner solution without cultivation to an interior solution with it.[10] (166)

The 'punctuated equilibrium dynamic' of this evolutionary alternative to their conventional Marshallian matches the observed long duration of technological-institutional arrangements such as foraging and common property, interrupted by transitions that (on archaeological time scales) are quite rapid.

It may explain why the pristine emergence of farming was so rare (perhaps one to two dozen instances depending on how one counts (Price and Bar Yosef 2011, Purugganan and Fuller 2009) and did not occur in some geographic regions ideally suited for farming. Examples include agriculture not coming to prime farmland in California and Australia until the arrival of Europeans. It also provides a framework for explaining the coevolution of the disparate technological and social elements of the "Neolithic package" documented by Weide and his coauthors (Weide, Green, Hodgson, et al. 2022).

8. *Conclusion.*

Our doubts about both the models that Dow and Reed have used and some of their key empirical assessments do not diminish the contribution of their work. Beyond its impressive scope and command of disparate literatures we admire the nature of the project that Dow and Reed have undertaken. They started with a set of important questions about the evolution of human social structure, explored the relevant empirical literature, and then set out to build appropriate explanatory models, leveraging comparative evidence across different regions of the world, and

[10] Dow and Reed illustrate the evolutionary alternative to their approach by the above-cited work of Bowles and Choi; equally illustrative would have been evolutionary explanations of crop shares, e.g., Young and Burke (2001) .

frequently concluding with a consideration of caveats and alternative explanations. Their engagement with the facts of ancient society exemplifies the value of an empirical-question-driven theoretical approach that would enrich economics were it more widely adopted. Their contribution to archaeology is their demonstration of the power of simple economic models to generate interesting, sometimes even surprising, hypotheses about the causal mechanisms that might have been at work.

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