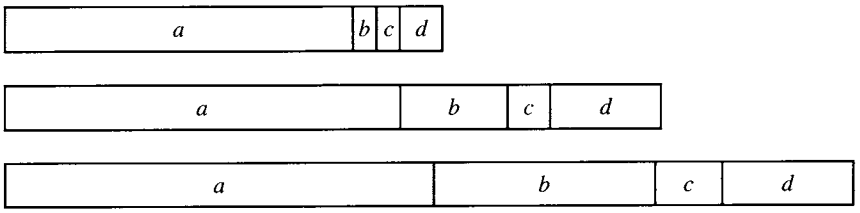
retreated in many parts of Greece after 800 as population grew, but again, we have no way to quantify the increasing costs.

Despite these uncertainties, the improvements that we saw in sections 4 and 5 in age at death, perhaps in stature, and clearly in housing suggest that the overall level of consumption rose strongly between 800 and 300. In Figure 9, I offer very simple quantitative models of how the overall consumption bundle changed across this half-millennium. To do this, I make one major assumption, which involves a series of smaller assumptions. The major assumption is that in the Dark Age, the typical Greek lived close to subsistence. I define "close to subsistence" in terms commonly used by ancient historians: average daily food consumption was something like 1700 calories per capita (more for adult men – say 2000 per day – and less for women and children). I assume that much of this came as "cheap calories," in the form of barley bread, supplemented by varying amounts of "expensive calories," from oil, wine, some fruit, pulses, legumes, meat, and (in favorable locations) seafood. The rich would substitute expensive for cheap calories. I also assume that crop yields were low. HOPKINS [2002, p. 198–203] has made a good case for 4 x seed as the typical yield in the western Roman Empire. It is not likely that Dark Age Greeks exceeded this; nor that they fell much below 3 x seed, because then even a few bad years would mean that they starved. Research on interannual variability in rainfall (GARNSEY [1988, p. 8–16]) has proved that there were bad years in plenty: one of the main reasons that barley bread dominated consumption was that barley was much more drought-resistant than wheat.

Figure 9
Simple Models of Consumption



Note: Top bar: c. 800 BC; middle bar: c. 300 BC, making minimal assumptions; bottom bar, c. 300 BC, making maximal assumptions. In each diagram, area *a* represents basic consumption (food, seed, fuel); *b* is housing; *c* is clothing and household goods; and *d* is tax and rent.

These assumptions can be challenged, but they seem consistent with the poverty of the archaeological record. In line with them, the top bar in Figure 9 shows the hypothetical consumption bundle of an imaginary typical Greek around 800 BC, broken into 100 units. Of these, 80 go to "basic" consumption (area *a*) – food (for humans and animals), seed, and fuel. It is very common in historically and ethnographically

documented agrarian societies for the primary agricultural producers to consume 75–80 percent of their output at the point of production, in the form of food and seed: I suggest that the same was true in Dark Age Greece. Housing (area *b*) accounts for just 5 units (averaged out across a lifetime, and including both new constructions and maintenance); clothing and household goods (area *c*) another 5; and tax and rent (area *d*) the final 10. "Tax and rent" are broadly defined as mechanisms sucking wealth out of the primary producing unit, the household. They cover everything from largely voluntary contributions to religious festivals, through customary dues and services for landowners, to labor on building projects or in wars. Dark Age Greece was a simple society, but there were some large buildings, and there was fighting. All this had to be paid for.

I have already commented that we completely lack evidence for some of these categories: we do not know what rents were in Dark Age Greece, or what people spent on clothing. But the crucial question is always: How wrong can this model be? If I am right that Dark Age Greeks on the whole lived close to subsistence, and if I am right that their agricultural technology was primitive, then the 80-unit figure must be more or less right; and if we accept this, then there is not much left for housing, clothing, and tax and rent. The numbers in the top bar are consistent with what historians have observed in other societies at a comparable technological and organizational level (e.g., CIPOLLA [1976, p. 27–45]). We can tinker with categories *b–d*, but cannot change them very much.

The middle and lower bars, showing equivalent hypothetical consumption bundles around 300 BC, build on the top bar by factoring in the empirical data for changes in nutrition and housing that I summarized in sections 4 and 5. The basic question is how much consumption levels must have changed to produce the results we observe archaeologically. The difficulty, of course, is that we have no independent evidence on the price elasticity of different goods in ancient Greece. I offer two reconstructions, one (the middle bar) minimizing the scale of changes since the ninth century, the other (the bottom bar) making more generous estimates. In the middle bar, basic consumption increases just 12.5 percent, from 80 to 90 units; in the bottom bar it increases 25 percent, to 100 units. Housing increases somewhere between five-fold, from 5 to 25 units, and ten-fold, from 5 to 50 units. Clothing and goods doubles in the minimal model, from 5 to 10 units, and triples in the second model, going to 15 units.

Tax and rent are more complicated. They involve different problems from the data I presented in sections 4 and 5: there the challenge was to get a sample large enough to deduce statistically significant estimates of mean per capita consumption. When talking about communal spending – on temples, wars, fortifications, public sacrifices, etc. – we have to work in the opposite direction, first forming an overall sense of the Greeks' total spending, then dividing it by changes in population size. This is much more difficult, because (a) the database is enormous, and (b) it is incomplete in unpredictable ways, requiring constant guesses. But once again, some general trends are clear. Spending exploded: the Parthenon alone, built in Athens between 447 and 432, cost more than all the temples of archaic Corinth

combined (SALMON [2001]), and Athens spent 45,000–50,000 talents fighting the Peloponnesian War. In aggregate the fortifications built in fourth-century Greece cost far more than this, not to mention all the statues, fountain-houses, gymnasia, and other public amenities. Of course, much of this spending fed back into the basic subsistence category by going to pay soldiers, stonemasons, etc. Further, the nature of extraction changed. Probably fewer Greeks paid simple rents than in the Dark Age, since there was a trend toward independent freeholding citizens. More extraction went on through indirect taxes (especially harbor and market dues, which formed the main source of state revenue in almost every documented city-state).

I have not yet collected these data in the detail that is necessary, but in the middle and bottom bars in Figure 9, I try to show the range of plausible preliminary estimates. I suggest that extraction through tax and rent increased at least 150 percent, but not more than 200 percent (i.e., from 10 units to 25–30 units).

Depending on which assumptions we use, we get overall per capita increases in typical consumption between 800 and 300 BC of 50 to 95 percent. In our own age, when we have seen per capita consumption double in a decade in China and Indonesia, this seems trivial; but by ancient standards, it ranks as a major transformation. Eric JONES [2000] famously argued that the world before the eighteenth century saw episodes of "growth recurring," in which economies would expand, sometimes raising standards of living. He singled out Sung China as the most important such event. The western Roman Empire between 200 BC and AD 200 was another (see SCHEIDEL [2004]), and HOPKINS [2002] and SALLER [2002] have estimated that it saw improvements of a rather similar order to those proposed here for Greece. Averaged out across 500 years, the improvement in living standards illustrated in Figure 9 comes to 0.07–0.14 percent *per annum*, which we might compare to 0.2 percent for Holland in the period 1580–1820, and 1.2 percent for the UK between 1820 and 1920. The performance of the Greek economy in the first millennium BC was a whole order of magnitude lower than that of post-Industrial Revolution Britain, but it bears comparison with the some of the most dynamic pre-industrial economies that we know of.

When we move from per capita consumption to aggregate consumption, the picture is even more remarkable. Ancient texts preserve many numbers that can be used for population estimates, although they are highly problematic, and come mostly from the fifth century BC onward. Karl Julius Beloch collected the evidence long ago (BELOCH [1886], [1889]). Archaeology and more systematic use of demographic theory now allow for longer-term and more robust estimates (see especially SCHEIDEL [2001a], [2001b], [2001c], [2003], [2006]), although it is surprising how often Beloch's figures turn out to be roughly correct.

The most important technique for archaeological estimates of population is intensive surface survey, collecting materials on the surface to produce maps of changing settlement patterns across the whole of human history. This technique involves many tricky interpretive issues, from geomorphology to rates of discard and problems of dating (see SBONIAS [1999]), but in the last twenty years archaeologists have built up a large and impressively consistent body of results. Figure 10 shows my very