Quantifying Household Inequality in Early Pueblo Villages

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The rapid rise of the "Chaco phenomenon" in northern New Mexico in the ninth century AD invites a search for either historical precursors or generative processes that might have explanatory utility. We analyze one candidate system, the well-known Basketmaker III and Pueblo I communities investigated by the Dolores Archaeological Program in southwestern Colorado, to determine whether there is evidence of change through time in the direction of more inequality of households. We use the Gini index to quantify concentration in the distributions of living space, storage space, and total household space. We see no prominent trend toward increasing inequality in these data, but we do note possible evidence for leveling, in that inequality in an "income" measure is higher than in a "total wealth" measure. These leveling processes seem to be stronger for households in villages than for those in dispersed settings. Comparably produced Gini coefficients for other ancient settings would greatly enhance the comparative search for the causes of higher levels of household inequality frequently manifested in agricultural societies.

Many researchers have singled out the northern US Southwest during the second half of the first millennium AD for insights on the history and processes by which sociopolitical complexity and inequality increase in Neolithic societies. These discussions draw heavily on habitation and ritual structures of the Pueblo I period (725–900; all dates are AD). Even three decades after its completion, excavations by the Dolores Archaeological Program (DAP) in the central Mesa Verde region of southwestern Colorado between 1978 and 1985 (Breternitz, Robinson, and Gross 1986) have been especially important in debates on the origins of sociopolitical complexity (e.g., Kohler and Reed 2011; Schachner 2001, 2010; Wilshusen et al. 2012). Here we provide an additional dimension to this discussion by calculating formal measures of inequality in (mostly) DAP domestic and storage spaces for comparison with other Neolithic societies, contributing to the struggle to make archaeology comparative in ways that can be connected with contemporary social concerns. We incidentally question two DAP analytical conventions and examine the impacts of changes in those conventions on our results.

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Origins of Inequality in Human Societies

Of course, a vast literature stretching over more than two centuries charts and attempts to explain the pronounced tendency for development of hierarchies as societies grow in size (e.g., Dubreuil 2010; Flannery and Marcus 2012 and references therein). Here we draw particular inspiration from the recent Intergenerational Wealth Transmission and Inequality in Premodern Societies project (Borgerhoff Mulder et al. 2009; Bowles, Smith, and Borgerhoff Mulder 2010; Smith et al. 2010), since it developed and applied a uniform analytical approach to determining the relationship between production systems, inheritance, and inequality in a number of contemporary or recent societies, including hunter-gatherers, horticulturalists, and relatively small-scale agriculturalists. Conclusions from this study, which particularly clarify the importance of inheritance in building inequality, establish theory that encourages archaeologists to see what can be gained by applying some of these same approaches to truly premodern societies. Here we examine a prehispanic society that had no possibility of influence by or market integration with contemporary Western societies.

In their project, Bowles and colleagues made a useful distinction among embodied, relational, and material wealth, all measured at the individual or family level. Embodied wealth was assessed by weight, grip strength, practical skills, knowledge measured by foraging returns or farming skills, and reproductive success. Depending on the society, relational wealth might include number of exchange partners, number of allies in conflict, and so forth. Material wealth was measured by such indicators as boat shares, quality of housing, amount of livestock, and value of land. A distinctive aspect of the analysis was their ability to measure these variables in parent-offspring pairs, enabling assessment of the degree to which various aspects of wealth are transmitted (correlated) across generations in various societies, possibly leading to cumulative advantage resulting in increasing concentration of wealth, which they measured using Gini coefficients.[1]

1. Gini coefficients are a commonly used measure of concentration in a distribution (here, assumed to be a distribution of wealth) where 0 indicates equality of wealth across the units and 1.0 indicates that all wealth is concentrated within one unit. Smith et al. (2014; see also McGuire 1983) provide an introduction to these measures in an archaeological domain. Of course, no single parameter can describe a distribution in detail; a histogram of the distribution, or the Lorenz curve derived from it, are richer (but less compact) representations.

In their entire sample, material wealth is more readily transmitted across generations than is embodied or relational wealth, perhaps because it can be more easily controlled (Smith et al. 2010:87, 92). Horticultural populations, though, like hunter-gatherers, exhibit much less transmission of material wealth than do pastoralists or agriculturalists and somewhat more transmission of embodied and relational wealth.[2] Gini coefficients for 15 horticulturalist wealth measures (Gurven et al. 2010, table 3) average about 0.27, but when weighted by an ethnographer's impression of the relative importance of the available wealth measures in each society, the mean Gini decreases to 0.21. Among horticulturalists, Gini coefficients are highest for measures of material wealth (mean: 0.52), especially for land (0.67 for the one case that could be estimated), but low intergenerational transmission of material wealth in these societies limits accumulation of differences (Gurven et al. 2010:61).

Building on these results, it can be predicted that high levels of inequality are more likely to emerge in horticultural or agricultural societies as (1) arable land becomes limited, either through population growth or climate change (if productive land is not limited, it cannot be a source of differential wealth; Goody 1976:97; Midlarsky 1999); (2) social norms recognizing private property in land, growing crops, and stored food develop or strengthen (reducing the amount of theft tolerated); and (3) settlement stability increases, increasing the durability of relations between households and fields; all of which contribute to (4) efficient transmission of wealth across generations (cf. Gurven et al. 2010:61). A number of signs suggest that Pueblo I societies were moving in precisely these directions.

Brief Account of Context

Population growth rates in the Southwest as a whole likely peaked between ~500 and 1000 (Kohler and Reese 2014:10105). In the northern of the two areas studied by the Village Ecodynamics Project II, which includes the DAP area and much of the rest of the central Mesa Verde region, population grew from near zero at ~600 to over 10,000 people by the late 800s, and eventually, after a decrease in the 900s and early 1000s, to about 27,000 in the mid-1200s before complete depopulation by ~1280 (Schwindt et al. 2016). Field houses became common in the DAP area by at least the mid-800s and are interpreted as marking control by a household or lineage over agricultural land that was previously open access (Kohler 1992), testifying to the presence by that time of social norms acknowledging private (including corporate) property in this domain.

Using sherd accumulation rates calculated from a series of excavated and tree-ring-dated sites, Varien and colleagues (Varien and Ortman 2005; Varien et al. 2007) estimate that house use-lives in small sites increased from an average of about 8 years in the 600s to about 18 years in the 800s and 900s, eventually peaking around 45 years in the early 1200s. Until the early 1100s, when house use-lives in the two site types converge, houses in villages (community centers) were occupied for about a decade longer than those in smaller hamlets. Longer house use-lives through time in this sequence may imply greater probability of intergenerational transmission of wealth. By this logic, higher probabilities of inheritance for households in villages can also be inferred for most of the sequence. If so, then the model proposed by Bowles and colleagues suggests that levels of household inequality should generally increase during the 300-year DAP sequence and that households in villages should evince higher levels of inequality than households in more dispersed settings.

Beginning in the mid-to-late 700s, households in the DAP area began to build and use surface rooms for both storage and living areas, supplementing but not supplanting the pit structures that served as both the main domestic space and storage space up to that time. Contiguous surface rooms, often with a front living room having a hearth and paired storage rooms behind it, are a defining feature of the Dos Casas subphase, beginning at approximately 760–780 (Wilshusen 1988*a*). Already by that time, some pit structures were being built with either simple or complex sipapus and associated prayer-stick holes considered to have figured in ritual practice (Wilshusen 1988*b*). More complicated and specialized features, central or lateral vaults, appear in some pit structures predominately between 860 and 880 and may have functioned as foot drums (Wilshusen 1988*b*). At Dolores, by ~875, there was a hierarchy in pit structure size in which the largest structures (excluding great kivas, which have no residential features) were most likely to have the most complex ritual features (floor vaults), floor assemblages enriched with nonlocal and visually striking redware sherds and bowl sherds in general (Blinman 1989), and were most likely to have been burned down on abandonment (Wilshusen 1988*b*). This hierarchy was most evident at McPhee Village, the largest of the Dolores villages, where the largest pit structures are associated with U-shaped room blocks, whereas most room blocks are straight or curve slightly. McPhee Pueblo, a unit within this village with one such U-shaped room block, was the only excavated unit of the village to display faunal evidence of feasting behaviors and the manufacture, use, and/or intentional discard of fauna used for ritual paraphernalia (Potter 1997). These U-shaped room blocks also emphasized masonry construction at a time when most local contemporary room blocks were mixes of wood, stone, and jacal.

2. The division between horticulturalists and agriculturalists is somewhat indistinct. According to Bowles, Smith, and Borgerhoff Mulder (2010: 11), the former tend to use hoes and digging sticks rather than plows, have access to abundant land, and use hunting, fishing, or gathering more than animal domesticates to supplement their diets. In the Pueblo sequence, Basketmaker II and III societies are clearly horticultural by this definition, but Pueblo II and III societies might be considered agricultural on the basis of the increased scarcity per capita of land and the importance of domesticated turkey in the diet. Pueblo I populations fall between these poles along the dimension of scarcity of agricultural land, though their dietary use of turkey remained low (Lipe et al. 2016), and neither they nor later prehispanic Pueblo populations used plows.

The spatial distribution and sizes of DAP pit structures suggest that the largest played ritual roles for an entire community; somewhat smaller, but still oversized, pit structures perhaps served a corporate group, such as a lineage or clan segment localized in the associated room block; and the smallest size class served just a household. Great kivas likely served multiple communities. Thus, there is reason to believe that, in this sequence, pit structure size reflects not just the number of family members or the storage size needed but also something about the social and ritual role of that structure in the community. Inequality in the sizes of spaces attributed to households in this sequence, then, is likely a joint result of differential embodied wealth (e.g., reproductive success reflected by family size and farming skills represented by storage size); relational success (e.g., roles in kinship, ritual practice, and sociopolitical relationships); and material wealth (e.g., productivity of fields). We do not attempt to separate these sources of wealth in this analysis, although the importance of relational success should be evident from the preceding discussion.

Since we will employ the spaces used by specific households to construct Gini coefficients, it is critical to be clear about how those are inferred. How spaces were assigned to households by DAP archaeologists has, in fact, come under criticism (Lightfoot, Wilshusen, and Varien 2014).

During the period of active DAP research (1978–1985), southwestern archaeologists typically assumed that the small masonry-lined pit structures becoming evident throughout most of the Pueblo world during Pueblo II times (900–1140) were used for strictly ceremonial (nonresidential) purposes. This was a position inherited from disciplinary pioneers, such as Edgar Lee Hewett and Jesse Walter Fewkes, and was based on their observation that pueblos of the late nineteenth and early twentieth century had special rooms, called kivas, largely reserved for ceremonies (Kidder 1927:490).

Probably influenced by this position, some DAP archaeologists adopted the term "protokiva" to refer to pit structures that were larger than most, appeared toward the end of the DAP sequence, and contained some ritual features—structures seemingly caught in the act of turning into Pueblo II kivas. But Pueblo II kivas, by contemporary orthodoxy, were not residential. As a result, the largest DAP protokivas were also often considered to be nonresidential even when they contained floor assemblages and suites of features that included all of those also found in ordinary, smaller, clearly residential pit structures.

As the DAP final reports were coming out, however, the notion that all post–Pueblo I, nongreat kivas were strictly ceremonial was successfully attacked (Cater and Chenault 1988; Lekson 1988). Today, archaeologists, at least in the central Mesa Verde region, typically adopt the position that, through the end of Pueblo III times (~1280), households were centered in pit structures, with surface rooms used for various ancillary activities, including storage. So today, archaeologists (e.g., Schwindt et al. 2016) typically count households by simply counting pit structures—including oversized "protokivas"—in pre–Pueblo IV sites. Adopting this framework affects the status of one pit structure in our sample, pit structure 1–3 from 5MT4475, McPhee Pueblo, counted as solely integrative by its excavators (Brisbin, Kane, and Morris 1988) but considered to have residential use as well in what we will call the "Lightfoot" protocol below.

DAP archaeologists were also committed to the position that the nature of the spaces used by households shifted somewhat through time (Kane 1986). Specifically, they counted households by counting pit structures up through the beginning of the Dos Casas subphase. For later Pueblo I phases (with the possible exception of the late, anomalous Grass Mesa subphase), DAP archaeologists counted households by counting suites of adjacent surface rooms, usually consisting of one front living room and two rear storage rooms, assuming that the associated pit structure was shared by two to four such households. The space occupied by a single household was called a "household cluster," and the space occupied by the households sharing one pit house was called an "interhousehold cluster."

This position too began to be reexamined in the late 1980s and early 1990s with the careful dissection of the nearby late Pueblo I Duckfoot site by Crow Canyon Archaeological Center (Lightfoot 1994). On the basis of a close analysis of activity redundancy and complementarity, Lightfoot argued that, even in this late Pueblo I hamlet, households could be counted by counting pit structures, even though that resulted in more than three surface rooms being assigned to some households.

Summary, Methods, and Expectations

For both theoretical and evidentiary reasons, then, we focus here on measures of house size and storage area that seem to aggregate three conceptually distinct types of wealth. Smith et al. (2014) justify size of residence as a wealth measure, and here we will not be dealing with evidence from studies based on artifact distributions, although we allude to such studies in our conclusions. Even though we prefer Lightfoot's protocol for allocating space to households, in the following we will calculate Gini coefficients in two different ways, first according to the way DAP archaeologists did it and second ("Lightfoot protocol") according to current interpretations of those same spaces. Details are in CA+ online supplement A.

We calculate Gini coefficients separately for the spaces we infer to have been used mostly for living versus mostly for storage, and we also aggregate these to calculate coefficients over total household area. The results estimate household, not per capita, inequality.

We will also divide the cases in two ways. First, we look for change through time by defining two sequential groups: household spaces predating 780 (largely Tres Bobos and Sagehill subphases) and those built and occupied during or after 780 (largely Dos Casas and Periman subphases). Second, we contrast all households of any subphase in hamlets with all those in vil-

lages. Finally, we aggregate all subsets to provide summary figures for Basketmaker III and Pueblo I.

We expect to see Gini indices for DAP households within the general range found by Gurven et al. (2010) for horticultural societies. We would not be surprised to see these indices increasing in the AD 800s—especially when populations in villages are included—in response to decreased per capita availability of agricultural land, increased structure use-life, and obvious social acceptance of marking ownership of dispersed fields as these populations began a transition from a horticultural to an agricultural way of life.

Results

Change through Time

Figure 1 shows that, independent of protocol, the size of areas within households for both storage and living tends to increase in the second half of the sequence, beginning in the late 700s, though the increase is stronger using the Lightfoot protocol, which also affects living areas more than storage areas. These increases were also noted by Wilshusen (1988*a*: 615) using a database overlapping with that used here. We note in passing that Flannery (2002) might consider this sequence as reflecting the beginning of the emergence of extended families as the base social unit. By that reckoning, the DAP protocol attempts to isolate nuclear-family spaces throughout the sequence, whereas the basal social unit spaces distinguished by the Lightfoot protocol may first identify nuclear families and, later, extended families.

Table 1 shows that Gini coefficients are similar across the temporal subdivisions regardless of protocol, indicating that increases in storage and living areas through time were spread widely across society. Under either protocol, however, storage space is less equitably distributed than living space or total space, both before and after 780. There are no indications from these data that, overall, Dolores households were getting more unequal over these 300 years, despite obvious changes in site and structure size and type. In fact, all values computed under the Lightfoot protocol, which we prefer, trend slightly down-

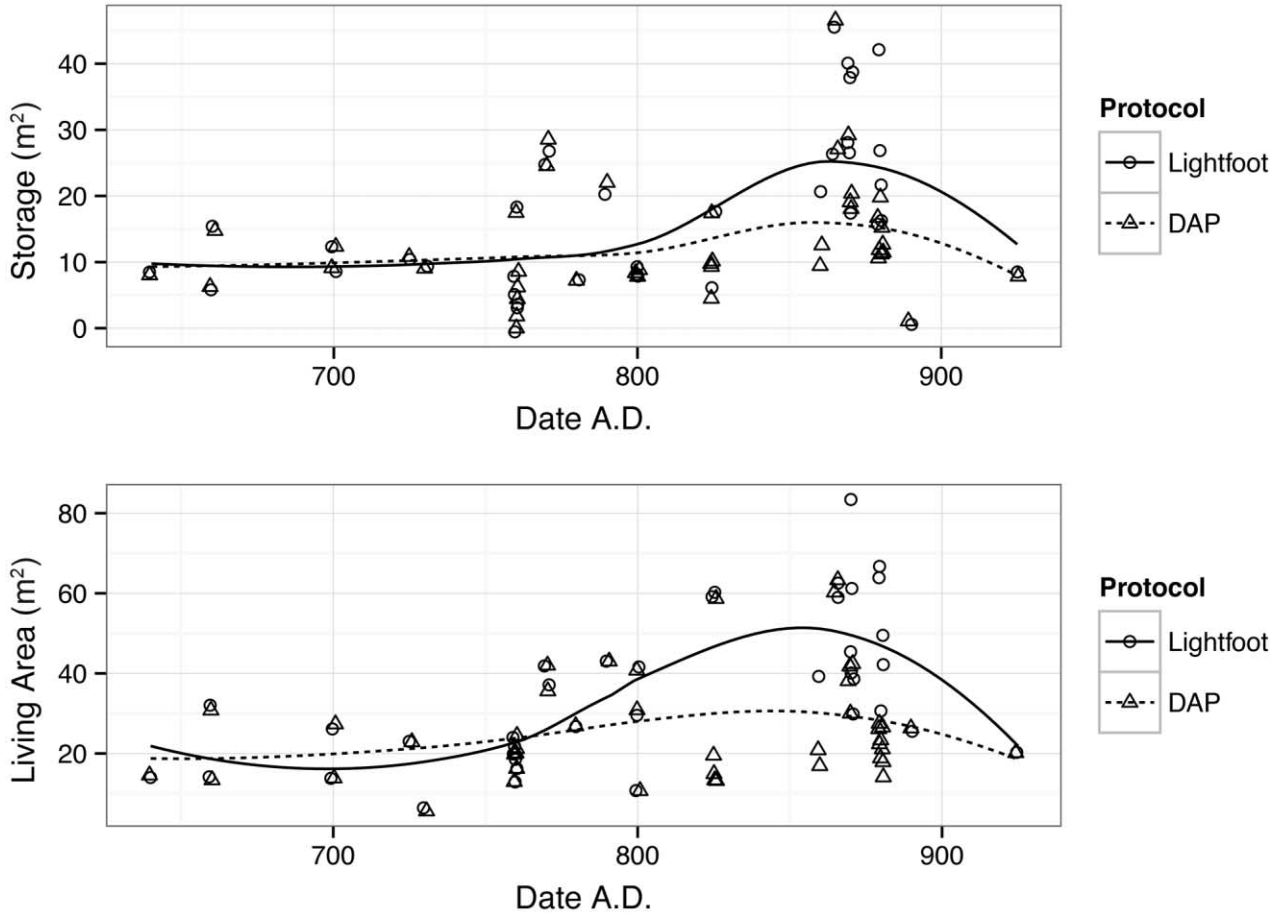

Figure 1. Sizes of storage areas (*top*) and living areas (*bottom*) across households through time. For sample sizes, see table 1. Fit is loess (alpha = 0.9). Points are jittered slightly so that overlaps can be seen. Total household space (not shown) would be the sum for each household of its living and storage areas. DAP = Dolores Archaeological Project.

Table 1. Gini coefficients for Basketmaker III and Pueblo I households in and near the Dolores Archaeological Project (DAP) area

	Living space[a]	Storage space[b]	Total household space[c]	*N*
DAP protocol:				
Through time:				
640–779 AD	.24	.38	.25	15
780–925 AD	.26	.30	.25	29
By settlement type:				
Hamlets	.33	.35	.32	22
Villages	.18	.30	.19	22
Pooled sample:				
All households	.26	.33	.26	44
Lightfoot protocol:				
Through time:				
640–779 AD	.24	.38	.25	15
780–925 AD	.22	.34	.23	23
By settlement type:				
Hamlets	.31	.37	.31	22
Villages	.26	.40	.29	16
Pooled sample:				
All households	.29	.39	.30	38

Note. Calculations based on data in tables A1 and A2.
[a] Pit structure area excluding antechamber and area behind wingwalls plus pit structure area behind wingwalls plus surface room living areas (generally with hearths).
[b] Pit structure antechamber and floor or wall cists plus surface rooms and external features inferred to have been used primarily for storage.
[c] Living plus storage space.

ward through time (toward greater equality), as does the value for storage under the DAP protocol.

An incidental methodological point emerges from these results. Where there is a secular trend in some measure, the most accurate Gini coefficients will be those computed for the most finely resolved periods possible without sacrificing representativity. For the Lightfoot protocol, the coefficients calculated across the entire sample are always higher than the values for the temporal subdivisions, because the pooled coefficients are calculated across a distribution that includes both earlier, smaller households and later, larger households. Even our finer periods violate the contemporaneity of measurement assumed by the Gini coefficient, since they are ~140 years in length. Inflation due to time averaging may be almost unavoidable in archaeological uses of the Gini but should be guarded against to the extent possible.

Hamlets versus Villages

Surprisingly, by either protocol, households in villages have more equally distributed living space and total household space than do households in hamlets. Application of the DAP protocol results in households in hamlets having less equally distributed storage space than households in villages, whereas use of the Lightfoot protocol delivers the opposite conclusion. In any case, the expected signal of greater inequality in villages than in hamlets does not emerge from the analysis. Though we might anticipate that aggregation into villages provided more opportunities for wealth creation than living in dispersed settlements (e.g., Beinhocker 2006:266–267), to the extent this was true, such gains seem to have been broadly divided.

Discussion and Comparisons

The fact that Gini coefficients are consistently larger for storage than for living area or total household size is interesting and unanticipated. We acknowledge that some surface storage might not have been recognized or connected with the correct household. We suggest storage sizes may indicate "income" (e.g., due to the expected sizes of maize crops) better than living areas, which are more similar to a distribution of "total wealth"—an important part of which would have been the size of the domestic labor pool. In contemporary societies, disparities in income that do not result in disparities in wealth typically reflect redistribution through taxation and transfers. So long as we interpret those terms broadly, the relationship between the sizes of these coefficients gives us reason to suspect that some such leveling was taking place, perhaps as high-producing households contributed more to the "potluck"-style feasting typical of this society (Blinman 1989) and to production of other public or common goods (Kohler et al. 2012) than did lower-producing households. If this inference is correct, these leveling processes were evidently more pronounced in villages than in hamlets. Since the structures most obviously used for ritual occur only in villages, it is logical to conclude that the activities within such structures tended to level out wealth among households.

If longer household use-lives are correlated with increased likelihood of inheritance, and if inheritance is fundamental to accumulating wealth disparities, as argued by Bowles, Smith, and Borgerhoff Mulder (2010), we would expect Gini coefficients to increase through time and also to be higher in villages than in hamlets, since these are the directions for increases in household use-lives. Neither is generally true, although living space becomes slightly less equitable through time under the DAP protocol, as does storage space in villages under the Lightfoot protocol. It is important to note that the increases in structure use-life during this sequence were small, and structures were still in use for less than a generation, on average, by the late 800s. We expect that the processes envisioned by the Bowles, Smith, and Borgerhoff Mulder (2010) model would become more visible in Pueblo II and III periods, with their considerably longer structure use-lives (Varien 1999).

The best estimate for an overall mean Gini value from table 1 is 0.28, averaging the six values for the temporal subdivisions under the Lightfoot protocol. This is remarkably similar to the average for 15 horticulturalist wealth mea-

sures of 0.27 reported by Gurven et al. (2010, table 3) and is well below the average of 0.48 computed across all types of wealth for eight agricultural societies by Shenk et al. (2010). Interestingly, DAP values are markedly higher than those calculated by Smith et al. (2014) for Xolalpan-period (approximately 400–500) Teotihuacan, where apartments of monotonous similarity, likely built by the state, yield a Gini index of 0.12, calculated on inferred compound area per household. This low value is probably due in part to the dominance of intermediate-status households in the population. The Dolores-area indices are more similar to measures calculated for house areas in Late Postclassic Morelos villages, towns, and one city, which range from 0.10 to 0.48 with a mean of 0.24 (Smith et al. 2014, table 1). DAP values are markedly lower than those computed by Pailes (2014) on sizes of house clusters for a thirteenth-century Hohokam site (0.42), similar to those calculated across residential units at the late Postclassic capital of Mayapan (0.32), and yet much below those calculated for Classic-period Palenque (0.44) and the Puuc late/terminal Classic Sayil (0.71, an extremely high value; Brown et al. 2012). Finally, the DAP values are close to contemporary values for countries like Romania and Albania (0.28) and markedly below estimates for countries like Brazil and Columbia (0.53; World Bank 2015).

Conclusions

Gini coefficients, or similar measures of concentration in distributions, will have an important role to play in comparative analyses of the sources and extent of inequality in past societies as they become available for more contexts. Archaeologists are justifiably impressed with the size and monumentality of structures such as the imposing great kiva on Grass Mesa (Lightfoot 1988) and the much oversized pit structure 1–3 that is enclosed in the U-shaped masonry room block of McPhee Pueblo. This very monumentality might suggest differences in material wealth among certain households, but most researchers who have examined the Dolores data and other early Pueblo village research in this region concur with our findings, pointing to very few or only subtle differences in material wealth between households. Consequently, the focus of research has come to focus on understanding the distribution of relational wealth within communities to account for their organization.

Wilshusen, Ortman, and Phillips (2012:208) suggest that "[t]he significant change brought about by village formation . . . was the unification of private and public ritual in a single built environment." They and others (Potter 2012; Wilshusen and Potter 2010; Wilshusen et al. 2012) argue that the transformation of community socioreligious institutions, feasting, the control of ritual knowledge, and security—not conspicuous individual, household, or corporate wealth differences—were at the heart of the political organization and the (rather limited) power of particular groups in these early villages. To this we add the inference that such ritual had leveling effects within society that may have been especially pronounced in villages, even while their architectural facilities marked some corporate groups as different from others. Others have also proposed, for other areas, that Neolithic rituals were about maintaining equality (Kuijt 2000).

Some archaeologists have argued that Dolores society was a direct precursor to or competitor with Chaco Canyon, where scarlet macaws were being imported from Mesoamerica by the early or mid-tenth century (Watson et al. 2015), and where, by the mid-ninth century, vast quantities of turquoise jewelry were sometimes interred with high-ranked individuals in a great house crypt used for centuries (Plog and Heitman 2010). Most discussions of Dolores political organization (Kane 1989; Lipe and Kane 1986; Schachner 2010), however, present a more modest view, reinforced by our analysis here. The great houses of Chaco Canyon of the late ninth and tenth centuries must have been fundamentally different from the earlier villages described here, even those with room blocks that have been suggested to be great houses. To the extent that differential power existed in the DAP area, it was likely held in common by specific corporate groups localized in specific room blocks and their associated pit structures, with the clan or lineage head presumably residing in the largest pit structure and functioning as primus inter pares, assuming duties such as hosting feasts and coordinating various social and ritual activities. In Dolores society as a whole, the analysis reported here finds no evidence that concentration of wealth (and, perhaps, power) increased from the 700s to the 800s. Kane suggested that development of more overt leadership in this society was constrained by "internal checks including traditional exertion of decision-making processes through ritual and ceremony and architectural conformity" (1989:360). For the most part, Pueblo I societies still valued relational over material wealth. For better or worse, steps toward the inversion of those values constituted a key innovation of the Chaco system.

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