

2018-01-05

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DM Carballo, Gary M Feinman. 2018. "Collaborative and Competitive Strategies in the Variability and Resiliency of Large-Scale Societies in Mesoamerica." *Economic Anthropology*, Volume 5, Issue 1, pp. 7 - 19.

<https://hdl.handle.net/2144/26914>

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Collaborative and Competitive Strategies in the Variability and Resiliency of Large-Scale Societies in Mesoamerica

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Abstract: Examinations of the variation and duration of past large-scale societies have long involved a conceptual struggle between efforts at generalization and the unraveling of specific trajectories.

Although historical particulars are critical to understanding individual cases, there exists both scientific and policy rationales for drawing broader implications regarding the growing corpus of cross-cultural data germane to understanding variability in the constitution of human societies, past and present.

Archaeologists have recently paid increased attention to successes and failures in communal resource management over the long term, as articulated by the transdisciplinary theory on cooperation and collective action. In this paper we consider frameworks that have been traditionally employed in studies of the rise, diversity, and fall of large-scale preindustrial aggregations. We suggest that a comparative theoretical perspective, which foregrounds collective-action problems, unaligned individual and group interests, and the social mechanisms that promote or hamper cooperation, advances our understanding of variability in these early cooperative arrangements. We apply such a perspective to an examination of cities from Precolumbian Mesoamerica to demonstrate tendencies for more collective systems to be larger and longer lasting than less collective ones, likely reflecting greater resiliency in the face of the ecological and cultural perturbations specific to the region and era.

Keywords: Collective Action; Resource Management; Population; Political Economy; Mesoamerica.

Cooperation and competition have long been recognized as fundamental characteristics of the human career (Mead 1937). Anthropologists have had sustained interest in evaluating how variability in this axis of behavior relates to the emergence, durability, and diversity of large-scale societies (e.g., Carballo et al. 2014; Fuentes 2004). Still, as Trigger (2003, 3) remarked, researchers continue to work for an appropriate balance between general and specific factors (or processes and history) in developing frameworks for understanding cultural and behavioral variability viewed in deep, temporal perspective through the archaeological record. We address these issues through a comparative analysis of Precolumbian Mesoamerican urban centers that focally examines differences in the ways that they were governed and how organizational variation relates to their size and longevity.

Framing Urbanism in Precolumbian Mesoamerica

Precolumbian Mesoamerica has long been recognized as a cultural region where early cities and large-scale polities arose autochthonously (e.g., Adams 1966; Steward 1949). Given the impediments to communication and resource extraction relative to ancient Eurasia (for example, the lack of beasts of burden and wheeled transport, and the markedly limited and relatively late use of metal implements), the significant size and durability of Precolumbian Mesoamerican urban centers has raised special interest (e.g., Wright 1989, 99). How were these preindustrial cooperative arrangements organized? Were they durable, and if so, what accounts for their comparative resilience across time? Large-scale cooperative arrangements are rare in the natural world (Carballo 2013; Carballo and Feinman 2016; Melis and Semmann 2010; Sterelny 2013), and humans are the only species that sustains them among individuals whom are not necessarily close kin. Thus, the socioeconomic processes and mechanisms that underpin such human aggregations, the relative degrees of cooperation and coercion involved, and how such interpersonal relations and different forms of governance impact the scale and durability of

such formations are key issues for understanding Precolumbian Mesoamerica that also potentially have broader temporal and geographic implications (e.g., Acemoglu and Robinson 2012).

The study of Precolumbian Mesoamerica underwent a significant shift in emphasis during the middle of the last century (Wolf 1994:3–4). In the field, greater research focus was placed on the study of regional settlement patterns, urban layouts, domestic economies, and agrarian production. In parallel, Eric Wolf, and other intellectual giants (e.g., Palerm and Wolf 1957; Wolf 1976), ushered in new theoretical perspectives that not only gave greater prominence to economic matters but asked questions such as how were Precolumbian Mesoamerican cities ruled and what sustained those who governed. Frankly, the analyses that we undertake here would not have been possible before the multiple generations of investigations that began more than seven decades ago as well as the conceptual frames that inspired and guided them.

With explicitly comparative interests, Wolf and colleagues (e.g., Sanders and Price 1968), understandably drew heavily on the models and conceptual frames that were predominant in much of anthropology at that time in their efforts to understand Precolumbian Mesoamerican polities (Feinman and Nicholas 2012; Wolf 1994). Inspired by elements of Marxist thought, these cultural evolutionary theoretical perspectives were heavily grounded in extant interpretations of the development of urban societies in Eurasia (e.g., Childe 1942; Marx 1971; Polanyi et al. 1957; Wittfogel 1957). The frames stressed despotic rule, generally funded by command economies in which production and distribution were presumed centered on the ruler. Coercive forms of rule were taken as a given, a perspective that did not challenge the prior (and other) dominant theoretical approach at that time, culture history, which tends to afford great importance to the actions of the elite (see Carballo et al. 2014; Trigger 1989). Likewise, this conception of Precolumbian Mesoamerican rule found seeming support from the one historical case where documents relevant to the fiscal foundations of power were available, the Aztec empire, which seemingly was financed through coercively derived tribute (Barlow 1949).

Yet the same empirical investigations that were inspired by early cultural evolutionary frames subsequently have led to serious doubts regarding the presumed key tenets of those conceptual perspectives; in particular there is little empirical support for the notion that despotic rulers centrally controlled Precolumbian Mesoamerican economic production or distribution (Baker 1998; Feinman and Nicholas 2012; Offner 1981a, 1981b). In fact, most production for exchange was carried out domestically (Feinman 1999; Hirth 2009), and markets were important across Mesoamerica long before the Aztec empire (Feinman and Garraty 2010; Garraty and Stark 2010; Hirth and Pillsbury 2013; Kowalewski 2012). Even the financing of that empire was dependent principally on taxes, in both labor and goods, while tribute was secondary and very much intertwined with markets and other mechanisms of distribution (Berdan 1977, 1985; Smith 2015). Therefore, if most aspects of Precolumbian Mesoamerican economies were not centrally controlled, was governance universally coercive as proposed? What would non- or less-coercive sociopolitical systems look like, and how much variance in governance was there? How closely is diversity in political organization, urban size, and the duration of specific cities linked to regional cultural traditions, in accord with culture historical expectations (e.g., Gillespie 1993), or do other frames exist that could help account for variability along these axes?

Until recently, all major frameworks (e.g., cultural evolution and culture history) that have considered the diversity and dynamics of Precolumbian Mesoamerican urban centers and their political hinterlands have focused almost exclusively at the scale of societies, often treating societies as if they were organisms with a holistic, stage-like life-cycle (see Butzer 2012). Across history, no predictable formula or timetable for the life cycle and ultimate collapse of societies has ever been advanced, and it is simply not demonstrable with empirical data (e.g., Turchin 2003, 26). Although diachronic analysis repeatedly has illustrated that the power of particular places and specific dynasties and regional populations have ebbed and flowed over time, the precise timing of these oscillations is neither externally preset nor regular, and instead it relates to the dynamic relations between people and the

challenges they face. As Boettiger and Hastings (2013, 158) state more generally, “no ‘one-size-fits-all’ property has been found that signals the imminent collapse of a complex system.”

Collectivity in Large-Scale Premodern Societies

The examination of urban collapse and transformation requires multiscalar approaches (Blanton 2012). These should probe the “black-boxes” of human social dynamics and organization, which in a basic sense entails the consideration of the shifting relations between followers and leaders (e.g., Blanton 2010), while also taking into account networks and relations that extend beyond regions and political boundaries (e.g., Wolf 1982). No longer can we restrict considerations of individual agency solely to small elite subsets of populations (see Nassaney and Sassaman 1995, xxi-xxii). Although power must be seriously considered, leadership is always dyadic and implies a consideration of the objectives of followers as well as those on top (Ahlquist and Levi 2011, 5). This relational aspect of leadership is a particular consideration for ancient cities and states, where the frictions of population and governance at a distance placed real constraints on the degrees of control, the maintenance of boundaries, and a reliance on force and power alone (Smith 2005). Instead, following broader social science literature on collective action (e.g., Adger 2003; Blanton 2010, 2016; Blanton and Fargher 2008, 2011; Carballo 2016; Levi 1988), we frame our consideration of past large-scale societies using a comparative perspective, one that recognizes institutional variation and the resultant responses to challenges and perturbations.

Decades ago in an effort to compare ancient Mesoamerican civilizations diachronically, the senior author and colleagues (Blanton et al. 1996; Feinman 1995, 2001) advanced a conceptual frame that considered variability along an axis of political strategy within hierarchical societies termed corporate and network. Newer work has more explicitly connected this frame with collective-action theory in order to consider a broader spectrum of individual and group interests undergirding variability in social organization and to connect archaeological concerns with a broader literature in the social and

behavioral sciences (e.g., Blanton 2016; Blanton and Fargher 2008, 2011; Carballo et al. 2014; Carballo and Feinman 2016; Fargher et al. 2011; Feinman 2010; Feinman and Nicholas 2016a). In outlining characteristics, such as the uses of urban space (e.g., Blanton and Fargher 2011; Carballo 2016; Castells 1978, 15–21; Wade 2017), indicative of what we consider more or less collective forms of organization in past large-scale societies (Table 1), we understand that all variables are gradated spectra with differing levels of visibility in the archaeological record. Some of the less collective formations are consistent with patron-client or highly autocratic systems known historically and ethnographically, though we recognize these are not a social “type” and vary through time and culture area (Crumley 1987). Less collective formations generally have a single or small number of principals or despots, who are able to highly concentrate or monopolize power with very limited checks, although their specific titles and associated structures may vary (Blanton 2016, 115–158).

Following the work of Levi (1988) and Blanton and Fargher (2008), we emphasize that a key factor determining variability in the organization of large-scale societies is the form of political financing and whether revenues are largely internal (more communal resources) or external (less communal), as this directly impacts the levels of accountability that leaders face from commoners and the likelihood that governance and power will be shared or individualized (Blanton 2016, 106–114; D’Altroy and Earle). In addition to greater accountability for governing authorities, higher levels of internal financing and communal resources often correlate with higher dissemination of public goods and bureaucratization of civic offices, together creating systems that may grow larger and be more resilient to social perturbations than more autocratic or despotic formations (Blanton 2016). The hypothetical relationship between population size and social complexity (measured as indices such as bureaucratization) indicates that collective formations often outgrow less collective, or more autocratic formations (Blanton 2016, 40, 264; Carballo et al. 2014, figure 4; Dubreuil 2010; Feinman 2013). The

cases we present from Precolumbian Mesoamerica support such a relationship, and this contradicts long-held presumptions that cooperation is most evident in small groups (cf. Olson 1965, 36).

Collectivity in Precolumbian Mesoamerican Cities

To evaluate the frameworks and hypotheses that we have proposed, we coded data from 26 Precolumbian Mesoamerican cities and proto-urban centers that are not consensually agreed to be cities. The important criterion for the latter, which all date to the Formative period Olmec horizon, is that they were the prominent political centers within their respective regions (Figure 1). We began by identifying centers with solid estimates of population and longevity of occupation. For the first, we relied on publications with population estimates based on systematic site mapping, regional survey, or other empirically based assessment. For the second, our ideal was to record the years at which the estimated population was at 50% or above its proposed maximum. This proved to be possible in only a few instances, and we more often had to default to reported apogee of settlement population. Our interest in community longevity or duration also precluded us from including many well-documented Postclassic cities in this aspect of the analysis as the histories of these localities were truncated by Spanish conquest, colonialism, and associated vectors of disease. Centers were then coded for criteria along a spectrum of collectivity in which a score of one signified the most collective and zero signified the least, with half-point scores awarded for intermediate cases (Table 2); the collectivity score for each center sums the values for political economy, governance, and architecture and ranges from 0 to 3. Because of the aforementioned truncation due to Spanish invasion as well as a few instances where we lacked suitable demographic estimates, each of the 26 cases was not included in every analysis.

Table 3 lists all the cities and urban centers in the study, including the values applied for population, apogee, and collectivity. Sources listed in the final column are primarily for population and apogee, whereas our collectivity scoring drew on our understanding of a much larger literature on these

sites (see Carballo 2016, 120). We present the coding of each value so that our colleagues who study ancient Mesoamerica can evaluate our distillation of this literature. For population figures, which can range widely by author, we endeavored to select conservative estimates that had an empirical basis.

We emphasize that our coding does not ascribe single cultures to one side of the spectrum or the other and that, indeed, variability is discernible both diachronically and synchronically within culture areas (Figure 2a). For instance, less collective formations are more characteristic of the Preclassic Gulf Coast, Classic Maya, and Postclassic highlands in the Mixteca-Puebla (or eastern Nahua) interaction sphere (Pohl 2003). These societies tended to be palace-centric and focused on prestige economies and individualized leadership—the best examples are certain Classic period Maya cities at which governance was organized following an institution of divine kingship (the *k'uhul ajaw*). More collective formations characterized the Preclassic highlands, much of the Maya Preclassic, Classic highland states such as Monte Albán and Teotihuacan, Postclassic Tula, and the Postclassic Maya polities of explicitly shared rule (*multepal*). Variability also was apparent within the Classic Maya world, with northern Yucatecan cities such as Chunchuchmil scoring firmly in the collective category and Caracol in Belize coded only slightly less so. The more collective societies in the sample tended to emphasize public space and monuments over palaces, suprahousehold infrastructural projects such as terrace or irrigation networks, household and market economies over palace and prestige economies, and more shared rule with no evidence of divine kingship (a later example would be the Aztec name for paramount ruler: *huey tlatoani*, or “Great Speaker”).

In other words, we consider the degree of collectivity to have been potentially rather fluid over time, even within specific regions, with collaborative and competitive strategies having been pursued simultaneously in all societies and in flux during the occupation of any particular city. The Classic Maya city of Copán provides an illustrative example, thanks to the availability of both epigraphic and architectural evidence. We scored Copán in the aggregate at the less collective end of the spectrum but

consider that it fluctuated over time. Following the major political crisis when its thirteenth king was captured and killed by a rival city, the fourteenth king of Copán initiated a collaborative strategy of more consensual aristocratic rule centered on a council house to get the dynasty back on its footing, before the fifteenth king reversed this strategy and dedicated the longest preserved Precolumbian text in the Americas to the glory of the dynasty (Fash 2002; Fash et al. 1992). Likewise, in the Valley of Oaxaca, a transition from more collective to less collective governance with increasing focus on the palace is documented for the end of the Classic period and into the Postclassic period (Feinman and Nicholas 2016b). There is not a simple highland-lowland dichotomy; lowland centers such as Tres Zapotes and Mayapan have relatively high scores for collectivity, while highland centers such as Cacaxtla and Cerro Jasmín do not. These examples underscore historical variability within any particular environmental context, city, or regional history, which we necessarily gloss over here in order to evaluate broader trends that are visible when we consider degrees of collectivity in an aggregate sense.

Results and Discussion

With the above caveats in mind, we have discovered patterns that align with models that contrast the properties of more as opposed to less collective formations (Acemoglu and Robinson 2012; Blanton 2016; Blanton and Fargher 2008). Collectively oriented cities in ancient Mesoamerica had longer apogees and larger maximal populations that support the hypothetical relationship between size/growth and collectivity (see Carballo et al. 2014, figure 4). Cities in the sample with collectivity scores of 2 or higher had a mean population of 49,821 (median=30,000) and a mean apogee of 525 years (median=550); those with collectivity scores of 1 or lower had a mean population of 18,900 (median=12,500) and a mean apogee of 311 years (median=300). Cumulatively, more collective urban centers in Mesoamerica were more than twice as large in population and endured 55-60% longer than the less collectively organized settlements in the sample.

Correlations are positive when both population (Figure 2b) and apogee (Figure 2c) are plotted against collectivity score—again indicating that collective settlements were larger and more durable—but the correlation between collective formations and durability is stronger. Of the 23 cases with population data, there is a weak positive correlation ($r=0.28$, $p=0.95$) with collectivity score; of the 22 cases with apogee data, there is a moderate to strong positive correlation ($r=0.59$, $p=0.95$) with collectivity score. We note, however, that variance is high, and not all collective settlements were large or long-lived. Thus, the nature of the specific challenges and perturbations faced in particular contexts would seem to be relevant. The results also indicate that the largest collective cases may have been somewhat less stable than midsized ones, perhaps due to oversized political ambitions and rapid expansionism, which potentially could outstrip extant social contracts and institutions. Another consideration is that the early centers in Mesoamerica tended to be more collective in organization compared to the later examples (Figure 2a, Table 3). El Mirador, an early lowland Maya city that was not included in our sample due to an absence of explicit demographic estimates, also would fit this pattern. The cyclical pulses of urbanization and state formation observable between the Mirador and Calakmul regions (Marcus 2012) further demonstrate the fluidity in collectivity that could operate in a single sphere of cultural interaction.

Although we recognize that these historical shifts within cities, polities, and regions are important, we suspect that the broader pattern we have detected underscores that more collective cases from Mesoamerica exhibited generally greater resiliency to the sorts of perturbations that ancient peoples in this part of the world faced most often: namely, periodicities in production related to adequate land and water for agriculture (i.e., droughts, inundations, soil erosion) and cultural factors (i.e., warfare, shifting exchange networks). These findings dovetail a related cross-cultural analysis (Peregrine 2017) of cases from across the Precolumbian Americas in which societies with greater political participation tended to be more resilient. Anthropologists and ecologists (e.g., Eakin 2006;

Wilken 1987) have documented variability in resource management strategies that could be applicable to the more in-depth evaluation of this hypothesis using cases from the archaeological record where agricultural regimes, paleoclimatic reconstructions, and other possible perturbations are well documented. Examples might involve the construction and maintenance of small-scale hydraulic works, residential and agricultural terracing, communal systems of land tenure, intensive household multicrafting, and commoner participation in exchange networks and markets (Carballo 2016, 22–36). Currently, however, archaeological cases from Mesoamerica with fine-grained data that speak to these diverse strategies of resource management are the exception rather than the rule.

Our comparative analysis of Precolumbian Mesoamerican urban centers provides an empirical first step in supporting the proposition that the governance of these settlements varied and more than half were not despotically ruled. It opens a new line of inquiry that we think requires further study: the sociopolitical ramifications of there being none of the major military or transportation bottlenecks in Mesoamerica that historians of early Eurasian (and other) societies identify as important mechanisms in driving social change (Boix 2015; Earle 2011; Morris 2010; Turchin 2003). As Mesoamerican technological evolution unfolded, there was no centralizing impact from the monopolization of bronze weaponry through control of scarce tin deposits, nor the "democratizing" or decentralizing effects of the adoption of more widely available iron. Likewise, in Mesoamerica there was never the stark inequality in military and transportation technologies that developed in Eurasia with the chariot, serious naval capabilities, or fortified palace keeps. In Mesoamerica, military might came through the control of large infantries using weapons made primarily from widely available stone—all of which underpin generally more balanced political relations as compared to Eurasian contexts. Of course, in all areas of the world, depending on the specific ways that power and governance were financed and distributed, humans have coalesced in both more and less collectively organized political formations (e.g., Blanton 2016; Blanton and Fargher 2008).

A further finding was that the cities in the sample that addressed social perturbations through more collective forms of governance and resource management were somewhat larger and more resilient than the less collective systems whose political financing was derived primarily from trade, war booty, or the control of spot resources along with individualized rulership based on supernatural sanctioning. The latter form of organization likely placed less collective systems at greater risk when exchange networks changed or during other ecological and cultural perturbations. Although relative environmental risk may be an important variable in the propensity for collective governance and social institutions (for instance, more precocious leadership systems may have developed in less risky environments), it is clear that risk cannot explain all the variability, because we see the historical fluctuation between more and less collective systems in the same environment and even synchronic variability within subregions of Mesoamerica. For these reasons we emphasize the role of institutions, as framed by a broad cross-disciplinary theory of collective action, as a basis to generate more robust comparative models for communal-resource management and cultural resiliency.

Acknowledgments

We thank Brandon Lundy, Kate Browne, and the editorial staff of the journal for their assistance in the publication of this paper. Christopher Pool, Peter Peregrine, Linda Nicholas, Daniel Finkelstein, and two anonymous reviewers provided highly constructive comments to help us improve the manuscript. Pool also generously provided unpublished data. All misrepresentations of the cases in the study remain our own. An earlier version of this manuscript was presented in a 2013 session at the American Anthropological Association meetings. We thank Ludomir Lozny and Thomas McGovern for the inspiration their invitation provided.

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Figure 1. Mesoamerica with sites used in the analysis.

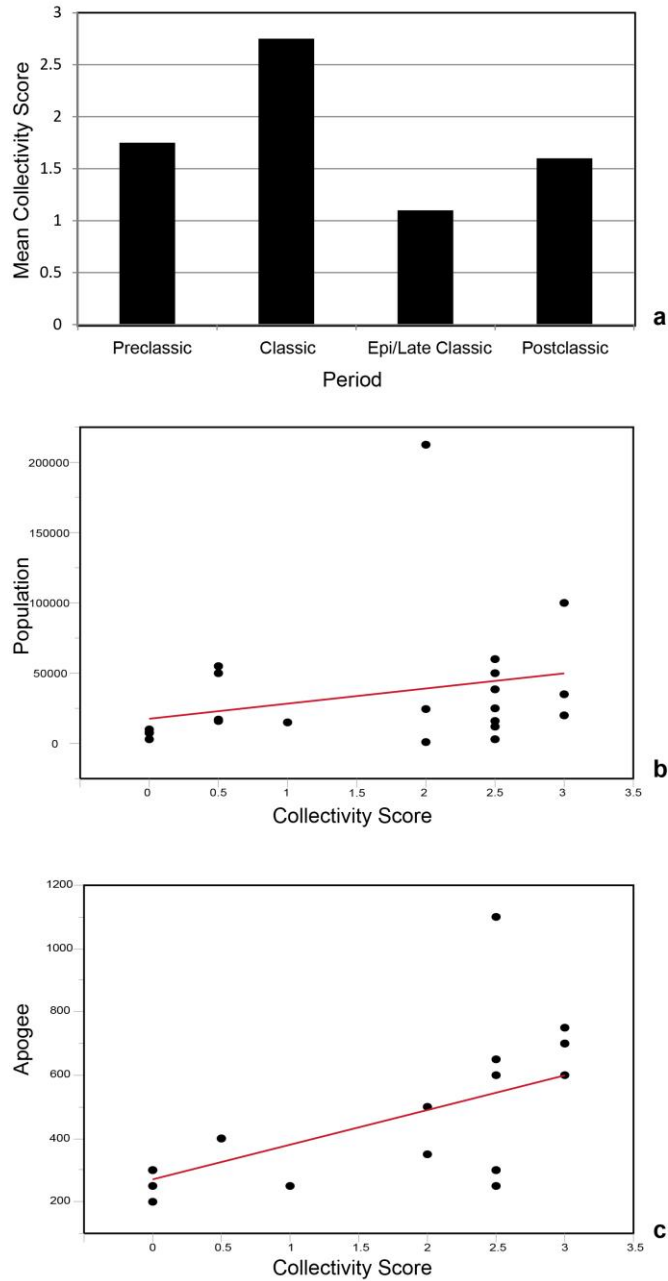


Figure 2. Results of analyses. (a) Mean collectivity scores for sites grouped by chronological period. Periods are roughly as follows: Preclassic, 1200 BC–AD 100; Classic, AD 100–600; Epi/Late Classic, AD 600–900; Postclassic, AD 900–1500. (b) Weak positive correlation between collectivity and population ($r=0.28$, $p=0.95$). (c) Moderate to strong positive correlation between collectivity and apogee ($r=0.59$, $p=0.95$).

TABLE 1. Axes of Collectivity for Premodern Complex Societies.

More Collective	Less Collective
Internal revenues: regularized taxation, a focus on staple finance and regional goods	External revenues: long-distance trade, importance of portable wealth, spoils of war, control of spot resources
More communally owned or managed land	Less communally owned or managed land
Fewer disparities of wealth in life and death	Greater disparities of wealth in life and death
Greater potential for shared power	Greater potential for individualized power
Political ideology emphasizes abstract principles of offices and strength of the polity, cosmology, and fertility	Political ideology emphasizes lineal descent systems for succession and legitimation, divine kingship and royal patron deities
Not centered on palaces	Centrality of palaces
Monumental architecture fosters access (e.g., open plazas, wide access-ways, community temples)	Monumental architecture fosters exclusivity (e.g., elite tombs and memorials, dynastic temples)
Greater expenditures on public goods	Smaller expenditures on public goods

TABLE 2. Axes of Collectivity Coded for Mesoamerican Cases.

Variable/Collectivity Score	1 – More Collective	0 – Less Collective
Political Economy	Internal financing with greater focus on staple goods and market exchange; more muted socioeconomic differentiation.	External financing with greater focus on prestige goods derived from long-distance exchange or control of spot resources; palace-centric production; more heightened socioeconomic differentiation.
Governance	“Faceless” rulership; low mortuary differentiation; secular and bureaucratized political offices.	Highly conspicuous rulers in burials and iconography; individualized rulers; divine kingship.
Architecture	Emphasis on communal architecture over palaces, including temples, plazas, access-ways; art emphasizing public goods.	Emphasis on palaces so that their elaboration and centrality matches or exceeds more communal architecture; art emphasizing exclusive access.

TABLE 3. Mesoamerican Cities and Urban Centers Used in Analysis.

Site	Period	Apogee	Maximum Population	Political Economy	Leaders	Architecture	Collectivity Score	Sources
Cacaxtla	Epi/Late Classic	250	15,000	0.5	0.5	0	1	Serra & Lazcano (2008, 2011)
Calakmul	Epi/Late Classic	400	50,000	0	0	0.5	0.5	Folan et al. (2008); Turner (1990)
Cantona	Classic-Epiclassic	650	60,000	1	1	0.5	2.5	García Cook (2003)
Caracol	Epi/Late Classic	250	100,000	0.5	0.5	1	2	Chase and Chase (2009, 2016)
Cerro Jasmín	Postclassic	400	17,000	0	0	0.5	0.5	Pérez et al. (2011)
Chalcatzingo	Preclassic	500	1,000	0.5	0.5	1	2	Grove (1987)
Chichén Itzá	Postclassic	350	24,500	0.5	0.5	1	2	Cobos (2003); Hassig (1992)
Cholula	Classic-Epiclassic	750	--	1	1	1	3	Plunket & Uruñuela (2005); Uruñuela et al. (2009)
Chunchuchmil	Classic	300	38,500	0.5	1	1	2.5	Dahlin (2009); Magloni et al. (2012)
Copán	Epi/Late Classic	250	10,000	0	0	0	0	Fash (2008); Webster (2008)
Cuicuilco	Preclassic	700	20,000	1	1	1	3	Pastrana & Ramírez (2014); Plunket & Uruñuela 2012
La Venta	Preclassic	300	3,000	0	0	0	0	Rust (1992, 2008)
Mayapan	Postclassic	300	16,000	0.5	1	1	2.5	Peraza et al. (2006)
Monte Albán	Classic	1100	25,000	1	0.5	1	2.5	Blanton (1978)
Palenque	Epi/Late Classic	300	7,500	0	0	0	0	Barnhart (2008)
San Lorenzo	Preclassic	300	8,000	0	0	0	0	Arieta Baizabal (2013); Coe & Diehl (1981); Cyphers (2012)
Seibal	Epi/Late Classic	200	7,500	0	0	0	0	Tourtellot (1990)
Tenochtitlan	Postclassic	--	212,500	1	0.5	0.5	2	Calnek (2003); Smith (2008)
Teotihuacan	Classic	600	100,000	1	1	1	3	Cowgill (2008)
Tikal	Epi/Late Classic	400	55,000	0	0	0.5	0.5	Culbert et al. (1990); Haviland (2008)
Tlaxcallan	Postclassic	--	35,000	1	1	1	3	Fargher et al. (2011)
Tres Zapotes	Preclassic	600	3000	1	1	0.5	2.5	Pool (2010);

Tula	Postclassic	300	50,000	1	1	0.5	2.5	Pool and Laughlin (2016, 2017); Healan (2012); Mastache & Cobean (2003)
Tututepec	Postclassic	--	16,000	0.5	0	0	0.5	Joyce et al. 2004; Levine 2017
Xochicalco	Epi/Late Classic	250	12,000	1	0.5	1	2.5	Hirth (2003)
Xochitecatl	Preclassic	700	--	1	1	1	3	Serra (2003); Serra & Lazcano (2011)