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Journal of Anthropological Archaeology 25 (2006) 82–116
JOURNAL OF Anthropological Archaeology
www.elsevier.com/locate/jaa

Monitoring regional market systems in prehistory: Models, methods, and metrics

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Received 23 August 2004; revision received 20 September 2005
Available online 2 December 2005

Abstract

While market systems have long been recognized as key factors in the development and integration of many complex societies, market exchange has been largely ignored in recent studies of archaic states. The underlying causes appear threefold: (1) we overlook the rich conceptual framework developed within economic geography that identifies key differences among regional market systems; (2) we underestimate the degree to which these differences constrain or create distinct opportunities for other productive activities; and/or (3) we lack appropriate measures for monitoring organizational differences in the archaeological record. To understand the role of markets within the ancient economy, measures are needed to model and monitor its regional organization. The method proposed here focuses on the distribution of goods which circulated through the market system. By examining how different types of market systems move goods through the regional system in different ways, distinct patterns of commodity distribution are predicted. Metrics for monitoring exchange based on artifact assemblage similarity are then proposed. As a case study, the analysis applies these insights to characterizing the regional market system in the Aztec heartland, an area where the organization of exchange and the degree of political interference remain topics of active debate.

Keywords: Market systems; Regional exchange; Aztec empire

Introduction

Although market systems have long been recognized as a key factor in the development and integration of complex societies (e.g., Berdan, 1989; Brumfiel and Earle, 1987; Flannery, 1972; Morrison and Sinopoli, 1992; Sanders and Price, 1968; Sinopoli, 1994), market exchange has received relatively little attention in recent studies of archaic state economies (Smith, 2004, pp. 83–84; Stein, 1998). The slight is especially noticeable when contrasted with the degree of attention focused on agrarian and craft production (Costin, 1991, 2001; Denevan, 2001; Sinopoli, 2003; Trigger, 2003, pp. 358–373; Whitmore and Turner, 2001), households and domestic consumption (D'Altroy and Hastorf, 2001; Feinman and Nicholas, 2000; Santley and Hirth, 1993), and mechanisms of elite finance (Earle, 2001, 2002; Feinman and Nicholas, 2004; Yoffee, 1995).

The shift away from market studies is both puzzling and troubling. In many complex societies,

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doi:10.1016/j.jaa.2005.09.003

market exchange is inextricably linked to production and consumption, and is critical for the effective articulation and coordination of these economic processes. Typically, market systems are seen as supporting increasingly specialized production in both agrarian and craft sectors by mobilizing resources directly from producers, and enabling households to provision themselves with needed items. Further, market systems coordinate these activities both spatially and temporally, by concentrating exchange in a predictable time and location that allows participants to schedule.

Yet the relationship between market exchange and production is not simply a supporting role. It is widely recognized by economic anthropologists and cultural geographers that different market systems create very different contexts for production, exchange, and consumption according to the structure and scale of their regional organization (Hodges, 1988; Larson, 1985; Plattner, 1985, 1989a,b; Smith, 1974, 1976a,b,c,d, 1977). Solar, dendritic, and interlocking network systems, for example, generate distinctive conditions for market participation that affect the degree of reliance on (and investment in) market exchange as a viable economic strategy. In addition, these systems represent different levels of political involvement or interference in the arena of exchange activities on the part of ruling elites.

To understand the complex role of markets within the ancient economy, measures are needed not only to detect the existence of market exchange, but to monitor key dimensions of its regional organization. Prior approaches to modeling regional market system organization have focused heavily on the infrastructure of market systems, including the spatial distribution of economic central places or market centers, and networks of roads and transportation routes that developed in response to market forces (Santley, 1986, 1991; Skinner, 1964, 1977; Smith, 1979; Trombold, 1991). Aside from concerns over the applicability of commercial models such as Central Place Theory (CPT) to pre-industrial societies (e.g., Evans, 1980), archaeologists face the additional problem of identifying economic nodes and networks from settlement pattern data. Settlement systems are determined by multiple factors in addition to economic concerns, including ecological, geographic, political, religious, and historical circumstances, such that settlement size and location are not responsive indicators of market forces alone.[1]

The approach taken here, in contrast, focuses on the distribution of goods which circulated through the market system, and is grounded on observations from economic geographers that different market systems move goods through the regional system in different ways. Accordingly, this study begins by examining the major types of regional exchange systems and their organizational features, drawing from the insights of previous studies in economic anthropology (Feinman, 1980; Fry, 1979, 1980; Fry and Cox, 1974; Hodges, 1988; Plattner, 1985; Renfrew, 1975, 1977; Santley, 1986, 1991; Smith, 1974, 1976d). Second, by evaluating how these organizational features affect commodity flows, distinct patterns of commodity distribution associated with each market system type are identified.

The resulting models of regional exchange are potentially amenable to testing using a range of data types, including chemical, typological, and stylistic analyses of goods that circulated through the market system. Metrics for monitoring exchange based on artifact assemblage similarity are proposed here, in that these data are a common product of archaeological surveys and provide the necessary regional perspective. Finally, as a case study, the analysis applies these insights to the task of characterizing the regional market system in the Aztec heartland, an area where the organization of exchange and the degree of political interference remain topics of active debate.

Models of market system organization

In a regional perspective, market systems consist of a series of (1) *market centers* that function as foci of economic exchange, and (2) the *market zone* or service area provisioned by a given market center. As economic central places, market centers bring together producers and consumers on a regular

[1] Central Place Theory and related models derived from network analysis (Berry, 1967; Christaller, 1966; Skinner, 1964) are based on assumptions that may not hold in pre-industrial, non-commercial societies (Smith 1976a 1:8,12; Hassig, 1991, p. 20). For example, CPT holds that if the market principle is dominant then microeconomic forces will generate a predictable spatial patterning in the distribution and hierarchical arrangement of economic central places (King, 1984); conversely, if this predictable pattern is observed to be present, then the underlying market principle is assumed to have been operative. For a more detailed critique, see reviews by Evans (1980) and Hirth (1998).

basis (either daily or periodic) for exchanges involving a broad range of goods and services. The area provisioned by a market center depends on the range of goods available at the market center and their demand function (Plattner, 1989b). Lower-order centers provide basic subsistence and household items of relatively low unit cost; since such goods are widely available, they are not typically transported great distances to market nor distributed far from the market centers, resulting in a relatively small service zone. In contrast, higher-order centers additionally offer commodities requiring greater labor input or energy investment, with correspondingly higher unit cost and lower demand. These goods travel greater distances from producers to point of redistribution in the market center and attract consumers from a broader area.

The organization and integration of multiple market centers within a regional market system can be assessed along three primary dimensions: (1) *scale of inclusiveness* (areal extent of exchange interactions or system integration), (2) *network* (the amount of horizontal commodity flows between market centers of the same size), and (3) *hierarchy* (the amount of vertical commodity flows between market centers at different levels of the settlement hierarchy) (Smith 1976d, pp. 314–315). A fourth dimension, *political congruence*, assesses the spatial organization of market systems relative to features of political geography, including administrative centers and territorial boundaries.

Economic geographers suggest that the dimensions of scale, network, and hierarchy can be integrated to characterize the distinct organizational features of four different market system models, as described below (Fig. 1; Table 1). While these ideal types do not claim to cover all possible cases, they do provide a well-tested starting point for evaluating ancient, historic, and modern market systems (Hodges, 1988, p. 25).

Solar market systems, also known as simple centralized market exchange systems, are characterized by both poorly developed hierarchy and network, and relatively small scale. As a system of central places, a solar market system consists of a localized, low-level market hierarchy (usually involving an administrative center serviced by several small rural market places) that is poorly articulated with other low-level hierarchies in the same region (Hodges, 1988, p. 73; Smith, 1974, p. 176). A key feature of solar systems is that the center provides both political and economic functions for dependent communities within its hinterland. As a result, the extent of political control is spatially congruent with the sphere of economic influence.

Under a system of enforced dependence on the primary center for both economic goods and administrative services, rural market participants (as either producers or consumers) are unable to exercise a choice in market destinations—they must patronize the center to which they are politically dependent (Smith, 1974, pp. 176–177). Goods move from production sources into the central marketplace where they are redistributed throughout the area served by the centralized market. If a number of producers contribute to this system, their products will have nearly identical, overlapping patterns of spatial distribution, resulting in a high degree of internal homogeneity within the area served by the central market.

At the regional level, restricted consumer and retailer movements result in poor articulation between solar market systems, marked by sharp discontinuities in commodity flows across system boundaries. The resulting pattern is one of discontinuous, bounded market territories. Linkages between these territories occur only as elite-controlled trade between administrative centers, indicated by the movement of foreign commodities or prestige goods between primary central places.

Under a solar market system, then, the regional spatial patterns of commodity flow should be characterized by (1) bounded, discontinuous market territories that (2) are coterminous with political administrative units. If commodity exchange was centralized at the level of the local polity, then the boundaries of market systems would be apparent as sharp discontinuities in commodity distribution, corresponding to polity borders. Household assemblages within communities participating in the same market system will appear relatively homogeneous in composition but distinct from those served by neighboring market systems.

Non-centralized or overlapping market exchange systems (also called network exchange systems) are also characterized by poorly developed hierarchy, but the higher degree of horizontal exchanges results in a higher degree of market network at the regional level than found under solar market systems (Bohannan and Bohannan, 1968; Fry, 1979; Smith, 1974, pp. 179–180). In non-centralized market exchange systems, political authority is decentralized and relatively weak, and administrative boundaries do not constrain the movements of

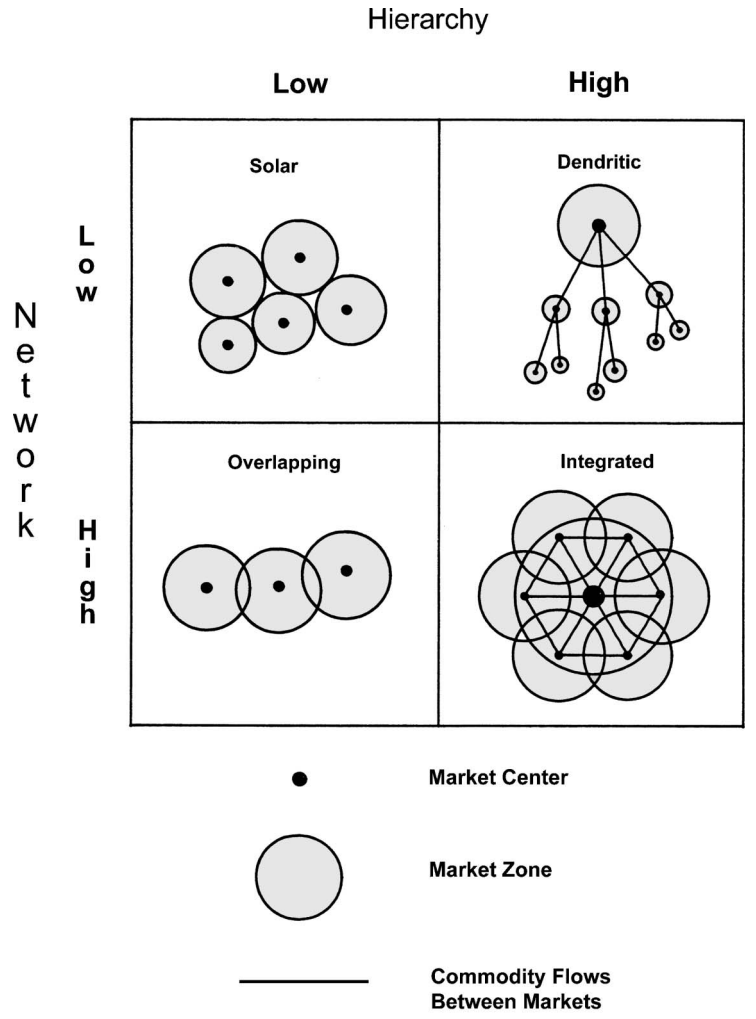

Fig. 1. The primary dimensions of scale, network, and hierarchy generate distinct organizational features for four different regional market systems.

Table 1
Dimensions of market system variation

Dimension of variation	Regional market systems			
	Solar	Non-centralized Overlapping	Dendritic	Complex Interlocking
Scale	Small, local	Small, relatively local	Large, regional	Large, Regional
Network	Poorly developed	Well developed	Poorly developed	Well developed
Hierarchy	Poorly developed	Poorly developed	Well developed	Well developed
Political Congruence	Coterminous with local polity	Not constrained by political boundaries	Coterminous with control of primate center	Coterminous with regional polity

goods or people. Producers and consumers have access to several independent market centers, and goods move readily between adjacent market zones. Based on the distribution of goods, no sharp boundaries are visible between market zones; rather, a gradient in similarity of assemblages extends along a line between exchange centers, as the frequency of each product declines with distance from its original source. However, political instability precludes the development of a market hierarchy and the system

is characterized by poor regional articulation; as a result, economic interaction between communities declines rapidly with distance. Neighboring communities will thus share a large number of commodities, while the assemblages of more distant communities will be more dissimilar.

These characteristics suggest several key aspects of regional spatial patterning generated by non-centralized or network market systems: (1) the structure is characterized by a series of fluid, overlapping market territories; and (2) the network is spatially unbounded by local political or administrative boundaries. If commodities were distributed through a non-centralized market system in which several independent exchange systems interacted, then individual goods or artifact types would likely form overlapping distributions and they would be represented in increasingly smaller proportions with distance from their source. Individual market territories would emerge as areas with similar assemblages, but the degree of similarity between adjacent market territories would be high and differences across these boundaries relatively weak.

Dendritic market systems, in contrast, are characterized by a well-developed market hierarchy, in conjunction with a poorly developed market network. Within the regional system, political and economic control emanates from a single primate center, which connects to dependent communities through a linear chain of exchange interactions (Appleby, 1976; Johnson, 1970; Kelley, 1976; Smith, 1974, pp. 177–179). In the resulting branch-like structure, goods flow vertically up and down the market hierarchy, while horizontal connections among communities at the same level of the hierarchy are minimal.

Dendritic market structures depend on a strong centralized authority in which "political and economic elites are one and the same, and political decisions are made to safeguard elite economic interests" (Santley, 1991, p. 199). This imbalance of power precludes the development of a competitive market system, as elites are able to manipulate market commerce to their own ends. Under a strategy of commodity oligopoly, for example, administrative elites control the availability of goods and services needed by the rural populace to force them to produce for the urban market; monopolistic controls over access to trading partners, transportation, and currency can be equally effective in directing and controlling the flow of goods (Hodges, 1988, pp. 42–52; Smith, 1974, p. 179).

Although primarily associated with mercantile or colonial powers (e.g., Smith, 1976d; Larson, 1985; Vance, 1970), several authors note that such market imperfections were probably widespread, and the model has considerable utility in highlighting the effects of strong vertical market integration in prehistoric and early historic economies as well (e.g., Allen, 1992; French, 1964, pp. 120–122; Hodges, 1988, pp. 42–52; Santley, 1991; Smith 1974, p. 179; 1976a, p. 36). In particular, while the dendritic system supports the primate center, this marketing structure suppresses economic development within the hinterland (Plattner, 1989b, p. 203). Rural goods do not flow with regularity across rural markets, and rural producers cannot depend on those markets for subsistence goods (Smith 1976a, pp. 34–35). The incomplete development of market network reduces hinterland dependence on the market system either as an outlet for products or as a source of desired goods (Smith 1974, pp. 177–178; 1976d, pp. 319–320).

A key characteristic of dendritic market systems, then, is the differential integration of communities into the regional system based on their distance from the primate center (Smith, 1974, p. 177). If the regional economy is dendritic in structure, the geographic pattern would be that of distinct zones characterized by different levels of central market participation, including (1) a well-integrated core zone around the primate center displaying high market participation, and (2) a poorly integrated rural periphery with low market participation. The degree of central market system participation will be reflected in the degree of access to higher-order goods produced in (or imported into) the primate center. As market participation declines with distance from the primate center, we can expect to see a decline in the abundance of centrally produced goods. Within the periphery, locally produced subsistence and utilitarian goods will predominate. Reduced lateral commodity flows within the periphery will result in localized differences in style and assemblage composition.

Complex, interlocking market systems or hierarchically integrated market networks are characterized by both well-developed market hierarchy and network. In such a market system, goods are channeled through a series of local and regional centers, serving overlapping market regions of various spatial scales:

> "In interlocking systems each market center is linked to several higher-level centers as well as to several lower-level centers. This creates a network with several levels, several links between levels, and hierarchically organized service to all places in the system. Goods flow to and from other systems and regions but are also exchanged within the local system at each level. Trade areas are overlapping and economic regions unbounded. Hence, supply and demand or price information is communicated across broad areas to ensure coordination of specialization. Under these circumstances the rural consumer can stay put and still enjoy product diversity in his marketplace; he can also depend on a broad market for the goods he produces. This allows specialization within the realm of food production, so that rural areas become as market dependent if not as diversified as urban centers" (Smith 1976d, p. 320).

A primary feature of interlocking market systems is the high degree of regional economic integration (Plattner, 1989b, p. 203). Because goods move both vertically and horizontally between centers, distribution patterns are geographically widespread and create a higher degree of similarity in consumer goods throughout the regional system. Local variations in the availability of goods from a given source may persist, however, generating minor differences between local market systems.

If the regional economy was organized as a complex interlocking market system, the distribution of artifact types should reflect a pattern of widespread, relatively uniform distribution throughout the region served by the market system. Minimal intra-regional variation in type frequencies would occur, although pockets of locally produced types might appear. However, because trade areas are overlapping and unbounded, no sharp internal boundaries in distribution would be apparent. Similarly, because rural areas are well integrated into the market system, no sharp core-periphery pattern in market participation is expected.

Archaeological correlates of regional market systems

The preceding models of regional market system organization present distinct expectations for commodity distribution patterns against which the archaeological case can be compared. Fundamental to such an analysis, however, is the empirical identification of areas participating in the same market system, and the delineation of market zones—the archaeological manifestation of market territories—based on patterns of consumption. Once market zones have been delineated, the organization of the regional market system can be evaluated in terms of the size and number of distinct market zones, their spatial organization, the horizontal and vertical relationships among market zones, and their distribution relative to features of political geography.

Identifying market zones and boundaries

In archaeological terms, market zones are defined here as areas serviced by the same market center(s) within which communities have access to the same array of goods. One direct measure of whether communities visit the same market center is the degree to which they obtain goods from the same producers, as determined through compositional analyses of artifacts and raw materials (Arnold et al., 1991; Bishop and Blackman, 2002; Bishop and Neff, 1989; Glascock and Neff, 2003; Neff, 1992; Neff and Glascock, 1995). Trace-element studies have been particularly fruitful in modeling the extent and mechanisms of long-distance exchange in high-status elite goods (e.g., Glascock, 2002; Renfrew, 1975, 1977). At the intra-regional level, however, the success of trace-element studies depends on the spatial scale of geochemical variability in raw (source) materials and our ability to differentiate the products of local producers (Bishop and Blackman, 2002). Even when variability in source materials supports a fine-grained spatial analysis, the cost of such analyses has generally limited their application in the assessment of regional market systems, where a large number of samples and a regional sampling strategy are required to map quantitative differences in the volume of exchange and identify market boundaries. As demonstrated below, however, compositional analyses play a critical role in verifying key aspects of market system organization as delineated from less direct measures of exchange.

An alternative means for defining market zones focuses on the degree of assemblage similarity among sites within the study area based on typological and stylistic grounds. This tactic follows up on the "distributional approach" formalized by Hirth (1998), which demonstrated that market participation to provision households results in a high level

of homogeneity in the distribution of circulating commodities. Briefly, Hirth argues that market places provide equal access to commodities for all consumers, independent of social status (1998, p. 458). Since consumers participate directly in market exchange, and all households (whether low-status or high-status) have access to the same types of resources in the marketplace, the result is an increase in the homogeneity of material culture assemblages at the community level. In the archaeological record, "the homogenizing effects of trade" (Creamer, 1998) among households offers a clear indicator of marketplace exchange.

Beyond identifying the existence of market exchange, however, the distributional approach offers a powerful tool for examining the spatial organization of exchange at a regional level.[2] Archaeologists have long utilized stylistic similarity (particularly that of ceramics) to assess the relative degree of economic interaction among different communities, arguing that greater exchange of goods, technology, and artistic norms results in greater uniformity (Fry, 1979, 1980; Fry and Cox, 1974; Hodge and Minc, 1990; Pires-Ferreira, 1976; Plog, 1976, 1978). Where markets provide the primary mechanism for exchange and commodity distribution, Hirth's analyses suggest that the degree to which communities share similar artifact assemblages can be used to assess the degree to which they attend the same market centers. Because they have access to the same array of goods, communities attending the same market center(s) will have highly similar assemblages of basic craft goods; in contrast, those participating in completely different exchange networks will have largely dissimilar assemblages. It is therefore possible to identify and map the spatial distribution of communities participating in the same market zone from areas which display compositionally similar material culture assemblages. Conversely, boundaries between market zones will be apparent as discontinuities in assemblage similarity reflecting a decline in exchange activities.

Several factors may distort the presumed relationship between assemblage similarity and economic interaction, however. Primary among these are differences in site function and status that can alter the mix of different functional and prestige artifact classes found at a site. In order to minimize variability in assemblage composition owing to such functional or wealth differences, the delineation of market zones can focus on stylistic variability within a single functional artifact type or class. The implementation of the distributional method is illustrated below based on stylistic variability within the class of decorated ceramic serving vessels.

The identification of market zones utilizes the methodology entitled "unconstrained clustering for the analysis of spatial data" developed by Whallon (1984). The goal of unconstrained cluster analysis is the identification of spatial clusters or areas with similar artifact assemblages that are not constrained as to their size, shape, density, composition, or patterns of artifact covariation by the very quantitative methods employed to identify them. This methodology was originally designed to assist intra-site analyses in the identification of activity areas within occupation floors. It is, however, a general approach rather than a specific technique (Whallon, 1984, p. 244), and as such is appropriate for the analysis of regional spatial data as well.

The approach requires, first, that we have data on the distributions of a number of different artifact types over a contiguous spatial area. Second, it requires that information on artifact type distributions within this area be sufficiently detailed to characterize the underlying distributional patterns. Ceramic collections generated by regional site surveys potentially satisfy both these requirements. Surveys attempt to provide relatively complete information on settlement distributions for a large contiguous area. The surface collections generated through these surveys theoretically represent samples drawn from the underlying "true" ceramic distribution patterns. Individual samples or collections, however, are subject to local noise or distortion of the regional pattern, due to differences in surface collecting conditions and factors affecting artifact preservation and visibility. One major goal of unconstrained cluster analysis, therefore, is to even out the local perturbations in artifact recovery to expose the larger underlying patterns of distribution.

Input data consist of information on both the absolute and relative densities of artifact types, as these potentially provide complementary types of information. On one hand, relative measures (e.g., percent of ceramic assemblage) reflect potential similarities and differences in consumer behavior that

[2] Several reviewers (Hassig, 1998; Hicks, 1998) of Hirth's approach suggested that it had wider utility, e.g., "The judicious elaboration of his approach holds promise for going beyond the detection of markets to the tentative identification of market types and systems" (Hassig, 1998, p. 467).

are independent of differences in assemblage size. This is an advantage where assemblage size may well vary according to differences in settlement density or surface survey conditions. Assuming, as Hirth (1998) suggests, that market participation promotes equal access and that consumers (on average) obtained goods proportionate to their availability in the market place, then communities participating in same market zone will be marked by assemblages with highly similar proportions of ceramic types.

On the other hand, absolute densities (e.g., differences in the total number of sherds per unit area) potentially reflect differences in access to a particular source, as a function of distance. Typically, we can associate source areas for a given ceramic type with high availability and high consumption (high absolute densities) and assume that accessibility declines with distance from a source, such that marginal areas will be characterized by low densities of that type. Absolute densities are also critical in identifying areas with low overall artifact densities within which percentage data may be unreliable or misleading. Thus, through combining both perspectives, we gain insights into both the relative degree of interaction as well as the volume of interaction between different areas. To the extent that the results of the two analyses agree, we can be assured that the patterning within the spatial data is relatively robust.

Unconstrained cluster analysis proceeds through a number of steps; at each step specific decisions must be made to tailor the approach to the problem at hand. Briefly, the basic sequence involves:

(1) *Creation of a regular data grid from irregularly spaced data points for each artifact type included in the analysis*. A regular grid of points is established over the study area, and the value of each grid point (e.g., ceramic type density) is estimated from neighboring data points (e.g., sites or collection areas), usually as a weighted average of the values of points within a certain distance of the grid point. Generally, the weights applied are the inverse square of the distances from the central point.

(2) *Smoothing the data within each grid*. In a second optional step, the density grid is smoothed using a moving template of surrounding grid points, and each grid point is replaced with the average of itself plus its closest neighbors. Grid smoothing does involve some degree of generalizing from the data, but Whallon (1984, p. 245) argues that this is necessary: "We are interested in distributional pattern, and pattern is a characteristic of the data as a whole rather than of the array of individual item locations. That is, pattern *is* a generalization from the data." In this context, grid smoothing is recommended in that it reduces noise and enhances the underlying pattern by averaging out random fluctuations.

(3) *Clustering of grid points based on density values for multiple artifact types*. Cluster analysis is utilized to summarize the information contained in the multiple density contour maps and to reveal the joint patterning of the different artifact types or stylistic variants within the study area (Whallon, 1984, p. 245). Input data for the cluster analysis consists of type densities as calculated for each grid point. It should be emphasized here that what is being clustered are grid points, with clusters of grid points presumably representing areas with similar assemblage composition. As a result, the focus is on identifying areas with similar ceramics, rather than on identifying groups of sites with similar ceramics. An explicitly hierarchical algorithm, such as the minimum variance or Ward's method that joins clusters by minimizing intra-cluster variance (Aldenderfer and Blashfield, 1984), is useful in revealing the degree of relatedness among areas within the study area. The clustering is based on Euclidean distances between grid points as calculated from the densities of the different artifact types or stylistic variants at those points. The appropriate cluster solution is identified using the scree method, based on major changes in error sum of squares (SSE). According to this criterion, "clustering proceeds ... until a series of marked jumps in the error sum of squares are produced by the fusion of relatively dissimilar groups. These sudden jumps in the clustering criterion indicate significant increases in the heterogeneity of the groups being defined" (Whallon, 1984, p. 253). The strategy here is to examine cluster solutions just prior to major increases in the SSE, as these divisions represent relatively distinct groups.

(4) *Cluster mapping*. Once the appropriate cluster solution has been identified, grid points belonging to each cluster are plotted on a

map of the study area, and these groups are examined for spatial integrity and geographic interpretability. It is expected that grid points belonging to the same cluster will also cluster spatially, and that as a group they represent an area with a distinctive ceramic assemblage.

(5) *Cluster interpretation*. If clusters pass these preliminary tests, the analysis proceeds to cluster interpretation using descriptive statistics to quantify differences in assemblage composition between clusters or areas. Cluster interpretation must also consider the spatial configuration of clusters, their size, and their location relative to features of political geography, including political centers and polity boundaries.

Assessing relationships among market zones

Once market zones have been delimited, the relationships within and among the zones are examined to characterize the regional market system structure. Metrics for the key organizational attributes of scale, network, hierarchy, and political congruence are suggested below.

Scale

The scale of market zones can be evaluated directly from the number of market zones and their relative spatial extent. Of primary interest here is the characterization of the regional system as comprising one or a few large market zones as opposed to many, smaller market zones. The size of market zones relative to travel time and distance is also of interest, as indicating whether the service zone corresponds to a local, regional, or supra-regional market center.

Network

The degree of horizontal integration among market zones reflects the extent of trade and exchange between adjacent market zones in goods of the same order, and can be assessed from the overall similarity among their ceramic assemblages. For example, the Brainerd-Robinson agreement coefficient (Cowgill, 1990) measures similarity between pairs of market zones, when assemblage composition data are expressed as percentages of various ceramic types and variants. The coefficient can range from 0 (when pairs of market zones share no types in common) to 200 (when pairs of market zones share all types in common and in the same proportions). As a measure of network, a high coefficient indicates a high degree of interaction among market zones. Conversely, a low coefficient suggests a lower degree of interaction; a sharp decrease in the agreement coefficient represents a boundary in economic interaction. In addition, the degree of horizontal integration can be assessed qualitatively from the spatial congruence between market zones and individual type distributions, that is, whether type distributions appear to conform to market zone boundaries (low network) or cross over market zone boundaries (higher network).

Hierarchy

The degree of vertical integration within the regional market system can be evaluated from the dual perspective of differential access to a greater diversity of goods and to better quality goods. In a hierarchically organized system, higher-order markets offer higher-order goods (including higher cost, higher status items), plus all lower-order goods (such as basic necessities) (King, 1984, p. 32; Smith, 1985). As a result, higher-order markets are more diverse than lower-order markets, and carry a greater proportion of higher-order goods. In the presence of a well-developed market hierarchy, market zones surrounding the highest-order market centers are therefore expected to have a greater diversity and greater volume of high quality ceramics. In contrast, in a non-hierarchically organized system, we can expect that all market zones will be more equally diverse and/or have roughly equal access to higher quality goods.

A large number of indices have been developed to measure assemblage richness and/or diversity (Ludwig and Reynolds, 1988, pp. 85–95; Pielou, 1975); most do not adequately account for the sample-size effect; that is, that the larger the assemblage is, the more artifact classes it should have, simply as a function of sample size (Rhode, 1988). In contrast, the so-called "regression approach" (Grayson, 1984; Jones et al., 1983), focuses on the systematic relationship (generally linear or curvilinear) between assemblage richness and assemblage size, and examines differences in the rate of acquisition. The region with the steeper slope adds artifact classes at a faster rate, indicating access to a more diverse array of goods and, in this context, proximity to higher-order markets.

With respect to higher quality goods, differential access can be calculated by first using the production-step index to rank the different types according to the level of labor input or number of distinct steps

Table 2
Archaeological measures of regional market systems

Dimension	Definition	Potential Measures
Delineation of market zones	Areas serviced by the same market center(s) that have access to the same array of goods	Spatially unconstrained cluster analysis to identify market zones from areas with similar artifact assemblages
Scale	Relative size of market territories.	Number and areal extent of distinct market zones
Network	Degree of horizontal interaction or overlap between market territories of the same order	a. Measures of similarity/ dissimilarity between adjacent market zones b. Degree of spatial congruence between artifact type distributions and market zones
Hierarchy	Degree of vertical interaction between market territories of a different order	a. Assemblage richness/diversity b. Differential access to higher quality goods
Political Congruence	Spatial organization of market territories relative to administrative centers and territorial boundaries	Distribution of market zones relative to administrative territories as reconstructed from: a. Archaeological measures (CPT, Thiessen polygons, etc.); or b. Ethnohistoric documentation of territorial extent.

involved in their production (Feinman, 1980; Feinman et al., 1981; Garraty, 2000). The distribution (relative to market zone boundaries) of ceramics belonging to different "labor input" classes can be assessed using a simple χ^2 test for homogeneity, based on type counts at sites assigned to market zones. Standardized χ^2 residuals represent departures from the expected frequencies in standard deviations (Reynolds, 1977, 1984). By examining the sign and strength of the standardized χ^2 residuals, market zones having greater access to more labor-intensive ceramics can be identified.

Political congruence

The spatial organization of market zones relative to features of political geography, including administrative centers and territorial boundaries, provides a potential measure of political controls over market system participation. For prehistoric societies where the distribution of administrative centers is known from archaeological surveys, the extent of market zones can be compared with reconstructed political territories (e.g., Thiessen polygons) or markers of ethnicity (such as representations of conquest on stelae, etc.). Where administrative centers and their dependent territories have been mapped from documentary evidence such as tribute lists, the degree of political congruence can be assessed directly from the degree of spatial conformity between ethnohistoric and archaeological data.

The proposed measures are summarized in Table 2. Clearly, all measures are relative scales, such that assessment is best approached on a comparative basis.

[3] The absolute chronology for the pre-imperial period is currently under revision (Cowgill, 1996; Nichols and Charlton, 1996; Parsons et al., 1996), in part based on radiocarbon dates suggesting a much earlier inception than traditionally held. In addition, while finer grain ceramic chronologies are available for parts of the Basin, the complex variation in ceramic sequences continues to frustrate attempts to refine the regional picture beyond the traditional Early Aztec and Late Aztec employed here.