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Market niche *

Ronald S. Burt
Columbia University, New York, NY 10027, USA

Ilan Talmud
Department of Sociology and Center for the Social Sciences, Columbia University, New York, NY 10027, USA

Our purpose in this note is to make explicit how two lines of work in sociology – the population ecology of organizations and the structural hole theory behind network studies of markets – are based on the same unit of analysis. The unit is a set of structurally equivalent producers; termed a niche in population ecology and a market in structural hole theory. Making the market niche analogy explicit puts a bridge in place for what we believe, and begin to explain here, should be productive exchange between the two lines of work.

Population ecology theory describes growth and decline processes in a population operating in a niche. This approach builds from insights in biology and ecology about the conditions under which a species will prosper in an environment. The approach was developed by Hannan and Freeman (1977) and elaborated with Carroll (e.g., 1984, 1985; Hannan and Carroll 1991). Numerous people have contributed to the approach. Hannan and Freeman (1989) provide a systematic introduction, illustrative empirical evidence, and integration with institutional theories of organization.

Structural hole theory is less easily referenced because its develop-

Correspondence to: R.S. Burt, Department of Sociology and Graduate School of Business, Columbia University, New York, NY 10027, USA.

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ment is scattered across more individuals. The theory brings together several lines of work on markets in the general theme that discontinuities in the social structure of markets define systematic competitive advantage for certain players. As a frame for introducing this work, consider network structure as a market regulation mechanism. Analyses can be distributed across a continuum defined by the relative importance of social and economic regulation.

At one extreme, social integration provides a form of regulation that replaces the usual image of competitive market pricing (cf., Barber 1977). This idea is supported in network studies such as Baker's (1984) analysis of centrality and volatility within a securities market, Faulkner's (1983) analysis of prominence and achievement in the music industry (and later analysis of credits in the film industry81 Faulkner and Anderson 1987), or Galaskiewicz's (1985) analysis of philanthropy and prominence within a local corporate network. Analogous to Geertz's (1979) rich anthropological account of social order in a Moroccan bazaar, these analyses describe how social relations, rather than a price mechanism, regulate behavior among competitors in certain markets. This is one of the central points in Granovetter's (1985) discussion of market relations being embedded in social relations. [1] These studies can be viewed as sociological analyses of phenomena that could be analyzed within a market competition metaphor. Market pricing is an image to get out of the way to get on with the business of describing social order. At this end of the continuum, price rarely enters the discussion in other than the most extreme form of perfect competition – which is a very slow moving, easily discredited, target. Market pricing defined in a sufficiently extreme way is unlikely to describe the behavior observed in any market.

Further along the continuum, network structure restricts competitive market pricing by indicating where transactions can occur. For example, Cook and Emerson (1978; Cook *et al.* 1983) use experiments to show how an individual's accumulation of resources in an exchange

[1] The social integration versus price theme is closely related to Berkowitz's (1988; Berkowitz *et al.* 1979) analysis of economic production. He uses ownership and interlock ties to define corporate actors as enterprises, then defines market areas as clusters of production activities carried out within the same enterprises. The idea is that market areas defined as enterprises are a more realistic image of competitive markets than markets defined by technology requirements alone as in input–output analysis. The next step in this work is to link the redefined market units to behavioral variables.

system is not dependent on their power within the overall system (analogous to price in a perfect competition) so much as the alternative exchange transactions immediately available. Markovsky *et al.* (1988) modify the model to show the importance of indirect exchange alternatives. Moving out of the laboratory, students at the University of Chicago have described ways in which the price mechanism of perfect competition in Coleman's (1966, 1971, 1973) exchange model is modified by prior relations among the players. For example, Burt (1979a) describes how networks create substitutabilities that reshape the interests driving exchange. More generally, Marsden (1981, 1983; Marsden and Laumann 1977) describes how the distribution of power reshapes interests and how outcomes can be changed if exchange is restricted to available network channels. Marsden and Laumann (1977) refer to this as the problem of embedding market exchange processes in other social structures, the theme later elaborated by Granovetter (1985). Laumann and Knoke (1987, esp. Ch. 13 with Yong-Hak Kim) offer the most ambitious analysis in this genre with their description of communication networks and resource mobilization among large organizations concerned with national American energy and health policy.

At the other extreme of the continuum, network structure defines competitive market pricing. For example, White uses variations in production price and volume to define market stability (1981a 1981b 1988; Leifer and White 1988). Burt uses transaction networks and concentration ratios to define market boundaries around production roles and constraints on pricing; which then predict relative profit margins across markets and the structure of large firms optimal for individual markets (Burt 1979b, 1980, 1982: Ch. 8, 1983, 1988; Burt and Carlton 1989; see Leifer 1985, for an instructive bridge between these approaches). These analyses, ill contrast to those emphasizing social integration, use the structure of transactions among suppliers, producers and consumers to define the parameters of imperfect competition responsible for the pricing and strategic behavior actually observed in markets. [2]

[2] These analyses are related to economic analyses of networks, but distinct from them in the sense that network structure is used to define price rather than vice versa. Example economic analyses are Boorman's (1975) analysis of the optimal allocation of energy to developing strong versus weak ties to obtain job information and Winship's (1977) analysis of equilibrium allocations of time to relations in a network.

The brokerage metaphor that animates much of the work in the middle and latter end of the continuum is the basis for structural hole theory. The theory describes processes of imperfect competition responsible for the relative prosperity of populations operating in different markets. The idea is that holes in social structure – defined by disconnections and structural nonequivalence – channel the benefits of access, referrals, information and negotiated control to certain players, excluding others. There are no such holes in a perfect competition market. Each player has equal access to everyone else. Players are defined by their goods, not their connections. In reality, every market is full of holes evident to the discerning entrepreneur, and structural hole theory describes their implications. The distribution of holes in a competitive arena defines where certain individuals have an advantage and others are disadvantaged. In essence, the control mechanism of perfect competition is recast in network terms by the structural hole argument to generalize hierarchical control to new forms, and to informal structures. Beginning with the focus on disconnected positions in blockmodels (White *et al.* 1976) and weak tie bridges between positions (Granovetter 1973), this approach developed into predictive models with Freeman's (1977) model of betweenness centrality in terms of connecting otherwise disconnected individuals, Cook and Emerson's (1978; Cook *et al.* 1983) model of power in terms of exclusive exchange opportunities, and Burt's (1980, 1983, 1988) model of structural autonomy cast in terms of conflicting group-affiliations and variably disorganized exchange partners. Again, numerous people have contributed to the approach. Burt (1992) provides a systematic introduction, empirical evidence, and integration with other lines of work, including population ecology.

The niche in population ecology and the market in structural hole theory are a fundamental point of contact between the two approaches. The boundaries around each are defined by conditions of structural equivalence Our purpose in this note is to make that statement more precise.

Defining boundaries

In both lines of work, the unit of analysis is a pattern of connections to segments in a differentiated resource environment. In Fig. 1 for example, a producer (person or organization) lives in a differentiated

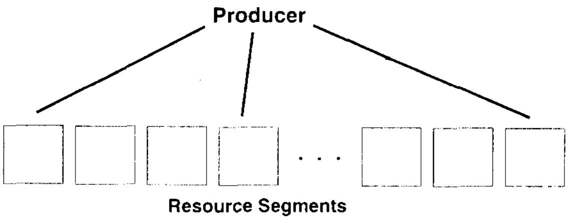

Fig. 1. Producer and differentiated resource environment.

resource environment, surviving on the first, fourth and last kinds of resources.

In structural hole theory, resources are keyed to the relations between players and kinds of resources are defined in terms of clusters of players similarly positioned in the environment. Producer i is connected to the resources of a specific cluster q by relationship z_{iq} that increases with the volume of resources that i gets from q. The z_{iq} are the lines in Fig. 1 connecting the individual to each resource in the environment. Producers are competitors in the same market to the extent that they depend on the same kinds of resources, i.e., to the extent that they have identical patterns of relations to each potential source of resources. Such individuals are structurally equivalent. The extent of equivalence is measured by the Euclidean distance between their relation patterns, such as the following:

$$d_{ij} = \left[\Sigma_q(z_{iq} - z_{jq})^2\right]^{1/2}, \qquad i \neq q \neq j \tag{1}$$

where zero distance between i and j indicates that they have identical relations with each resource segment q. This is similarly the criterion defining boundaries between segments in the environment. Two producers are competitors in the same market to the extent that they are structurally equivalent in their dependence on kinds of resources and kinds of resources are defined by the benefits provided by structurally equivalent individuals. Applied to input–output data on dollars of commodities exchanged between markets, the above equation defines two producers i and j as competitors in the same market to the extent that they make similar levels of purchases from the same supplier markets and make similar levels of sales to the same customer markets. The same criterion defines competitors within each supplier market and competitors within each customer market. Discussion of these ideas with references to the related sociology and economics literature is available elsewhere (e.g., Burt 1983: Ch. 2, 1988, 1992: Ch. 3).

This network image of a market corresponds to the niche in population ecology analysis. As Hannan and Freeman (1989: 50) put it; "The niche of a population consists of combinations of resource abundances and constraints in which members can arise and persist." Stated in social structural terms, the niche of a population is a pattern of variably constrained relationships providing the resources that sustain the population's members. So stated, population niches correspond to the markets analyzed in structural hole theory as locations in the social structure of the economy.

The similarity is clearer when Hannan and Freeman (1989: 103–104) explicitly define competition between populations. Using their terminology, $u_i(z)$ is a measure of the intensity with which population i utilizes a particular resource at level z. Partitions between resources in Fig. 1 distinguish kinds of transactions in the resource environment. The lines correspond to the $u_i(z)$ to indicate the extent to which producers in population i feed on each segment of the environment. Hannan and Freeman use transaction size as an example. In construction, for example, contracts range from a few hundred dollars for household construction to billions of dollars for constructing dams or highways. The population of construction firms that specialize in the former is distinct from the population specializing in the latter. Different populations of organizations specialize in competing for transactions of a certain size, general contractors specializing at the low end and large multinational firms specializing at the high end. The competition between populations i and j is a function of the extent to which they feed on the same resources, which Hannan and Freeman (1989: 104) define in theory as follows:

$$\alpha_{ij} = \frac{\int u_i(z) u_j(z)\, \mathrm{d}z}{\int u_i^2(z)\, \mathrm{d}z}. \tag{2}$$

With respect to Fig. 1, this expression measures the extent to which populations i and j feed on the same segments of the resource environment. As Hannan and Freeman put it (1989: 104):

This expression tells the probability that a member of population i will encounter a member of population j at a particular resource position averaged over all resource positions divided by the probability that it will encounter a member of its own population at each position. Thus, the competition coefficient tells the probability of inter-population interaction in resource acquisition relative to intra-population interaction.

In other words, competition increases with the extent to which a member of one population utilizing a kind of resource is likely to encounter a member of the other population utilizing the same resource. Resource segments i and j could be nations (Carroll 1981) or occupational groups in an educational system (Hannan and Freeman 1984), categories of demographic or professional attributes (McPherson 1983; McPherson and Smith-Lovin 1988), or kinds of corporate strategies (Brittain and Wholey 1988).

The connection with structural equivalence is especially clear in the empirical research by McPherson (e.g., McPherson 1983: 524–537, for estimates of the alpha competition coefficients). His concern is organizations recruiting new members. The resource environment is defined by the people available to be recruited. The environment is stratified in terms of certain empirical attributes such as age, sex, etc. The boxes in Fig. 1 could be levels of education, age categories, men versus women, or combinations of these attributes or others. The niche in which an organization operates is defined by the kinds of people to whom it appeals (e.g., older men with little education or younger well-educated women). Organizations operate in the same niche, i.e., have extensively overlapping niches, to the extent that they try to recruit the same kinds of people as members. Such organizations are structurally equivalent with respect to the defined resource segments.

There are differences between the structural hole boundary around competitors in Equation (1) and the population ecology boundary in Equation (2), but both are clearly examples of structural equivalence. The connection between structural equivalence, input–output sectors, and markets has been long recognized by network analysts, but that work developed with closer ties to organizational sociology and industrial economics than to population ecology. DiMaggio (1986) was the first to call the structural equivalence analogy to the attention of population ecologists (e.g., Hannan and Freeman 1989: 52–53). Hannan and Freeman (1989: 52) wonder about the stability of equivalence boundaries defined at the level of individual firms, but market boundaries are defined in terms of transactions between classes of structurally equivalent establishments, not between firms, and available evidence shows these to be quite stable in recent decades (e.g., Burt 1988). There are not sufficient data to test stability across the broader time periods often covered by population ecology analyses (e.g., the mid-1800s through today); but it is reasonable to ask whether the boundaries around markets defined by technology production requirements, are any less stable than the population boundaries implicit in the archival compilations of firms by market used in ecology analyses. The more important point is that the boundary around the theoretical unit of analysis in each approach is a boundary defined by structural equivalence.

Resolving differences

Although the differences are minor in comparison to the similarities, there are three to note. Two are obvious, concerning distinctions between resource segments in the environment and normalizing differences in the connections to segments. The third is less obvious, concerning the role of the boundaries in the respective arguments.

Resource segments in the environment

For the structural sociologist, resources are keyed to the relations between players in the environment. The clusters q in the definition of market boundaries are clusters of structurally equivalent players similarly positioned in the flow of resources. In other words, resource segments in the environment are defined by the same boundaries that define the producer's market. The relative significance of each resource segment for the survival and prosperity of producers is defined by the structure of relations surrounding producer relations with players in the resource segment. Distinctions between resource segments are less clearly defined a priori in population ecology theory. The analyst is encouraged to identify resources critical to survival, typically one broadly defined class of resources, and segments are defined by whatever criterion seems appropriate. Hannan and Freeman (1989: 103–104) use the scale or scope of transactions to illustrate distinctions between resource segments without suggesting that this is the only criterion. The network analyses of markets show that this is too simplistic an image of differentiation in the resource environment; the pattern of transactions with kinds of suppliers and consumers is strongly associated with producer performance. However, that differentiation is already implicit in the empirical definitions of populations for population ecology analysis. Incorporating it into the definition of niche is completely consistent with, and improves the reality of, population ecology theory. At the same time, the population ecology differentiation by kind of transaction does no violence to the network definition of market boundaries. The following combines conditions in Equations (1) and (2) to define the structural equivalence boundaries around a market niche:

$$d_{ij} = \left[\Sigma_q \Sigma_k \left(z_{iqk} - z_{jqk} \right)^2 \right]^{1/2}, \qquad i \neq q \neq j \tag{3}$$

where k is the scale at which a transaction is conducted (or a category of some criterion other than scale used to define classes of transactions). In the aggregate transaction between construction firms and lumber companies, for example, some construction firms specialize in small volumes of high quality woods for residential projects while other construction firms specialize in projects that require a large volume of low quality wood for large-scale construction. In the above definition, two establishments operate in the same market to the extent that their buying and selling is with the same kinds of suppliers and consumers (same q) in the same kinds of transactions (same k). The key point here is that a single logic of differentiation is involved. The idea of structural equivalence is not limited to one level of aggregation. It is free to slide from more to less aggregate levels of analysis, from boundaries around kinds of suppliers or consumers as establishments similarly positioned in flow of goods between markets down to boundaries around kinds of transactions similarly positioned in the volume of flow.

Normalizing resource flows

That is the analogy between the numerators of the two definitions. They also differ in the denominator. The population ecology definition is normalized by the volume of producer business (with the probability that an organization will encounter a member of its own population in each resource segment). A similar normalization is used in input–output analysis to define input coefficients; sales from market i to market j divided by total purchases by market j. This is a proper normalization for tracing the flow of dollars across markets, but when incorporated in a definition of structural equivalence, it homogenizes important distinctions between markets. The problem is that the aggregate volume is so large that it obscures differences in the pattern of transactions with specific supplier and consumer markets. The primary quality recovered is the distinction between markets that primarily do business will, a single other market versus those that do business with several markets. This point is discussed in detail in Burt and Carleton (1989). A clearer picture of market boundaries is obtained if transactions are measured relative to the largest volume of business producers transact with any one supplier or consumer market. This point too is discussed and illustrated in Burt and Carleton (1989). The implication for a single boundary definition around a market niche is that the z_{iqk} in Equation (3) should be measured as a marginal strength transaction – as the dollars of goods exchanged between i and q at resource position k divided by the largest volume of dollars exchanged by i with any other supplier-consumer market q.

Causal force

While the causal propositions of population ecology and structural hole theory are defined for the same market niche unit of analysis, they draw causal force from different aspects of the unit. This difference can be discussed as network analyses being static while population ecology analyses are dynamic (to emphasize the virtues of ecological analysis) or the difference can be discussed as network analyses being comparative while population ecology analyses are case studies (to emphasize the virtues of network analysis). The fact of the difference is that the two lines of work draw causal inferences from different kinds of comparisons.

Structural hole theory looks at the network of relations that defines a market of producers among their suppliers and consumers. Producers similarly positioned in that network are structurally equivalent and competitors in the same market. Competition is captured by producers seeking profit from the same classes of transactions. Causal inference is made from the covariation across markets between market prosperity and the social structure of a market vis-à-vis other markets. The structural equivalence boundaries around a market are used to make distinctions for comparative analysis.

Population ecology looks not at the existing conditions that define structural equivalence, but at patterns of growth within the boundaries. The structural equivalence boundaries around a market are used to define a population for case study over time. Competition is measured by the extent to which growth in the members of one population occur at the expense of another population. To the extent that this is true, the two populations are competitors feeding on the same resources – whatever those resources are. The point is illustrated by the role of the alpha coefficient in the Lotka–Volterra model describing expected change in the number of organizations within population ($\mathrm{d}N_i$) during a given time interval ($\mathrm{d}t$):

$$\frac{\mathrm{d}N_i}{\mathrm{d}t} = r_i N_i \left[\frac{K_i - (N_i + \alpha_{ij} N_j)}{K_i} \right],$$

where r_i is the per capita number of new organizations expected in the time interval with everything else held constant (intrinsic growth rate), N_i is the existing number of organizations in the population (population density), and K_i is the equilibrium number of organizations that can survive on the resources available to the population (niche carrying capacity). The term in brackets adjusts growth for the extent to which the existing population is close to the carrying capacity of available resources. Where the existing population is much smaller than the carrying capacity (i.e., N_i near zero relative to K_i), growth is unconstrained by available resources because they are so abundant. Where the existing population is close to the carrying capacity (i.e., N_i about equal to K_i), growth is severely constrained by the fact that the existing population already stretches available resources to their limit. To the extent that some other population j feeds on the same resources, their numbers have to be taken into account along with the number of organizations in population i. This is the function of the alpha coefficients. The existing size of population i is the number in the population, N_i, plus the number in population j to the extent that j feeds on i's resources, $\alpha_{ij} N_j$.

In other words, population ecology infers competition from the conditions of differential growth that result from competition while structural hole theory infers competition from the social structural conditions that generate competition. This is an important clarification for two reasons. (1) It explains the greater rigor with which structural hole theory defines resource segments (our first difference between the approaches). Distinctions between the segments are a key component in the causal variables for the theory. Population ecology does not have the same requirement and so is less preoccupied with the problem. (2) The different analytical uses of structural equivalence boundaries is independent of the boundaries themselves. Market and niche are similarly defined by structural equivalence criteria, whether one draws comparisons between markets, or studies a niche over time. Population ecology and structural hole theory differ in what they do with their units of analysis at the same time that they correspond in their structural equivalence definition of the units.

Discussion

Comparative analysis versus case study, cross-sectional analysis versus over-time analysis, inference from covariation between cause and outcome versus inference from variation in outcomes. It is impressive that communication between population ecology and the market approaches is as good as it is (poor as that is). Our purpose has been to make explicit how the two lines of work in sociology – the population ecology of organizations and the structural hole theory behind network studies of markets – are based on the same unit of analysis. The unit is a set (call it a market or call it a population niche) of structurally equivalent producers. Making the terms of the analogy between market and niche explicit puts a bridge in place for what we believe should be productive exchange between the two lines of work.

Population ecology brings the time dimension to network studies of markets and an explicit connection with sophisticated mathematical models from population biology. The first class of issues adds in obvious ways to the familiar cross-sectional analyses of markets and opens exciting opportunities for empirical research. The second point is an exciting theoretical frontier for the structural hole theory used to explain differences between the markets. We refer here to work in population biology that describes structures of competition coefficients – the a_{ij} coefficients in the Lotka–Volterra model – needed to ensure a stable ecosystem (see Hannan and Freeman 1989: 101–102). These results, in light of the analogy between market and niche, have implications for the structural conditions needed to ensure stability in systems of markets. Certain exchange networks among markets should be able to survive profitably, while certain others implode with one market coming to dominate the others. This is an avenue for developing the dynamic component of structural hole theory.

Network studies of markets bring two things to population ecology. Structural hole theory describes how the structure of relations with and among players in the resource environment determines an individual's opportunities to prosper. The variables are defined in the same way for a market within an economy, an organization within a market, or an individual employee within an organization (see Burt 1992: Ch. 7, for elaboration). Given the analogy between market and niche, the structural hole market variables that measure organization control over transactions and price have an analogous role as growth covariates in population ecology. This is particularly interesting in the stage it sets for rigorous comparative research across organization populations. Even the limited empirical evidence available is sufficient to support an argument that the population ecology parameters of organization mortality vary systematically across American markets with network parameters of imperfect competition in the markets. The more constrained the transactions defining a market, the higher the probability of new firms in the market dying shortly after they are born (Burt 1992: Ch. 6).

There is secondly the issue of selecting the unit of organization at which causal processes operate. The proper organizational unit for population ecology is not the firm as a legal entity; it is the establishment – as in structural hole theory and industrial economics. The causal processes of negotiated control that provide entrepreneurial opportunity and profit advantages in structural hole theory operate at whatever level of aggregation is used to define relationships between players in the resource environment. When based on input–output table data, that level is relations between markets and the corresponding organization unit is the establishment. With the analogy between market and population niche, the causal processes of population ecology operate at the same level, which means that the organization unit most directly affected by those processes is the establishment, not the firm.

An establishment is an organization unit that produces a single product. The product is anything within the class of goods generated by a market. In other words, the definition of establishment shifts with the definition of markets. A chemicals plant is an establishment in the chemicals market, a farm is an establishment in agriculture, a retail store is an establishment in the wholesale and retail market, and so on. Two organizations are different establishments to the extent that they produce goods in separate markets (a chemicals establishment versus a retail establishment), or they are separated by geography (a chemicals establishment in New Jersey versus a chemicals establishment in Tennessee). Establishments are defined by positions in the social structure of production (where positions are given the various labels of industry, sector, or market). Firms are another kind of animal. They are the legal entities through which capital is distributed to establishments. One firm can own many establishments in one market or a few in several markets.

The presumption in population ecology is that firms and establishments are isomorphic – each firm owns one establishment. [3] This presumption is explicit in the Lotka–Volterra population growth model. The count of population members presumes roughly equivalent consumption of resources. Bucks might consume more than does, but there is a basic level of food required to sustain the average deer. From this, you can predict the resource needs of a population of N deer through a specific period of time, for example, through one winter. There is an analogy to establishments. A large plant requires more resources than a small one, but technology no doubt defines a tight range of plant sizes for optimum efficiency in producing a specific good. You can predict how much business is needed for a population of N establishments producing a specific good to survive through a specific period of time. Firms are quite different. The resource needs of N firms depends on the number of establishments they operate. As the legal entity coordinating establishments, they are

[3] This point most concerns density dependence effects in population ecology analysis. Liability of newness effects are keyed to diversity of organization forms within a population, which are likely to be homogeneous across establishments within the same firm relative to the diversity between firms.

free to vary widely around the optimum size and resource requirements of their establishments. Establishments coordinated within a large firm have a survival advantage relative to establishments out on their own. Where the firm – establishment isomorphism holds, there is no problem with using the population models to predict counts of firms as counts of establishments. Where a newspaper or restaurant is an independently owned firm, the isomorphism holds. But even in these populations, there are many restaurant and newspaper establishments that are owned by the same parent firm, or coordinated by the same firm granting their franchise. Where the firm-establishment isomorphism does not hold – as is the case of most large American firms which operate establishments in multiple markets – then the counts of establishments predicted by population models do not apply to counts of firms. Ignoring the obvious pun, the inferential problems of ecological fallacy apply.

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