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A note on structural holes theory and niche overlap

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Abstract

Diffuse competition due to niche overlap between actors without (direct) ties with each other, constrains their structural autonomy. This is not dealt with in Burt's mathematical model of his well-known structural holes theory. We fix his model by introducing a network measure of niche overlap.

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In structural holes, the social structure of competition, Burt (1992) explains competitive advantage (for promotion, profit, or other kinds of success) by structural autonomous positions in a social network. He also provides a mathematical model of structural autonomy. There is a certain tension between theory and model, though. We will produce an example showing that organizations in a focal industry can constrain each other—hence reduce each other's structural autonomy according to the theory—in a way that is not captured by Burt's model. Subsequently, we will suggest a way to improve the model.

In Burt's model applied to a market organization i, relevant actors are divided into (1) i's industry, I; (2) i's network, N_i, of suppliers and customers, j; and (3) the market segment of which supplier or customer j is part, M_j. Then, the structural autonomy, A_i, of organization i, is a monotonically increasing function of the degree to which (a) i joins together with its competitors, $r \neq i \in I$, such that it would be more difficult for j to play r against i; (b) j does not join together with $k \neq j \in M_j$, since less coordinated customers (or suppliers) are weaker bargainers; and (c) j is non-redundant in N_i, i.e. it cannot exchange with any of

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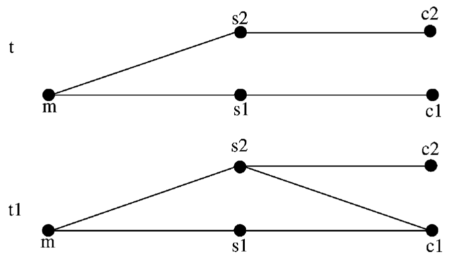

Fig. 1. A network at *t* and at *t*1, of two shops, s1 and s2, their common supplier, m, and their customers, c1 and c2.

i's suppliers (or customers), $q \neq j \in N_i$, without *i* brokering the transaction. Burt's model, then is

$$A_i = \alpha(1 - O_i)^{\beta_o} \left(\sum_j (p_{i,j} + \sum_q p_{i,q} p_{q,j})^2 O_j \right)^{\beta_c} \tag{1}$$

where $q \neq j \neq i$. The parameters obey to the following restrictions: $\alpha > 0$, and $\beta_o, \beta_c < 0$. In model 1, O_i captures (a); the reciprocal of O_j captures (b); in the squared term, which captures (c), $p_{i,j}$ is the proportion of *i*'s network resources in its contact with *j*, relative to *i*'s total amount of network resources, formally $p_{i,j} = (z_{i,j} + z_{j,i}) / \sum_x (z_{i,x} + z_{x,i})$, $x \in N_i$; variables $p_{i,q}$ and $p_{q,j}$ are defined analogously.[1] An elaborate treatment of the model is in Burt (1992).

Now, suppose we have the following market (see Fig. 1). At a time *t*, a manufacturer of electric guitars, m, sells to a shop s1 in Pittsburgh and to a shop s2 in Chicago. Customer c1 in Pittsburgh buys a guitar from s1. At a later time, *t*1, s2 is using the Internet to offer its guitars to customers both in Chicago and in Pittsburgh, whereas s1 is not. Notice that there is no direct social relationship between s1 and s2. Customer c1 wants a second guitar and is now tempted by, and can resort to, the offerings of both s1 and s2. As a consequence, s1 is more constrained with respect to c than it was at *t*.

The competitive pressure generated by actors $r \in I$ that do not have direct ties to a focal actor $i \in I$, but do have ties to its relevant others (i.e. members of N_i) is well-known in organizational ecology, according to which at *t*1, s2 enters s1's realized niche, thus increasing niche overlap (e.g. Carroll and Hannan, 2000). Likewise, Chicago sociologist Park (1992) noticed that diffuse competition can take place even if competitors are not aware of each other's existence, like in our example.

Does Burt's model capture the effects of diffuse competition from niche overlap on s1's structural autonomy? In Burt's model, O_{s1} varies with ties $z_{s1,s2}$ and $z_{s2,s1}$, which do not change between *t* and *t*1. O_{c1} remains unchanged too, because no tie between c1 and other guitar buyers has been established, changed in value, or eliminated. The only values that changed from *t* to *t*1 are those of the variables in the squared term, because at *t*1, $p_{s1,c1}$

[1] The difference between variables *x* and *q* is that $x \in N_i$, whereas $q \in N_i - \{j\}$, which is important because $p_{i,j}$ is a measure of proportion (Burt, 1992, p. 51), and it should be true that $\sum p_{i,j} = 1$ for all *i*. Burt is not very precise about this matter: compare p. 51 with p. 54.

is smaller and, as a consequence, $p_{\mathrm{s1,m}}$ is larger. Because in our example the terms in the summation, $\sum_q p_{i,q}\, p_{q,j}$, add up to zero at both t and $t1$, the redundancy (i.e. the squared term) of s1's network is minimal if s1's network resources are equally distributed among its contacts c1 and m. Then the entry of s2, rebalancing the distribution of s1's network resources, reduces s1's redundancy, thus *increases*, rather than decreases, s1's structural autonomy. In conclusion, Burt's model does not capture the effects of diffuse competition from niche overlap.

In the example, the entry of s2 in s1's realized niche generates a structural hole around s1 that c1 can broker at s1's detriment. More in general, because a focal actor's niche overlap depends on ties that connect its competitors to its relevant others—but not to the focal actor itself—an increase in niche overlap implies an increase in the structural holes around the focal actor. Therefore, although diffuse competitors are not captured by Burt's model, their effects on *i*'s autonomy can be predicted by the same explanatory mechanism that constitutes the core of structural holes theory.

To account for diffuse competition, an additional term for ties $z_{r,j}$ and $z_{j,r}$ between *i*'s competitors, $r \in I$, and I's customers (or suppliers) $j \in N_i$, must be introduced in Burt's original model. Let A_i^* denote the new measure of structural autonomy, then a straightforward way of modeling A_i^* is to multiply A_i, from model 1, by an additional term

$$A_i^* = A_i \left(\sum_j p_{i,j}\, p_{j,r} \right)^{\beta_{\mathrm{d}}} \tag{2}$$

where $p_{j,r} = (z_{j,i} + z_{i,j}) / \sum_r (z_{j,r} + z_{r,j})$, and r runs across all elements of I including i; $\beta_{\mathrm{d}} > 0$, and the remainder conditions are as in (1).

In this additional term, the value of the summation varies inversely with the degree of diffuse competition within the interval (0, 1]: it equals 1 when *i*'s competitors have no contacts within *i*'s realized niche, and it approaches zero when *i*'s contacts have most of their network resources vested in *i*'s competitors. Moreover, the competitive pressure exerted by an additional diffuse-competition-tie, $z_{j,r} + z_{r,j}$, increases with (i) the strength of the tie between r and j; (ii) the degree to which j is a relatively important customer (or supplier) for i; and (iii) the degree to which i is a relatively important supplier (or customer) for j.[2]

As an example, consider the networks in Fig. 2, and the calculations for the measure of diffuse competition.

In all three networks in Fig. 2, focal actor, s1, spends 90 units of network resources (e.g. money or time) on its customer, c, and 10 units on its supplier, m, and let us assume that the ties are symmetric. In network (Fig. 2a), no competitor has ties with any of s1's contacts. As a consequence, s1 is not subjected to diffuse competition. In network (Fig. 2b and c), a competitor, s2, enters s1's realized niche by spending 20 units of network resources on one of s1's contacts, which generates (diffuse) competitive pressure on s1. However, the amount of competitive pressure exerted by s2 on s1 is substantially lower in network (Fig. 2b) than

[2] Sohn (2001) argues that a competition coefficient should have the following properties. It is between 0 and 1, which our network measure is; it is in ratio scale, which our measure is, due to the underlying *z* measures; and it must take differences in size into account, which our measure does as well, because larger actors, with higher *z* values, generate stronger (diffuse) competition.

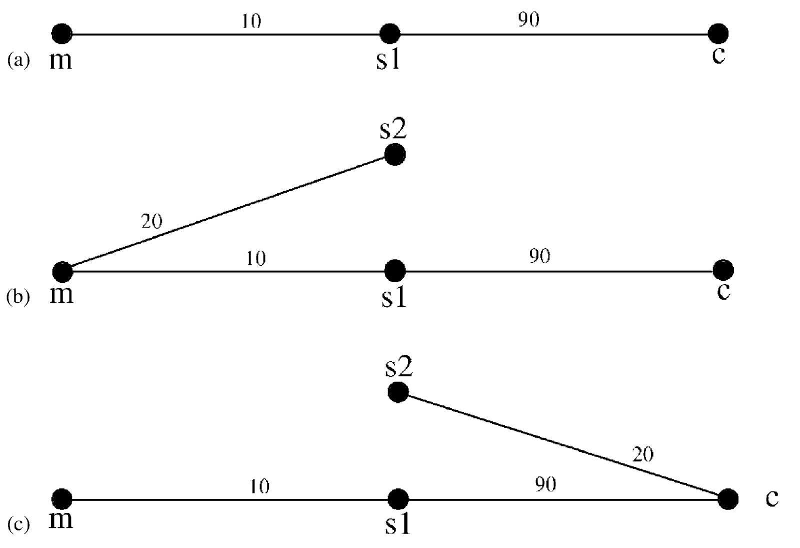

Fig. 2. Three networks with calculations of diffuse competition from niche overlap: (a) $\sum_j p_{i,j} p_{j,r} = [90/(90+10)](90/90)+[10/(90+10)](10/10) = 1$; (b) $\sum_j p_{i,j} p_{j,r} = [90/(90+10)](90/90)+[10/(90+10)][10/(20+10)] = 0.933$; (c) $\sum_j p_{i,j} p_{j,r} = [90/(90+10)][90/(90+20)]+[10/(90+10)](10/10) = 0.836$.

in network (Fig. 2c). In network (Fig. 2b), s2 invests 20 units on m, which is a relatively unimportant contact for s1. In network (Fig. 2c), in contrast, s2 taps from an important member of s1's realized niche, on which s1 spends 90 units of its network resources.

The formalization[3] of niche overlap in model 2 conforms closely to the explanatory mechanism of structural holes theory, because it captures the assumption that the constraint exerted on a focal actor by contacts that broker structural holes varies with the strength of the inter-dependency that links them to the focal actor.[4]

In sum, our model better represents structural holes theory, by incorporating niche overlap and thereby giving a fuller account of structural autonomy. We hope that our model makes possible new and fruitful applications of structural holes theory and the concept of niche overlap.

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[3] An alternative formalization of niche overlap, which does not take into account the relative importance of i for j and vice-versa, but does take into account the strength of the ties between r and j, is: $(\sum_j (z_{i,j}+z_{j,i})/\sum_j \sum_r (z_{j,r}+z_{r,j}))^{\beta_d}$, where $\beta_d > 0$. According to this formalization the value of diffuse competition from niche overlap is the same in networks (b) and (c) in Fig. 2 (0.833^{β_d}).

[4] See Burt (1992) for an elaborate treatment of the topic, particularly pp. 54–62.

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