ACED
ANTWERP CENTRE OF
EVOLUTIONARY DEMOGRAPHY

DEPARTMENT OF MANAGEMENT

CULTURAL NICHE DIMENSIONALITY AND SMALL FIRM SUBSISTENCE

JEROEN BRUGGEMAN & GÁBOR PÉLI

UNIVERSITY OF ANTWERP
FACULTY OF APPLIED ECONOMICS, DEPT. OF MANAGEMENT
KIPDORP 61 (S.Z.105) BE-2000 ANTWERPEN
TEL. +32 (0)3 265 50 64 | FAX +32 (0)3 265 50 79
HTTP://WWW.UA.AC.BE/ACED

ACED

FACULTY OF APPLIED ECONOMICS

DEPARTMENT OF MANAGEMENT

Cultural Niche Dimensionality and Small Firm Subsistence

Jeroen Bruggeman & Gábor Péli

RESEARCH PAPER 2011-005
ACED 2011-010
MARCH 2011

University of Antwerp, City Campus, Kipdorp 61, B-2000 Antwerp, Belgium
ACED Administration – room S.Z.105
phone: (32) 3 265 50 64 - fax: (32) 3 265 50 79
e-mail: anne.vanderplanken@ua.ac.be

The papers can be also found at website:
http://www.ua.ac.be/aced & http://www.ua.ac.be/TEW
(research > working papers)

D/2011/1169/005
ACED/2011/010

Cultural Niche Dimensionality and Small Firm Subsistence

Jeroen Bruggeman* and Gábor Péli

March 2011

Abstract

In populations of human organizations (e.g. firms) that operate in cultural niches (markets), size differences are usually large. As large organizations can in principle out-compete small ones, the actual presence of many small organizations asks for an explanation. In ours, we focus on the dimensionality of cultural niches, that can change as a consequence of product innovations, preference elaboration, or institutions. We show that increasing market dimensionality substantially enlarges the market periphery relative to the market center, which creates new potential niches for small firms. Decreasing dimensionality, in contrast, preserves market positions for a portion of the incumbent small firms rather than forcing all of them to exit. We thereby provide a parsimonious explanation for small firm existence when dimensionality changes, even in concentrated markets and net of other factors.

Introduction

Throughout history, humans have cooperated in groups of various sizes, which in modern societies are often business firms and other kinds of organizations [1]. These organizations became corporate actors in their own right [2,3] that compete, and sometimes cooperate, with other organizations. For most of them, only few of their resources come from nature, while most of their resources are obtained through exchanges with clients, investors, employees, and governments, and are regulated by institutions [4]. Organizations thus largely operate in cultural niches [5], and their key resource is the demand for their offerings.

*Corresponding j.p.bruggeman@uva.nl, Department of Sociology, University of Amsterdam, Netherlands.

To grasp the dynamics of organizations in their cultural environments, social scientists started using ecological models [6]. For the dynamics of organizational populations, e.g. of newspaper publishers and car manufacturers, it turned out that the general law of density dependence holds [7, 8]. But organizational audiences as well as culture modify population dynamics in ways somewhat different from populations in natural environments.

Arguably a striking feature of organizational populations is their size distribution [9, 10]. The largest organizations can easily become orders of magnitude larger than the smallest ones, e.g. a multinational beer brewer versus a local brewery pub. As a first step to model this size variation, demand (or alternatively, organizational offerings) was mapped onto an n-dimensional niche, or market, space [11, 12]. Attributes (i.e. traits) represented by such dimensions can be the audience's level of education, age, religion, or political preference, as well as their geographical location [13]. Demand (i.e. resource) distributions over those dimensions are usually characterized by a peak, called the center of the market containing mainstream preferences, versus lower levels of resources in the peripheral, non-mainstream, parts of the distribution [14]. At a market center, organizations that use modern technology [15] combined with bureaucratic control [16] benefit from economies of scale, i.e. decreasing costs with the number or volume of units produced. As a consequence, firms at market centers are typically much larger than firms at market peripheries, and they have higher survival chances as well [8]. Whereas many scholars initially believed that in such concentrated markets (indicated by the Herfindahl index) there are barriers to entry [17, 18], more recent empirical studies pointed out the inflow of many small firms, among others in beer brewing, newspaper publishing, and auditing markets [14]. The entry and enduring presence of small organizations is not only of scientific interest, but is also important for society, as small firms increase product choice, create jobs, and account for the bulk of major innovations [19].

To explain the co-presence of small and large organizations, social scientists adapted resource partitioning theory [20], and predicted that large organizations reside in market centers, where they can out-compete small organizations, while small organizations evade competition by differentiating their offerings in the resource-sparser peripheries [14].

Our explanation is based on a geometric effect of increasing dimensionality, which in turn explains resource partitioning as well. A case in point is the inflow of ethnic shops in a retail population with large supermarkets. There, migrants use their cultural background in a new environment, not only for fellow migrants, but eventually also to appeal to the native audience. Through the "commodification of ethno-cultural diversity" [21], the

dimensionality of the retail market then increases. Obviously, adding a new dimension multiplies the number of potential positions for organizations, which may materialize some of these positions. Possibly less intuitive is that this additional space is highly unevenly distributed. We will demonstrate that if market dimensionality increases, there is a disproportionate increase of market space at the periphery with respect to the center. Our explanation of small firm proliferation is more parsimonious than other theories, and in contrast to an earlier geometric model based on multi-dimensional sphere packing [22], we make assumptions neither about the shape nor the overlap of firms' niches.

The opposite process, of dimensionality decrease, does also occur [23], for example when an innovation renders a once salient product characteristic obsolete, or when a given characteristic is institutionally constrained, like the alcohol content of beverages during the American prohibition period. Analogously to market spaces, a political issue space [24] can collapse during a crisis characterized by discursive simplification or polarization. While increasing dimensionality normally lessens the chances of small firms' niches overlapping with those of large and powerful firms, decreasing dimensionality is likely to increase niche crowding. One might therefore expect that dimensionality decrease hits small organizations the hardest. But empirical evidence shows that a portion of the small organizations can then survive, even under conditions when large organizations are forced out. For example, when modern processor technology removed weight from the list of ICT characteristics, it caused a shakeout among well-established producers of vacuum tubes. Some vacuum tube producers, however, survived in the domains of high- end audio appliances and in military equipment resistant to the electromagnetic pulse of nuclear explosions.

In the remainder, we will explain the consequences of both increasing and decreasing dimensionality, but will abstract away from the particular innovations, preferences or institutions that cause it.

Model

From a potentially large number of niche dimensions, only few are important. These dominant, or salient, dimensions can be found by analyzing empirical data, for example obtained by interviewing consumers on the substitutability, $0 \leq s_{kj} \leq 1$, of firm k's offerings by firm j's. Alternatively, archival data can be used, e.g. from the Web. Either way, the eigenvectors corresponding to the largest eigenvalues of the substitutability matrix (with

cells s_{kj}) will point out the salient dimensions [25], on which we focus in the remainder.

Consider a market or political issue space with n salient dimensions. As said, empirical research pointed out that, with few exceptions, resource distributions in modern societies feature a center and a periphery [14]. Furthermore, the span on each dimension is finite, i.e. audience traits such as age and education have lower and upper bounds. We stylize these facts into our **assumption (1)** about the resource distribution: For each dimension i, its finite span r_i can be divided into a center $c_i > 0$ and a periphery $p_i > 0$, so that $r_i = c_i + p_i$. In non-metric spaces with ordered categories, or cells, it should be the case that the number of categories, m_i, on each dimension $m_i \geq 3$, in order to have a center and at least two peripheral categories; there, $r_i = m_i$.

To facilitate the presentation of our argument, but without affecting its generality, we simplify the uni-modal distribution by assuming a center to market span ratio c_i/r_i that is constant along all dimensions. We thus proceed with non-indexed r and c values, because our conclusion relies only on the amount of change of the ratio of the periphery volume to the entire market volume, cf. Eq. (3). A market space can now be modeled by an n-dimensional hypersphere with radius r, or alternatively by a hypercube with edge r. Its hypervolume $V(r)_n$ is

$$V(r)_n = \gamma_n r^n \tag{1}$$

where γ_n depends only on n [26]. For $\gamma_n = 1$, Eq. (1) yields the hypercube volume as a special case. The hypervolume $V(p)_n$ of the periphery is

$$V(p)_n = \gamma_n r^n - \gamma_n c^n = \gamma_n (r^n - c^n) \tag{2}$$

from which it follows that the ratio of the periphery volume to the entire market volume is

$$\frac{V(p)_n}{V(r)_n} = \frac{\gamma_n (r^n - c^n)}{\gamma_n r^n} = 1 - \left(\frac{c}{r}\right)^n . \tag{3}$$

If n increases, Eq. (3) converges to 1, hence the bulk of the market volume shifts to the periphery. This volume shift creates room for new entrants to proliferate. For example, if $c = \frac{1}{2}r$ and $n = 5$, which is still relatively low [27], the periphery contains 97% of total market volume (Table 1). Even when enlarging the center to $c = \frac{3}{4}r$, still 76% of the market volume is at the periphery.

c/r	0.1	0.25	0.5	0.75	0.9
$n = 1$	0.9	0.75	0.50	0.25	0.1
2	0.99	0.94	0.75	0.44	0.19
3	1	0.99	0.88	0.58	0.27
4	1	1	0.94	0.68	0.34
5	1	1	0.97	0.76	0.41

Table 1: Periphery-entire-market volume ratio, $V(p)_n/V(r)_n$, as a function of dimensionality, n, and of the proportion of center-breadth to market span, c/r.

Peripheral patches

We do not assume that with increasing market dimensionality, the total amount of resources (carrying capacity) increases as well. Spreading the same amount over more space implies that resources will spread thinner on average. Since volume increase is much higher at the periphery than at the center, peripheral resources may spread very thin indeed. Below some density threshold, scarce resources don't support a minimal sustainable level of operations. Empirically, however, we often do see small organizations at market peripheries, suggesting the existence of resource density variations between periphery locations. Resources are apparently clumped together into patches, which at the periphery are separated by virtually empty market space.

Why would resources cluster? Humans coordinate their interactions through common languages, norms, and other cultural elements [28]. Within groups, people have cultural elements in common, as well as associated preferences, e.g. for music, politics, or fashion. Between groups, we often see cultural cleavages, even if their memberships overlap, and cultural elements are used as symbols to signal group identity and group distinctions [29]. These considerations we summarize in an additional **assumption (2)**: peripheral resources cluster into locally denser patches. We neither assume that all culture and preferences are clustered, nor do we make assumptions about the shapes or sizes of these patches. When assumption (2) holds, even at high dimensionality peripheral resources may remain sufficiently dense at certain locations to support small firms.

Peripheral volume increase in conjunction with resource clustering explain the often observed resource partitioning between large firms in the

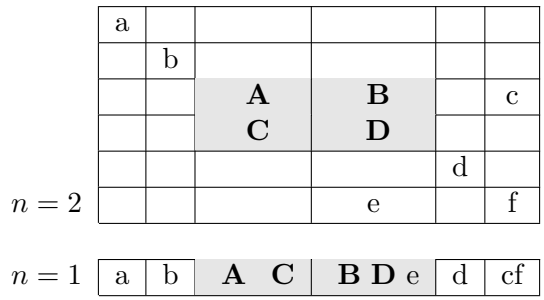

Figure 1: The impact of dimensionality decrease on the center and periphery of a two-dimensional market that shrinks to a one dimensional market. Capitals identify large firms at the center, while lower case identify small firms at the periphery, of which one, e, ends up at the center after dimensionality reduction.

center of concentrated markets versus small firms specialized in peripheral positions. As organizations have to trade-off niche width for appeal [6], the empty space in between the resource patches precludes large organizations in the center from invading the niches of small organizations, and it precludes small organizations at one patch from invading other patches.

The issue whether firms are independent, outlets of a chain, or under the umbrella of a holding company is largely unimportant for our result, except that small firms that do get part of their resources from a holding company can have a competitive edge.

Decreasing dimensionality

For ease of demonstration, we show in Fig.1 the differential impact of decreasing dimensionality for a market space with two dimensions, with large firms A–D populating the center (gray), and small firms a–f specializing in peripheral positions. When the vertical dimension disappears and n decreases from two to one, crowding increases throughout the center, while the filled peripheral niches are less likely to overlap; in this example only half of the peripheral players faces increased crowding. In general, dimension reduction increases the chances of niche overlap, hence the exit hazard, but this hazard is unequally distributed and is lower at the periphery. There, multiple positions remain for small organizations.

Discussion

We have explained both the proliferation of small firms with increasing dimensionality, and the continuing presence of some of them with decreasing dimensionality. For our explanation we have used few assumptions, and our center-periphery distribution of resources seems a more accurate representation of markets than an earlier model's even distribution [22].

Here, we did not investigate an increasing or decreasing market span on a given dimension, like when turbojet engines for aircraft were substituted for piston engines, and increased the span on the speed dimension [30]. One might incorporate changing spans in our framework by relaxing assumption (1). Future research may focus on this aspect, on factors we abstracted away from, or on the temporal dynamics of resource patches [31].

References

[1] Arrow K (1974) The Limits of Organization. New York: W.W. Norton.

[2] Coleman J (1974) Power and Structure of Society. New York: W.W. Norton.

[3] Greif A (2006) Institutions and the Path to the Modern Economy: Lessons from Medieval Trade. Camebridge, MA: Cambridge University Press.

[4] North D (1990) Institutions, Institutional Change and Economic Performance. Camebridge, MA: Cambridge University Press.

[5] Laland K, Odling-Smee F, Feldman M (2000) Niche construction, biological evolution, and cultural change. Behavioral and Brain Sciences 23: 131-146.

[6] Hannan M, Freeman J (1977) The population ecology of organizations. American Journal of Sociology 82: 929-964.

[7] Turchin P (2001) Does population ecology have general laws? Oikos 94: 17-26.

[8] Hannan M (2005) Ecologies of organizations: Diversity and identity. Journal of Economic Perspectives 19: 51-70.

[9] Ijiri Y, Simon H (1977) Skew Distributions and the Sizes of Business Firms. Amsterdam: North-Holland.

[10] Axtell R (2001) Zipf distribution of US firm sizes. Science 293: 1818-1820.

[11] Lancaster K (1966) A new approach to consumer theory. Journal of Political Economy 74: 132-157.

[12] Irmen A, Thisse J (1998) Competition in multi-characteristics spaces: Hotelling was almost right. Journal of Economic Theory 78: 76-102.

[13] Boone C, Carroll G, van Witteloostuijn A (2002) Resource distribution and market partitioning: Dutch daily newspapers, 1968 to 1994. American Sociological Review 67: 408-413.

[14] Carroll G, Dobrev S, Swaminathan A (2002) Organizational processes of resource partitioning. Research in Organizational Behavior 24: 1-40.

[15] Mokyr J (2002) The gifts of Athena: Historical origins of the knowledge economy. Princeton: Princeton University Press.

[16] Stinchcombe A (2001) When Formality Works: Authority and Abstraction in Law and Organizations. Chicago: University of Chicago Press.

[17] Geroski P (1995) What do we know about entry? International Journal of Industrial Organization 13: 421-440.

[18] Jovanovic B (2001) Fitness and age: Review of Carroll and Hannan's Demography of Corporations and Industries. Journal of Economic Literature 39: 105-119.

[19] Baumol W (2005) Education for innovation: Entrepreneurial breakthroughs vs. corporate incremental improvements. In: Jaffe A, Lerner J, Scott S, editors, Innovation Policy and the Economy, Cambridge, MA: MIT press. pp. 33–56.

[20] Schoener T (1974) Resource partitioning in ecological communities. Science 185: 27-39.

[21] Rath J (2005) Feeding the festive city: Immigrant entrepreneurs and tourist industry. In: Guild E, van Selm J, editors, International migration and secutity: Opportunities and challenges, New York: Routledge. pp. 238–253.

[22] Péli G, Nooteboom B (1999) Market partitioning and the geometry of the recourse space. American Journal of Sociology 104: 1132-1153.

[23] Dobrev S (2000) Decreasing concentration and reversibility of the resource partitioning model: Supply shortages and deregulation in the Bulgarian newspaper industry, 1887-1992. Organization Studies 21: 383-404.

[24] Downs A (1957) An Economic Theory of Democracy. New York: Harper and Row.

[25] Green P, Carmone F (1972) Multidimensional scaling and related techniques in marketing analysis. Boston, MA: Allyn and Bacon.

[26] Conway J, Sloane N (1998) Sphere packings, lattices and groups. Comprehensive Studies in Mathematics 290. New York: Springer.

[27] Swann P (1990) Product competition and the dimensions of product space. International Journal of Industrial Organization 8: 281295.

[28] Richerson P, Boyd R (2005) Not By Genes Alone. Chicago: University of Chicago Press.

[29] Efferson C, Lalive R, Fehr E (2008) The coevolution of cultural groups and ingroup favoritism. Science 321: 1844-1849.

[30] Constant II E (1980) The Origins of Turbojet Revolution. Baltimore: Johns Hopkins University Press.

[31] Bruggeman J, Ó Nualláin B (2000) A niche width model of optimal specialization. Computational and Mathematical Organization Theory 6: 161-170.