
RESEARCH REPORTS

INTERFACES

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Introduction

The first question should be why our topic, organizations, looms so exceedingly small in the main ranges of social science theory. I think the answer is that the existence of organizations is regarded by many theorists as contributing only frictional effects, minor disturbances. It is instructive to probe the presuppositions that divert effort from measures of organization.

It is not that main line theories deny the existence of "organizations as actors or agents in the process of social change," to use the words of our convenors. A major current vehicle for institutionalist objections to the mainline is Managerialism as revived and extended by Chandler (1969, 1977) and others. Managerialists insist on the boundedness and the self-absorption of the organization, which takes on the self-sufficient aura of a Hollingshead Elmtown. Mainline theorists can accept this, either so long as there are processes of creation and dissolution, or of entry and exit for these organizational actors under environmental press, or else in the special case where the organization is a Sovereign State.

Mainline theories rely on averages; they construe average flows as driving the social system with enough pressure to overcome what are thought of as minor institutional rigidities thrown up by organizations. I think this theme is common across otherwise disparate theories: Marxists see cumulating pressures which, though they may change the system eventually, are effective at once in establishing first-moments, just as the centerpiece of neoclassic economics is the thoroughly linear General Equilibrium Theory (Arrow and Halm, 1971). I argue that we play into this view if we reify organizations each as an actor in a generalized environment about which it speculates.

Variances, not means, and indeed variances rubbing against one another are the basis of the control profiles from which we precipitate out organizations as reifications. A boundary is a social "act," an act hard to keep together and sustain; it is not a skin. I propose that we throw out the term altogether in social system analysis because it is so misleading, such an inappropriate borrowing from natural science. "Interface" is a term with appropriate connotations, especially that any "dividing line" in a social system is a two-sided affair which must be actively created, perceived and reproduced on each side, in order that there be a demarcation. Interfaces sustain themselves on differences among variances.

Markets are not marked off from firms in the perspective I advocate, for all are ways of talking about interfaces, in strings and other concatenations imbedded in and making up a particular chunk of economy. In three recent publications (White 1981 a, b, c). I have worked out a family of specific models for a particular form of interface which describes many markets in the sale of goods by a set of producers of differentiated products. There is a mismatch in size between constituent flows on producer and buyer sides, and there results a strong asymmetry. The market interface can be described as a one-way mirror. Producers are watching the trace of each others' actions, are seeing each other in the reflection from the terms of trade sustained by myriad flows of purchase from the other side. The other side looks through this mirror interface to the particular products and their terms they wish, without being concerned with each others' actions.

All actions are decided in terms of directly observable acts and on criteria of self-interest. The models make it clear that such interfaces, as terms of trade, sustain and reproduce themselves only as profiles which turn out to balance off dispersions among producers costs (across volume and across quality) against dispersions among buyers' valuations. Thus, a market is not driven by some average need on one side or the other, nor by some convergence of aggregates averages, called Supply and Demand, but rather by a matching of variances possible from any of a wide range of profiles.

That is but one type of interface, and one applied to an economic empirical context. Below I shall sketch variants plus an entirely different class of interfaces dealing with interpenetration rather than confrontation. I suggest that the same dependence on the second order, on variances across constituents will apply in all. Persons work through interfaces, and work to be in interfaces and work at interfaces, and in all these senses an interface is an envelope of the actions different individuals on each side take with

respect to one another's perceived actions. The fact that it is an envelope reflects an interface's being an aggregator, a gearer of constituents into an overall pattern, a locale for conversion from "micro" to "macro." But this is no mechanical act, no cultural fiat. People don't get taught by cultural code to make interfaces in concrete social systems; people learn to do so from the social presence of interface terms perceived by them as external, though seen by observers as being in a sense negotiated. It should be clear that I am trying to draw practical lessons concerning large systems from the great advances in social phenomenology of recent decades (Garfinkel 1967, Goffman 1963), advances too long confined by implication to small groups and intimate settings.

The organizational, I am saying, is the peculiarly social aspect of large social systems. It excludes the speculative psychological features appealed to by some of economic theory, and it excludes the cultural, imposed regularity postulated by some political science. Rhetorics, of course, are there as the frame in which people talk, talk often about speculations; but measures of organization should focus on those profiles of observable acts which lead participants to reconstitute through continuing acts the profile. It is suitable to name these profiles "control profiles," whether or not they are especially open to conscious shift by particular subsets of actors.

Let me cite a classic as authority. On the last page of Chester Barnard's Functions of the Executive, he speaks of humans in organizational life as "searching for limitations in order to make decisions." I do not think he quite realized the power of that perspective carried to its phenomenological limit. It says to me that our external culture does very little to site us in our actual social world, aside from some important namings and a set of stories available for posting on to what happened after the fact, so that we always are searching for and participating in joint action, seen by each as external and ineluctable, interpretable in an objective way. Barnard's quote does as well or better for arenas of political organization, and in a variety of cultural settings ranging out to the Pakhtun machinations Barth has dissected in a classic study (1970).

Social indicators for organizations should deal with the episodic as well as the continuing, and I cite two such studies, of the World War I War Industries Board (Cuff, 1973), and of the Depression Era National Recovery Administration (Hawley, 1966) in this country, to give verisimilitude to my scepticism about the first order flow determinism of mainline theories. Cuff describes organizational creatures striving to be born and thence to control national flows of industrial orders; he details how these very notions crumbled as infeasible myths to be replaced by self-constituting interfaces--in various guises of official committee or other cabals--whose outcomes were not determinate in advance by any first order code. Hawley (p. 459), in my view, reports a similar pattern except that instead of opting for any real organizational pattern at all to replace the myth of master organization by fiat, there was a retreat to the new Keynesian variant of the myth that flows on average force system performance despite organizational frictions.

In the strictly technical literature there also are signs of trouble for the dogmas of flows overriding structure. A basic concern of flow models is with trajectories of individuals. As I see it, this major line of work is culminating in models which are forced to deny the flow postulates. I argued this a decade ago (White, 1970). Just within the past months, James Heckman and Burton Singer, economist and statistician respectively, have circulated two papers which may set the new agenda. They center their model on an unobservable distribution on a latent variable which I argue can stand for organizational structure containing the flows. I argue so partly because of the very strange properties which estimation of the latent distribution proves to have: On the one hand, when particular familiar functional forms (lognormal, beta, and the like) are imposed to ease computation, the results prove completely wrong; and yet when the proper inductive approach is used, and yields good estimates of observable parameters, it seems not to be possible to estimate the unobservable distribution explicitly. This seems consistent with an underlying organization constraint of totally different form.

Current business practices give more homely examples in support of my themes. It is common for companies to be running revolving loans with banks, accounts receivable from work shipped out being the collateral, such that ordinary monthly payrolls are made with the bank's money; loan terms often are such that firms can be thrown into "chapter 10" almost at will. The point here is not bank power or greed, for terms rarely are enforced, not least because the local banks themselves interface with yet other banks and financial institutions again on formal terms almost unenforceable. Or lift your sights to the large firms, Fortune 500 and the like: The internal distinctions among divisions are baffling. Eccles' (1981b) recent comparative field study, as well as his review of earlier studies, suggest to me two certainties regarding "transfer pricing." (This is the Make-or-Buy issue amalgamated with the Inside-or-Outside sourcing for some or all of a product needed by own division.) The two certainties, as I read them, are that whatever is said to be the company policy is in fact not being followed, and whatever the practice is now it will not be the same in another year or two. Again it sounds like interfaces rather than tidy separate actors, interfaces which get negotiated on locally robust bases which are not and cannot be pressured through some average system-flows.

Appropriate Measures

The companion to the first question should be how does one devise measures appropriate to the skein-of-interfaces perspective on the organization system we wish to keep tabs on for social indicator purposes? How do we avoid building into the measures reification of organizations as disjunct integral actors? How to allow for non-linearities and for determination by curvature of the local situation? To answer these is to use second order measures, in any of several senses.

Ijiri and Simon (1977) elaborate earlier work of Simon on size distributions of firms. Their focus on a few parameters, given a stable form of the size distribution, is both economic and a way of considering directly a profile of control. Systematic updating of this work, and refinement, and comparative extension are in order. Cliff and Robson (1978) are a brilliant exploitation of this approach in a much more problematic field, that of city sizes, with its confounding by the autocorrelation of geographical distributions (see next section). Cliff and Robson show, with time series since 1800 of the British distribution of city sizes, a striking departure from common skew form as great new industrial cities popped up unexpectedly--and then a return to standard form by early in the twentieth century.

My market interface models assert that dispersions on producer and buyer sides must both be ordered by quality for that market to have sustained itself. In Table 1 are given the minimal set of four parameters required to identify the dispersions. I lay out in Figure 1 the two-dimensional space in which viable constituencies (gradations of cost structures and of valuation structures) for interfaces can be located. My point here is not the details of this figure, nor is it the validity of my particular operationalization of production markets; the point is that some such figure can be used to describe organization form and range in a second order way which is independent of the particular number of, and isolated characteristics of, firms as separate actors. That is, Figure 1 applies whatever the particular number of producers, or of consumers or their detailed characteristics, because all these have been boiled down to variations in the relative dispersions which matter to the establishment of a market interface. This figure is used for industrial markets in White 1981a and 1981b, and applied in the context of artistic production in White 1981c.

Take as a given a viable pair of constituencies for a market. It is now of equal importance to emphasize that the possible particular interfaces (as represented by terms-of-trade schedule) are numerous, and which if any becomes established depends entirely on the accidents of local history in negotiating a market. The moral for measures of organization is twofold, and with a warning. Don't measure particular organizations or even particular sets, but rather more general and robust parameters defining the viability of interfaces. Recognize that local gradients and not average long-range flows determine interfaces. Yet the combination of these two guides warns one that it is difficult to disentangle long-term change trends--e.g., a shift of interfaces in a direction in Figure 1--from local fluctuations--just from an observation of one interface over time.

Padgett's recent work on budget making (1981), where a collection of organizations are regarded as parts of one master, the State, examines a type of interface which is similar to the market, once concrete economic interpretations are abstracted. His is a stochastic model and introduces the important point that occasional catastrophic changes--governmental analogues of bankruptcies--must be considered a normal part of interface negotiation. Even in this most doctrinaire sort of "organization," the State, one again finds that mutual orientation to perceived interface traced from previous actions at the center of observation. External flow pressures--from Congress and from Executive branches--are exerted, paradoxically, only at a remove from the actual interface: One can see this from the fact that parameters reflecting those pressures are either below or above the interface in scale. The parameters which one wants Padgett to measure again later in order to trace change are again second order parameters (σ , δ , α): They bound the form for particular distributions or bound correlation measures of degree of independence (e.g., between departmental and OMB cuts). Particular organizations and their programs come and go, without the real continuity in the skein of interfaces being interrupted. One gets the same flavor about an earlier era in England from Roseveare's (1973) account.

It will not have escaped you that what we observers can note can also be noted by those participants who have time, position, and intellectual resources. Remember that we early introduced a quote from Chester Barnard, the New Jersey Bell president. My theme has been that organization phenomena are (at least) two-sided social constructions by active perceiver-participants; extend this to the idea that participants themselves sometimes can consciously take second order perspectives on how the system is working. Consider how Hollywood works in the era after T.V. Faulkner (1982) has laid out in lucid detail how films are put together as combinations of personages in specialized areas. Personages are defined socially by their sociometric-star location in networks of other such personages (for a technical framework, see Holland and Leinhardt 1981). Each of them, and their various agents, is eager to match only with equivalent personages: They understand well how interfaces are negotiated in their organization economy, in which separate organization-identities have been largely dropped as superfluous.

Williamson (1970) early emphasized how takeover and merger are crucial to economists' argument for regulation of organizations by a higher order capital market. Recent empirical studies (e.g., Salter and Weinhold, 1979 and Steiner 1975) give support to this argument, which has owners and their top agents consciously acting toward the field of economic organization as it is skeins of interfaces to be recombined, not discrete persona. I interpret the failures and difficulties of these mergers and the like as signs of how difficult it is to manipulate interfaces from afar (see Bower, 1971), since the essential to be preserved is not some hunk of assets but position in and existence of an interface, which is better thought of as a continually renewed barrier made up of flows than as a tangible material construction.

How are we to allow in our construction of measures for such second order participation? Somehow, we have to allow for a sort of reflexive recognition by the structure; surely no mere index scheme will do. I suspect that we shall have to build in measures of the organizational traces of this reflexive self-intelligence of the system by its privileged participants. The English have coined a wonderful new term, "quango" for Quasi-Autonomous-Non-Governmental-Organization, which designate one sort of outcome from second order intelligence on organization systems. The greatly enhanced and changed roles of accounting and consultant agencies is another outcome and contributor. A first step in social indicator measurement should be systematic tracing of access to and from such self-intelligence agents. It is a natural partner of the new developments in director interlock measures (e.g., Carrington, 1981) of mutual intelligence across our economy.

The same sort of insights as urged by Burns and Stalker (1961) long ago, also are applied by at least some managers, such as the legendary Dee Hock of VISA, to continual shakeup and re-interfacing within their own organizational field (Eccles, 1981c). VISA itself is a kind of quango straddling conventional banking lines. Padgett (1981a) has devised a model to James March's (Cohen and March, 1974) garbage can theory of organization: I see it as a very plausible portrayal of how Dwight Eisenhower ran the USA, a model for all executives who bend the interfaces so as to achieve their goals by second order leverage and free up time for lots of golf. The argument for second order indicator measures is reinforced.

Inequality

Particularism marks the measures which I have advocated so far for social indicator purposes. There is a natural hankering for a more universal base of measurement. I think this hankering is responsible for social science preoccupation with measurements of individuals as atoms and in flows. In natural sciences the universal base is physical space. One of the most effective of the social sciences, for that reason, is geography, which is a treasury of ideas for organizational social indicators: See the excellent recent survey by Haggett et al. (1977). But geographers, unlike most of us, are acutely aware both of the extraordinary constraint exerted by metric space (see for a full exposition Weyl 1949 and Poston and Stewart 1978), and also of the awkwardness of combining the limited direct impact of space on social systems with social topology. Spatial autocorrelation bedevils analysis. Wellman's "communities as networks" liberated the notion of community from physical spatial constraints.

Inequality provides a broad base for organization measurement. The very word presupposes there is an underlying comparability, in order that lack of equality have meaning. Its measure is inherently a second order one. In my market interface models, a correlate of each terms-of-trade schedule is a gradient of inequality (see White 1981b for details). The whole basis of an interface is the induction of such gradients on each side. According to my formulation, the mere entry or exit of firms or other actors at such an interface cannot erase this inequality gradient, since without it the interface evaporates. Firms in a market don't just happen to differ in profit rates; they necessarily differ in that, as they do in volume; an interface is an interrelated set of niches, to use the imagery Freeman and Hannan have introduced.

Inequality derives from equality, which is a specifically social construction as a concept. Measures of inequality should be predicated on there being a degree of recognition by participants of such inequality. But there remains a major gap between inequality as a byproduct of the operation of complex social organization, on the one hand, and inequality as a deliberately constructed pattern in an organization. The distinction is between crevice inequality and enacted inequality.

The Lorenz curve, of cumulative population versus cumulative goody, together with its Gini index, are an effective framework for comparing inequality across very different contexts--whether different in size of population, in kind of goody or in crevice versus enacted (cf. the survey of Schwartz and Winship, 1980, and the exposition by Alker, 1965). Consider first the Simon tree model of organization pay as developed by Williamson (1970, Ch. 2). It is straightforward to express their findings in terms of a Lorenz curve:

$$P = 1 - (1 - F)^{1-k} \quad (1)$$

as a very good asymptotic approximation, with P the cumulative proportion of the total goody received by the cumulative fraction F of the population. Here the parameter k sums up all one needs to know about the two independent parameters assumed in this deliberately homogenized model: If b is the ratio between pay of

subordinate and immediate superior and n is the number of subordinates to a superior (in each case throughout the organization in all branches and levels of the hypothesized tree), then

$$k = (\log b) / (\log n) \quad (2)$$

Here n is expected to be larger than b so that k is less than unity. In the limit as the cumulative fraction F approaches one, it is obvious that

$$(1 - P) \rightarrow (1 - F)^{1-k} \quad (3)$$

The upper tail of the enacted inequality distribution, the pay hierarchy of Simon's pyramidal tree, is seen to suggest a Pareto distribution.

The Pareto distribution takes us to the world of crecive inequality, where taxmen's reports of earned income across a broad population are tallied and modelled. After looking at many comparisons of crecive and enacted, I offer the following conjecture, which may seem counter-intuitive: Degree of inequality is always smaller in enacted than in crecive settings. That is, organizations, to the extent they actually follow common cultural forms of enacted inequality, are a device for reducing inequality relative to the un-planned workings of the entire organizational context.

To simplify our referent, let us shift to the Gini index that summarizes, as a fraction, the overall degree of inequality. Typical figures for wealth or other ownership distributions within a society range from 0.7 to 0.95; typical figures for income inequality in current Western societies range around 1/3 up to 1/2; typical figures for earnings inequality within a specialized area of the economy, which is not entirely encapsulated in bureaucracies, say among lawyers or among accountants, can be higher than those across the working population. The Gini index for enacted inequality as modelled in equations (1) - (3) is

$$G = \frac{k}{2 - k} \quad (4)$$

Now sit down and pull out your pocket calculator and try what seem to be plausible values for b and n ; you will be very hard put to come up with inequality as great as these figures for crecive inequality!

To my knowledge only one analyst has tried to make sense out of putting together crecive with the above sort of enacted hierarchical inequality. R. H. Tuck (1954) proposed that income inequality in the UK be accounted for by assuming persons blocked from promotion spun off their own firms, which then joined a standard pattern of growth. In appendices he actually carried out an extensive fitting of published statistics, some akin to Ijiri and Simon's, separated by regions of the economy. His work implicitly assumes that all interfaces of importance are within firms. It illustrates that one cannot separate measurement of social indicators from theory about organization.

Inequality can be construed more broadly, both by observer and by participant, to suggest measurement of differential position in a structure, and how it changes. This is coordinate with a broader concept of equality, as structural equivalence within a field of relations and/or movements. I think that the construct of social network should only be introduced in some such context. There is a real temptation to try to substitute "network" for "space" to give social science some topology. But the raw construct has and will continue to be of limited use; it is subject to the same limitations as the mainline preoccupations with isolate "actors" and imperious flows discussed earlier. Douglas White (1974) shows a number of ingenious ways to measure organizations from the standpoint of structural equivalence.

In three recent articles, Ronald Breiger (1978, 1981a, 1981b) has demonstrated how to induce measures of organization from changing fields of flows in networks as interpreted from a structural equivalence point of view. In one article, changing interfaces are derived among countries as trading partners in various sorts of goods. A second one infers elite factionalization process in Laumann and Pappi's German and American cities. Both these use blockmodelling approaches and algorithms originally developed to give measures of small group structure. In the current issue of the American Journal of Sociology, Breiger adapts loglinear measures to uncover the leading interfaces implicit in recorded flows of persons among detailed occupational categories.

Interpenetration

Interfaces, despite great variety, are not sufficient basis for construing social organization for purposes of indicator series. Nor is inequality, however generalized, everywhere applicable to measurement. I want to sketch some examples of another class, interpenetration.

Consider again the protean idea of social network, but now emphasizing not resonances in flows that push up structural equivalences (cf. Wilkov, 1972), but rather network as representation of distance. Granovetter has continued developing (1981) the phenomenology for strength of tie originally suggested by Rappoport. Think of the network as composed of two radically different types of ties, strong and weak: This net traces, on Granovetter's account, an interpenetration of two radically disjunct forms of organization (intimate in-grown versus casual farflung) on the same population in a manner hard to represent in terms of separate sets of people. Scott Boorman (1975) shows via a combinatorics model how homogeneous tendency toward concentration on strong or on weak ties can, in the context of others' choices, impact the spread of information on desired jobs. The general phenomenon, worth measurement in a variety of indicator series, is how networks function as triage systems for social organizations. Shotland's monograph (1975) applying Small World measures within specific organizational context is one beginning.

Patronage systems (e.g., Badian 1967, Chevalier 1963) derive importance from the way strings of patronage bring interpenetration of what can be very disparate layers and kinds of social organization. A regularized analogue is the parallel hierarchy (Windmuller 1969, Evans 1977, Crozier and Thoenig 1976). In my opinion, a promising direction for second order measures here is a focus on alternation patterns in times of activations of the strings or pillars in such systems. A special case of this kind of interpenetration is the mobilization upraising of a hierarchy so lucidly described by Michael Schwartz (1975). A profound study of such interpenetration through conflict mobilization on an even larger and longer continued canvas is Kuhn (1970), whose monograph has generated a considerable literature which could be the basis of an ex-post indicators series.

Interpenetration takes quite a different form when there is use of a detailed cultural framework as mapping device. Job frames are a major example. Kelsall (1955) early on introduced one form, where mapping was by rather broad categories defined by external class criteria. I carried out (1970) a study at the other extreme of mappings of individual persons to jobs, and Stewman and others (Stewman and Konda, 1980) have worked on interpenetration at an intermediate coarseness of mapping. Herbert Simon's idea of counterpart units--the mirroring of one organization by a specialized organ in others with which there are dealings--is a sort of interpenetration intermediate between these job systems and the parallel hierarchies above. This intermediate sort reminds us of how unreliable a distinction is the cultural dress applied--I could as well have emphasized the "heterodox versus orthodox" aspect of multiple hierarchy. This reinforces my hunch that timing measures, especially of initiation of streams of events, will prove the most reliable base for indicator series.

Perhaps the most common form of interpenetration among social organization will be structures of access. Whether in a business or a governmental context, much of the intense action concerns access to "centers" defined by their being difficult to access! It is not a simple matter of referral levels of a technical sort--as for example in placement of city services (Chaiken and Larson, 1972)--but a matter of outreach through agents of a center interpenetrating into arrays of other organizations, seeking access. Congestion phenomena are one concrete form.

There are negative forms for exclusion. Vicinage, for example, and entailment were procedures for pruning access from positions in descent trees into ownership structures. I think the table-of-organization tree should be seen in this light: It is the envelope of ties left after all systematic prunings of access have been effected.

Measurement of interpenetration for social indicator series could begin with such obvious data as records of telephone intercommunication in managerial reaches of large hierarchies. Could one even tell, given such records but without any other hints, where the boundaries of one and another "organization" were to be distinguished in the field of telephone numbers? A second obvious place is records of judicial appeal of cases: Shapiro (1980) makes a trenchant argument for appeal as being a manipulative process of control by access to a center of power. The most general context for measuring interpenetration, it seems to me, is the intercalation of committees across large systems: How to do this is not clear, but I suspect the main path has to be through coding careers of individuals in terms of the evolving array of committees.

Conclusion

High polymer gels may seem a peculiar topic with which to end, but I think deGennes' book (1979) is a magnificent work which can hearten us, instruct us, and warn us in our pursuit of appropriate indicators of organizations in society. His problem is not totally unlike ours: How to account for the strange properties of gels which are dominated by very long molecule-chains, chains so long they have individualizing kinks and quirks of spatial location (knotting) and of constituents. Compare his account with an early account in Seitz's classic survey of the physics of matter (1940): Night and day; so such messy problems of gloppy structure can be dealt with powerfully!

One aspect of the achievement seems to me to be, in the terms used earlier, an early shift to second order measures. Rosen (1974) shows how to use "envelopes" in social science much as is done by deGennes. Another aspect is an assumption that local gradients of intertwining would prove to be crucial determinants of overall properties. I think a main problem of work on social organizations has been an unspoken presupposition that somehow they were lawful in the way of gases, or, sometimes, lawful in the manner of regular crystals. Lawful they are, but the analogue surely is in messy allotropic goos or glasses.

The warning I extract is that one must push very hard on the exact meaning of one's most fundamental presuppositions of context in order to get major results. DeGennes has physical space, we do not; but ironically it turned out that physical space had to be understood in a more profound sense than Descartes' to make real progress on these systems ordered at the second level. Kenneth Wilson (1979) was the pioneer of the very strange view that space could best be construed as having a decimal number of dimensions as the context for messy systems near break points so decisive that distinctive chemical features lost all importance.

TABLE 1

i) Phenomenology of Market Context

		<u>Dispersions</u>	
		on volume (y) of Firm's Production	across Firms on Quality Index (n)
S c h e d u l e s	Valuation	<u>Contribution</u> of the product increases with volume, as perceived by the buyers	<u>Desirability</u> of the product increases with quality as judged by the buyers
	Costs	<u>Cost</u> of production increases as volume increases	<u>Expense</u> of building in the quality changes (+ or -) with increased quality
		Increases With Volume	Changes With Quality

ii) Parameters--Proportionate (log) Rates

a	b
c	d

iii) The Basic Tradeoffs

-- Over variation in product volume: $\frac{\text{Contribution}}{\text{Cost}} = a/c$

-- Over variation in producers' quality: $\frac{\text{Desirability}}{\text{Expense}} = b/d$

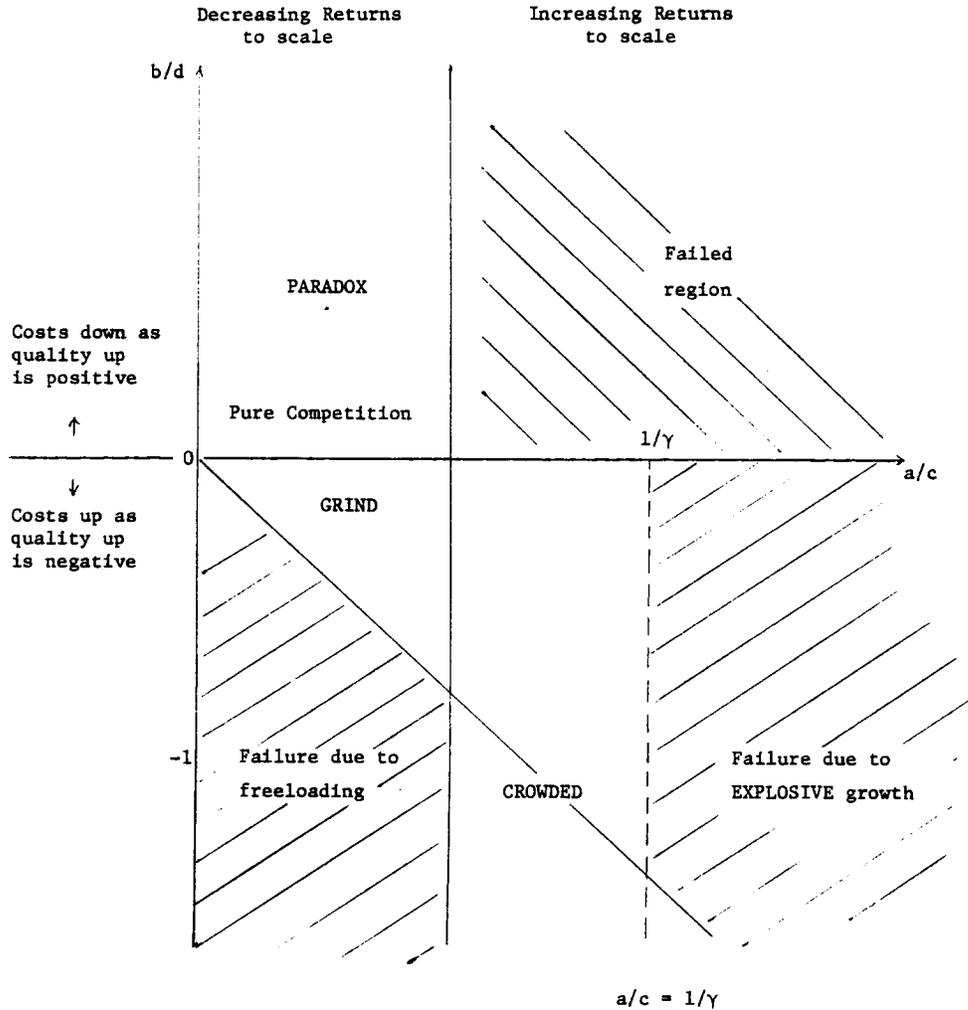


Figure 1: Tradeoffs in cost versus valuation, across growth in quality (ordinate) and in volume (abscissa)

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