HOW BUSINESSES MOBILIZE PRODUCTION THROUGH MARKETS:

Parametric Modeling of Path-dependent Outcomes in Network Flows

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Abstract

Business is modeled as interlocking social constructions that emerge in mobilizing differentiated production flows amidst uncertainty. The model is stochastic, non-linear, and sited in a network ecology for identities that have come to share a discourse which itself recognizes distinct levels of firm, market and sector

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Most markets today regulate production flows of goods and services, rather than exchanges of existing stocks as in traditional sorts of markets. Persistent directionality in continuing flows of intermediate goods is indeed the hallmark of our economy. So three roles, not just buyer and seller, are involved in the commitments that producers in each given market make each period. Each producer firm guides itself into a niche along a market profile from watching actions of its compatriots. That profile is sustained when it offers tradeoffs of quality versus volume that are equally attractive downstream to buyers.

Economists have not as yet agreed on how to characterize the process and structure through which particular firms actually constitute a market. So they largely pass over particular <u>firms</u> by settling for a stylized story of pure competition where buyers don't distinguish between different firms' qualities of product. On the other hand, analysts of firms' histories and strategies, as well as structures, usually pass over particular <u>markets</u> and focus on various relations among, and orientations by, firms. Neither of these approaches has been able to provide a plausible account of a production economy, because neither is able to explain how markets and firms interdigitate as they co-evolve in networks of flows.

As in other articles in this issue, complexity emerges from network interactions. But here the constituent 'actions' depend upon interpretive understandings, joint and several, and this has to guide the elicitation of parameters and the handling of path dependencies and other indeterminacies. This account thus attempts to meld interpretive with positivist modes of analysis and modeling.

Networks of relations define social space and forces. Each connection to some degree entails and warrants other connections in that locale. This field of local forces induces also effects of longer range computable in terms of patterns of structural equivalence. The task of this paper is to operationalize this across production markets with flows together with payment flows determined by generalized rather than localized exchange.

Each producer firm is of course eager to optimize net returns over the costs it incurs upstream. But the key intervening influence is search by producers to reduce uncertainty in outcomes from their commitments. Network ties can insure some degree of habitual placement but thereby also limit options in adapting to changes downstream in the uncertain world of business. A niche within an industry establishes you in a line of business, with wide recognition. The more profitable the niche, the better, of course. So the market is a joint social construction that sidesteps as much as it utilizes binding in social networks.

The first parts model a signaling mechanism which can sustain different sorts of markets in equilibrium, each across various assortments of producers by quality. I abstract from the solution a two-dimensional map for market varieties. Then I also parameterize interactions among markets lying cross-stream from one another that are substitutable to some degree in buyers' eyes within networks of productions flows from upstream to downstream. A final section introduces a dual form of production market whose profile is oriented back upstream to suppliers when they are perceived as the greater source of uncertainty for choosing production commitments.

Profile as signaling mechanism

Aggregate revenue to a market, $\boldsymbol{W}$, must be computed as the sum of worth $W(y)$ of flow volume y from each producer firm in the market. But these latter lie along a profile that frames and thus disciplines their commitment choices, thereby affording secure identity as a recognized line of business spread among distinct niches for each firm. So the analyst, given that this profile reproduces itself out of social pressures from upstream and downstream, must figure out how to scroll across the particularities and total number of the firms.

Quality niches--Start with the very special case of perfect competition where downstream buyers do not distinguish one firm's product from another so that only the cost side distinguishes one from another as they jockey to fill volume that is accepted downstream. Good old Supply-and Demand reigns as each chooses volume where its unit cost equals the common price from perfect competition. Sensitivity in valuation downstream of volume and the same upstream as to cost are the parameters you need. But the mathematics shows that only the ratio matters; so the state space for market context that is sufficient to identify market outcomes in price and volumes for any particular set of producers is just a line segment representing possible ratios from zero just up to 1 (Figure 1).

-- FIGURE 1 ABOUT HERE --

In this state space you know that only firms whose unit costs increase with volume fit here, unlike in most actual markets. The denominator is *c*, and let *a* designate sensitivity downstream.

But obviously most markets must embrace producers who differ by quality perceived downstream that correlates with differences in producers' costs. And conversely: see Zuckerman (1999). Let *n* designate quality. There must be sensitivities in valuation also to quality, both downstream and upstream. It makes sense that again only the ratio really matters for market outcomes; so we suppose that the state space gets extended as shown in Figure 2:

-- FIGURE 2 ABOUT HERE --

Designate the ratio for quality as *b/d*, in parallel to the ratio for volume, *a/c*.

Market profiles--What could hold together this market ensemble of firms of differing quality and cost? There's no referee, and the buyers can only react once the different producers have committed to volumes. So the mechanism must be some framing of the firm's choice such that the volume it perceives as optimizing its net receipts also is accepted downstream as being a tradeoff between volume for quality as desirable as for each other producer.

Not all firms are run by rocket scientists so the signals they attend to in making their choices must be ordinary observables and without any elaborate computation being necessary. Quality normally is not observable in any numerical form. I propose that the producers watch each other's shipment/price outcomes and interpolate among them to guide own optimizing choice. This mechanism reinterprets the signaling model of Spence (1974). Their confidence that any choice along this profile will be confirmed rests on the common sense that curvature of market profile reflects existing tradeoff downstream that concedes higher price to higher quality at lower volume. Each producer interpolates a profile through the revenue and volume outcomes of all, and chooses an optimum volume versus cost (Figure 3).

-- FIGURE 3 ABOUT HERE --

MAP for state space--I will spare the mathematics, but plausible specifications of the families of cost and attraction structures across the producers' flows do in fact characterize what profiles are viable. One of the two big shifts from perfect competition is that no longer is market aggregate $\boldsymbol{W}$ determinate. Supply and demand are replaced by path dependence in finding a profile that will reproduce itself and survive.

The other big move beyond perfect competition is exactly that there is curvature in the profile, rather than the straight line for price constant with volume. The mathematics show just how the curvature in the market profile is determined by context (one uses a partial differential equation). This curvature must obtain regardless of just how many producers there are and how spread out on quality, and so on. From the mathematics the context that really matters is defined by two ratios. One is the downstream versus upstream ratio of valuation sensitivity to variation in volume: just the ratio plotted in Figure 1. Designate it hereafter as *v*. The other is a parallel ratio but now with regards to sensitivity to quality level. Designate it as *u*. These two ratios yield a plane state space like in Figure 2. The mathematics predicts curvature of viable market profile just from location in this plane, which can be seen as the state space of the market.

But now enters substitutability between parallel markets. Introduce a substitutability parameter *x*, the degree of "Xcuse me for butting in." Let the limiting case of no substitutability, a market as unique source to downstream customers and upstream procurement, be $x = 1$; with more substitutability represented by higher value of *x*. This *x* is not a ratio. (The mathematical device used is an exponential cap. on the sum of buyers' valuations indexed by the numerators of *v* and *u* across the packages of volume and price, $W(y)$, offered by the various firms.)

No longer can one say the volume sensitivity ratio of Figure 1 is capped at unity: markets can be viable even when producers have increasing returns to scale with volume. So the proper state space given some degree of substitutability *x* is an enlargement of Figure 2: Denote this Figure 4 as MAP. The range of *v* is extended above 1 up until *x*, as indicated.

-- FIGURE 4 ABOUT HERE --

One can think about where various industries and service markets among us may be located. I have entered one suggestion in each region of MAP. Each is dated, since a given industry may move through the state space, for example according to the life cycle of a product as technology and taste change. My book shows (White 2002a, chapters 7 and 8) how to estimate context parameters from observed market profile and then predict firm and market outcomes: Guidance for necessary computation algorithms comes from closed solutions for special cases, which is all I report in this paper. Details of these equations are furnished just around discussions of *x*, substitutability. But first consider indeterminacies in the solution.

Path dependency--My models give formulas for market sizes and concentration ratios along with price structure and profitability, for each point in MAP. But predictions are subject to path dependencies, which appear as two indices in the formulae. One index, labeled *k*, appears as a constant of integration that displaces the market profile, keeping its given curvature determined from *u* and *v*, the location in MAP.

This index *k* is also an expression of flexibilities that entrepreneurs can exploit to shift existing markets to new locations. A market profile curvature is viable only for some particular range of *k*, differently for different regions in MAP. Figure 4 already outlined triangular regions in MAP accordingly. Figure 5 supplies some specification of range of *k* for viable market profile.

-- FIGURE 5 ABOUT HERE --

Only when k = 0are explicit closed formulas obtained, and Figure 5 shows that those profiles are viable only in two triangular regions that share a common point at v = 1, u = 1. In the special case of k = 0, profitability is the same for the firms in a market, and this common profitability ratio furthermore is constant along a diagonal through the (1,1) point across the two triangles: indeed, with k = 0,

$$\text{profitability} = (1 - v)/ (1 - u) \qquad (1),$$

where profitability is revenue less cost, divided by revenue. So it is low along the v = 1 boundary line, and grows for successively lower diagonals through (1,1) toward 100% on the one through (0,0): Illustrative diagonals are entered on Figure 5 as dashed lines; instead of profitability just the ratio of revenue over cost is indicated.

For diagonals still further down, a viable market is not guaranteed with k = 0 as will now be shown.

Quality descriptors, aggregate size, and PARADOX and **unraveling** regions-- Return to the set of firms with distinctive quality niches that reproduce a market profile such as in Figure 3. The mathematical prediction of profile curvature are derived for a representative firm: designate its quality or niceness by a variable n. But the particular profile's height depends also on both path dependency indexes, whose sizes for profiles that are viable depend on the full set of firm locations on quality n. In particular, in the region of MAP to be labeled **unraveling,** for all values of k there is the possibility that an otherwise viable profile will disintegrate if firms from lower range of quality offer production from a niche along the profile (White 2002a, chapter 3). Figure 6 supplies this labeling.

And of course the aggregate size $\boldsymbol{W}$ of the market revenue also depends on the full set of n. So does the aggregate market size in volume of production, call it Y, which also is to be computed in the second section. Besides sticking to the median value of k = 0, in order to simplify the second section further I will assume the firms, of number #, are spaced evenly on quality from a minimum value of 1 to a maximum quality of N.

The prediction formulas accommodate any locations of the set of # firms along quality n. Actual computation, however, requires iterative numerical algorithms to deal with arbitrary sets on n, and also for k not zero (White 2002a, Appendix). The phenomenology supporting this profile mechanism also embraces such arbitrary sets. But there is a proviso.

It is an analytic convenience to speak of 'the quality" and designate it by n. But of course there are two different perspectives on quality, one for buyers by the most they would pay for a quality level for given volume. The other perspective, by the producer firms, focuses on cost associated with various volumes for the quality they have spent for in facilities and procedures. These two contrasting perspectives have, for analytic convenience, been folded, respectively, into the numerator and denominator of u. So the spacings on cost quality and on buyer quality are allowed to be different, but the remaining inflexibility is yet another approximation in the interest of tracing explicit solutions amid complex nonlinear processes with feedbacks.

What is absolutely essential in the phenomenology, which is not compromised by the model, is the **same ordering of firms by cost quality as by buyer quality**. But the derivation shows that this common ordering need not have the same polarity. It turns out that viable market profiles will be found also when the product most highly valued for quality by buyers is at the same time the producer with the lowest cost structure.

Mathematically, this means that the ratio u is negative, less than zero. Thus MAP, the space of market contexts, must be doubled, as shown in Figure 6. This whole additional region is split only by the $v = 1$ ray: no profiles are viable for contexts above that line, it turns out, and all profiles with non-positive values of k are sure to be viable in the bottom half. It turns out that each diagonal for fixed profitability drawn through (1,1) back in Figure 5 just extend on down into this PARADOX region. Locations for two industries are suggested there.

-- FIGURE 6 ABOUT HERE --

Substitutability as siphoning--Now turn to the larger canvas of whole sectors of parallel markets that neither buy from nor sell to each others members. Substitutability is a more abstract notion than curvature of market profile, cost curve, and the like, or than polarity of quality order. Construing the parameter x introduced earlier presupposes--as with $W(y)$ and with n, but unlike for u and v and y--actors and process embedded in distinct levels. And the value of x is not tied to values of u and v, anymore than they are tied to one another. So the state space of Figures 4 or 6 must be projected into a cube, with each plane corresponding to a value of x. Figure 7 traces how market aggregate size $\boldsymbol{W}$ varies along a perpendicular sticking out of the plane of Figure 4, which is indexed by x.

-- FIGURE 7 ABOUT HERE --

The upper curve in Figure 7 applies along a diagonal ray in MAP through (1,1) that is close to horizontal; the lower curve applies at points in MAP along diagonals lying closer to 45 degrees. For equations and explanation see White (2002b).

Figure 7 suggests just how differentiated competition can sustain markets even though its firms have increasing returns to scale. The upper curve of Figure 8 shows how the market size $\boldsymbol{W}$ grows as substitutability x shrinks for any particular value of u and also of v. The lower curve is for some smaller value of v; so each can be seen as along a perpendicular to one point on the MAP plane of Figure 4. Both points are in the region with $v > 1$ labeled CROWDED in MAP. And of course $v > 1$ says that buyer willingness grows faster with volume than does cost; so Figure 7 describes markets with increasing returns to scale. (In a market specified by a point in some lower regions of MAP, change in x has much less impact on the market size $\boldsymbol{W}$).

Siphoning is metaphor for the upper curve in Figure 7, where as substitutability x increases, the size of the market shrinks because of presence of similar markets lying cross-stream from it. But note the discontinuity: market size actually blows up, before x gets down to unity, exactly when x gets down to equal v. (Below v corresponds to the EXPLOSIVE region in MAP, where indeed increasing returns to scale make persistence of the market unlikely.)

But what about effects from sensitivities to quality? A relevant question, since differentiation in quality fuels this market mechanism. Indeed the quality sensitivity ratio u is crucial. When the value of v is below some critical size v_C (that is computed using the value of u), siphoning is flipped into its opposite! The lower curve in Figure 7 is for such a v, labeled v' there. Instead of siphoning from, the size of the given market is bled away into those parallel markets. So only part of the whole triangle region labeled CROWDED (Figure 4) supports viable markets despite increasing returns to scale. Of the whole triangle as shown in Figures 4- 7, a band along its bottom is disregarded: There the backward-siphoning of Figure 8 takes hold so that the aggregate size of market will be small.

Upstream orientation

The two major regions of MAP labeled ***unraveling*** and **TRUST** in Figure 6 do not sustain market profiles sure to be stable with $k = 0$. When the distribution of quality across firms actually seeking niches in any market will sustain a stable profile, one can always turn to iterative numerical calculations (White 2002a Appendix) for making predictions. Even so, overall guidance from exact equations is not available for ***unraveling*** and **TRUST.** Such qualitative guidance, with sensible outcomes for dependent variables, does prove feasible for a dual mechanism for market oriented back upstream.

Return to the basics. Production flows, of goods or services, are what most markets establish today, rather than exchanges of stocks as in traditional sorts of markets. Three roles, not just buyer and seller, are involved in commitments decided in making these markets. I have already worked through the implications of these assertions with the aid of a specific signaling mechanism operating across some set of firms arrayed on quality: The outcomes depended on ratios of contextual sensitivity downstream to that upstream, first with respect to valuations of volume produced and second with respect to valuation of differential quality of these flows. Across the world more and more of economic action is becoming engrossed into such network systems of production markets.

But half the possibilities for viable market mechanism have been left out so far. The operation of each market, its patterning of commitments by firms to production volumes, evolved to shield firms from Knightian uncertainty of their line of business as they perceived it. Yet, in various contexts and eras the <u>focus of perceived uncertainty may lie back upstream versus suppliers,</u> rather than, as assumed thus far, being downstream vis-à-vis purchasers. It turns out that the two orientations are largely, though not wholly, complementary in that contexts known to support a considerable range of viable market profiles in one orientation usually do not support such a range for the other orientation. Range here means range of evolutionary paths, that was indexed by k for downstream orientation.

I begin with a brief sketch of the market mechanism with upstream orientation. Then I explore substitutability and feedback interactions. I end by examining how upstream and downstream orientations complement and contrast with one another.

Much the same phenomenology of signaling for downstream still can support a market profile facing back upstream as shield against uncertainty. And this dual upstream mechanism proves to yield much the same MAP space for arraying outcomes for a market according to its context. Again the embedding of a market set of firms into context is measured by two sensitivity ratios, one as to volume and one as to quality. Continue to use the same designators v and u for these two ratios.

But now the context is upside down: Draw again a contrast to perfect competition with which we started. With upstream orientation it is the downstream buyer side that is seen as predictable, with each firm approximating the revenue it anticipates from volume of its output by a determinate curve, analogous to cost structure for downstream (but now lying above the $W(y)$ profile). Take as a first example Home Depot and its competitor wholesalers; a second example would be supermarket chains in a region. Each such producer has enough marketing expertise and experience to be confident of what revenues it can earn according to overall volume of throughput it commits to. Only in an occasional era would they come to see winds of Knightian uncertainty blowing downstream, say when a movement against coupons and sales as improper morally took hold.

Turn to the wine sector. Consider an established market say in Burgundy or Rhone reds where experience gives the set of producer-brokers confidence about revenues they can get from various levels of production. So instead their headache is acquisition of their shares of suitably skilled vintners. One also could think of Australian producers who have created from scratch a whole industry calibrated to predictable sales internationally of their reliable yet distinctive wines of good quality at production volumes large when they can inveigle enough skills (possibly recruiting from France).

So now its billings from suppliers, e.g., its wage bill, is the puzzle for the representative firm in choosing its optimum commitment from among a menu curve it reads from peers' signals. Now $W(y)$ is this revenue expended, rather than the revenue received by the representative firm according to its level of output y. The dual to Figure 3 thus has the set of determinate curves lying above rather than below the market profile. This $W(y)$ is now, in producers' eyes, a liability to be pushed down, rather than its reward to be pushed up. Maximization by the producer pushes down against rather than up with $W(y)$.

What concerns the suppliers, of course, is the gap by which $W(y)$ exceeds their aggregate reluctance to deliver to the representative producer the amounts required to produce flow of volume y. This supplier side can enforce equally good deals, as to wages over their reluctance or distaste. By how much do the wages payments they receive $\boldsymbol{W}$ exceed their aggregate reluctance to supply? This measure, the dual to tau, is the ratio of aggregate reluctance to aggregate $\boldsymbol{W}$. It must be less than unity. Suppliers would simply evaporate from situations described by a ratio of unity or more. Operationally, this reluctance to supply amounts to the minimum aggregate payment suppliers would have accepted for that menu of equally attractive offers.

But again, the choice of volume commitments is still by the producers. Each chooses from its own determinate curve of revenue from downstream. It picks that volume which maximizes its net profit after subtraction of the wage bill $W(y)$ which it paid.

Again the sensitivity ratios determine the curvature of $W(y)$. This is the curvature that can sustain itself against the competing pressures from producers and from suppliers, It coaxes each producer into a distinctive niche on price, such that the niches offer equally good deals in suppliers' eyes.

With such curvature given, again a whole family of profiles, index them again by k, may each prove sustainable. Exactly the same abstract formula (1) continues to apply, but with the substantive meaning reversed, $W(y)$ being a liability rather than a reward of the representative producer.

The results are easiest to read not from formulas but from the upstream analog to MAP that is given in Figure 8. This also reports, like Figure 5, the ranges of k that yield viable markets, now in upstream orientation.

-- FIGURE 8 ABOUT HERE --

Not surprisingly, the pattern of bounding regions by the diagonal and unity lines carries through. Figure 8 is the dual MAP to that in Figure 6 for downstream orientation. Five features are striking.

First, what was the ORDINARY triangle is now forbidden, not viable. So upstream orientation cannot hold in contexts close to what is assumed in approximating the market in terms of pure competition. The contrast between upstream and downstream orientations is greatest just in these contexts.

And the delights of operation in ADVANCED contexts are not available. When buyer sensitivity to quality gets very high relative to suppliers' (large *u*) that must be counterbalanced by low buyer valuation of higher volume relative to suppliers' disvaluation of such. But that requires just that ***unraveling*** quadrant not available in downstream orientation, because of unraveling of profile discussed around Figure 5. So these are the second and third striking features.

The fourth feature is that upstream orientation is maximally viable (range of *k* largest) for the quadrangle with volume sensitivity ratio greater than unity and quality sensitivity ratio less than unity (rectangle labeled TRUST for downstream orientation earlier). This quadrant is really more turf for upstream. And the fifth feature is that the remaining half plane, PARADOX, is indeed equally suitable either for downstream or for upstream orientation of market signaling mechanism (but for *k* non-negative rather than non-positive).

Substitutability and feedback--Somewhat the same account can be given for cross-stream interaction as earlier was given for downstream orientation. The analog to cross-stream substitutability across markets facing downstream will continue to be greater than unity, like the parameter *x* was for downstream. This analog to *x* is the exponential power by which aggregate reluctance of suppliers to the market in isolation is pushed up by any presence of alternative calls for supplies from other markets. Whereas *x* reflected the shrinking of buyer call for products from the given markets because of substitutability with the parallel markets.

So continue to designate the cross-stream interaction parameter by *x*, now a mnemonic for 'Xcuse me for butting OUT'. Again its minimum size is unity. Again, being an independent parameter it defines a third dimension for the dual MAP.

The ratios of parameters are inverted, but the label kept because the same numerical value is assigned for computing results which are comparable as to substantive context on cost and buyer sides. The analog to formulas for the rays in Figures 5 and 7 in terms of *e* is now

$$h = (u - v) / v\,(u - 1)$$

It follows that the analog to a ray is an hyperbola passing through the center point (1,1), defined by a formula in coordinates measured from that center, U= u-1, V= v-1:

$$h = (U - V) / (V - 1) \cdot U \qquad (2)$$

whereas in these coordinates the defining equation for the linear ray for downstream (which was not reported explicitly earlier) is just

$$e = (U - V) / U \qquad (3)$$

Conclusion

What remains for further exploration is how cross-stream interactions among markets with one orientation may interact with cross-stream interactions among markets with the other orientation. Bothner and White (2001) have explored this. And Zuckerman (1999) and Mackenzie (2001, 2002) have examined effects of interactions across investment and finance markets. These suggest extensions and likely correlations to various factor markets as well as further correlation with the economics of Conventions (Favereau, Biencourt and Eymard-Duvernay 2002).

Like other social constructions, production markets of a given variety accumulate distinctive cultural patterns, mores and tones, and I cite work on that aspect. I use markets in wine, especially French wines, for illustrations. Wine markets exemplify many of the major varieties of market while yet being also related through some degree of mutual substitutability as a sector. They are the focus of collaborative work both with an interdisciplinary group at INRA-Montpelier and also with sociologists in business schools here (cf. Benjamin and Podolny 1999). Furthermore, wine markets bring out the tangibly historical paths through which all markets come into recognition as distinct lines of business.

What the model points up is a possibility not recognized either in ordinary business discourse, or in the offshoot rhetoric in economics. A dual form of the model characterizes a dual version of market that orients to uncertainty back upstream. This upstream dual yields a different MAP, with different instabilities. A market with undifferentiated products, so-called pure competition, is a valid limiting case for downstream but not for these dual upstream-oriented markets.

Tie-ins of this theory of production markets with networks and complexity – or better, how it grows out of network theory – may also be seen if we translate the terminology of the book (White 2002a) into that of conventional social network analysis. A producer market occupies a *role* identified by *structural equivalence* among firms in the network of one-way commodity flows from suppliers upstream toward purchasers downstream. *Identity* is gained as firms *share temporal uncertainty* (variance) as *risk* in either the upstream or downstream flows. Network *signaling* along these streams creates an alignment profile in the quality-volume or $W(y)$ profile. *Asymmetries* arise because of the orientations to uncertainties and the flow-through-of-commodities of production markets that evolved out of other, often less asymmetrically structured, markets. Signals read along these coordinated asymmetries orient and align commitments – *lock-in of roles* – with expected revenue profiles, via the familiar mechanisms of exchange networks, that are explicitly modeled under appropriate *constraints* and *parameters* that correspond to the network *environments* of actors and their *cognitions*. These provide a realistic model for a market as competition in differentiated goods, shaped by equilibrium processes operating on *variabilities* rather than averages. The map of the role-structures of distinct *market profiles* forms two dimensions in the network parameter space, while the structure of network flows between markets (*substitutabilities*) forms the third dimension. Movement of markets through the parameter space is conservative, subject to historical *path dependence*. Trajectories are established by trial-and-error, the interactive potential for *unraveling* and eruptions of *agency* and *strategy*. Like many network theories, this one has a dual form when upstream orientation is substituted for downstream orientation: these asymmetries work themselves out in a broader set of applications and dynamics in terms of the possibilities and constraints on switching between these orientations.

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Figure 1. Space of parameter ratio (downstream to up) for predicting outcome in perfect competition from volume sensitivities.

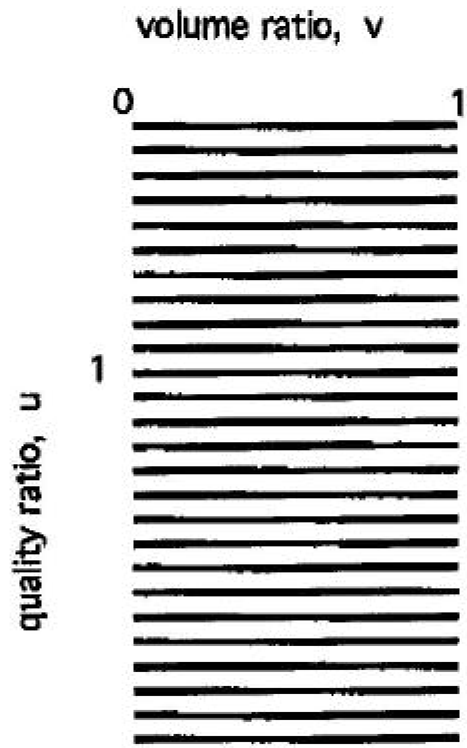

Figure 2. Space of parameter ratios for predicting outcomes in differentiated competition,
vertical axis–valuation by quality, zero to infinity
horizontal axis–valuation by volume, zero to 1 .

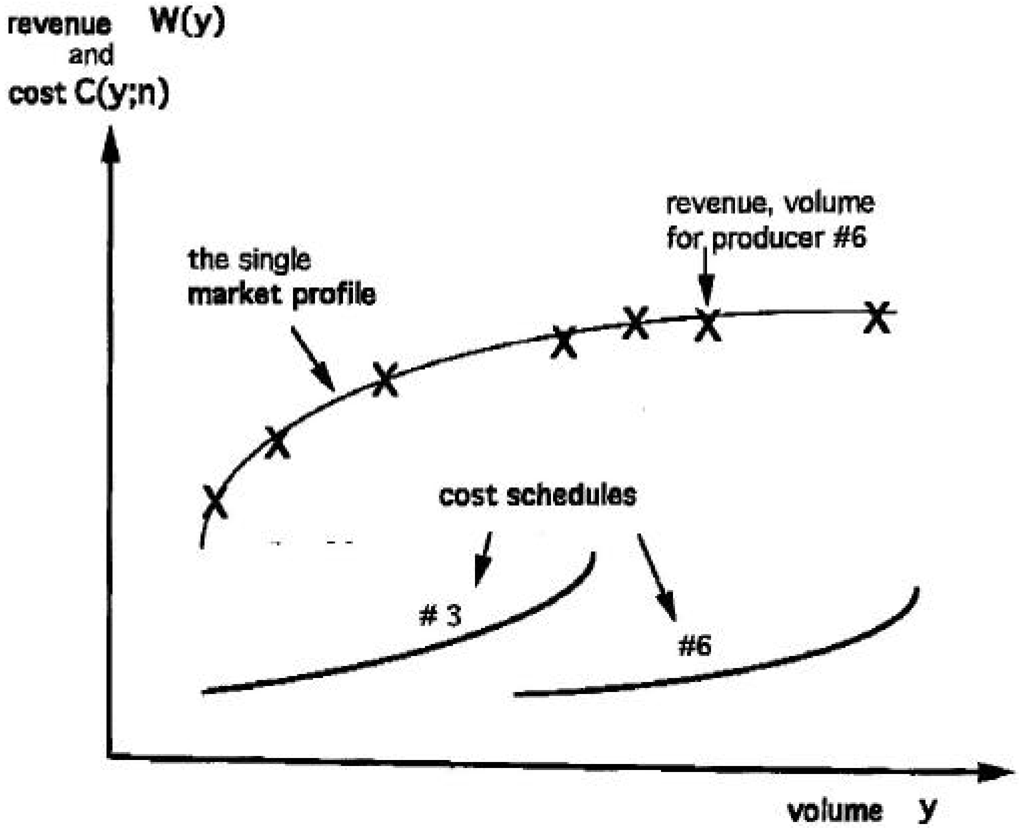

Figure 3. Each producer interpolates a profile through the (revenue, volume) outcomes of all, and then chooses optimum volume versus own cost curve

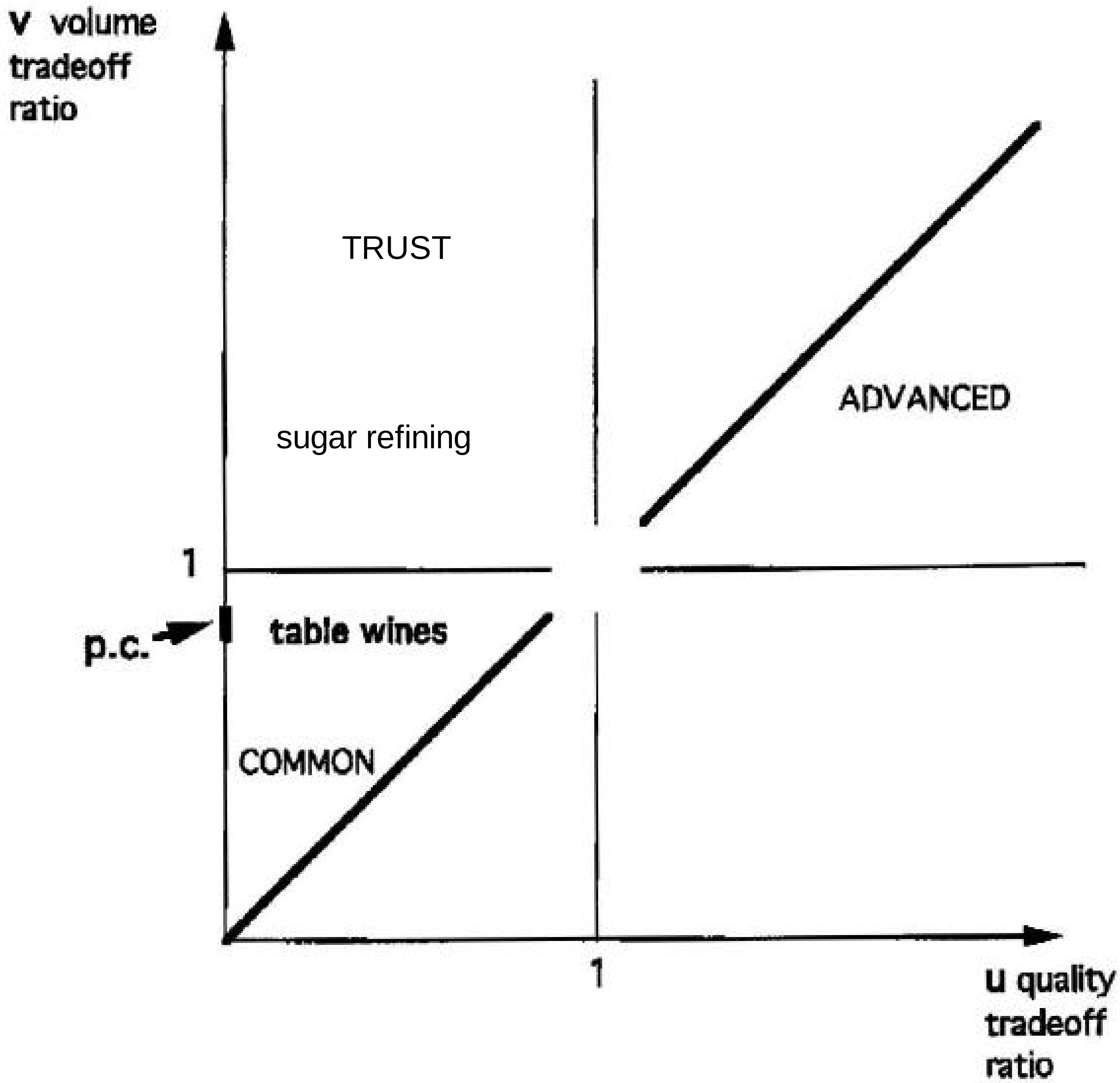

Figure 4 Plane of contexts yielding distinct curvatures of market profile

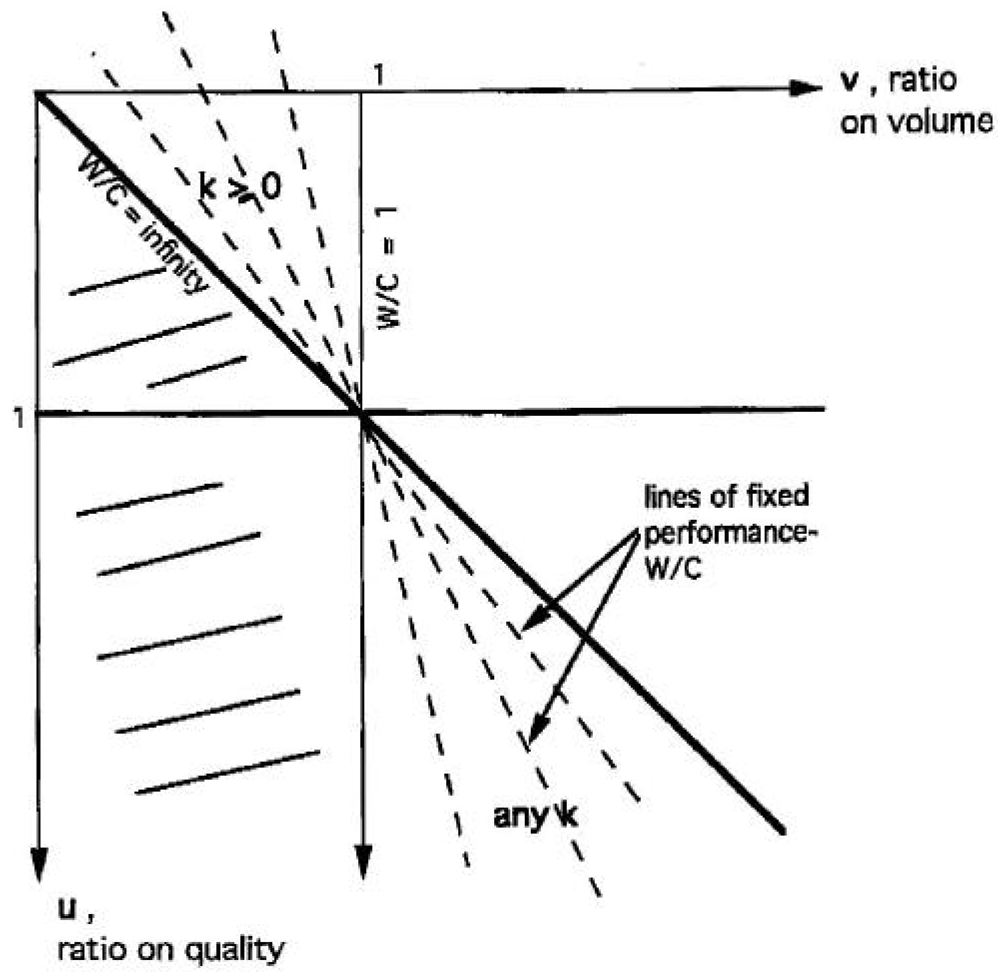

Figure 5 Dependence of firm performance on location along rays in market space.

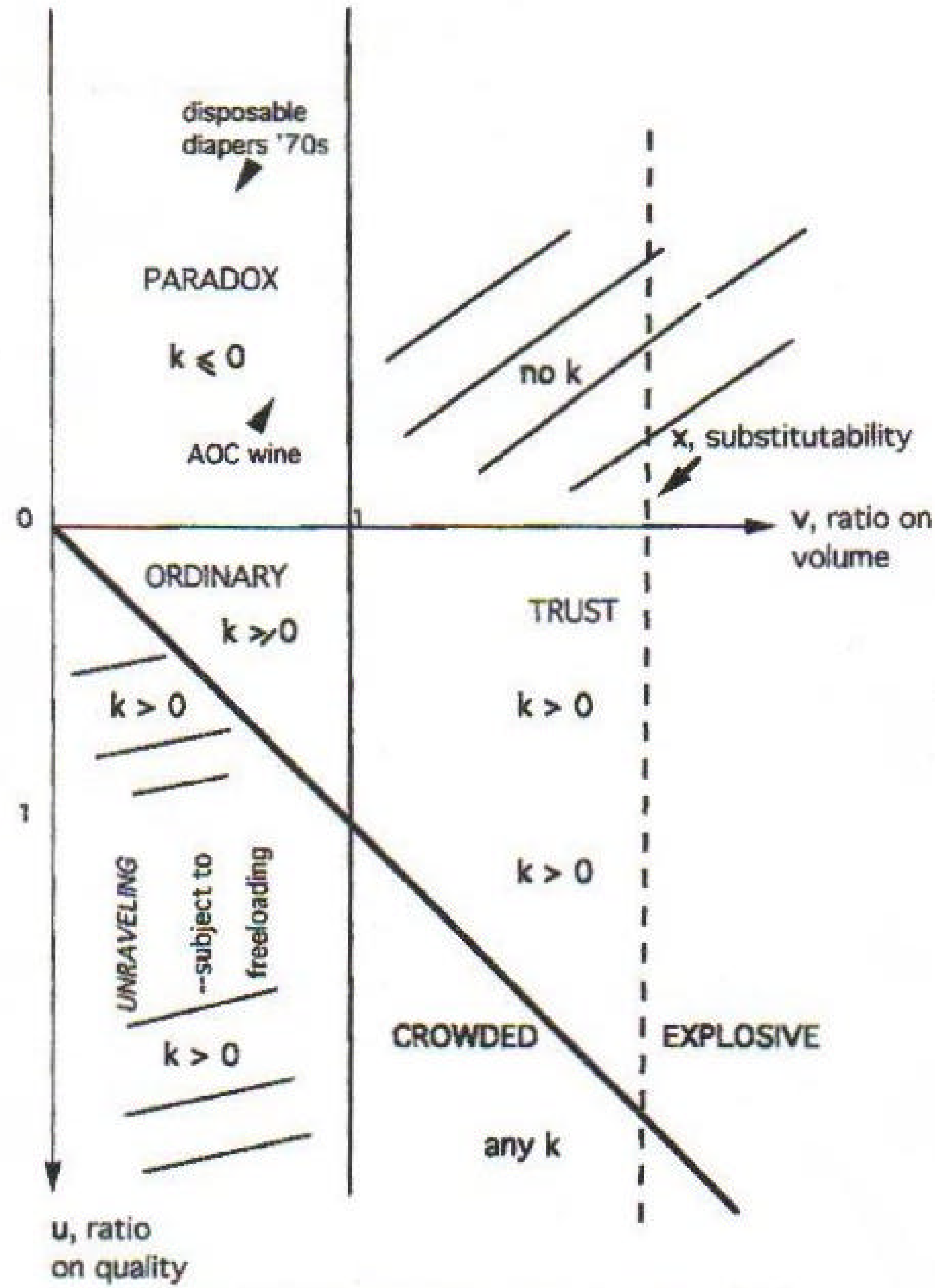

Figure 6 Market plane, MAP,extended to PARADOX, and with third dimension,substitutability x specified, and ranges of k for viable profiles indicated by region.

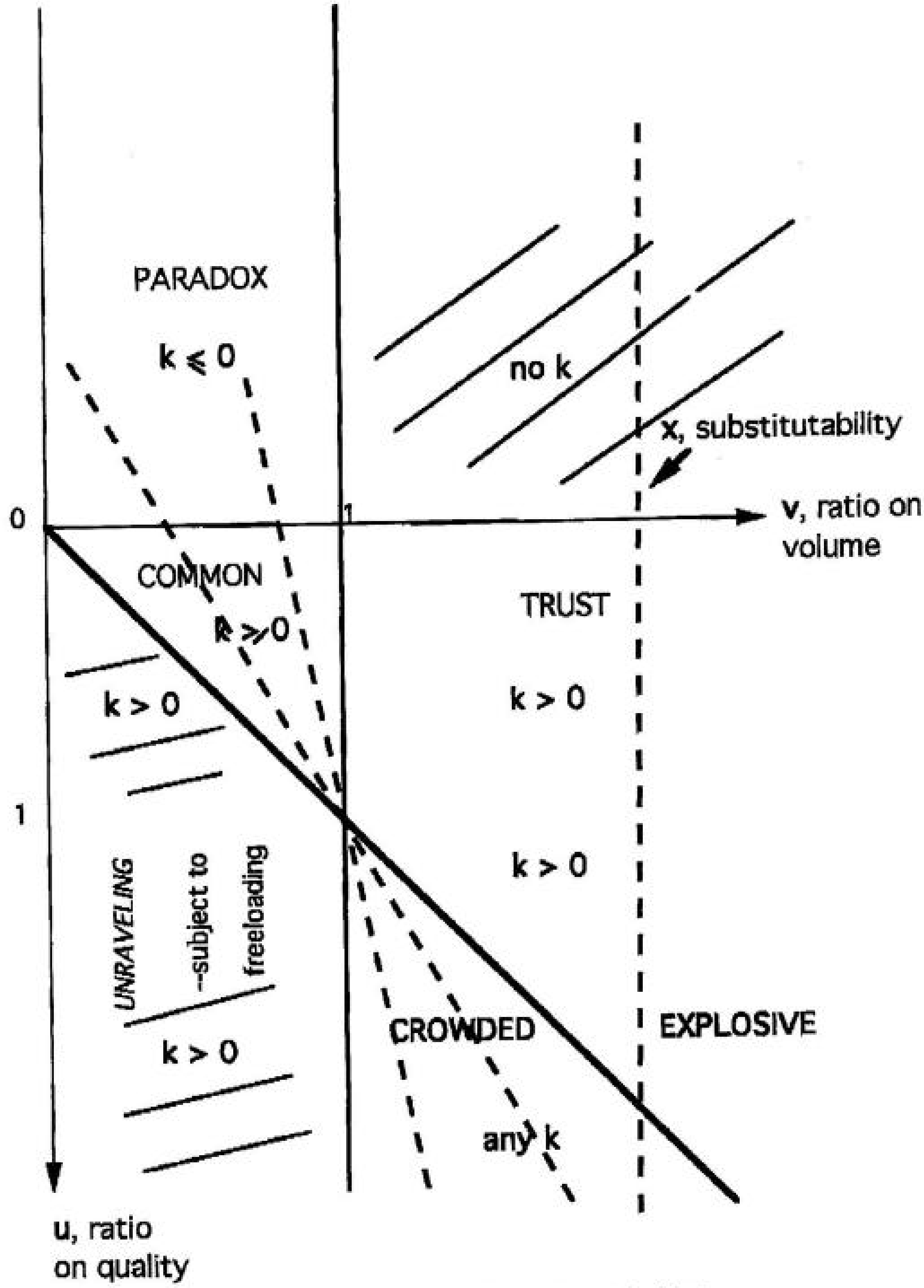

Figure 7 Market plane, MAP, as in figure 6, with third dimension,substitutability x specified, and ranges of k for viable profiles indicated by region.

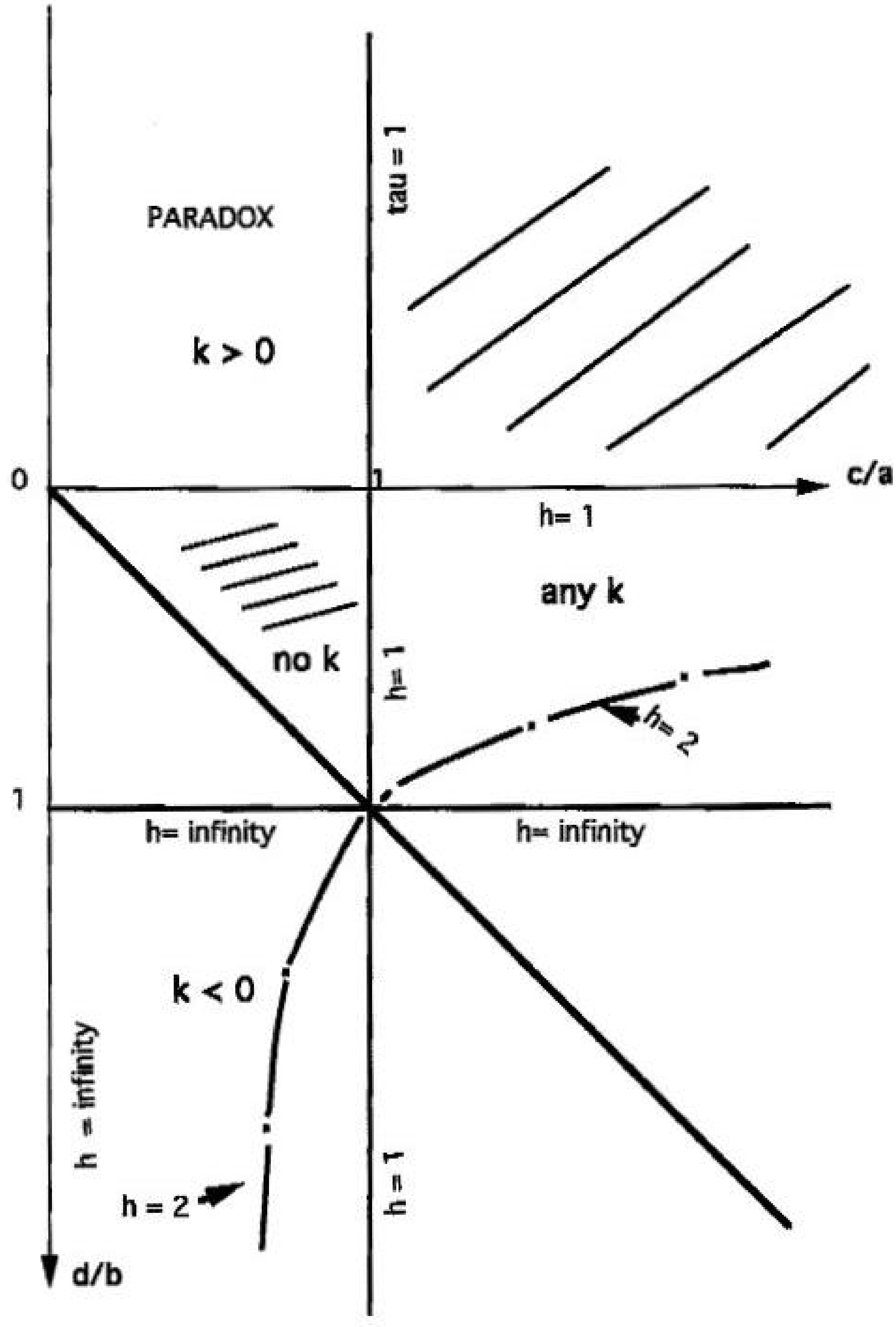

Figure 8. Lines of constant [*C/W*], labeled by h value, in the state space for market profiles, **upstream,** in two regions supporting profiles with k = 0.