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balancing their volume and quality sensitivities to firms through an oriented market profile of signals

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ABSTRACT
Varieties of quality competition across producers are extrapolated out of the two dual forms of perfect competition. oriented upstream and downstream. Only then are general, path-dependent solutions for market derived (which came first in the previous book of 2002). Attention is focused on advanced markets for high ratios of sensitivities between upstream and downstream relations of producers. Parameter identification and estimations identify impacts from substitutability with cross-stream markets as being major only for certain bands of sensitivity ratios, identified within the state space for production market contexts. Illustrative applications are sketched for strategic manipulations and investment decisions and trends in sectors.

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Any large producer--in our economy, some sort of firm--is wedged between upstream context of procurement and downstream context of delivery. It has to commit, each period, to scale of production, but a fog of uncertainty obscures the terms it can obtain, both in costs back to upstream and in revenue from downstream. Figure 1 sketches the producer's quandaries as a graph for valuations versus possible choice of scale--designate that by volume y:

- FIGURE 1 ABOUT HERE -

Toward the top are marked ranges of payment levels that ranges of y might induce from downstream players, while the other cross-hatched region toward the bottom is for payments to upstream that may be required for producing at that scope y. In between, where question marks are scattered, is where the producer needs to wedge its own valuations.

Clustering into an industry with other producers who come to be seen as similar enhances the reach of any one producer's repute. Together they gain recognition as a line of business, the place to turn for what comes to be seen as the sort of product which all are offering. Each producer is then less vulnerable to disruption of particular ties, upstream and/or down, and the fog of uncertainty thereby lessens.

Each producer becomes positioned in a niche within the array on quality that comes to be perceived generally, along lines first suggested by Chamberlin (1933). Favereau, Biencourt, and Eymard-

Duvernay(2003) analyze in depth why some form of quality order is inescapable in such social construction of production markets in terms of observables, volumes and revenues. The volume y for the niche of a producer counts flow of its generic output, which may be as a standard package of sizes, colors and the like.

Now we can reinterpret the various question marks in Figure 1 as possible commitment choices by the whole set of producer firms for the next period. The array of producers will attend most to the side, upstream or down, where the valuations in their ties are least certain, most spread. Each will choose from along the observable range of choices that location optimum for itself.

Section I derives foundation results, separately for markets oriented in each direction. How does operation of this market mechanism depend, in broad strokes, on its contexts upstream and down? Within each market how do member firms fare on revenues, and profits? What is their distribution in market shares? I point out complementarities with socioeconomic approaches to market analysis by **Burt** (1992), by Fligstein (2002), and by Podolny (2001). Special attention is then given to a class of contexts (PARADOX) for markets where either upstream or downstream orientation is robust.

Section II opens up a larger class of solutions in which profitabilities of member firms no longer need be equal (and where the varieties in market operation become fuzzier). Robustness of markets is assessed vis-a-vis unraveling by low-quality producers. Section III extends the framework to allow for substitutability with other markets lying cross-stream in somewhat equivalent positions. Both Section II and Section III offer major generalizations, yet each account can be kept short because the Section I results are just being extrapolated around the same core of parameters, equations and maps, a core kept simple to enable tracing indirect consequences.

Section IV sketches applications made or in process since the 2002 book publication. to both French and American industries.

I. WITH PERFECT COMPETITION AS PROTOTYPE

This section develops the core framework for analyzing the market mechanism. Here production markets are portrayed as social constructions evolved out of an array of viable perfect-competition markets. First we assume the markets face downstream, and only later detail the dual market mechanism that emerges when facing upstream.

MARKET FACING DOWNSTREAM

Figure 2 sketches the situation. Each producer now sees its procurements upstream as unproblematic and distinct from its neighbors', and so perceives its own separate structure of costs versus volume. This is shown as a definite curve rather than a band of uncertainty, since the producer buys from suppliers at off-the-shelf prices.

- FIGURE 2 ABOUT HERE --

These cost curves within the given line of business will be similarly curved, just displaced to greater cost level for greater quality attributed. Each producer will bother to estimate such curve only over a range of volumes y that it has experienced, but for simplicity we will specify cost curve across all possible volumes. Designate this as C(y; n) for producer with quality niceness level n:

$$C(y; n) = q\, y^c\, n^d \qquad (1)$$

Here q is just numerical calibration, and the curve with y is described by the power c to which y is raised—curving upward when c > 1, and linear when c = 1, and curving downward for c < 1 (so marginal cost decreasing). Set n to unity for the lowest quality producer. To calibrate quality n just from the cost side, set the power d to unity: the cost structure of each producer then just multiplies the power of y times the cost scaling q of the low cost producer, times n.

How do producers decide their commitments to scopes y for downstream delivery?

Revenue profile as signals--Producers signal each other, and buyers, through their set of observed volumes and associated revenues from the previous period. Figure 2 has no markings for upstream valuations exactly because the producers are in a fog of uncertainty as to these valuations. They may not know the cost structures of their peers and in any case they cannot read these as direct measures of their qualities as perceived downstream, which remain mere speculation within the fog of uncertainty. Instead they **interpolate** through the set of observed (volume, revenue) pairs to establish a revenue profile, W(y), that frames the choices of each.

The market mechanism--Each producer chooses from along W(y) that volume for its own n, call it y(n), that maximizes its net after subtracting its cost curve from the common revenue profile.

However, that set of choices will be validated by purchase downstream if and only if the downstream is as happy with one producers choice as another's. That is, there must be some tradeoff in quality and/or volume between producers' offerings to make them equally attractive downstream.

Modeling viable market outcomes--Suppose the y(n)s of a market's firms are observed to fit along a revenue profile at locations where its slope indeed matches the slope of that firm's cost curve (see equation 1) at that y(n). We want to know whether Thai market remains viable, and with what if any change in revenue profile with changes--in number # of firms, and in their array of cost scalars, q n^d. This surely may depend on the unknown details of how downstream valuates these different firms and their offerings.

To investigate, specify a flexible form for valuation as seen by the downstream. Cast it akin to equation (1), and let Salability downstream of firm n's production volume y be

$$S(y; n) = (a\ q)\ ya\ n^b \qquad (2)$$

Here we express the sizing constant as a multiple, alpha, times that for cost, so that the whole model scales up from the lowest cost level among producers (q times n=l). Now one could choose b=l if one wanted quality to calibrate on the buyer side rather than the cost side: it seems prudent instead to keep both b and d general.

The firms are then offering equally good deals in buyers collective eyes if and only if

$$\tau\ W(y(n)) = S\ (y(n); n) \qquad (3)$$

The point is that the offerings, y(n) for revenue W(y(n)), from various firms each is at the same markdown, tau, from the corresponding buyer valuation we hypothesized. The crux is that each firm has found an optimum niche, by its own self-interested choice, even though the revenue curve W(y) does not refer to quality distinctions n at all; this is because of the counter-pressure from the buying side for equally good deals across the combinations of volume and quality being offered. Hereafter, simplify W(y(n)) to W(n).

Ratios of parameters--It is straightforward to verify, by substitution, that the forms for W(y) and the associated y(n) given in equations (6) and (7) below will satisfy the conditions given above for viable market. To penetrate the formalism, it helps to have grouped the four parameters a,b,c,d into two ratios:

$$v = a/c \qquad (4)$$

and

$$u = b/d \qquad (5)$$

Note that a,b,c,d appear in the formulas almost entirely in terms of these two ratios. This is a basic finding: what the market outcomes are (and their viabilities) depends on the ratio of downstream to upstream sensitivity, on volume and on quality.

Formulas for market outcomes--

$$W(y) = q \ (\alpha/\tau)^{1/(1-u)} \ [(v-u)/(1-u)]^{u/(1-u)} y^{c(v-u)/(1-u)} \qquad (6),$$

along which the choices made by firms of various quality n are

$$y(n) = [(\alpha/\tau) \ (v-u)/(1-u)]^{1/c(1-v)} \ \ 1/n^{d(1-u)/c(1-v)} \qquad (7)$$

as to volume, with the associated revenue to the firm being

$$W(n) = q \ \{(\alpha/\tau) \ [(v-u)/(1-u)]^{v}\}^{1/(1-v)} \ 1/n^{de} \qquad (8)$$

where here to simplify notation we labeled the power of n as e:

$$e = (v-u)/(1-v). \qquad (9)$$

And without loss of generality, the magnitude of d can be set to unity; so we can rewrite equation (8) further as

$$W(n) = q \ \{(\alpha/\tau) \ [e/(e+1)]^{v}\}^{1/(1-v)} \ 1/n^{e} \quad (10)$$

Equation (10) is central in all that follows.

To get a better intuitive understanding we will build up to these results from a special case, perfect competition (p.c.), that is b=0. But already some important features are manifest: Both the W(y) and the particular W(n) are calibrated by the monetary scale q from the lowest cost producer. Higher quality producers scale down in revenue according to the ratio of their quality n to the n=l for lowest cost, but as raised to a power e in which the volume and quality sensitivity ratios v and u are intertwined--see equation (9). Neither n nor the volume y are expressed in monetary units of course.

The market sizes, equations 6-8, depend crucially on the ratio of alpha to tau. Think of this ratio as the scope for building a market: in terms of Figure 1, the ratio calibrates how far below the upstream valuations are the downstream costs which must be more than covered from upstream receipts. The alpha numerator just records the ratio of downstream to upstream operational scales.

The denominator tau indexes how the market mechanism has worked out: the deal each firm offers must be equally good, but the size of this common ratio tau is not constrained. The size of tau is a path-dependent outcome, which therefore might become a tunable parameter under influence of strategic manipulations by participants. The crux is that, contrary to some orthodox claims, market outcomes are not determinate even when the so-called 'demand' side is specified (as for example in equation 2 above).

The technical challenge is to understand dependence of outcomes also on intricate interpenetration of u and v sensitivity ratios, which we see as basic descriptors of the contexts, upstream and down, in which the set of # producer firms of various qualities n have come to operate as an industry.

So far, each firm's quality contributes through an independent multiplicative factor to its, and thus to total, market revenue. But this simple multiplier status for quality will disappear, and the discount factor tau will become elaborated as a path-dependent fitting factor rather than a tunable parameter, in the course of generalizations later beyond perfect-competition characteristics (Section II) and to include cross-stream substitutability (Section III).

Perfect competition as both prototype and special case--The producers cannot exclude that the buying side in aggregate sees little or no difference in quality. They remain in a fog of uncertainty even when a lecture room theorist might declare them in a perfect competition market. The downstream side of course encounters them as distinct firms and also evaluates increments of flow differently at different overall levels y: this proves sufficient to trigger the market mechanism. Yet since there is no explicit quality differentiation, the parameter b, and hence the ratio u must be zero.

The solutions in equations (6-10) still hold, the forms simplifying to:

$$W(y) = q \ (\alpha/\tau) \ y^a \qquad (6)'$$

The formula for W(y) in (6)' appears much simpler than in (6), but industry observers would not see any reason in the field to distinguish one from the other; nor would they see that only a, not c, affected W(y).

Next use u=0 to reduce equation (7):

$$y(n) = [(\alpha/\tau)\ v]^{1/(c-a)} \quad 1/n^{\,d/(c-a)} \qquad (7)'$$

The y(n) in equation (7) are seen to depend on both a and c, despite W(y) depending only on a.

Thence from equation (8) come the observable revenue sizes sustained in the p.c. market for the firms with the different cost structures of equation (1). Since u=0, v is designated as VQ in the simplified form of equation (8):

$$W(n) = q \ [(\alpha/\tau)\ v_0{}^{v_0}]^{1/(1-v_0)}\ 1/n^e \qquad (8)'$$

The parallel simplifications

$$e = v_0/(1-v_0), \quad \text{and thus } e/(e+l) = VQ \qquad (9)'$$

ensure that equation (8)' already is the simplified form of equation(10), which can be rephrased also as, still with u=0:

$$W(n) = q \ (\alpha/\tau)^{e/v_0}\ (v_0/n)^{\,e} \qquad (10)''$$

Pause to examine what the costs paid out are by each firm: substitute equation (7)' into the definition of C(y; n), equation (1). Routine calculation shows that for each n the cost is the same fraction of that revenue W(n):

$$C(n)/W(n) = v_0 \qquad (11)',$$

which is to say that the profit percentage is the same for all firms. Indeed this is also true even when u is not zero:

$$C(n)/W(n) = (v - u)/(l-u) = e/(e+l). \qquad (11).$$

One can trace (11) and (11)' mathematically to W(y) going to zero when y=0. Section II offers solutions where W(y) has a non-zero intercept and thus firms can differ in profitability.

Using equations (8)' and (9)', the p.c. market outcome can be specified just from the single parameter v_0, along with the set of n's that each enter into a factor, and along with the monetary scaling q, and the scope scaling (a/T). When VQ goes to zero, regardless of the size of (α/τ),

$$W(n) = q\ (a/T) \qquad (12),$$

whereas when VQ goes to unity, e goes to infinity which means that only the lowest cost firm produces, at an amount which is indefinitely large, given that (a/T) > 1, since

$$W(1) = q\ (\alpha/\tau)^{1/0} \qquad (13).$$

What about when v >1? Then, from (9)', e is negative, which translates in (10)" to higher cost firms having higher revenues, and moreover to revenues, surprisingly, going down as scope (a/T) goes up, and also as v itself goes up. This could only transpire through some sort of feedback in which firms more than compensate for a context that appears dampening. Great attention must then be given to stability, which, in the present circumstances, means examining robustness of the formal results to slight perturbations in each of the parameters. By the end of Part II we will see that p.c. with v > 1 is not viable. But stability of results must be examined in particular when u is allowed to take some non-zero value, and that we can do here.

Downstream markets with quality **differentiation--Turn** now then to the introduction of u. Each case of p.c. for a value of the ratio v, $0<v<l$, proves to extrapolate into a whole infinite linear array of quality-competition markets. Visualize the situation in terms of a state space for markets: Figure 3, for one region labeled ORDINARY.

-- FIGURE 3 ABOUT HERE --

Left out of the state space are the # of firms and their various values on quality n: the justification is the separation of n into a separate factor in the equations. Instead the state space is just a plane, with v for ordinate and u for abscissa.

The chunk of v axis from 0 to 1 are the possible locations, by sensitivity ratio v_0 of perfect-competition markets. Consider some one of these VQ. The basic finding from equations (6) -(10) is that introduction and increase of quality differentiation downstream, b > 0 and hence also u > o, decreases the market revenues W(n) of each firm. As one moves to the right with u rising, the W(n) will decrease and fade out after a bit. To keep the size of W(n) up one can however at the same time raise the level of v above VQ, which is seen from the equations to tend to increase W(n), thus making up for the decrease with u.

Geometrically, one expects to find a diagonal rising from the initial point on the p.c. axis as the locations for similarly sized markets. That is just what equations (9) and (10) tell us. The slope of this diagonal, which must be a ray, a straight line passing through the central point (u=l,v=l), is just the e of equation (9). Note that e is the power to which n is raised, which thus is a constant along the whole ray. And equation (9)' for p.c. tells us that this common value is

$$e = v_0/(1-v_0) \qquad (14)$$

since the ray begins at v_0 on the v axis, where u=0. Note that the range of e is from zero, for $v_0 = 0$, to infinity, for $v_0=1$.

Figure 4 will report the variation of W(n) with v along two rays, each with e held at a constant value. These examples lie above and below a special median ray.

The **Spline**--**Consider** the special case where

$$v_0 = T/a = e/(e+l) \quad (15)$$

and so the slope of its ray is

$$e_S = 1/\ [(\alpha/\tau)\ -1] \qquad (16)$$

which for example would be unity when alpha is twice tau.
And W(n) reduces in equation (10) to exactly

$$W(n) = q\ (\alpha/\tau)\ 1/\ n^{e_S} \qquad (17)$$

The Spline divides in two the narrowing cone of locations of viable markets in the u,v state space whose vertex is at (1,1). As u increases towards 1, the full variation of e remains, but it is so to speak squeezed into a narrowing cone of context designations. Above the spline, the sizes of market revenues are larger, whereas they trail off on the rays below the spline: this becomes obvious from the following recasting of equation (10):

$$W(n) = q\ (a/T)\ [j]^{v/(1-v)} 1/n^e \ (18)$$

wherein the auxiliary j is defined by

$$j = (a/T)\ \ [e/(e+1)]\ (19)$$

On the Spline j=l, above the Spline j > 1 and so obviously W(n) is greater, for every v, than the constant value, equation (17), that it takes along the Spline. And conversely when j < 1.

Remember also that the leverage of higher quality on revenue goes down as e goes up, as one moves from below to above the spline. So market shares are more unequal in contexts where the absolute sizes of producer revenues are going up. And equation (11) notifies us that profitability goes down, **C(n)/W(n)** approaches unity, also as e goes up, with profitability going to zero in the limit as e approaches infinity, for v=l.

Figure 4 graphs the size of market revenue W(n) along a ray for three different values of the extrapolation slope, e. The middle

FIGURE 4 ABOUT HERE -

one is the Spline and so is of course a constant level. Each of these illustrative rays is continued on through (1,1) to the upper right quadrant, to which we now turn.

The jump to ADVANCED markets

The most startling prediction from this model is the existence of an additional whole cone of contexts on the u/v state plane which sustain viable markets which can generate much larger revenues than discussed above. Participants themselves of course do not think in terms of such a state space, which cannot be derived from evidence they can observe. Rather, producers grope through the fog of uncertainty in business reality, relying on signals from each other to frame their commitment choices to volume of production, that are disciplined by downstream insistence on equally good deals. This counter pressure for equally good deals emanating from downstream interlocks with the producers' own self-interested choices to maximize profits: the result is niches for each producer, volume choice that cannot be unilaterally changed--regardless of speculations about how much production the overall context of the market might support for any given producer. Social mechanism is what rules, not final causes or ultimate beliefs, in this as in other configurations from social construction.

A jump is required to reach this additional, upper cone from the lower one. See Figure 5, which repeats Figure 3 but with focus shifted to the upper cone in the state space. Mathematically, one can draw the converging rays on through the (1,1) point, but the immediate region

-- FIGURE 5 ABOUT HERE --

around this pivot point are contexts without enough playoff between u and v to sustain market discipline. It is only spread between u and v, together with their divergence from unity, that through the signaling mechanism sustains discipline as market niches.

Most of the statements about the lower cone of diagonal rays through (1,1) are reversed in the upper cone--as indeed the geometry of rotation around (1,1) as pivot would suggest. The diagonal ray, from (1,1) through the origin (0,0), in its upper part still has e=0 and so still has equality of market share across producers. But now that is also the ray along which the sizes of market revenues are largest.

Return to equation (10): the crux is that throughout the upper cone v is greater than unity; so a flip of numerator with denominator is called for in the initial **factor--whereas** the factor in quality n is unchanged.

$$W(n) = q \{(\tau/\alpha) [(e+1)/e]^{v}\}^{1/(v-1)} 1/n^{e} \quad (20)$$

One sees at once that as e approaches zero, the main diagonal, the W(n) predicted increases without limit. The term in tau and alpha now is less than one, is inverted, being counterbalanced by the ratio in e being greater than unity.

What remains the same is the Spline; equations 15-17 continue in force along the whole diagonal. Figure 6 parallels Figure 4.

-- **FIGURE** 6 ABOUT HERE --

Note it is still the upper half above the Spline that has larger revenues for firms, but now from the geometry these are for smaller rather than larger values of e around the spline value of e_S, equation (16). Within equation (18), j flips over in parallel:

$$W(n) = q \quad (a/T) \quad [1/j]^{v/(v-1)} \quad 1/n^{e} \quad (21)$$

Thus note the jump up. across discontinuity at v=l=u. in revenue along the ray for <u>j=0.7</u>, and conversely the discontinuous fall in revenue along the **j=1.5** ray.

Borderline <u>asymptotics</u> and ideal <u>types</u>--Any mathematical model idealizes empirical messiness to some extent. Certainly the stereotype shapes of equations (2) are hypothetical ideal types for capturing the central features in variation of valuation with volume and quality. This is less true of equation (1) since in practice the producer's decision tends to depend on rule of thumb rather than elaborate formula. The precision achieved through these idealizations is what enables us to trace long and intricate chains of effects leading to such unexpected predictions as ADVANCED markets.

In each concrete market situation the ranges invoked or perceived by participants, in volume and revenue alike, tend to be narrow and thus will not strain idealizations. Borderlines in these models should however be handled with care. Revenues going infinite along the ray with v = 1 is of course a mathematical exaggeration, as is precise equality to tau of ratios in (3). A calculus of asymptotic approximations is necessary to disentangle the meaning of borderline results such as in equation (13), and for other boundary lines and points.

Asymptotic analysis around (1,1). confirms that the upper cone, contexts for ADVANCED markets, indeed must be a jump across borderline anomalies, a jump up from the lower cone, labeled ORDINARY in Figure 3. And the v=l ray beyond (1,1) now has market revenues predicted to explode as v decreases from above 1 to unity, tending to vanish below unity, just the flip of the situation for the lower cone.

Missing quadrants--Turn back to Figures 3 and 5. How is it that no viable market solutions have been found for contexts identified by points in the two other quadrants—upper left (high v and low u) and lower right (low v and high u)? The next section will in fact locate upstream-oriented markets there, but nonetheless why not also downstream?

Equations 8-10 were introduced with the claim that they satisfied the upstream constraints of equally good deals while also giving each producer its maximum net revenue. When, however, we compute them for points in upper left and lower right this is no longer true. In Section II we propose a more general set of solutions, of which 8-10 are but special cases. Some of this larger set of downstream solutions will in fact yield some viable markets in parts of the upper left and lower right, but the maze of complications and restrictions is best put off until Section II.

MARKETS FACING UPSTREAM

Mathematical derivations for market outcomes come quickly and easily because they are a particular dual to those for downstream, and so we can duplicate the ordering in topics and sections above for downstream orientation. The phenomenology is also inverted and skewed, however, and that is harder to come to grips with. The overriding finding will be that upstream orientation must be evoked to yield viable markets in exactly the other two quadrants around the center point (1,1).

When producers are jointly confronting and signaling each other about their upstream, procurement side, the shoe is of course on the other foot. Instead of seeking revenue from the other side they are instead making payments. On that side, degree of quality is supplanted by degree of distaste from the other side, which has to be paid to provide supplies needed for production volume y! So producers are jockeying for a niche along the profile of inducement payments they have to make upstream to support their chosen volume.

On the other, downstream side, the producers have each come to think their marketing intelligence is sufficient to predict how much revenue they will obtain seeing various levels of output, y.

Thus each will seek to choose the volume that will maximize the difference between its known anticipated revenue from downstream, over the amount they most pay out to the supplier side, read from their joint signaling profile.

Inverting the **mathematics--The** mathematics for downstream can be turned inside out to yield upstream solutions. For convenience keep the designation W(y) for the signaling profile, but think of it as wages, since in substantive terms it compares to the C(y;n) that it would have paid out if upstream was the determinate side. Also retain the notation of n for quality which still is a two-sided ordering with different leverages on the upstream and the downstream sides.

The mathematical switch calls for keeping the C(y;n) notation for the determinate valuation schedule even though that now in substantive terms is the analog of the S(y;n) schedules above. The latter, equation (2), are now to be interpreted as negative, avoidance valuations on the part of the upstream for supplying work hours to one and another producer, whose working demands correlate with the quality of their product perceived downstream.

The solution equations are the same! True, the others' side now are interested in pushing up the signaling curve W(y) whereas the producers wish to push it down. But still the other side is insisting that each of the producers offer equally good deals (albeit now in money received for work sent), and still also each producer seeks to choose that y for its n that optimizes the margin of its revenue over its cost.

Plus turns into minus. Each producer is choosing y(n) to maximize the difference C(y;n) - W(y). So profit is now the negative of what it was in downstream orientation, C-W rather than W-C. Thus maximization of floating curve, W(y), over determinate curve, C(y;n), is reversed into minimization.

The market solutions will be strikingly different despite the formal similarity of the equations. The set of parameters must flip roles so that d/b, which is to say **1/u**, corresponds in substantive terms to the u for the downstream orientation. And similarly c/a, which is to say **1/v**, corresponds in substantive terms to the v for downstream orientation:

$$1/u \text{ for } u, \text{ and } 1/v \text{ for } v \qquad (22)$$

The solution equations 8-10 still apply, but only after the substitutions in (22), which enable us to position markets in the same state space, Figure 3.

So, despite some formal parallelism, there are major changes in viable market predictions, corresponding to real substantive differences between market mechanism upstream and that for downstream orientation. Once again, and indeed especially for upstream orientation, intuition can be guided by starting from the array of special cases in perfect competition.

Perfect <u>competition</u>, in dual **form**, is both prototype and special case for upstream-oriented markets—Each of the producers is now of course differently perceived on the downstream side, as evidenced by the distinct valuation structures they can count on (still, for mathematical convenience described by the C function of equation 1).

But there can still be perfect-competition in the dual form: namely in cases when all of the producers are perceived, from the upstream side in aggregate, as equally unattractive as employers so that

$$b = 0 \qquad (23)$$

(Equation (23) also applies above for orthodox perfect competition where earlier b was also set to zero, but the substantive meaning of b back then was volume sensitivity of downstream buyers). Thus this dual perfect-competition corresponds to u here approaching infinity.

Let the subscript "00" stands for infinity; so we examine the array of p.c. markets with values for VQQ between 0 and 1, just as for v_0 with downstream orientation, but now out at infinite u rather than at zero u. Again we will trace out from each VQQ a ray in state space along which market size will tend to stay the same, now because increase in v counteracts the decrease in size associated with decrease in u below infinity.

Again we hope to characterize this ray, rising from a VQQ by the e defined in equation (8), but only after it is transformed by (22), which yields

$$e = (1/u)\ (u-v)/\ (v-1) \qquad (23)$$

and so, as u--> infinity,

$$e = \ [1-(v/u)]/\ (v-1)\ \text{-->}\ 1/(v_{00} - 1) \qquad (24)$$

Equation (24) replaces equation (14) in calibrating e with the value of v in perfect-competition, and the solutions for specific values of v discussed in equations 12-13 for downstream must be adjusted accordingly.

Turn now to variation with parameter u: it will prove to be the case now that to maintain revenues constant as u increases, v must, as offset, be decreased. .

Upstream-oriented markets with quality differentiation--The transformed e [in either (23) or (24)] is no longer a positive number. It stands for negative slope in the lower right quadrant in Figure 3, where both u>v and v<l, and on along through (1,1) to upper left quadrant. To simplify discussion, label the magnitude of this slope by h:

$$-e = h = (u-v)/u\ (1-v). \qquad (25)$$

The chief equation (10) becomes, for upstream orientation,

$$W(n) = q \ \{(\tau/\alpha)^{v}\ [(h-1)/h)]\}^{1/(1-v)}\ n^{h} \qquad (26)$$

This is referred to the lower right quadrant which abuts the dual p.c. Its form mixes features from downstream orientation for both equation (20), which refers to the upper right quadrant, and equation (10)

Remember, the W(n) is now the cost, say the wage bill, rather than the revenue of the firm as it was in equation (10). And indeed equation (11) translates into

$$C(n)/W(n) = (u - v)/u\ (u - 1) = h/(h-l)\ , \qquad (27)$$

still a ratio fixed along a ray, but now with C larger than W. Note that the q used as baseline scope now in substantive terms calibrates the high valuations downstream. The scope parameter alpha is now less than one, a fraction rather than a multiple, given that alpha remains defined in equation (2) as the ratio to q of the sizing constant for the

S(y;n) valuations, which are now reinterpreted as disdain schedules of the upstream side.

The first striking change from downstream orientation is that the power to which n is raised in equation (26) is positive, whereas it was negative in equation (10). This means that higher quality firms have greater size, in contrast with downstream. Higher quality firms would welcome a shift of market from downstream to upstream orientation to increase their market shares.

Parabolic rays and Spline--From equation (25) it follows that the analog of the 'rays' for downstream are now parabolas, although they too run through the central point (1,1). Visualize the situation as in Figure 7, with h as index for the parabolas. Figure 7 repeats the (u,v) state space of Figures 3 and 5, but enters results on markets oriented upstream.

- FIGURE 7 ABOUT HERE --

Each value of the ratio v_{00}, for a case of p.c., $0<v_{00}<1$, proves to extrapolate into a whole long curve that arrays quality-competition markets of similar size.

Each parabola is calibrated by an equation to its value of h. The formula is simplest when u and v are measured from the center:

$$U = u - 1; \quad V = v - 1; \qquad (28)$$

whence

$$(U - V)/ U (V + 1) = h \qquad (29)$$

As stated earlier e is the slope of the ray for downstream markets, which in parallel notation is

$$e = (U - V)/ V \qquad (30)$$

which has no product terms in U and V and so is a straight line.

For upstream too there is a Spline. And one could report as in Figure 4 the variation of W(n) as v increases along a parabolic ray. Again W(n) is higher than for the Spline in the cone of rays lying above the Spline, and lower in the lower cone: this is as true in the upper left quadrant too, for v above unity, where note the ray lying 'lower' of course is designated by a higher value of h (analogously to the discussion for downstream orientation).

This upper left quadrant is designated by TRUSTS in the state space of Figure 5. Here the buyers downstream are interested in getting large volumes delivered from their particular suppliers, yet they do not concede much more unit value to a flow from a higher quality producer. A sugar trust, at least in the old days, or an active industry producing rather standard metal-work products might fit there. Turn to a sketch of how these context variations fit together across quadrants for downstream and for upstream.

Overlaps and contrasts between upstream and downstream **contexts**--It help intuition to contrast the different configurations of contexts, that is of sets of valuation schedules upstream and downstream, which underlie viable W(y) profiles of market signals, on the one hand for mechanism oriented upstream and on the other hand for that oriented downstream. Figure 8 provides visualization. A small duplicate of the state space common to both orientations appears in the center of the figure. An arrow leads from each of these quadrants around (1,1) to a stylized set of upper and lower valuation schedules (downstream valuation and upstream cost).

- FIGURE 8 ABOUT HERE --

Just four producers are shown, rather evenly spaced on quality. Rather extreme values of a and c compatible with a given ratio v are used so as to heighten contrast. The key is the trade-off of that contrast with, on the other hand, the contrast in growth of the vertical (monetary) placements of the a curves and the c curves— which is set of course by the relative sizes of b and d. (Since designations of curves by C and by S are switched between reporting upstream and reporting downstream orientation, they are omitted.)

Overlaps and contrasts between upstream and downstream **solutions**--Locations approaching and on the ray v=l are contexts where both downstream and upstream solutions are predicted. The contrast between solutions is striking, and this contrast switches according to whether u is greater or less than unity. With upstream orientation markets are predicted, when **u>1**, to yield very large W(n). Whereas along this same half of the v=l line, downstream markets are predicted small. Just the reverse obtains for the part of **v=1** ray for small u, less than unity.

The u=l ray, the vertical through (1,1) in Figure 7, is, on the other hand, the province solely of upstream oriented markets, since in the neighboring region where their sway does not hold neither are there any downstream markets. Above v=l, the sizes W(n) tend to be very large. For v<l on the other hand the W(n) tend to be small. Both these are results from the previous analysis around upstream Spline

and other hyperbolas (with the u=l line, when adjoined to the part of the v=0 line beyond u=l, being seen as a degenerate extreme of the parabolas).

Extreme values of ratios come from extreme values of individual parameters, with c=0 yielding v=infinity, and a=0 yielding v=0. Zero value of an exponent corresponds to zero variation, that is to constant cost curve C(y;n) and valuation curve S(y;n), respectively. In general, the market signaling mechanism should be applicable even when one or the other of these constituent valuation schedules is constant. This corresponds, in Figures 1 and 2, to horizontal lines for the C or the S. Examine equations (10) and (26) for the downstream and upstream solution rays. For v=0 the W(n) shrink to zero, disappear in both equations and thus for all of the state space with u positive. However, in the PARADOX region, u negative, equations (10) and (26) are transformed by the flip in sign of u so that W(n) takes the value (q/n). with upstream orientation and the value $(q\ (\alpha/\tau)\ n^{h})$ with downstream orientation. The divergences within sets of constituent valuations (see Figure 8) are great enough to sustain the mechanism even with one of the sorts being a constant.

Comparison with other socioeconomic analyses--Production in these network flows can continue amidst chaotic scramblings by entrepreneurs exploiting networks of social relations, as theorized by Burt (1993). In contexts in the center of the state space, Figure 3, Burt's analysis surely is called for, and Fligstein's interventions by the state also may be expected there. Podolny (2001) develops a phenomenology of uncertainty in relations across a market interface.

His classical two-by-two table of market types seems to correspond to the four regions in Figure 3 demarcated by the main diagonal u=v, and the ray v=l. See Figure 9.

- FIGURE 9 ABOUT HERE -

The four can, when framed by a state space, be seen as complements (a fuller account can be found in my paper included in Breiger (2003)).

Other socioeconomic approaches, in particular the population ecology line of Hannan and collaborators, are harder to compare because they focus on perceived attributes of individual firms rather than identifying market role clusters as the key to context. The niches they speak of, recently in Dobrev, Kim and Hannan (2001), are like niches in pick-up games in parks rather than competitive niches within an architecture of teams (cf. Leifer 1995). The W(y) model can be seen as invoking "middle-status conformity" (Phillips and Zuckerman 2001) on the level of firms rather than managers.

PARADOX: THE OTHER HALF OF CONTEXTS, FOR MARKETS FACING EITHER UPSTREAM OR DOWN

The state space shown already in Figures 3. 5 and 7, should be doubled. The W(y) signaling profile can work to broker between upstream and downstream whenever the producers are arrayed in the same ordering (not actual spacings) from both upstream and downstream perspectives. For a market facing downstream this raises the paradoxical possibility that as quality of goods produced goes up the cost structure is going down. This means that the ratio u can be negative (either the b or the d can be calibrated as negative). Figure 10 reproduces Figure 5 and extends it to this negative half plane.

-- FIGURE 10 ABOUT HERE --

Once again, as in the switch to upstream orientation, the mathematical solution is easy: just introduce the minus sign into the equations already given above. And yet once again the substantive outcomes are surprisingly different. Intuition as to that can be guided by inspection of the strikingly different contexts, sets of valuation schedules, being invoked: see Figure 11, which is parallel to Figure 8.

-- FIGURE 11 ABOUT HERE --

There are three striking differences. First, so long as u is negative, call it the PARADOX region, the signaling mechanism does not work to yield viable market solutions for any v > 1 (as throughout this Section I the details of failure are postponed until Section II). Second, the dependence of market revenue for a producer, W(n), varies in inverse fashion with n to what obtained with u being positive. The third difference is perhaps the most instructive: at every point with v<l and u negative, the signaling mechanism works both with upstream orientation and with downstream orientation.

And yet there is also remarkable commonalty with results for the u>0 half: PARADOX markets also all are extrapolations of p.c., indeed extrapolations of both the dual forms. Figure 10 shows this graphically by extending both the downstream rays and the upstream **parabolas--the** former from the u=0 edge and the latter from the u=00 edge, into and through the whole length of PARADOX.

What this means is that the very equations for y(n) and for W(n) already given above apply for u<0 also. It is the reversal of sign of u that leads to the second major difference just cited. (One could argue that PARADOX is no longer an apt label for these contexts when market orientation is upstream, since then the W(n) of higher quality producers is indeed lower, through the upstream view of it being more dismissive.)

Overview: substance and modeling

Producers cope with uncertainty by orienting to the commitment choices being made by their peers that get supported by another side. The other side's acceptances rest both on its sensitivity to volume and on its sensitivity to differential quality across the producers. Equation (10) is the key throughout, reporting the revenues that producers select from along their joint offer curve, each in its own self-interest.

This jointly perceived offer curve, W(y), may be turned and twisted in various ways, which we observers relate to context. We summarize context by a few parameters arrayed into a state space, taken together with the set of qualities. All the various regions of state space, and the two orientations, work with this same mechanism.

How should we understand and interpret quality differentiation? First, root it in perfect competition, and second, do so for both the upstream and downstream orientations of market mechanism. The dual upstream orientation satisfies the same equation (10), once one switches labels of W with C, along with inverting the sensitivity ratios. Along any ray through (1,1) in state space, the leverage of quality on revenue remains fixed across the whole range of v.

The jump to a volume sensitivity ratio v greater than unity flips the signs of exponents, so that the multiplier of quality switches dependence on context variation, which can open up dramatically larger outputs, the ADVANCED region. The other PARADOX half of state space accommodates both upstream and downstream orientation, in each case just by reversing the sign of quality sensitivity ratio u from plus to minus.

Aspects of modeling--**Return** to the initial Figures 1 and 2 that motivate the whole model. A key role is played by the relative sensitivities of valuations to volume between upstream and downstream contexts of the producers. Thus, ratios rather than actual exponents are what count, so that for instance constant returns to scale, c=l, does not need separate treatment, nor does a=l.

Observe that the mathematics can be kept elementary, just undergraduate calculus plus persistence. Use of special forms for valuation schedules permits tracing complex chains of causation, such as we traced to ADVANCED operation of markets. And yet, by principles of analytic continuity, even as topology changes with schedule forms one can expect the main features of solutions to be generalizable. Intricate patterns of fitting are the key, not formal generality.

We now go on to two major generalizations which, however, will still keep equation (10) central.

//. MARKET OUTCOMES WITH PATH DEPENDENCY

Take observations of some particular market of say # producers that runs on the signaling mechanism, that meets the constraints laid out in Section I. From observing just the volume and the revenue of each producer, together with the slope observed there (either that of its cost curve or of the W(y) there), from just these three numbers, for each of the producers of number #, one can derive estimations for all the parameters--an n for each producer, together with q and a,b,c,d and thence u and v and e. Without loss of generality one takes the lowest quality as n=l and for convenience set d=1.[1] The one slippery point, on which we expand in Section III, is fixing tau and alpha. In fact only their ratio, a/T, can be estimated from the observations of the one market.

The main point is that the outcomes for this observed market will not in general fit the predictions from the equations in Section I. The extrapolations from perfect competitions limited the possibilities unnecessarily. In reality the process by which a signaling mechanism settles in for a given context is a path-dependent matter of adjustments and readjustments.

Return to equation (6), which is indeed sufficient but is not necessary for a viable solution. See White (2002, chapter 2) for a

[1] For details see the first seventeen equations in chapter 8 of White (2002).

derivation in elementary mathematics of the necessary and sufficient form of W(y):

$$W(y) = (A\, y^{g} + k)^{f} \qquad (31)$$

with translations into the previous parameters as follows

$$f= u/(u-l);\ g= c(u-v)/u;\ A= c\ [\tau/(\alpha\, q)]^{1/u} (u-l)/(u-v) \qquad (32)$$

so that only k, as numerical index of the generalization, is novel. [2] The substantive point corresponding to the mathematical fact that the solution contains a constant of integration, here named k, is that there may be a whole plethora of satisfactory solutions in addition to that in equation (6), which is seen now to correspond to k=0 in equation (31).

Return to the observations on a concrete market. One can at once estimate k, from the observations on any one producer plus the parameters above aside from the set of n's. But the model should be able to tell us which values of k will work. We have already seen with Figures 3, 5, and 7 that there are whole ranges of contexts, that is point in state space, for which k=0 does not yield viable solutions and any other particular value of k, being less central and not a continuation of p.c., is presumably more exposed to rejection.

Let us develop systematically two further tests for viability of market mechanism beyond those enforced explicitly in Part I: first, for whether W(n) yields an extremum for that producer, and second whether the extremum indeed yields it positive profit. For both orientations the solution equations in Section I already guaranteed the slopes of W(y) and C(y;n) to be equal at y(n).

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[2] One can also consult Spence (1975), where this result is obtained from partial differential calculus, and White (2002), where elementary calculus is used.

For downstream orientation, with W(y) being revenue, the extremum must be a maximum, so that the first test if that the second derivative of W-C is negative at y(n). Whereas for upstream orientation the first test becomes that the second derivative with y of W-C be positive, so that the distance of its negative, of C above W, is maximized. For downstream orientation positive profit means W>C, and the reverse for upstream orientation.

Calculations show that the first and second tests can each be expressed in terms of inequalities which k must satisfy. Each inequality takes a different form in the distinct polygonal regions of the state space.[3] Figure 12 reports the range of k values allowed by region, for downstream orientation, and Figure 13 does so for upstream orientation: note that each, like Figure 10, includes the whole PARADOX half.

-- FIGURE 12 ABOUT HERE -

- FIGURE 13 ABOUT HERE --

Note that k=0 is indeed allowed in and only in those regions where solutions extrapolating p.c. have been reported earlier. In particular, PARADOX is the only region wherein k=0 is allowed in both Figures 12 and 13. Our main business is to explore the solutions where k is not zero. For participants in business, surely, the main issue is how large will the market revenues be. But first, examine further the bottom right quadrant of Figure 3 state space, for u>l combined with v<l.

[3] See Table 3.2 in White (2002, pp.54-5)

Unraveling by location on quality--The signaling mechanism has an additional vulnerability. Some producers may opt to offer just the same output volume, with all other constraints satisfied. This happens when the W(y) curve with a given value of k does not offer unique optimizing choice on y to each lower quality producer, who nonetheless estimate that they will make a profit at the lowest volume being offered by other producers. The buying side will not however sustain this and thus turn away from the producer whose quality does justify that edge volume. So step by step the market profile of signals is unraveled.

Earlier (White 2002, chapter 4) I illustrated how unravelings fit with maneuvers by entrepreneurs within these social network constructions (and see Burt 1993). For upstream orientation this is especially commonplace for market contexts in the cone marked ORDINARY for downstream orientation, Figure 12. For downstream orientation it is especially common in the lower right quadrant that in the upstream orientation merges into the dual perfect-competition. Interesting examples can be found, as for road haulage (Biencourt 2000) and I have labeled this region UNRAVELING in both Figures 12 and 13.

Markets for contexts in any region where unraveling is common cannot sustain themselves for just any distribution of quality across their producers. They are especially vulnerable to and likely to manifest manipulations and maneuverings as entrepreneurs seek advantage through turmoil that eventuates in

Shifts in market outcomes--Equation (10) requires numerical solutions, which can be obtained through a computer algorithm for self-consistent search (cf. Leifer 1985; Bothner and White 2001). But the array of possible contexts is staggeringly large so that even carefully selected sets of examples (e.g. White 2002, Appendix Tables, pp,. 334-338) give inadequate guidance. Yet, for each context where the solution for k=0 is allowed for that orientation of market, insights can be derived.

Asymptotic approximations around k=0--What variations in revenues result from interaction between k, indexing the path of evolution, and parameters defining the context? Answers come from expressing W(n) as a deviation growing as k grows from zero.

The first step is easy and obvious. Designate W(y) for k=0 by W_0.(y) When k is small, the formula in (31) can be approximated as

$$W(y) = W_0(y) \; [\; 1 + k/\{W_0(y)\}^{1/f} \;] \qquad (33)$$

The value of k itself can be expressed in terms of the intercept of W(y), its size when y=0: $k = [W(y{=}0)\}^{1/f}$ So (32) can be rephrased as

$$W(y) = W_0(y) \; [\; 1 + \{W(y{=}0)/W_0(y)\}^{1/f}] \qquad (33)'$$

where (33)' like (33) is a better approximation the smaller k is.

Our interest is in the actual market revenues, the W(n), each the revenue for the volume y chosen by that firm of quality n, y(n). Equation (7) already gives us the y(n) for k=0, designate it now by $y_0(n)$. But a given quality n will yield for any non-zero k a y(n) which is not the same as $y_0(n)$. Thus equation (32) is deceptive:

We must return to equation (7) and, using (31) and (32) together with (33), develop first an asymptotic approximation for y(n) itself in terms of $y_0(n)$ and its revenue $W_0(n)$ together with the k. The result is

$$y(n) = y_0(n)\,[1 + [k/\{W_0(n)\}^{1/f}]\ [1/c(v-1)]\ ] \qquad (34)$$

Using this we can finally obtain a usable approximation for market revenue,:

$$W(n) = W_0(n)\,[1 + \{k/\{W_0(n)\}^{(u-1)/u}\}\ [v(u-1)/u(v-1)]\ ] \qquad (35)$$

where 1/f has been written out in terms of u. These approximations need to be spelled out separately by regions in the state space to guide understanding of the effects of the allowed k shown in Figures 12 and 13.

For example, in the ORDINARY region for downstream orientation, we see that, since k must be positive, W(n) is always larger than $W_0(n)$. The fraction by which it is larger, for a given small k, is proportional to the positive ratio ((1/u)-1/((1/v)-1). This latter ratio is, since l>v>u, always greater than unity: it becomes very large either when u is small, that is along the p.c. axis, or when on the other hand v approaches unity. So the most important distortions introduced by non-zero k, are to increase revenues for contexts close to perfect-competition--as v--> 1 already the revenue $W_0(n)$ is exploding.

Somewhat similar results obtain in the ADVANCED region, where the ratio just discussed is rephrased as (1-(1/u))/(1-(1/v)), since now l<v<u. The size of the ratio explodes as v-->1, so that even small k leverages big increases in W(n) along the bottom of ADVANCED region; whereas along the diagonal, u=v, the ratio is just unity so that Section I results are not much affected. The major difference for ADVANCED, however, is that now negative values of k also yield sustainable market solutions and these will be reduced from the corresponding $W_0(n)$.

Turn now to upstream orientation, where the substitutions in (22) convert equation (35) into a simpler form:

$$W(n) = W_0(n) [1 + \{k / \{W_0(n)\}^{(1-u)}\} [(1-u)/(1-v)]] \qquad (36)$$

The principal finding is that positive k now always generates decreases in W(n), since in the TRUSTS region (1-v) is negative while in the UNRAVELING region (1-u) is negative. Their ratio will go in magnitude toward zero as u-->1, meaning little impact from k, but will grow very large as v-->1. Remember that in upstream orientation it is the high quality firms that have the bigger revenues, that will be boosted most in absolute terms when a signal profile W(y) is shifted by k from $W_0(y)$.

III. OUTCOMES WITH CROSS-STREAM SUBSTITUTABILITY

What would be effects from substitutability of a given industry's outputs with those from other markets lying cross-stream, in locations structurally equivalent to some extent within the upstream to downstream flows with the location of the given market? For downstream orientation the most obvious formulation is erosion of the valuation schedules of downstream buyers (which are not directly observable, of course).

Indeed signs of such **substitutability** may also appear as between the separate producers of the given market. Consolidate all this into one parameter for discount, call it x. Because of such cross-discounting, the true valuation by buyers in aggregate downstream must involve interactions between the separate valuation schedules hypothesized earlier in equation (2). Let this aggregate valuation be designated as *V*. Approximate it by a discount of a summation across the separate producer schedules S:

$$V = [\Sigma \; S(y;n)]^{1/x} \qquad (37)$$

It is appropriate to then also focus on the overall aggregate market volume, designate it by *W* . This is the sum over the revenues W(n) of all the firms of various qualities n in that market:

$$W = \Sigma \; W(n) \qquad (38)$$

The equally good deals constraint, equation (3), must be retained, but now its actual numerical size depends on the aggregate market revenues *W* . To clarify this, re-label the multiplier in equation (3), say as theta, now a numerical fitting constant as much as a tunable parameter: Replace (3) by

$$0 \; W(n) = S\;(y(n);\, n) \qquad (3)'$$

where as before we simplify W(y(n)) to W(n).

Now transfer use of tau to the aggregate level:

$$1 \; W = V \qquad (39)$$

where tau has been put in boldface to signify its being defined for aggregates. Whereas equation (3) or (3)' emphasizes that each producer must offer terms equally as good as for the other producers, one uses equation (39) just to point out that in aggregate the valuation must exceed the revenue paid producers for the market. That is, equation (39) entails that *1* > 1 .

Some degree of substitutability, x>l, is surely to be expected. So hereafter we will talk in terms of tau. Tau being unity means that the profile of revenues W(y) is extracting the most aggregate revenue that the buyers in aggregate could be pushed into paying for such menu of deals (not that this maximum is observable).

Yet all the previous equations are expressed in terms of what is now redefined and re labeled as 0 . We need a translation formula. Put equations (3)' and (39) together through the use of the definitions in equation (37) and (38):

$$\tau\, W \;= V \;= [Z \;\; S(y;n)]^{1/x} = [Z \;\; 0 \;\; W(n)]^{1/x} = \theta^{1/x} W^{\;\;1/x} \qquad (40)$$

so that

$$0 \;=\; \tau^{\,x} W^{\;\;x\,-1} \qquad (41).$$

the converse being

$$\tau \;=\; \theta^{1/x} W^{\;\;(1/x)\;-1} \qquad (41)'$$

In substantive terms, equation (41) means that the solutions for y(n) and W(n) for a producer given so far in fact depend in size on what the whole set of volumes and revenues--across all firms, and thus the market aggregate revenue--are.

Note that these results so far on substitutability are general and thus applicable whatever the value of the path constant k is (Section II). But there is no closed formula giving results for market aggregate or for individual producers except in the case of k=0, the extrapolation of perfect competition in which all producers have the same profits and the intercept of the W(y) curve is zero.

We now proceed to derive formulas for this k=0 case as a guide more generally to the impact of substitutability upon market outcomes. All we need do is substitute the right side of equation (40) in place of what we have written as tau in all the equations of the previous two Sections. For downstream market, substitute equation (10), with this transposition, into equation (36). **W** appears now on both sides of the equation; the necessary consolidation yields, using the tau defined by equation (38),

$$W = q \{(\alpha/\tau)^{v} [e/(e+1)]^{v}\}^{1/(x-v)} [\Sigma 1/n^{e}]^{(1-v)/(x-v)} \qquad [42\}$$

Quality leverage appears only in a separate factor $[\Sigma\ 1/n^{e}]$, which we can denote for simplicity just by Σ in Figure 15 later.

Our main concern is to show the variations--mostly not very large--that it brings to the results in previous Sections. The Spline and associated rays, for upstream as well as for downstream, carry through pretty much, along with the region boundaries discriminated as in earlier Figures 5, 7, 12, 13 for state spaces, including PARADOX.

Note that the impact of the particular array of qualities, the set of n's, appears in the aggregate revenue formula also as a multiplier, the sum raised to a power that combines and thus contrasts the distance of v below unity with its distance below the substitutability, x. Indeed the main impact from degree of substitutability is just in the band in state space where v lies between 1 and x--and of course with u >v>l in order to lie within ADVANCED region of viable markets. All the previous constraints on solutions still hold with x introduced too.

Inspection of (42) indeed shows a curious drop in the contribution from this quality sum exactly in this band, which we designate

$$\text{CROWDED: } 1 < v < x \qquad (43) \; .$$

In equation (42) the power to which $[\Sigma \; 1/n^e]$ is raised is negative in this band. That means, for example, that if new producers (along with corresponding consumer valuations) are added to the market, with other parameters unchanged, the market aggregate will decrease (although within the given aggregate the revenues to higher quality firms will still be lower). Figure 14 superposes the CROWDED band onto the earlier Figure 5.

-- FIGURE 14 ABOUT HERE --

Visualize the variation of aggregate revenue W , equation [42}, as v increases from its minimum, v_0 , along a ray through (1,1), for one value of x, 1.25. Figure 15 graphs W along the central ray, the Spline. Compare it with the Spline in Figures 4 and 6 earlier. It is in and near the CROWDED band that substitutability has its impact. Elsewhere (White 2002b) I have derived partial differential equations for not only change in W with v, but also for its change with x and with other parameters, (α/τ), e, and with the Σ These are, however, logarithmic partial differential equations which tend to conceal discontinuities so that computation is important..

-- FIGURE 15 ABOUT HERE --

Satisfactory understanding requires also specifying how the W(n) of individual producers are affected by degree of substitutability x. It is straightforward to show that equation (10) becomes

$$W(n) = q\{(\alpha/\tau)^{x} \; [e/(e+1)]^{v}\}^{1/(x-v)} \; (1/n^{e}) \; [1/W^{(x-1)/(1-v)}] \quad (44)$$

One can see that the primary impact from x on any particular W(n) is an extra multiplier, at the end. This multiplier is the feedback effect of aggregate revenue and is the same for each of the producers. It is neutralized when x goes to unity, but will tend to wipe out the W(n) for v close to unity.

The analysis suggests that *W* and W(n) ordinarily are not much affected by substitutability, except for the sharp drop in the CROWDED band from v=l to v=1.25. The main conclusion is that substitutability does not much distort the result of analyses given earlier assuming x=l. The generalization in Section II to non-zero k is of more importance, except in the CROWDED band. This is just as well, for the problems in estimating a value for substitutability x are formidable.

Identifying the **CROWDED** <u>parameter</u>--**Return** to the discussion of estimating parameters for an observed market thought to be produced by the W(y) signaling mechanism. Already it was shown impossible, at least with one panel of observations, to identity tau and alpha separately only as a ratio. The results in this Section III, in particular equations (41) and (42), now show that even this ratio cannot be identified separately from the value of x, and conversely.

The estimation equation which packages (α/τ) with x derives from equation (40). Section II showed that theta can be separately estimated from the observed values of y and W and slope for each producer, but only as a ratio to (a q), the scaling factor for buyer valuations S. And now equations (40). and (41) show that the observed value of aggregate market revenue W must figure in the identification of a value for the underlying parameter tau.

The following specifies an equality between an expression in the ratio of **theta** to its alpha, involving W , and on the other side an expression in the ratio of tau to its alpha, that involves both W and x. The point is that it is the same W and q on both sides of the equation, since the issue is only whether the observed market, with given aggregate revenue and q long since estimated, are fitted by theta or instead by tau coupled with some x larger than unity.

$$[(\theta/\alpha) / q)]W = [(\tau / \alpha)W / q]^{x} \tag{45}$$

So the x value required to support changing from no substitutability is given by (with '**ln**' for logarithm to the base e)

$$x\,[\ln (T /\alpha)+ \ln (W /q)] = \ln [(\theta/\alpha)/q)] + \ln W \tag{46}$$

Both terms on the right hand side of equation (46) are observables, known quantities fitted for that market. If x is chosen to be 1 then of course the left side becomes identical with the right. But the equation can only specify a continuum of pairs of value (x, (T $/\alpha$)) for the two parameters as sufficient substitutes.

We can now see how to interpret this indeterminacy, in terms of equation (15) and the basic Figure 4 (and analogously for upstream). The central ray, the Spline has its numerical location v_0 on the v axis between 0 and 1 determined by T / a. And similarly for the numerical value of its slope e_S . So if one argues that substitutability is higher than unity, then the location of the Spline changes, but without disturbing the relative structure of rays in the cone. Earlier we saw in Figures 14 and 15 that, by and large, the numerical values of W(n) and *W* were not much affected by increasing the value of x, with the exception of the CROWDED band where they were sharply reduced.

The problem has a tendency to correct itself. One is unlikely to observe and actual market which is in the CROWDED band in state space because mostly there its size would be so small. Computations show that when x is increased then VQ is decreased because the $/(\tau/\alpha)$ is decreased. But then for v<l the part of the cone above the Spline with larger revenues is enhanced (and these are not much impacted by the increased x), whereas for v>l the upper part of the cone above Spine, again with greater revenues, is **decreased--and** more to the point the lower part with reduced revenues even aside from the CROWDED impact, becomes a larger share of the cone. So High values of x are unlikely to be encountered except for markets with high v.

The CROWDED band which is induced by increased substitutability x can be lumped with borderlines and regions of unraveling in the state space where the W(y) market mechanism of signaling also is not robust. In such contexts the underlying production work will no doubt get done by some other sort of social construction. This can range from the intervention of government of various sorts and levels, discussed by Fligstein (2002), to organization through tradition along kinship or patrimonial lines: see earlier discussion around Figure 9.

IV. APPLICATIONS

In their recent reviews of *Markets from Networks* , sociologist Fligstein (2003) and economist Loasby (2003) both call especially for empirical applications. Some applications of W(y) models were reported in the book (White 2002) and earlier: see e.g., Burt (1992, chapter 6), Leifer (1985) and White (1981). A couple of other applications have been published since the book went to press: Biencourt and Urrutiaguer (2002); Bothner and White (2002). The present paper offers a compact, yet self-contained guide for further modeling. The increased emphasis here on the dual orientations of markets should encourage extrapolation to macro-economic topics (e.g., White 2002d, 2003a) and especially labor markets. The explicit rooting of quality competition in perfect competition clarifies the phenomenology, and bears on the admirable dissection by Favereau, Biencourt and Eymard-Duvernay (2002), who pay particular attention to labor.

Fligstein suggests that W(y) models suggest how industries pull themselves apart into distinct new industrial role sets, and Bothner develops this same idea (Bothner, Stuart and White 2004). Fligstein calls for applications to particular industries and sectors. In collaboration with a French team (Chiffoleau, Dreyfus, Laporte, and Touzard 2003), I am engaged in a multi-year study of their wine sector. Interim results (White 2002b, 2002c, 2002d) include technical simplifications to ease use of conventional data on average market prices, as well as substantive extrapolations.

Long-term tracing of a particular sector and its industries is promising. King (2003) offers preliminary results for the dairy sector in the U.S. from the 1880s through to World War II. As for the French wine sector, heavy influences from cooperative organization forms and from regional specializations complicate the analysis. Still, one of the new phenomena predicted by W(y) models may be recognizable. King came to focus on the processed cheese industry, for which the contexts in this era, when consumers valued more what industrial operations made with less expense, appear to fit into PARADOX region. This is the only region of state space (Figures 5, 12, 13) where both upstream and downstream orientations of the market are sustainable. And a striking feature of the dairy sector in this era was a series of switchings between primary concern with upstream and with down.

CONCLUSION

The seed of quality competition as general mechanism for markets is already there in the array of regimes for perfect competition facing upstream, as well as also in the dual, and more orthodox array for downstream regimes. And in turn perfect competition as social construction derives from general recognition of each producer as an actor with distinct identity yet seeking shelter from uncertainty. Primordial for that, in turn, is emergent recognition of a particular set of producers as where to go for a recognized line of business, and industry, that is a set of peers seen by selves and others as structurally equivalent within the networks of flows that are the underlying reality in human work processes of production.

Economist Marshall long ago (1923) gave a brilliant overview of such a production economy, many historians and economists have traced particular examples variously in Europe. Sociologist Udy (1970) offers the best cross-cultural analysis of the imperatives of human work organization for production in general. And evolution is not a one-way process. Within the frame of analysis in Sections **I-III** above I can argue that industries spring up in all sorts of particular ways and then are subject to pressures from changes in context, as in product life cycles, that may push them back down a ray into a final state of undifferentiated perfect competition.

Note the distinction from other socio-economic network views: This production market mechanism is seen as the way in which producers actually dodge their network embeddings in order to consortium uncertainties in these individual relations.

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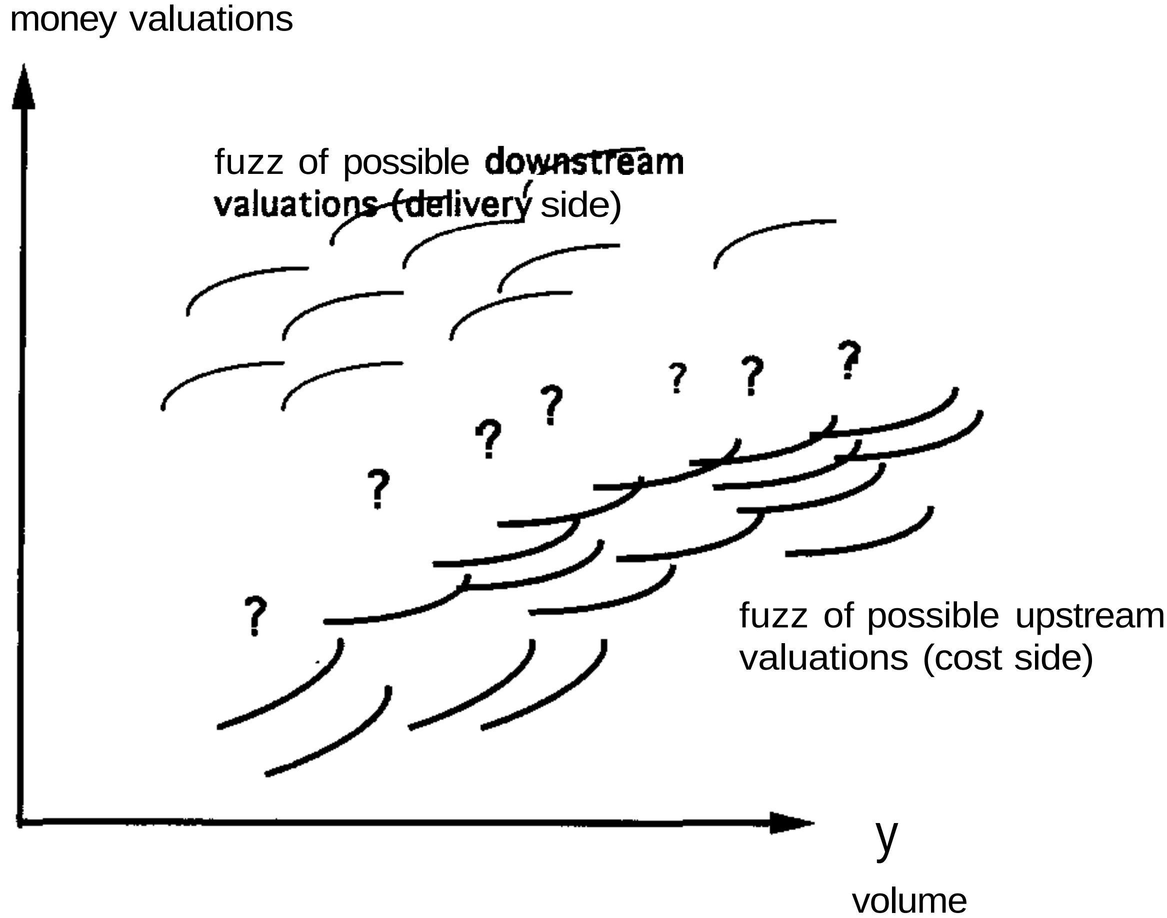

Figure 1.

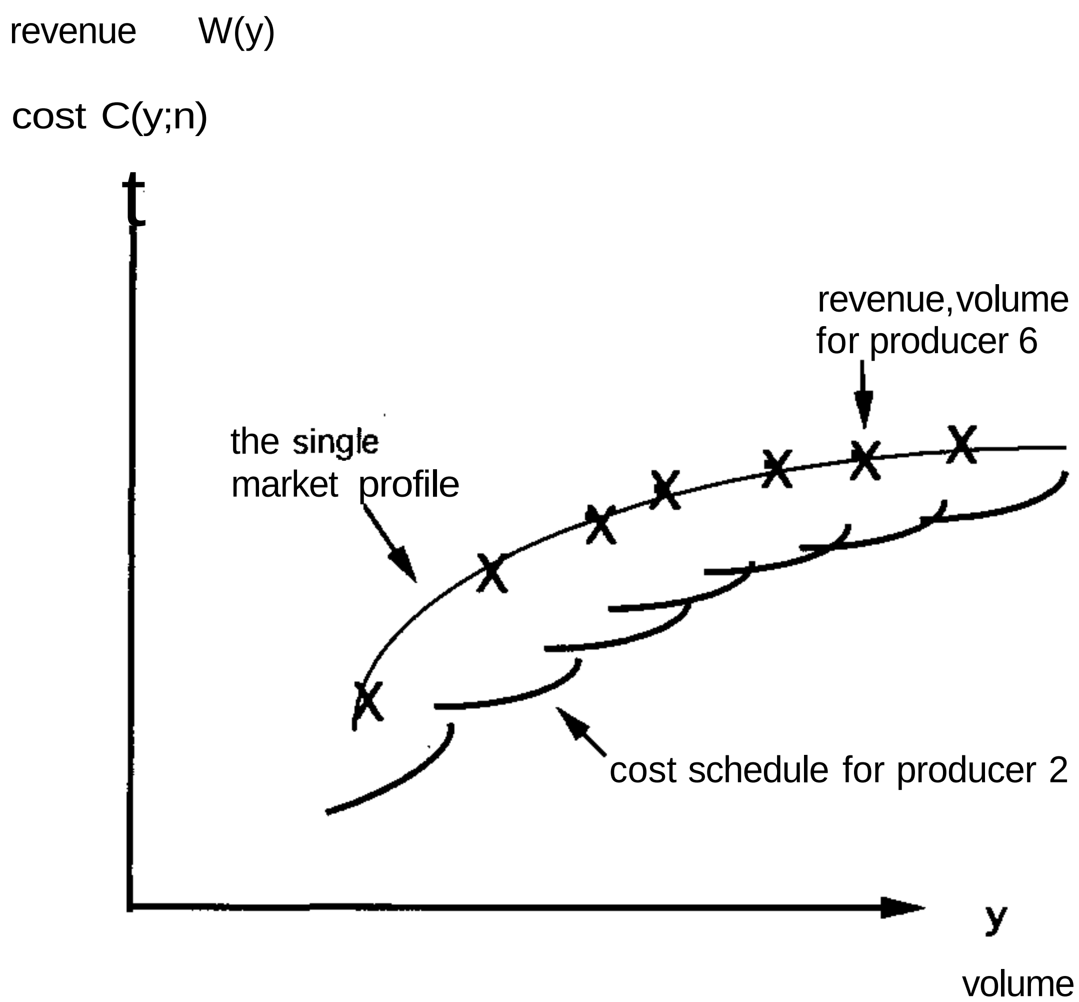
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Figure 2.

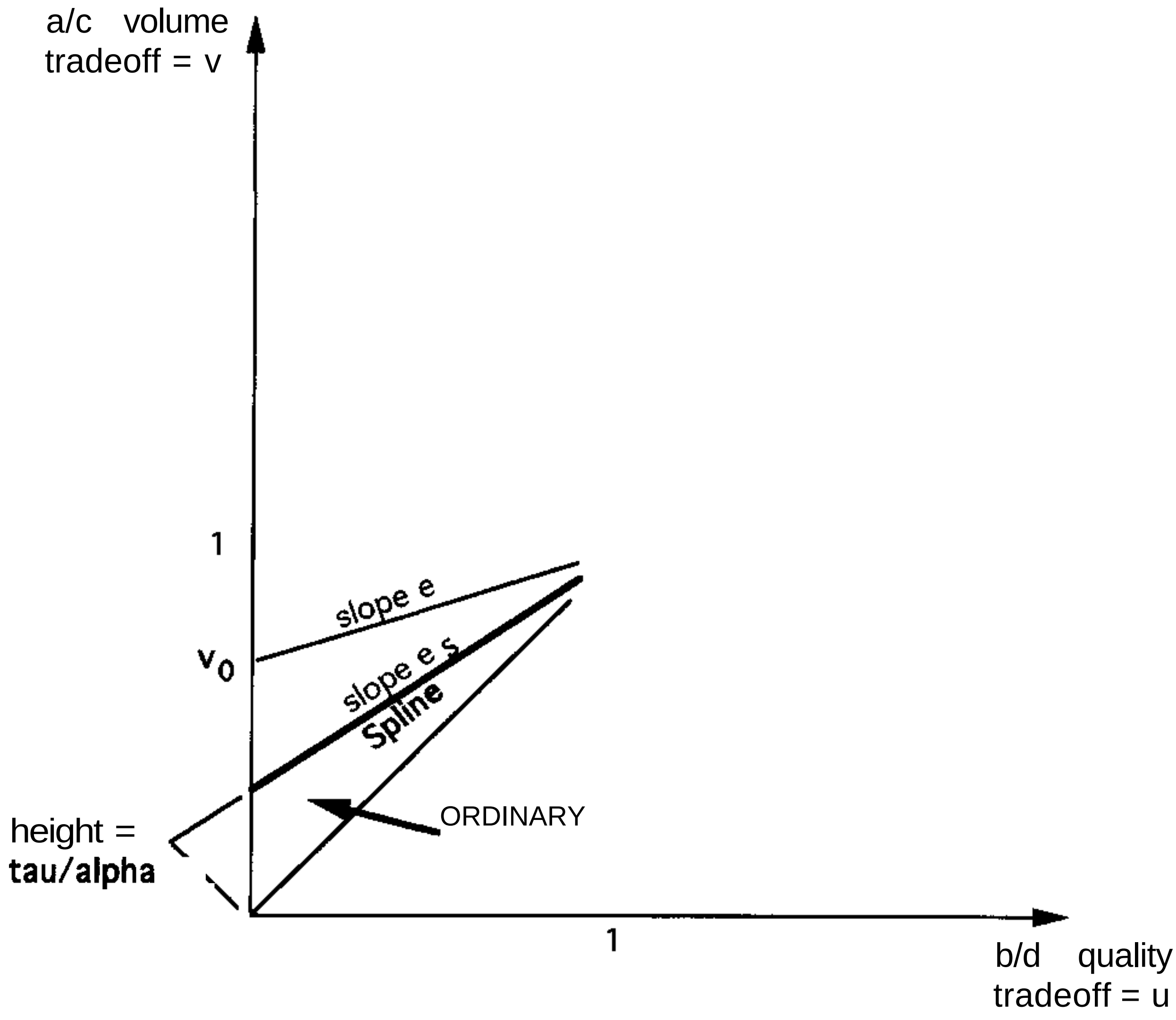
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Figure 3

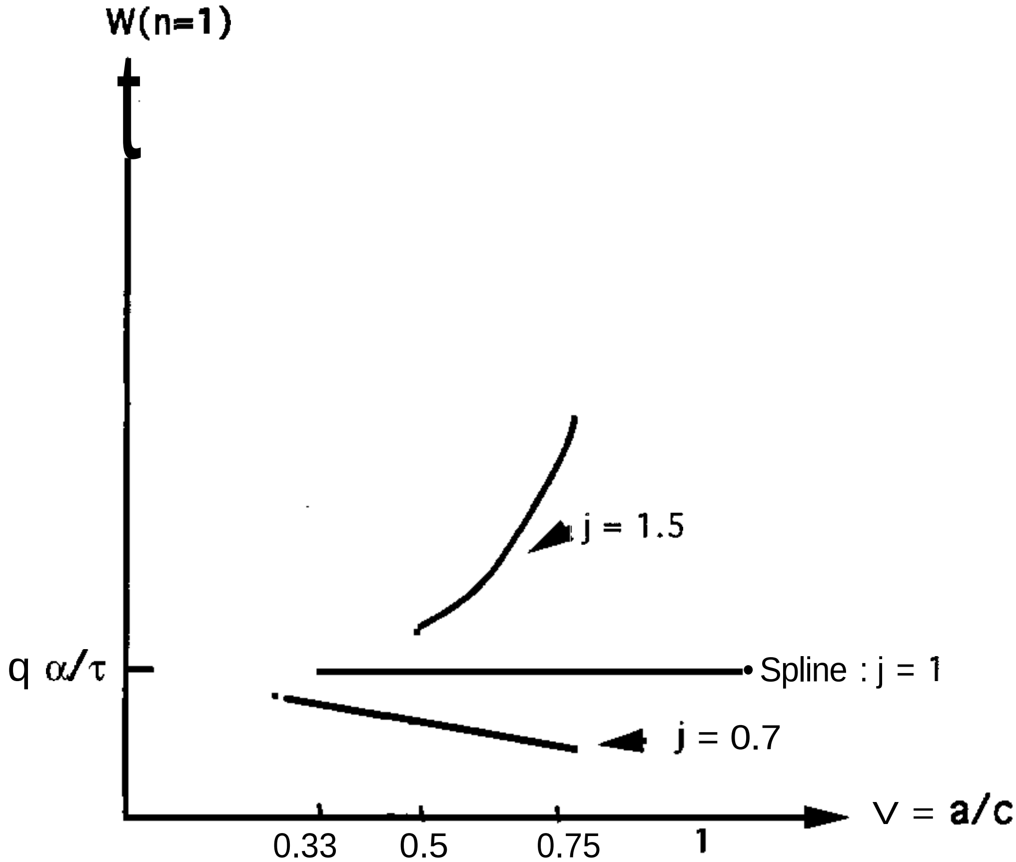

Figure 4. Variation of revenue for lowest cost producer on each of three rays: eq (18) with α/τ taken to be 1/3. Each curve terminates on the left at the p.c. v for that ray.

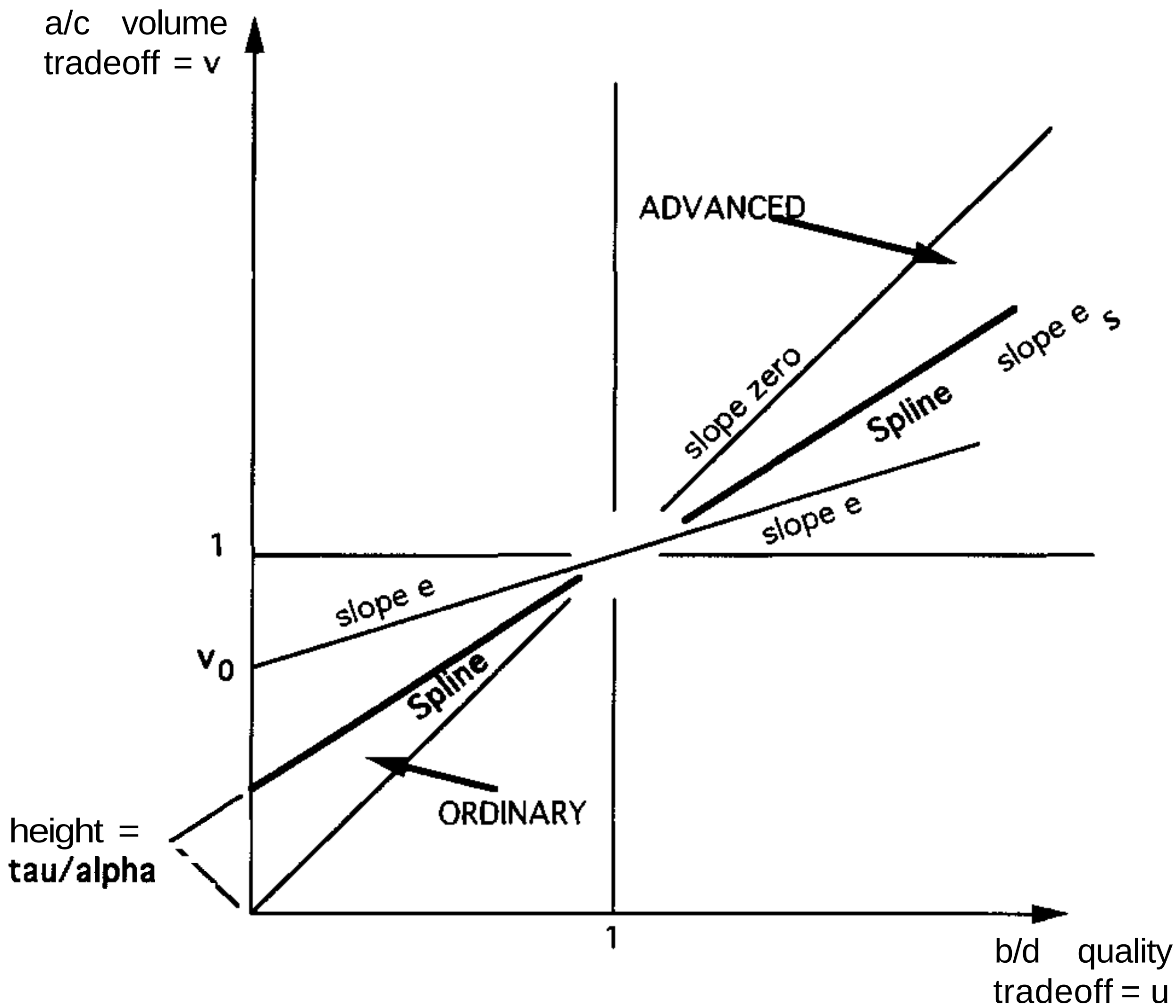
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Figure 5

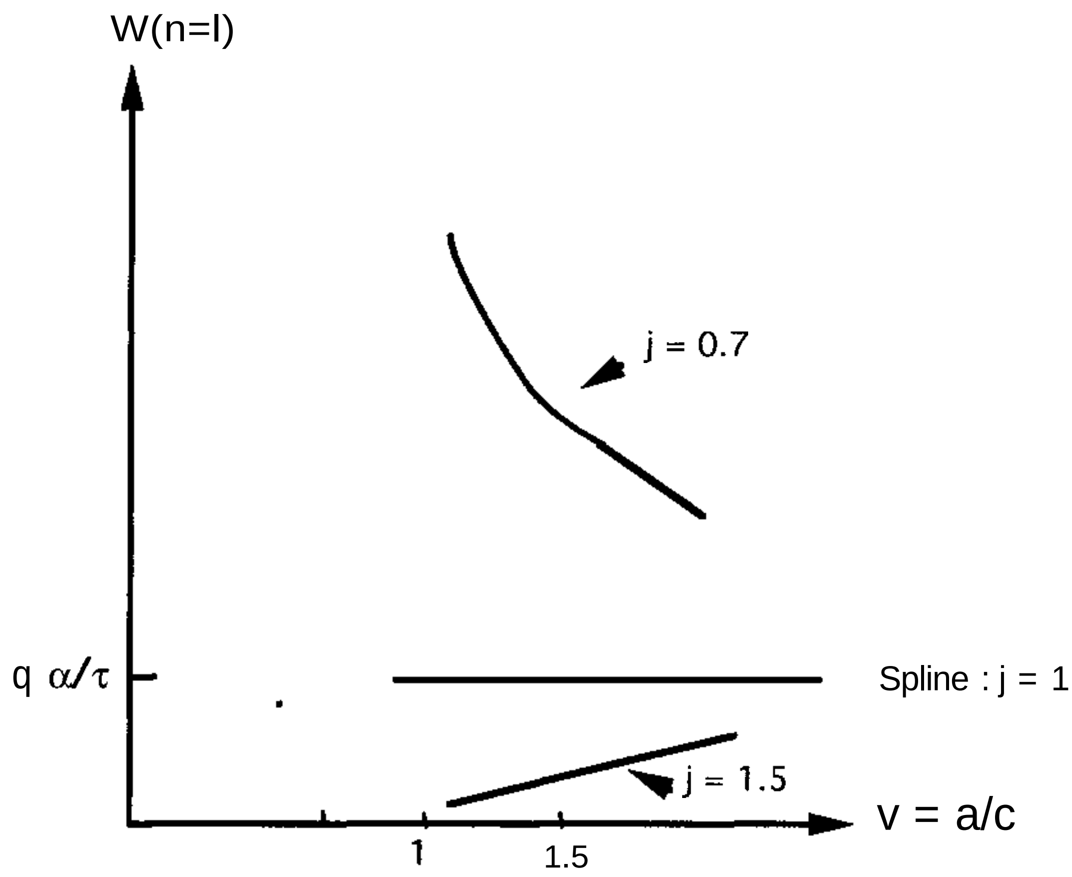


Figure 6. ADVANCED region: Variation of revenue for lowest cost producer on each of three rays: eq (21) with α/τ taken to be 1/3.

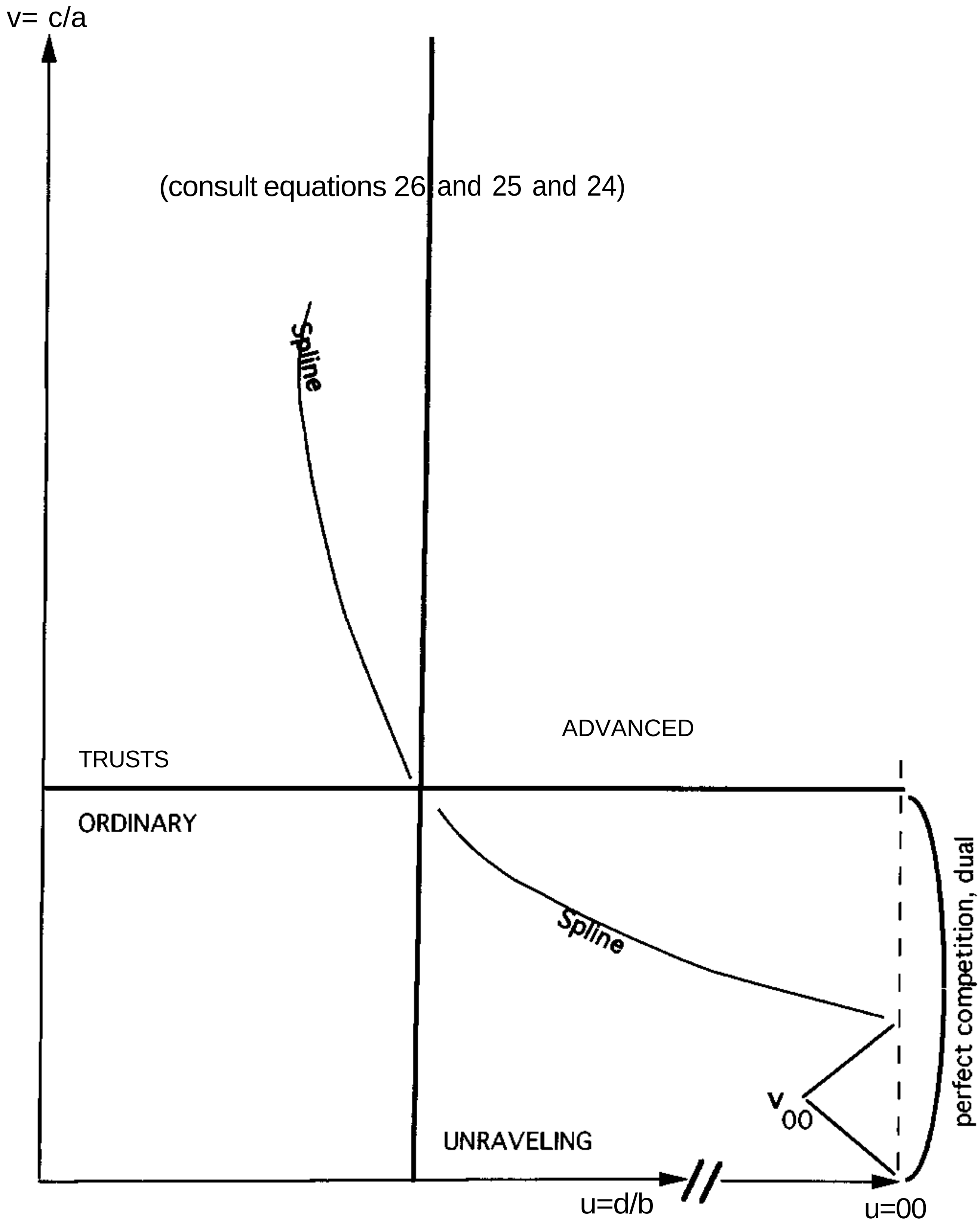


Figure 7. Parabolic rays for growth in revenue, with upstream orientation, from dual perfect competition -state space analogous to Figure 5.

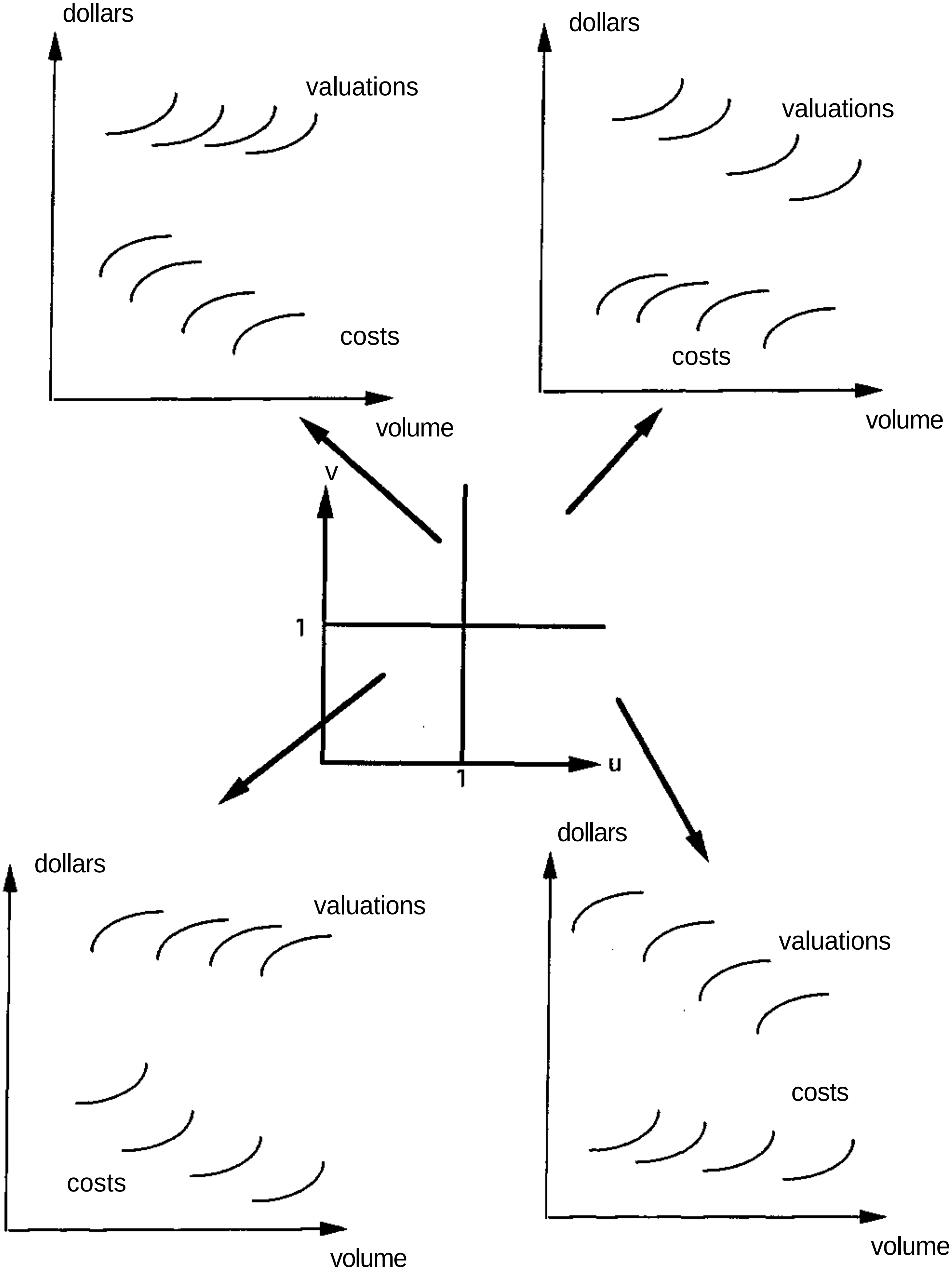
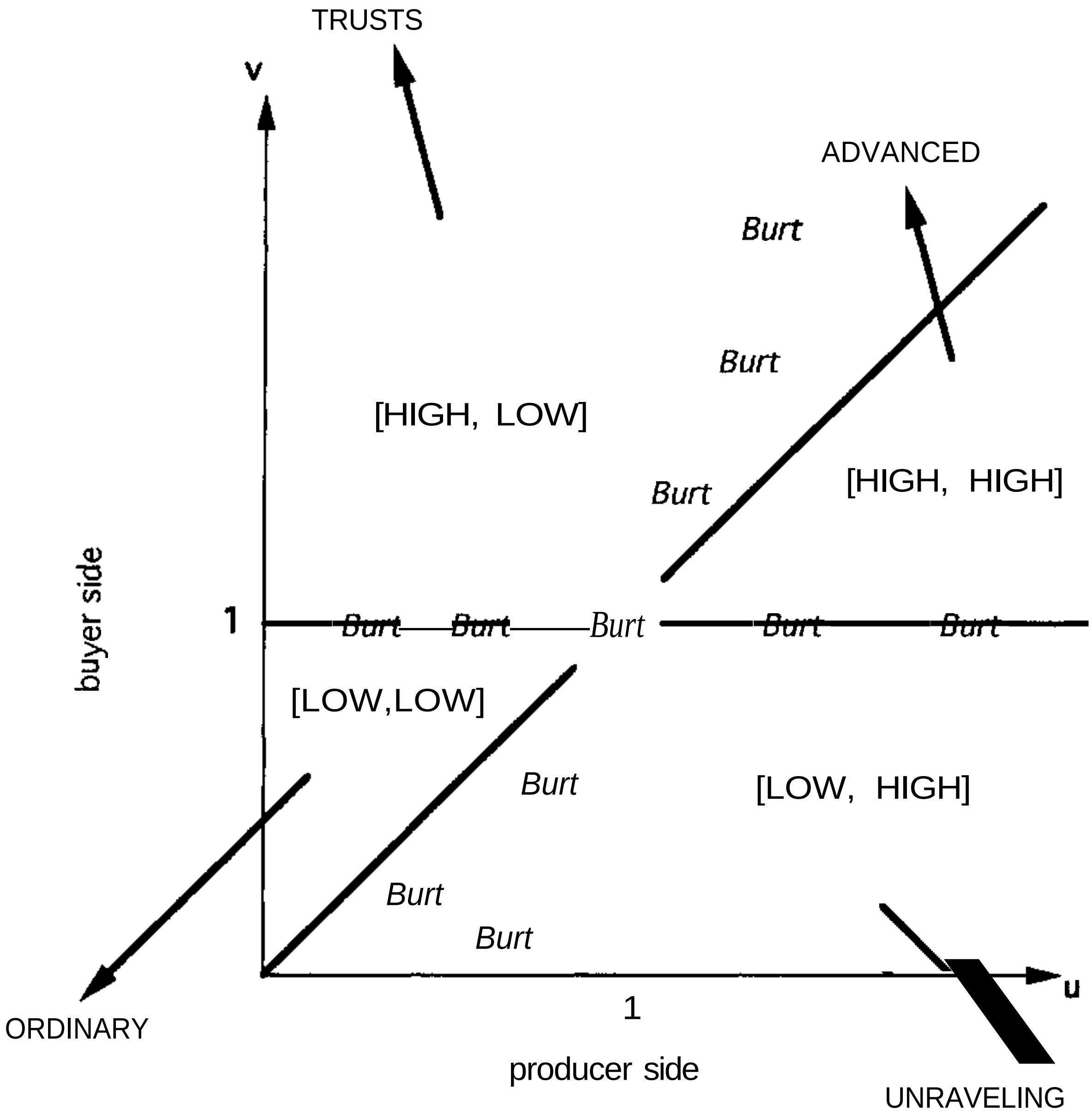


Figure 8 Contrasts, by quadrant of state space, between curvatures of monetary schedules and their vertical displacements by quality of producers (four for illustration)



2x2 table entries:

[BUYER SIDE UNCERTAINTY, PRODUCER SIDE UNCERTAINTY]

Figure 9. Market state space seen as Podolny (1991) 2x2 table of uncertainties, *with interleaved borders of Burt (1993) manipulation*

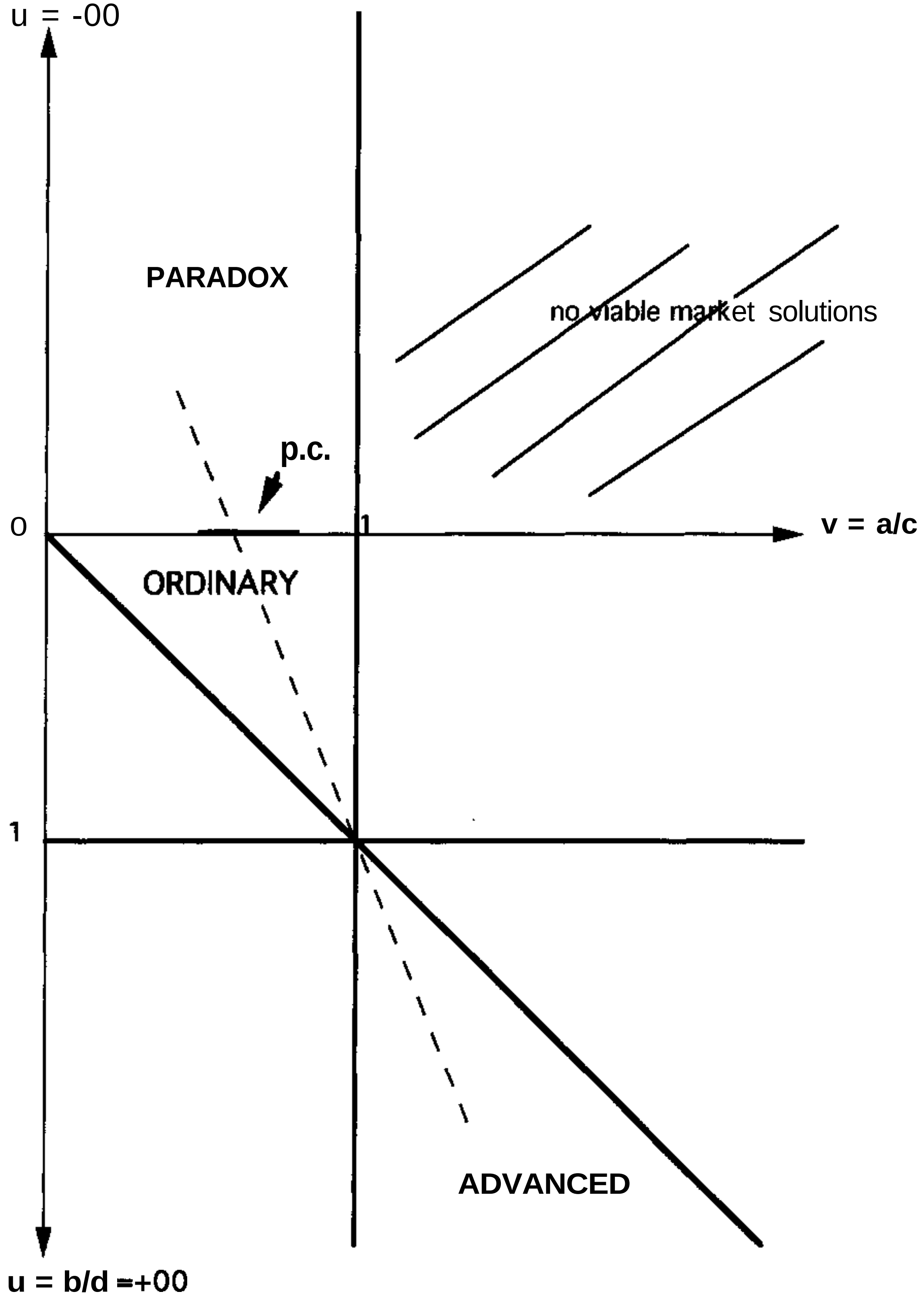


Figure 10. PARADOX region, for negative values of u, adjoined to state space for downstream orientation of **Fig.** 5 (rotated by 90, abd showing the illustrative ray extended)

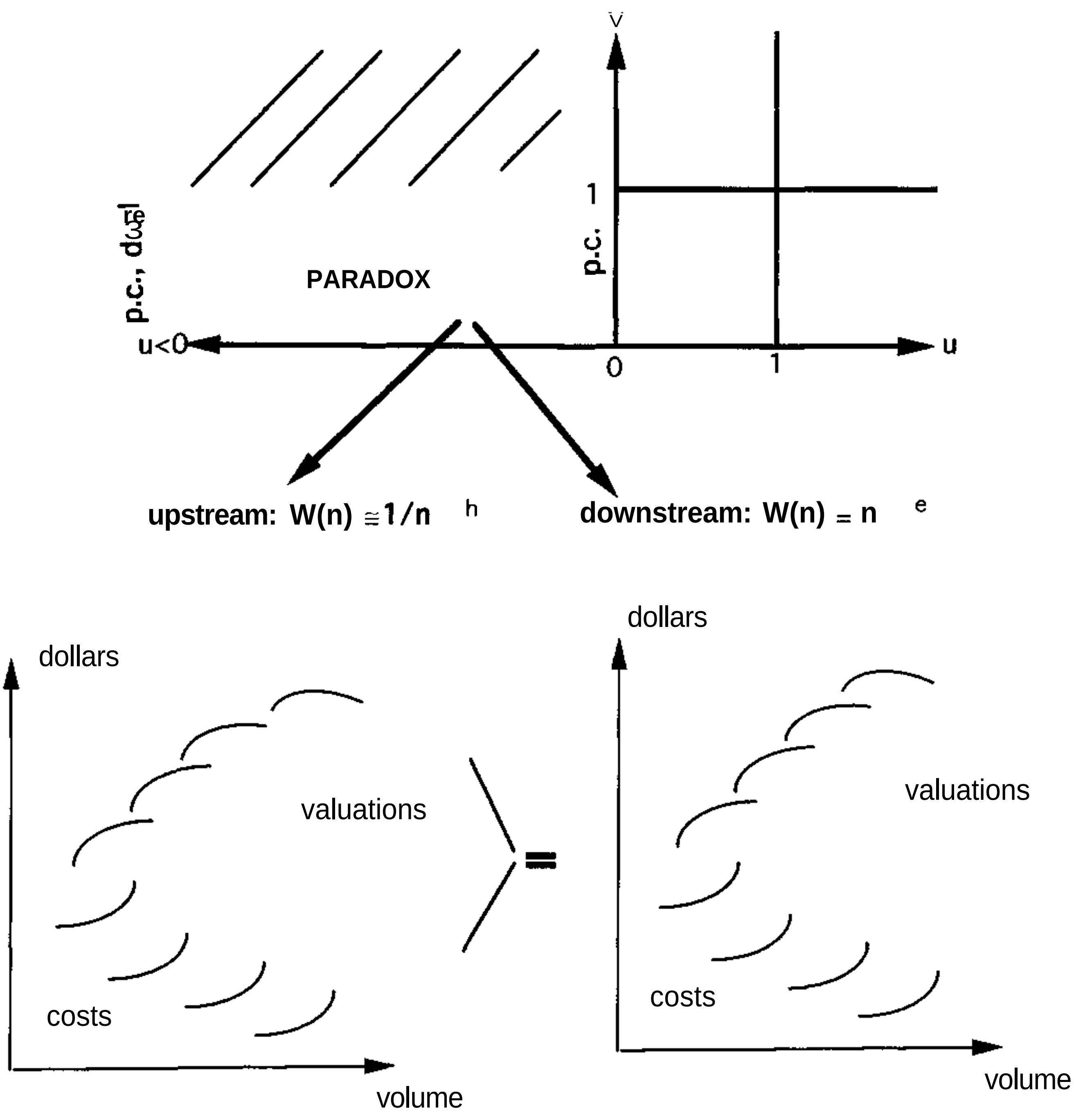


Figure 11. For PARADOX region (see Fig. 10} contrasts between the curvatures of monetary schedules and their vertical displacements by quality, for orientations upstream and down

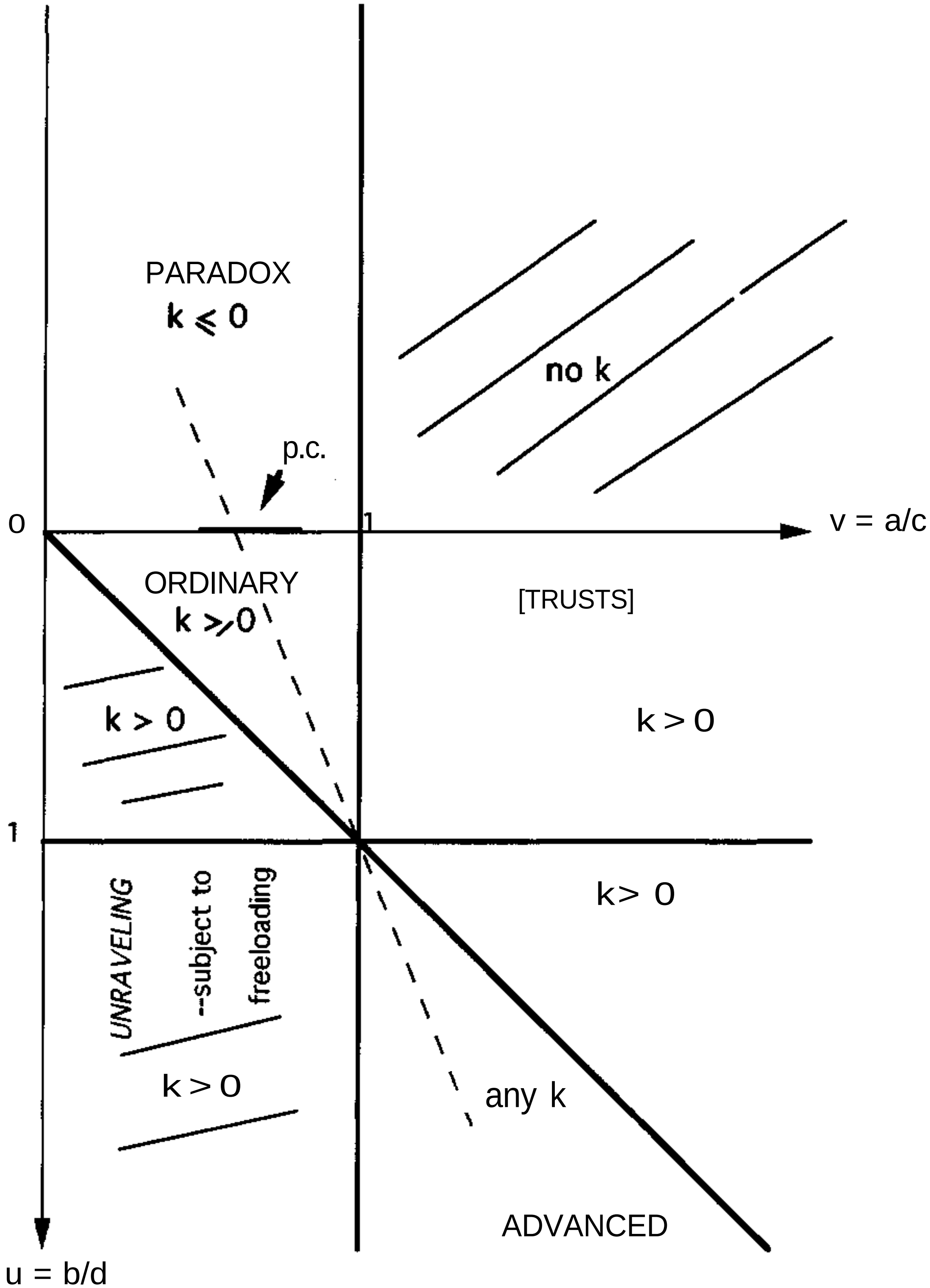


Figure 12. Allowed range of solutions for W(y),
by region for downstream orientation: consult eqs 31,32

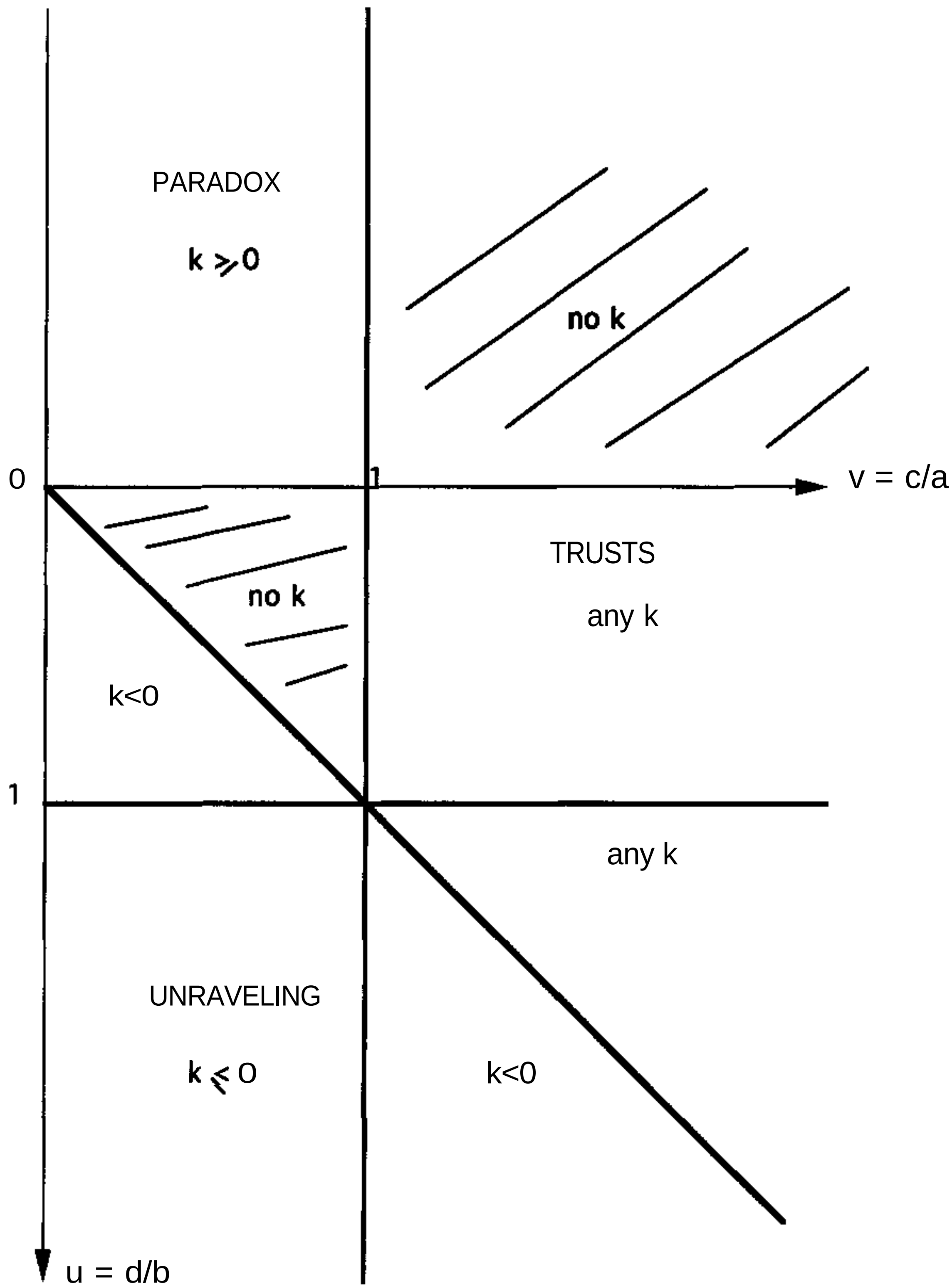


Figure 13. Allowed range of solutions for W(y), by region for upstream orientation

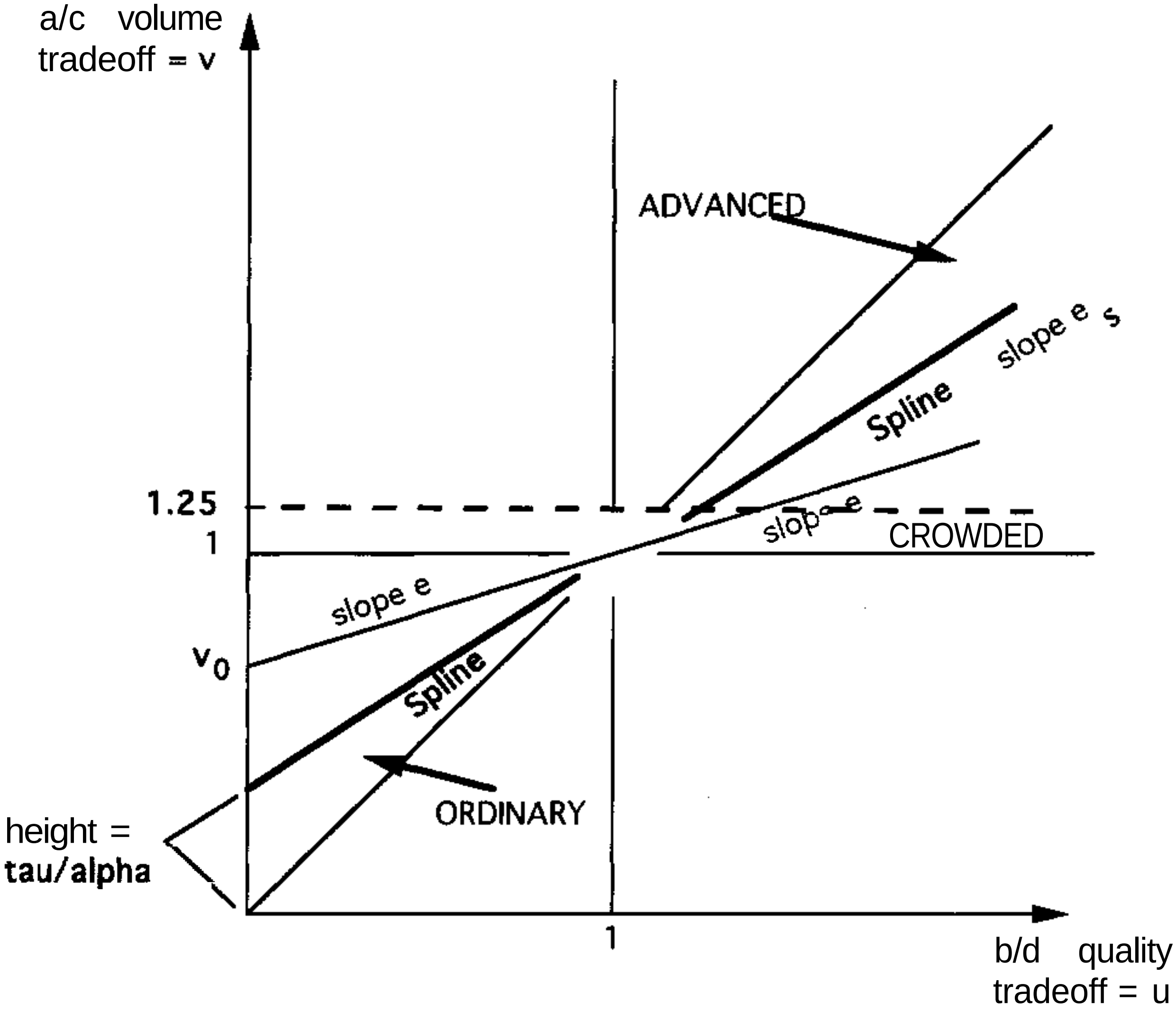


Figure **14.** Crowded band

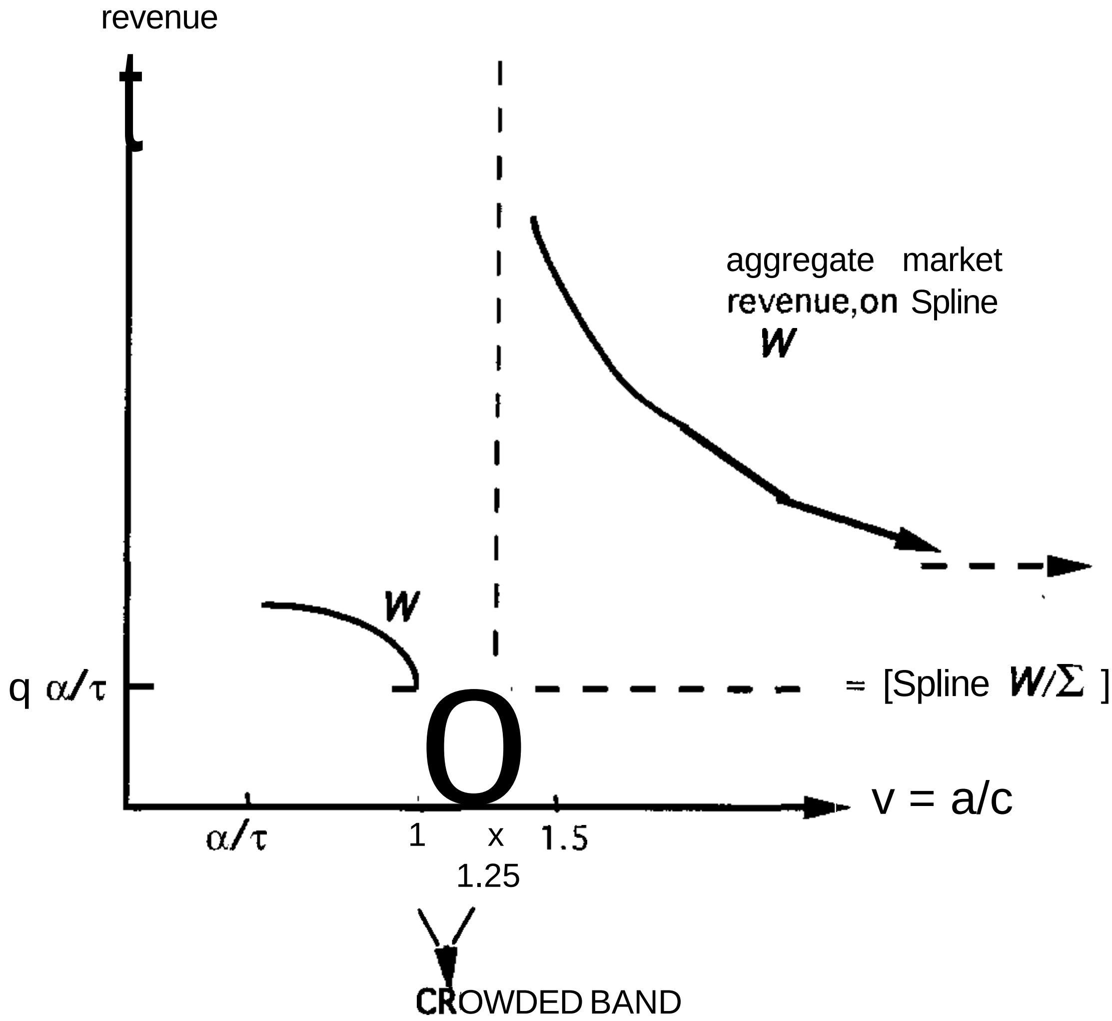


Figure **15.** With substitutability **x=1.25,** variation of aggregate market **revenue** *W* along Spline, downstream orientation

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