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A New Proposal for Setting Intra-Company Transfer Prices

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A NEW PROPOSAL FOR SETTING INTRA-COMPANY TRANSFER PRICES

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Summary:

This paper proposes a method for establishing transfer prices based on the Shapley value. This is done by determining an agreed-upon weighting of factors of profitability within a firm, and then allocating the direct costing gross margin of the firm to its divisions by means of these factors and the Shapley value.

The allocation of profit to divisions that results from this technique is a negotiated one only to the extent that those managerial factors most relevant to firm profit must first be agreed upon. Once reached, such an agreement eliminates periodic bargaining on transfer prices and embodies certain properties of equity that are suggested by the Shapley value.

We shall also show the close relationship of the proposed allocation method to a widely used technique for the calculation of state corporation and franchise taxes, known as the "Massachusetts formula." This technique has grown out of the efforts of the states to take into account the complex causality of income in a Federal System which permits corporations to domicile in whatever state they choose while engaging in productive operations and marketing their goods wherever they choose.

An Illustration of the Procedure

The procedure can perhaps best be explained by a numerical example. We assume a centralized planning body using a mathematical programming model to generate its forthcoming production schedule as follows:

$$\text{Max Profit} = 2x_1 + 4x_2 + 5.5x_3 + 8x_4$$

$$\begin{aligned} \text{S.t (1)} \quad & x_1 + x_2 + 1.2x_3 + 2x_4 \leq 250 \\ \text{(2)} \quad & x_2 + 1.5x_3 + 2x_4 \leq 200 \\ \text{(3)} \quad & x_3 + 1.5x_4 \leq 150 \end{aligned}$$

$$\text{and all } x \text{ is } \geq 0$$

Assume that there are three major divisions in the firm and that constraints 1 to 3 represent the capacity limits of the divisions respectively. Product one, x_1 is a processed raw material which can be sold

The transfer pricing problem has given rise to an extensive literature, in which several ways have been suggested for determining the prices of intermediate products.[1] These ways include systems based on:

1) Market prices
2) Marginal costs or variable costs when the cost function is not known
3) Average costs plus or full cost plus, either actual or standard
4) Opportunity costs or shadow prices[2]
5) Negotiated prices, for which negotiation might be initiated from any of the previous four methods.[3]

In general there is no quarrel that when competitive market prices exist, these prices, adequately adjusted for internal economies of the integrated firm,[4] should be the prices used to calculate divisional profits. Difficulties arise, however, whenever there is no clear market price for an intermediate product and whenever integrated firms are required[5] or whenever they elect to treat as profit centers their own divisions exchanging intermediate products.

This paper will examine a method for establishing transfer prices based on the Shapley value. The approach is a form of variable cost "plus" pricing, in which the "plus" or, addition to variable cost, is determined according to an agreed-upon weighting of factors of profitability. In an ex ante planning process, the Shapley value will be used to distribute profit after the optimal schedule of production has been determined. Subsequent to this profit distribution, transfer prices will be calculated. A consequence of this approach is that the resulting transfer prices are neutral with respect to decision-making.

Table 2

Profit Factors for 197x Profit

Profit Factors	Division 1	Division 2	Division 3	Total for Firm
Total Assets	$ 1550	$ 2000	$ 1200	$ 4750.00
Total Payroll	300	500	300	1100.00
Total Sales	$ 180	-	$ 2666.67	$ 2846.66

We have no special reason for selecting these factors as most appropriate among those that are relevant to producing income. However, we do note that these profit factors are the same ones which states employ to assess the causal relationships for generating the income of corporations operating within their taxing jurisdictions.[6]

In Table 2 Total Assets are simply the debit side of the profit center's balance sheet, (we assume that these totals are the average of the opening and closing balances). Total Payroll includes not only direct labor as embodied in the c_j's, but also supervisory, sales, and administrative personnel of the divisions. As such, each total payroll represents the responsibility of a division's management for the direction of its own personnel, for the training of that personnel, for union relationships, etc. Finally Total Sales are the totals of ultimate deliveries by the firm to outside markets at freely competitive prices. Specifically, the sales values which are given in Table 2 are those for the solution of our illustrative example.

by Division 1 at a competitive market price. Product x_2 is a semi-finished good sold to manufacturers by Division 2 at a competitive market price. Products x_3 and x_4 are manufactured goods, x_3 being a low cost good and x_4 being a higher quality, more carefully finished version of x_3.

Additionally, we know the per unit prices and variable costs of the x_j's as these costs are incurred in each division processing them.

Table 1

Prices and Variable Costs

		x_1	x_2	x_3	x_4
p_j		\$ 8	\$ 12	\$ 20	\$ 25
Variable Cost - Div.	1	6	5.5	3.50	4
	2	-	2.5	7.00	8.50
	3	-	-	4.00	4.50
Total Variable Cost		6	8	14.50	17.00
Contribution Margin, c_j		2	4	5.50	8.00

And we also know, as any self respecting budget office would, the total assets and the payroll of the "profit centers" required to implement this schedule of production (refer to Table 2).

total assets downwards by x_1's utilization of Division 1's total capacity, i.e., by 90/250.

Table 2 Revised

Profit Factors for 197x Budget Adjusted to Eliminate Separate Market Transactions

Profit Factors	Division 1	Division 2	Division 3	Total
Total Assets	$ 1000	$ 2000	$ 1200	$ 4200
Total Payroll	200	500	300	1000
Total Sales	0	0	2667	2667

Calculation of Transfer Prices

Now we proceed to the calculation of transfer prices. First we observe from our income statement that the mark-up on product x_3 is approximately 38%. Then we calculate for every coalition of divisions the gross margin which appertains to that coalition of divisions given its total variable costs. (Refer to Table 3, Column 3). Next, using Table 2 Revised, we calculate for each coalition its profit factor apportionment ratio in column 4. An interpretation of this ratio is that it represents the extent to which all of the possible coalitions of divisions utilize the full services of the firm and benefit from the integrated power of the firm. One can think of the existence of each of the separate sub-coalitions (including coalitions of a single division) as representative of groups "going it alone," i.e., groups obliged to buy goods and services of all sorts outside of the firm and thus forced to share profits with outsiders. The grand coalition of all divisions is the fully integrated firm which benefits from the total income producing power of the firm.[7]

Profit	$913.33	Shadow Prices	
x_1	90 units	Division 1 Capacity	$ 2.000
x_3	133 1/3 units	Division 2 Capacity	2.067
x_7	16 2/3 units [slack of Div. 3]	Division 3 Capacity	0

A pro forma income statement for this budgeted schedule of production follows

Pro Forma Income Statement for 197x Budget

		x_1	x_3	Total
Sales Revenue		$ 720	$ 2666.66	$ 2846.66
Less Cost of Goods Sold:	Division 1	540	466.66	1006.66
	Division 2	-	933.33	933.33
	Division 3	-	533.33	533.33
Sub Total		540	1933.33	2473.33
Gross Margin		$ 180	$ 733.33	$ 913.33

Only one adjustment to our data remains to be made before we calculate internal transfer prices. Wherever competitive market prices exist, and sales are made at those prices in such a way that we can completely disengage those transactions from the rest of the company's income statement and from Table 2 (The Table of Profit Factors), we shall do so. Specifically, for our problem we make this adjustment for x_1, the revenues and costs of which can be eliminated easily from the income statement. We also must adjust Table 2 to eliminate x_1 sales and payroll costs from Divison 1 data and to revise Division 1 total property so that it will represent only those assets committed to x_3. Here, the "bugaboo" of cost allocation must be faced. We do this by adjusting

Table 3

Divisional Coalitions, Apportionment Ratios and Profits

Col (1) Coalition of Division	Col (2) Variable Costs	Col (3) Mark-up Col (2) x38%	Col (4) Profit Factor Apportionment Ratio	Col (5) Adjusted Coalition Profit Col (3) x Col (4) = 5
1	$ 466.66	$ 177	$\frac{1}{3}\{\frac{1000}{4200}+\frac{200}{1000}+\frac{0}{2667}\}=.146$	$ 26
2	933.33	354	$\frac{1}{3}\{\frac{2000}{4200}+\frac{500}{1000}+\frac{0}{2667}\}=.327$	116
3	533.33	202	$\frac{1}{3}\{\frac{1200}{4200}+\frac{300}{1000}+\frac{2667}{2667}\}=.526$	106
1 + 2	1400.00	531	$\frac{1}{3}\{\frac{3000}{4200}+\frac{700}{1000}+\frac{0}{2667}\}=.470$	249
1 + 3	1000.00	379	$\frac{1}{3}\{\frac{2200}{4200}+\frac{500}{1000}+\frac{2667}{2667}\}=.675$	256
2 + 3	1466.67	556	$\frac{1}{3}\{\frac{3200}{4200}+\frac{800}{1000}+\frac{2667}{2667}\}=.837$	465
1, 2 + 3	1933.33	733	$\frac{1}{3}\{\frac{4200}{4200}+\frac{1000}{1000}+\frac{2667}{2667}\}=1.000$	733

Finally, using Column 5, Adjusted Coalition Profit (ACP), we allocate the $733 profit from intermediate product sales of x_3 to divisions using the Shapley value.[8] Profit allocation to each division is:

$$\text{Share of Profit Allocated to Division} = \sum_{S \in N} \frac{(s-1)!(n-s)!}{n!}\,(ACP(S) - ACP(S-\{i\})),$$

where s is the number of divisions in coalition S and n is 3, the total number of divisions. The results are presented in Table 4.

Table 4

Calculation of Transfer Prices

	Col 1 Shapley Profit Allocation	Col 2 Per Unit Divisional Profit Col (1) ÷ 133 1/3 Units	Col 3 Variable Cost per Unit	Col 4 Carried Forward Cost from Col. 5 of Previous Division	Col 5 Transfer Price
Div 1	$ 145.17	$ 1.09	$ 3.50	$ 0	$ 4.59/unit
2	294.66	2.21	7.00	4.59	13.80
3	293.16	2.20	4.00	13.80	20.00
Total	733.00				

Comments About the Procedure

This method of setting transfer prices has been offered and explained in the framework of a mathematically programmed budget solution. However, note that a mathematically programmed budget is not at all necessary since the same calculations could have been made for a production schedule generated by clever intuition or by gross incompetence (albeit, for a more or less diminished profit). Putting the calculation in the framework of an l.p. model does illustrate that this transfer pricing method in no way interferes with optimal decision making.

Behaviorly we do not see how it suffers from any of the many complaints levied at other transfer pricing procedures. Unlike an opportunity cost or shadow price approach, it does not reward bottlenecks and penalize long range provisions of capacity to the benefit of short run maximizers. It is neither biased in favor of the buyer (be he monopolist) or in favor of

the seller (be he monopolist). As Roth and Verrecchia have pointed out (and assuming that agreement can be arrived at regarding factors contributing to profit) the Shapley value provides a one-time negotiated procedure which is equitable.[9] Although a division manager might be induced to overstate the portion of his division's assets and payroll to be devoted to the production of intermediate products, there is every reason, in fact, to him to use labor and capital as efficiently as possible, since profit can only be enjoyed if a manager helps to create it. Some readers will argue that too heavy a weighting has been accorded to sales. That may very well be. If, in any particular case it proves to be so, management must then decide on a priori, negotiated basis how best to weight selling effort, or personnel management, or the operation and maintenance of plants. For firms which wish to use an ROI measure of the management of profit centers, the Shapley value allocation makes a profit attribution to assets such that an ROI calculation can readily be made.

All in all, if we are willing to assume the admittedly difficult task of specifying those responsibilities of management which cause profit, i.e., the "factors of profitability", then we have a technique which does the following. It supplements decision making without interfering in it; it recognizes the need for measuring relevant variable costs but attributes profit to centers in a manner compatible with top management's desire to measure performance on the basis of multiple factors, such as return on investment, personnel management and market results.

Footnotes

[1]A selective list of references on the subject must start with reference to managment science and economic literature on the subject such as: J. Hirshliefer, "On the Economics of Transfer Pricing," The Journal of Business, Vol. 29, 1956 and "Economics of the Divisionalized Firm," The Journal of Business, Vol. 30, 1957; M. Shubik, "Incentives, Decentralized Control, the Assignment of Joint Costs and Transfer Pricing," Management Science, Vol. 8, 1962; and W. J. Baumol and T. Fabian, "Decomposition, Pricing for Decentralization and External Economies," Management Science, Sept. 1964, pp. 1-31. Among earlier papers in accounting on the subject refer to H. Bierman, Jr., "Pricing Intracompany Transfers," The Accounting Review, July 1959; D. Solomons, Divisional Performance: Measurement and Control, R. D. Irwin, Inc., 1965, Chap. 6 & Appendix A; N. Dopuch and D. Drake, "Accounting Implications of a Mathematical Programming Approach to the Transfer Price Problem," The Journal of Accounting Research, Spring 1964; J. Ronen and G. McKinney III, "Transfer Pricing to Divisional Autonomy," The Journal of Accounting Research, VIII, Spring 1970; and R. Abdel-Khalik and E. Lusk, "Transfer Pricing: A Synthesis," The Accounting Review, January 1974, pp. 8-23.

[2]M. Onsi, "A Transfer Pricing System Based on Opportunity Cost," The Accounting Review, July 1970, pp. 535-43 and R. Manes, "Birch Paper Company Revisited: An Exercize in Transfer Pricing," The Accounting Review, July 1970, pp. 640-43.

[3]G. Shillinglaw, Managerial Cost Accounting, 4th Ed., R. D. Irwin, Inc., 1977, Chap. 26.

[4]P. W. Cook, Jr., "Decentralization and the Transfer Price Problem," The Journal of Business, XXVII, 1955; J. R. Gould, "Internal Pricing in Terms When There Are Costs of Using an Outside Market," The Journal of Business, January 1964.

[5]Research on transfer pricing has often criticized firms with highly centralized planning budgets for enforcing transfer prices artificially, but it has not taken into account how often transfer prices for intermediate products are required for institutional reasons: such as international boundaries, joint ventures, regulatory commissions, historical combinations and acquisitions in which separate corporate entities are maintained, the existence of minority interests in consolidated systems, etc. Refer to A. L. Thomas, "Transfer Prices of the Multinational Firm: When Will They Be Arbitrary," Information Decision Making, 2nd Ed., A Rappaport, 1975.

[6]O. Oldman and F. P. Schoettle, State and Local Taxes and Finance, The Foundation Press, 1974, Chapter 5, pp. 550-586. Twenty six states use three factor formulas to assess state corporation income and franchise taxes, i.e.,

$$\frac{1}{3}\left\{\frac{\text{In State Property}}{\text{Total Property}}+\frac{\text{In State Property}}{\text{Total Payroll}}+\frac{\text{In State Sales}}{\text{Total Sales}}\right\}=\text{Apportionment Ratio}$$

A corporation's tax payment is then calculated to be a product of its total corporate-wide income, its apportionment, and the tax rate, as each are defined by the taxing jurisdiction, e.g., [Total Corporate Income x Tax Rate x Apportionment Ratio]. Another ten or more states use variations on the three-factor "Massachusetts formula" in an attempt to exact revenue from corporations which, for example, avoid doing business in a state by setting up only a sales outlet in that state, or avoid having income in a state by transferring manufactured goods out of its factories in the state at cost.

[7] Note that adjusted coalition profit is increasingly profitable to the scale or degree of integration, i.e, that it is superadditive, although this property is not a necessary one. Note also that one simple, and we believe too simple, way to establish transfer prices would be to attribute the average mark-up to each division. Then the three divisions would share profit in accordance with the first three numbers in column 3 of Table 3.

[8] In the last ten years several articles have detailed the application of the Shapley value to problems of public finance and of accounting. The most specific instructions are to be found in D. Jensen, "A Class of Mutually Satisfactory Allocations," The Accounting Review, Oct. 1977, pp. 842-856 and in S. S. Hamlen, W. A. Hamlen and J. T. Tschirhart, "The Use of Core Theory in Evaluating Joint Cost Allocation Schemes," The Accounting Review, July 1977, pp. 616-627. Refer also to E. T. Loehman and A. B. Whinston, "A New Theory of Pricing and Decision Making in Public Investment," The Bell Journal of Economics and Management Science, Autumn 1971, pp. 606-628; and J. L. Callen, "Financial Cost Allocation: A Game Theoretic Approach," The Accounting Review, April 1978, pp. 303-308.

[9] A. E. Roth and R. E. Verrecchia, "The Shapley Value as Applied to Cost Allocation: A Reinterpretation," forthcoming in The Journal of Accounting Research, and R. E. Verrecchia, "A Question of Equity: Use of the Shapley Value to Allocate State and Local Income and Franchise Taxes." University of Illinois Col. of Commerce and Bus. Admin., Working Paper 569.