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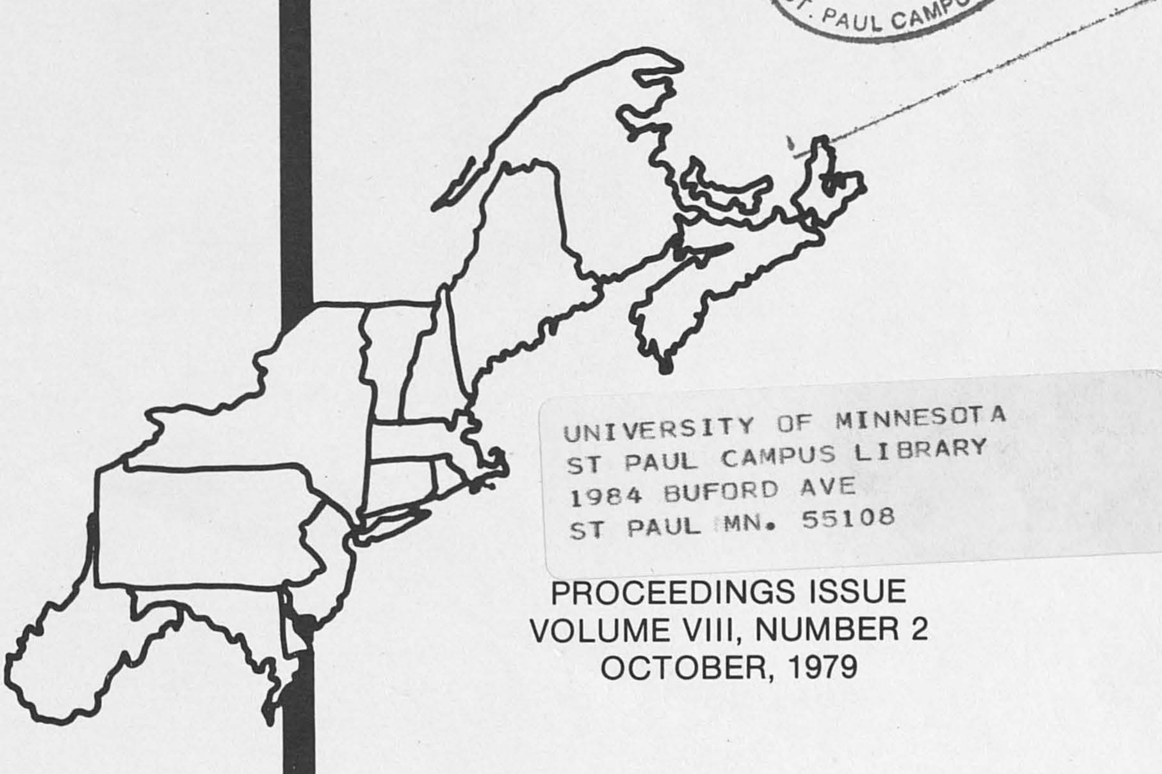

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THE ECONOMIC FEASIBILITY OF AN INTEGRATED PULP AND PAPER MILL

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Periodic assessments of the Northeast Forest Experiment Station have consistently shown timber growth in the Northeast to exceed harvest. Most of this net growth is on the regions' stock of lower quality hardwood trees more useful for fiber and fuelwood than for sawn products. The increasing quantity of this type of timber raises some question about it's economic potential. We do not know if this resource could support an expanded timber industry or if its use is currently economically infeasible.

Woodpulp appears to the the highest-valued use of the existing low-quality hardwood (Bones and Dickson). Thus, the answer to the resource-use question may depend upon the economic feasibility of new regional pulp and paper production capacity. New pulp mills would shift demand for the non-select timber to the right and provide larger markets for the hardwood resource. Without this shift in demand, the regional market may be inadequate to absorb the available timber stocks and land may remain locked up in increasing inventories of low quality hardwoods.

We have recently completed an analysis of the economic feasibility of locating a new integrated pulp and paper mill in the southern portion of the Northeast United States (Hardie, Esworthy, and Daberkow). The study's objective was to measure the current incentive for a wood processor or other large investor to invest in the mill. This incentive was defined as the net returns available to investors after all operating costs are covered and all capital costs are amortized at current interest rates over the mill's expected life. Thus the measured net returns can be interpreted as the sum of payments for risk taking, returns to scarce management skills, premiums for investing equity capital, etc. Since tax and other financial considerations were not included in the analysis, the estimated net returns are in terms of before-tax dollars.

Procedures

The method used to estimate the net returns was based on forecasts

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of U.S. prices for representative grades of fine paper products. These price forecasts were adjusted to represent the study region and to provide an estimated stream of expected per unit gross revenues accruing to the mill. Operating and capital costs were also projected over the mills expected life, and then put on a per-ton-of-product basis. Subtracting the costs from the gross revenues yielded the expected stream of net returns. Comparison of the present value of this net return stream with the investment required to construct the integrated mill provided a measure of the relative value of the investment to the mill operators. This comparison also indicates the feasibility of the new mill.

The price forecasts were developed from an econometric demand-supply model of the U.S. fine paper industry. A structural model was estimated for two representative products from times series data covering 1950-1976. Price forecasts were then obtained from the associate reduced form equations by inserting independently projected values of the exogenous variables and solving for the endogenous variables. Projections of the exogenous variables are based on two long-run trend simulations of the U.S. Economy developed by Data Resources Incorporated (DRI).

Mill costs were based on existing mill data compiled from a 1975-1976 regional survey of operating pulp and paper mills. Capital costs considered in the study included mill construction costs, land costs and the costs of the pollution abatement equipment necessary to meet currently promulgated water and air standards. Operating costs included the costs of procuring pulpwood, operation of a pulp and a paper mill, and the costs of marketing paper. These survey costs served as the basis for a stream of future costs which were projected using various price indices from the Data Resources Incorporated simulations.

Projected costs were for a hypothetical 500 ton-per-day integrated pulp and paper mill located in Maryland, Pennsylvania, New Jersey, Delaware or West Virginia. The pulp mill was assumed to use the Kraft-sulfate process, which is the dominant chemical pulping process currently used in the manufacture of book and writing papers. The integrated mill would be built by 1981-1982 and would have an expected life of 16 years. The mills' output would consist of writing paper and uncoated book paper, two grades of paper widely used in the U.S. economy.

An integrated operation was chosen after discussion of the mill's potential with individuals in the industry. These individuals suggested that current regional markets for woodpulp are inadequate to support an independent pulp or paper mill. The states considered for the new mill have the greatest surplus of hardwood growth over removal in the Northeast. However, since softwoods are relatively scarce in the Northeast, portions of the states of New York, Kentucky, Ohio and Virginia were added to the study region when softwood procurement was considered.

Major Findings

The results of the study indicate a new integrated pulp and paper mill producing fine paper products will not only be economically feasible but also quite profitable. As Table 1 shows, the hypothetical operation is estimated to have a 25 to 45 percent rate of return to management before taxes but after accounting for all operating and capital costs. This amounts to a present net return ranging from 57 to 99 million dollars for an investment of $222 million. Most of these net returns are generated toward the end of the mill's expected life, when its amortized costs have been reduced by inflation and when real prices have increased relative to costs.

Projected net returns did not vary greatly when the product mix was changed. This can be seen by comparing the 100 percent writing paper, 100 percent uncoated book paper and the 40-60 product mix options in Table 1. Net returns varied more widely when the discount rate was changed from 8 to 10 percent, and most widely when the assumptions about growth in real GNP, prices and other indicators of the general economic situation were varied. As might be expected, the shift from a balanced growth-full employment alternative to one with an 8 percent rate of inflation, rising real food and fuel prices, high interest rates and low investment-to-GNP ratio resulted in a slower growth rate and higher price rise for the paper products. This indicates the importance of the DRI forecasts of future economic conditions to the study's results.

The net return figures are based on price forecasts in which real prices rise an average of .35 to .40 percent per year for writing paper and an average of .42 to .43 percent per year for uncoated book paper. These compare to an average annual rate of increase between 1950-1976 of .7 percent per year for writing paper and .9 percent per year for uncoated book paper.

The price forecasts used in the net return computation were derived from direct estimation of the reduced form of the demand-supply model developed during the study (Figure 1). Price projections were also indirectly derived from algebriac manipulation of the estimated demand-supply model. However, net returns accruing to writing paper increased significantly faster than did the net returns accruing to the uncoated book paper in the estimates based on the indirect projections. The divergence stemmed from our inability to explicitly account for substitution between products in the structural supply equations. It was the primary reason for favoring the directly-estimated over the indirectly-derived reduced forms.

When total costs were projected using a 12 percent amortization rate, they ranged from $688 per ton in 1981 to $1346 per ton in 1996 under the assumption of balanced economic growth. Given a continuation of the present inflationary situation, the per ton costs increased to $702 per ton in 1981 and $1,744 per ton in 1996. However, after the cost figures were deflated, real costs remained essentially constant in both alternatives over the 1981-1996 projection period.

The Demand-Supply Model

The demand-supply model for the representative products is given in Figure 1. Since the writing and uncoated book paper prices are considered to be simultaneously determined with quantities, the model's coefficients were estimated using two stage least squares. In one equation - the writing paper demand equation - lagged price of writing paper was included as an additional instrument to improve the equation's fit.

As Figure 1 shows, the statistical results of the model are satisfactory.

Signs on the coefficients are consistent with expectations. The standard errors of estimation (S_e) are low, indicating that the model explains most of the historical variation in quantities. All but one of the slope coefficients are significantly different from zero at the 90 percent confidence level one-tailed test), as is indicated by the "t" statistics in the parentheses below the coefficients. Furthermore, the Durbin-Watson statistics (D.W.) lead to an acceptance of the hypothesis of no serial correlation at the 95% confidence level for all four equations. Coefficients of determination (R^2) have little meaning when using two-stage-least squares, therefore, they are not presented in the equations.

Demand

Writing paper is a widely used product with few substitutes; demand for it should consequently be relatively inelastic. This expectation is reflected in the model, since the price elasticity of demand for writing paper turned out to be -.41. The corresponding price elasticity estimated from the uncoated book paper equation is -.97 more than double the estimate for writing paper. Even so, this elasticity is between 0 and -1.0, a result consistent with the notion that the demand for this product is inelastic.

Sales of writing and uncoated book paper fluctuate closely with the level of economic activity through time. This pattern, combined with the widespread purchases of paper throughout the economy, suggests that GNP is a logical demand shifter for writing paper. The relationship between the sales of this paper and the general level of economic activity is reflected in the 1.74 estimate of elasticity between GNP and quantities demanded. Since this elasticity is greater than unity, writing paper sales should rise faster than GNP during business expansions and fall more rapidly during recessions. This particular relationship between GNP and paper quantities has been cited by Slatin (1978).

GNP is not used as the demand shifter for the uncoated book paper demand equation. Instead, fluctuations in demand through time are accounted for by an index of production for the printing and publishing industry. This sector is an important purchaser of uncoated book paper, and its production is thought to be a good proxy for the changes in the demand for uncoated book paper. The estimated elasticity of 1.23 between the index of production and the quantities of uncoated book paper suggests that sales to purchasers outside the printing-publishing industry correlate through time with the purchases made by the industry.

The possiblity of demand substitution between grades of paper was initially investigated by including other paper prices in the demand equations. Multicollinearity and identification problems frustrated this approach, however, and forced the use of a price index for all paper (except newsprint) as a proxy variable for the substitute product prices. The proxy variable was included in the uncoated book demand equation, but was not used in the writing paper equation.

Inventories of paper held by consumers - especially by firms who make large purchases - have had significant effect on quantities demanded at various times since 1950 (National Commission on Supplies and Shortages). These effects appear to be relatively short run phenomena which dissipate rapidly. Dummy variables were tried in the demand equations to account for this inventory effect, but were ultimately discarded in favor of the assumption that inventory fluctuations are randomly distributed around the long run trend in quantities demanded.

Some thought was given to using a derived demand appraoch for the uncoated book paper. Lack of data and multicollinearity problems limited the usefulness of this formulation and it was discarded in favor of the market demand approach embodied in the model. Demand equations using per capita variables were also tested, but their insertion into the model introduced a non-linear system, making it difficult to forecast or project paper prices and quantities. Consequently, when the results of the per capita equations turned out to be no better than the aggregate variable equations, the per capita approach was abandoned.

Supply

Price elasticities of supply for writing and uncoated book paper turned out to be virtually identical at 0.7 in both supply equations. This is not an unreasonable result since the two papers can be produced by the same process, with the primary differences being in the pulp mixture used and in the coating applied to the paper. For both products, the inelastic nature of the supply elasticities implies a relatively low response in quantities supplied to product price changes.

Supplies of writing and uncoated book paper were initially hypothesized to be a function of price, mill capacity and factor costs. Multicollinearity and other statistical problems foiled attempts to estimate these initial equations, however, and so we decided to use lagged quantities as supply shifters in the demand-supply model. The hypothesis behind the choice is similar to Nerlove's lagged adjustment hypothesis, namely that the lagged quantities would summarize past mill investment decisions. The equations show current quantities to be closely correlated to past output, so the hypothesis was not invalidated by the statistical estimates.

Since the supply equations are specified to be market equations, imports, exports and inventories could have important effects on quantities supplied. Historical import-export data indicated trade volumes of less than 5 percent of total domestic supply, however, and so these variables were not incorporated into the demand-supply model. Ending inventory data for stocks of paper held by paper manufacturers were tried in the supply equations, but their impacts on quantities supplied turned out to be negligible.

Attempts to explicitly incorporate the substitution in processing between writing and uncoated book paper into the supply equations were unsuccessful. As noted earlier, this had an adverse effect on the algebraically-derived reduced form of the model.

Costs and Net Returns

Mill costs and prices were compiled from a 1975-1976 survey of operating pulp and paper mills in the study region and are shown in Table 2. Total costs for an integrated pulp-paper operation producing 60% writing paper and 40% uncoated book paper in 1975, are \$503 and \$520 per ton for $9\frac{1}{2}$% and 12% amortization rates respectively. These costs turned out to be high compared to the 1975 regional prices: net returns for this year ranged from \$-6.45 to \$10.00.

The capital Costs in Table 2 were amortized over a 16 year expected life for the plant and equipment. A 20 year amortization period was used for land. The $9\frac{1}{2}\%$ amortization rate is representative of interest costs on industrial bonds and is presumed to be one estimate of the opportunity cost of capital. Since interest rates have been increasing, a 12% rate was also used in the study.

Future costs of production for an integrated pulp-paper mill were assumed to follow national trends and DRI forecasts for various national wholesale price indices were applied to the 1975 cost estimates to create cost forecasts for the regional mills. The only exception made was in the case of wood procurement, where, after investigating several procurement alternatives, it was assumed that all pulpwood would come from standing timber and that the average distance hauled would increase 22 miles by 1966.

Conclusions

The results of the quantitiative analysis suggest new regional pulp and paper production - and consequently, the use of the increasing timber resource - is economically feasible. By 1981, the earliest date a new integrated pulp and paper mill could be brought into production, derived net returns are positive and increasing. They continue to increase throughout the expected life of the mill to a point where substantial profits are being forecast for the 1990's. A net return of 25 to 45 percent of the initial investment would be generated by the new mill. These returns are estimated before taxes but after accounting for all operating and capital costs.

The net returns are derived from the difference between price forecasts and projected per ton costs. Price forecasts imply real prices will rise an average of .35 to .40 percent per year for writing paper and an average of .42 to .43 percent per year for uncoated book paper, the two representative products used in the analysis. Cost projections imply that the average annual increase for the real costs will be constant during the life of the hypothetical mill. This difference between the average annual rates of change in prices and costs accounts for the relatively high net return estimates.

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Table 1

Present Values of the Projected Streams of Net Returns for an Integrated Pulp-Paper Mill[a], 1981-1996

(Millions of Dollars and Percent of Mill Investment)[6]

Alternative	8% Discount Rate		10% Discount Rate	
	Dollars	Percent	Dollars	Percent
1. Balanced Growth Simulation				
40% uncoated book paper-60% writing paper mix	75.8	34.1	63.4	28.6
100% writing paper	80.0	36.0	66.9	30.1
100% uncoated book paper	68.9	31.0	57.6	25.9
2. Current Inflationary Simulation				
40% uncoated book paper-60% writing paper	94.5	42.6	79.0	35.6
100% writing paper	99.4	44.7	83.0	37.4
100% uncoated book paper	87.2	39.3	72.9	32.8

[a] 500 ton-per-day capacity.

[b] Mill construction, land and equipment investment of 222 million dollars.

Figure 1. The Demand-Supply Model for Writing and Uncoated Book Paper

I. Writing Paper Demand

$$\mathrm{Ln}Q_{w,t} = \underset{(-23.32)}{-6.15985} - \underset{(-2.12)}{.41259}\,\mathrm{Ln}P_{w,t} + \underset{(33.66)}{1.74238}\,\mathrm{Ln}G_{t}$$

Se = .05082 D.W. = 2.17

II. Uncoated Book Paper Demand

$$\mathrm{Ln}Q_{b,t} = \underset{(4.58)}{2.34868} - \underset{(-2.02)}{.97366}\,\mathrm{Ln}P_{b,t} + \underset{(6.39)}{1.23265}\,\mathrm{Ln}I_{g,t} - \underset{(-1.54)}{.27213}\,\mathrm{Ln}I_{p,t}$$

Se = .08286 D.W. = 1.59

III. Writing Paper Supply

$$\mathrm{Ln}Q_{w,t} = \underset{(-1.10)}{-.43650} + \underset{(1.70)}{.70112}\,\mathrm{Ln}P_{w,t} + \underset{(15.92)}{.91753}\,\mathrm{Ln}Q_{w,t-1}$$

Se = .09232 D.W. = 2.16

IV. Book Paper Supply

$$\mathrm{Ln}Q_{b,t} = \underset{(.85)}{.82681} + \underset{(1.68)}{.69692}\,\mathrm{Ln}P_{b,t} + \underset{(1.68)}{.49442}\,\mathrm{Ln}Q_{b,t-1} + \underset{(1.24)}{.20516}\,\mathrm{Ln}Q_{w,t-1}$$

Se = .09355 D.W. = 2.04

where Q_w, Q_b = quantities of writing and uncoated book paper

P_w, P_b = real prices of writing and uncoated book paper

G = gross national product

I_Q = production index for publishing and printing sector

I_P = index of paper prices (all paper except newsprint)

TABLE 2

Prices, Costs and Net Returns Per Ton for Products from 500 Ton Per Day Mills, 1975

	Hardwood Pulp	Writing Paper	Uncoated Book Paper	Integrated Operation 60%-40% Product Mix
1. $9\frac{1}{2}$% Amortization Rate				
Selling Price Minus Costs	$307.00	$541.00	$472.00	$513.40
Operating Costs	133.00	375.00	290.00	341.00
Marketing Costs	9.20	19.00	19.00	19.00
Plant Amortization	86.82	119.84	119.84	119.84
Polution Abatement	13.88	20.88	20.88	20.88
Land Amortization	1.60	2.28	2.28	2.28
Total	$244.50	$537.00	$452.00	$503.00
Net Returns	$ 63.50	$ 4.00	$ 20.00	$ 10.00
2. 12% Amortization Rate				
Selling Price Minus Costs	$307.00	$541.00	$472.00	$513.40
Operating Costs	133.00	375.00	290.00	341.00
Marketing Costs	9.20	19.00	19.00	19.00
Plant Amortization	97.03	133.93	133.93	133.93
Polution Abatement	15.51	23.34	23.34	23.34
Land Amortization	1.81	2.58	2.58	2.58
Total	$256.55	$553.85	$468.85	$519.85
Net Returns	$ 50.45	$-12.85	$ 3.15	$ -6.45