WORKER-OWNED PLYWOOD COMPANIES OF THE PACIFIC NORTHWEST

by
Ben Craig
Department of Economics, University of Indiana
and
John Pencavel
Department of Economics, Stanford University

January 1993

THE WORKER-OWNED PLYWOOD COMPANIES OF THE PACIFIC NORTHWEST

by
Ben Craig and John Pencavel[1]

In recent years, there has been a strong revival of interest in exploring the basis for alternative forms of organizing production. One distinctive and enduring form of organization is the firm both owned and managed by the individuals who work in it. Such worker or producer cooperatives exist in some guise or other in virtually all economies and they have often been lauded as the extension of the democratic principle to production.

There exists a large literature on labor-managed firms in economics, but it is predominantly theoretical.[2] It has thrown up a number of important and testable hypotheses about the behavior of worker-owned firms, but there has been remarkably little convincing work examining the empirical relevance of these hypotheses. Most of the empirical research relies on comparisons between conventional and worker-owned firms in different industries or in different regions or countries and they usually involve aggregates of firms. There are some valuable case studies of particular cooperatives, but it is difficult to infer from these anything about how a cooperative's responses to a given shock would differ from those by a conventional firm experiencing the same shock.

This report contributes to our understanding of the behavior of cooperatives by examining the largest and most durable worker-owned sector in United States manufacturing industry, namely, the plywood firms in the Pacific Northwest. After a data-gathering effort over several years, we have constructed a sample of cooperatives and conventional firms operating in the same industry, the same region, and the same period of time. There exist already excellent descriptions of the plywood producer cooperatives[3] and we will draw upon this prior research extensively, but we believe we have put together the most systematic body of data on these firms to date.

These provide almost an ideal set of observations to examine the effects of property rights structures on firm behavior. In particular, we are able to address the question of whether worker cooperatives and conventional firms respond differently to common changes in their economic environment, an issue long debated in the literature. Also, we have collected information on the prices of the cooperatives' shares, the first such data of which we are aware, and from these share prices we calculate the profitability of becoming a member of a cooperative mill. These share prices give the appearance of being undervalued. This is consistent with the difficulties the coops have experienced in raising sufficient capital and we conjecture the cooperative form of organization is vulnerable to this sort of problem. We have also looked into the question of whether coops are more efficient than conventional firms.

Our general goal is to document the empirical regularities with respect to wages, employment, hours, and production in these producer cooperatives in comparison with other firms in the industry and to offer some conjectures about the way in which the property rights structure of firms affect outcomes.

In Section I below, we describe briefly the main features of the coops in the plywood industry in the Pacific Northwest. In Section II we sketch the plywood manufacturing process. In Section III we examine the responses of the different types of firms to increases in output prices and log input prices. In Section IV we analyze the prices of the coops' shares and investigate the supply of capital to the coops. Section V reports on the measured differences in productivity between coops and conventional firms. Some conclusions are summarized in Section VI.

I THE PRODUCER COOPERATIVES IN THE PLYWOOD INDUSTRY

The producer cooperatives in the plywood industry of the Pacific Northwest date from the establishment of the Olympia Veneer Company in 1921. Its remarkable success led to the establishment of many more plywood cooperatives so that in the late 1940s and early 1950s almost 25 percent of the industry's output was believed to come from the cooperatives. At that time, virtually all of total U.S. output was produced in the Pacific Northwest. However, from the mid-1960s plywood production took hold in the South and the Pacific Northwest's share of total U.S. output fell considerably. This is shown in column (2) of Table 1: 99.8

percent of U.S. output of plywood was manufactured in the Pacific Northwest in 1957, but by 1986 this had fallen to below forty percent.

The cooperatives' importance in the industry fell with the region's relative decline. Within the region, however, the cooperatives' share of plywood production has remained substantial: we conjecture it was around 42 percent in the late 1960s and almost fifty percent by 1986. Variations in the fraction of output produced by cooperatives reflects both their successes and their failures. Some of the most successful have been bought out by larger private enterprise companies (such as Georgia-Pacific and ITT-Rayonier) while others have gone out of business.

Table 1

Data on the Plywood Manufacturing Industry in the Pacific North-West, 1957-86

	(1)	(2)	(3)	(4)	(5)	(6)
	Softwood plywood production					
	Total	Percent of US	Output Employment	Hourly Price $s	Timber Earnings $s	Prices $s
1957	5.45	99.8	169.2	67.7	2.25	19.0
1958	6.33	99.8	165.2	68.3	2.33	15.2
1959	7.78	99.4	180.2	71.9	2.49	25.0
1960	7.74	99.0	171.2	62.3	2.49	22.1
1961	8.40	97.9	159.8	59.8	2.50	18.5
1962	9.28	97.5	163.2	57.6	2.54	16.6
1963	9.86	96.5	164.2	60.0	2.66	18.5
1964	11.10	95.1	172.9	58.4	2.81	24.2
1965	11.31	90.9	172.1	58.0	2.88	27.5
1966	11.02	84.4	169.9	60.8	3.01	31.5
1967	10.12	78.1	160.4	55.7	3.13	28.0
1968	11.26	76.6	168.0	74.0	3.34	42.4
1969	9.90	72.3	167.0	77.5	3.60	58.8
1970	10.07	70.5	157.1	64.3	3.83	26.7
1971	11.20	67.3	164.3	72.6	4.08	30.1
1972	11.94	65.1	174.9	87.8	4.30	53.2
1973	11.71	64.0	182.0	111.6	4.76	102.8
1974	9.75	61.4	175.4	125.8	5.12	142.4
1975	9.30	57.9	163.6	131.8	5.57	101.6
1976	10.41	56.5	183.3	145.0	6.20	113.2
1977	10.67	55.1	198.0	162.5	6.89	153.8
1978	10.82	54.2	206.4	191.9	7.71	185.0
1979	10.12	51.5	202.5	201.7	8.43	270.0
1980	7.83	47.6	178.6	190.6	9.02	285.5
1981	7.29	42.9	166.1	182.0	9.75	230.6
1982	6.48	39.5	140.8	166.0	10.29	80.2
1983	8.35	40.2	153.9	189.4	10.50	112.5
1984	8.55	38.9	163.1	189.4	10.65	94.6
1985	8.56	37.5	156.8	186.6	10.86	101.4
1986	9.67	37.7	160.1	184.5	10.41	127.9

Notes to Table 1: (1) Softwood plywood production in Washington, Oregon, and California in billions of square feet (3/8 inch basis); (2) column (1) as a percentage of total U.S. production of softwood plywood; (3) employment (in thousands) in all lumber and wood products in Washington, Oregon, and California; (4) wholesale price (in dollars per thousand square feet) of softwood plywood (1/4 inch, interior); (5) average hourly earnings (in dollars) of production workers in plywood and veneer in Oregon and Washington; (6) average price (in dollars per thousand board feet) of sawtimber (all species) sold from National Forests in Oregon and Washington.

For all except column (5), the sources for the data are issues of U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Production, Prices, Employment, and Trade in Northwest Forest Industries. The data in column (5) are from issues of U.S. Department of Labor, Bureau of Labor Statistics, Supplement to Employment and Earnings, States and Areas.

The cooperatives are heterogeneous and inferences derived from the observation of one or two may be quite misleading as a generalization of them all. Their most distinctive feature is that, for the most part, they fuse ownership and employment: most workers are shareholders and most shareholders are workers. In many cases, non-owner workers are employed though shareholders have preference in the event of layoffs.[4] Most firms regulate the sale of stock. Usually the cooperative has the first right to purchase any stock at the prevailing price except for transfers within the family. To ensure a new shareholder has desirable attitudes and sympathies, the cooperative's Board of Directors often has to approve any sale of stock and candidates for new owners work for a probationary period in the company. A new shareholder has the right to employment only when a vacancy appears.

Usually, each stockholder holds one share and is entitled to one vote in selecting the Board of Directors who themselves must be shareholders. Board members receive no additional compensation for their service on the Board. The turnover of directors is usually high and normally the shareholders participate actively in the management of the company. Indeed, some general managers have complained of excessive involvement of the shareholders in the day-to-day operations of the firms.

Another remarkable feature of these cooperatives is that of equal hourly pay. Exceptions are occasionally made for top management positions if they are held by non-members, but other than this pay differentials among the workers are nonexistent. Job assignments are varied and sometimes rotated though, if a particularly attractive position opens up, its allocation is determined by seniority or previous work performance. Often no dividends are paid on common stock (in fact, the by-laws of a few companies actually prohibit the payment of dividends) so that the returns to ownership take the form of wages. The workers' wealth is also affected, of course, by variations in the price of stock which, as we show below, may be substantial. However, most observers identify takehome pay as the companies' primary goal. Thus Berman (1967, pp 180-1) writes: "Worker-owned plywood companies have in practice been far more concerned with the maximum wage objective than with profit maximization. The employee-shareholders tend to think as work-

ers rather than as owners".[5]

It is evident from the fact that a number of producer cooperatives were formed to save the jobs of employees in conventional, unprofitable plants that employment has been a primary goal of the organizations. The initiative in establishing the companies has sometimes come from the workers themselves and sometimes from others, but maintaining or increasing employment has figured quite explicitly in the cooperatives' goals. Where the workers have taken over old and failing plants, they have faced the problem of raising capital to modernize facilities. The usual method has been to sell shares of stock to the workers though there is a natural limit to what can be garnered in this way so that most at one time or another have found it necessary to seek loans from outside.

The plywood cooperatives are routinely credited with being more productive than conventional firms in the same industry though it is not clear whether this is correct.[6] We report below on our attempts to determine whether productivity differences exist between the coops and conventional firms. The issue of differential productivity has arisen in disputes between the IRS and the cooperative mills over the computation of taxable business income. The cooperatives involved in these disputes claimed that their members' higher earnings relative to the pay received by unionized workers in the industry reflected superior work effort. As such, this differential income represented wage payments to labor which should be deductible from the mills' gross income as legitimate business expenses and should not be subject to tax. In adjudicating these disputes, law courts agreed that at least part of these differential earnings indicated higher productivity. But these disputes have been restricted to those coops that have been profitable enough to catch the IRS's attention and whether the claim of superior productivity is an appropriate generalization has not yet been demonstrated. Documenting this higher productivity is not straightforward. Measures of output per manhour are suggestive, but they are frustrated by differences in the quality of raw materials and in the grades of plywood produced.[7]

In operations such as selecting the appropriate thickness of the veneer to be cut, the gluing and sanding of the panels, and the care and maintenance of the machinery, there is certainly the opportunity for variations in the quality of work performance. Advocates of producer cooperatives claim workers in such companies have natural incentives to apply more effort and police themselves and their fellow workers with less need to be monitored by supervisors. Indeed, in his survey, Greenberg (1986) found plywood cooperatives usually used only one or two supervisors per shift compared with the six or seven used by conventional firms in the same industry and location. When one cooperative was converted to a privately-owned mill, the number of supervisors and foremen was immediately quadrupled. According to the general manager of this mill who had also been its manager prior to its conversion, "We need more foremen because, in the old days, the shareholders supervised themselves... They cared for the machinery, kept their areas picked up, helped break up production bottlenecks all by themselves. That's not true anymore. We've got to pretty much keep on them all of the time" (Greenberg, 1986, p. 44).

Offsetting these production line advantages are problems delineating the authority of managers and that of the Board of Directors. Some managers complain of inadequate discretion over daily operations and of exaggerated attention by the shareholders to the company's current financial health with insufficient planning for future contingencies. The fact is that both conventional and cooperative plywood firms have existed side by side for almost seventy years in the Pacific Northwest suggesting that there are enduring advantages to each type of firm, but that neither clearly dominates the other in overall efficiency within the larger context of a private enterprise economy.

II PLYWOOD MANUFACTURING

The primary raw material in the plywood manufacturing process consists of logs. Veneer is peeled from the logs, then cut and dried. There is a separate market for veneer with some firms producing veneer exclusively and others purchasing all their veneer from other firms. The veneer is glued and assembled into panels, then trimmed and sanded, and finally inspected and graded. Roughly half of production costs consists of expenditures on wood (including veneer) and labor costs represent about one-third of the total.[8] Although there are several large firms in plywood production in the Pacific Northwest, the industry is not dominated by these firms. Plywood is produced in large quantities outside the region and, though there are many different grades of plywood, each firm has no influence on the price of its product.

The consumption of plywood moves closely with housing construction and plywood prices are quite volatile as is evident from the data in column (4) of Table 1. By the early 1970s, plywood prices were little different from their values in the late 1950s. Then they rose rapidly to 1979 before falling off in the 1980s. The last decade has been a very difficult time for firms in the industry especially for those in the Pacific Northwest.

Column 6 of Table 1 shows timber prices to have been even more volatile with periods of first sharply rising prices and then of abruptly falling prices as in the years between 1971 and 1975 and again between 1977 and 1982. The difference in 1980 between falling plywood (and other lumber product) prices and rising prices of contracted timber supplies generated a crisis in the western timber industry that was ultimately resolved in 1984 by the Timber Contract Buyout.[9]

Some of the conventional plywood mills have their own timber supply and may have been less affected by the rise in raw material prices in the early 1980s even though their accounting practices call for costing their timber at market prices. The cooperative mills are dependent on publicly held timberlands for their raw material supplies and this might make them appear to be more exposed to sharp changes in timber prices. However, they try to operate on longer lead times with their raw materials and, as we shall see, generally maintain larger log inventories.

At least until the recent use of computerized technology, important large scale economies are not evident in plywood production though there has been a slight trend toward some vertical integration with some manufacturers assuming warehouse and wholesaling functions (Berman, (1967), pp.62-84). The industry is served by a number of jobbers who act as middlemen storing the plywood over the swings in seasonal demand. In addition, the industry has benefitted from the activities of its trade association, the American Plywood Association. It has standardized and graded the products of the manufacturers and undertaken promotional and advertising functions that would not be in the interests of a single firm.[10]

III RESPONSES TO OUTPUT AND INPUT PRICES

The purpose of this section is to determine whether the three types of firms - the classical (that is, the conventional nonunion) mills, the unionized mills, and the producer cooperatives -in the plywood industry of the Pacific Northwest respond differently to changes in the prices of their output and primary input. As mentioned earlier, each mill exercises no influence on the price of its output nor on the price of its supplies of logs. These prices serve as sufficient statistics to describe conditions in the product market and in the market for their major input, logs.

Data

The observations underlying our work in this section are drawn from four separate sources all pertaining to the state of Washington.[11] The first is a survey of all plywood mills in the state conducted by the Department of Natural Resources on each even numbered year starting in 1968. The second is the compensation and employment information collected by the state's Employment Security Department and used by the U.S. Bureau of Labor Statistics for its Employment and Earnings publication. The third is information collected by the International Woodworkers of America on employment and hours for the purpose of determining pension contributions. Finally, we collected annual reports directly from the producer cooperatives. In a number of cases, these sources provided more than one observation on a given variable for a particular firm and this was exploited to check on the accuracy of the data. Further details on the construction of the data are provided in the appendix.

The result is a set of observations on 41 firms in even numbered years from 1968 to 1986. For only three firms (one classical, one unionized, and one cooperative) are there observations in every even numbered year so this is not a balanced panel. The distribution of observations across the different types of firms and over time is given in Table 2. In most cases, the reason

Table 2

Distribution of Observations by Types of Firms and over Time: Washington State

Year	Classical	Unionized	Cooperative	All Types
1968	2	6	5	13
1970	2	8	3	13
1972	2	12	5	19
1974	2	14	2	18
1976	2	14	4	20
1978	4	14	4	22
1980	7	14	8	29
1982	5	11	8	24
1984	6	10	8	24
1986	5	5	8	18
All Years	37	108	55	200
Number of Firms	9	21	11	41

for missing observations is simply the inability to obtain data on a particular variable or on all variables, but in a few instances a firm was not operative in a given year. As indicated in Table 2, there are more than two observations on conventional firms (both union and nonunion) for every one on the cooperatives, most of the observations on the conventional firms being unionized.

Mean values (and standard deviations in parentheses) of variables in our sample for all the years and for three specific years are given in Table 3.[12] The plywood industry faced very different product market conditions in the three years shown. 1972 was a prosperous year for the firms with production and prices surging above their previous year's values. By contrast, in 1980 production and prices were falling as the industry entered a severe recession. By 1984, the industry was gradually coming out of the recession though production and prices still had not attained the levels of the late 1970s.

It is evident from Table 3 that the classical firms are small operations with relatively few employees and

Table 3

Sample Means (and Standard Deviations) of Variables
by Type of Firm and by Year

1972	Classical		Union		Coop		All Firm	
Nominal Hourly Wage	5.31	(1.10)	5.63	(1.42)	4.72	(0.52)	5.36	(1.24)
Employment	102	(82)	278	(152)	262	(119)	255	(143)
Annual Hours per Worker	1960	(57)	1916	(121)	2253	(299)	2009	(227)
Index of Output Price	164.5	(14.6)	159.3	(9.4)	154.1	(0)	158.5	(8.7)
Index of Price of Logs	120.5	(4.2)	115.8	(8.6)	117.7	(3.5)	116.8	(7.2)
Inventories of Logs	804	(429)	6021	(6334)	7302	(2997)	5809	(5474)
Output	3.70	(2.85)	7.52	(3.63)	6.79	(2.04)	6.93	(3.29)
Labor Productivity	18.9	(0.4)	16.4	(10.6)	12.2	(2.9)	15.6	(8.6)
1980	**Classical**		**Union**		**Coop**		**All Firms**	
Nominal Hourly Wage	11.49	(2.75)	11.58	(2.23)	8.79	(1.06)	10.79	(2.40)
Employment	73	(31)	236	(135)	259	(59)	203	(123)
Annual Hours per Worker	1425	(403)	1759	(326)	1935	(388)	1727	(397)
Index of Output Price	339.1	(26.4)	325.0	(23.2)	294.1	(47.5)	319.9	(35.5)
Index of Price of Logs	284.1	(25.1)	291.6	(33.0)	295.6	(20.5)	290.9	(27.6)
Inventories of Logs	1293	(2760)	4047	(5581)	5901	(6672)	3894	(5484)
Output	1.18	(0.76)	5.07	(3.10)	5.69	(2.36)	4.30	(3.05)
Labor Productivity	12.3	(8.2)	13.5	(8.2)	11.5	(3.5)	12.7	(7.0)

Table 3 (Concluded)

Sample Means (and Standard Deviations) of Variables
by Type of Firm and by Year

1984	Classical		Union		Coop		All Firms	
Nominal Hourly Wage	10.20	(6.29)	12.65	(2.51)	10.31	(1.64)	11.26	(3.65)
Employment	67	(65)	233	(88)	240	(73)	194	(106)
Annual Hours per Worker	1487	(905)	1876	(324)	1962	(280)	1807	(529)
Index of Output Price	279.3	(48.7)	302.7	(3.8)	289.0	(43.9)	292.3	(34.7)
Index of Price of Logs	241.0	(17.5)	230.7	(12.1)	233.0	(14.8)	234.0	(14.5)
Inventories of Logs	75	(183)	3086	(5214)	5698	(7866)	3204	(5848)
Output	1.87	(2.66)	5.09	(3.10)	5.18	(1.83)	4.31	(2.90)
Labor Productivity	12.2	(6.2)	12.0	(6.5)	11.4	(3.2)	11.8	(5.3)
All Years	**Classical**		**Union**		**Coop**		**All Firms**	
Real Hourly Wage	4.11	(1.67)	4.36	(1.17)	3.36	(0.71)	4.04	(1.25)
Employment	77	(52)	275	(146)	257	(78)	233	(139)
Annual Hours per Worker	1647	(574)	1860	(293)	2086	(303)	1883	(391)
Real Output Price	120.1	(33.0)	127.1	(25.0)	110.3	(23.8)	121.2	(27.2)
Real Price of Logs	103.4	(23.7)	109.8	(24.1)	100.6	(22.3)	106.1	(23.8)
Inventories of Logs	858	(1879)	6102	(7440)	7028	(6742)	5387	(6898)
Output	2.06	(2.01)	6.05	(3.32)	5.97	(1.89)	5.29	(3.16)
Labor Productivity	14.0	(6.6)	13.2	(8.4)	11.7	(3.4)	13.0	(7.0)

Notes to Table 3: The nominal price indices of output and logs equal 100 in 1967. Log inventories are observed at the beginning of the year shown and are measured in thousand board feet. Output is the weighted sum of the production of softwood, hardwood, and veneer (each measured in thousands of square feet, 3/8 inch basis) where the weights are given by the real prices (in 1967 dollars) of these three types of output. Labor productivity means output per million manhours. More information on the data are contained in the appendix.

hold small inventories of logs. In a few cases, they do not operate for the entire year. They are individual proprietorships or partnerships, not corporations or parts of corporations. Most plywood production in Washington takes place in the unionized firms and in the cooperatives.

Average employment in the union firms and the cooperatives is almost the same though in our sample the variation in employment among firms is smaller for the cooperatives. The cooperatives operate consistently with higher inventories of logs suggesting perhaps an attempt to shelter themselves from the effects of sharp changes in the prices of raw material supplies. The workers in cooperatives also work substantially more hours each year, the union-coop hours differential being as large as 17.2% in a prosperous year such as 1972.[13] Hence the annual earnings differentials in our data between union mills and cooperatives are considerably smaller than hourly earnings differentials. The earnings data for the cooperative mills in this table include the payment of any dividends.

Employment and Earnings Comparisons over Time

A comparison of employment and earnings in an expansion year such as 1972 with those in a year of contraction 1980 may suggest how conventional mills and cooperatives respond to adverse product market conditions.[14] The data in Table 3 indicate that, whereas in the union mills employment in 1980 averaged 86 percent of employment in 1972 and in the classical mills employment in 1980 averaged 72 percent of employment in 1980, in the cooperatives employment in 1980 was 99 percent of employment in 1972. At the same time, nominal hourly earnings grew less between 1972 and 1980 in the cooperatives than in the conventional plants. It might be inferred from this simple comparison that, when reductions in labor costs are called for, the cooperatives are inclined to protect employment and tolerate more moderate wage increases, if not cuts in earnings, than conventional firms (both union and nonunion).

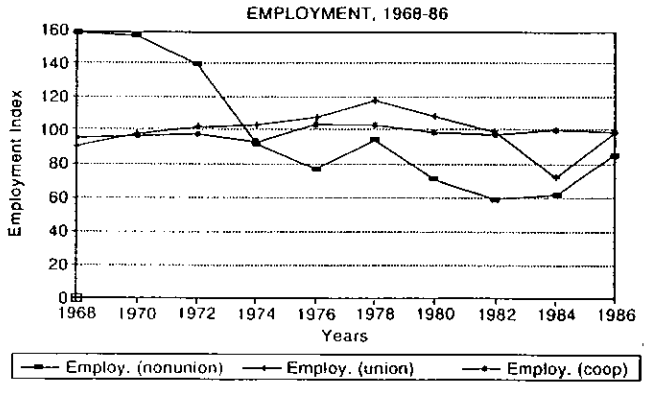
These comparisons are over a slightly changing composition of firms. If we restrict the comparisons to those mills observed both in 1972 and 1980, even more striking differences emerge: in the union mills, employment in 1980 averaged 83.6 percent and in the classical mills employment in 1980 averaged 51.3 percent of their 1972 values whereas in the coops employment was 115.9 percent of 1972; with respect to nominal average hourly earnings, in the union mills earnings more than doubled between 1972 and 1980 whereas in the coops in 1980 earnings were 183.8 percent of their 1972 levels.

The three firms for which we have continuous data over the period from 1968 to 1986 also illustrate the relative volatility of employment in the conventional firms. Employment in each firm expressed as a percentage of its average is graphed in each year in Figure 1. The range of employment expressed as a percent of average employment is 99.0 for the classical firm, 44.7 for the union firm, and 11.2 for the cooperative.

We conjecture that the cooperatives' employment responses are likely to depend on the number of its employees who are members.[15] Regrettably, it proved impossible to compile a comprehensive series on membership for all the cooperatives, but we were able to piece together some information for certain mills in particular years. These data are shown in Table 4 which gives the percentage of employees who were members in fourteen cooperatives in Washington and Oregon in seven years from 1958 to 1982. Eight of the cooperatives included in Table 4 are among the sample of Washington cooperatives whose descriptive statistics are provided in Table 3 and these are identified by an asterisk. A blank in this table means we could not obtain information on membership.

Clearly, there are marked differences across mills in the relative importance of membership. Though the average is 75 percent, membership ranges from 37.5 percent of total employees to 100 percent. Also, there is a meaningful decline in the importance of membership over time.[16] This is particularly evident in firms J and L which are observed in each of the years. Insofar as a relatively large pool of nonmember employees provides cooperatives with a margin for adjusting

Figure 1



employment to changing market conditions, then the data in Table 4 suggest this margin has tended to increase over time.

The increasing use of nonmember labor over time sustains the notion that worker ownership is a degenerative process, that a producer cooperative moves over time increasingly away from the ideal of the complete identity of workers and owners and towards an organizational form in which ownership is restricted to a few shareholders who hire labor. This is what happened to the first plywood cooperative in the Pacific Northwest, the Olympia Veneer Company, and this slow erosion of the cooperative principle has been noted in other worker-owned firms. Unless there are substantial efficiency advantages from worker ownership or unless there is a strong commitment to the cooperative principle, worker-owners are presented with strong incentives not to dilute their special status and perhaps income by sharing it with new members.[17]

The inferences drawn above about the firms' responses are made by comparing the means of variables (especially earnings and employment) across years by firm type. Such comparisons, of course, do not distinguish between the impacts of output price from those of input prices and between 1968 to 1986 the prices of logs and those of plywood moved in the same directions. We need to unscramble their separate impacts.

Effects of Changing Input and Output Prices

In this sub-section, we relate the firms' decision variables to the economic environment facing them. As mentioned above, their environment is defined almost entirely by the price of their output and the price of their primary input, logs. Mainly because of differences in the particular type of their output and log inputs, these prices vary across mills though most of the variation in these variables in our data is over time. By contrast, most of the variation in real wages, employment, hours, and output within these 200 firm-year observations is across firms.[18] Therefore, the price variables alone cannot be expected to remove much of the variation in the wage, employment, hours, and output data. Notwithstanding this, is there any role for output and input prices in affecting the mills' decision variables?

To address this question, we specified the following regression equation:

$$(1) \quad \ln y_{it} = \alpha_i + \beta \ln p_{it} + \gamma \ln r_{it} + \varepsilon_{it}$$

In this equation, y stands alternately for average hourly earnings, annual hours per worker, employment, and output. The price of output is given by p and the price of logs is r. α_i is a fixed effect for each firm so that the impacts of output and input prices are measured relative to each firm's mean value of the logarithm of y. Average hourly earnings and the prices of output and logs are all deflated by the consumer price index so the regression estimates report movements in real prices. ε_{it} is a stochastic disturbance assumed to have the conventional desirable properties. This equation was fitted to each of the three types of mills and to all the mills together. The estimate of β

Table 4

Membership as a Percentage of Employment by Firm and by Year

Firm	1958	1963	1967	1972	1976	1977	1982
A	62.9	64.7	66.2	68.8	71.1	65.6	70.5
B*							94.3
C	73.5	82.8	69.7	52.9		54.0	
D*	63.6	57.5	60.5				
E	67.0						
F*		93.4	97.3	89.8	91.2	96.8	96.8
G*		82.3	66.9	68.1	60.8	61.6	76.9
H*		74.6	79.0	66.2		60.8	37.5
I*	88.6	85.0	81.3	94.4	76.6	76.0	85.8
J*	100	97.3	78.0	76.4	81.7	71.2	53.3
K	100	83.1	77.5	74.5	80.0	76.6	
L	100	95.9	93.6	87.6	90.6	89.6	83.7
M	54.7	43.2	49.2	52.6	51.3	45.1	75.2
N*	77.3	78.0	76.2	81.9	58.6	59.8	69.6

Notes for Table 4: The asterisk denotes those cooperatives included in our sample of Washington cooperatives described in Table 3.

Table 5

Least-Squares Estimates of Equation (1) by Type of Firm
(estimated standard errors in parentheses)

		y			
		Wages	Annual Hours	Employment	Output
Estimated Coefficient on Logarithm of Plywood Price ($\hat{\beta}$)	Classical	-0.02	0.73	0.61	1.51
		(0.28)	(0.48)	(0.37)	(1.01)
	Union	0.19	0.37	0.70	1.82
		(0.16)	(0.12)	(0.16)	(0.29)
	Coop	0.94	-0.01	0.03	0.91
		(0.21)	(0.17)	(0.14)	(0.25)
	All Firms	0.32	0.39	0.56	1.52
		(0.12)	(0.12)	(0.12)	(0.26)
Estimated Coefficient on Logarithm of Log Price ($\hat{\gamma}$)	Classical	0.30	-0.41	-0.26	-1.23
		(0.28)	(0.48)	(0.37)	(1.01)
	Union	-0.09	-0.15	-0.25	-0.35
		(0.13)	(0.10)	(0.13)	(0.24)
	Coop	-0.25	-0.10	-0.05	-0.49
		(0.16)	(0.13)	(0.11)	(0.19)
	All Firms	-0.03	-0.21	-0.19	-0.51
		(0.10)	(0.09)	(0.10)	(0.22)

shows the proportionate response of y to proportionate increases in the price of output. A similar interpretation holds for the γ coefficients regarding the price of logs.

Each entry in Table 5 is, for each type of firm, the least-squares estimate from equation (1) of the proportionate response of the variable listed in each column to (in the upper panel) proportionate changes in output prices and to (in the lower panel) proportionate changes in log input prices.

For the classical firms, an increase in the price of output is associated with increases in employment, hours per worker, and output. Movements in real wages are uncorrelated with movements in output prices. Increases in the price of the major input (logs) accompany decreases in employment, hours, and output though these responses are smaller in absolute value than those associated with the price of output. The union firms' hours, employment, and output responses are similar to those of the classical firms' and again there is little evidence of wages responding to changes in output price.

The point estimates for the cooperatives are different from those of the conventional firms'. Hours and employment are uncorrelated with output price for the coops. On the other hand, a one percent change in the price of output is associated with almost the same change in real wages. With respect to changes in the price of logs, the coops' point estimates suggest real wages respond more than hours or employment to input price changes. Nevertheless, output among the cooperatives responds positively to product market prices contrary to concerns expressed in the economic literature that the output supply function of worker-owned enterprises will be negatively-sloped with respect to the price of output.[19] However, the elasticity of the cooperatives' supply curve is one-half the value estimated for the union mills.[20]

The discussion in the previous two paragraphs focuses upon the economic significance of the estimates reported in Table 5. Differences across firms in the statistical significance of these estimates are much less clear. The standard errors attached to the point estimates caution against strong inferences. Though the coops' responses to changes in output prices appear quite different from those of the conventional firms, conventional statistical tests cannot reject the null hypothesis of no difference across the three types of firms in their responses. Perhaps this should not occasion much surprise given that (in the presence of firm fixed effects in equation (1)) β and γ measure responses around each firm's mean values of y: in some cases we have only a few observations on each firm so the estimates of β and γ are likely to be quite imprecise. All of the cooperative mills produce plywood, but some of the conventional firms produce veneer only.[21] Are the estimates of the responses across the types of firms reported in Table 5 sensitive to the inclusion of mills producing only veneer? This is unlikely because those firms producing veneer for the plywood manufacturing firms operate in the same price environment as those firms producing their own veneer: other things equal, an increase in plywood prices encourages the production of veneer and an increase in timber prices discourages the production of veneer. However, to confirm our conjecture, we also fitted equation (1) to the sample of mills that excludes those producing veneer only. The qualitative results are similar to those in Table 5.[22]

These results suggest that, in the face of virtually the same economic environment, the cooperative firms' adjustments are somewhat different from those of the conventional firms'. Though confident statements are unwarranted, the coops' appear to respond to changing output prices by adjusting wages and not by altering employment and hours. By contrast, in the conventional firms the adjustments fall more on hours and employment and less on wages.[23] The competitive nature of the plywood manufacturing industry suggests there are little rents to be bargained over and, therefore, there might seem to be little room for differences among the firms. However, firms may make different adjustments to common changes in their economic environment and this is what the results in Table 5 suggest. These different adjustments are related to the process by which earnings are determined for the union firms and the cooperatives. In the unionized sector, wages are set through collective bargaining agreements that apply to all covered firms and the most of the movements in wages are the consequence of factors beyond the discretion of any single firm.

One might expect, therefore, at least for the unionized firms, a relationship running from the industry-wide determined wage rate to each firm's inputs and its supply of output. This would imply the following specification:

$$(2) \quad lny_{it} = \alpha_i + \beta \ln p_{it} + \gamma \ln r_{it} + \delta \ln w_{it} + \varepsilon_{it}$$

where w represents real hourly earnings, p the real price of output, and r the real price of logs. y stands

alternately for annual hours per worker, total employment, and real output. Fixed firm effects are represented by α_i.

The least-squares estimates of this equation for the unionized mills are shown in Table 6 where, for comparison, the corresponding estimates resulting from fitting the equation to the classical firms and to the cooperatives are also given. For conventional firms, the estimates in Table 6 broadly conform to what would be expected if they were interpreted as conventional input demand and output supply equations: though estimated standard errors are sometimes large relative to their associated point estimates, employment is negatively related to real wages and to the price of logs and positively related to the real price of output. For the cooperatives, the partial correlation between wages and employment is not merely statistically insignificant, but very small.

Conclusions

In general, the estimates in Tables 5 and 6 suggest that the cooperatives respond to changes in their price environment differently from classical and unionized firms. Given the estimated standard errors, this must be a tentative, not a confident inference. This inference squares, however, with the general features of the institutional environment within which wages are determined. In the union sector, wages are set through a multi-firm collective bargaining agreement and each mill may set employment and hours conditional upon this collectively bargained wage. By contrast, each cooperative determines for itself how much of its income net of contractual payments to distribute to the workers in the form of current earnings and how much to set aside as retained earnings.[24] Hourly earnings may vary from year to year.[25] And it appears they do.

Table 6

Least-Squares Estimates of Equation (2) by Type of Firm
(estimated standard errors in parentheses)

		y		
		Annual Hours	Employment	Output
Estimated Coefficient on Logarithm of Plywood Price ($\hat{\beta}$)	Classical	0.70 (0.21)	0.59 (0.32)	1.46 (0.69)
	Union	0.36 (0.12)	0.74 (0.16)	1.80 (0.29)
	Coop	0.22 (0.20)	0.07 (0.17)	0.93 (0.31)
	All Firms	0.49 (0.12)	0.64 (0.12)	1.67 (0.26)
Estimated Coefficient on Logarithm of Log Price ($\hat{\gamma}$)	Classical	0.05 (0.21)	-0.05 (0.32)	-0.44 (0.70)
	Union	-0.14 (0.10)	-0.27 (0.13)	-0.34 (0.24)
	Coop	-0.16 (0.13)	-0.06 (0.11)	-0.49 (0.20)
	All Firms	-0.22 (0.09)	-0.20 (0.10)	-0.52 (0.21)
Estimated Coefficient on Logarithm of Log Price ($\hat{\delta}$)	Classical	-1.54 (0.14)	-0.71 (0.22)	-2.63 (0.48)
	Union	0.06 (0.08)	-0.20 (0.10)	0.11 (0.20)
	Coop	-0.23 (0.12)	-0.04 (0.11)	-0.02 (0.19)
	All Firms	-0.31 (0.07)	-0.23 (0.08)	-0.45 (0.17)

IV RETURNS TO JOINING THE COOPERATIVES

For the sample of firms in Washington state described in the previous section, there is little difference in annual earnings between unionized mills and cooperative mills though the volatility of employment in the cooperatives is smaller than that in the unionized mills. This might suggest that the primary monetary advantage offered members of the cooperatives is the security of employment over time. If so, the value that the worker-owners place on this advantage should cause the prices of the coop's shares to be higher than they would otherwise be so that the expected returns to working in the union mills and the cooperative mills be equated. This prompted us to collect data on the prices of the cooperatives' shares and to determine from these prices whether being an owner-worker in a cooperative mill has been a profitable investment. This section reports our findings.

To date, there has been no systematic analysis of the prices of the plywood cooperatives' shares. To provide such an analysis, we collected advertised share prices from the Business Opportunities section of the Portland *Oregonian* for each issue of the newspaper from 1957 to 1986. In many instances insufficient information on prices was provided,[26] but nevertheless we were able to garner 248 observations on share prices for eleven companies in Oregon and Washington. As is the case whenever listed prices are used for analysis, the classified advertisements specify asking prices and may not correspond to prices actually paid. We take up this issue below.

Many advertisements specify an amount that must be paid now and an amount that must be paid later. In

other words, often only a fraction of the asking price has to be paid up front and the purchaser assumes a loan (of a length unspecified in the advertisement) on the remaining balance. Indeed, in a few cases an advertisement provided two options: one option is an amount that has to be paid now plus an amount to be paid later; and the other option calls for a smaller total amount to be paid in full now. Naturally, the asking price is lower, the smaller the amount of the loan.[27]

To describe the pattern of share prices, we related the real share price of firm i in year t, S_{it}, (measured in thousands of 1983 dollars) to a vector of firm dummy variables, a vector of year dummy variables, and the proportion of the asking price to be paid at the time of transfer of the share (D_{it}):

$$(3) \quad S_{it} = \alpha_i + \alpha_t + \beta D_{it} + \varepsilon_{it}$$

The parameters were estimated by least-squares. Ninety percent of the variation in these share prices is removed by this specification. The estimated value of β is -13.56 with an estimated standard error of 1.65: a ten percent increase in the fraction of the asking price to be paid now is associated with a $1,356 lower price (in 1983 prices) which represents about 3 percent of the mean of S_{it}. Clearly, the price discount for a larger down payment should depend on the length and other characteristics of the loan, but very few advertisements specified these features so we are not in a position to exploit such information.[28]

The time-series movement in real share prices as implied by the estimates of α_t is graphed in Figure 2. This series follows roughly the fortunes of the plywood industry with a marked peak in the late 1970s followed by a drastic fall in the 1980s.[29] This leads naturally to the conjecture that the time-series pattern in share prices is driven by variations in plywood prices and indeed there exists a significantly positive contemporaneous correlation between share prices and plywood prices over time. (Plywood prices are also graphed in Figure 2.) However, only 43 percent of the time-series variation in share prices is removed by plywood prices so there remains much residual movement left unaccounted for. There exists, for instance, a significant upward trend in real share prices even after controlling for the effects of plywood prices.[30]

The cross-sectional variation in real share prices implied in 1983, that is, the estimates of α_i from equation (3), are given in column (1) of Table 7. (The first six mills labelled in Table 7 also appear in Table 4 with the same letters.) These prices range from a high of $89,300 for mill L to $10,300 for mill R. Mill L is well known to be a very prosperous company while mill R is now out of business. Characteristics on a few of these firms are provided in columns (2) and (3) of Table 7. Thus, column (2) computes average annual earnings implied for 1982 for those firms for which adequate earnings data are available while column (3) indicates the membership-to-employment percentage implied for 1982 as taken from the data in Table 4.[31] Among those five mills with earnings data, the mill with the highest earnings, mill M, has the highest share price. Mill M is also the mill with the lowest percentage of employees who are members. The mill with the highest membership-to-employment percentage, mill F, has the lowest earnings of the five. If a cooperative mill's earnings contain an element of rent, these should be capitalized into its share prices. We have examined this for three mills for which we are able to obtain a

Figure 2

Real Share and Plywood Prices, 1957-86

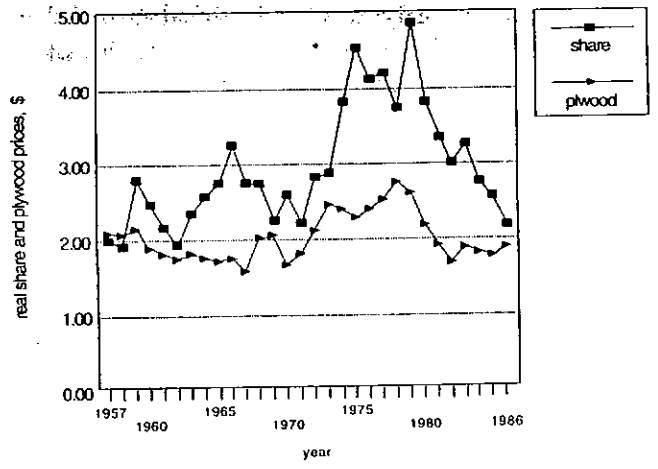


Table 7

Share Prices in 1983 across Cooperative Mills with Selected Earnings and Membership Information

Mill	(1) 1983 Share Prices (in $ thousands)	(2) 1982 Annual Earnings (in $ thousands)	(3) 1982 Implied Membership to Employment Percentage
A	78.6	24.0	63.9
F	52.4	18.8	92.5
H	29.2	23.7	61.3
J	52.4	19.6	76.5
L	89.3		88.4
M	79.0	30.5	49.9
O	28.7		
P	31.0		
Q	29.0		
R	10.3		
S	69.0		

sufficiently long time series of share prices and earnings. These are mills A, J, and M. For firm M, in particular, we obtained annual earnings data for member workers for each year from 1957 to 1980.

Denote the real earnings (including all distributions of any dividends) of a member of mill M in year t by Y^m_t and denote the real price of mill M's share in year t by S_t. Then the discounted present value, $R^m(0,T)$, of purchasing a share in year 0 and working in the mill until year T is

$$\Sigma_t \delta^t Y^m_t - S_0 + \delta^T S_T = R^m(0, T)$$

where δ is the discount factor.

Suppose the relevant alternative to joining the cooperative is to work as a union employee in the conventional plywood mill where the annual earnings are Y^n_t. The wealth used to purchase a share in the cooperative mill, S_0, may be invested instead in the form of a local savings deposit where it earns a rate of interest in year t of i_t. Suppose the individual invests the principal S_0 until he leaves employment in the unionized mill in year T. The discounted present value from this activity, $R^n(0,T)$, between year 0 and year T is

$$\Sigma_t \delta^t Y^m_t - S_0 + \delta^T S_0 \Pi_t (1 + i_t) = R^n(0, T)$$

The net present value of being an owner-worker in mill M in year 0 is, therefore, $R^m(0,T)-R^n(0,T)$.

We computed these net present values for all years from 1957 to 1980 using the share prices for mill M implied by equation (3) (when $D_{it}=1$), the annual series on mill M's member earnings and the earnings of unionized workers, and the interest rate payable on savings deposits in Portland (as the values for i_t). All values are denominated in 1983 dollars.

Instead of tabulating discounted net present values, define S_0^* as the price of a share in year 0 such that the discounted net present value is zero:

$$S_0^* = [\delta^T \Pi_t (1 + i_t)]^{-1} [\Sigma_t \delta^t (Y^m_t - Y^n_t) + \delta^T S_T]$$

S_0^* is the price of a share in year 0 such that the discounted present value of joining a cooperative and that of being employed in the unionized mill are equated. For brevity, we dub S_0^* the equilibrium value of a share. When $S_0/S_0^*<1$, a share is trading for less than the value that would equalize R^n and R^m, the discounted present values of alternative employments.

In fact, according to the top panel of Table 8, this was the experience of mill M's shares throughout the period from 1957 to 1980: mill M's shares were trading consistently for less than the value that would have equalized the discounted present values of joining and of not joining the mill.[32] For instance, the price of mill M's shares in 1957 was selling for 60 percent of the equilibrium price for someone planning to work in the mill until 1960. For someone planning to work from 1957 to 1980 in mill M, the price of the mill's shares in 1957 was only 35 percent of the equilibrium price. All the entries for S_0/S_0^* in Table 8 are less than unity indicating that mill M's shares were consistently undervalued by the criterion of equality of discounted present values.[33]

The middle and bottom panels of Table 8 provide values of S_0/S_0^* for two other cooperative mills, mills A and J.[34] The prices of mill A's shares also appear consistently undervalued. For mill J, the prices of shares purchased in the 1970s were also undervalued, but some of those purchased in the early and mid-1960s appear not to have been. Someone working in a union mill from 1962 to 1980 and investing his capital in a local savings account would earn 91% of the monetary return from purchasing a share in mill J in 1962 and working in the mill until 1980. Nevertheless, even for

Table 8

Share Prices Relative to their Equilibrium Values, S_0/S_0^*

Mill M

		Year Employment Started				
		1957	1960	1965	1970	1975
Year Employment Terminated	1960	0.60				
	1965	0.42	0.49			
	1970	0.35	0.39	0.58		
	1975	0.46	0.49	0.59	0.65	
	1980	0.35	0.36	0.41	0.41	0.47

Mill A

		Year Employment Started			
		1966	1970	1974	1978
Year Employment Terminated	1967	0.83			
	1971	0.61	0.89		
	1975	0.67	0.72	0.79	
	1979	0.62	0.63	0.65	0.82

Mill J

		Year Employment Started				
		1962	1967	1972	1977	1982
Year Employment Terminated	1965	1.09				
	1970	1.16	0.90			
	1975	1.22	0.97	0.84		
	1980	0.91	0.73	0.63	0.78	
	1986	0.44	0.35	0.30	0.42	0.67

mill J, most of the values of S_0/S_0^* between 1962 and 1986 are less than one.[35]

Lest it be thought that this prevalence of undervalued share prices are the consequence of using (higher) advertised prices rather than traded prices, it should be noted that, in principle, lower share prices have an ambiguous effect upon discounted net present values. Lower share prices at time of purchase, 0, raise the present value of becoming a member, R^m, but at time of sale, T, lower share prices lower the present value. If share prices were traded at some fixed proportion of advertised prices, the effect on net present values depends on the difference between share prices at period 0 and at period T.[36] In fact, if shares consistently traded at ninety percent of their advertised values, then the values of S_0/S_0^* are given by the entries in Table 9. These are lower than those in Table 8. In other words, if shares traded at consistently lower values than advertised prices, the under-valuation of these cooperatives' shares would be even more marked.

Why have these mills' share prices normally been under-valued? One immediate reaction might be that the apparent discount at which the shares were selling reflects the risk (indeed, for some formulations, is a measure of the risk) of holding an asset whose price

Table 9

Share Prices Relative to their Equilibrium Values, S_0/S_0^*.
Assuming Shares Trade at 90% of Advertised Prices

Mill M

Year Employment Terminated	Year Employment Started: 1957	1960	1965	1970	1975
1960	0.56				
1965	0.39	0.45			
1970	0.32	0.36	0.55		
1975	0.43	0.45	0.55	0.61	
1980	0.32	0.33	0.37	0.38	0.43

Mill A

Year Employment Terminated	Year Employment Started: 1966	1970	1974	1978
1967	0.81			
1971	0.57	0.88		
1975	0.65	0.71	0.77	
1979	0.58	0.61	0.61	0.80

Mill J

Year Employment Terminated	Year Employment Started: 1962	1967	1972	1977	1982
1965	1.09				
1970	1.14	0.88			
1975	1.18	0.93	0.81		
1980	0.85	0.68	0.59	0.75	
1986	0.40	0.32	0.28	0.39	0.63

fluctuates over time. However, this is not the only source of risk here: we have implicitly assumed the worker to be fully employed in each year although, according to the results in the previous section, the probability of employment in the unionized firm in a recession is likely to be lower than that for the cooperative. This differential probability of employment should have the effect of bidding up the price of the cooperatives' shares.

Another factor in our analysis of net present values concerns the loans that are often shouldered upon purchase of a share. Our computation assumes that shares are bought and sold outright whereas, in fact, in some cases, the transaction involves the purchaser taking on a loan with the associated interest cost. However, the net effect on share prices of this loan activity is unclear if the individual both borrows at the time of purchasing a share and then lends at the time of selling his share.

Though the market for these shares might be thought to be thin, in fact, the activity in shares as evidenced from the advertisements suggest a steady stream of buying and selling opportunities. The sample of 248 price quotations used in the analysis above represents only a fraction of the offers as many did not contain sufficient information on prices for us to use and the advertisements invited potential buyers to make further inquiries. It could be the case, of course, that the sample we have put together is unrepresentative in some sense although we have no reason to believe this is so. It is the case that these three firms have been among the more successful of the cooperative mills though they have been relatively successful throughout the period studied. These are not mills that were foundering in the early years and then performed exceptionally well in more recent years.

Our results do not contradict Berman's conclusion drawn from her analysis of some share prices in the 1960s that "Imperfect information, speculative motives, and exaggerated expectations (both optimistic and pessimistic) have played substantial roles [in the determination of share prices]" (Berman, 1967, p.195). At the same time, this statement does not mention our principal result, namely, the persistent undervaluation of the share prices. We know of no other research on the cooperatives' shares that examines this issue.

This suggests the capital market for cooperatives is not operating as expected and it supports the notion that, in a predominantly capitalist environment, worker-owned firms operate at something of a disadvantage in

capital markets. Proponents of worker coops have maintained for years that this is the case. When they were established, the typical cooperative attempted to issue only as many shares as its anticipated employment. At the same time, the price of the stock was kept within the financial abilities of the worker to purchase it. This meant that the company was often undercapitalized at the time of its establishment. As a consequence, many cooperatives subsequently turned to banks for loans. Banks were not accustomed to dealing with the cooperative form of organization and, in particular, they had to recognize they were dealing with managements that served at the discretion of the employees rather than the other way around.[37] Given the precarious position of management in some companies, the banks have found it necessary to reach agreements with all the members rather than with their representatives.

We also wonder whether the cooperative form of organization is susceptible to this sort of apparent undervaluation. In the form of cooperative in the plywood industry, a condition of employment is that an individual tie up a significant fraction of his assets in the company in which he works, the result being that the worker's labor income and capital income are subject to the same risks. By comparison, the conventional firm detaches the supply of labor from the supply of capital: a worker in a conventional firm may choose to purchase shares in the firm in which he works (provided the firm is a corporation), but he is not obliged to do so; in other words, the worker in a conventional firm may expose his labor income to a different source of uncertainty from that facing his capital. Many workers lack the capital to invest in a mill and others will be averse to subjecting their labor income to the same risks as those exposed to their capital. The result will be a reduction in the supply of labor (and the supply of cooperating capital) to the cooperative mills. If this reduced supply is sufficiently large, it will manifest itself in the sort of undervaluation of cooperatives' shares that we have found for most of the period since the mid-1960s in the Pacific Northwest. We hope that research on other cooperative organizations can be undertaken to determine whether our conjecture is correct.

V PRODUCTIVITY DIFFERENCES BETWEEN COOPS AND CONVENTIONAL FIRMS

In Section II of this report, we presented an analysis of the relationship across different types of firms between employment, hours, earnings, and output on the one hand and plywood prices and log prices on the other hand. This analysis involved examining 200 firm-year observations. For a subset of 171 observations, we have data also on each firm's input of logs in addition to measures of their plant and equipment and this enables us to enquire into productivity differences between conventional firms and coops.

Table 10 reports by type of firm the mean values of output per manhour and output per log input for three separate years and for all years together. Because this is not a balanced data set (that is, different firms are observed in different years), the variations in the productivity figures across years reflects in part the changing composition of the sample. Nevertheless, in each year labor productivity (output per manhour) is least for the coops and most for the classical firms. The differences in labor productivity between union firms and the coops are often small. Productivity measured in terms of output per unit of log input is usually greatest for the coops (1984 being the exception). These summary data do not suggest clear and consistent differences in productivity across the firm types.

More meaningful than simple mean differences in productivity are estimates of production functions in which the effects of several variables on productivity may be taken into account at the same time. To this effect, we fitted the following equation to describe

Table 10

Mean Productivity Differences by Type of Firm by Year

	Classical	Union	Coop	All Firms
1972				
Output per Manhour	18.87	14.70	12.24	14.48
Output per Log Input	3.45	2.32	4.47	3.04
1980				
Output per Manhour	13.08	12.89	11.45	12.59
Output per Log Input	1.40	4.15	11.18	5.18
1984				
Output per Manhour	11.95	11.60	11.30	11.65
Output per Log Input	1.10	6.99	2.25	4.42
All Years				
Output per Manhour	14.46	12.29	11.88	12.61
Output per Log Input	1.56	3.73	5.00	3.61

Notes: Output is the weighted sum of the production of softwood, hardwood, and veneer (each measured in thousands of square feet, 3/8 inch basis) where the weights are given by the real prices (in 1967 dollars) of these three types of output.

differences in output per unit of labor and log inputs across the 171 firm-year observations:

$$(4)\quad \ln[X/(M.L)]_{it} = \alpha_i + \beta lnM_{it} + \gamma\, lnL_{it} + \varepsilon_{it}$$

Here X is real output, M represents manhours (the product of employment and annual hours per worker), and L is the input of logs. If the input-output relationship for plywood manufacturing is approximated well by a log-linear production function, then the coefficients β and γ are each input-output elasticities minus unity. The approximation error is given by the term εit and it stands for factors affecting productivity that are omitted from the equation.

Note that equation (4) incorporates no information about each mill's physical capital. In fact, information on certain types of capital was collected (such as the size of lathes). We found that these capital measures were often quite different across firms, but for a given firm they changed very little over time. Therefore, instead of introducing these capital variables into the production function explicitly, equation (4) incorporates them implicitly by allowing each firm to have its own intercept, αi. In other words, for given amounts of labor and raw materials, equation (4) allows each mill to have a different production function, a specification that was once advised to deal with what was called "management bias" (Mundlak (1961)).

The least-squares estimates of equation (4) are given in Table 11 for each type of firm and for all firms. The values of β and γ are always between minus one and zero implying that, although proportional increases in each input raise output, the proportional increase in output is smaller than the proportional increase in the input. In other words, the law of diminishing returns operates. The estimated coefficients attached to manhours are very similar across firm types. The point estimates of γ show more variation, but the associated standard errors caution against any strong inferences. Indeed, conventional statistical tests cannot reject the hypothesis that there is no difference among the estimates of β and γ for the coops' observations, the unionized firms' observations, and the classical firms' observations.

If the separate firm intercepts in equation (4) are suppressed and replaced with dummy variables indicating type of firm (that is, coop or union or classical), the coefficients attached to these dummy variables suggest that productivity is lower in the conventional firms. However, this difference is not significantly different from zero according to the customary criteria. The data do not suggest one type of firm is more productive than another.

There are a number of shortcomings with these estimates of productivity differences across firm types. First, the least-squares estimates in Table 11 are biased because they do not recognize that the inputs of labor and logs are determined jointly with output.[38] Also,

Table 11

Estimates of Productivity Equation (4)

Firm Type	Number of Observations	Mean (Standard Deviation) of Dependent Variable	Least-Squares Estimates $\hat{\beta}$	Least-Squares Estimates $\hat{\gamma}$	Least-Squares Estimates R^2	Least-Squares Estimates see	Instrumental Variable Estimates $\hat{\beta}$	Instrumental Variable Estimates $\hat{\gamma}$
Coops	38	1.91	-0.419	-0.816	0.97	0.19	-0.635	-0.716
		(0.19)	(0.264)	(0.097)			(0.469)	(0.179)
Union	101	1.74	-0.371	-0.572	0.88	0.31	0.890	-0.981
		(0.10)	(0.147)	(0.088)			(0.471)	(0.244)
Classical	32	2.85	-0.356	-0.390	0.90	0.31	-0.322	-0.320
		(0.26)	(0.128)	(0.102)			(0.155)	(0.138)
All Conventional Firms	133	2.00	-0.356	-0.508	0.91	0.31	0.168	-0.642
		(0.13)	(0.098)	(0.066)			(0.207)	(0.134)
All Firms	171	1.98	-0.327	-0.582	0.92	0.30	0.178	-0.716
		(0.13	(0.089)	(0.057)			(0.196)	(0.122)

Notes: $\hat{\beta}$ is the estimated coefficient attached to manhours and $\hat{\gamma}$ is the estimated coefficient attached to the input of logs. Estimated standard errors are in parentheses. "see" denotes the standard error of estimate of the equation. The instruments for the estimated in the last tow columns are firm dummies, δnp, δnr, $(\delta np)^2$, $(\delta nr)^2$, and $(\delta np)(\delta nr)$ where p is the real price of plywood and r is the real preice of the input of logs.

least-squares bias arises because the inputs included in equation (4) diverge from those that are the relevant ones in production. The labor input in equation (4) counts employment and hours, but does not take into account work effort per hour per worker, a dimension of labor input that proponents of the cooperative structure emphasize when discussing the production advantages of labor management. The input of logs in equation (4) does not take into account differences in the quality of the logs. In other words, the inputs in the fitted production function contain errors in measurement and this causes the least-squares estimates of the production function parameters to be biased and inconsistent.

In these circumstances, a natural response is to seek help through the application of an instrumental variables estimator. There would seem to be natural candidates for valid instruments: the prices of plywood output and of log input. These prices are predetermined with respect to any single firm's behavior and yet clearly help to determine each firm's choices of its inputs. The difficulty is that though these prices are valid instruments, they are not very good ones: most of the variation in both manhours and log inputs is across firms while most of the variation in output and input prices is across time, not across firms. The result is that the values of manhours and logs imputed by plywood and log prices (and by the firm dummies) are extremely highly correlated with one another and with the firm effects (αi) in equation (4). Hence the instrumental variable estimates of equation (4) yield imprecisely estimated coefficients and estimates that are very sensitive to small alterations in the size and characteristics of the sample.

For the sake of completeness, we present in the final two columns of Table 11 the instrumental variable estimates of equation (4). Most of the estimates are similar to the least-squares estimates. The exception is the estimates for the unionized firms where the effects of increases in manhours on productivity (β) are much higher. However, the corresponding standard error is also much larger. In general, confident inferences cannot be drawn from the instrumental variable estimates.[39]

The work reported in this section does not provide any convincing reason for believing that there are meaningful differences in the productivity of cooperatives, unionized firms, and classical firms. The fact that all three types of firms have coexisted for several decades in the plywood industry in the Pacific Northwest suggests that one type does not dominate the others in overall efficiency and the productivity equations we have fitted do not persuade us to reject that hypothesis.

VI CONCLUSIONS

This report has been concerned with the behavior of producer cooperatives. We have identified an environment in which three types of firms operate - cooperatives, private unionized firms, and private nonunion firms - and where they have operated for many years, namely, the plywood manufacturing industry in the Pacific Northwest. Clearly, the industry equilibrium supports all three types of firms. What is particularly attractive about this industry as a case study is that these firms face virtually the same economic environment so that differences in outcomes are more likely to reflect differences in the firms' objectives. This common economic environment is described by the prices of major inputs and of output, each firm being characterized as a price-taker in these markets.

This paper has addressed several classes of issues in the literature on worker ownership and management. First, are the responses of the cooperative form of organization to changes in its environment different from those of conventional firms? Using data collected for this particular study describing 41 firms over the period from 1968 to 1986, we find evidence that the cooperative's responses are different: the cooperative is more likely to adjust earnings and less likely to adjust employment to changes in output prices and input prices than the conventional firm. Though the elasticity of the supply of output with respect to product price is smaller for the cooperative, we find no evidence for a negatively-sloped output supply function, a construct that has figured prominently in the literature on labor managed firms since Ward's (1958) original article.

The second issue concerns the supply of capital to cooperatives. On the basis of data collected for this study on the prices of the shares of the cooperatives over a period of thirty years, we find sharp variations in these prices across firms and over time. For three cooperatives for which we were able to collect a reliable time-series on earnings, we find that their share prices have been habitually (though not invariably) undervalued. This is a novel finding. We speculate that this apparent undervaluation of the cooperative's shares is endemic to this form of organization in which a worker is required to subject his labor income to the

same risk as his capital. If so, this would help to explain the difficulties these firms have had in raising capital for their operations.

The third issue concerns productivity differences between cooperatives and conventional firms. The survival in the plywood industry of the Pacific Northwest of both coops and conventional firms over many decades suggests there are no dominant advantages to one form of organization over the other. This hypothesis of no productivity differences could not be refuted by analyzing the data available on output, labor, and log inputs on 171 firm-year observations.

Our work suggests that what needs to be done in the research on cooperatives is to shift the focus of effort away from more speculation on the way cooperatives behave and towards work that investigates their actual behavior. Our impression is that currently most economics research on these issues takes the form of variations on a number of theoretical themes while the empirical investigation of these issues is relatively neglected. The type of empirical research that will be persuasive makes use of observations on firms (not industries) and it involves comparisons of firms within the same industry or region. This sort of empirical research appears to be quite unusual at present.

Ultimately, we would like to know why the distribution of types of firms takes the form it does. Producer cooperatives constitute just one configuration of an organization's property rights. There are many others so the empirical analysis of the consequences of different institutional arrangements represents a vast research agenda.

REFERENCES

Bellas, Carl J., *Industrial Democracy and the Worker-Owner Firm*, New York: Praeger, 1972.

Ben-Ner, Avner, "On the Stability of the Cooperative Type of Organization", *Journal of Comparative Economics*, September 1984, *8*, 247-60.

Berman, Katrina V., *Worker-Owned Plywood Companies: An Economic Analysis*, Pullman, WA.: Washington State University Press, 1967.

Berman, Katrina V. and Berman, Matthew D. 1978: The Long-Run Analysis of the Labor-Managed Firm: Comment, *American Economic Review*, 68, 4, September, pp. 701-5.

Berman, Katrina V. and Berman, Matthew D. 1989: An Empirical Test of the Theory of the Labor-Managed Firm, *Journal of Comparative Economics*, 13, 2, June, 281-300.

Bonin, John P., Jones Derek C., and Putterman, Louis, "Theoretical and Empirical Studies of Producer Cooperatives", unpublished manuscript, 1992.

Bonin, John P. and Putterman, Louis, *Economics of Cooperation and the Labor-Managed Economy*, New York: Harwood Academic Publishers, 1987.

Clark, Andrew and Oswald, Andrew 1990: Trade Union Utility Functions: A Survey of Union Leaders' Views, unpublished manuscript, Dartmouth College, August.

Dahl, Henry G., Jr., "Worker-Owned Plywood Companies in the State of Washington", unpublished manuscript, Everett, Washington, April 1957.

Greenberg, Edward S., *Workplace Democracy: The Political Effects of Participation*, Ithaca, New York: Cornell University Press, 1986.

Ireland, Norman J. and Law, Peter J., *The Economics of Labor- Managed Enterprises*, New York: St. Martin's Press, 1982.

Jones, Derek C. and Svejnar, Jan, (eds), *Participatory and Self-Managed Firms*, Lexington, Mass.: D.C. Heath & Co., 1982.

Levin, Henry M. 1984: Employment and Productivity of Producer Cooperatives. In Robert Jackall and Henry M. Levin, (eds), *Worker Cooperatives in America*, Berkeley and Los Angeles: University of California Press, 16-31.

MaCurdy, Thomas E. and Pencavel, John 1986: Testing Between Competing Models of Wage and Employment Determination in Unionized Markets, *Journal of Political Economy*, 94, 3, 2, June, S3-S39.

Mattey, Joe P., *The Timber Bubble That Burst*, New York: Oxford University Press, 1990.

Russell, Raymond, *Sharing Ownership in the Workplace*, Albany: State University of New York Press, 1985.

Sertel, Murat R. 1982: *Workers and Incentives*, Amsterdam: North- Holland Publishing Company.

Stephen, Frank H. (ed), *The Performance of Labor-*

Managed Firms, New York: St. Martin's Press, 1982.

Vanek, Jaroslav 1970: *The General Theory of Labor-Managed Market Economies*, Ithaca: Cornell University Press.

Ward, Benjamin, "The Firm in Illyria: Market Syndicalism", *American Economic Review*, September 1958, *47*, 565-89.

DATA APPENDIX

Our data on the plywood mills are from four sources. In each case, confidentiality of the data had to be assured, in writing, before they were released. The sources are as follows.

1. A survey of all plywood mills in the state of Washington has been conducted by the Department of Natural Resources (DNR) on each even numbered year from 1968. Information collected from these surveys that are relevant to this research are

(a) the number of hours on a standard shift,
(b) the number of days during the year that each mill was operating,
(c) whether the mill produced veneer or plywood and the mill's use of hardwood, and
(d) plywood and veneer inventories at the beginning and end of each year.

The vast majority of plywood mills operating in the state were surveyed. Only very small mills were not covered, most employing less than ten people.

2. Data on total compensation and monthly employment are collected for each mill by the state's Employment Security Department on its so-called ES-202 forms. Data for most of the mills are available from 1980. Prior to that date only county aggregates are available, but because of the large number of counties and the small number of mills many county-level observations could be matched with individual mills. The definition of total compensation is that relevant to the state's unemployment compensation laws: bonuses, tips, and stocks paid by the employer are included, but employer payments to private pension or welfare funds are excluded. The employment figures cover production, supervisory, clerical, and piece workers as well as workers on paid vacation. They do not include those on layoff, on unpaid vacations, or involved in work stoppages.

3. The International Woodworkers of America and the Western Council of the IWA collect data on membership employment and hours for each unionized mill for the purpose of managing their pension funds. Employment data were collected for the median month of employment meaning the median month in which the plywood mill was in operation. For those mills where employment data were available also from the Employment Security Department (ESD), the least-squares regression of employment from the ESD on membership employment from the IWA is as follows:

$$\underset{(17.9)}{\text{(ESD employment)} = 34.34} + \underset{(0.067)}{0.976}\ \text{(IWA employment)} \qquad R^2=0.95$$

where estimated standard errors are in parentheses. Using the average wage for the plants as calculated from the contract files in the IWA archives. The least-squares regression of total compensation from the ESD on compensation from the IWA is as follows:

$$\underset{(424{,}877)}{\text{(ESD compensation)} = 1{,}407{,}442} + \underset{(0.120)}{0.846}\ \text{(IWA compensation)} \qquad R^2=0.79$$

4. Data were collected from the annual reports of the producer cooperatives. When data from both the annual reports and the Employment Security Department were available, the figures did not exactly agree (which is to be expected in view of the different accounting periods and the different definitions of compensation), but they were close to one another.

The annual hours of work variable used in this paper is defined as the number of hours per shift per worker times the number of days the mill was in operation. Clearly this is an approximation to average hours worked. The hours data we have record regular shifts and we lack information on extended or short shifts. Further, workers may not work each day the mill is in operation. From the union pension data and the annual reports of the cooperatives, we sometimes had data on annual hours per *member* (not per worker). The ratio of these per member hours to our per worker hours were 1.167 for the union data (with a standard deviation of 0.26) and 1.015 for the producer cooperatives (with a standard deviation of 0.43).

Hourly wages as used in this paper are defined as annual total compensation divided by the product of employment and hours per worker (where the latter is measured in the manner outlined in the previous paragraph).

For output prices, most of the firms concentrated their production in softwood plywood so we used the producer price index for western softwood plywood. A few plants produced only veneer and for these observations we used the softwood veneer price index. A couple of mills produced only specialty hardwood so we used the hardwood plywood price index for these. The price of logs is collected by the Agricultural Marketing Service of the State of Washington. These prices are collected every other month for four regions in the state. We used the price of a number 3 Douglas fir peeler log in the region in which the mill was located.

FOOTNOTES

[1] We thank Katrina Berman, David Larson, Don Truax, Cheryl Erickson, Dory Leach, James Norgaard, and Robert Anderson for their generous help and advice during the collection of the data used in this report. We thank Margaret Evans for her loyal and professional research assistance. The research leading to this report was financed in part by the University of California Center for Cooperatives as part of its Competitive Grants Project. Pencavel also received research assistance from Stanford University's Center for Economic Policy Research.

[2] See, for example, John P. Bonin and Louis Putterman (1987), Bonin, Derek C. Jones, and Putterman (forthcoming), Norman J. Ireland and Peter J. Law (1982), Jones and Jan Svejnar (1982), and Frank H. Stephen (1982).

[3] For instance, see Henry G. Dahl (1957), Carl J. Bellas (1972), Edward S. Greenberg (1986), and, above all, Katrina V. Berman (1967).

[4] Shareholders can also be fired for repeated malfeasance.

[5] Note, however, that on the same page Berman writes, "An additional measure [of success] of stability of employment might be included here, but steady employment of shareholders is generally assumed, so that the wage rate becomes the measure of shareholders' income from the company". Dahl (1957) concurs with Berman on the importance of wages: "Generally, the majority of the shareholders tend to think much the same as they used to think in their previous jobs as union members. They are primarily concerned with the wage they take home"(p. 50).

[6] Previous researchers have never made it clear, but they have probably compared the coops with the unionized firms in the industry and have often drawn unfavorable inferences about conventional firms from these comparisons.

[7] The decisions involving the IRS were apparently reached by comparing costs for individual departments in a particular cooperative with those in neighboring conventional firms.

[8] Expenditures on glue and special adhesives make up about 5 percent of production costs with the remainder being administrative and fixed costs. Information on costs is provided by Berman (1967, pp. 39-61).

[9] This Federal Government "bailout" provided generous conditions under which certain timber contract holders were able to write off their liabilities. The episode is analyzed by Joe P. Mattey (1990). He attributes the price bubble in the late 1970s and early 1980s not simply to changes in macroeconomic activity and policy, but to the propensity of overcapitalized and recklessly optimistic buyers to assume a risky postures. We know of no plywood firms that were part of the bailout.

[10] The activities of the Association are financed by dues levied on the output of each member.

[11] In each case, confidentiality of the data had to be assured in writing before the data were released. In addition to the signed release, permission from the individual mills had to be obtained for the use of the Employment Security data and for the annual reports of the producer cooperatives.

[12] Annual hours per production worker are defined as the number of hours per shift times the days operated per year. Average hourly earnings is defined as total annual compensation divided by the product of average annual hours per worker and employment.

[13] Average labor productivity (output per manhour) is consistently lower in our sample of cooperatives than in the conventional firms. (It would not be so evident if we measured productivity as output per man.) Similar calculations in the 1950s and early 1960s suggested that the cooperatives were more productive than the conventional firms (Dahl (1957), pp.31-6, Berman (1967), pp.189-91).

[14] Note from Table 1 that, though plywood prices were rising in 1972 and falling in 1980, they were considerably higher in 1980 than in 1972: according to Table 1, nominal plywood prices in 1980 were more than double their value in 1972. Also, timber prices (the prices of the mills' major input) were rising in 1972 and falling in 1980 with nominal prices in 1980 more than four times their 1972 levels. The separate impacts of product and input prices are measured below.

[15] Dahl (1957, p. 16) noted, "In hard times the worker-owned mills lay off the non-shareholder employees, they curtail production by eliminating Saturday operation, they reduce the wages of the shareholders; but they continue to employ those shareholders who wish to work and they continue to operate."

[16] Describing the data in Table 4 by means of conventional variance-covariance analysis, the estimated coefficients on the yearly dummies (measured relative to 1958) are as follows (with estimated standard errors in parentheses): for 1963, -3.04 (3.99); for 1967, -6.65 (3.99); for 1972, -8.93 (4.11); for 1976, -11.56 (4.31); for 1977, -14.03 (4.11); and for 1982, -11.08 (4.36).

[17] These incentives are discussed, for example, in Avner Ben-Ner (1984) while Raymond Russell (1985) provides evidence of the tendency of cooperatives to evolve into conventional firms for the scavenger companies in the San Francisco Bay area and taxi cooperatives in Boston and Los Angeles.

[18] Regressing, in turn, the logarithms of real wages, employment, hours, and real output on yearly dummy variables alone removes, respectively, 18%, 4%, 8%, and 8% of the variation in these variables. By contrast, the same regressions for the logarithm of output price and the price of logs removes 72% and 91% of the variation respectively. The variation of real wages, employment, hours, and output is also greater across firms than over time within each type of firm (classical, union, and coop) except, interestingly enough, for real wages for the coops: real wages for the coops vary more over time than across firms.

[19] This supposition originated with Benjamin Ward's (1958)

model of the dividend-maximizing labor managed firm. Though the result is sensitive to the particular specification of the model, it has disturbed many supporters of cooperatives ever since.

[20] How can the coops' output supply function be responsive to prices when employment and work hours appear so insensitive? In other work we have undertaken, we have found the coops' purchases of log inputs to be quite responsive to prices, the elasticities of log inputs with respect to plywood prices and to log prices being approximately plus unity and minus unity respectively. In addition, of course, holding constant the number of workers and their hours, workers' effort per hour may vary to produce more output when the price of output rises.

[21] Whereas none of the cooperatives produces veneer exclusively, 21 percent of our firm-year observations on unionized mills produce veneer exclusively and 59 percent of our nonunion firm-year observations describe mills producing veneer only.

[22] The only difference of note is that some wage responsiveness to output prices becomes evident among the conventional firms though their response remains one-half that of the coops'.

[23] Some (not all) of the classical firms are fringe producers (open for a part of the year or open in years when product prices are high) so the differences between the cooperatives and the classical firms are perhaps to be expected. However, this characterization of the nonunion mills is not appropriate of all them and we have shown in Figure 1 how one continuously operating classical mill's employment varied over the years 1968-86 compared with the corresponding cooperative mill's employment.

[24] This different process means it is meaningful to inquire into the effect of wages on employment, hours, and output for a unionized firm whereas for a cooperative mill it is no more meaningful to assess the impact of wages on employment than it is to measure the impact of employment on wages.

[25] Berman (1967, p.197) draws this inference from her survey of thirteen cooperatives in 1964: "Shareholder wages in worker-owned companies have not been maintained at fixed levels but have varied in response to business conditions and the companies financial circumstances. In some firms these variations have been frequent.....Although the 1964 rates equaled the highest ever paid for some companies, more than half had paid higher wages at some earlier date."

[26] Thus, some advertisements simply instructed interested buyers to contact someone for a price quote.

[27] The mean nominal price of shares in our sample of 248 is $25,090 with a standard deviation of $21,360. In 1983 dollars, the mean and standard deviation of share prices are $44,610 and $25,237. The highest nominal asking price encountered is $90,000 with $30,000 down for a share in mill L in 1980. Of the 248 advertisements, 138 asked for the entire price to be paid in cash at the time of transfer of the share. Of those offering a loan, the most frequent arrangement asked for between 20 and 30 percent of the price to be paid in cash at the time of share transfer.

[28] Many variants of equation (3) were fitted such as specifying the dependent variable in logarithms and allowing the effect of Dit to be nonlinear. The out-of-sample predicted values from fitting (3) were much more plausible than those in which the dependent variable was the logarithm of the real share price while there were no meaningful nonlinearities in the measured effects of Dit. The specification in equation (3) requires the time-series variation in share prices to be the same for all firms. This is unlikely to be the case, but we lack sufficient observations on the share prices of firms to investigate richer specifications. (No firm's share prices are observed in every year.) As this specification removes ninety percent of the variation in observed share prices, there is relatively little movement left over to be accounted for by firm-time interactions.

[29] To facilitate the comparison of share prices with plywood prices in one graph, the share price series has been modified by dividing the estimates of α_t by 20. For instance, share prices are predicted to be 39.55 thousand real (1983) dollars in 1957 (for mill A). When divided by 20, this yields the value of 1.9775 which is graphed in Figure 2. The plywood prices graphed in Figure 2 are nominal prices of plywood (per thousand square feet) divided by the total finished goods producer price index (1982=100). This yields the value of 2.08 for 1957 which is graphed in Figure 2.

[30] The correlations between lagged or future plywood prices and share prices are lower than those involving contemporaneous plywood prices.

[31] That is, we regressed real annual earnings and the membership-to-employment percentage, respectively, on fixed year effects and fixed firm effects. The entries in columns (2) and (3) are the fixed year effects evaluated in 1982.

[32] All possible durations of employment for each year of hire were considered in calculating S_0/S_0^*. The years listed in Table 8 are representative of the whole matrix.

[33] The entries in Table 8 were constructed assuming a value of δ of 1/1.05. Naturally the precise values in Table 8 are affected by alternative assumptions about δ. However, they are not very sensitive to commonly assumed values of δ and the qualitative results are unaffected. For instance, for δ=1/1.10, the values in the first column of Table 8 would read 0.58, 0.37, 0.30, 0.26, and 0.20. Our findings about the apparent undervaluation of the shares also holds if δ=1/1.025.

[34] Unlike mill M, we were unable to locate earnings data for every single year for mills A and J. (Earnings for mill A are absent for 1973 while earnings for mill J are absent for 1964, 1965, 1969, 1970, and for the odd years from 1979 to 1985.) We used various interpolation methods to derive earnings values for the missing years, all of these methods yielding qualitative results very similar to those given in the tables (which correspond to a straight-line assumption for the change in earnings).

[35] For mill J's shares purchased between 1962 and 1967, 54% have values of S_0/S_0^* that are greater than unity. For shares purchased from 1968 onwards, none is greater than unity.

[36] More precisely, suppose share prices trade at λ their advertised values where λ lies between zero and unity. Then it is straightforward to show that an increase in λ increases discounted net present values by $\delta^T(S_T - kS_0)$ (where $k = \pi(1 + i_t)$) which is ambiguous in sign. Similarly, an increase in λ raises S_0/S_0^* by $E\delta\tau(Y^m_t - Y^n_t)$ which is also ambiguous in sign.

[37] The banks require some security that at least some of the mill's net income will be used to repay loans and not simply to distribute to workers in the form of wages. Hence the loan agreements have often specified that wages be subject to some constraint. This requires the assent of each member increasing the costs of negotiating a loan.

[38] In these circumstances, researchers are inclined to invoke an argument due to Zellner, Kmenta, and Drèze (1966) according to which simultaneous equation bias may be avoided in Cobb-Douglas production function estimation if firms maximize the math-

ematical expectation of profit. Even if this argument may be invoked for the union and classical firms in our sample, it seems unlikely to be relevant to the coops whose maximand is unclear. The following section of the report addresses this issue.

[39] We also examined other equations to describe output in these plywood mills including quadratic functions and translog functions. The inferences from these more elaborate specifications do not cause us to alter the inferences stated in the text.