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Author(s): Douglas W. Caves and Laurits R. Christensen
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The Relative Efficiency of Public and Private Firms in a Competitive Environment: The Case of Canadian Railroads

Douglas W. Caves and Laurits R. Christensen

University of Wisconsin–Madison

The efficiency of public and private firms is usually compared in industries which have heavy regulation and limited competition. In this paper we present a case study in which the effects of property rights can be isolated from the effects of regulation on noncompetitive markets. We compare the postwar productivity performance of the Canadian National and Canadian Pacific Railroads. Contrary to the predictions of the property rights literature, we find no evidence of inferior performance by the government-owned railroad. We conclude that any tendency toward inefficiency resulting from public ownership has been overcome by the benefits of competition.

I. Introduction

A major theme in the recent literature on the economics of property rights is the notion that public ownership is inherently less efficient than private ownership.[1] Alchian is a leading proponent of this view, and his 1965 paper is a frequently cited discussion of the issues

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[1] See Furubotn and Pejovich (1972) for a survey of the property rights literature.

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involved. The essential argument is based on the fact that public ownership is diffused among all members of society, and no member has the right to sell his share. Given these aspects of public ownership, there is little economic incentive for any owner to monitor the behavior of the firm's management. In contrast, it is argued, the ownership of private firms is concentrated among fewer individuals, each having the right to sell his shares; and thus the owners have incentives to scrutinize management to ensure efficiency in the production of goods or services.

Parallel to the theory which predicts efficiency differentials on the basis of type of ownership is a theory which predicts efficiency differentials on the basis of market structure. This theory, which is most widely discussed in the industrial organization literature, predicts superior efficiency in markets characterized by effective competition among firms. The essential element of the theory is that in competitive markets productive efficiency is a prerequisite for survival—at least for privately owned firms.

The two classifications of ownership, public and private, and the two classifications of market structure, competitive and noncompetitive, provide four categories into which firms might fall. Three of the four categories have been extensively studied. The fourth category, government-owned firms operating in a competitive environment, has received much less attention. The principal reason is undoubtedly that few enterprises fall into this category. Nonetheless, the study of such firms has the potential to yield important policy insights.

An important question of public policy is how the four categories of firms rank in terms of relative productive efficiency. There is little doubt that expert opinion would rank competitive private firms as the most efficient and noncompetitive public firms as the least efficient.[2] Ranking the remaining two categories would be more difficult. There is no clear consensus as to whether public firms facing competition behave more like their private counterparts or more like their noncompetitive government counterparts. Both views can be found in the literature. Peltzman (1971, p. 147) suggests: "The differences between government monopolies and government firms with private competitors might be greater than the differences between government firms and private firms in competition with one another." A similar opinion is expressed by Spann (1977, p. 75): "One would expect competition to exert some market pressure on government enterprises to hold down costs . . . and to eliminate some of the

[2] This discussion abstracts from the complicating factor of scale economies. It is possible that for a particular industry efficiencies resulting from a competitive market structure would be more than offset by inefficiencies resulting from the sacrifice of scale economies.

opportunities for discretionary behavior on the part of bureaucracies." A contrary view is provided by De Alessi (1974, p. 7): "The managers of political firms . . . are less constrained by market considerations . . . and find it easier to obtain subsidy and to mask bad management under the guise of fulfilling other 'social' goals. Government firms . . . can survive for long periods . . . [with] grossly inefficient management."

There have been numerous comparative studies of the behavior of public and private firms.[3] The studies are generally of service industries which are heavily regulated. In some cases there exists a degree of direct or indirect competition between private and public firms. But we are not aware of any study of public and private firms coexisting in a competitive environment. Thus the findings of previous studies reflect a mixture of effects of property rights, regulation, and limited competition.

Our objective in this paper is to perform a case study in which the effects of differing property rights can be isolated from the effects of regulation and noncompetitive markets. To achieve this objective we have chosen to study the Canadian National (CN) and Canadian Pacific (CP) Railroads. They are very large railroads of roughly equal size. The CP is a privately owned railroad which spanned the North American continent in 1885. The CN is a crown corporation, wholly owned by the Canadian government. The CN became a nationwide competitor of the CP in 1923, when the government took over and consolidated the operations of several failing railroads.

The CN and CP have received the bulk of railway revenues in Canada for over half a century; currently they account for approximately 90 percent of gross railway revenues. Since World War II the CN and CP have faced stiff competition from other modes of transportation. During the postwar period restrictions on the railroads' ability to compete for traffic have been removed. Thus the Canadian railroad industry provides an attractive case in which to study the efficiency effects of property rights in a competitive environment.

The best single measure of productive efficiency is total factor productivity (TFP)—real output per unit of real resources expended.[4] In this paper we estimate both the rates of growth of TFP and the relative levels of TFP for the CN and CP during the period 1956–75. We find that both railroads have achieved high rates of growth in TFP. Contrary to what is predicted in the property rights literature, we find no evidence of inferior efficiency performance by

[3] Examples, in addition to the papers already cited, include Davies (1971, 1977), Clarkson (1972), Ahlbrandt (1973), Frech (1976), Lindsay (1976), Pashigian (1976), and Savas (1977).

[4] For a general discussion of productivity measurement, see Fabricant (1974).

the government-owned railroad. In fact, our evidence indicates that the CN has achieved larger gains in productivity than the CP since 1956. In the late 1950s and early 1960s the CN had a level of productivity approximately 90 percent as high as the CP, but this gap has been closed. We conclude that in the case of Canadian railroads the beneficial effects of competition have been sufficient to overcome any tendency toward inefficiency resulting from public ownership.

II. The Canadian Railroad Industry[5]

The CP became a transcontinental railroad in 1885, largely as the result of massive aid from the Canadian government. The major impetus was a desire to tie British Columbia to the other provinces and to facilitate development of all of Canada's western provinces. During the last half of the nineteenth century numerous other railroads were established, also with generous amounts of government construction, financing, subsidies, and land grants. By World War I it was clear that the Canadian rail network was severely overexpanded.

After the war the government took over three large privately owned rail systems, which were near bankruptcy, and amalgamated them with the existing Canadian Government Railways. Thus the Canadian National Railways had an inauspicious beginning as a government-owned firm with massive amounts of debt and extensive overlapping facilities.

Prior to World War II Canada's two dominant railroads enjoyed substantial market power and, accordingly, were heavily regulated by the Canadian government. By the 1950s, however, their market power had declined considerably. The railroads found themselves facing stiff competition for freight traffic from highway and waterway carriers, and for passenger traffic from private passenger cars, buses, and airplanes. Under the burden of pervasive economic regulation the railroad industry was unable to respond effectively to the rising competition from the other transport modes, which were essentially unregulated.

During the 1950s the railroads gained limited relief from regulation through provisions allowing them to negotiate "agreed" charges with individual shippers. The movement toward deregulation gained substantial momentum in the early 1960s with the report of the MacPherson Commission, which urged that prices be determined by the competitive market rather than by government regulation. By 1967 most rate regulations had been swept away. The chief impedi-

[5] For further discussion of the Canadian railroad industry, see Purdy (1972) and Heaver and Nelsen (1977).

ment to fully competitive rates was the retention of statutory rates for hauling grain and flour to be exported. Other than statutory grain rates, the railroads are free to set rates between the limits of variable cost and two and one-half times variable cost.[6]

Although Canadian railroads have great leeway in the setting of rates, they do not have complete freedom to adjust their physical plant or the services they offer. There are restrictions on the abandonment of track and on the discontinuation of passenger service. The restrictions on discontinuation of passenger service have not been severe, and it appears that the importance of this mode of transportation will continue its steady decline in Canada. The abandonment of uneconomic trackage is a more difficult issue.

Both the CN and CP have large amounts of lightly used track. The CN appears to have a more severe problem in that it inherited excess trackage from its predecessors. The magnitude of the difference in the situation of the CN and CP is suggested by the fact that ton-miles per mile of track for the CP exceeds the CN figure by approximately 10 percent.[7] Up to 1967 there was a gradual abandonment of branch lines by both railroads. However, by 1967 it became clear that many branch lines in the prairies were uneconomical because of statutory grain rates, which were far below variable costs. As part of the 1967 National Transportation Act which ended rate regulation, thousands of miles of prairie branch lines were protected against abandonment. In the three western provinces of Alberta, Manitoba, and Saskatchewan 9,591 miles of CN track and 8,512 of CP track were protected by the 1967 legislation.[8]

The related problems of statutory grain rates and restrictions on abandonment of prairie branch lines cannot be dismissed lightly. However, the bulk of railroad operations are free from regulatory interference. Furthermore, for present purposes, it is important to note that the grain-hauling problem affects both railroads. If there is any differential impact, it appears likely that the CN is more heavily burdened due to the greater size of its rail network in the prairies, much of which has never been profitable. Other than the possible distorting effects of the enforced uneconomical haulage of grain, we are not aware of any factors which would undermine the validity of a comparison of economic efficiency based on measures of TFP. Both railroads operate coast to coast, serving all major industrial areas. The railroads appear to face similar levels of competition from other transport modes. It appears that neither railroad has an inherent

[6] See Heaver and Nelsen (1977) for further discussion.

[7] E.g., in 1970 CP net ton-miles per track mile were 1.74 million vs. 1.59 million for the CN.

[8] Purdy 1972, p. 264.

advantage in terms of low-cost traffic, but we investigate this possibility below.

Finally, we address the possibility that one of the railroads has a cost advantage due to differential scale economies. The CN is somewhat larger in size than the CP; thus the existence of scale economies would provide the CN with the possibility of lower-cost operation. It seems clear, however, that both railroads are so large that any possible scale economies have been fully exploited by each of them.[9] Therefore, our comparison ought not be affected by the difference in size between the CN and CP.

III. Methodology for Measurement of Total Factor Productivity

Christensen and Jorgenson (1970) proposed the following index of total factor productivity:

$$\ln\left(\mathrm{TFP}_k/\mathrm{TFP}_l\right) = \sum_{i}^{m}\left(\frac{R_{ik}+R_{il}}{2}\right)\ln\left(Y_{ik}/Y_{il}\right) - \sum_{i}^{n}\left(\frac{S_{ik}+S_{il}}{2}\right)\ln\left(X_{ik}/X_{il}\right), \tag{1}$$

where k and l are adjacent time periods, the Y's are output indexes, the X's are input indexes, the R's are output revenue shares, the S's are input cost shares, and the i subscripts denote the individual outputs or inputs. Diewert (1976) has shown that (1) is the exact index procedure which corresponds to a homogeneous translog production or transformation function. Caves and Christensen (1980) have further shown that no restrictions of separability or neutral technological change are implicit in (1).

Caves, Christensen, and Swanson (CCS) (1980) have noted that it is not justifiable to use (1) to measure TFP in the railroad industry. The problem is that the revenue shares in (1) are used as estimates of the elasticities of total cost with respect to the individual outputs. This procedure is satisfactory only if the price of each output is equal to its marginal cost of production. It is widely accepted that prices for railroad services do not reflect marginal costs of production. Thus CCS proposed that railroad TFP measurements make use of estimated output cost elasticities in place of revenue shares:

[9] Griliches (1972) has argued that large U.S. railroads do not have available any unexploited scale economies. Both the CN and the CP are larger than all but a few U.S. railroads.

$$\ln\left(\mathrm{TFP}_k/\mathrm{TFP}_l\right) = \sum_i \left[\tfrac{1}{2}\left(\frac{\partial \ln C}{\partial \ln Y_i}\right)_k + \tfrac{1}{2}\left(\frac{\partial \ln C}{\partial \ln Y_i}\right)_l\right] \ln\left(Y_{ik}/Y_{il}\right) - \sum_i \left(\frac{S_{ik} + S_{il}}{2}\right) \ln\left(X_{ik}/X_{il}\right). \tag{2}$$

We follow CCS in using (2) to compute TFP for the CN and CP. As pointed out by Jorgenson and Nishimizu (1978), formulas such as (1) and (2) can be used to make both time-series and cross-sectional comparisons of TFP. In the case of cross-sectional comparisons, the indexes k and l are interpreted as different firms rather than different time periods. We follow Jorgenson and Nishimizu in choosing a base year (1963) to carry out a comparison of the levels of CN and CP productivity. The growth rates of CN and CP productivity are used to extend the level comparison to earlier and later years.

IV. Productivity Estimates

Our primary productivity estimates distinguish two indexes of railroad output and five indexes of railroad inputs. The two output indexes are freight ton-miles and passenger-miles. The five input indexes are labor, structures (including right-of-way), equipment (including rolling stock), fuel, and materials.

A detailed description of the sources and methods used to develop our data base is contained in Caves and Christensen (1978). We have relied heavily on the annual reports of the CN and CP filed with the Canadian Transport Commission (CTC). The CTC provided us with access to these reports and made available supplementary data which were essential for completion of the study. The annual reports follow the Uniform System of Accounts which was instituted in 1956. Accounting procedures and reporting practices before 1956 were significantly different from those instituted in 1956. Thus, our study is limited to the period from 1956 to 1975, the most recent year for which annual reports were available when our research was being carried out. The major task in the data development involved the estimation of capital input for structures and equipment. The procedures which we have used are very similar to those suggested by Christensen and Jorgenson (1969).

Cost elasticities with respect to output levels are not directly observable. They must be estimated in order to implement our approach to productivity measurement. The most attractive approach to obtaining cost elasticities is the estimation of a multiproduct cost function using cross-section data. There are not enough Canadian railroads to provide data for such estimation; however, CCS (1980) have used cross-section data from the U.S. railroad industry to estimate the structure of rail costs. We have taken the approach of using their estimated equations to infer Canadian cost elasticities. The CCS estimates were developed from cross-section data for 1955, 1963, and 1974.[10] We use their estimated coefficients along with data on CN and CP output levels and input prices to estimate the cost elasticities for ton-miles and passenger-miles for the CN and CP in 1956, 1963, and 1974.[11] The estimated cost elasticities and their standard errors are presented in table 1.[12] The cost elasticities are then interpolated between the cross-section years in order to provide annual weights for the productivity indexes.

We now have all the series required to obtain productivity estimates from (2). We summarize this information in table 1 by presenting figures for 1956, 1963, and 1974.[13] The first three rows of table 1 contain the inputs and outputs of the CN relative to the CP. The next six rows contain the average annual percentage rates of growth of CN and CP inputs and outputs between the cross-section years and over the full sample period. The final six rows contain the cost shares and estimated cost elasticities for the CN and CP for the cross-section years.

Between 1956 and 1963 there was no growth in ton-miles for either the CN or CP, and passenger-miles declined substantially. During this period both railroads were able to make large cuts in their fuel usage. This reflects the rapid replacement of steam locomotives by more fuel-efficient diesel locomotives. Diesel locomotives also required substantially less labor for operation and maintenance, which partially accounts for the decline in total labor input. The major difference

[10] The numbers of firms included in the samples for these years were 58, 56, and 40, respectively. They employed the generalized translog multiproduct cost function, proposed by Caves, Christensen, and Tretheway (1980), to obtain the estimated cost elasticities. This cost function has the same form as the translog multiproduct cost function (Burgess 1974; Brown, Caves, and Christensen 1979) except for output levels, where the Box-Cox metric is substituted for the natural log metric. This generalization permits the inclusion of firms with zero output levels for some products. In railroad applications, it permits the inclusion in the sample of firms with no passenger output.

[11] Although CCS did not compile U.S. cross-section data for 1956, their analysis showed that the formula for the cost elasticity as a function of output and input prices was independent of time. Therefore to estimate 1956 cost elasticities for the CN and CP we have inserted 1956 output levels and input prices for the CN and CP into the estimated 1955 cost-elasticity equation.

[12] The estimated multiproduct cost functions for all 3 years display significant scale economies at low output levels but not at high output levels. Constant returns to scale imply that the freight and passenger cost elasticities must sum to unity. In the region of freight and passenger output levels produced by the CN and the CP, the hypothesis of constant returns to scale cannot be rejected.

[13] The figures for all years are presented in the data appendix of Caves and Christensen (1979), which is available on request from the Social Systems Research Institute, 1180 Observatory Drive, Madison, Wisconsin 53706.

TABLE 1

SUMMARY OF DATA FOR PRODUCTIVITY ESTIMATES

Railroad and Year	Labor	Structures	Equipment	Fuel	Materials	Ton-Miles	Passenger-Miles
	Input and Output Indexes						
CN/CP, 1956	1.33	1.36	1.19	1.35	1.38	1.23	1.06
CN/CP, 1963	1.34	1.80	1.34	1.47	1.51	1.26	1.33
CN/CP, 1974	1.66	1.77	1.73	1.32	1.38	1.28	3.81
	Input and Output Growth Rates (Average Annual %/Year)						
CN, 1956–63	−4.9	3.6	2.0	−19.0	1.2	−.3	−3.1
CN, 1963–74	−1.1	.1	3.3	3.5	1.6	5.5	1.6
CN, 1956–75	−2.6	1.3	3.4	−5.3	1.9	3.0	−.2
CP, 1956–63	−5.1	−.4	.3	−20.2	−.1	−.6	−6.3
CP, 1963–74	−3.0	.3	.9	4.4	2.4	5.4	−8.0
CP, 1956–75	−4.0	.1	.8	−5.2	1.5	2.8	−8.0
	Cost Shares and Estimated Cost Elasticities						
CN, 1956	.584	.067	.094	.088	.167	.769 (.041)	.237 (.022)
CN, 1963	.487	.183	.130	.038	.162	.773 (.040)	.225 (.021)
CN, 1974	.552	.109	.110	.057	.173	.799 (.056)	.222 (.022)
CP, 1956	.540	.096	.140	.078	.146	.760 (.037)	.238 (.022)
CP, 1963	.453	.194	.182	.034	.137	.766 (.036)	.213 (.020)
CP, 1974	.464	.151	.145	.062	.178	.811 (.052)	.159 (.016)

NOTE.—SEs in parentheses.

between the railroads during the 1956–63 period was that the CN stock of structures increased while the CP stock decreased.

After 1963 both railroads experienced large increases in freight traffic. Both railroads also showed increases in inputs of all factors except labor, which continued to decline. The major difference between the railroads in this period was in the growth of passenger service—the CP experienced a large decrease in passenger-miles while the CN experienced a modest increase. However, neither of the figures reflects the large gyrations in passenger traffic after 1963. In 1964 both railroads successfully stimulated additional passenger traffic with discount pricing schemes. For the next few years the CN made an all-out attempt to make a success of their passenger service. The 1967 World's Fair (Expo) in Montreal, which generated large amounts of traffic, marked the end of this era. In 1967 CN passenger-miles were more than twice the 1963 level. Thereafter the CN apparently joined the CP in the belief that there was no possibility of obtaining adequate revenues from passenger service. By 1973 its passenger-miles had declined almost to the 1963 level.[14] Since the ratio of CN to CP passenger output changed so dramatically from 1956 to 1974, the weights which we assign to passenger output in equation (2) take on great importance. In Section V we investigate the sensitivity of our results to the sampling error underlying our estimated cost elasticities.

In the first three columns of table 2 we present our estimates of the growth of CN and CP productivity and their relative levels. Our estimates indicate that between 1956 and 1965 CN productivity was between 80 and 90 percent as high as that of the CP. Both CN and CP productivity was stagnant from 1956 to 1962 but then surged upward in 1963 and 1964. From 1964 to 1968 CN productivity increased rapidly while CP productivity again stagnated. In this 4-year period CN productivity rose, relative to CP productivity, from 0.85 to 1.12. From 1968 through 1975 the CP's productivity growth exceeded that of the CN. At the end of the period we find CN productivity slightly below that of the CP.

V. Robustness of the Output Indexes and Cost Elasticities

The output indexes and cost elasticities used in computing our productivity estimates are both open to criticism. The problem with the cost elasticities is that they are based on econometric estimates and

[14] See Purdy (1972) for further discussion of the approaches taken by the CN and CP to the provision of passenger service.

TABLE 2

PRODUCTIVITY GROWTH AND LEVEL COMPARISONS FOR THE CN AND CP

YEAR	Primary Productivity Estimates			First Alternative Productivity Estimates (Four Output Indexes)			Second Alternative Productivity Estimates (Quality-adjusted Ton-Miles and Passenger-Miles)		
	Annual Growth Rate		CN Relative to CP	Annual Growth Rate		CN Relative to CP	Annual Growth Rate		CN Relative to CP
	CN	CP		CN	CP		CN	CP	
1956	. . .	. . .	.87	. . .	. . .	.88	. . .	. . .	.88
1957	−7.6	−2.2	.82	−7.6	−2.7	.84	−7.6	−2.2	.83
1958	−.2	1.2	.81	−.7	.8	.82	−1.2	−1.8	.84
1959	3.2	−.8	.84	3.3	−.0	.85	4.3	2.7	.85
1960	.3	3.2	.82	.2	3.1	.83	1.5	3.6	.83
1961	.9	2.4	.81	.8	2.5	.81	−.4	.6	.82
1962	4.5	−.2	.85	4.6	−.3	.85	4.5	2.9	.84

1963	12.3	8.7	.88	12.1	8.3	.89	13.2	5.1	.91
1964	12.8	16.0	.85	12.8	15.7	.86	11.0	13.2	.89
1965	4.4	−1.9	.91	4.8	−1.5	.92	8.5	3.7	.93
1966	8.6	.3	.98	8.1	.5	.99	9.5	−3.3	1.06
1967	3.6	−3.3	1.05	3.5	−3.2	1.06	4.7	.6	1.10
1968	4.4	−1.3	1.12	4.3	−1.3	1.12	7.4	2.7	1.16
1969	.2	3.0	1.09	−.1	2.5	1.09	.2	3.0	1.12
1970	7.7	9.0	1.07	7.3	9.5	1.07	7.8	9.2	1.11
1971	6.1	4.0	1.09	5.6	3.8	1.09	1.5	6.0	1.06
1972	1.5	5.8	1.05	1.5	5.9	1.04	5.0	4.3	1.07
1973	−3.0	.9	1.01	−2.7	1.2	1.00	−2.3	−.6	1.05
1974	2.2	3.8	.99	2.1	3.6	.99	1.1	4.3	1.02
1975	−2.6	−2.0	.99	−3.8	−2.1	.97	.1	−4.9	1.07
	Average Annual Growth Rates								
1956–63	1.9	1.7	.2	1.8	1.7	.1	2.0	1.6	.5
1963–74	4.4	3.3	1.1	4.3	3.3	1.0	4.9	3.9	1.0
1956–75	3.1	2.5	.7	2.9	2.4	.5	3.6	2.6	1.0

TABLE 3

ESTIMATED PERCENTAGES BY WHICH CP PRODUCTIVITY EXCEEDED CN PRODUCTIVITY, WITH SEs (in Parentheses) REFLECTING IMPRECISION OF THE COST ELASTICITIES

Year	Primary Productivity Estimates	First Alternative Productivity Estimates (Four Output Indexes)
1956	14.4 (.7)	13.0 (1.8)
1963	13.0 (.7)	11.9 (1.5)
1974	.9 (2.1)	1.2 (3.0)

therefore are subject to imprecision. The problem with the output indexes is that biases may result from the use of ton-miles and passenger-miles to represent a large number of heterogeneous outputs. The purpose of this section is to assess the sensitivity of our productivity estimates to these problems.

To investigate the imprecision in the cost elasticities, we have computed the covariance matrix of the estimated cost elasticities for the 3 cross-section years. The resulting standard errors for the cost elasticities, shown in table 1, indicate that the imprecision in the elasticity estimates is not large. The implication of this imprecision for our TFP comparison can be assessed by using the estimated covariance matrix to compute the variance of (2) for each of the cross-section years. The resulting standard errors are shown in table 3 along with the logarithmic difference between CN and CP productivity (both in percentage terms). These figures indicate that CN productivity was significantly lower than CP productivity in 1956 and 1963, but the difference between the CN and CP was not significant in 1974.

Our estimates of the growth of productivity are biased if there have been shifts in the composition of output toward (or away from) traffic which is less costly to carry. Similarly, our estimates of the relative level of CN and CP productivity are biased if one of the railroads carries a higher proportion of low-cost traffic. Two of the most important factors which may cause variation in the cost of providing freight service are the length of the haul and the type of commodity being carried. It is often asserted that shipments involving long hauls or consisting of bulk commodities can be carried at lower cost per mile than shipments which involve short hauls or finished goods. This assertion arises from the fact that terminal costs are an important component of total freight costs. Bulk commodities typically require less handling than finished goods, and equipment can often be specially designed to facilitate the handling of bulk commodities. These features tend to lower the cost of handling bulk commodities relative to finished goods. Within any commodity type, handling costs per mile decline as length of haul increases. The costs of passenger service may also differ with the degree of comfort and service being provided and with the length of the passenger's trip.

We use two approaches to assess the sensitivity of our findings to output heterogeneity. First, we follow CCS and reestimate the cost functions with two additional output indexes—average length of haul for ton-miles and average length of trip for passenger-miles. Second, we distinguish two categories of passenger-miles and 28 categories of ton-miles. We use these breakdowns to compute "weighted" passenger-miles and ton-miles indexes, which reflect differences in the composition of output between the railroads and across time.

Using the reestimated cost function we compute our first set of alternative productivity estimates. These estimates are based on (2) expanded to include four output indexes and the corresponding cost elasticities. The results are presented in the middle three columns of table 2. We find that our estimates of the ratio of CN to CP productivity are very similar to those found in our primary productivity estimates.

For these estimates we repeat the computation of standard errors of the difference in productivity levels—based on the estimated cost functions with four output indexes. The standard errors are presented in table 3. They are somewhat larger than the standard errors from the primary estimates, due to the presence of additional regressors in the cost functions. Nonetheless, the conclusions from the primary estimates are unchanged—the CN had significantly lower productivity early in the period, but there was no significant difference later in the period.

In our first set of alternative productivity estimates we have accounted for output heterogeneity arising from different lengths of freight haul and passenger trip. However, this treatment accounts for differences in commodity composition only insofar as different commodities are associated with different lengths of haul. Unfortunately, there are no published data either for Canadian or U.S. railroads in which ton-miles are cross-classified by commodity type and length of haul. The only hope of shedding light on the importance of differences in commodity composition rests with the 1 percent waybill sample provided by the CTC. We have serious doubts as to the reliability of estimates based on this waybill sample.[15] Nonetheless, we believe that the question of commodity composition is important

[15] A description of the waybill sample and a statement of traffic covered by the sample are included in Canadian Transport Commission (1975). Two of the most serious flaws of the waybill sample are that the waybills are unaudited and that the sample is systematic rather than random. Additional flaws are the lack of data for 2 years, 1956 and 1969, and the fact that the categories differ somewhat for the 1957–68 and 1970–75 periods.

enough to warrant its examination via the waybill sample. The results obtained from these data should not be treated as precise. They should rather be viewed as providing an indication of the seriousness of the problem of output heterogeneity in our comparison.

With the waybill data we are able to distinguish ton-miles by seven commodity groups and four mileage bands. The total ton-mile figures from the waybill sample are not as reliable as the total ton-mile figures from the railroads' annual reports. Thus we use the latter figures for total ton-miles and the waybill sample figures for estimates of the proportions of total ton-miles falling in the various categories. We have not been able to obtain any data on the marginal cost of ton-miles in the various categories. It is necessary to use revenue figures as crude estimates of the appropriate cost figures. The waybill sample contains data on revenue per ton-mile for each of our categories. We have used these figures to compute the weights to aggregate the ton-mile categories.[16]

The only data available on passenger output for the 1956–62 period are total passenger-miles. From 1963 to 1975, data are available for two categories of passenger-miles—commuter and line-haul service. We have no information on the relative cost of commuter and line-haul service. Thus for the 1963–75 period we construct an index of passenger output using revenue shares as weights.

Using the weighted indexes of ton-miles and passenger-miles, we compute our second set of alternative estimates of productivity, which are presented in the final three columns of table 2.[17] The principal difference from the primary estimates is that both CN and CP productivity are found to grow considerably faster in the 1963–75 period. This is somewhat surprising since the conventional wisdom is that the average length of haul has increased and the commodity composition has shifted toward low-cost bulk commodities. The average length of haul has increased, but the waybill data indicate that there has not been a movement away from traffic in high-cost manufactured goods. On the contrary, for both railroads the commodity class that includes end products and manufactured goods grew at more than twice the rate for total ton-miles over the 1956–75 period.

Using weighted ton-miles and passenger-miles, the average annual rate of growth of CN productivity, 1956–75, is increased from 3.1 to 3.6 percent, while the CP rate is increased from 2.5 to 2.6 percent. The

[16] The revenue for statutory grain clearly does not reflect marginal cost. The Commission on the Costs of Transporting Grain by Rail (Snavely 1976) estimated that the cost per ton-mile was 1.3¢ in 1974. We have used this figure, adjusted over time to reflect inflation, rather than revenue.

[17] We do not have estimates of weighted ton-miles and passenger-miles for our cross-section data sets. Thus we do not have estimates of the cost elasticities which are specific to these alternative output estimates. We employ the cost elasticities based on unweighted ton-miles and passenger-miles as the best estimates available.

result is that CN productivity is somewhat above CP productivity at the end of the period rather than slightly below—as indicated by the primary estimates. However, for the last cross-section year (1974) all three sets of productivity estimates indicate very little difference between the levels of CN and CP productivity.

We conclude that our findings on the relative productivity levels of the CN and CP are not sensitive to the problems of measurement of output indexes and cost elasticities. We have presented two alternative sets of productivity estimates, which yield the same conclusion as our primary estimates: The CN had a significantly lower level of productivity than the CP in the late 1950s and early 1960s. However, this gap was closed in the late 1960s, and there is no evidence of a significant difference in their levels of productivity in the mid-1970s.

VI. Robustness of the Productivity Conclusion to Alternative Cost Elasticities

The cross-section estimates of CCS provide cost elasticities with small standard errors. There remains some question, however, as to whether these cost elasticities estimated from U.S. data are directly applicable to Canadian railroads. Although we cannot answer this question from Canadian data, we can investigate how different the Canadian cost elasticities would have to be to overturn our conclusion that CN productivity has grown more rapidly than CP productivity.

We carry out this investigation by abstracting from the year-to-year variation in the cost elasticities and assuming that constant freight and passenger cost elasticities are applicable to the CN and CP. As our point of reference we average the elasticities over the CN and CP and over the 19 years; this yields 0.80 for freight and 0.20 for passengers. Using these fixed elasticities we can recompute the productivity growth series for the CN and CP. The difference between the average growth rates turns out to be 0.73 percent per year; this is very close to 0.68 percent per year—the difference we estimated using railroad-specific annual elasticities.

We now compute the cost elasticities, which imply equal average growth rates of productivity for the CN and CP, 1956–75. We obtain a passenger-cost elasticity of 0.10 and a freight-cost elasticity of 0.90. Thus, even with a passenger-cost elasticity only one-half as large as that of similar U.S. railroads, we would still conclude that CN productivity growth has been no less than CP productivity growth.

VII. Concluding Remarks

The Canadian experience with public ownership of a major railroad arose out of practical considerations early in the twentieth century. At that time public ownership was viewed as necessary to avert the repercussions which would have followed the bankruptcy of several railroads. The ownership arrangement which evolved was unusual in that the role of the government was restricted to that of stockholder. Not only was the CN instructed to operate on a commercial basis under a management insulated from politics, it was also placed in direct competition with both the privately owned railroads and with highway and water transport. Throughout this century the trend in Canadian transportation regulation has been to further encourage competition among suppliers of transportation services, and the publicly owned CN has not been sheltered from this competition.

Both the CN and CP have performed well in the competitive market for transportation services. Over the past 2 decades total factor productivity has increased at a rapid rate for both the CN and CP.[18] Comparing the productivity levels of the CN and CP, we found that although the CN had a lower level of total factor productivity at the beginning of the period it had caught up with the CP by 1967; thereafter the CN record of productivity growth was approximately equal to that of the CP.

The Canadian experience has important implications for the study of the effect of ownership on economic performance. Previous studies in this area have concentrated upon the effect of public ownership in a noncompetitive environment. These results have generally supported the view that the lack of incentives associated with public ownership has resulted in poor performance relative to private firms. The Canadian experience provides an opportunity to assess the impact of competition in offsetting the negative aspects of public ownership. Our results indicate that the impact of competition can be substantial.

Our principal conclusion is that public ownership is not inherently less efficient than private ownership—that the oft-noted inefficiency of government enterprises stems from their isolation from effective competition rather than their public ownership per se. Of course our findings do not provide any evidence in favor of public ownership over private ownership. There may be criteria other than productive efficiency which provide the basis for preferring either public or private ownership, but that is another question.

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[18] Productivity growth for the CN and CP has been approximately twice as fast as for U.S. railroads (see Caves, Christensen, and Swanson 1980). Furthermore, the productivity growth rates achieved by the CN and CP are higher than those achieved by virtually all other U.S. industries (see Gollop and Jorgenson 1977).

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