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RAIL COST-DISTANCE RELATIONSHIPS AND THE CROW RATE TAPER

by

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"The effect of distance on haulage costs is apparently one of the simpler elements in rate-making, yet the more one examines it, the less simple it does become.

---- J.M. Clark, 1923 ----

1.0 Introduction

The changes to the statutory rail rates on grain (the so called "Crow Rates", from the Crow's Nest Pass Agreement of 1897) by the Western Grain Transportation Act (WGTA) of 1983 was a major event in the evolution of Canadian transportation policy. The WGTA ammended a rate level which had been in existence since the last century. Adjusting statutory rates on grain from a nineteenth century to a modern level poses significant problems.

The leap is great. In 1897, gràin for export moved only to the Great Lakes and from a limited number of points on the Prairies. Rail technology was vastly different from that in existence today. A train operating on the Prairies at the turn of the century might have been composed of cars and freight weighing 800 tons. Today, three or more 3,000 H.P. locomotives may pull 14,000 tonnes of grain. It was this contrast in operating and cost conditions that led to our interest in cost and rate distance gradients.

It is to be expected that adjusting the rates from nineteenth century to current conditions would require a considerable increase in the level of rates. Other changes that might be required in the structure of rates are not so obvious. The purpose of this paper is to explore some other changes that might be required, in particular, to raise questions about the change in rates with distance.

The approach taken in this paper is to examine basic hypotheses about the general pattern of change of railway costs and rates over the last century, especially as they relate to distance travelled. Two specific hypotheses are put forward and these lead to a third:

1. real railway linehaul costs per ton mile have decreased on hauls of a given distance;

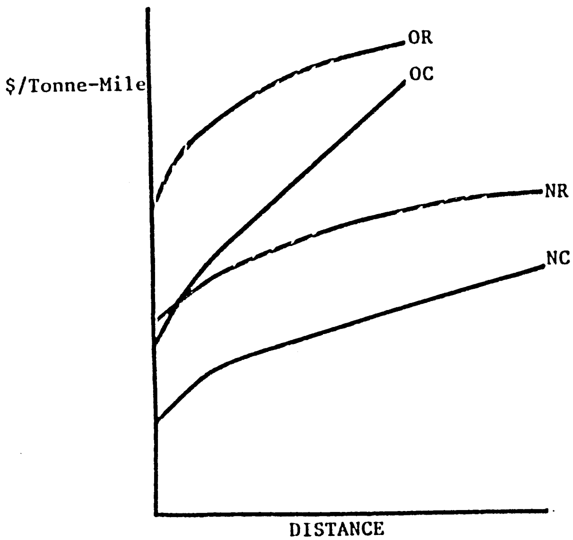
2. the general slope in railway rates with distance is responsive in the long run to the distance gradient in costs;

3. from 1 and 2, it is hypothesized that simply increasing the level of statutory rates by a uniform percentage to a level covering current costs in total may not be appropriate; this amounts to extrapolating a nineteenth century distance relationship to the late 20th century.

The hypotheses may be illustrated by a simple diagram. Figure 1 illustrates the reduced gradient in costs over time in real dollars; current costs (NC) have a lower slope than old costs (OC). This allows the gradient in rates to be less in real terms today (NR) than it was formerly (OR). (No precise expectations are implied by the position of the rate gradients relative to the cost gradients.)

FIGURE 1

RAIL COST AND RATE GRADIENTS



However, the effect of inflation on the cost and rate gradients may be noted, also. If inflation takes place, the cost function expressed in current (nominal) dollars shifts up proportionately by the amount of inflation. This affects the gradients expressed in current dollars. Assuming for the moment that rates reflect costs exactly, the more distant shippers would face the same proportionate increase in nominal rates as short distance shippers, but this represents a larger absolute increase in the rate paid by the latter.

It is important, then, that this inflation-induced rate increase for long-haul shippers be based on the appropriate cost (rate) gradient. If our hypotheses are correct, an excessive gradient would result from "inflating" the Crow rates (exemplified by OR) without a downward adjustment in the gradient to reflect the technological changes underlying the reduced real gradients (NR and NC).

The hypotheses are examined in the following sections. The first elaborates on rail cost-distance relationships and how they have changed over the years. The second section focuses on the relevance of costs for rate-distance relationships. The next section examines the rate-distance relationships for the old and new Crow rates, and makes comparisons of how these rate-distance relationships compare with selected other rate and cost comparisons. The paper concludes by presenting the implications of the analysis for the current review of statutory rates and for future research.

2.0 Rail Costs and Distance

This paper does not dwell on the inherent conplexities of railway costing or with the rationale for the different approaches to costing taken at different times. We recognize that the separation of the costs of railway service into distance and non-distance components related is fraught with difficulty. Some costs clearly do vary directly with distance -- fuel costs are an example. But there are more subtle cost influences of distance. For example, longer distances entail longer travel time; ceteris paribus, this necessitates a larger car fleet and larger yard investments. Yet the latter would not normally be directly identified as a distance-related cost item. Another example is that there are tradeoffs between distance and "non-distance" costs. Running longer and heavier trains may economize on linehaul costs per ton, but this requires greater expenditures on yards and related costs. Further, we recognize that there is debate about the validity of the proposition that railway costs are linear with distance beyond short-haul movements.

The reductions in the real cost of line haul service by the railways since the 1890's is to be expected because of the substantial technological change that has taken place. Three elements are of particular importance. First, the increase of traffic density, as measured by ton miles per route mile. The importance of traffic density for cost levels was recognized as early as 1916 by Lorenz. Second, trains of greater size have been enabled both by the increase of traffic volumes and by technological innovations. Third, technological innovation has greatly increased the potential weight and speed of trains, thereby increasing output per unit of energy and labour needed.

Demonstration of the effects of these changes on costs is not easy. It depends on the information in the costing literature. Detailed examination of past cost estimates and costing studies is beyond the scope of this paper. Studies have used varied methods and different data bases. Appendix A draws on some historical studies of rail costs related to distance. However, it has not been possible to produce precise estimates of the change in real costs of distance over time. The average costs per ton mile of rail transport have clearly fallen through most of the twentieth century, but we are unable to separate the extent to which the falling average costs can be attributed to changes in the average length of haul as distinguished from changes in traffic density and rail technology.

3.0 Rail Rates and Cost-Distance Relationships

It is well known that rate making involves more than cost considerations. Cost measurement itself is ambiguous, not like the precise formula portrayed in Exhibit 1. Agreement on cost formulae for rate making purposes is contentious at best. More important, railway rate making makes extensive use of value of service considerations. This is not only a reflection of the goals of a profit-oriented enterprise; value of service pricing is recognized as an economically efficient pricing mechanism where unallocable costs must be recouped from a number of customers.

Nonetheless, costs are a consideration in rate making and especially, cost changes frequently are cited in making adjustments to an established scale of rates. Therefore, as cost-distance relationships change over time, one would expect this to influence rate distance relationships.

The cost-distance relationship is shown as a constant slope in Figure 1 whereas the rates embody some taper with increasing distance. Although there are some limited cost arguments which can be invoked to explain a rate taper with distance, it more likely reflects some value-of-service elements. Shippers distant from a market are likely to face competition from intermediate suppliers and are not able to bear freight charges as readily as less distant shippers. Figure 1 is representative of a general relationship among costs and rates, but this could differ depending on particular circumstances.

Is there evidence of a link between changing cost-distance relationships and rate adjustments? A review of historical literature on railway rate making and regulation supports suggests that there was. It is well known that railway rates in the late nineteenth and early twentieth centuries often were quite unrelated to costs. This is because very little was known about costs and costing techniques. But it is clear that as knowlege of rail costs increased, costs became examined in rate cases in both Canada and the United States. As more was learned about costs, and as transportation costs declined over time, cost considerations appear to have been given greater emphasis in regulatory matters.

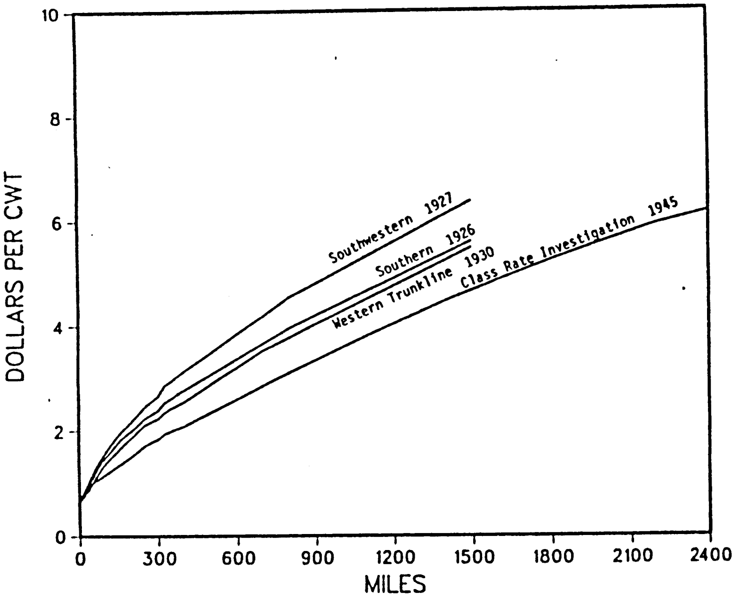
One illustration of the influence of changing cost-distance relationships and rail rate structures is shown in Figure 2. The changes in Class rate structures in the U.S. grew out of sequential investigations by the ICC. When restated in constant dollars Figure 2 shows a tendency for the rate distance gradients to be falling over time reflecting on-going cost investigations by the ICC.

4.0 The Crow Rates and Distance

The WGTA brought about fundamental changes to the statutory grain rates, changes which are still coming about. At the present time, individual grain producers still pay rates well below the true costs of moving grain. Some grain may move at fully compensatory rates (traffic in excess of base tonnage), but these higher freight charges are averaged over all grain producers. There are many points which can still be debated about the level of the Crow rates, the method of payment, and other potential changes to grain handling and transportation in Canada. Here we limit our attention to how the Crow rate changes with distance. The analysis does not deal with the level of the rates which has determined the overall profitability of grain traffic.

The old Crow rate gradient had an unusual shape. The slope increased beyond about 1,200 miles. The increase per mile in the rate for distances between 210 and 1,251 miles was .269 cents. The increase in the rate between 1,251 and 2,200 miles was .464 cents. This is not consistent with our expectation about the slope of either cost or rate gradients. Further, the slope for the distances

FIGURE 2
EARLY ICC DISTANCE SCALES
(1958 constant dollars)



SOURCE:

Class Rate Scales from Various Interstate Commerce Commission Reports:

113 ICC 207 1926
234 ICC 477 1927
164 ICC 249 1930
262 ICC 699 1945

up to 1,200 miles is surprisingly low in relation to our general understanding of railway costs at the turn of the century and in relation to the average cost per mile for 1,900 estimated in Appendix 1. It is interesting that the gradient in the rate beyond 1,200 miles is slightly higher than that estimated cost.

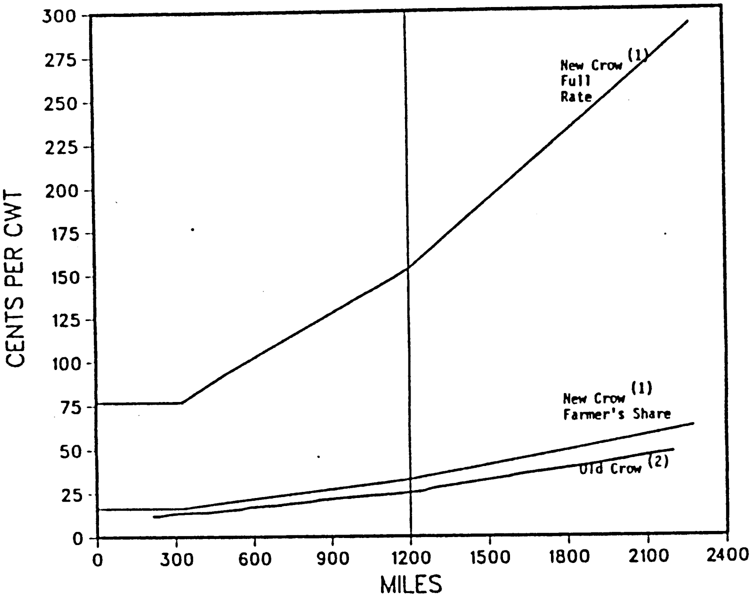
Figure 3 plots the old Crow rate along with the "New Crow" rate which is intended to be a fully compensatory rate. The latter rate is obtained by inflating the "Old Crow" rate schedule by the multiple of total rail costs relative to revenues paid by the shippers. It presumes that it is appropriate to recover the difference between the revenue at the old Crow rates and the current rail costs by increasing the historical rate gradient by a proportionate amount.

A few caveats should be noted about the plot of the Crow rate schedule. The vast majority of grain shipments take place only on a limited portion of the rate schedule. For example, nearly all grain is shipped over 600 miles. Further, very little grain moves in the region above 1,200 miles (the portion of the rate formula with a steeper gradient). There are also special adjustments to rates such as recording the longer CN distance to Vancouver rather than the CP distance, and that grain shipped to a more distant port will pay a rate as though it was shipped to a closer port. But these and other details are not critical to the interest of this paper which is on the general distance relationships. The general point is that inflating the Crow level by a proportionate increase basically keeps this historical cost-distance gradient but changes it to current dollars. Of particular interest to us is the appropriateness of keeping the historical distance gradient and simply inflating it to current conditions. Concern was expressed by the Inquiry on Crow Benefit Payment that such an increase could pose special burdens on the more distant shippers.

Figure 4 plots the Old and New Crow rates in comparison with a few rate and cost curves. Included are an estimate from Ming and Tolliver of the cost of moving U.S. grain to Duluth and to Portland using the U.S. Uniform Rail Cost System, and an estimate of the cost of moving Canadian domestic and export canola from the Report of the Task Force on Rates. The rate gradients for grain, flax and canola, and for fertilizer are obtained from the latter source also.

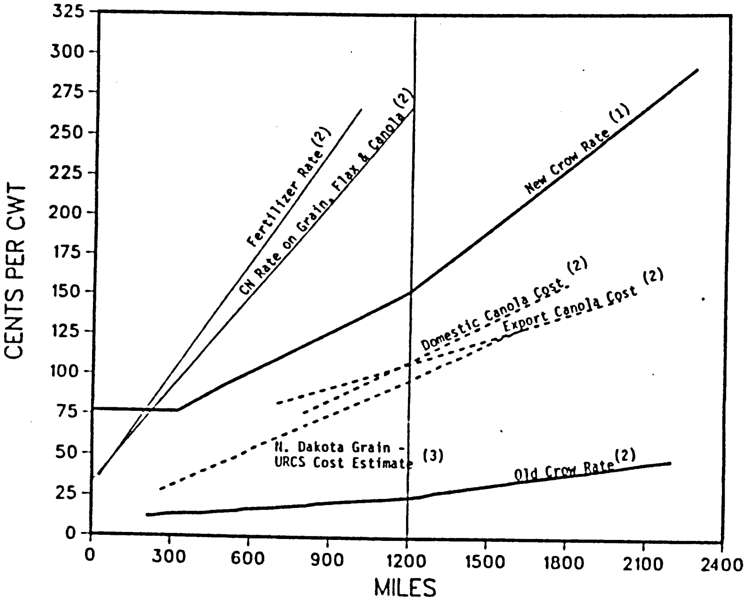
Contrary to our hypothesis the distance gradient of the escalated Crow Rate is not out of line with other rates and costs which are plotted. This is corroborated by interviews with railway officials who maintain that the distance relationship indicated is at least broadly in

FIGURE 3
COMPARISON OF CROW RATE



SOURCES:
(1) The Western Producer, May 16, 1985.
(2) TRANSPORT CANADA, REPORT OF THE TASK FORCE ON RATES, Nov. 1982, ENCLOSURE 3.

FIGURE 4
COMPARISON OF RECENT RATE AND COST DISTANCE TAPERS



SOURCES:

(1) The Western Producer, May 16, 1985.

(2) TRANSPORT CANADA, REPORT OF THE TASK FORCE ON RATES, Nov. 1982, ENCLOSURE 3.

(3) Ming and Tolliver, "AN ANALYSIS OF RAIL RATES FOR GRAIN IN NORTH DAKOTA: An Alternative to the Crow's Nest Pass Rates?" in 1984 CTRF Proceedings pp 9-22.

line with their cost experience. But if escalating the distance gradient in the obsolete Crow rate is not out of line with other current rates and costs, what does this imply about the historical cost-distance relationship embodied in the original Crow rate? Given the real decline in rail cost-distance relationships during the twentieth century, this suggests that the rate-distance relationship embodied in the original Crow rates must have been quite out of line with the cost conditions of the time.

We have not had the oportunity to research adequately the development of the rates on grain prior to 1897. However, it is known that railway rates on grain were kept at a low level to encourage the spread of settlement based largely on the export of grain. There was an incentive, therefore, to keep the penalty of distance to a low level. Also, of course, the rate scale used now for west and eastbound movement, was applicable only to relatively few points and to the lower cost eastbound traffic.

Whatever the explanation for the origin of the rate-distance taper embodied in the Crow rate, it appears to have been a distance relationship quite out of line with cost conditions of the time. This leads to a somewhat paradoxical conclusion about the economic distortions engendered by the freezing the rate for most of the twentieth century and inflating them proportionately today.

5.0 Conclusion

There has been extensive discussion and analysis of the inefficiences and distortions in resource allocation caused by the rigidity of the Crow rates in the face of changing technology and market conditions. Most attention has focused on the level of rates whereas this paper addresses the change in the rate with distance.

The constancy of the Crow rate schedule over time despite changes in general price levels gave rise to economic distortions. As nominal costs and prices rose but the Crow rate remained fixed, both the general rate level and the charge for distance did not keep pace with inflation. But it appears that the rate-distance relationship embodied in the Crow rate schedule became less distorted over time, whereas the rate level became increasingly distorted.

The historical distance gradient in the Crow rate seems too flat to have reflected rail cost conditions at the time. But over time, the real costs of distance have fallen, making the distance differential of rates (expressed in 1897 dollars) more reflective of new cost conditions. An across the board adjustment to bring the rates to a compensatory level produces a rate-distance gradient quite similar to other modern rate and cost estimates.

An unusual feature of the Crow rate gradient is the "kink" at about 1,200 miles so that the distance gradient is greater for long than for short hauls. While little traffic moves beyond 1,200 miles now, the pattern is not consistent with cost characteristics. As the rates are revised over time this "kink" will become more significant. It is a matter that should be addressed and dealt with now rather than left to become critical. We do not know whether the rate gradient for hauls beyond 1,200 miles already exceeds the gradient in cost, but it could do so.

Two final caveats should be restated. First, our observations are impressionistic rather than precise. Although we have reviewed the early literature on rail costs and rate making, we cannot offer definitive proof in support of our analysis. The second caveat is a reminder that, while cost-distance relationships do influence rate-distance ones, costs are not the sole consideration in devising a rate formula. While we expect cost considerations to be the dominant influence on amending the Crow rate schedules to facilitate a more efficient grain transportation system, there is a role for value-of-service considerations. It is appropriate to allow some flexibility in devising rates applicable to the shippers most distant from a market to reflect the burden of higher absolute rate levels.

Appendix A

Table A-1 provides an estimate of U.S. line-haul cost per mile in constant (1972) and nominal dollars for various years, 1900-1978. These estimates are constructed by taking the operating expenses per net ton mile for the aggregate of all Class I railroads multiplied by a distance factor. The distance factors are engineering estimates of the extent to which operating expenses were affected by a change in distance (for example, maintenance of way and structures, maintenance of equipment, transportation, etc.). For 1900-1920 use was made of Wellington's 1915 estimates. For 1930-1960, Hay's 1953 estimate was used. Hay's 1982 estimates were applied to 1970 and 1978. Note that over time there has been a decline in these percentage estimates. This is evidence of a relative decline in line-haul costs.

The estimates of real line-haul cost per mile in Table A-1 indicate a pattern of falling costs with the exception of 1978 which reflects the substantial increase in fuel costs. The affects of inflation are noticeable

Table A-1
Estimate of Line-Haul Cost Per Mile
1900-1978

Year	Op. Costs	Distance	Line Haul Cost Per Mile 1972 (Constant)	Line Haul Cost Per Mile (Nominal $)
1900	.0431	.63	.0272	.0043
1910	.0388	.63	.0246	.0047
1920	.0340	.63	.0214	.0091
1930	.0327	.5856	.0192	.0061
1940	.0285	.5856	.0168	.0049
1950	.0226	.5856	.0132	.0071
1960	.0194	.5856	.0114	.0078
1970	.0139	.5045	.007	.0064
1978	.0165	.5045	.0083	.0125

Notes:
1. Operating expenses per net ton mile; derived from "Transportation Statistics in the U.S.", ICC -- Bureau of Accounts. Real dollar figures derived using GNP deflator used in Gordon, "Macroeconomics".

2. Distance Factors represent the percentage of operating expenses which vary with distance. For 1900-1920 use was made of Wellington, 1915; 1930-1960; Hay, 1953; and 1970-1978: Hay, 1982.

3. Product of column 2 times column 3.

when comparing the constant and nominal line-haul costs.

To illustrate, in 1900, the average operating cost per net ton mile for U.S. railways was 0.68 cents on an average haul of 132 miles. Applying the percentage applicable to line-haul operation yields a line-haul cost per mile of .43 cents (nominal dollars). For 1978, the comparable figure is 1.25 cents. When put in constant dollar terms (using a GNP deflator, 1972=100), the line-haul costs per mile for 1900 and 1978 are 2.72 and .83 cents respectively.

References

Clark, J.M. Studies in the Economics of Overhead Costs, Chicago: Univ. of Chicago Press, Fifth Edition, 1933.

Gordon, Robert, Macroeconomics, 2nd Edition, Boston: Little, Brown and Co., 1981.

Hay, William W., Railroad Engineering, New York: John Wiley and Sons Inc., 1953, 1982.

Interstate Commerce Commission, Bureau of Accounts, "Transportation Statistics in the U.S.", Wash. D.C., 1978.

Lorenz, M.O., "Cost and Value of Service in Railroad Rate-Making", 30 Quarterly Journal of Economics, 205 (1916).

Ming, D.R., and D.D. Tolliver, "An Analysis of Rail Rates for Grain in North Dakota: An Alternative to the Crow's Nest Pass Rates?", in Canadian Transportation Research Forum, 19th Annual Meeting Proceedings, May, 1984.

Report of the Task Force on Rates, Ottawa: Transport Canada, 1982.

Willington, A.M., The Economic Theory of the Location of Railways, London: John Wiley and Sons, Inc., 1915.