THE ADOPTION AND USE OF THE UNIFORM RAILROAD COSTING SYSTEM: EX PARTE 431

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I. OVERVIEW

The following comments are directed towards possible future refinements in the Uniform Railroad Costing System. The comments focus specifically on two major areas of concern: (1) the estimation of running crew wages and (2) the specification of maintenance of roadway models. In both instances, the comments point-out potential alternatives to the proposed cost models which may provide more specific or detailed estimations of railroad cost.

Considerations in the Estimation of Cost

The bottom line in railroad cost estimation is to define and quantify costs which are relevant to individual end uses. Ideally, the cost estimation system should be tailored towards the specific uses to which the data are put. The system should specify the conditions under which the estimated cost-output relationships are realistic and will remain valid and, where possible, allow for estimation techniques which reflect the different and specific conditions under which railroad services are produced.

The end uses to which the cost data will be put, in this instance, are in the regulation and/or administration of joint line surcharges and the determination of jurisdictional threshold issues. In both cases, the eventual application of the unit costs produced by the formula will be towards the estimation of costs for specific classes of traffic or costs for particular sections of a carrier's system.

Thus, in general, a costing system is desirable which would identify and account for the dominant characteristics of railroad subsystems, in terms of traffic and operating characteristics, as well as for the different classes of service which are provided. These comments point-out two primary areas where, using existing data, more specific and relevant cost models might be developed -- models which speak more directly to the individual end uses of the formula. First, an alternative model for running crew wages is examined. Here, a different specification is presented which allows for operating and locomotive differences between unit, through and way trains which affect crew wage differentials. Secondly, maintenance of roadway models are examined and alternative specifications are presented which introduce values for various subsystems or categories of track density.

II. Running Crew Wages

The postulated URCS model for running crew wages incorporates two explanatory output variables and a capacity variable. The model takes the form of:

(2.1) RW = f(MR, TM, THW)

where:

RW = running wage cluster: account 402, engine crews, and account 403, train crews

TM = total train miles of output: Form OS-A, Line 7

THW = train hours way switching: Form OS-A, Line 130

MR = miles of road: Schedule 700, Column 10

In postulating this model, an implicit assumption has been made regarding one of the output variables; an assumption which restricts the model. It is assumed, although not stated, that the explanatory variable TM is an homogenous unit of output. One train mile in any classification of train, in other words, is the same as any other. The inclusion of a train switching variable (THW) is designed to account for differences in train classifications; the hypothesis being, as the Commission stated, that:

> ...the major difference in wages per mile (between types of train) is dependent upon the amount of switching service performed by each train type. Once the switching expense is transferred from line-haul to switching services, the cost per train mile is approximately equal for train types.[1]

This hypothesis, while seemingly logical on the surface, has not been tested empirically. The hypothesis, (that there is no difference between train classes with regard to crew wages when controlling for the time spent train switching) was apparently, in the words of the Commission, based on a procedural understanding of the manner in which crews are paid. To quote the Commission again:

> Our examination of the data and procedures by which crews are paid indicates that the major difference in wages per train mile is dependent upon the amount of switching service performed by each train type.[2]

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[1] Bureau of Accounts, Interstate Commerce Commission, 1980 Rail Cost Study, Washington, D.C., December, 1982, p. 1-9.

[2] Ibid.

However, in previous rule-makings, the Commission had noted that:

> Unit trains....typically exceed normal train lengths but also have more or heavier locomotives than would be assigned to the average through train. Because of the formula upon which engine and train crew compensation are based, these differences can be reflected in the wage costs of the train.[3]

Intuitively, this is logical as crews are paid in relation to weight on drivers and on a combination time-and-mileage basis. In addition to the weight of the locomotive consist, there may be certain aspects of train speed which are reflected in crew wage differentials. The postulated URCS models (Exhibit One) assume that the only difference in speed between types of trains is the proportion of time spent train switching. However, it appears more likely that way trains in particular operate over lower classes of track (based on Federal Railroad Administration operating and safety standards, for example) than do typical through or unit trains. The average running speed limit on these tracks will generally be lower because of track design. Slow order restrictions, in addition, may impede the running speed of way trains. These factors, taken together, can clearly affect the average miles accrued to train crews per hour or day.

The suggestion expressed here, in short, is that there may be additional operating and cost factors other than time spent way switching which impact cost differentials between train classifications. This hypothesis is tested empirically in the following paragraphs.

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[3] Interstate Commerce Commission, Class I Railroads, Adopting A Cost Center Accounting and Reporting System, Notice of Proposed Rule-Making, Federal Register, Volume 44, No. 211, Tuesday, October 30, 1979.

EXHIBIT ONE: REGRESSION SUMMARY TABLE: 1980 RAIL COST STUDY.

Regression Number and Year	Coefficient for	t Statistic	Coefficient for	t Statistic	Coefficient for	t Statistic	R2	Percent Variable
EQUATION NO. 1: $\frac{Y}{\sqrt{MR}} = a \cdot MR^{.3} + b \cdot \frac{TM}{\sqrt{MR}} + \frac{TH(W)}{\sqrt{MR}}$								
	MRT03 (constant)		TMD (variable)		THWD (variable)			
1978	3234	1.95	4.62	8.83	56.33	1.28	0.97	80
1979	3626	2.04	4.49	8.57	78.36	1.71	0.92	78
1980	3609	1.91	4.32	8.45	83.74	1.86	0.91	75
1981	3091	1.67	4.62	8.81	55.65	1.70	0.92	80
Composite	3409	3.93	4.53	18.08	66.83	3.38	0.91	78
EQUATION NO. 2: $\frac{Y}{\sqrt{MR}} = a \cdot \sqrt{MR} + \frac{b}{\sqrt{MR}} + c \cdot \frac{TM}{\sqrt{MR}}$								
	RTMR (constant)		INVMR (constant)		TMD (variable)			
1978	3782	3.27	- 560	- 0.57	4.58	9.60	0.92	75
1979	4692	3.98	- 1067	- 1.02	4.49	9.71	0.93	72
1980	6262	5.08	- 1495	- 1.56	3.82	8.10	0.94	63
1981	5316	4.34	- 1784	- 1.93	4.07	8.18	0.94	68
Composite	4895	8.34	- 1217	- 2.53	4.28	18.36	0.93	70
EQUATION NO. 3: $Y = a \cdot TR + b \cdot TM + TH(W)$								
	TR (constant)		TM (variable)		THW (variable)			
1978	1678	2.05	4.47	9.33	91.10	2.88	0.98	86
1979	1976	2.36	4.54	9.68	96.99	3.03	0.98	84
1980	2778	2.40	4.14	8.23	92.34	2.84	0.98	78
1981	2411	2.31	4.43	8.52	62.18	2.59	0.98	80
Composite	2055	4.50	4.49	19.09	83.81	5.87	0.98	83

The Data Base

The data used in the statistical analysis which follows consists of the 1978-1980 ICC verified data file, which is a compendium of all reported data available on computer tape. The specific data used in this analysis consists of the running crew wage account cluster (Accounts 402 and 403) from Schedule 410 and operating and capacity statistics from Schedules 700 and 755 (Form OS-A). This is the same data used by the Bureau of Accounts (BOA) in developing the URCS Phase I regressions. The results of the analysis presented here, therefore, are easily replicable by the BOA.

The Alternative Model

The alternative model, discussed in general terms above, is explicitly stated below

(2.2) RW = f(UTM, WTM, TTM, THW)

where:

RW = running crew wage complex
UTM = unit train miles
WTM = way train miles
TTM = through train miles
THW = train hours way switching

The generic output measure (TM), it will be noted, has been replaced by three output measures, each reflecting a different classification of train output. Instead of producing an aggregate measure of output, train miles, the firm is posited to produce three types of output, distinguishable by their production characteristics.

Since, regardless of which functional form is eventually selected from the three equations noted in Exhibit One, the coefficients for the explanatory variables will be linear in parameters the alternative model may be stated below in the general multiple regression format

(2.3) $RW = B_0 + B_1\ UTM + B_2 WTM + B_3 TTM + B_4 THW + E$

where:

B(betas): denote multiple linear regression coefficients which are solvable via least squares procedures

E(Epsilon): denotes an error term which is assumed normally distributed, where all E_i's are uncorrelated

The Hypothesis

The implicit null hypothesis stated in (2.1) is that after contolling for train hours way switching, there is no statistical difference between running wages per type of train. From (2.3), this hypothesis is stated below in terms of the regression parameters, along with the alternative hypothesis:

(2.4) H_o: $B_1 = B_2 = B_3$

H_a: any beta, $B_1 - B_3$, $\neq$ to other betas

where:

H_o = null hypothesis; there is no difference between train types.

H_a = alternative hypothesis; there is a difference between train types.

Equation 2.4 constitutes a testable null hypothesis which can be confronted with data to verify its validity or misconstruction. The data for each of the disaggregate train mile output measures are contained in Form OS-A, Lines 2, 3, and 5. Using 1980 data as a test year, the results of the statistical analysis and hypothesis test are presented below.[4]

Test of the Hypothesis

An analysis of variance table (ANOVA) for the reformulated running wage model is depicted in Exhibit Two. The ANOVA table contains the standard set of statistics normally associated with regression output: the sum of squares, an F-test for significance of the model, the coefficient of determination (R^2), and parameter estimates with the student's test for the null hypothesis that the parameter is not different from zero. As the table indicates, the statistical tests are generally good for the model: an F-value significant for the 99% confidence interval, and an adjusted R^2 of .959. These are not the really important statistics in this table, however. The ANOVA table, in addition, contains the result of a test for the null hypothesis stated in (2.4) that $B_1=B_2=B_3$, or that there is no significant difference between the parameter estimates for the various classes of train output, when controlling for train hours way switching. The results of the F-test, presented in the lower right-hand corner of the table, show that the null hypothesis may be rejected for an alpha of .05. In other words, for the 95% confidence interval, the data

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[4] The regression data base excluded the data for Conrail and Rock Island, as was done in the BOA regressions.

reveal that there is a significant difference between the estimated parameters.

EXHIBIT TWO: ANOVA TABLE FOR REGRESSION OF RUNNING CREW WAGES, BASED ON 1980 DATA.

```
                        SUM OF            MEAN
SOURCE        DF       SQUARES          SQUARE          F VALUE         PROB>F

MODEL          4  262413900819     65603475205          223.057         0.0001
ERROR         34    9999780728       294111198
C TOTAL       38  272413681547

      ROOT MSE       17149.670        R-SQUARE           0.9633
      DEP MEAN       63153.385        ADJ R-SQ           0.9590
      C.V.            27.15558

                     PARAMETER        STANDARD   T FOR H0:
VARIABLE      DF      ESTIMATE           ERROR   PARAMETER=0     PROB > |T|

INTERCEP       1     -5564.783        3605.590          -1.543         0.1320
UTM            1   0.002352915     0.002153689           1.093         0.2823
WTM            1      0.013770     0.003837281           3.589         0.0010
TTM            1   0.004211633    0.0007475923           5.634         0.0001
THW            1      0.069921        0.055611           1.257         0.2172

TEST: B1=B2=B3      NUMERATOR:       1.6E+09   DF:      1   F VALUE:        5.2876
                    DENOMINATOR:     2.9E+08   DF:     34   PROB >F :       0.0277
```

Statistical Interpretation

The message which the ANOVA table presents is that, even when controlling for the effects of train hours way switching there is still a significant difference between the estimated parameters for way train, through train and unit train miles. In other words, the marginal wage cost per train mile differs significantly between classes of train. This suggests the possibility of specification error with regard to postulated URCS equations in Exhibit One and introduces the probability of specification bias concerning the variable THW.

To illustrate this latter point, Exhibit Three depicts on ANOVA table for the regression of running crew wages and the output variables train miles (TM) and train hours way switching. This is the equation that would be specified if it were indeed felt that the variable THW explained all of the variation in running crew wages.

EXHIBIT THREE: REGRESSION MODEL FOR RUNNING CREW WAGES USING TRAIN MILES AND TRAIN HOURS WAY SWITCHING

```
                          SUM OF            MEAN
SOURCE        DF         SQUARES          SQUARE          F VALUE        PROB>F

MODEL          2  260725916315  130362958158          401.537        0.0001
ERROR         36   11687765232     324660145
C TOTAL       38  272413681547

          ROOT MSE      18018.328        R-SQUARE          0.9571
          DEP MEAN      63153.385        ADJ R-SQ          0.9547
          C.V.           28.53106

                       PARAMETER        STANDARD     T FOR H0:
VARIABLE      DF        ESTIMATE           ERROR   PARAMETER=0    PROB > |T|

INTERCEP       1       -3894.544        3743.373        -1.040        0.3051
TM             1     0.004586725     0.000438205        10.467        0.0001
THW            1        0.162159        0.045867         3.535        0.0011
```

From the ANOVA table in Exhibit Two, it will be noted that the parameter estimates and statistical tests change considerably when disaggregate measures of train output are introduced into the regression analysis. This strongly suggests the existing URCS equations, as currently specified, may be characterized by specification bias and the parameter estimates for THW and TM may not be valid for analyzing costs under specific and different operating conditions such as that which might occur on any given movement.

Implications for URCS Costing

The result of the above analysis has been to indicate that greater specificity can be attained in a running crew wages model. This specificity is needed for several reasons. First, in determining jurisdictional threshold indicators, as proposed in this rule-making, it is critical that wage differentials between unit and non-unit trains be established. Unit trains will invariably offer labor advantages to the shipper, and these should be reflected in the cost calculations. Secondly, differences in way train wages should be approximated for joint-line surcharge cases. Many surcharges, by virtue of the legislation, will be targeted at lighter-density lines. Lighter density lines themselves connote different train operating characteristics.

Adaptability to URCS

The potential does exist within the Uniform Rail Cost System for accomodating different estimates for train crew wages. Phase III of URCS allows for the potential separate specification of crew wages by train type. Using separate coefficient estimates developed from such a regression analysis as that illustrated in the foregoing comments, separate unit costs could be developed for each train type, it would appear, without substantial modification to Phase II worktables.

III. Maintenance of Roadway Models

The other consideration which is addressed in this comment is the specification of maintenance of roadway models. As it now stands, two separate roadway cost models have been postulated for separate clusters of account expenses. The first cluster, classified as maintenance of running track expenses (RMAINT), consists of the repair and maintenance of basic running track elements such as rails, ties, ballast, and other track material, as well as track laying and surfacing, signals and interlockers, highway grade crossings and bridges and trestles. This cluster, as noted above, contains expenses only for running track. Way and yard switching expenses are maintained separately under the Uniform System of Accounts (USOA). The second cluster consists of track maintenance overhead and other equipment overhead -- (MAINTOH). This cluster consists of maintenance of way and structure expenditures which cannot be directly associated with running track maintenance but can be associated with system output and miles of road. These costs are somewhat analogous to indirect maintenance expenditures.

The various functional forms for each of these models are depicted in Exhibits Four and Five. Any of the models listed will probably predict, to a greater or lesser degree, maintenance of roadway (MOR) costs based on the system-average traffic density for a carrier or a region, and herein lies the problem. Because the unit costs produced by URCS are based on system average densities, these costs are not necessarily relevant to a movement cost setting, where particular subsystems of a carrier's network are utilized.

To illustrate the point, suppose a 1,000 mile shipment has been interlined between carrier A and carrier B. While moving on carrier B's system, the shipment may move across 3 different links. Link A

EXHIBIT FOUR: PROPOSED BUREAU OF ACCOUNTS RMAINT MODELS.

Regression Number and Year	Coefficient for	t Statistic	Coefficient for	t Statistic	Coefficient for	t Statistic	R2	Percent Variable
EQUATION NO. 1: $\frac{Y}{\sqrt{MR}} = C + b \cdot \frac{GTM(C)}{\sqrt{MR}}$								
	C (constant)		GTMCD (variable)					
1978	3871	2.44	.001138	15.74	-	-	0.88	84
1979	3399	2.05	.001192	16.65	-	-	0.89	87
1980	4023	2.25	.001156	15.23	-	-	0.87	84
1981	5809	2.94	.001111	13.30	-	-	0.84	78
Composite	4230	4.91	.001151	30.84	-	-	0.87	83
EQUATION NO. 2: $\frac{Y}{\sqrt{MR}} = a \cdot \sqrt{MR} + \frac{b}{\sqrt{MR}} + c \cdot \frac{GTM(C)}{\sqrt{MR}}$								
	RTMR (constant)		INVMR (constant)		GTMCD (variable)			
1978	3548	2.95	1268.0	1.26	.0009341	8.09	0.89	69
1979	4610	3.96	339.8	0.35	.0009140	8.69	0.92	67
1980	5987	4.05	420.7	0.40	.0007879	6.18	0.90	58
1981	7216	4.70	1162.0	0.98	.0006743	4.95	0.89	47
Composite	5087	7.76	799.4	1.53	.0008479	14.34	0.90	62
EQUATION NO. 3: $Y = a \cdot TR + b \cdot GTM(C)$								
	TR (constant)		GTMC (variable)					
1978	3343	3.39	.0008947	7.75	-	-	0.97	68
1979	4423	4.68	.0008324	8.04	-	-	0.97	61
1980	7253	5.36	.0005330	3.81	-	-	0.97	39
1981	8077	7.40	.0004062	3.45	-	-	0.98	30
Composite	5120	9.38	.0007312	12.26	-	-	0.97	55

EXHIBIT FIVE: PROPOSED BUREAU OF ACCOUNTS MAINTOH MODELS.

Regression Number and Year	Coefficient for	t Statistic	Coefficient for	t Statistic	Coefficient for	t Statistic	R2	Percent Variable
EQUATION NO. 1: $\frac{Y}{\sqrt{MR}} = a . MR^{.2} + b . \frac{GTMC(C)}{\sqrt{MR}}$								
	MRT02 (constant)		GTMCD (variable)					
1978	5223	3.43	.0006008	6.95	-	-	0.77	63
1979	5391	3.27	.0006185	7.01	-	-	0.76	64
1980	5405	3.58	.0006049	7.63	-	-	0.81	64
1981	5885	3.54	.0006501	7.43	-	-	0.81	63
Composite	5430	6.95	.0006210	14.76	-	-	0.79	64
EQUATION NO. 2: $\frac{Y}{\sqrt{MR}} = a . \sqrt{MR} + \frac{b}{\sqrt{MR}} + c . \frac{GTM(C)}{\sqrt{MR}}$								
	RTMR (constant)		INVMR (constant)		GTMCD (variable)			
1978	3105	2.68	1923	1.99	.0005446	4.91	0.77	57
1979	3064	2.47	2249	2.16	.0005706	5.09	0.77	59
1980	3902	2.96	1591	1.68	.0005030	4.41	0.81	53
1981	4413	3.14	1558	1.43	.0005233	4.20	0.82	52
Composite	3501	5.64	1841	3.72	.0005454	9.74	0.79	56
EQUATION NO. 3: $Y = a . T + b . GTM(C)$								
	T (constant)		GTMC (variable)					
1978	1952	3.33	.0005513	6.24	-	-	0.95	63
1979	2073	3.44	.0005603	6.58	-	-	0.96	62
1980	2816	3.39	.0004483	4.06	-	-	0.95	52
1981	3559	3.56	.0003861	2.78	-	-	0.94	42
Composite	2423	6.70	.0005103	10.04	-	-	0.95	58

has a density of 22 million gross ton miles per mile (GTMM), link B has 7 million, and link C 150,000. If the system average carrier density (16 million GTMM, for example), is applied in cost estimation techniques the costs will be accurate only if the shipment moves a distance over each link which corresponds exactly to the proportion of miles of track in each category for the carrier's system as a whole. Otherwise, the results will be biased.

Worktable A-7 of URCS was originally designed to allow user-specification of traffic density. Worktable A-7, however, is not now workable. Even if worktable A-7 were functional, the user would be required to input very detailed and specific data about the subsystem over which the movement occurs--data which are frequently unknown and difficult to obtain without extensive resources. What is needed in terms of a costing system with respect to MOR expenses is one which provides for a greater degree of specificity in cost estimation by accounting for differences in traffic density between various categories of track and at the same time can be applied within the confines of the URCS costing system without exhaustive data input and resource requirements.

In the following paragraphs a set of alternative procedures is described for deriving APV of costs for various classifications of track. In addition, the possibility of econometric specification of a subsystem model is raised, and some preliminary statistical procedures discussed.

The Subsystem Data Base

A subsystem data base currently exists which contains capacity and output measures for each of five running track categories. Schedule 720, reported annually by the carriers to the ICC, contains the number of miles of track and the average annual gross ton miles per mile of track for the density based categories shown in Table 2. Given the miles of track in each category and the average traffic density, it is an arithmetic problem to calculate the gross ton miles of output.[5]

TABLE 1. FREIGHT TRACK CATEGORIES CONTAINED IN SCHEDULE 720.

Track Category	Density Class
A	20 million GTMM or greater
B	20 million to 5 million GTMM
C	5 million to 1 million GTMM
D	Less than 1 million GTMM
Potential Abandonments	N/A

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[5] The number of gross ton miles of output for any given track category is a product of the number of miles of track and the average number of gross ton miles per mile.

Deriving Subsystem Percent Variables

The existence of such a subsystem data base as that contained in Schedule 720 offers considerable potential for the calculation of subsystem variable costs within the Uniform Railroad Costing System--costs which are more relevant to specific and different movement characteristics. To illustrate, the results of regression 3, Exhibit One, are applied to the Burlington Northern Railroad for the year 1980; first at a system-average level and then at various subsystem levels.

Regression 3 suggests that total running maintenance cost (RMAINT) for a given railroad system are a function of $5120 times the miles of track plus $0.0003712 times the gross ton miles of output. This is the true theoretical form of the deflated equations in Exhibit One as well. So for purposes of illustration, the undeflated equation, which is more theoretically appealing and straightforward, is used.

Table 2 depicts the derivation of an annual percent variable for the railroad as a whole and then for each of the first four density categories shown in Table 1. The calculable equation for percent variable for each category is given as follows:

(3.1) $APV = (VC/TC)\ 100$

where:

VC = variable cost

TC = total cost

TABLE 2. ANNUAL PERCENT VARIABLE FOR THE BURLINGTON NORTHERN RAILROAD FOR DIFFERENT CLASSES OF TRACK.

Level	Miles of Track	Average GTMM (Millions)	APV
System-Wide	32,139*	13.6	66.0
Class A	9,676	38.6	84.6
Class B	5,281	11.2	61.5
Class C	4,425	2.3	24.7
Class D	6,836	0.3	4.1

*Schedule 700

Thus for each level, system-wide and sub-system, the coefficients from Regression 3, Exhibit One, were applied as follows:

$$(3.2)\ \text{APV} = \frac{0.0007312 \times \text{Gross Ton Miles}}{(5120 \times \text{miles of track}) + (0.0007312 \times \text{gross ton miles})}$$

Allowing for Subsystem Economics of Density in Rail Cost Estimation

Table 2 suggests several things. First, it is clear that the annual percent variable calculated at the system level is not necessarily reflective of the APV for any given subsystem. Secondly, the APV is higher for denser classes of track and lower for lighter-density categories. Intuitively, this is a logical representation of subsystem cost characteristics.

To expand on this point, Regression 3 posits RMAINT to be a function of track miles and gross ton miles. For each track mile, the equation says, $5120 in expenses are incurred annually. For every gross ton mile of output an additional $0.0007312 is incurred. The capacity cost (miles of track) represents, in essence, the short-run fixed cost of maintaining the line-segment since it does not vary with output. Within certain capacity ranges, therefore, increasing the gross ton miles of output would only result in an additional $0.0007312 per GTM. This specification connotes in and of itself the potential for substantial economies (or diseconomies) of traffic within any given subsystem.

The following section discusses a possible procedure for reflecting these economies or diseconomies of traffic in a unit cost calculation.

Subsystem Unit Costs

From the subsystem data contained in Schedule 720, an URCS unit cost could potentially be calculated for each class of track density. Table 3 depicts both the fixed (capacity) cost and variable cost for each classification. When placed on a gross ton mile basis, the statistics clearly show the difference between classes of track in terms of running track maintenance cost per gross ton mile.

The variable cost per output does not change. However, the fixed line segment costs vary substantially between subsystems, reflecting the economies of density of higher classes and the diseconomics of density in lower classes. This has some serious implications for movement cost estimation.

TABLE 3. SUBSYSTEM COST TOTALS FOR THE BURLINGTON NORTHERN RAILROAD: 1980

Track Class	Miles of Track	Capacity* Cost	Gross** Ton Miles	Variable* Cost	Total Cost	Variable Cost GTM	Fixed Cost Per GTM	Total Cost Per GTM
A	9,676	49,541	373,493.6	273,098	322,639	.00073119	.00013264	.00086384
B	5,281	27,039	59,147.2	43,248	70,287	.00073119	.0004571	.00118834
C	4,425	22,656	10,177.5	7,442	30,098	.00073119	.00222608	.00295727
D	6,836	35,000	2,150.8	1,500	36,500	.00073119	.01706651	.0177977

* Cost in thousands of dollars

**In millions

It is suggested that in order to account for differences among various subsystems with regard to maintenance, URCS unit costs be estimated separately from the other expenses which are allocated to the gross ton mile, and be estimated on both a fixed and variable basis. To expand on this point, URCS now calculates a variable cost per gross ton mile which includes the MOR clusters as well as additional expense items. If maintenance of roadway costs were removed from the gross ton mile unit cost and calculated separately for each class of density, they could then be added to the non-maintenance gross ton mile cost during the movement costing process.

For example, if a variable and fixed cost per gross ton mile were calculated for track classes A through D, as described above, and the movement was known to occur over class A track, then the RMAINT costs could be reintroduced to the gross ton mile cost following either one of two options: either the variable cost could be reintroduced only or the total cost per gross ton mile could be added. The GTM unit cost would thus reflect the specific characteristics of the subsystem being utilized. This is summarized in equation format below.

(3.3) $GTM_a = GTMO + VGTM_a + FGTM_a$

where:

GTMA = total gross ton mile unit cost for subsystem A.

GTMO = URCS gross ton mile unit cost other than MOR.

$VGTM_a$ = variable gross ton mile unit cost for subsystem A.

$FGTM_a$ = fixed gross ton mile cost for subsystem A.

A gross ton mile unit cost could thus be calculated for each subsystem classification which could then be used in movement cost calculations.

Adaptability to the movement costing process should be fairly straightforward. For multiple subsystem movements, that is movements which utilize more than one subsystem of a carrier's network, the only movement variable which needs to be known is the mileage which the shipment moves over each class of track; from these the gross ton miles in each subsystem could be calculated and the appropriate unit cost applied.

The classification of any given line in a carrier's network is data which is maintained internally by rail carriers. The majority of carriers compile annually a gross tonnage density chart which shows the average annual density of each portion of their system. Perhaps a better approach, however, would be to utilize the Federal Railroad Administration's density maps which show density at a broader level of density, which corresponds almost precisely to the categories shown in Schedule 720. The point being here that it should not be a major problem for a cost analyst to determine the particular subsystems and mileages utilized by a given shipment.

As a closing comment regarding the feasibility of implementing a subsystem costing capability within the Uniform Railroad Costing System, this could be treated as an option which the user would have the discretion to access, but which would not be produced based on a normal application of the formula. Not every user or situation would call for such specificity in cost-finding. When such specificity is needed, however, it would benefit greatly users of the system as well as the Commission to have the capability to estimate such cases. For the above reason, subsystem costing procedures would perhaps best be treated within the formula as an optional worktable, such as A-7 was envisioned. It could be called for by the user, and, upon specification, generate costs for gross ton mile for any given classification.

An Alternative Model

Up until now the discussion has focused solely on the possibility of using estimated regression coefficients to calculate an APV and a unit cost for given subsystems. This is one, and perhaps the most immediately feasible method of approaching the problem. The possibility exists, however, that an expanded cost model might be contrived using Schedule 720 data which would calibrate multiple regression coefficients for the various categories of track; both capacity and output coefficients.

Using the Schedule 720 data in conjunction with Schedule 410 expenses for the RMAINT cluster, a preliminary statistical analysis was undertaken. For purposes of the analysis, potential abandonment statistics were combined with class D data for comprising a weighted average for the lower classification of density. The model which was specified was:

$$(3.4)\quad \mathrm{RMAINT} = f(\mathrm{MT}_a, \mathrm{MT}_b, \mathrm{MT}_c, \mathrm{MT}_d, \mathrm{GTM}_a, \mathrm{GTM}_b, \mathrm{GTM}_c, \mathrm{GTM}_d)$$

where MT connotes the miles of track in categories A through D and GTM connotes the gross ton miles of output. An identical model was posited for the MAINTOH cluster.

The results of the preliminary statistical analyses are depicted in Exhibits Six and Seven. It will be noted that while good statistical measures were obtained for the model in each instance, not all T-statistics

EXHIBITS SIX AND SEVEN

PRELIMINARY STATISTICAL ANOVA TABLES FOR RMAINT AND MAINTOH CLUSTERS.

```
DEP VARIABLE: RMAINT

                          SUM OF           MEAN
SOURCE        DF         SQUARES          SQUARE        F VALUE        PROB>F

MODEL          8     1.45574E+17     1.81968E+16         25.101        0.0001
ERROR         28     2.02985E+16     7.24945E+14
C TOTAL       36     1.65873E+17

     ROOT MSE           26924799        R-SQUARE         0.8776
     DEP MEAN           55936568        ADJ R-SQ         0.8427
     C.V.               48.13452

                       PARAMETER        STANDARD     T FOR H0:
VARIABLE      DF        ESTIMATE           ERROR   PARAMETER=0    PROB > |T|

INTERCEP       1        23883650        17181508         1.390        0.1755
MT1            1        6359.918        5306.956         1.198        0.2408
MT2            1       20546.006        6675.116         3.078        0.0046
MT3            1       24842.081       12629.674         1.967        0.0592
MT4            1       74.188522        7424.183         0.010        0.9921
GTM1           1       -0.049593        0.437353        -0.113        0.9105
GTM2           1       -1.899191        1.307093        -1.453        0.1573
GTM3           1        0.225425        2.770913         0.081        0.9357
GTM4           1       -4.554065       13.912152        -0.327        0.7458
```

```
DEP VARIABLE: MAINTOH

                          SUM OF           MEAN
SOURCE        DF         SQUARES          SQUARE        F VALUE        PROB>F

MODEL          8     2.35826E+14     2.94783E+13         61.332        0.0001
ERROR         28     1.34579E+13    480638288010
C TOTAL       36     2.49284E+14

     ROOT MSE             693281        R-SQUARE         0.9460
     DEP MEAN            2303275        ADJ R-SQ         0.9306
     C.V.               30.09978

                       PARAMETER        STANDARD     T FOR H0:
VARIABLE      DF        ESTIMATE           ERROR   PARAMETER=0    PROB > |T|

INTERCEP       1          526218          442403         1.189        0.2443
MT1            1         537.653         136.648         3.935        0.0005
MT2            1         778.007         171.876         4.527        0.0001
MT3            1         459.936         325.199         1.414        0.1683
MT4            1      -68.526029         191.164        -0.358        0.7227
GTM1           1     0.003812633        0.011261         0.339        0.7375
GTM2           1       -0.040381        0.033656        -1.200        0.2403
GTM3           1    0.0007840846        0.071348         0.011        0.9913
GTM4           1        0.041476        0.358221         0.116        0.9086
```

for the parameters were significant. In addition, some unexpected signs (negative) were obtained for the coefficients. This speaks perhaps of the possible existence of multicollinearity among the independent variables. Also, the equation was not deflated and deflating may change some of the parameter values and/or signs.

Thus, in general, while preliminary statistical analyses indicate some potential for econometive specification of a subsystem MOR model, final conclusion could not be reached within the time constraints imposed by the comment period. Additional analysis in this area, however, might be fruitful and might yield valid and useable statistical results.