Investigating the Cost Structure of Taiwanese Railway Industry: 1975-1995

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Abstract

The study mainly focuses on estimating the cost structure of Taiwanese railway Industry over the period of 1975-1995. The economic characteristics of Taiwanese railway industry are analyzed by applying translog cost function estimation. Three outputs including long-trip passenger service, short-trip passenger service and freight service, and three input factors including labor, fuel and intermediate items are specified in the cost function. In addition, capital variable and technology variable are also employed to investigate the effects of fixed cost and technical change respectively. The growth of total costs of Taiwan railway over the study period reflected an increasing trend. The empirical results reveal its labor-intensive nature of the industry. Fuel and intermediate factors are complementary, while the others factors are substitutes. The elasticity of costs with respect to output is 0.43741 indicating given fixed capacity (short- run) unit costs of production will increase but less than proportionally as outputs increases.

Keywords: translog cost function, railway industry, economic characteristics

Introduction

The cost analysis of transport industries, or more precisely, the railway industry, is an important task for various purposes, including commercial enterprise, public service obligations, regulatory decisions, government policy decision-making, economic research etc. This study focuses on the first and the last of these mentioned above. Unfortunately, however, there are a number of characteristics of rail operations which give rise to difficulties in identifying the variable costs associated with a specific, given rail movement. First, railways are multi-product enterprises; second, there are various indivisibilities in the production process of railways; third, railways employs fixed assets with differing lives, hence the variability of the cost items varies with the time horizon of the decision, and fourth, limitations exist in the accounting and management information system of railways. (Waters II, 1985)

Since it is impossible to calculate a true and precise measure of cost; estimates must be of the cost of one traffic movement based on explicit or implicit assumptions about the volumes and pattern of other traffic movements. The growth of total costs of Taiwan railway over the past two decades reflected an increasing trend[1]. In this study we take the issue of the empirical estimation of costs in Taiwan's railway industry, and also provide examples of the productivity growth of this industry over the period under review.

The rest of this study is organized as follows: Section 2 is the theoretical model of cost function. In particular, the translog cost function is chosen and discussed. Section 3 specifies the cost function employed in this study. The variables involved in the cost function are defined and measured in the Section 4. Section 5 presents the estimated results of the cost function. The main economic features of Taiwan railway industry are analyzed. Finally, some concluding remarks are drawn in section 6.

1. Theoretical Model

Let $T(Q,X;\beta,t)$ represents the transformation function, where Q is a vector of outputs, X is a vector of inputs, β is a vector of fixed parameters to be estimated, and t represents time and technology. Firms are assumed to minimize cost, denoted C, given the transformation function and input prices, W_i. Without direct constraints on choice variables, the cost minimization problem confronted by firms is

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[1] This is mainly because of the effect of the application of Labour Standard Law (LSL) and the financial burden of personnel costs. (Referring to Appendix)

$$\underset{X_i}{Min}C = \sum_i W_i X_i$$
$$s.t. \quad T(Q, X; \beta, t) = 1 \qquad (1)$$

Under the appropriate regularity conditions, the solution yields a set of conditional factor demands (X_i^*) and the minimum cost function becomes

$$C = \sum_i W_i X_i^*(Q, W, \beta, t)$$
$$= C(Q, W, \beta, t) \qquad (2)$$

If the firm minimizes cost with respect to all inputs, and there is a convex input structure, then the cost function in logarithmic form is

$$\ln C = G(\ln Y_1, \ldots, \ln Y_m, \ln W_1, \ldots, \ln W_m, t) \qquad (3)$$

where Y is a vector of outputs

Due to the application of duality theory and the utilization of generalized functional forms, which allow for greater flexibility by reducing the number of restrictions on the parameters of the relevant cost function, considerable advances have been made in analyzing railway and other transport modes during the last two decades[2]. The functional form most favored in the literature has been the transcendental logarithmic, i..e. translog, cost function, primarily because it places no prior restriction on the elasticities of substitution between the various restrictions such as homotheicity, homogeneity and unitary elasticities of substitution (Varian,1985), and the desirability of their imposition on the production structure (McGeeham,1993). The translog functional form for a single output technology was introduced by Christensen, Jorgenson and Lau (1971); the multi-output case was defined by Burgress (1974) and Diewert (1974). Brown, Cases and Christensen (1979), Oum(1979), Spady(1979), Apady and Friedlaender (1978) were the pioneers to use translog for transport cost and/or demand modeling.

The translog functional form is given in Equation (4).

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[2] By the late 1970s, the studies of productivity measurement were typically undertaken by the use of the production function, especially the Cobb-Douglas functional form. (Diewert,1992)

$$
\begin{aligned}
\ln C(y,W) = a_0 &+ \sum_i a_i \ln y_i + \sum_j b_j \ln W_j \\
&+ \frac{1}{2}\sum_i \sum_j a_{ij} (\ln y_i \ln y_j) + \frac{1}{2}\sum_i \sum_j b_{ij} \ln W_i \ln W_j \\
&+ \sum_i \sum_j c_{kj} \ln y_i \ln W_j
\end{aligned} \tag{4}
$$

where C is total cost, y_i is the *i*th output, and W*i* is price of *j*th input. In addition, $a_{ij}=a_{ji}$ and $b_{ij}=b_{ji}$.

For linear homogeneity in the input prices, we require that the following restrictions on the parameters hold:

$$\sum_{i=1}^{n} b_i = 1 \tag{5}$$

$$\sum_{i=1}^{m} b_{ij} = \sum_{j=1}^{m} c_{ij} = 0 \tag{6}$$

Also, the input cost share equations can be derived, using Shephard's lemma, and are linear functions of the logs of output and of input prices.

$$
\begin{aligned}
S_i &= \frac{\partial \ln C}{\partial \ln W_i} \\
&= b_j + \sum_{j}^{n} b_{ij} \ln W_j + \sum_{i=1}^{m} c_{ki} \ln y_i
\end{aligned} \tag{7}
$$

where S_i is the cost share of input i.

According to Brendt and Wood (1975), Allen partial elasticities of substitution are given by the following formulas:

$$\sigma_{ii} = \frac{\delta_{ii} + S_i^2 - S_i}{S_i^2} \tag{8}$$

$$\sigma_{ij} = \frac{\delta_{ij} + S_i S_j}{S_i S_j}, \qquad i \neq j \tag{9}$$

A negative value for σ_{ij} indicates substitutability and a positive value, complementarity. The own- and cross-price elasticities of demand for inputs can be derived from the elasticities of substitution, since

$$\varepsilon_{ij} = S_i \sigma_{ij} \tag{10}$$

2. Function Specification

Due to the characteristics of sunk cost and some quasu-fixed factor inputs (for example, permanent ways and structures), the railway is in ‘disequilibrium’. This suggests the use of a variable cost function (McGeehan,1993). In addition, as there is only one railway in Taiwan, our estimation is on the cost function of individual networks over time, rather than a cross-section analysis. The cost function is estimated with a fixed factor of production (related to lines and works, building and land), the prices of factor inputs, technology and output.

The relationship can be specified as follows:

$$VC = C(y_1, y_2, y_3, w_l, w_f, w_i, K, T) \tag{11}$$

where VC is total variable costs, y_1 is passenger-kms for long trips, y_2 is passenger-kms for short trips, y_3 is freighrt ton-kms, and w_l,w_k,w_i are the prices of input factors (labour, fuel and intermediate factors respectively). K is the fixed factor, and T represents a time trend that acts as a proxy for technical change.

A generalized translog multi-product variable cost function (Caves, Christensen and Tretheway, 1980) which serves as a second-order approximation to a twice-differentiable transformation surfaces is specified in order to serve the purposes of estimation in this study.

$$\begin{aligned}
\ln VC = {} & \alpha_0 + \alpha_1 \ln w_l + \alpha_f \ln w_f + \alpha_i \ln w_i \\
& + \beta_{y1} \ln y_1 + \beta_{y2} \ln y_2 + \beta_{y3} \ln y_3 + \gamma_k \ln K + \delta_T T \\
& + \frac{1}{2}\alpha_{ll} (\ln w_l)^2 + \alpha_{lf} \ln w_l \ln w_f + \alpha_{li} \ln w_l \ln w_i \\
& + \frac{1}{2}\alpha_{ff} (\ln w_f)^2 + \alpha_{fi} \ln w_f \ln w_i + \frac{1}{2}\alpha_{ii} (\ln w_i)^2 \\
& + \lambda_{ly1} \ln w_l \ln y_1 + \lambda_{ly2} \ln w_l \ln y_2 + \lambda_{ly3} \ln w_l \ln y_3 \\
& + \lambda_{fy1} \ln w_f \ln y_1 + \lambda_{fy2} \ln w_f \ln y_2 + \lambda_{fy3} \ln w_f \ln y_3 \\
& + \lambda_{iy1} \ln w_i \ln y_1 + \lambda_{iy2} \ln w_i \ln y_2 + \lambda_{iy3} \ln w_i \ln y_3 \\
& + \frac{1}{2}\varphi_{11} (\ln y_1)^2 + \varphi_{12} \ln y_1 \ln y_2 + \varphi_{13} \ln y_1 \ln y_3 \\
& + \frac{1}{2}\varphi_{22} (\ln y_2)^2 + \varphi_{23} \ln y_2 \ln y_3 + \frac{1}{2}\varphi_{33} (\ln y_3)^2
\end{aligned} \tag{12}$$

For homogeneity of degree one in input factor prices, the following restriction must be satisfied:

$$\alpha_l + \alpha_f + \alpha_i = 1$$
$$\alpha_{ll} + \alpha_{lf} + \alpha_{li} = 0$$
$$\alpha_{fl} + \alpha_{ff} + \alpha_{fi} = 0$$
$$\alpha_{li} + \alpha_{fi} + \alpha_{ii} = 0$$
$$\lambda_{ly1} + \lambda_{fy1} + \lambda_{iy1} = 0$$
$$\lambda_{ly2} + \lambda_{fy2} + \lambda_{iy2} = 0$$
$$\lambda_{ly3} + \lambda_{fy3} + \lambda_{iy3} = 0 \qquad (13)$$

Differentiating Eq. (12) with respect to factor price yields the derived demand for factor inputs in terms of a set of cost equations.

$$S_l = \partial \ln VC / \partial \ln w_l$$
$$= \alpha_l + \alpha_{ll} \ln w_l + \alpha_{lf} \ln w_f + \alpha_{li} \ln w_i + \lambda_{ly1} \ln y_1 + \lambda_{ly2} \ln y_2 + \lambda_{ly3} \ln y_3$$
$$S_f = \partial \ln VC / \partial \ln w_f$$
$$= \alpha_f + \alpha_{lf} \ln w_l + \alpha_{ff} \ln w_f + \alpha_{fi} \ln w_i + \lambda_{fy1} \ln y_1 + \lambda_{fy2} \ln y_2 + \lambda_{fy3} \ln y_3$$
$$S_i = \partial \ln VC / \partial \ln w_i$$
$$= \alpha_i + \alpha_{li} \ln w_l + \alpha_{fi} \ln w_f + \alpha_{ii} \ln w_i + \lambda_{iy1} \ln y_1 + \lambda_{iy2} \ln y_2 + \lambda_{iy3} \ln y_3 \qquad (14)$$

where S_l, S_f and S_i are the cost shares of input factors labour, fuel and intermediate factors respectively.

Estimating the cost share equations jointly with the translog cost function in Eq. (12) improves the efficiency of the estimation process. Further, the number of degrees of freedom is increased, without an increase in the number of parameters to be estimated. Since the cost shares sum to unity, there are only two linearity independent factor share equations. Thus, in forming the estimated system, one of the share equations is omitted. The parameters estimated are invariant with respect to the omitted equation, since a maximum likelihood estimator is used.

The specification of the translog function allows for the measurement of the extent of economies of scale in the operation of rail services. Given a fixed network configuration, economies of scale resulting from increasing traffic volumes can be defined as economies of density (Keeler,1974). Economies of density measure the relationship between unit costs and the intensity of utilization of capacity. Following

Brown et al's (1979), the multi-product economies of density can be defined as unity minus the sum of cost elasticities with respect to outputs. From Eq (15) economies of density (E.D.) are given by

$$E.D. = 1 - \left(\frac{\partial \ln VC}{\partial \ln Y_1} + \frac{\partial \ln VC}{\partial \ln Y_2} + \frac{\partial \ln VC}{\partial \ln Y_3} \right) \quad (15)$$

3. Variable definitions and Measurements

Since various outputs (i.e. passenger and freight services) of rail transport are 'provided' by the same track, facilities and infrastructure, it is very difficult to allocate costs to a specific service. In this study we employ the multi-product cost theory proposed by Baumol et al. (1982) in order to account for the characteristic of joint production in the railway industry. A major difficulty with this cost function involves the appropriate definition of outputs and inputs. In turn, the estimated cost function may not properly capture those characteristics of output the actually cause costs to vary between systems or through time. Hence, it is not a straightforward matter to choose the best estimate, even though there have been a number of studies dedicated to this task. (Dodgson, 1985, Oum and Water II, 1996).

3.1 Dependent Variable

The dependent variable of the cost function is specified as the short-run variable cost, denoted VC. Variable cost is primarily derived from conventional 'operation costs' as defined in standard railway accounting (Friedlaender et al., 1993). The variable cost in this study is obtained from the total costs, excluding the costs generated by non-passenger and non-freight services (e.g. agent fees, freight delivery service expenses and catering service expenses, and so on), and the quasi-fixed coste, i.e. interest and depreciation, which are treated as the capital variable K

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3.2 Independent Variables

(1) Output variables

Passenger services aned freight services are the two major outputs in the railway industry. Due to their different attributes, it is necessary to specify various services. Two passenger variables (for long-trip and short-trip passenger services) and one freight variable are specified in this study. It is common practice to classify passenger output in terms of three categories with respect to passenger's travel attributes: communal passenger service, short-trip passenger and long-trip passenger service[3]. As our concern is to explore the cost characteristics of inter-city passenger travel, the category of 'communal passenger' is included in the short-trip passenger service category. Hence, the two passenger variables are the 'long-trip passenger service', denoted Y_1 and 'short-trip passenger service', denoted Y_2. The trip distance of 50 kilometers is used as the criterion for both passenger services.

Regarding freight services, two services, i.e. 'carload' and 'less than carload' are offered by the TRA. From recent statistical data (Chen, 2000), however, it appears that the former has comprised almost the entire freight output over the last two decades[4]. Foe the sake of simplification, the aggregate data of both services are used to represent freight output, denoted Y_3. The data of all factors involved are obtained from the Annual statistical Report of TRA (1996) and Transportation Information by IOT (1996), over the period 1975-1995. The passenger outputs are measured in passenger kilometers while the freight output is measures in tonnage-kilometers.

(2) Input Factor Variables

As mentioned above, the input factors involved in railway production include labour, fuel and intermediate items. The price indices for each variable are measured by the following Eq.(16)-(18), given in 1991 prices as the base. To eliminate the effects of inflation, all variables are measured in real terms. The data employed are obtained from the Annual Statistical Report of TRA over the period 1975-1995.

(a) Labour Price Index (W_L)

$$w_{Li} = \frac{P_{Li}}{P_{Lb}} \qquad ,i = 1975 - 1995 \tag{16}$$

where,

W_{Li}: labour price index for year i.

P_{Li}: labour unit price for year i, i.e. P_{Li} = (Labour Cost)/(No. of Lobour)

P_{Lb}: labour unit price for base year (i.e. year 1991)

The total labour costs in question include wage expenses and pension expenses. The size of the workforce is the total number of employees, excluding those who work in the departments not associated with passenger and freight operations, for example, the Freight Delivery Service Department and the Catering Service

[3] Referring to related studies of Taiwan's railway industry (Wan and Wu, 1993)

[4] The carload traffic consists of the bulk of construction materials, coal, grains and container traffic.

Department.

(b) Fuel Price Index (W_F)

$$w_{Fi} = \frac{P_{Fi}}{P_{Fb}} \qquad ,i = 1975-1995 \qquad (17)$$

where,

W_{Fi}: Fuel price index for year i.

P_{Fi}: Fuel unit price for year I, i.e., P_{Fi} = (Fuel cost)/ (Train ton-km)

P_{Fb}: Fuel unit price for base year.

The fuel costs include the costs of diesel, electricity and coal with respect to the various locomotives. The unit price of fuel is measured by the ratio of total fuel costs to the total train tonnage kilometers operated.

(c) Immediate Price Index (W_I)

$$w_{Ii} = \frac{P_{Ii}}{P_{Ib}} \qquad ,i = 1975-1995 \qquad (18)$$

where,

W_{Ii}: Intermediate price index for year i.

P_{Ii}: Intermediate unit price for i, i.e., P_{Ii} = (Intermediate Cost)/(Train-km)

P_{Ib}: Intermediate unit price for base year.

Intermediate costs include the expenses of materials and supplies, the charges for service, rents, taxes and fees etc. The unit intermediate price is measured as the ratio of the total intermediate costs to the total train kilometers operated.

(3) Capital Variable (K)

Capital is defined as the sum of interest and depreciation associated with the permanent way and structure capital. The permanent way and structure capital represents roadbed, track, bridges, and so on. As these are typically long-lived, permanent way and structure capital is here treated as a fixed factor[5]. The capital variable, denoted K, is measured as the sum of interest and depreciation associated with the permanent way and structure.

(4) Technology Variable (T)

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[5] The same specification of way and structure capital can be found in Friedlaender et al.'s study (1993).

A time trend, denoted T, is employed as a proxy for technical change. T represents a vector of time counters intended to capture the effect of productivity growth.

4. Estimation Results

We estimated a system of equations consisting of the cost function and the n-1 cost share equations, omitting the linearity dependent intermediate cost share equation, and using the SURE command to apply maximum likelihood methods in LIMDEP (version7.0).

Table 1 presents the estimate results for the cost function. Only those coefficients that are significant at a 5% level are listed. As a result, some cross-multiplying parameters are ignored in Table 1, according to their corresponding t-values. Standard errors and t-values of each parameter and the log likelihood function for the cost equation are also reported in Table 1. The residual covariance of the estimation is shown in Table 2.

Under the assumption of production cost minimization, and in order that the cost function be well-behaved, the estimated model must be non-negative in input prices, concave in factor prices and monotonically increasing in outputs (Varian, 1984). Non-negativity in input price is satisfied if the cost shares of the input factors are positive. Concavity is satisfied if the Hessian matrix[6] of second order coefficients is negative semi-definite. Monotonicity is satisfied if the predicted costs increase as outputs increase (McGeehan, 1993). All three conditions are satisfied in our estimates, thus indicating the translog cost function captures well the underlying technology.

Table 1 Parameter Estimates for Translog Variable Cost Function of Taiwan Railway, 1975-1995

Coefficient	Variable	Estimate	Std. Error	t-Value
α_0	(constant)	10.882	2.017	5.395
α_L	$\ln P_L$	0.63540	0.2956E-02	214.954
α_F	$\ln P_F$	0.11804	0.2273E-02	51.928
α_I	$\ln P_I$	0.24695	0.3428E-02	72.031
β_{Y1}	$\ln Y_1$	0.20500	0.2435E-01	8.419
β_{Y2}	$\ln Y_2$	0.14221	0.4978E-01	2.857
β_{Y3}	$\ln Y_3$	0.21539	0.7718E-01	2.791

[6] The Hessian matrix is defined as flows.
$H= [\delta^2 C/\delta W_i \delta W_j]=[\alpha_{ij}]$
Aij is the second order price coefficients

β_K	lnK	0.25792E-01	0.1610E-01	1.602
β_T	lnT	-0.57232E-02	0.4610E-02	-1.242
α_{LL}	$(\ln P_L)^2$	0.18608	0.4467E-02	41.657
α_{LF}	$\ln P_L \ln P_F$	-0.62169E-01	0.5373E-02	-11.570
α_{LI}	$\ln P_L \ln P_I$	-0.12278	0.4227E-02	-29.049
α_{FF}	$(\ln P_F)^2$	0.10863	0.9464E-02	11.479
α_{FI}	$\ln P_F \ln P_I$	-0.45410E-01	0.4689E-02	-9.684
α_{II}	$(\ln P_I)^2$	0.16363	0.5032E-02	32.520
Log likelihood function = 279.809				

Table 2 Residual Covariance Matrix of Cost Function

	1-C	2-S_L	3-S_F	4-S_I
1-C	0.16610E-02			
2-S_L	0.52936E-04	0.10322E-03		
3-S_F	-0.12215E-03	-0.30523E-05	0.52310E-04	
4-S_I	0.11168E-03	-0.99547E-04	-0.49341E-04	0.15000E-03

5.1 Features of the Input Factors

The various estimates of the Allen-Uzawa elasticities of substitution are shown in Table 3 (where estimation is at the mean cost share). The own-elasticities of substitution have as expected, the required negative sign. Except for the cross-elasticity between fuel and intermediate inputs, the other cross-elasticity estimates are significant and positive which implies that these factors are substitutes in production. Fuel and intermediate factors are complementary.

Table 3 Allen-Partial Elasticities of Substitution for Rail Cost Function
（at point-of-means） *

	Labour	Fuel	Intermediate
Labour	-0.20759 （0.083833）	0.151616 （0.156732）	0.296905 （0.103109）
Fuel		-0.42232 （0.590815）	-0.05691 （0.422798）
Intermediate			-0.52705 （0.436556）

The own- and cross-price elasticities of demand are shown in Table 4. The own-price estimates have the required negative sign. This implies that demand decreases when input prices increase. The price elasticity of labour is the smallest (i.e. –0.11329) among them, and this suggests a degree of insufficiency among the work force. The estimated cross-price elasticities in table 4 are all quite low.

Table 4 Own- and Cross-Price Elasticities of Demand for Rail Cost Function（at point-of-means）*

	Labour	Fuel	Intermediate
Labour	-0.1132 （0.031375）	0.020358 （0.02163）	0.095004 （0.045419）
Fuel	0.082744 （0.089909）	-0.05671 （0.080403）	-0.01821 （0.099427）
\Intermediate	0.162035 （0.051594）	-0.00764 （0.0533352）	-0.16864 （0.09322）

In addition, we can estimate returns to scale by means of the appropriate cost elasticities.

Elasticity of cost with respect to long-trip passenger-kilometers, denoted E_{Y1}, is

$$E_{Y1} = \frac{\partial \ln VC}{\partial \ln Y_1} = 0.20500$$

Elasticity of cost with respect to long-trip passenger-kilometers, denoted E_{Y2}, is

$$E_{Y2} = \frac{\partial \ln VC}{\partial \ln Y_2} = 0.14221$$

Elasticity of cost with respect to long-trip passenger-kilometers, denoted E_{Y3}, is

$$E_{Y3} = \frac{\partial \ln VC}{\partial \ln Y_3} = 0.21539$$

The economies of density can be calculated by using Eq. (17). If E.D. > 0 positive economy of density exists, and if E.D. < 0 diseconomy exists. E.D. rises as the physical load increases while carrying capacity remains unchanged.

$$\begin{aligned} E.D. &= 1 - \sum (\partial \ln VC / \partial \ln Y_i) \\ &= 1 - \left(\frac{\partial \ln VC}{\partial \ln Y_1} + \frac{\partial \ln VC}{\partial \ln Y_2} + \frac{\partial \ln VC}{\partial \ln Y_3} \right) \\ &= 0.43741 \end{aligned}$$

At the point of expansion, the elasticity of costs with respect to output is 0.43741. this indicates that over the period under review the TRA rail network has operated with positive economies of density. Thus, as outputs increase, given fixed capacity, (short- run) unit costs of production will increasing but less than proportionally.

5. Concluding Remarks

Due to the introduction of a new pension system in 1987, labour costs, which include pensions, rose dramatically, and eventually became a heavy financial burden. In this study, we have examined the cost structure of the Taiwan railway industry and established its labour-intensive nature. The translog cost function was obtained by using annual observations for Taiwan railway over the period 1975-1995. Throughout the period studied, substantial economies of density were present in the operations of the railway. This implied that unit cost increased less than proportionately with output, given fixed capacity. In addition, fuel and intermediate factors are complementary, while the others input factors are substitutes.

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Appendix

Appendix-Table 1 Costs Components of Taiwan Railway (1995)

Unit: NT$

1. Operating Costs	
	23,769,320,266 (84.49％)
1.1 Transportation and Storage Costs	
1.1.1 Station Expenses	
1.1.2 Civil Engineering Maintenance Expenses	
1.1.3 Electric Maintenance Expenses	
1.1.4 Mechanical Maintenance Expenses	
1.1.5 Running Expenses	
1.2 Other Operating Costs	
2. Operating Expenses	
	1,418,393,071 （5.04％）
2.1 Business Expenses	
2.2 General and Administrative Expenses	
2.3 Other Operating Expenses	
3. Non-Operating Expenses	
	2,943,826,761 （10.47％）

Total Cost	28,131,540,099 （100％）

Source: TRA, Annual Statistical Report, 1996

Appendix-Table 2 Cost Share in Transportation and Storage (1995)

Unit: ％

Station Expenses	Running Expenses	Civil Engineering Maintenance	Electric Maintenance	Mechanical Maintenance
23.19	21.91	16.66	8.36	30.88

Source: TRA, Annual Statistical Report, 1996

Appendix-Table 3 Cost Allocation by Input Factors (1995)

Unit: million NT$

Input factor	Labour[1]	Material[2]	Capital
Costs （％）	16,773 （59.6％）	3,395 （12％）	8,003 （28.3％）

NT： 1.Pensions is included in the labour costs.

2.Materail costs include materials and supplies costs, and power charges.

Source: TRA, Annual Statistical Report, 1996

台灣鐵路產業成本結構分析之研究：1975-1995

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摘要

本研究主要針對台灣鐵路產業在 1975 年至 1995 年期間之成本結構進行探討，運用 Translog 成本函數之估計分析鐵路產業之經濟特性。鐵路產業成本函數之設定包括長途客運、短途客運及貨運等三項產出項和勞力、燃料及中間物料等三項投入項。此外，資本及技術變數亦被納入成本函數中以分別探討固定成本及技術變動之效果影響。實證結果發現：鐵路產業成本於研究期間呈現遞增趨勢，並具有勞力密集之屬性。燃料與中間物料投入項間具互補性，其餘投入項間則呈替代性。產出成本彈性約為 0.43741，代表在短期固定容量條件下，當產出增加一個百分比，單位產出成本將增加 0.4371 個百分比。

關鍵詞：translog 成本函數，鐵路產業，經濟特性

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