"Separations and Settlements"

A Two Jurisdiction Model"*

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Separations - the allocation of revenues between telephone companies and jurisdictions - represents a redistribution of income among telephone companies. This study develops a two jurisdiction model examining the local exchange and toll communications. The model is altered with the additional assumptions and constraints brought about by rate of return regulation and the separations process and compared to the basic model to show how separations, in addition to rate of return regulation, has distortionary effects upon input selection.

Separations and settlements have the ultimate effect of causing a misallocation of resources. The Averch-Johnson (A-J) effect is the most well known theoretical result dealing with the impact of rate of return regulation.[1] The model is the subject of many investigations, yet in telecommunications, the sum of the formulas used, in both the settlements and separations processes, may far outweigh the A-J effect in inducing firms to alter input mixes. Three models of a profit maximizing firm are examined in this chapter. The first model is a profit maximizing firm subject to no regulatory constraints, the second model examines the effect of a regulatory restraint upon the firm, and the third looks at a firm with shared costs and two different rates of return for the interstate and local jurisdictions. Included in this model is the settlements process for redistribution of revenues from the interstate market to those forms supplying interstate toll service.

There models examine the question of input for a profit maximizing, two product (local service and long distance toll service) firm. The firm is allowed only to vary capital and labor; a specific input can only be used to produce one output assigned to the corresponding market. A

[1]The A-J distortion which will be discussed below concerns the effects of regulation on the employment of capital inputs.

common input (e.g., capital that can be used to contribute to both inputs) is apportioned to the two jurisdictions, while the shares of common costs assigned to each jurisdiction are set by the regulatory agencies. The effects of the separations and settlements process on input decisions can be determined by comparing the three models.[2]

Unregulated Profit Maximization

For the first model assume the following:

$$Q = F(K_1, K_2, K_c, L_1, L_2, L_c) \tag{1}$$

$$q_1 = f_1(K_1, K_c, L_1, L_c) \tag{2}$$

$$q_2 = f_2(K_2, K_c, L_2, L_c) \tag{3}$$

where

$$q_1 + q_2 = Q$$

$$L_1 + K_2 + L_c = L = \text{total labor employed}$$

$$K_1 + K_2 + K_c = K = \text{total capital employed}$$

K_i = capital used in jurisdiction i

i = 1 (interstate market)
i = 2 (local market)

L_i = labor used in jurisdiction i

K = common capital shared by both jurisdictions

L = common labor shared by both jurisdictions

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[2]This approach is adapted from Lee I. Sparling, "Regulatory Distortions in Transportation and Telecommunications" (Ph.D. dissertation, California Institute of Technology, 1980), pp. 87-126. Sparling, however, examined the effect of separations on the use of wasteful inputs and did not consider the settlements process.

r = cost of capital

w = labor wage rate

P_i = price of service in jurisdiction i and is the inverse demand function.

For an unregulated firm to maximize profits (Π) with respect to the decision variables involves profits as defined below:

$$\text{Max } \Pi = P_1q_1 + P_2q_2 - w\,(L_1 + L_2 + L_c) - r\,(K_1 + K_2 + K_c) \qquad (4)$$

Maximizing the above problem gives the first order conditions which show a cost minimizing (and thus profit maximizing) firm setting the ratio of the wage rates equal to the ratio of marginal revenue products (Equation 5).[3]

$$\frac{w}{r} = \frac{MRPL_1}{MRPK_1} = \frac{MRPL_2}{MRPK_2} = \frac{MRP_{L_1} + MRP_{L_2}}{MRP_{K_1} + MRP_{K_2}} \qquad (5)$$

This result shows that a firm produces where the production isoquant is tangent to the input price's isocost curve, so the ratio of the value of the marginal products will be equivalent to the input price ratios.

Rate of Return Regulation

Now, given the above result, it is possible to compare the second model with the first, but more assumptions are needed if the firm is a monopoly, a case can be built for some type of regulation. Typically, a regulatory body will constrain the rate of return of a firm in order to

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[3]Marginal revenue product of input X in jurisdiction i will by symbolized MRPxi for inputs in the specific jurisdiction and MRP_{ci} for the common inputs.

lower service's prices from where they normally would be under monopoly conditions and to increase the quantity of service provided by the firm.[4]

If there is only one regulatory constraint that binds both jurisdictions in the form of:

$$P_1q_1 + P_2q_2 - w\,(L_1 + L_2 + L_c) - s\,(K_1 + K_2 + K_c) \tag{6}$$

where s is the regulatory body's allowed rate of return on investment and is greater than the cost of capital, but less than the monopoly rate of return. Using the same objective function as in the first model and forming the Lagrangean, the following equation is constructed:

$$\begin{aligned} \text{Max } \Pi = {} & P_1q_1 + P_2q_2 - w\,(L_1 + L_2 + L_c) - r\,(K_1 + K_2 + K_c) \\ & + \mu\,[P_1q_1 + P_2q_2 - w\,(L_1 + L_2 + L_c) - s\,(K_1 + K_2 + K_c) \end{aligned} \tag{7}$$

This equation (7) says that the firm's objective is to maximize profit, but it cannot let its rate of return go above s. Maximizing the profit gives the following first order conditions:

$$\frac{\partial \Pi}{\partial \Pi_1} = P_1 \frac{\partial q_1}{\partial L_1} - w + \mu \left[P_1 \frac{\partial q_1}{\partial L_1} - w \right] = 0 \tag{3}$$

$$\frac{\partial \Pi}{\partial K_1} = P_1 \frac{\partial q_1}{\partial K_1} - r + \mu \left[P_1 \frac{\partial q_1}{\partial K_1} - s \right] = 0 \tag{9}$$

$$\frac{\partial \Pi}{\partial L_2} = P_2 \frac{\partial q_0}{\partial L_2} - w + \mu \left[P_2 \frac{\partial q_2}{\partial K_2} - w \right] = 0 \tag{10}$$

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[4] See for a more thorough discussion of this issue Roger Sherman, The Economics of Industry (Boston: Little, Brown and Company, 1974), pp. 383-400.

$$\frac{\partial \Pi}{\partial K_2} = P_2 \frac{\partial q_2}{\partial L_2} - r + \mu \left[P_2 \frac{\partial q_2}{\partial K_2} - s \right] = 0 \qquad (11)$$

$$\frac{\partial \Pi}{\partial L} = P_1 \frac{\partial q_1}{\partial L} + P_2 \frac{\partial q_2}{\partial L} - w + \mu \left[P_1 \frac{\partial q_1}{\partial L} + P_2 \frac{\partial q_2}{\partial L} - w \right] = 0 \qquad (12)$$

$$\frac{\partial \Pi}{\partial K} = P_1 \frac{\partial q_1}{\partial K} + P_2 \frac{\partial q_2}{\partial K} - r + \mu \left[P_1 \frac{\partial q_1}{\partial K} + P_2 \frac{\partial q_2}{\partial K} - s \right] = 0 \qquad (13)$$

Again, looking at what the cost minimizing example is, it can be seen that the ratio of marginal revenue products gives the ratio or the wage rates. Because of the rate of return constraint, a distortion in the imput wage ratios is evident.[5] The ratios of marginal revenue productivities now equals:

$$\frac{MRPL1}{MRPK1} = \frac{MRPL2}{MRPK2} = \frac{MRP_{L_1} + MRP_{L_2}}{MRP_{K_1} + MRP_{K_2}} = \frac{w}{r - \frac{\mu s}{1 - \mu}} \qquad (14)$$

where μ is the Lagrangean multiplier and $0 < \mu < 1$ and can be considered the measure of constraint of the regulatory rate of return. It is assumed that

$$\frac{r - \mu}{1 - \mu} < r$$

since $(r - \mu s) < (r - \mu r)$ if and only if $s > r$. It can be seen that when $s > r$,

[5]See Harvey Averch and Leland Johnson, "Behavior of the Firm Under Regulatory Constraint," American Economic Review 52 (December 1962),

$$\frac{w}{r - \frac{\mu s}{1 - \mu}} > r \tag{14b}$$

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pp. 1052-1069. It should be point out, however, that many empirical studies have been undertaken examining the Averch-Johnson hypothesis and the results have been inconclusive. These tests have centered around the electric utility industry and have employed various methodologies.

A comparison was made by Moore [Thomas Moore, "The Effectiveness of Regulation of Electric Utility Prices," Southern Economic Journal 36 (April 1970), pp. 365-375]. He found no evidence of an A-J bias in an examination of public versus private firms. His data even points to a bias in the opposite direction for inefficient muncipal utilities. Courville [L. Courville, "Regulation and Efficiency in the Electric Utility Industry," Bell Journal of Economics 5 (Spring 1974), pp. 55-74]. examined the issue of factor substitution among generating plants and found that an A-J bias did exist. Peterson [H. C. Peterson, "An Empirical Test of Regulatory Effects," Bell Journal of Economics 6 (Spring 1975), pp. 111-126] studied the effects of a restrictive regulatory policy (i.e., the allowed rate of return is close to the cost of capital) finding that costs rise and the amount of dollars spent on capital input rises supporting the A-J hypothesis.

Boyes [W. J. Boyes, "An Empirical Examination of the A-J Effect," Economic Inquiry (March 1976), pp. 25-35] in his study of 60 new steam plants tried to prove λ, the regulatory constraint to be greater than zero, but his results were such that λ was not significantly different from zero, discrediting the A-J effect. Finally, Barron and Taggart [D. P. Barron & R. A. Taggart, "A model of Regulation Under Uncertainty and a Test of Regulatory Bias," Bell Journal of Economics 8 (Spring 1977), pp. 151-167] examine the effects of firm's expectations of its choice of capital input to see if the choice influences the regulated price. An A-J bias would result if the regulatory price responded to increases in capital inputs. Barron and Taggart found after analyzing 48 companies that the price anticipation of an increase in capital is negative (perhaps under-capitalization) and that regulation effectively keeps prices below the profit maximizing level, suggesting that the A-J distortion exists, so the theoretical results can be softened but not discarded.

This relationship is exactly what the static Averch-Johnson model would predict if there is no uncertainty: no longer is the firm going to produce at the cost minimizing point A in Figure 3.1, given the bias towards the use of capital. If the firm is permitted only a certain rate of return through regulation, and when an unregulated firm could earn a greater rate of return, the firm will take the constraint into account switching resources into capital to take advantage of the extra return available.[6] This analysis indicates that to produce specific levels q_1 and q_2, an unregulated firm would use more capital than an unregulated firm and would not be cost minimizing.

The effect on q_1 and q_2 individually, depends upon their capital labor ratios. For example, if $K_1/L_1 > K_2/L_2$, then the regulatory constraint pushes the firm to use more K_1 and K_2. Since $K_1/L_1 > K_2/L_2$, a relatively greater share will go to the more capital intensive section causing a relatively greater amount of output to be produced in that jurisdiction. So if $K_1/L_1 > K_2/L_2$ and given a rate of return constraint, q_1 will increase more than q_2.

Despite the overuse of capital caused by the regulatory constraint in this simple model, there are other issues to address in the labor input market. From (14) it can be inferred that $w = MRP_i$ which at first glance could be interpreted to say the regulated firm will employ the optimal quantity of labor. However, the firm subjected to regulatory constraint employs a smaller amount of labor than is efficient for all

[6]For an analysis of dynamic view of the A-J distortion, see Yoram C. Peles and Jerome L. Stein, "The Effect of Rate of Return Regulation is Highly Sensitive to the Nature of Uncertainty," American Economic Review 66 (June 1976), pp. 278-279. When uncertainty is introduced into the model, the A-J effect can be reversed.

levels of production. For $w = MPL_i$ to be the efficient wage rate it also must be true that $r = MPK_i$ which only occurs at the unregulated firms cost minimizing position. Baumol and Klevorich prove that as r gets closer to s (if K_i and L_i are complementary in the revenue function) then as the amount of capital used increases (from the regulatory constraint) the amount of labor employed also increases. If, however, K_i and L_i are substitutes in the revenue function, an increase in K_i will cause a decrease in L_i.[7] It is theoretically possible that for a telephone company which is capital intensive and has a complementary production, and thus revenue function, the A-J distortion causes both an overuse of capital and an overuse of labor.

Using the A-J approach, the firm adjusts to the regulatory constraint by substituting capital for labor and expanding total output. If the unregulated firm were constrained to move along the socially efficient expansion path (where $w/r = MRP_{L_i}/MRP_{K_i}$), the firm would operate at a price slightly above average cost (AC) reflecting the fact that $s > r$. Since the firm is subject to this distortion, the social cost or regulation causes the AC to shift to a higher position forcing the firm to expand its output past the monopoly output position.[8]

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[7]William J. Baumol and Alvin K. Klevorick, "Input Choices and Rate of Return Regulation: An Overview of the Discussion," Bell Journal of Economics 1 (Autumn 1970), pp. 175-176.

[8]Averch, Johnson, p. 1057; see also Jerome L. Stein and George H. Borts, "Behavior of the Firm Under Regulatory Constraint," American Economic Review 52 (December 1972), pp. 964-965.

Settlements and Separation

The third model introduces both the settlements and separations processes into the anlaysis. The settlement process essentially puts all interstate billings for all companies into a nationwide pool (see Figure 3.1). All companies then aggregate all their plant and equipment into the interstate jurisdiction under the process outlined in the Ozark plan. The companies are then allowed to recover their expenses from the pool which is then redistributed to the telephone companies by a ratio of each company's total income to the aggregate of interstate investment. Given this process, total revenues in the interstate jurisdicion are no longer P_1q_1.

Other changes in the model concern the Ozark plan definition of capital assigned to the interstate jurisdiction. The SLF is levied against the joint or common capital used by both jurisdictions so that total interstate plant and equipment is now equivalent to K_1 + (SPF)K. This explicit SPF for capital is defined in this model as α_1. Labor is also given a share (α_2) to be allocated to the jurisdictions but the decision is left to the firm as to how the labor supply is to be used, so total labor assigned to the interstate jurisdiction is equal to $L_1 + \alpha_2 L$.

There are also two different regulatory jurisdictions for the intrastate and interstate services such that s_1 is the rate of return allowed for toll services and s_2 is the allowed return for local services. Settlements are treated in the plan by replacing P_1q_1 with the return to company j (R_j) received through the settlement process where R_j is as follows:

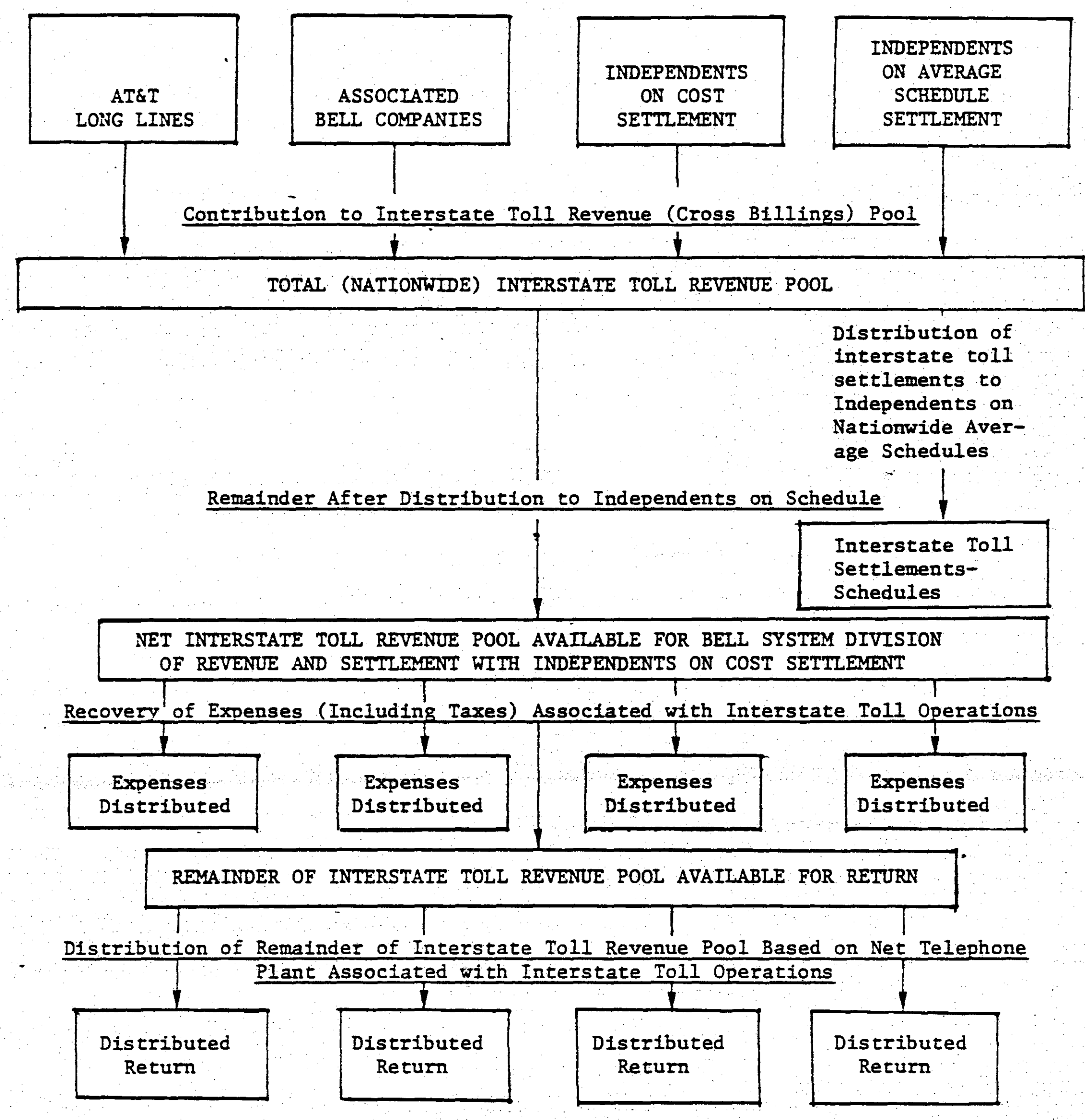

FIGURE 3.1

BREAKDOWN FOR SETTLEMENTS PROCEDURES

Source: Anthony Oettinger, The Federal Side of Telecommunications Cost Allocations (Cambridge: Program on Information Resources Policy, 1980) p. 63.

$$R_j = \rho BV_j$$

$$\rho = \frac{\text{Total income from interstate services for all companies}}{\text{Total interstate investment for all companies}}$$

$$= \frac{\Sigma_j p_{1j} q_{ij} - r(\Sigma_j K_{1j} + \alpha_1 \Sigma_j K^*) - w(\Sigma_j L_{1j} - \alpha_{2j} \Sigma_j L^*)}{\Sigma K_{1j} + K_j} \tag{15a}$$

and

BV_j = interstate plant and equipment for company j

$$= K_{1j} + \alpha_1 K^*_j \tag{15b}$$

where

R_j = Amount of pool returned to a firm for provision of interstate toll services

P_{ij} = Price for service in jurisdiction i by firm i which is the inverse of the demand function

q_{ij} = Quantity of service provided in i by j

K_{ij} = Amount of capital employed in i by j

L_{ij} = Amount of labor employed in i by j

K^*_j = Amount of common capital employed by j

L^*_j = Amount of common capital employed by j

α_1 = Share of capital used to allocate K^*_j between jurisdictions

α_2 = Share of labor used to allocate L^*_j between jurisdictions $\alpha_i > 0$, $(1 - \alpha_i) > 0$

Before examining the profit maximization problem faced by the firm the incentives involved in the settlements process need to be discussed. It must be remembered that the firm tries to maximize profit, not settlement income. A priori, it is expected that the following conditions will hold:

1. If K_{ij} or K_1^* increases, R_j increases if and only if $(K_{1j} + \alpha_1 K_1^*)$ increases at a faster rate than
$\sum_j K_{1j} + \alpha_1 \sum_j K_j^*$
2. If K_{12} of K_2^* increases, R_j decreases.
3. If L_{ij} or L_j^* increases, R_j decreases.
4. If α_2 or α_1 increases, R_j decreases.
5. If w or r increases, R_j decreases.

Looking at a simple example with only two firms and no taxes, the following first order conditions are found:

$$\frac{\partial R_1}{\partial K_{11}} = \Sigma P_{12} q_{12} + \alpha_1 K_1^* MRP_{K_{11}} - r[2\,(K_{11} + \alpha_1 K_1^*) - w[L_{11} + L_{12} + \alpha_2\,(L_1^* + L_2^*)] \lesseqgtr 0 \tag{16a}$$

$$\frac{\partial R_1}{\partial K_1^*} = P_{11} \frac{\partial q_{11}}{\partial K_1^*} + \alpha_1\ [\Sigma P_{ij} q_{ij} - r\ [2\,(K_{11} + K_1^*) + K_{12} + K_2^*] - w\ [\,L_{11} + L_{12} + \alpha_2\,(L^* + L^*)\,]]\quad b - C\alpha_1 \lesseqgtr 0 \tag{16b}$$

$$\frac{\partial R_1}{\partial K_{12}} = P_{12} \frac{\partial q_{12}}{\partial K_{12}} - r < 0 \tag{17a}$$

$$\frac{\partial R_1}{\partial K_2} = P_{12} \frac{\partial q_{12}}{\partial K_2^*} - r \quad b - C\alpha_1 < 0 \tag{17b}$$

$$\frac{\partial R_1}{\partial L_{11}} = P_{11} \frac{\partial q_{11}}{\partial L_{11}} - w < 0 \tag{18a}$$

$$\frac{\partial R_1}{\partial L_{12}} = P_{12} \frac{\partial q_{12}}{\partial L_{12}} - w < 0 \qquad (18b)$$

$$\frac{\partial R_1}{\partial L_1^*} = P_{11} \frac{\partial q_{11}}{\partial L_1^*} - \alpha_2 w < 0 \qquad (18c)$$

$$\frac{\partial R_1}{\partial L_2^*} = P_{12} \frac{\partial q_{12}}{\partial L_2^*} - \alpha_2 w < 0 \qquad (18d)$$

$$\begin{aligned}\frac{\partial R_1}{\partial \alpha_1} = \{ &\Sigma P_{ij} q_{ij} (K_j^*) - rK_1^* [\Sigma K_{ij} + 2\alpha_1 (1 + K_1^*)] - K_1 [L_{11} + \\ &+ L_{12} + \alpha 2 (L_1{}^* + L_2{}^*)]\} b \\ &- C (K_1^* + K_2^*) < 0 \end{aligned} \qquad (19a)$$

$$\frac{\partial R_1}{\partial \alpha_2} = L_1^* [K_{11} + \alpha_1 K_1^*] b - C (L_1^*) < 0 \qquad (19b)$$

Equation 16 shows the relationship between the return to the company, and that firm's use of more capital. Equation 16a would be expected to be positive if K_{11} increases at a faster rate than the capital employed by firm two. Otherwise it will be negative since additional K_{11} increases expenses. Since firm two does not have incentive to maximize firm one's revenues equation 17a implies that marginal revenue product for interstate capital for firm one is paid less than its wage rate. Equation 16b shows the effects of altering the amount of K_1^* on the firms return from the settlements pool. Equation 17a would be expected to be negative because additional K_1^* increases the expenses in the interstate jurisdiction, but it can be positvie if $K_{11} + \alpha_1 K_1^*$ increases at a faster rate than $\Sigma K_{1j} + \alpha_1 \Sigma K_j^*$. From 17b it is expected that $\frac{\partial R_1}{\partial K_2^*}$ would be negative since an increase in capital by firm two increases its expenses and decreases the amount of the pool available for redistribution.

Equations (18a-d) show the effects of changing the amount of labor employed by the two firms on the settlements pool. Increases in the amount of labor employed will increase expenses thus reducing the pool. In all cases the marginal revenue product of labor is less than the wage rate, which means labor is being used inefficiently by the firm.

It is also important to note that the marginal revenue products of the firms are interrelated. The marginal revenue product of common labor for firm two, for example, is a function of firm one's allocation of capital and labor and vice versa which increases the level of complication involved in this model.

Equation 19a says that α_1 decreases the revenue available for distribution. So α_1 increases the expenses associated with K_1^* increase which decreases the settlements pool. In addition, as α_2 increases, the pool decreases because of increased expenses. Overall, the settlements process has disincentives to minimize costs. Whenever expenses associated with the interstate market increase, the firm can retrieve them through the interstate pool. It is also important to note that it may be possible to maximize total profits without maximizing settlement returns.

Now, given the incentives described above, there are some additional assumptions. First, there are two jurisdictions subject to rate of return requirements of the FCC and the state utility commissions. The SPF from the Ozark separation plan is α_1 in the model, while α_2 is implicity decided by the firm. The model as modified now looks like this:

$$\text{Max } \Pi = R_1 + P_{12}q_{12} - r\ [\ K_{12} + (1 - \alpha_1)\ K_1^*\ ] - w\ [\ L_{12} + (1 - \alpha_2)\ L_1^*\ ]$$
$$+ \lambda_1\ [\ R_1 - s_1\ (K_{11} + \alpha_1 K_1^*)\ ]$$
$$+ \lambda_2\ [\ P_{12}q_{12} - w\ (L_{12} + (1 - \alpha_2)\ L_2^* - s_2\ (K_{12} + (1 - \alpha_1)\ K_2^*\ ] \tag{20}$$

where s_1 = rate of return in interstate market

s_2 = rate of return in local market

R_1 = return from interstate pool

Maximizing the equation, the following first order considerations are obtained:

$$\frac{\partial \Pi}{\partial K_{11}} = \frac{\partial R_1}{\partial K_{11}} + \lambda_1 \left[\frac{\partial R_1}{\partial K_{11}} - S_1 \right] = 0 \tag{21}$$

$$\frac{\partial \Pi}{\partial K_{21}} = P_{21} \frac{\partial q_{12}}{K_{21}} - r + \lambda_2 \left[P_{21} \frac{\partial q_{21}}{\partial K_{21}} - S_2 \right] = 0 \tag{22}$$

$$\frac{\partial \Pi}{\partial K_1^*} = \frac{\partial R_1}{\partial L_{11}} + (1 - \alpha_1) \quad P_{21} \frac{\partial q_{21}}{\partial K_1^*} - r \quad + \lambda_1 \left[\frac{\partial R_j}{\partial K_1^*} - \alpha_1 S_1 \right]$$
$$+ \lambda_2 \left[(1 - \alpha_1 \quad P_{21} \frac{\partial q_{21}}{\partial K_1^*} - S_2 \right] = 0 \tag{23}$$

$$\frac{\partial \Pi}{\partial L_{11}} = \frac{\partial R_j}{\partial L_{11}} + \lambda_1 \left[\frac{\partial R_j}{\partial L_{11}} - w \right] = 0 \tag{24}$$

$$\frac{\partial \Pi}{\partial L_{21}} = P_{21} \frac{\partial q_{21}}{\partial L_{21}} - w + \lambda_2 \left[P_{21} \frac{\partial q_{21}}{\partial L_{21}} - w \right] = 0 \tag{25}$$

$$\frac{\partial \Pi}{\partial L_1} = \frac{\partial R_1}{\partial L_1} + (1 - \alpha_2)\ P_{21} \frac{\partial q_{21}}{\partial L_1^*} - w + \lambda_1 \quad \frac{\partial R_1}{\partial L_1^*}$$
$$+ \lambda_2 \left[(1 - \alpha_2) \quad P_{21} \frac{\partial q_{21}}{\partial L_1^*} - w \right] = 0 \tag{26}$$

$$\frac{\partial \Pi}{\partial \alpha_1} = \frac{\partial R_1}{\partial \alpha_1} - r\, K_1^* + \lambda_1 \left[\frac{\partial R_j}{\partial \alpha_1} - S_1 K_1^* \right] + \lambda_2\, S_1\, K_1 = 0 \tag{27}$$

$$\frac{\partial \Pi}{\partial \alpha_1} = \frac{\partial R_1}{\partial \alpha_2} - w\, L_1^* + \lambda_1 \frac{\partial R_1}{\partial \alpha} + \lambda_2 - wL_1^* = 0 \tag{28}$$

It is evident that the ratio of the marginal revenue products does not equal the ratio of the wage rates. The profit maximizing firm facing regulatory constraints (as formulated by Averch-Johnson) is also subject to a distortion from the settlements and separations procedures. For example, the ratio of the wage rates for the interstate jurisdiction is:

$$\frac{w}{r} = \frac{MRP_{L_{11}} \left[K_{11} + K_{12} + \alpha_1 \left(\partial K_1^* + K_2^* \right) \right]}{\left[\sum_j P_{1j} q_{1j} + \alpha_1 K_1^* MRP_{K_{11}} - S_1 - L_{11} - L_{12} - \alpha_2 \left(L_1 + L_2 \right) \right] \left[1 + \left(K_{11} + \alpha_2 K_1 \right) \right]} \tag{29}$$

The ratio reflects the biases caused by the arbitrary capital allocation methodology inherent in the separations and settlements process. The ratio of wage rates for the local market is similar to the result obtained in equation 14a:

$$\frac{w}{r} = \frac{MRP_{L_{21}} \left(1 + \lambda_2\right)}{MRP_{K_{21}} \left(1 + \lambda_2\right) - \lambda_2 s_2 \left(1 + \lambda_2\right)} \tag{30}$$

Because of the separations and settlements process however, the marginal revenue products are altered due to the allocative distorting, so the effects from the procedures spill into the local jurisdiction through altered marginal revenue productivities. For the ratio of common capital and labor inputs, this distortion can also be seen.

$$\frac{w}{r} = \frac{\frac{\partial R}{\partial L_1^*}(1 + \lambda_1) + (1 - \alpha_2)(1 + \lambda_2)MRP_L^* \quad (1 - \alpha_1)}{\frac{\partial R}{\partial K_1^*}(1 + \lambda_1) + (1 - \alpha_1)(1 + \lambda_2)MRP_K^* - \lambda_1 \alpha_1 S_1 - \lambda_2(1 - \alpha_1) S_2} \tag{31}$$

It seems that from this ratio there is a tendency for over capitalization, but there cannot be a definitive statement concerning the ratio because of the effects of settlements. It is clear, though, the marginal revenue productivities do not equal the wage rates.

The pressure for the constant changes in the allocative procedure is evident. The telephone industry over the past 30 years has been very dynamic. Changes in technology and demand for different classes of telephone service constantly conflict with the objective stated in the separations plans. In addition, the use of separations revenues to subsidize the local telephone market is inefficient in itself, in addition to the distortions it causes in the selection and use of inputs. This paper has not discussed the output mix distortion created by settlements which cross subsidize local service. If anything, there may be a tendency to over capitalize in the toll markets to gain settlements revenue. These complications cannot be discussed solely in terms of separations and settlements, but in terms of other facets of today's telecommunication markets.

Discussion of Models in Light of History

The history of the separations process shows the FCC, state public utility commissions, NARUC, and AT&T supporting various changes upon the methods of allocating costs. Using the two jurisdictional model above, it is possible to trace the changes and their effects on settlements. For example, if intercity toll traffic between two major cities such as New York and San Fransico were to double over the course of a year; given the same rate structure, the amount of toll revenues in the national pool would increase. Some of these revenues will be recovered as additional operating expenses for the company providing the services within the cities. Local and exchange costs allocated to interstate services by the New York and San Francisco companies will be greater due to a relative increase in toll usage. Given this result, it is important to note that interstate toll revenues resulting from the increased toll traffic will increase more than costs (as costs are defined by the present separations plan) through economies of scale and the uniform toll rate structure. So, not only do the local exchanges in San Francisco and New York experience the increased toll traffic benefit because they are able to recover more of their exchange plant costs from the interstate revenue pool, but the amount left over (not allocated to the San Francisco and New York companies) is still larger than it was in the preceeding year leaving more to be divided among the telephone companies providing toll services. The result is that all telephone companies in the message toll business receive additional return on investment on interstate plant and equipment.[9]

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[9]Basil J. Boritzki "Settlements and Separations," Public Utilities Fortnightly, 94 (October 10, 1974), p. 30.

With the increased demand for toll services and an improving long distance technology costs started to decline at the same time revenues were increasing. After the Smith decision and the separations procedures were implemented, the FCC had three alternatives to deal with higher rates of return in the interstate jurisdiction. The first was to decrease interstate rates, the second was to change separations procedures allocating more plant in the local jurisdiction to the long distance jurisdiction, or finally, it could use a combination of the two methods.

The first option is, according to the model described above, to decrease s_1. At first, this was the FCC's sole reaction to the increased rates of return on interstate toll calls. The result, though, brought about many complaints by the states which were complaining about the rate disparity problem. It costs much more to call 100 miles solely within a state than to call 100 miles interstate. There were interstate rate reductions in 1935, and every year between 1940 to 1946, while the Bell System exchange and toll rate had increased by more than $400 million annually.[10]

This inequity of sorts was recognized finally in 1947 with the NARUC-FCC Joint Board Separations Manual. In order to ease the rate disparity problem, some capital in the local jurisdiction, K_2, was removed and allocated to the interstate jurisdictions. In addition, the separations manual set up the α_1 as a means for allocating future costs. When the Charleston plan was adopted in 1952, the same process was repeated, a new definition of K_1 was created and α_1 was altered to try to

[10]Gable, pp. 37, 65-66.

allocate costs more effectively. For the later plans, similar action was taken to reallocate costs and change interstate investment. Table 3.1 and Figure 3.2 show the increases in allocation of capital to the interstate jurisdiction from the start of the use of separations; the frequency and the size of the reallocations show the ineffectiveness of these policies.

TABLE 3.1

EFFECTS OF CHANGING SEPARATIONS FORMULA ON INTERSTATE REVENUE REQUIREMENTS

Year	Separations Change	Estimated Increase in Revenue Requirements
1947	Original Plan	$ 13,000,000
1952	Charleston Plan	30,000,000
1956	Modified Phoenix Plan	40,000,000
1962	Simplification	46,000,000
1965	Denver Plan	134,000,000
1969	FCC Plan	108,000,000
1971	Ozark Plan	131,000,000

Source: Sparling, p. 90.

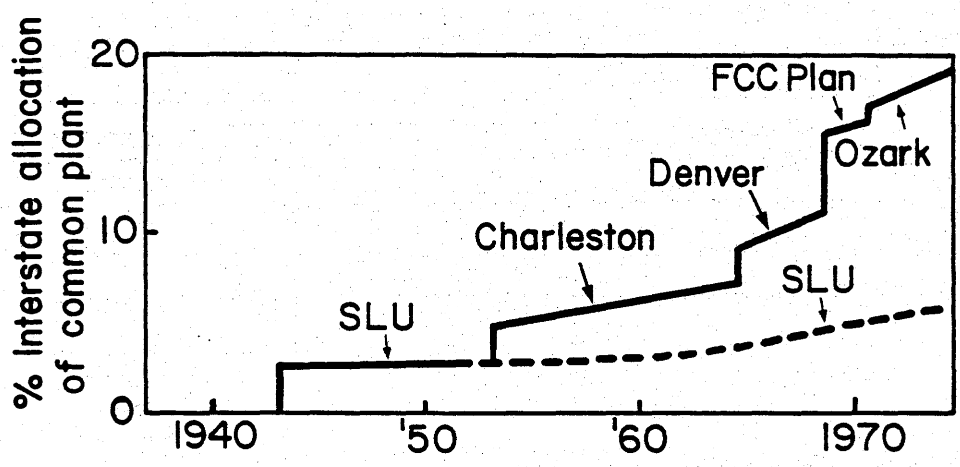

FIGURE 3.2

SEPARATION CHANGES OVER TIME

Source: Anthony Oettinger, The Federal Side of Telecommunications Cost Allocation (Cambridge: Harvard University Program on Information Resources Policy, 1980), p. 33.

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BIOGRAPHICAL SKETCH

Mr. Grace was born in El Paso, Texas in September of 1958. He has lived in various parts of the country going to high school in Colorado Springs, Colorado and Leavenworth, Kansas. After finishing high school, Grace entered the University of New Hampshire in the fall of 1976, graduating in 1980 with a B.A. cum laude in Political Science and Economics. Previous to entering the University of Florida, Mr. Grace worked in the Common Carrier Bureau's Enforcement Division at the Federal Communications Commission as an intern economist. After receiving his Master's Degree, Mr. Grace hopes to work as a regulatory economist for a few years and then pursue a legal education.