Explaining the Choice Among Regulatory Plans

in the U. S. Telecommunications Industry

by

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ABSTRACT

We investigate why different states in the United States choose different regulatory plans in their telecommunications industry. We present a simple theoretical model and an empirical analysis of the issue. We find that a state is more likely to replace rate-of-return regulation with incentive regulation when: (1) historic earnings under rate-of-return regulation in the state are either particularly high or particularly low; (2) key political leadership in the state comes from the Democratic party; and (3) the bypass activity of competitors is less pronounced in the state.

1. Introduction.

Not long ago, rate-of-return regulation was *the* form of regulation employed to control the intrastate earnings of telecommunications firms in the United States. Today, state regulators employ a variety of alternatives to rate-of-return regulation. Some states (e.g., Kansas, Vermont, and Wisconsin) have imposed moratoria on rate hearings and major price changes. Other states (e.g., California, New Jersey, Oregon, and Rhode Island) have adopted forms of price cap regulation, in which regulatory controls are focused on the prices charged by the firm, rather than its earnings. Earnings sharing plans are particularly popular today. Under these plans (employed, for example, in Colorado, Connecticut, Florida, Georgia, Kentucky, Tennessee, and Texas) the regulated firm shares with its customers realized earnings above a specified level.[1]

Economists have devoted considerable attention to theoretical investigations of the merits and drawbacks of rate-of-return regulation and its alternatives.[2] Much less attention has been devoted to empirical investigations of the reasons why different regulatory plans are adopted in different regulatory jurisdictions.[3] Knowledge of adoption patterns is very important, however. This knowledge can inform predictions about how rapidly and how widely regulatory innovations will spread. It can also be useful in assessing the merits of providing the states with regulatory autonomy, rather than imposing centralized federal regulations in all jurisdictions. This latter issue played a central role in the recent debates on how to best revise federal regulation of the U. S. telecommunications industry.

The purpose of this research is to examine empirically the factors that explain the transition from rate-of-return regulation to incentive regulation in the U. S. telecommunications industry. We analyze demographic, political, and regulatory factors, as well as characteristics of the providers of telecommunications services. Our econometric model predicts that states are more likely to replace rate-of-return regulation with incentive regulation (broadly defined) when: (1)

historic earnings under rate-of-return regulation in the state are either particularly high or particularly low; (2) key political leadership in the state comes from the Democratic party rather than the Republican party; and (3) industry conditions in the state favor greater earnings potential for the regulated firm. A key favorable condition is less pronounced bypass activity of competitors.

These findings are recorded and discussed in section 4, after we describe our data and estimation procedure in section 3. Section 2 sketches a simple theoretical model that provides a framework for understanding our empirical findings. Section 5 summarizes our findings, and suggests future research directions.

The model developed in section 2 suggests that the perceived gains from incentive regulation are particularly large when rate-of-return regulation has been particularly constraining in the past, and therefore has dulled incentives for innovation and cost reduction. The model also suggests that incentive regulation is more likely to be adopted in jurisdictions where the regulated firm can be confident that promised rewards for superior performance will actually be delivered. The model also predicts that the regulated firm will be more anxious to operate under incentive regulation when it perceives greater potential profit in the environment where it operates. Thus, less pronounced pressure from competitors and higher expected population growth, for example, can render incentive regulation more attractive to the regulated firm. The model also predicts that, to the extent that Democratic regimes favor the visible, up-front gains for key consumer groups that incentive regulation can provide, incentive regulation may be more likely to be implemented in states where Democrats hold key political offices. These predictions are consistent with the empirical findings described above.

2. A Simple Model.

In this section, we introduce a simple, stylized model which informs the empirical investigation that follows. We begin by describing the model. Then we derive the empirical predictions of the model.

A. Description of the Model.

We analyze a setting with two possible regulatory regimes: rate-of-return regulation (*R*) and incentive regulation (*I*). Under *R*, the maximum level of earnings to which the firm is entitled is Π^R. Consumers receive welfare level W^R under *R*. W^R can be viewed as the level of consumers' surplus generated at the price levels established under *R*.

Under incentive regulation, consumers are sure to receive at least welfare level W^R. They are also sure to receive an additional up-front payoff of magnitude *L*. In practice, the up-front payoff commonly includes such benefits as: (1) a guarantee that the prices of essential services like residential basic local exchange service will not be increased in the near future; (2) investment by the regulated firm, designed to modernize its entire network; (3) specific network modernization and enhancement in rural areas; and (4) the provision of advanced capabilities at no charge to selected non-profit institutions such as schools and hospitals. In our model, incentive regulation also awards to consumers a share of any earnings in excess of Π^R generated by the regulated firm. $1 - s$ will denote the consumers' share of incremental earnings; $s \in (0, 1)$ will represent the firm's share.

Although the incentive regulation plan calls for the sharing of all earnings in excess of Π^R, political considerations may make it impossible for the regulator to credibly commit to allow the firm to earn exceptionally high profits.[4] We model these limits on the regulator's commitment ability very simply, by assuming that the regulator cannot allow the firm any share of earnings in excess of $\overline{\Pi}\,(> \Pi^R)$ under incentive regulation.

The firm's earnings are denoted $\Pi(e; v)$. *e* is effort that the firm devotes to enhancing earnings. For instance, e might represent the managerial effort devoted to studying the production process and reducing costs by streamlining operations. The regulator cannot observe e, but recognizes that the firm will select e to maximize its profits, $\Pi(e;\nu) - e$. Higher effort increases earnings at a decreasing rate, i.e., $\Pi_e(\cdot) > 0$ and $\Pi_{ee}(\cdot) < 0$, where subscripts denote partial derivatives.

$\nu \in [\underline{\nu}, \bar{\nu}]$ is a parameter that influences the firm's ability to generate higher earnings in the regulated environment. For example, ν may reflect the strength of competitive pressures. As a normalization, higher values of ν will denote environments in which earnings are higher for any level of effort by the regulated firm, and in which increased effort by the firm is more effective at increasing earnings, i.e., $\Pi_\nu(e;\nu) > 0$ and $\Pi_{e\nu}(e;\nu) > 0$.[5]

Rate-of-return regulation, which limits the firm's earnings to Π^R, is assumed to reduce the firm's effort to a point where the extra earnings generated by additional effort exceed the cost of that effort, i.e., $\Pi_e(e^R(\nu);\nu) > 1$ where $\Pi(e^R(\nu);\nu) = \Pi^R$.[6] Therefore, if sufficient incentive is provided under incentive regulation, the firm can be induced to provide additional effort that will increase both profits and the financial rewards of consumers. "Sufficient incentive" requires $s > \underline{s}(\nu)$, where $\underline{s}(\nu)\,\Pi_e(e^R(\nu);\nu) = 1$. In words, the firm must be awarded enough of the extra earnings it generates to ensure that the firm's financial gain from increasing its effort above the level supplied under rate-of-return regulation outweighs the associated cost. To focus the analysis on meaningful incentive regulation, s will be assumed to exceed $\underline{s}(\nu)$ for all ν throughout the ensuing analysis.

The timing in the model is as follows. At the outset, the regulated firm operates under rate-of-return regulation, R. It can, however, propose to replace R with incentive regulation, I. If the regulator accepts the firm's proposal, I is implemented and the firm delivers L to consumers immediately. If the firm's proposal is not accepted, R remains in place.[7] After the regulatory regime is determined in this manner, the regulated firm supplies the profit-maximizing level of effort. Earnings and consumer welfare are then realized. Under I, the fraction $1 - s$ of realized earnings in excess of Π^R but below $\overline{\Pi}$ is awarded to consumers, and the firm retains $\Pi^R + s[\Pi(\cdot) - \Pi^R] \leq \overline{\Pi}$. Any earnings in excess of $\overline{\Pi}$ are given to consumers. We will refer to the consumers' extra gains from higher earnings as consumer dividends, D, where $D \equiv [1 - s][\overline{\Pi} - \Pi^R] + \Pi(\cdot) - \overline{\Pi}$ if $\Pi(\cdot) > \overline{\Pi}$, and $D \equiv [1 - s][\Pi(\cdot) - \Pi^R]$ if $\Pi(\cdot) \leq \overline{\Pi}$.[8]

The regulated firm will propose I as an alternative to R if it anticipates higher profit under I and if it believes the regulator will agree to adopt I. The regulator will adopt I if doing so sufficiently increases the well-being of consumers. The regulator values the future stream of consumer welfare (W^R) that is ensured under both I and R. He also values the flow of consumer dividends (D) and the up-front payoff (L) consumers receive under I. To account for discounting and for any other differential regulatory valuation of L and D, the regulator's utility function is taken to be $\alpha L + W^R + D$, where $\alpha > 0$. The greater is α, the more highly the regulator values the up-front payoff consumers receive under I.[9]

Our primary concern is with the likelihood that incentive regulation, I, will be adopted in place of rate-of-return regulation, R. I will replace R when:

$$-L + \Pi^R + s[\Pi(e^I; v) - \Pi^R] - e^I \geq \Pi^R - e^R(v), \text{ and} \tag{1}$$

$$\alpha L + [1 - s][\Pi(e^I; v) - \Pi^R] \geq T, \tag{2}$$

where $e^I \equiv \underset{e}{\operatorname{argmax}} \{\Pi^R + s[\Pi(e; v) - \Pi^R] - e\}$ and $\Pi(e^R(v); v) = \Pi^R$.[10] T in (2) can be viewed as a transactions cost of switching regulatory regimes. This cost may stem from legal or political considerations, for example, or it may be influenced by the regulator's expertise and/or his resources. The higher is T, the greater is the increase in consumer welfare the regulator must anticipate before he will authorize a switch from R to I.

B. Testable Implications of the Model.

The foregoing model predicts that incentive regulation, I, is more likely to replace rate-of-return regulation, R, in regulatory settings where inequalities (1) and (2) are more likely to hold. To explore these relationships more systematically, define the differences in the firm's profit and the regulator's utility under incentive regulation and rate-of-return regulation as follows:

$$\Delta^f \equiv -L + s\,[\Pi(e^I;v) - \Pi^R(v)] - [e^I - e^R(v)], \text{ and} \tag{3}$$

$$\Delta^r \equiv \alpha L + [1-s][\Pi(e^I;v) - \Pi^R] - T. \tag{4}$$

We now identify the factors in the model that lead to increases in Δ^f and Δ^r, and thus to an increased likelihood of I.

Observation 1. $\dfrac{d\Delta^f}{d\Pi^R} < 0$ and $\dfrac{d\Delta^r}{d\Pi^R} < 0.$

Observation 1 holds because a higher profit ceiling under rate-of-return regulation, R, results in a smaller increase in earnings, profits, and consumer dividends under incentive regulation, I.[11] The reduction in incremental profits arises because profits under I are not affected by marginal changes in Π^R, whereas profits under R increase with Π^R. The reduction in consumer dividends follows from the smaller increment in earnings under I.[12]

Observation 2. $\dfrac{d\Delta^f}{d\overline{\Pi}} \geq 0$ and $\dfrac{d\Delta^r}{d\overline{\Pi}} \geq 0$, with strict inequalities if $\overline{\Pi}$ constitutes a binding constraint on the firm's earnings under I.

Observation 2 states that the higher the level of earnings the regulator can credibly promise to the firm under incentive regulation, I, the greater the gain in profit the firm anticipates from a switch to I. The ensuing increased earnings also provide increased consumer dividends, which ensure an increased gain for the regulator from a switch to I.

Observation 3. $\frac{d\Delta^f}{dv} > 0$ and $\frac{d\Delta^r}{dv} \geq 0$, where the latter inequality is strict if $\overline{\Pi}$ is not a binding constraint on the firm's earnings under I.

Observation 3 reveals that the gains from incentive regulation are more pronounced for both the firm and consumers in environments that admit greater profit potential for the regulated firm. The greater potential leads to both higher profit and higher consumer dividends under incentive regulation.

Observation 4. $\frac{d\Delta^f}{d\alpha} = 0$ and $\frac{d\Delta^r}{d\alpha} > 0$.

Observation 4 records the obvious point that as the regulator values more highly the up-front payoff (L) that consumers receive under incentive regulation, the net gains the regulator anticipates from adopting incentive regulation increase. The firm's net payoff from incentive regulation is not affected directly by differences in the regulator's valuation of L.

Observation 5. $\frac{d\Delta^f}{dT} = 0$ and $\frac{d\Delta^r}{dT} < 0$.

Observation 5 simply states that the higher are the regulator's transactions costs of switching regulatory regimes, the smaller are the regulator's net gains from switching from R to I.

Observations 1 - 5 suggest the following empirical predictions. First, the more stringent are the limits on earnings under rate-of-return regulation, R, the more likely is a switch from R to incentive regulation, I. Second, the greater is the regulator's ability to refrain from usurping for consumers higher earnings achieved by the firm, the greater is the likelihood of a switch to I.

Third, the greater is the potential for enhanced profit in the regulated industry, the more probable is *I*. Fourth, the more highly the regulator values the up-front payoff for key consumer groups that *I* provides, the more likely is a switch from *R* to *I*. Fifth, the more pronounced the transactions costs of switching regulatory regimes, the less likely is *I*.

3. The Empirical Analysis.

To test the predictions of the foregoing simple model, we analyzed the observed choice among regulatory plans in the United States telecommunications industry. The state regulatory plans in effect for the relevant regional Bell Operating Company (RBOC) in 1991 were classified into one of two categories[13]: rate-of-return regulation (*R*)[14] or incentive regulation (*I*).[15] The incentive regulation classification encompasses regulatory plans with different features.[16] Under the most prominent form of incentive regulation, the regulated firm shared incremental earnings with its customers. Nineteen of the thirty states that had adopted incentive regulation by 1991 employed a form of sharing.[17] Many states also adopted rate case moratoria, which postponed major reviews of realized and prospective earnings for a specified period of time, and often imposed rate freezes and/or required up-front investments in network modernization.[18] Although regulatory plans that impose a moratorium on rate hearings do not explicitly call for the earnings sharing depicted in the model of section 2, sharing of realized gains is common in practice when the firm's performance is reviewed following the plan's expiration.

We employed the logit model[19] to analyze the choice between the two regulatory regimes (*R* and *I*), largely because of the model's computational ease. The dependent variable in our regressions took on one of two values: 0 if *R* was imposed on the RBOC operating in the state in 1991; and 1 if *I* was the chosen regulatory regime. There were five main explanatory variables in our primary regression, whose choice was informed by the parameters in the model of section 2.

The variables are labelled: AROR, BYPASS, POPGROW, DEMOCRAT, and ELECT. Key features of these variables are summarized in Tables 1 and 2.

AROR stands for the average relative allowed rate of return. AROR for an RBOC is calculated by averaging over the relevant years the ratio of the RBOC's allowed rate of return on rate base in each year to the average allowed rate of return for all RBOC's in that year. The relevant years for this calculation depend on whether and when an RBOC adopted incentive regulation, *I*. For states in which the RBOC operated under *R* in 1991, the average allowed rate of return was calculated between 1984 (the year the divestiture of AT&T took effect) and 1990. For states where the RBOC operated under *I* in 1991, the average was calculated between 1984 and the year prior to the adoption of incentive regulation.[20] This procedure was designed to capture the influence of allowed returns during the period when a switch from *R* to *I* might have been under active consideration. We employed relative allowed returns rather than nominal allowed returns to account for any trends in allowed returns over time.[21]

Observation 1 predicts an inverse relationship between AROR and the likelihood of incentive regulation, *I*. In contrast, Observation 2 suggests a direct relationship between AROR and the probability of *I*, to the extent that higher allowed returns under rate-of-return regulation reflect an enhanced regulatory ability to permit higher earnings under *I*. To account for both these effects, each of which may be more pronounced over different ranges of allowed returns, we included both AROR and its square, AROR*2, in our regression.

BYPASS is the first of two variables we employed to reflect the potential profitability of the regulated environment in a state (i.e., v in the model of section 2). BYPASS for an RBOC is the average of its estimated revenue loss to facility-switched and facility-private line bypass (expressed as a fraction of the firm's total operating revenues) divided by the average of the corresponding statistic for all RBOC's.[22] The average is calculated between 1987 and 1990 for those states that employed R in 1991, and between 1987 and the year before incentive regulation was adopted in other states.[23] Facility-switched (respectively, facility-private line) bypass occurs when former or potential customers of an RBOC use facilities other than the RBOC's to satisfy their communication needs, rather than purchase the switched (respectively, the private line) services offered by the RBOC. Cable television wires, microwave and satellite systems, and the fiber cables installed by competitive access providers (such as Teleport and Metropolitan Fiber Systems) can all facilitate bypass of an RBOC's network.[24] We suspect that in those states where competitive pressures are more pronounced, the extra earnings that arise from a given level of increased effort by the regulated firm will be more meager. Consequently, as Observation 3 suggests, the firm will anticipate smaller gains from incentive regulation, leading to an inverse relationship between the extent of bypass and the likelihood of incentive regulation, and thus a negative sign on BYPASS in our regression.[25,26]

The variable POPGROW was also introduced as a measure of the potential profitability of the regulated environment. POPGROW for a state is the estimated percentage growth in the state's population between 1988 and 1995, as thus serves as a rough measure of likely growth in near-term demand for telecommunications services in the state.[27] With well-developed networks in place, expanding demand for telecommunications services generally increases net revenues for providers of these services. Thus, Observation 3 suggests the coefficient on POPGROW in our regression should be positive.

The variable DEMOCRAT was introduced as a measure of α in the model of section 2. α, recall, reflects the regulator's valuation of the up-front payoff to consumers that incentive regulation provides. DEMOCRAT reflects the party of the governor in the state. The variable averages over the period 1984-1991 the value of a binary variable that is 0 when the governor is a member of the Republican party in a given year, and 1 when the governor in that year is a Democrat.[28] Thus, a higher value for DEMOCRAT reflects a state with more pronounced Democratic influence in the governor's office. Because of the governor's power to make key appointments and because of other related gubernatorial powers, political influence in the governor's office translates into broader political influence throughout the state. To the extent that Democratic interests are more consumer oriented than Republican interests, states with Democratic leadership may differentially value the gains that incentive regulation can secure for key consumer groups -- particularly gains that would not normally be provided by the free market, such as continued subsidies for residential basic local service and network enhancement in rural areas. Thus, in line with Observation 4, states with Democratic leadership may be more likely to adopt incentive regulation.

On the other hand, Democrats are often less enthusiastic than Republicans about governance structures that rely more on the unfettered operation of the free market, particularly if the structures are likely to increase the earnings of large corporations. Therefore, the transactions costs of switching from R to I may be higher in states with Democratic leadership. Consequently, taking Observation 5 into account, the sign of the coefficient on the DEMOCRAT variable in our regression is difficult to predict *a priori*.[29]

The variable ELECT was also introduced as an additional possible proxy for α. ELECT is a binary variable with value 0 if regulatory commissioners are appointed in the state, and 1 if they are elected.[30] Because elected commissioners are often compelled to document their accomplishments to the layman at frequent intervals, they may particularly value the immediate, visible gains that incentive regulation can secure for voters. Consequently, Observation 4 suggests a positive coefficient on the ELECT variable in our regression, reflecting an increased likelihood of incentive regulation in states where regulatory commissioners are elected. On the other hand, because appointed commissioners may be more insulated from the immediate reactions of voters, they may be more willing to experiment with untested forms of regulation. Thus, the transactions (e.g., political) costs of switching regulatory regimes may be lower for appointed commissions. Consequently, Observation 5 suggests a negative coefficient on ELECT. On balance, the sign of the coefficient on ELECT is difficult to predict *a priori*.

4. Findings.

The parameter estimates and standard errors for our main regression are reported in Table 3. To interpret these estimates, recall that the two regulatory alternatives in our analysis are labelled 0 (for rate of return regulation, *R*) and 1 (for incentive regulation, *I*). Under the assumptions of the logit model, the probability that alternative 1 will be chosen is:

$$P(1\,|\,x) = \frac{\exp(x'\beta)}{1 + \exp(x'\beta)}, \tag{5}$$

where x is the vector of explanatory variables and β is the vector of associated parameters. β_i will denote the parameter estimate on the i'th explanatory variable. It follows from (5) that β_i reflects the extent to which an increase in the i'th explanatory variable increases the probability that *I* will be chosen *relative* to the probability of *R*. Formally:

$$\beta_i = \frac{\partial}{\partial x_i} \log\left(\frac{P(1|x)}{P(0|x)}\right). \tag{6}$$

A measure of the impact on the likelihood of *I* of changes in each of the explanatory variables can also be derived from equation (5). These impacts are reported in Table 4. For the continuous variables, AROR, BYPASS, and POPGROW, the entries in the second (respectively, the third) column of Table 4 report the change in the estimated probability of *I* that results as the relevant explanatory variable is increased (respectively, decreased) by one standard deviation above (respectively, below) its mean, evaluating all other explanatory variables at their mean values. The entries in the last column of Table 4 reflect the change in the estimated probability of *I* that results as the variables DEMOCRAT and ELECT are (individually) increased from 0 to 1, evaluating all other explanatory variables at their sample means.

These impacts of changes in the explanatory variables on the probability of incentive regulation will be discussed in detail when we interpret our findings. Before doing so, we briefly address the overall performance of our primary regression. A likelihood ratio test of the null hypothesis that all of the coefficients on the explanatory variables are zero can be rejected at all conventional levels of significance. The relevant *p*-value is .004, which indicates that the variables we consider jointly have a meaningful impact on the choice of regulatory regime. As reported below Table 3, the R^2 statistic for our model is .40.[31] Furthermore, 39 of the 47 choices in our sample (83%) are predicted correctly by our estimating equation. Tests for heteroskedasticity proved negative at the 5% level. The details of our tests and the impact that heteroskedasticity might have on our estimates are reported in Appendix B.

Turning to the individual variables in our regression, consider, first, our measure of average relative allowed returns under *R*. A likelihood ratio test of the hypothesis that the coefficients on AROR and AROR*2 are both zero rejects this hypothesis at the 2% level. (The relevant *p*-value is .014.) Furthermore, as Table 3 reports, AROR and AROR*2 are each significant at the 3% level. These findings suggest some nonlinearity in the relationship between allowed earnings and the choice of regulatory regime, perhaps reflecting the two effects summarized in Observations 1 and 2. The coefficient estimates in Table 3 indicate that the likelihood of incentive regulation: (1) decreases as AROR increases when AROR is less than 0.96;

and (2) increases as AROR increases when AROR exceeds 0.96. Thus, in the range where a firm's (average) allowed return under *R* is more than four percent below (the corresponding average of) the allowed returns for all firms, the inverse relationship between allowed returns and the incidence of incentive regulation predicted in Observation 1 arises. This finding suggests the regulated firm may anticipate substantial gains from *I* when its earnings under *R* are particularly constrained relative to the average. In contrast, in the range where a firm's allowed return under *R* exceeds ninety-six percent of the average of allowed returns for all firms, the likelihood of *I* increases as the firm's allowed return increases. To the extent that the higher allowed returns under *R* reflect an enhanced ability of regulators to deliver promised earnings to the regulated firm, this direct relationship between allowed returns under *R* and the likelihood of *I* may reflect the effect identified in Observation 2: incentive regulation promises greater gains for all parties (and therefore is more likely to be implemented) when promises of substantial financial reward for superior performance are more credible.[31,32]

Table 4 provides some evidence regarding the magnitude of the effect of changes in AROR on the likelihood of *I*. The Table reports that as AROR is increased above its mean value by one standard deviation (i.e., as AROR increases from 1.00 to 1.08) the probability of *I* increases by approximately fifty-two percentage points. A corresponding decrease in AROR below its mean increases the probability of *I* by approximately four percentage points, which provides some feel for the nonlinear nature of the relationship between AROR and the probability of *I*.

Observation 3 suggested that incentive regulation should be more likely in environments where the potential for enhanced earnings by the regulated firm is more pronounced. The coefficient estimates on BYPASS and POPGROW recorded in Table 3 provide support for this prediction. Consider, first, the negative sign on the coefficient of BYPASS. The negative coefficient (which is significant at the 3% level) suggests that regulated firms may be reluctant to tie their financial returns more closely to their market performance in settings where competitive threats are particularly likely to hinder their market performance.[33] Table 4 reports that as BYPASS is increased above its mean value by one standard deviation (i.e., as BYPASS increases from 0.91 to 1.85), the probability of *I* decreases by almost .24. A corresponding decrease in BYPASS below its mean value raises the probability of *I* by approximately .29.

The expected positive coefficient on POPGROW reported in Table 3 provides some additional (weak) evidence that incentive regulation is more likely to be adopted in environments characterized by greater potential profitability. Table 4 reveals that as POPGROW increases above its mean by one standard deviation (i.e., as it increases from .05 to .09), the probability of *I* increases by almost sixteen percentage points. Of course, this estimate must be viewed with caution, since the *p*-value for POPGROW is only .22.[34]

The entries in Table 3 and 4 also suggest that political factors may influence the likelihood that incentive regulation is adopted in a state. The coefficient on DEMOCRAT is significant at the 3% level. Its positive sign indicates an increased likelihood of *I* in states with greater Democratic influence in the governor's office. A switch from complete Republican control of the governor's office to complete Democratic control increases the probability of *I* by nearly fifty-nine percentage points. Observation 4 suggests this finding may reflect greater concern on the part of Democrats with the up-front gains that incentive regulation can secure for key consumer groups.[35]

The hypothesis that elected commissioners may differentially value the up-front payoffs for consumers that incentive regulation can provide is not supported strongly by our estimates. The coefficient on ELECT is positive, but has a *p*-value of only .68, and so is not significant at conventional levels. As noted above, two countervailing influences suggested by Observations 4 and

5 may contribute to this lack of significance. On the one hand, elected commissioners may particularly value the up-front, visible gains for constituents that incentive regulation can provide. On the other hand, appointed commissioners may be more insulated from short-term adverse reactions by consumers, and may therefore perceive less pronounced transactions (e.g., political) costs of switching regulatory regimes.[36,37]

Overall, the findings summarized in Table 3 provide reasonable support for the predictions of the simple model developed in section 2. It should be emphasized, however, that the factors summarized in the model of section 2 and reflected in the variables listed in Table 3 are not the only factors that might influence the choice of regulatory regime in a state. One of the many other factors that may be relevant is the regulated firm's corporate philosophy regarding competition and the marketplace. As Teske (1990, p. 67) points out, U.S. West has a long-standing reputation for being a maverick among the RBOC's and for encouraging deregulation in the telecommunications industry. To test the hypothesis that U.S. West's unique corporate philosophy might make incentive regulation more likely in its territories, we included a dummy variable which took on the value 1 if U.S. West was the parent company of the RBOC in the state, and 0 otherwise. This variable turned out to be insignificant.

It is also conceivable that the choice of regulatory plan in a state might be influenced by the history of prices of telecommunications services in the state. For instance, in states where residential basic local service rates have always been relatively high, further increases in the rates might be deemed unacceptable, leading to pressure for a rate freeze as a component of a broader incentive regulation plan. This hypothesis was not confirmed empirically, however. A variable reflecting the level of residential basic local service rates proved to be insignificant in our regression equation.[38] One possible explanation for this finding is that relatively high residential basic local service rates themselves may reflect either: (1) a less pronounced aversion toward higher rates;[39] or (2) unmeasured demographic or technological factors associated with higher costs of supplying basic telephone service to residential customers.

A third additional factor that may influence the choice of regulatory regime is the recent success of the regulated firm in achieving its allowed rate of return. It is conceivable that in states where the firm routinely achieves its allowed rate of return, incentive regulation holds particular promise of enhanced earnings. In contrast, when the firm is often unable to achieve its allowed return, the higher potential earnings under incentive regulation may offer little of practical value to the firm. Furthermore, the increased downside risk that often accompanies incentive regulation may render incentive regulation unattractive to the firm. Unfortunately, data limitations precluded a careful test of this hypothesis. Imperfect proxies for actual earnings under rate-of-return regulation did not produce significant estimates.

5. Conclusions.

In summary, we investigated the likelihood that a state will adopt incentive regulation in place of rate-of-return regulation in its telecommunications industry. Three main empirical regularities were discovered. First, incentive regulation is more likely to be adopted when allowed returns under rate-of-return regulation were particularly high or particularly low. Meager historic earnings can make the higher earnings that incentive regulation can foster especially attractive to both the regulated firm and the regulator. Relatively high historic allowed rates of return can reflect settings where the regulated firm will be permitted to retain a portion of even particularly high earnings under incentive regulation, making incentive regulation particularly attractive. Second, incentive regulation is more likely to be implemented in states where industry conditions appear more conducive to enhanced earnings by the regulated firm. A key favorable condition is less pronounced bypass activity of competitors. Third, incentive regulation is more likely to be adopted in states where the Democratic party, rather than the Republican party, controls the governor's office. Stronger Democratic influence may enhance support for plans that secure benefits for key consumer groups.

While these findings provide some insight into the choice of regulatory regime in the telecommunications industry, considerable work remains to be done. Two directions for additional research seem particularly important. First, the simple static model of section 2 should be embellished to reflect other important features of state regulatory environments. Second, a model with richer intertemporal structure needs to be specified and tested.

The simple static model of section 2 would benefit from a number of extensions. For instance, a finer classification of regulatory regimes would be useful. In practice, incentive regulation plans vary widely, and particular forms of incentive regulation (e.g., earnings sharing plans or rate case moratoria) may be especially likely to be adopted in certain environments. Uncertainty is another element of all regulatory environments that warrants more careful consideration. Uncertainty about the potential for enhanced earnings, about consumer reactions to substantial increases in earnings, and about the causes of improved performance in the regulated industry can all influence the attraction of different regulatory regimes, particularly if relevant parties are averse to risk.

The intricate relationships among regulatory agencies, the executive and legislative branches of government, and the courts also deserve more detailed investigation. The model of section 2 endowed the regulator with the sole authority to implement incentive regulation. In practice, the courts can reverse commission rulings on incentive regulation,[40] and legislatures can impose incentive regulation despite opposition from the regulatory commission.[41] Furthermore, the governor can veto legislation. He or she can also either appoint regulatory commissioners or influence the likelihood of their election or re-election. A model that explicitly accounts for these important interactions would likely give rise to useful empirical predictions.

It is also important to recognize that the form of regulatory plan is just one of many decisions that regulators make. Regulators also set price levels, influence the competitive pressures brought to bear on incumbent producers, and specify quality standards, for example. It is likely that these decisions are intimately linked. The relevant linkages warrant careful investigation.

Perhaps the most pressing extension of our analysis is to incorporate a richer intertemporal structure. In the simple model of section 2, the relevant choice was simply the static choice between incentive regulation and rate-of-return regulation. In practice, the broader choice concerns which forms of regulation to implement at different points in time. Important new questions can be addressed in models with richer intertemporal structures. For instance, are there obvious patterns of departure from rate-of-return regulation? Do rate case moratoria commonly precede earnings sharing plans which, in turn, precede variants of price cap regulation, for example? Also, do states learn about the best forms of incentive regulation from the experience of other states? Which states lead regulatory transitions, and which states follow?

These are among the many questions that remain to be addressed in a fully intertemporal analysis of regulation in the telecommunications industry. A careful analysis of the success of different regulatory plans is also important to pursue. In addition, a structural approach to estimation would complement the reduced form approach adopted here.

Variable	Mean	Standard Deviation	Minimum	Maximum
AROR	1.000	0.079	0.855	1.162
BYPASS	0.912	0.935	0.069	4.641
POPGROW	0.053	0.038	- 0.01	0.194
DEMOCRAT	0.559	0.369	0.000	1.000
ELECT	0.255	0.441	0.000	1.000

Table 1. Means, Standard Deviations, and Ranges for the Explanatory Variables.

Variable	AROR	BYPASS	POPGROW	DEMOCRAT	ELECT
AROR	1.00				
BYPASS	- 0.12	1.00			
POPGROW	- 0.07	0.06	1.00		
DEMOCRAT	- 0.08	0.05	- 0.08	1.00	
ELECT	0.25	0.35	- 0.15	0.40	1.00

Table 2. Correlation Matrix.

Variable	Estimate	Standard Error	*p*-Value
CONSTANT	224.508	101.815	.027
AROR	-470.039	211.574	.026
AROR*2	243.740	109.340	.026
BYPASS	-1.293	0.592	.029
POPGROW	16.686	13.673	.222
DEMOCRAT	2.869	1.273	.024
ELECT	0.411	0.999	.681

Log of Likelihood Function = -21.20; R^2 = .40; Percent Correct Predictions = 83.

Table 3. Coefficient Estimates and *p*-Values.

Variable	Effect on P(*I*) of One Standard Deviation Increase	Effect on P(*I*) of One Standard Deviation Decrease	Effect on P(*I*) of Increasing from 0 to 1
AROR	.520	.041	
BYPASS	-.236	.209	
POPGROW	.156	-.043	
DEMOCRAT			.587
ELECT			.100

Table 4. The Impact of Changes in the Explanatory Variables on the Estimated Probability of *I* (P(*I*)).

FOOTNOTES

1. See BellSouth Telecommunications (1993) for a detailed description of the regulatory plans in the U. S. telecommunications industry.

2. See, for example, Averch and Johnson (1962), Baumol and Klevorick (1970), Joskow and Schmalensee (1986), Beesley and Littlechild (1989), Cabral and Riordan (1989), Braeutigam and Panzar (1989), Lewis and Sappington (1989), Schmalensee (1989), Brown et al. (1991), Liston (1993), Weisman (1993), Gasmi et al. (1994), and Sappington and Weisman (1994c).

3. Mathios and Rogers (1989, 1990), Taylor et al. (1992), Smart (1993), Tardiff and Taylor (1993), and Greenstein et al. (1994) undertake empirical investigations of the effects of regulatory policy on industry performance in the telecommunications industry. Our analysis is probably most closely related to those of Kaserman et al. (1993) and Teske (1990, 1991) who analyze the determinants of regulatory decisions regarding prices, competition, and deregulation. Also see Nowell and Tschirhart (1990), who examine the factors that influence state regulatory compliance with the national Public Utility Regulatory Policies Act.

4. Although all parties, including consumers, might be better off if the regulator could credibly promise *ex ante* not to usurp for consumers exceptional returns earned by the firm, *ex post* temptations to secure lucrative realized earnings may be overwhelming. See Sappington and Weisman (1994a,b) for a nontechnical discussion of this issue. More formal analyses of this issue include Sappington (1986), Baron and Besanko (1987),

Laffont and Tirole (1988), and Lewis and Sappington (1990).

5. W^R might also be a function of v. The results cited below do not change if that is the case.

6. The functional dependence of $e^R(\cdot)$ on Π^R is suppressed for notational simplicity.

7. In theory, the regulator might also propose an incentive regulation plan. In practice this is seldom the case. The regulated firm is almost invariably the party that designs the initial proposal for regulatory reform. The greater resources of the regulated firm may help to explain this phenomenon.

8. We abstract from meaningful uncertainty in the model to simplify the exposition. It is straightforward to verify that our main qualitative conclusions are unaltered if, for example, realized earnings are the sum of $\Pi(e, v)$ and a random variable with mean zero, whose realization becomes known to the firm only after e is chosen. In this setting, the firm simply adjusts its *ex ante* effort choice under both R and I to account for the fact that realized earnings will be affected both by its own effort and by the random variable. Appropriately structured incentive regulation still leads to higher e and enhanced payoffs for both consumers and the regulated firm in this setting.

9. Because we assume the regulator's sole concern is with the welfare of consumers, our approach may appear to be more consonant with the public interest view of regulation (e.g., Bailey (1976)) than the interest group view of regulation (e.g., Stigler (1971) and

Becker (1983)). However, all of our main qualitative conclusions continue to hold if the regulator places some value on the firm's profits. Of course, for reasons that parallel those developed in Evans and Garber (1988), it is not always apparent whether higher profits increase or decrease the regulator's utility. See Nowell and Tschirhart (1993) and Kaserman et al. (1993), respectively, for evidence supporting the public interest and the interest group view of regulation.

10. Notice that in defining e^I, we have omitted its functional dependence on v, s, and $\overline{\Pi}$ for expositional convenience. Also notice that earnings in excess of $\overline{\Pi}$ are not reflected in (1) or (2). Absent uncertainty about the relationship between effort and earnings, the firm will never provide effort in excess of the minimum level needed to ensure $\overline{\Pi}$ when all earnings above $\overline{\Pi}$ are awarded to consumers.

11. Formal proofs of all Observations are relegated to Appendix A.

12. Low historic returns for an RBOC may also be associated with limited historic investment by the firm. To the extent that limited historic investment increases the return to current investment (in network modernization, for example), incentive regulation plans that promote increased investment may be particularly popular in states where allowed returns have historically been low.

13. We examined the choice of regulatory regime in forty-seven states. Alaska, Connecticut, and Hawaii were not included in our sample because none of the seven RBOC's has a major presence in these states. Data on key explanatory variables is not available for non-

RBOC companies.

14. In 1991, rate-of-return regulation was imposed on the RBOC operating in the following states (using standard abbreviations): AK, CO, DE, IL, IN, IA, MA, MT, NH, NY, NC, OH, OK, PA, SD, UT, and WY.

15. A state was classified as operating under incentive regulation in 1991 as long as an incentive regulation plan was in effect for the RBOC in the state for more than half of the 1991 calendar year. The year 1991 was chosen because it was late enough that a reasonable diversity of regulatory plans were in effect, and early enough that other relevant data for the year was available. The classifications were inferred from the detailed description of regulatory incentive plans contained in BellSouth Telecommunications (1990-1993). The classifications are largely consistent with those provided in NARUC (1992b), Shifman and Arsenault (1992), Taylor et al. (1992), and Tardiff and Taylor (1993). Finer classifications of incentive regulation could easily be constructed. However, the relatively small number of data points forced us to limit the number of possible distinct values for the dependent variable.

16. The different plans range from nearly complete deregulation (in Nebraska) to banded rate-of-return regulation (in Virginia). Under the forms of banded rate-of-return regulation that we classified as incentive regulation, the RBOC was authorized to realize any rate of return within a range of more than one hundred basis points.

17. The RBOC operated under an earnings sharing plan in 1991 in the following states: AL,

CA, FL, GA, KY, MD, MI, MN, MS, MO, NV, NM, RI, SC, TN, TX, and WA. Revenue sharing plans were employed in ID and OR.

18. Network modernization was a precondition for incentive regulation in MO, NV, TN, and TX, for example.

19. See, for example, Maddala (1983) or Greene (1993).

20. Allowed rates of return were calculated from the data provided in NARUC (1984-5, Table 24; 1986, Table 34; 1987-8, Table 33; 1989, Table 34; 1990, Table 39) and in NARUC (1992b, Table 50).

21. The average allowed rate of return trended downward over our sample period. Therefore, our procedure of averaging allowed returns over a longer time period in states where *R* was practiced in 1991 would tend to unduly associate lower average returns with *R*. We eliminate this problem by examining individual allowed returns relative to the average of all allowed returns in each year. Lagged returns were employed to facilitate their treatment as exogenous determinants of the choice of regulatory regime.

22. The BYPASS data we employ is taken from the bypass impact reports the RBOC's filed with the FCC in April of 1988 through 1991 in connection with docket CC 87-339.

23. 1987 is the first year for which the RBOC's filed bypass estimates with the FCC. For those few states that introduced incentive regulation before 1988, only the 1987 bypass

numbers were employed.

24. See Huber et al. (1992) and Baumol and Sidak (1994, chapter 2) for more detailed discussions of the bypass issue.

25. Conceivably, a regulator might view incentive regulation as a means to replace the revenues an RBOC has lost to bypass, and thereby reduce the likelihood of having to authorize significant increases in the RBOC's service rates. To the extent this is the case and to the extent regulators rather than regulated firms propose incentive regulation plans, a direct relationship between the extent of bypass and the likelihood of incentive regulation is possible.

26. It is conceivable that the extent of bypass in a state might be influenced to some degree by regulatory policy in the state. For instance, bypass may be encouraged if network access fees are high, volume discounts are slight, large discrepancies between local business and residential rates are implemented, and the regulated firm is given little flexibility to respond to competitive pressures. If these effects are pronounced, BYPASS, itself, might be treated as an additional endogenous variable, and a system of simultaneous equations might be formulated and tested. In practice, the extent of bypass appears to be driven largely by population density and business concentration, and thus may be largely beyond the control of regulatory commissions.

27. The data for POPGROW is derived from the United States Department of Commerce (1990a, p. 3). Alternative proxies for projected population growth (e.g., those that

incorporated estimates through the year 2000) produced results almost identical to those presented below.

28. DEMOCRAT was constructed from data provided in the United States Department of Commerce (1990b, Table 433; and 1993, Table 445). Alternative representations of the effect of the party of the state's governor were also tested. For example, the binary variable was averaged between 1984 and 1990 in states where *R* was practiced in 1991, and between 1984 and the year before *I* was adopted in states where *I* was practiced in 1991. This averaging procedure was intended to restrict the influence of the party of the governor to the time period in which the choice between *R* and *I* was being contemplated. The procedure produced results similar to those reported below, but with slightly less explanatory power. Conceivably, the party of future governors in the state may reflect in part the power of the current governor, and thus his or her influence on state policy.

29. Of course, the party of the governor is not the only measure of political sentiment and influence in a state. Other measures that were employed to capture these effects are discussed in more detail in the next section.

30. The ELECT variable is constructed from data in NARUC (1992b, Table 5).

31. The R^2 statistic is calculated as $1 - \frac{SSE_1}{SSE_0}$, where SSE_1 is the sum of the squared deviations of the fitted probabilities from the dependent variable for the model, and SSE_0 is the sum of squared deviations when only a constant is used.

32. Notice, too, that incentive regulation may provide the most politically expedient means of raising allowed rates of return in states where they were already high under rate-of-return regulation.

33. Merrill Lynch and Co. formulates its own evaluation of the quality of the decisions made by state regulatory commissions. On the premise that Merrill Lynch's evaluation might serve as a reasonable proxy for a commission's ability to reward the regulated firm in its jurisdiction for superior financial performance, we incorporated the evaluation in our regression. The variable did not prove to be significant at conventional levels.

34. Although it seems unlikely, the negative coefficient on BYPASS could conceivably reflect limited regulatory response to changing industry conditions. Bypass might occur in part because regulators fail to empower the incumbent RBOC with the ability to deal effectively with competitive challenges. If this same reluctance to alter long-standing regulatory policy explains why incentive regulation is not adopted in a state, then the negative coefficient identified in our study would be expected. However, because our estimates varied very little when other controls for the characteristics of regulatory agencies were included in our regression, and because of the aforementioned observation that bypass seems to be driven largely by exogenous population characteristics, this alternative explanation of the sign of the BYPASS coefficient seems unlikely.

35. BYPASS and POPGROW provided greater explanatory power than other variables designed to reflect the potential profitability of the firm's environment. These other variables included: (1) estimates of future state employment in sectors (like the financial

sector) that rely heavily upon telecommunications services; (2) the number of Fortune 500 companies with headquarters in the state; (3) measures of technological development of the state's telecommunications network; (4) various ratings by the financial community of the attraction of investing in the states' public utilities; and (5) proxies for the firm's unavoidable fixed costs of production. The coefficients on these variables generally had the expected signs, but were not significant at conventional levels. Including these variables in our regression caused little change in the significant coefficients reported in Table 3.

36. A variety of other measures of political sentiment and influence in the state were employed in place of DEMOCRAT, but none provided greater overall explanatory power. For instance, the binary variable for the party of the governor was replaced by a continuous variable reflecting the fraction of the popular vote received by the winning party of the elected governor. The binary variable was also replaced by a variable that measured the proportion of the state legislature controlled by the various political parties. The liberal quotients constructed by the Americans for Democratic Action (1984-1992) to assess how liberal the voting patterns of members of the United States' Congress are were also employed. Measures reflecting the combined influence of the major political parties on both the governor's office and the state legislature were also employed in place of DEMOCRAT. These lattermost measures allowed us to test the "gridlock hypothesis" that major changes of regulatory regime would be less likely when the governor and the majority of state legislators were of different political parties. This hypothesis was not supported by the data.

37. Other possible proxies for the transactions costs of switching regulatory regimes proved to be insignificant. For instance, to the extent that regulators with greater expertise (and thus, perhaps, lower transactions cost of implementing new regulatory regimes) are more highly paid, it is possible that higher salaries for commissioners might be associated with an increased likelihood of incentive regulation. This hypothesis was not supported by the data. The insignificance of the salary variable may be due, in part, to the possibility that higher salaries for commissioners might be associated with larger, more bureaucratic agencies, and thus, perhaps, with a reduced chance of departing from traditional modes of regulation. Variables representing the budget and the number of employees at state public utility commissions also proved to be insignificant.

38. If ELECT and/or POPGROW are removed from the regression, the coefficients on the other explanatory variables are largely unaltered, but the R^2 and percent correct predictions decline slightly.

39. A variable reflecting changes in residential basic local service rates also proved to be insignificant, as did a variable reflecting the disparity in the rates charged to residential and business customers. Of course, a complete, fully-intertemporal model of the regulatory environment would treat both price levels and the selected regulatory regime as endogenous choice variables.

40. Other variables, such as the average per capita income of state residents and state welfare expenditures, were employed as possible proxies for a state's concern with the level of local service rates. None of these variables proved to be significant.

41. To illustrate, earnings sharings plans authorized by the public utility commissions in Illinois and South Carolina were remanded by state courts on the grounds that the commissions did not have the legal authority to implement such alternatives to rate-of-return regulation. (See BellSouth Telecommunications (1993, pp. 19, 61).)

42. The virtual deregulation of the telecommunications industry in Nebraska was accomplished by legislation (Legislative Bill 835), not by regulatory fiat. (See BellSouth Telecommunications (1993, p. 103) and Mueller (1993, pp. 4, 31-34).)

APPENDIX A

Proof of Observation 1.

From (3), $\dfrac{d\Delta^f}{d\Pi^R} = -s + \dfrac{de^R}{d\Pi^R} = -s + \underline{s}(v) < 0.$

From (4), $\dfrac{d\Delta^r}{d\Pi^R} = -[1-s] < 0.$ ■

Proof of Observation 2.

The firm's problem is to:

$$\underset{e}{\text{Maximize}}\ s\,[\Pi(e;v) - \Pi^R] - e \tag{A1}$$

$$\text{subject to:} \quad \Pi(e;v) \leq \overline{\Pi}. \tag{A2}$$

Let e^I denote the solution to this problem, and let $\lambda \geq 0$ denote the Lagrange multiplier associated with the constraint in (A2).

From (A1) and (A2), e^I is determined by:

$$[s - \lambda]\ \Pi_e(e^I;v) = 1. \tag{A3}$$

When constraint (A2) binds, $\Pi(e^I;v) = \overline{\Pi}$, and so

$$\frac{de^I}{d\overline{\Pi}} = \frac{1}{\Pi_e(e^I;v)} = s - \lambda, \text{ from (A3).} \tag{A4}$$

From (3):

$$\frac{d\Delta^f}{d\overline{\Pi}} = s\frac{d\Pi(\cdot)}{d\overline{\Pi}} - \frac{de^I}{d\overline{\Pi}} = s - (s - \lambda) = \lambda > 0. \tag{A5}$$

The second equality in (A5) follows from (A4). The inequality holds because, by assumption, (A2) is a binding constraint. When (A2) does not bind, $\dfrac{d\Pi(\cdot)}{d\overline{\Pi}} = 0$ and $\dfrac{de^I}{d\overline{\Pi}} = 0$, so $\dfrac{d\Delta^F}{d\overline{\Pi}} = 0$ from (A5).

Finally, from (4),

$$\frac{d\Delta^r}{d\overline{\Pi}} = [1 - s]\ \frac{d\Pi(e^I;v)}{d\overline{\Pi}}. \tag{A6}$$

Since $\frac{d\Pi(\cdot)}{d\overline{\Pi}} = 1$ when (A2) is a binding constraint, and $\frac{d\Pi(\cdot)}{d\overline{\Pi}} = 0$ otherwise, (A6) implies $\frac{d\Delta^r}{d\overline{\Pi}} > 0$ when (A2) is a binding constraint, and $\frac{d\Delta^r}{d\overline{\Pi}} = 0$ otherwise. ■

Proof of Observation 3.

From (3) and the envelope theorem, if (A2) is not a binding constraint:

$$\frac{d\Delta^f}{dv} = s\,\Pi_v(e^I;v) + \frac{de^R}{dv} = s\,\Pi_v(e^I;v) - \underline{s}(v)\Pi_v(e^R;v) > 0. \tag{A7}$$

The second inequality in (A7) holds because $\Pi(e^R;v) = \Pi^R$, $\frac{de^R}{dv} = -\frac{\Pi_v(e^R;v)}{\Pi_e(e^R;v)}$, and because $\underline{s}(v)\Pi_e(e^R;v) = 1$ by definition. The inequality in (A7) holds because $s > \underline{s}(v)$ by assumption, and because $e^I > e^R$ and $\Pi_{ev}(e;v) > 0$.

If (A2) is a binding constraint, then $\Pi(e^I;v) = \overline{\Pi}$ and so $\frac{de^I}{dv} = -\frac{\Pi_v(e^I;v)}{\Pi_e(e^I;v)}$. Consequently, from (3):

$$\frac{d\Delta^f}{dv} = \frac{de^R}{dv} - \frac{de^I}{dv} = \frac{\Pi_v(e^I;v)}{\Pi_e(e^I;v)} - \frac{\Pi_v(e^R;v)}{\Pi_e(e^R;v)} > 0. \tag{A8}$$

The inequality in (A8) holds because $e^I > e^R$, $\Pi_{ev}(\cdot) > 0$, and $\Pi_{ee}(\cdot) < 0$.

If (A2) is not a binding constraint, then from (4):

$$\frac{d\Delta^r}{dv} = [1-s][\Pi_e(e^I;v)\frac{de^I}{dv} + \Pi_v(e^I;v)] > 0. \tag{A9}$$

The inequality in (A9) holds because $\frac{de^I}{dv} = \frac{\Pi_{ev}(e^I;v)}{|\Pi_{ee}(e^I;v)|} > 0$. If (A2) is a binding constraint, then $\frac{d\Pi(e^I;v)}{dv} = 0$, so $\frac{d\Delta^r}{dv} = 0$ from (4). ■

Proof of Observations 4 and 5.

It follows immediately from (3) that $\frac{d\Delta^f}{d\alpha} = \frac{d\Delta^f}{dT} = 0$. From (4), $\frac{d\Delta^r}{d\alpha} = L > 0$, and $\frac{d\Delta^r}{dT} = -1 > 0$. ■

<u>APPENDIX B</u>

We employed the regression-based Lagrange multiplier test for heteroskedasticity suggested by Davidson and MacKinnon (1993, pp. 526-7). The test allows for the possibility that the variance of the latent residuals is related to all of the (nonconstant) variables in the model, so the test is asymptotically $\chi^2(6)$ under the null hypothesis of no heteroskedasticity. The test has a *p*-value of .069, which suggests that heteroskedasticity is unlikely to be a problem. However, since heteroskedasticity cannot be ruled out at the 10% level, we undertook two procedures to assess the robustness of our inferences. First, we calculated the misspecification robust standard errors suggested in White (1982). White's approach allows for the possibility that the expectation of the negative of the Hessian of the likelihood function may differ from the expectation of the outer product of the gradient. The standard errors derived from this procedure are reported in Table B1.

Second, because heteroskedasticity may cause inconsistent estimates in models with limited dependent variables, we allowed for heteroskedasticity directly. Because our tests for heteroskedasticity using each explanatory variable separately rejected the null hypothesis of homoskedasticity at conventional levels only for the case of DEMOCRAT, we allowed the variable of the latent residual to depend only on DEMOCRAT. In particular, we assumed the standard deviation of the latent residual was proportional to $\exp(c \cdot \mathrm{DEMOCRAT}) \,/\, [1 + \exp(c \cdot \mathrm{DEMOCRAT})]$ where $c > 0$ is a constant. This formulation provided a convenient specification that proved to be well behaved from a computational viewpoint. The maximum likelihood estimates for the coefficients on the explanatory variables and the parameter *c*, along with the associated robust standard errors from this procedure, are reported in Table B2.

The findings cited in Table B2 suggest that the conclusions reported in the text are fairly robust to assumptions about the behavior of the latent residual and the manner in which standard errors are calculated.

Variable	Estimate	Robust Standard Error	p-Value
CONSTANT	224.512	110.818	.043
AROR	-470.047	228.759	.040
AROR*2	243.745	117.505	.038
BYPASS	-1.293	0.641	.044
POPGROW	16.686	15.110	.269
DEMOCRAT	2.869	1.608	.074
ELECT	0.411	0.856	.631

Table B1. Robust Standard Errors for Model.

Variable	Estimate	Robust Standard Error	p-Value
CONSTANT	199.040	83.964	.018
AROR	-417.180	173.749	.016
AROR*2	216.720	89.455	.015
BYPASS	-1.193	0.585	.041
POPGROW	11.382	10.686	.287
DEMOCRAT	2.715	1.287	.035
ELECT	0.169	0.619	.784
c	3.096	0.702	.000

Table B2. Estimates with Heteroskedasticity Explicitly Modeled.

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