

Telecommunications Regulation and New Services: a Case Study at the State Level*

James E. Prieger
University of California, Davis
One Shields Avenue
Davis, CA 95616-8578
jeprieger@ucdavis.edu

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Abstract

This study introduces methodology to quantify the effects that regulation has on the innovation and the introduction of new products, and compares state-regulated services in Indiana under rate of return regulation (RoRR) and under alternative regulation. The econometric model comprises a count process (for innovation) followed by a duration process with selection (for regulatory delay). When the firm is released from RoRR, the rate of service creation triples and expected approval delays nearly disappear. The firm may have introduced up to 12 times as many services to consumers if the alternative regulation had been in place the entire time.

1 Introduction

Telecommunications regulation in the United States has changed rapidly in the past two decades.

Regulatory authorities in many states have moved away from rate of return regulation (RoRR)

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toward incentive regulation such as price caps. Most often, regulatory reform has focused on improving consumers' access to existing services: lower prices, availability to more households, higher service quality, improved efficiency in production, and so on. The economic literature also mirrors this emphasis. Most regulation studies take the existing product mix as given and look at "getting the prices right" or the incentive to reduce costs. Often overlooked—in both the regulatory arena and the economic literature—are the impacts on incentives to create and introduce new products. This study develops methodology for quantifying the impact of a regulatory reform on the creation and introduction of new services.

The regulatory regime change of interest is a form of alternative regulation known as Opportunity Indiana, described more fully in the next section. In 1994, the Indiana regulatory commission switched from traditional RoRR of Ameritech Indiana¹ to a combination of price caps and market (i.e., unregulated) pricing.² Since RoRR limits the ability of the firm to retain as profit the economic benefit created by the service,³ market pricing should increase the incentive to introduce a new product. Similarly, by controlling prices rather than profit levels, it is possible that a price caps regime would also see more new products than a rate of return regime.⁴ This study finds that the incentives apparently did increase under Opportunity Indiana: the creation of new services went up by 97% to 359%, depending on the type of service. Several qualifications to these conclusions are also explored.

A major contribution of this paper is an econometric model suitable for the innovation and introduction of regulated goods. I model the initial product creation as a count process and the subsequent regulatory approval process as a duration process. The two processes may be correlated.

¹Ameritech is the Bell Operating Company in Indiana, with 62% of the local phone lines. Ameritech's operating company is named Indiana Bell, which does business as Ameritech Indiana.

²Rate of return regulation limits profits by setting prices to achieve a desired return on capital. Price cap regulation limits prices directly, without explicit reference to profits or costs. See Averch and Johnson (1962) and Acton and Vogelsang (1989) for characterizations of rate of return regulation and price caps, respectively.

³As long as the targeted rate is binding, that is.

⁴Although the comparison could go the other way, if a new product allows a firm to increase its capital base under rate of return regulation, which would increase its allowed profit. The literature does not contain a clear answer on this point.

The model may be useful for identifying impacts of regulatory changes in other applications as well.

The literature on price caps and innovation focuses almost exclusively on cost reduction, known as *process innovation*. Littlechild (1983) claimed that price caps increase the incentive to reduce costs. Theoretical comparisons of rate of return and price cap regulation mainly confirm Littlechild's claims (e.g., Cabral and Riordan, 1989). *Product innovation*—bringing new goods to market—may be put into the theoretical framework of process innovation: product innovation occurs when a product's cost is reduced from infinity. However, the process innovation literature typically focuses on small cost changes, and not all claims for process innovation necessarily apply to product innovation.⁵ At least as important for product innovation as the distinction between price caps and RoRR is the treatment of new services. Are new services immediately placed in the rate base or the price cap basket, or is there a “grace period” to encourage innovation? Does regulatory approval delay differ markedly between traditional and alternative regulation? While these characteristics could be built into a theoretical model, ultimately whether price caps increase innovation in any particular setting is an empirical issue. In the present study, most of the new services were under market pricing rather than price caps. The comparison here, therefore, is not a clear-cut comparison of price caps and RoRR, but of RoRR and a mixture of incentive regulation and deregulation.

Opportunity Indiana effectively increased the expected profit to the firm of introducing a new service for at least two reasons. First, as mentioned above most new services were allowed to be freely priced. RoRR, on the other hand, places constraints on prices. Second, there are long tariff approval delays under RoRR associated with plan approval—over four months on average, a long time in the competitive and dynamic telecommunications industry. The delay reduces the present value of a proposed new service and (more importantly) allows competitors to beat the regulated firm to market when substitute services exist. As described in the next section, competing firms

⁵Bonamo and Haworth (1998) investigate the strategic differences between product and process innovation (although their concern is not with regulation).

often offered similar services, particular within the class of business services. By contrast with the approval delays under RoRR, there are few such delays under Opportunity Indiana.

The only empirical study of which I am aware looking at product innovation and telecommunications regulation is Mueller (1993), who examines new service offerings by US West in Nebraska. The (non-econometric) evidence suggests that deregulation was successful at speeding new service introductions in Nebraska, compared with other states.⁶ There are a few studies quantifying the impact of incentive regulation on process innovation. Taylor, Zarkadas and Zona (1992), Greenstein, McMaster and Spiller (1995), and Ai and Sappington (1998) all find that incentive regulation hastens the diffusion of digital infrastructure compared with other regulatory methods. Unlike these studies, which look at the means of providing a service, I look directly at the new services that consumers purchase. Unlike Hausman (1997), who estimates the impact of regulatory delay on cellular telephony and voice mail consumers, I am interested in the bigger picture of how regulation affects innovation in the entire class of telecommunications services and whether potential services are introduced.⁷ None of these other studies provides an empirical model allowing quantification of regulatory impacts on innovation and new product introduction.

The rest of this introduction previews the results. Ameritech greatly increased its rate of service introduction under Opportunity Indiana. The estimated rate of service creation under Opportunity Indiana is 2 to 4.5 times the rate under the rate of return regime. Expected approval delay times were reduced to almost nothing (from over 130 days before Opportunity Indiana to under four days during). During Opportunity Indiana, proposed services had a higher probability of being approved as quickly as the law allowed, and the law allowed quicker introductions. Using the estimated model to project the innovation and introduction process under RoRR and Opportunity Indiana, I find that Ameritech would have introduced up to twelve times as many services to consumers during

⁶ Mueller (1993) notes that US West may have merely shifted the order of introduction between states to provide a “success story” for deregulation.

⁷ There is another strand of literature that examines regulation’s effect on inputs to the innovative process such as R&D expenditure (e.g., Mayo and Flynn, 1988).

the study period if Opportunity Indiana had been in place the entire time.

The nature of the data do not permit a final answer on the question of causality, however, for a few reasons. Most importantly, the only “control group” available is the firm before Opportunity Indiana. Contemporaneous data from an Ameritech state still under RoRR during the Opportunity Indiana period are not available (Illinois, Ohio, and Wisconsin, the other Ameritech states under RoRR, switched to relaxed regulation about the same time Opportunity Indiana began). Therefore the strategy taken in this paper is to describe what happened in Indiana, to control for as many other potentially causal factors as possible, and to explore alternative explanations for the observed increase in innovation. Chief among alternative explanations are demonstration and sequencing effects. In the former the firm would innovate only to “demonstrate” to the regulator the success of a desired regulatory regime. In the latter the firm would suppress innovation under RoRR in anticipation of the relaxed regulation. These possibilities are further explained and tested for in section 6. Briefly, I find no evidence that they alone explain the firm’s response to the change in regulation, although they may exaggerate the impact of the regime change. Inference drawn from the model also depends on the model being correct: the regime change is assumed exogenous, the coefficients are time-invariant except as modeled, etc. Given the numerous assumptions underlying the model, it is best to view the results here as upper bounds on any causal effect of the regime change.

Opportunity Indiana is described in the next section and the econometric model is introduced in section 3. The data and estimations are in section 4.1 for the innovation submodel, and in section 4.2 for the regulatory delay submodel. Predictions for counterfactual scenarios, which illustrate the potential impact of regulation on innovation and delayed service introduction, are in section 5. Section 6 contains further discussion of the validity of the model for policy analysis and concluding remarks.

2 Opportunity Indiana

In Indiana, Ameritech offers basic local service, intrastate advanced services, and intrastate inter-LATA access services, which are regulated by the Indiana Utility Regulatory Commission (IURC). Mirroring regulation by the FCC, until the 1990s most state commissions placed the intrastate activities of incumbent local exchange companies under RoRR. Thereafter several states, Indiana included, began to experiment with alternative regulation.

This study examines new intrastate services introduced by Ameritech Indiana in its operating territory. New services may allow higher transmission capability (e.g., ISDN⁸), capability to transmit new kinds of data (e.g., video), or central office features such as caller ID or restricted access to 900 numbers. To offer these services, Ameritech typically makes use of technology developed by upstream firms and adapts it to work on their network and to offer the desired functionality.⁹ For many of these services, Ameritech is the first to offer them (particularly to residential subscribers). For other services, substitutes may already be available from other firms (particularly for business customers). For example, unregulated PBX services are close substitutes for the business Centrex services offered by Ameritech.¹⁰

Until 1994, Ameritech Indiana operated under traditional RoRR. On June 30, 1994, the IURC approved a stipulated agreement among various parties in response to an incentive regulation plan proposed by Ameritech.¹¹ The plan, known as *Opportunity Indiana*, gave Ameritech increased flexibility through 1997 to introduce and price services. Responding to Ameritech's concern about regulatory delay, the IURC streamlined the tariff approval process to allow quicker introduction of new services. Before Opportunity Indiana, approval of a new service required docketing and

⁸Integrated Services Digital Networks (although suspicious regulators sometimes refer to ISDN as "Improvements Subscribers Don't Need"). ISDN is composed of digital lines capable of circuit and packet transmission for voice and data communications at data rates up to 1.544 Mbps.

⁹There are elements of both innovation and diffusion to the service introduction process. For simplicity, I will use the term innovation.

¹⁰PBX (Private Branch Exchange) is a private telephone network used within a company. Centrex (CENTral office EXchange service) is a variation of PBX in which all switching occurs at the telephone company's central office instead of at the subscribing company's premises.

¹¹*Order* in Cause No. 39705 (Indiana Utility Regulatory Commission, 1990).

commission action. Under the new plan most services were approved automatically upon a day's notice. Also under the new plan, certain services related to basic local service were placed under price caps. Other services deemed to be competitive were moved to a separate tariff, the *Service Catalog*; pricing of Catalog services is essentially unregulated, under the presumption that actual or potential competition limits the prices Ameritech can charge. Opportunity Indiana also contains provisions for local service rate reductions, infrastructure and education investments, and a free subscription program in under-served areas (Indiana Utility Regulatory Commission, 1997*b*). After review of the first term, a modified version of Opportunity Indiana was approved in December 1997 for a second term.¹²

3 A Model for Service Innovation and Introduction

In the course of introducing regulated telecommunications services to subscribers, a firm goes through two steps. The firm first creates a new end-user service, using technology that may be developed by other firms; I refer to this as *innovation*. After innovation, the services are not *introduced* to subscribers until they are approved by the regulator. I model innovation as a count process and the regulatory approval process as a duration process with selection. In the selection model, the regulator first selects whether a service is to be delayed, and if so, the length of the delay. The conditional means of the distributions are modeled as functions of economic, demographic, and regulatory covariates. The model is formally equivalent to an infinite-server queuing model.¹³ This equivalence allows me to apply well-known queuing results, which will be useful for the projection exercise carried out in Section 5.

To construct the likelihood of the data for the arrival and regulatory approval processes, the marginal distributions and the nature of the correlation between the processes must be specified. Let the number of arrivals in period t be n_t , a realization of a count (non-negative integer) valued

¹² See Indiana Utility Regulatory Commission (1998).

¹³ See Prieger (1999) for details.

random variable, where $t = 1, \dots, T$. Denote the probability density function (pdf) of n_t , conditional on covariates \mathbf{w}_t , parameter vector $\boldsymbol{\alpha}$, and a random effect u_{1t} , by $f(n_t|\mathbf{w}'_t\boldsymbol{\alpha}, u_{1t})$. The simplest such count process is the Poisson model with mean

$$\lambda_t = \exp(\mathbf{w}'_t\boldsymbol{\alpha} + u_{1t}) = e^{u_{1t}} \exp(\mathbf{w}'_t\boldsymbol{\alpha}) \quad (1)$$

and pdf

$$f(n_t|\mathbf{w}'_t\boldsymbol{\alpha}, u_{1t}) = \exp(-\lambda_t)\lambda_t^{n_t}/n_t! \quad (2)$$

The random effect u_{1t} is an unobserved heterogeneity term with variance τ_1^2 ; assume that $E(e^{u_{1t}}) = 1$ so that $E(n_t) = \exp(\mathbf{w}'_t\boldsymbol{\alpha})$ and that the intercept coefficient in $\boldsymbol{\alpha}$ is identified. The inclusion of u_{1t} results in a generalized Poisson model that relaxes the equality of the mean and the variance implied by the simple Poisson model and allows overdispersion (Cameron and Trivedi, 1998).¹⁴

The econometric model I use for regulatory delay is the Type 2 Tobit bivariate selection model of Amemiya (1985), with an added random effect. Index the durations by i ; each arrival has an associated stochastic duration¹⁵ (possibly of length zero), so that $i = 1, \dots, N$, where $N \equiv \sum_{t=1}^T n_t$. Split i into index sets I_t so that $\{i|i \in I_t\}$ are the indices pertaining to period t . Let y_{1i} be the log duration of the i th regulatory delay, and let y_{2i} be an indicator for non-zero t_i . Assume that $\{y_{1i}, y_{2i}|i \in I_t\}$ are defined by

$$y_{1i} = \mathbf{x}'_i\boldsymbol{\beta} + \sigma\varepsilon_{1i} + u_{2t}, \text{ observed if } y_{2i} = 1 \quad (3)$$

$$y_{2i}^* = \mathbf{z}'_i\boldsymbol{\gamma} + \rho_2\varepsilon_{1i} + \sqrt{1 - \rho_2^2}\varepsilon_{2i} + u_{2t} \quad (4)$$

$$y_{2i} = 1\{y_{2i}^* > 0\}, \quad (5)$$

where $(\varepsilon_{1i}, \varepsilon_{2i})$ are iid draws from a bivariate standard normal distribution, $(\mathbf{x}'_i, \mathbf{z}'_i)$ are covariates, $\sigma > 0$, $\rho_2 \in [-1, 1]$, and $(\boldsymbol{\beta}, \boldsymbol{\gamma})$ are parameters to be estimated, and $1\{\cdot\}$ is the indicator function.

¹⁴In particular, if $m_t \equiv \exp(\mathbf{w}'_t\boldsymbol{\alpha})$ and $\delta \equiv \exp(\tau_1^2)$, then $E(n_t|\mathbf{w}_t) = m_t$ and $Var(n_t|\mathbf{w}_t) = m_t[1 + m_t(\delta - 1)]$ (Anscombe, 1950).

¹⁵Both before and during Opportunity Indiana, there is a non-random, mandated minimum regulatory delay (30 days under RoRR and one day under Opportunity Indiana).

The disturbances $(\sigma\varepsilon_{1i}, \rho_2\varepsilon_{1i} + \sqrt{1 - \rho_2^2}\varepsilon_{2i})$ in (3)–(4) are therefore mean zero bivariate normal with covariance matrix $\begin{bmatrix} \sigma & \rho_2\sigma \\ \rho_2\sigma & 1 \end{bmatrix}$ and correlation ρ_2 .¹⁶ Equations (4) and (5) compose a probit selection process. When $y_{2i} = 1$, the service is chosen to be delayed and the delay is drawn from the lognormal distribution given in (3). The model allows the random variable in the selection equation to be correlated with observed regulatory delays through ρ_2 and the random effect u_{2t} . If the selection and duration processes are correlated, then applying the baseline model to the *observed* nonzero delays would lead to biased inference. Correlation through ρ_2 is spell-specific, and might have many causes in the regulatory context. For example, if the regulator mistakenly delays approval of a service it would normally approve, then realizes its error and quickly approves the service after a short delay, then the selection and delay variables will be negatively correlated.¹⁷ Conversely, if unobserved factors make a specific service both more likely to be delayed and to have longer delays than observables account for, then there will be positive correlation. In (3) and (4), u_{2t} is a mixing term, common across y_{1i} and y_{2i}^* and across all i in period t . Correlation through u_{2t} might represent unobserved secular variables that influences regulatory delay.

Taken together, (u_{1t}, u_{2t}) represent unobserved period-specific heterogeneity. To complete the model, assume that (u_{1t}, u_{2t}) are defined by

$$\begin{aligned} u_{1t} &= \tau_1 (\eta_{1t} - \tau_1/2) \\ u_{2t} &= \tau_2 \left(\rho_1 \eta_{1t} + \sqrt{1 - \rho_1^2} \eta_{2t} \right) \end{aligned}$$

where (η_{1t}, η_{2t}) are iid draws from a bivariate standard normal distribution, $\tau_1, \tau_2 \geq 0$, and $\rho_1 \in [-1, 1]$. Furthermore, (η_{1t}, η_{2t}) are independent of all $(\varepsilon_{1i}, \varepsilon_{2i})$. Then (u_{1t}, u_{2t}) are bivariate normal with mean $\begin{bmatrix} -\tau_1^2/2 & 0 \end{bmatrix}'$, covariance $\begin{bmatrix} \tau_1^2 & \tau_1\tau_2\rho_1 \\ \tau_1\tau_2\rho_1 & \tau_2^2 \end{bmatrix}$, and correlation ρ_1 . Thus ρ_1 is the key parameter governing correlation between the count and regulatory delay processes. If ρ_1 is positive, then departures from the means in the count and regulatory delay processes are positively

¹⁶The variance of the selection equation disturbance is normalized to unity for identification of γ .

¹⁷I thank Michael Katz for this observation.

correlated, as might happen if there is “regulatory congestion” due to the finite resources of the regulator. If ρ_1 is negative, then the count and regulatory delay processes are negatively correlated. Negative correlation might occur if the regulator feels pressure to expedite service approvals when there are many new services created or if the firm submits more new services to the regulator when approval times are short. The definition of u_{1t} ensures that $E(e^{u_{1t}}) = 1$, as required above. All parameters are identified as long as $n_t \geq 1$ for at least one period.¹⁸

The joint pdf for the data in period t , $\{n_t, y_{1i}, y_{2i} | i \in I_t\}$, conditional on (u_{1t}, u_{2t}) , is then

$$f(\{n_t, y_{1i}, y_{2i} | i \in I_t\} | u_{1t}, u_{2t}) = f(n_t | u_{1t}) \cdot \prod_{i \in I_t} \left[F(y_{2i}^* | y_{2i} = 0, u_{2t})^{1(y_{2i}=0)} \cdot g(y_{1i} | u_{2t})^{1(y_{2i}=1)} \right] \quad (6)$$

where the dependence on the parameters is suppressed in the notation. In the expression above, the form of $f(n_t | u_{1t})$, the Poisson pdf, is given by (2). The probability of observing a stochastic duration of length zero, $F(y_{2i}^* | y_{2i} = 0, u_{2t})$, is given by

$$F(y_{2i}^* | y_{2i} = 0, u_{2t}) = \Phi(-\mathbf{z}'_i \boldsymbol{\gamma} - u_{2t}) \quad (7)$$

and the likelihood of the non-zero durations is

$$g(y_{1i} | u_{2t}) = f(y_{1i} | u_{2t}) F(y_{2i}^* | y_{2i} = 1, u_{2t}) \quad (8)$$

$$= \frac{1}{\sigma} \phi\left(\frac{y_{1i} - \mathbf{x}'_i \boldsymbol{\beta} - u_{2t}}{\sigma}\right) \Phi\left(\frac{\mathbf{z}'_i \boldsymbol{\gamma} + u_{2t} + \rho_2 [y_{1i} - \mathbf{x}'_i \boldsymbol{\beta} - u_{2t}] / \sigma}{\sqrt{1 - \rho_2^2}}\right) \quad (9)$$

where ϕ is the pdf of a standard normal random variable, Φ is the cdf of the same, $f(y_{1i} | u_{2t})$ is the pdf of the durations conditional on observation and $F(y_{2i}^* | y_{2i} = 1, u_{2t})$ is the probability of observing a non-zero duration (Amemiya, 1985). Since (u_{1t}, u_{2t}) are not observed, one finds the unconditional joint pdf by integrating out (u_{1t}, u_{2t}) :

$$f(n_t, \{y_{1i}, y_{2i} | i \in I_t\}) = E_{u_{1t}, u_{2t}} f(n_t | u_{1t}) \cdot \prod_{i \in I_t} \left[F(y_{2i}^* | y_{2i} = 0, u_{2t})^{1(y_{2i}=0)} \cdot g(y_{1i} | u_{2t})^{1(y_{2i}=1)} \right] \quad (10)$$

¹⁸ If not, then the disturbance terms for y_{1i}^* are not separable and (σ, τ_2) enters g (see (6)) only through $\sigma^2 + \tau_2^2$. Strictly speaking, σ and τ_2 are identified even in such a case through the cross equation restriction that τ_2 enters the equations for both y_{1i}^* and y_{2i}^* , but without large sample sizes that restriction is likely to only weakly numerically identify σ and τ_2 .

where $E_{u_{1t}, u_{2t}}$ denotes expectation taken over (u_{1t}, u_{2t}) . The log likelihood for all time periods is

$$l(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \rho_1, \rho_2, \sigma, \tau_1, \tau_2) = \sum_{t=1}^T \log f(n_t, \{y_{1i}, y_{2i} | i \in I_t\}) \quad (11)$$

The expectation in (10) is a double integral that cannot be solved analytically, and numerical methods must be used. I use Gaussian quadrature, with fifty evaluation points in both dimensions.¹⁹ Estimation of this model, therefore, can be expensive when there are many covariates. Because of this cost, in the application below, I experiment with small numbers of covariates at a time.

Although the general model (11) is rather complicated, it is about the simplest model that allows correlation between the innovation and regulatory delay processes. The model contains several familiar models as special cases. When $\rho_1 = 0$, the count and Tobit models are independent and may be estimated separately with full efficiency. When $\tau_1 = 0$, the count model is the standard Poisson model with no accounting for overdispersion. When $\tau_1 > 0$ the count model is the generalized Poisson model. When $\rho_1 = 0$, these count models are independent of the regulatory approval process, and $\boldsymbol{\alpha}$ can be estimated consistently in either model by MLE based on (2) with u_1 identically equal to zero.²⁰ Similarly, the Tobit model when $\rho_2 > 0$ but $\tau_2 = 0$ (selection but no correlation with the arrival process) may be estimated by any of the usual methods for the Type II Tobit model (Amemiya, 1985). Estimating these restricted models may be useful for hypothesis testing and to provide starting values of $(\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \rho_2, \sigma, \tau_1)$ for the full model maximum likelihood routine.

¹⁹ See Quandt (1983, section 8.2) for a brief introduction (and further references) to Gaussian quadrature.

²⁰ Even when $\tau_1 > 0$, MLE based on a simple Poisson model yields consistent estimates of $\boldsymbol{\alpha}$ as long as the conditional mean is correctly specified (Cameron and Trivedi, 1998, sec. 3.2.3).

4 Data and Estimation of the Model

4.1 The Innovation Model

4.1.1 Data

I examine new intrastate non-access services introduced by Ameritech in its Indiana territory. In 1997, Ameritech provided information on all of its non-access tariff filings since July 1991 (these tariff filings are part of the public record). The data compose a balanced study period of three years each before and after the start of Opportunity Indiana. Since no new service can be offered before being added to the tariff, the filings include all new services (see the Data Appendix for a complete list).

Ameritech filed 185 tariff revisions, of which 51 are for new services. The figure does not include promotional offerings (temporary price decreases for existing services) or access services. This figure includes 15 filings of new pricing options for existing services, which are filed as “new services” under IURC rules. Because I want to count truly new services, and not new ways to buy existing services, optional pricing plans are removed from the data set. After removing another filing that contained no new technology,²¹ 35 new service filings remain.

The new services are presented by category in table 1. The services are grouped into two categories. The first category, labeled A, comprises Local (exchange access), Centrex, and Central Office services and features. The second category, labeled B, comprises Operator, Public Telephone, Wireless, Dedicated Communications, ISDN, Video, and Wide Area Telecommunications Services, and other miscellaneous services. These categories are determined from the tariff section in which the new service is included.

²¹The ISDN Data Usage filing (11/25/92) is merely a different price for a particular usage of technology already covered in the ISDN Prime, Direct, and Centrex filings from the same date.

4.1.2 Results

The dependent variable n_t for (2) is the number of services in each month in each service category. Separating the filings between categories allows the arrival process to differ between categories (i.e., allows category-specific fixed effects). The random effect u_{1t} is common to both category counts in month t .²² The two categories and 72 months in the observation period yield 144 count observations.

The results of the estimation of (11) are in table 2. The first two columns are for the *no covariates* model, which contains only dummies for service category and Opportunity Indiana. The table includes the estimates for the regulatory delay models as well, which are jointly estimated, although I defer discussion of those results until section 4.2.

Both of the Opportunity Indiana coefficients are positive (although only the first is statistically significant); there were more services in each category during the alternative regulatory regime. To interpret the coefficients in the generalized Poisson estimations, recall that the log of the conditional mean of the count process is linear in the covariates, so that positive coefficients imply greater counts. The coefficients imply that the mean arrival rate of services in the Local, Centrex, and Central Office category is 359% higher during Opportunity Indiana than before; that for Other services is 97% higher.²³ The former is significant at the 5% level; the latter is not significant (although the two are jointly significant).²⁴ Thus Opportunity Indiana is correlated with a large increase in services created, especially Local, Centrex, and Central Office services.

Before putting weight on any interpretation of these results, it is necessary to test the *no covariates* model's assumptions. Consider first the possibility that the mean is incorrectly specified through the omission of relevant variables. In empirical studies of telecommunications innovation, economic and demographic variables often significantly affect innovation (e.g., Greenstein et al., 1995). We want to see if innovation jumps up during Opportunity Indiana in response to changes

²²For clarity of presentation, the notation in section 3 does not reflect the panel aspect of the count data.

²³The percentage change in arrivals due to an indicator x_j taking a value of 1 is $\% \Delta = e^{\beta_j} - 1$.

²⁴A Wald test statistic for joint significance is at the 0.96 quantile of a $\chi^2(2)$ distribution.

in some causal variable other than the removal of the regulatory burden. Accordingly, the second and third columns of table 2 (labeled *covariates*) report an expanded regression including other variables.²⁵

In the *covariates* regression, population is not significant.²⁶ The next variable to check in the specification is a control for changes in the size of the population of potential new services: the log of real R&D spending by Ameritech, lagged one year.²⁷ The estimated coefficient is positive and statistically significant at the 1% level. The coefficient on R&D implies that every extra percent spent by the firm on R&D resulted in 2.2 percent more new services the following year, which works out to about \$1.4M in R&D spending (above the average) per extra new service (above the average).²⁸ Adding the extra variables in the *covariates* estimation strengthens the significance from the Opportunity Indiana indicators,²⁹ and greatly increases the estimated impact (1784% more services in the category A and 708% more in category B).

A final area to explore is competition. To avoid the *competition effect* pitfall (Sappington and Weisman, 1996), which ascribes benefits to lighter regulation when in fact they are caused by increased competition, I control for the number of competitors in a separate estimation. What was the competitive environment in Indiana during the study period? For the services under consideration here, the closest form of competition would come from competing local exchange companies and competitive access providers (CAPs). Local competition was still virtually non-existent by the end of 1997.³⁰ CAPs were making more progress in Indiana, however. The variable

²⁵ All covariates are demeaned, so the intercepts are comparable across columns.

²⁶ In a short time series from a single state such as this one, most economic and demographic variables are highly correlated, so that multicollinearity precludes including all variables of interest. The same results obtain if access lines or per-capita income are included instead of population.

²⁷ Firm R&D figures are the portion of R&D spending by Ameritech allocated to Indiana Bell (FCC *Statistics of Communications Common Carriers*), adjusted by the GDP deflator.

²⁸ In exploratory work, neither industry R&D nor U.S. patent counts from relevant technological areas were significant.

²⁹ A Wald test statistic for the joint significance of the Opportunity Indiana indicators has a p -value of 8.2E-4.

³⁰ Compared with the 2.4 million access lines owned by Ameritech Indiana, the company sold only 159 local service lines for resale and five lines as unbundled network elements to other companies as of December 1997 (Indiana Utility Regulatory Commission, 1998).

CAPs is the log number of firms providing high-speed bypass access to businesses.³¹ The estimated coefficient on *CAPs* when it is added to the *covariates* regression is -0.990 (1.15), insignificant. Most importantly, the Opportunity Indiana coefficients are still positive and significant,³² it does not appear that competition explains the increase in services.

It is never possible to test every potential covariate when considering omitted variables. However, to examine the effects of shocks apart from the regulatory variables in a general way, I also estimated the innovation model with the variables from the first column of table 2 and a set of year dummies. These shocks might represent changes in the national or regional economy, competition, or demand that affect the firm’s innovation. Even with the year dummies (none of which was significant),³³ the Opportunity Indiana coefficients are still negative, with values falling between the *covariates* and *no covariates* estimates in table 2. Both are significant.³⁴

Finally, consider the generalized Poisson specification itself. The estimated dispersion parameter τ_1 is 0.8 in the *no covariates* estimation, which implies that the average ratio of the conditional variance to the conditional mean in the sample is 6.1 (this ratio would be unity in the simple Poisson model).³⁵ The estimated τ_1 drops to 0.42 in the *covariates* estimation, which implies that the average predicted coefficient of variation in the sample is 4.0. Apparently the added covariates account for some of the unexplained heterogeneity in the *no covariates* estimation. Since omitted variables in the conditional mean function can induce overdispersion, the smaller magnitude of τ_1 gives some assurance that any impact from omitted variables is reduced in the *covariates* estimation.

The predicted mean services per year from the *no covariates* and *covariates* models are given in table 3 for the periods before and during Opportunity Indiana. The prediction is $T^{-1} \sum \exp(\mathbf{w}'_t \hat{\boldsymbol{\alpha}})$,

³¹Data are from Harris (1997, exhibit 1), the FCC (Kraushaar, 1991–1997), and the IURC *Annual Report 1996–1997*. The number of CAPs ranges from one in 1991 to 14 in 1997.

³²The two Opportunity Indiana coefficients are 2.63*** (0.98) for category A and 1.79** (0.87) for category B. They are jointly significant.

³³An LR test of the model with year fixed effects vs. the model without fails to reject the simpler model (statistic is at the 0.818 quantile of a $\chi^2(6)$ random variable). In both estimations ρ_1 is fixed at zero.

³⁴The two Opportunity Indiana coefficients are 2.78*** (1.05) for category A and 1.96* (1.00) for category B. They are jointly significant.

³⁵The conditional variance of the generalized Poisson n_t is $\mu_t(1 + \mu_t[\exp(\tau_1^2) - 1])$, where the conditional mean μ_t is $\exp(\mathbf{w}'_t \hat{\boldsymbol{\alpha}})$.

the mean-in-sample of the predicted mean. The *no covariates* model estimates that under Opportunity Indiana the average number of new services increased by 5.5 per year compared with the RoRR period (a 182% increase), which is close to the actual observed increase of five and two-thirds per year.³⁶ The *covariates* model predictions are similar.

4.2 The Regulatory Delay Model

4.2.1 Data

Turn now to the regulatory delay submodel. The tariff data also contain the effective date of the filing, so that the approval delay can be calculated. Before Opportunity Indiana, a new service could not be introduced until its tariff filing had been actively approved by the IURC, and the commission required the filing to be docketed for at least 30 days before decision. Delay in excess of the 30 day minimum was caused by staff investigation of the tariff and the wait until the next commission meeting. After July 1994 under Opportunity Indiana, new services were generally presumed lawful (requiring no action by the IURC) and were introduced with one day of notice. The average delay for all services over the entire observation period was 39 days, the median was four days, and the maximum was 217 days.

The minimum mandated regulatory delays (30 days before Opportunity Indiana and one day during Opportunity Indiana) are treated as deterministic in the analysis (refer to discussion in section 15). Summary statistics on the remaining, stochastic part of the delay times are in table 4. I refer to the total delay less the deterministic part as the *adjusted delay time*.

The delays during Opportunity Indiana were very short, averaging about a week.³⁷ In fact, if the largest adjusted delay time of 93 days is dropped, the next highest is a mere nine days and

³⁶Unlike the standard Poisson model, when there are random effects ($\tau_1 > 0$) the mean-in-sample of the predicted mean calculated from the ML estimates is not identically equal to the sample average of the counts.

³⁷According to Ameritech, there were no approval delays at all during Opportunity Indiana, except when the company chose a later effective date for a filing than the minimum allowed (personal communication with Bruce Hazelett, Director of Regulatory Affairs, Ameritech Indiana). I remain agnostic about the cause of the apparent delays. Given that the “delays” (real or self-imposed) are so short, they do not affect the cost of regulation calculation much in section 5.

the average falls to three days. This outlier was not included in the estimations to avoid undue influence on the results.

Limited characteristics of each filing are also available. The number of pages composing the filing can proxy the unobserved complexity of the filing. During Opportunity Indiana we also have the projected revenue from the service, which is submitted to the IURC with the filing.

4.2.2 Results

Section 15 introduces a bivariate selection model to handle the large number of zeroes in the adjusted delay times. Recall that correlation between the decisions is captured by the parameter ρ_2 , which is zero if the decisions are uncorrelated. There are no zeroes in the data before Opportunity Indiana (i.e., the services are always delayed), so the selection equation is estimated only for the Opportunity Indiana period (i.e., before Opportunity Indiana the selection equation puts weight 1 on $y_2 = 1$).

The bottom part of table 2 contains the estimated parameters for this part of the model. The first two columns include no covariates, other than an indicator for Opportunity Indiana. The final two columns include the pages and revenue covariates. In both estimations, the indicator for Opportunity Indiana in the duration model is strongly significant. In fact, the indicator alone is responsible for reducing the delays nearly to zero: the percentage change due to the indicator is about -97% in each estimation.³⁸ Before Opportunity Indiana all approvals were delayed; during Opportunity Indiana the chance of delay drops to 0.76 (see table 5). Neither tariff filing pages nor service revenues are significant in either the selection or the duration models. Pages has the expected sign: more pages (i.e., more complex filings) means that the probability of delay is higher and that delays are longer. Services with higher expected revenues create longer delays when delayed. In both estimations the selection and delay disturbances are highly correlated; ρ_2 is over 0.9 and differs significantly from zero. This positive correlation might be caused by unobserved

³⁸The formula in footnote 23 applies to this part of the model as well.

factors that lead the regulator both to delay approval with higher probability and to make the delay longer than average.

The estimated total delay, including the minimum approval period, is much shorter under Opportunity Indiana. Combining the selection and the delay results, expected total observed delay time fell from over 130 days under RoRR to less than 4 days during Opportunity Indiana.³⁹ Table 5 lists the predicted delays from the two estimations.

4.3 Correlation Between the Models

An examination of the incidental parameters gives insight into the correlation between the innovation and delay models. The correlation between the count and duration models is negative, as measured by ρ_1 in the *no covariates* estimation. Such negative correlation means that a shock leading to more innovation, and therefore more tariffs submitted to the regulator, has the effect of reducing regulatory delay time. An interpretation might be that the IURC relaxes its scrutiny of tariffs as they stack up in the regulatory inbox. An alternate interpretation may be that causality runs the other way: in periods of unexpectedly low regulatory delay, the firm floods the regulator with applications, hoping to take advantage of an expected relaxation of scrutiny.⁴⁰ The estimate of ρ_1 is not significant, however. Turning to the *covariates* estimation, $\hat{\rho}_1$ is again negative but no assessment of its significance can be made because the likelihood is maximized at the boundary $\rho_1 = -1$. This is likely due to the modest sample size and the numerical complexity of the estimation. An LR test of the *no covariates* estimation against its restricted counterpart, in which

³⁹ Predicted total *observed* delay before Opportunity Indiana is calculated as the mean-in-sample of the minimum delay plus $E(e^{y_1}|\mathbf{x}_i)$: i.e., $30 + \exp(\mathbf{x}'_i\hat{\beta} + [\sigma^2 + \tau_2^2]/2)$ (e^{y_1} is lognormal). During OI, the formula is the average of $1 + \Pr(y_2 = 1|\mathbf{z}_i) \cdot E(e^{y_1}|y_2 = 1, \mathbf{x}_i, \mathbf{z}_i)$ in the OI sample, where $E(e^{y_1}|y_2 = 1)$ is approximated by $\exp\{E(y_1|y_2 = 1, \mathbf{x}_i, \mathbf{z}_i)\} \cdot [1 + V(y_1|y_2 = 1, \mathbf{x}_i, \mathbf{z}_i)/2]$, a second order approximation. The expressions for $E(y_1|y_2 = 1)$ and $V(y_1|y_2 = 1)$ are given in Greene (1993, p.707). Predicted total *latent* delay is the average of the minimum delay plus $\exp(\mathbf{x}'_i\hat{\beta} + [\sigma^2 + \tau_2^2]/2)$.

⁴⁰ It is important to keep in mind that the negative correlation is found in the random effects error terms, and so is above and beyond any correlation induced by the covariates included in the estimation. In particular, the negative correlation itself is not a result of the increased innovation and decreased regulatory delay during Opportunity Indiana. That effect is captured by the fixed effects for Opportunity Indiana in the innovation and regulatory delay models.

$\rho_1 = \tau_2 = 0$ (independence of the count and duration models), fails to reject the restricted model.⁴¹ The same is true for the *covariates* model. Given this, it appears best to rely on the restricted estimations for the prediction exercise in the next section.

5 The Overall Impact of Opportunity Indiana

Now that we have estimated the parameters for the entire model, we can compare the overall effect of the regulatory change on service introductions in the two periods. This section uses the parameters estimated in the restricted, independent *covariates* model (refer to the previous paragraph). We can compare two counterfactual scenarios. In scenario 1, Ameritech remains under RoRR for the entire observation period (July 1991 to June 1997). In scenario 2, Ameritech is under Opportunity Indiana for the entire observation period. For each scenario, the covariates for the innovation model are set to their appropriate yearly values and the covariates for the regulatory delay models are set to sample averages.

How many new services would we expect to have been introduced in each scenario? Comparing the two answers will measure the total effect that the regulatory regime had on innovation, assuming that the model is correct and that the observed increased innovation and decreased regulatory delay are indeed due to the regulatory change. In the absence of a better control group, these results should be viewed as an upper bound on the effects of the regulatory change.

These answers differ from a simple extrapolation of the predicted means in table 3 because of the counterfactual value of the Opportunity Indiana dummy variable here and because here I am interested in services that are both created and approved, not just innovation (although the latter ends up making little difference).

Table 6 shows that in Scenario 1, the model predicts Ameritech creates and introduces about 11 new services. Under Opportunity Indiana, the company creates and introduces about 133 services—

⁴¹The results of the restricted estimations were very close to those presented in Table 2. The results are available in the working paper (Prieger, 2000).

12 times as many as in scenario 1. In each scenario more services are created in the first part of the observation period because the coefficient on R&D is positive and observed R&D expenditure exhibits a downward trend. Approval delays have little effect in these calculations, because the delays in each scenario are relatively short compared to the observation period and because most services are created near the beginning of the observation period.⁴² The average is 121.82 more services approved under Opportunity Indiana than under rate of return regulation; the standard deviation of 16.7 indicates that the difference is bounded well away from zero in probability.⁴³

Exercises comparing counterfactual scenarios are only as good as the assumptions they rest upon. Given the difficulties inherent in out-of-sample prediction, it is perhaps best to view this exercise as illustrative rather than to place stress on the numerical results *per se*. The results from the exercise illustrate the two ways that incentive regulation benefits consumers of telecommunications services. First, many more new telecommunications services were created under the price caps and market pricing. It seems that the incentive to introduce new services increased substantially when the IURC replaced RoRR with Opportunity Indiana. Second, the reduced mandatory approval time and the lower probability of a service being delayed beyond the minimum means that services were available to customers sooner under price caps.

Even if Ameritech would have introduced twelve times as many services under Opportunity Indiana, welfare probably would not have risen proportionally. The services introduced during Opportunity Indiana were probably not of importance comparable to the services introduced under the rate of return regime. The incremental services introduced during Opportunity Indiana—those that would not have been introduced under the previous regime—most likely created less revenue for the BOCs since they were formerly deemed unprofitable to introduce. Accordingly, they were

⁴²Less than 0.1 service on average is still delayed at the end of the observation period in each scenario. Finding the services introduced net of those still pending approval at the end of the observation period requires a result from queuing theory. If arrivals are Poisson with mean λ and the CDF of the delays is G , then the services introduced (the output of the queuing system) at time t is a nonhomogeneous Poisson process with mean $\Lambda(t) = \lambda \int_0^t G(s) ds$ (Ross, 1983, p.39). The actual formula used is a modification of this result reflecting two extensions: the arrival process is generalized Poisson, and the arrival rate varies each year. Details of the calculation are available upon request.

⁴³The standard deviation accounts for intrinsic variation only, not estimation error.

probably worth less to consumers as well. There is no way to estimate this difference in worth (to the company or the consumer) with the present data.⁴⁴

6 The Validity of the Model for Policy Analysis

It appears that the price cap/deregulatory regime had a large impact on the number and timing of service introductions. There are potential problems to consider when moving from correlation to causality, however. In addition to the competition effect pitfall discussed above, two other pitfalls may apply. The *demonstration effects* pitfall (Sappington and Weisman, 1996) is created when regulated carriers perform actions regulators desire, such as introducing new services, to “demonstrate” the success of a favorable regulatory regime. Unfortunately—from the standpoint of looking for a “natural experiment”—it is quite likely that the demonstration effect influenced Ameritech’s actions. There was much discussion in the regulatory hearings about the potential for lighter regulation to spur innovation, both in 1994 before Opportunity Indiana and in 1997 when it was under review. Innovation was clearly one dimension of performance on which Ameritech was to be judged.

The *sequencing pitfall* applies if firms’ actions are spurred by anticipated changes in the regulatory regime. This pitfall might apply to these data if, right before the switch to Opportunity Indiana, Ameritech held off on introducing new services in anticipation of the more favorable environment shortly coming. This pitfall is related to the demonstration effect; shifting a service introduction into Opportunity Indiana also has the advantage of making the relaxed regulation look more conducive to innovation. The evidence on whether sequencing effects are present is inconclusive. Ameritech submitted a spate of tariffs shortly after Opportunity Indiana began. When indicators for the six months right before the regime change and right after are included in the *no covariates* estimation, they have the signs that the sequencing pitfall predicts. However,

⁴⁴Service revenue data are available only for the Opportunity Indiana filings.

when other covariates (population and R&D) are controlled for, neither sequencing effect indicator is significant. Most importantly, in both estimations the positive signs remain on the Opportunity Indiana indicators.⁴⁵

A simple test to see if the demonstration and sequencing effects unduly influence the data is to compare a prediction from the estimated model with some out-of-sample data. In particular, if the demonstration and sequencing effects caused Ameritech to introduce more services than Opportunity Indiana would have spurred apart from these incentives, then the rate of service introduction should drop off over time. The model predicts Ameritech would produce about 6.5 services on average in a nine month period under the lighter regulation (from table 3). During the first nine months of 1999, the company introduced eight new services—exceeding the prediction, and well within the normal variation of a Poisson process.⁴⁶ So although the caution remains, the demonstration and sequencing effects do not appear to unduly bias the estimation. An area for future work is to gather data from other firms and states that remained under RoRR, to provide a better control group.

This study is an initial step toward filling the lacuna in the literature concerning alternative regulation and product innovation. Apart from the specific numerical results obtained, the main contribution of this work is methodological. The econometric model places innovation and regulatory delay in a framework comprising correlated, unobserved random effects. The model should prove useful for other questions and data sets arising from regulatory settings.

⁴⁵When added to the *no covariates* estimation with $\rho_1 = 0$, the indicator for the six months just before the regime change has coefficient -0.458 (0.973); the indicator for the six months just after the regime change has coefficient 1.150 (0.500). Adding these indicators also steals some significance from the Opportunity Indiana indicator for local, Centrex, and CO services: the p -value rises to 0.089. When added to the *covariates* estimation with $\rho_1 = 0$, the indicator for the six months before the change has coefficient -0.111 (0.972); the indicator for the six months after the change has coefficient -1.12 (0.708). Again, adding these indicators steals some significance from the Opportunity Indiana indicator for local, Centrex, and CO services: the p -value rises to 0.062.

⁴⁶Eight is the 0.79-quantile of a Poisson random variable with mean 6.5.

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Data Appendix

Table 7 contains all the new services Ameritech introduced in Indiana during the period three years before and after the onset of Opportunity Indiana.

Service Category	RoRR Period (7/91–6/94)		OI Period (7/94–6/97)		Total
	Total	Yearly Rate	Total	Yearly Rate	
A: Local Access, Centrex, and Central Office Services	3	1.0	14	4.67	17
B: All Other Services	6	2.0	12	4.0	18
Total	9	3.0	26	8.67	35

Table notes: counts are new services in Ameritech Indiana's Tariff numbers 7 and 8 before Opportunity Indiana, and in their Service Catalog during Opportunity Indiana. *RoRR* is rate of return regulation; *OI* is Opportunity Indiana.

Table 1: New Services Introduced Before and After Opportunity Indiana

Variable	No Covariates		Covariates	
	coefficient	s.e.	coefficient	s.e.
<i>Innovation Count Model</i>				
intercept	-1.781***	0.452	-2.605***	0.498
category A services	-0.693	0.761	-0.693	0.758
Opp. Indiana: category A services	1.523**	0.707	2.936***	0.800
Opp. Indiana: category B services	0.676	0.561	2.089***	0.674
population			-0.155	1.406
firm R&D (one year lag)			2.198***	0.807
<i>Regulatory Delay Duration Model</i>				
intercept	4.294***	0.396	4.339***	0.330
Opportunity Indiana	-3.585***	0.364	-3.505***	0.366
revenue (Opp. Indiana period only)			0.011	0.032
pages in tariff filing			0.200	0.244
<i>Regulatory Delay Selection Model</i> (Opp. Indiana period only)				
intercept	0.709**	0.361	0.846***	0.299
pages in tariff filing			0.791	0.533
<i>Incidental Parameters</i>				
ρ_1 (innovation and delay corr.)	-0.279	0.661	-1.000	fixed†
ρ_2 (selection and duration corr.)	0.941***	0.092	0.966***	0.075
σ (duration dispersion)	0.666***	0.131	0.640***	0.140
τ_1 (innovation random effect s.d.)	0.794***	0.298	0.420**	0.250
τ_2 (delay random effect s.d.)	0.472***	0.203	0.541***	0.199
log likelihood	-124.15		-119.50	
observations (counts)	144		144	
observations (durations)	34		34	

* = 10% level significance;

** = 5% level significance;

*** = 1% level significance.

Table notes: estimation is MLE based on (11), where the likelihood is evaluated via Gauss-Hermite quadrature with 50 weighting points. Significance levels are for one-tailed tests for τ and σ and two-tailed tests for all other parameters. Dependent variable for the count model is monthly services within each category; dependent variable for the duration model is log of the stochastic part of the regulatory delays (in days); dependent variable for the selection equation is 1 if delayed, 0 if not. The selection model is estimated for the Opportunity Indiana (OI) period only; Pr(delay) before OI is taken to be 1. In each model, the conditional mean is linear in the covariates. Continuous variables are in logs. *Revenue* is the yearly forecast at time of filing, available only during OI.

Table 2: Estimation Results for the Generalized Poisson/Tobit II Model

Period	Predicted Mean Yearly Services		Actual Mean Yearly Services
	No Covariates	Covariates	
Rate of Return Regulation	3.04	3.08	3.00
Opportunity Indiana	8.57	8.46	8.67

Table 3: Predicted vs. Actual New Services

	Observations	Zeroes	For Non-Zero Observations			
			Min.	Median	Mean	Max.
RoRR	9	0	13	96	102.6	187
Opportunity Indiana	26	7	1	2	7.6	93
Entire Period	35	7	1	3	38.1	187

Table notes: all units are days. *RoRR* is Rate of Return Regulation. The adjusted delay times are the total delay times less the minimum mandated approval periods (30 days for the RoRR regime, one day for Opportunity Indiana).

Table 4: Summary Statistics for the Adjusted Approval Delay Durations

	No Covariates		Covariates	
	RoRR	OI	RoRR	OI
Mandated Minimum Delay	30	1	30	1
Predicted Probability of Delay	1.0 (fixed)	0.76	1.0 (fixed)	0.76
Predicted Total Delay				
observed	132.2	3.54	138.1	3.98
latent	132.2	3.83	138.1	4.24

Table notes: units are days. Last two rows are the sum of the mandated minimum delay and the predicted stochastic delay. *RoRR* is the rate of return regulation period; *OI* is the Opportunity Indiana period. Figures calculated as mean-in-sample using estimated coefficients from Table 2; see footnote 39 for details.

Table 5: Predicted Regulatory Approval Delays

	Scenario 1:	Scenario 2:	
	Rate of Return	Opportunity Indiana	Difference
Year 1	3.56	42.25	
Year 2	3.06	36.39	
Year 3	2.38	28.30	
Year 4	1.17	13.89	
Year 5	0.63	7.55	
Year 6	0.30	4.60	
Entire Period (sum)	11.10	132.98	121.88
<i>standard deviation</i>	<i>3.47</i>	<i>16.30</i>	<i>16.67</i>

Table notes: cell entries are the average number of services created in the given year that are introduced to subscribers (i.e., were approved by the regulator) by the end of the observation period. Prediction is based on the estimated *covariates* model. See text and footnote 43 for details.

Table 6: Comparison of Predicted Services Introduced to Subscribers

Service	Date of Filing	Date Effective	Approval Delay
<i>Before Opportunity Indiana</i>			
OPTINET 64 Kbps	11/14/91	02/05/92	83
Centrex Custom Calling Features	09/30/92	02/03/93	126
OPTINET DS1 384 Kbps	10/15/92	01/06/93	83
ISDN Prime	11/25/92	06/30/93	217
ISDN Direct	11/25/92	06/30/93	217
ISDN Centrex	11/25/92	06/30/93	217
Residence Custom Calling Type 2	03/29/93	09/08/93	163
Caller ID with Name	11/19/93	01/02/94	44
800 Directory Assistance	05/11/94	06/23/94	43
<i>During Opportunity Indiana</i>			
Billing Reports	07/27/94	07/28/94	1
Toll Restriction—Residential	09/08/94	09/13/94	5
Ameritech Area Wide Networking	09/15/94	09/19/94	4
Scan Alert	10/13/94	10/15/94	2
High Voltage Protection Service	10/28/94	10/30/94	2
128 & 256 Kbps (Fractional DS1)	10/28/94	10/31/94	3
ISDN Direct New Features	10/28/94	11/07/94	10
Ameritech ISDN Prime New Features	11/03/94	11/07/94	4
2-Way DID with Call Transfer	11/09/94	11/15/94	6
Answer Supervision with Line Side Interface	11/14/94	11/15/94	1
Ameritech Digital Transport Service	01/17/95	01/18/95	1
Ameritech Advanced Video Service	02/03/95	02/06/95	3
Packet Switched Network Services	02/24/95	02/27/95	3
Business Call Forwarding—Temporary	03/03/95	03/06/95	3
Ameritech Intercept Referral Extension	03/16/95	03/20/95	4
Advanced Custom Calling Features—Pay Per Use	05/31/95	06/01/95	1
Ameritech Call Control	07/07/95	07/10/95	3
FlexLine	09/15/95	09/18/95	3
Prepaid Card	12/11/95	12/15/95	4
Information Call Completion	02/29/96	03/01/96	1
Calling Party Pays—Paging	04/09/96	04/10/96	1
Movers Call Forwarding	05/24/96	08/26/96	94
Ameritech Prime Number	06/04/96	06/06/96	2
Call Detail	06/18/96	06/19/96	1
Inmate Collect	06/28/96	07/01/96	3
3-Way Calling Pay Per Use	03/20/97	03/24/97	4

Table 7: Telecommunications Services Introduced to Subscribers by Ameritech Indiana