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AN ECONOMETRIC ANALYSIS OF THE FACTORS AFFECTING THE DEPLOYMENT OF ADVANCED TELECOMMUNICATIONS SERVICES

by

EUGENE A. FLOYD III

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2003

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Chair of Examining Committee

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Abstract

AN ECONOMETRIC ANALYSIS OF THE FACTORS AFFECTING THE DEPLOYMENT OF ADVANCED TELECOMMUNICATIONS SERVICES

by

EUGENE A. FLOYD III

Advisor: Professor David Gabel

This study examines the decisions of all incumbent local exchange companies (ILECs) in the United States to deploy advanced telecommunications services within each of their wire center serving areas. The advanced telecommunications services examined are packet switching, digital signal level (DS) transport, and synchronous optical network (SONET) technologies. The study is unique in its level of granularity and the set of economic determinants controlled for in the econometric analysis.

Supplier, buyer, market and regulatory data has been collected at the wire center level that uniquely defines ILEC as well as its market including type of holding company, number of firms, number of competitors, and forms of regulation.

The implications from this study will provide policy insights on those economic determinants most conducive to the adoption of technological innovation and thus will provide answers to questions engendered by the implementation of the Telecommunications Act of 1996: Does competition and / or deregulation inhibit technological innovation? For economists, this study will go a long way in addressing the applicability of the Schumpeterian hypotheses - at least within the telecommunications industry. The results suggest that, by controlling for

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competition, most forms of alternative regulation may not be as effective as RBROR in introducing new technological services.

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This has been a long and arduous journey to satisfy a dream whose meaning goes far beyond its intellectual achievement. But no man is an island and I owe thanks to several people. First I say thank you to the Economics department at the CUNY Graduate Center. Beginning with Professor Michael Grossman, to whom I will always be indebted, through Professor Linda Edwards and finally to Professor Thom Thurston, the department heads have been encouraging and supportive. And of course I will always be grateful to my advisor, Professor David Gabel, who was patient, and from whom I learned a great deal. One is always thankful for a supportive family. And mine was there - especially my sister, Paulette. But I give particular thanks to a dear friend, Richard Friedman, who alone can appreciate what this means. And finally I say thanks to the two most important people in my life - my son, Matthew, and my wife, Barbara. Without them and their love, this would have never happened. Thanks folks.

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CHAPTER ONE

INTRODUCTION

What Is the Question?

The general question addressed in this inquiry is: Which economic factors have the greatest impact on technological innovation? The particular focus of this study is an assessment of the primary economic determinants underlying the adoption[1] of technological innovations in the telecommunications industry since the passage of the Telecommunications Act of 1996[2]. These economic determinants include market structure (including concentration or some measure of the level of competition), firm size, market demographics (business vs. residential characteristics), and - because it is the telecommunications industry - regulation.

Technological innovation is a form of technological change. According to Stoneman (2002, 4):

> Technological change means changes in the goods and services produced and the means by which they are produced. Technological advances are changes where the new in some sense is considered superior to the old. Technological advances in the nature and types of products produced are product innovations. Technological advances in the techniques used in production, whether they relate to the type of machinery employed, the layout of the factory, the raw material and intermediate inputs employed or the management methods used would all be considered as process innovations.

Why is this Issue Important?

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[1] The value of an innovation to society is only realized when it has been adopted or diffused. "It is diffusion rather than invention or innovation that ultimately determines the pace of economic growth and the rate of change of productivity." [Hall and Kahn (2003, 3)]

[2] The Telecommunications Act of 1996 was passed by Congress on January 31, 1996 and was the first major overhaul of the Communications Act of 1934. See Telecommunications Act of 1996, Pub L. 104-104, 110 Stat 56 (February 8, 1996). The primary purpose of the Act was to further open the telecommunications market to competition and facilitate innovations [Darby and Fuhr (2000)]. Key provisions obligated the local telephone companies to open their markets to competition. In return they would be allowed in the long-distance market.

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Technological innovation is considered one of the main drivers of our economy (Baumol 2002), yet, according to Tirole (1988, 409):

> ... economists have devoted little attention to the optimal size and mix of public policies with regard to R&D (patent length and protection, R&D subsidies, and so on). A similar remark can be made concerning the adoption and diffusion of new technologies.

Tirole's statement emphasizes the value of my research - i.e., it will shed light on those economic determinants crucial to technological innovation. This is of particular importance to policy makers as more markets are being opened to competition.[3] Since the study will focus on the telecommunications market and its unique characteristics, the observations obtained here will have singular significance to the interpretation and worth of the Telecommunications Act of 1996 and the setting of future telecommunications policy. This study will go a long way to responding to such statements as Crandall's (1999): "... by creating ample opportunities for entrants to use incumbents' network facilities, the Act discourages investment in new facilities."

Why is this Issue Interesting?

One of the more controversial issues in economics is whether competition or monopoly is more favorable to technological progress or innovation. The telecommunications market following the Telecom Act of 1996 will provide a unique market to observe the nature of competition and its effect on technical innovation. As a result of the Telecom Act of 1996, there are three means by which a new entrant can

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[3] The flowering of innovation is ultimately determined by the decisions of policymakers. According to Mokyr (1990, 16):

> Technological progress in societies is rare. It is like a fragile and vulnerable plant, whose flourishing is not only dependent on the appropriate surroundings and climate, but whose life is almost always short. It is highly sensitive to the social and economic environment and can easily be arrested by relative small external changes.

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enter the local telephone market: resale of ILEC[4] services; leasing of ILEC unbundled network components; facilities-based entry where the CLEC[5] provides its own network facilities. Nevertheless, in all cases, including facilities-based, the entrant must deal with the ILEC to provide local service even if only to lease space in an ILEC's wire center[6] or to interconnect with the ILEC. Thus, in this current telecommunications market, the ILEC and the CLEC each have two roles. The ILEC is both a supplier of intermediate factors as well as a competitor while the CLEC is both a customer (of the ILEC for intermediate input factors) as well as a competitor of the ILEC. Given this market structure, how will the incumbent respond to making advanced technological services available? Will it make those advanced services available in their competitive markets where they may have to share this advanced technology with its competitors? Or will it provide those services only in its more monopolistic markets where it doesn't have to share? Which are the most significant factors driving the decision to employ technological innovation? These are some of the policy and strategy issues that continue to affect the implementation of the Telecommunications Act after nearly seven years and underlies the recent, embittered Triennial Review.[7]

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[4] An Incumbent Local Exchange Carrier (ILEC) is certified to provide local telecommunications services in a specified geographical area and is the owner of the public switched network (PSN) in these areas. Such companies were often the sole or monopoly provider of local services within a wire center serving area at the time of the passage of the Telecommunications Act.

[5] A Competitive Local Exchange Carrier (CLEC) is the entrant into the serving area of the ILEC and will compete with the incumbent company to provide local services.

[6] A wire center is the location of the telephone company's switch where subscriber lines are terminated.

[7] See the FCC News (February 20, 2003) and Stephen Labaton, "Local Phone Rules to Stay in Place," *New York Times*, 21 February 2003. The FCC largely left its existing pricing rules in place, but limited the ILECs' obligation to provide broadband. The intention is that this would be an incentive for broadband build-out.

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This study also addresses the issues identified in Section 706 of the Telecommunications Act - Advanced Telecommunications Incentives - which seek to understand those conditions that will encourage the deployment of advanced telecommunications services. The FCC has conducted a series of proceedings that embrace these and related matters.[8] Much attention has been focused on this because, as stated in (FCC 2002b, 1), "The widespread deployment of broadband infrastructure has become the central communications policy objective of the day."

Background

Much of the economic literature and many of the empirical studies have been devoted to understanding the relationship between innovation and market structure – in particular, the degree of concentration and firm size. In general this has stemmed from various interpretations of the Schumpeter (1942) argument[9] that innovation is more likely to occur in concentrated markets than in purely competitive markets.

According to Cohen and Levin (1989), Schumpeter's assertions have inspired the second largest body of empirical literature in the field of industrial organization. Most of this literature is devoted to testing two hypotheses associated with Schumpeter:

(1) innovation increases more than proportionately with firm size,

(2) innovation increases with market concentration.

Clearly, the economics profession has found the relationship between innovation and market structure to be a fertile area of study. Just as obviously, it appears that the

---

[8] Section 706 of the Act explicitly directs the FCC to conduct regular inquiries as to the deployment of advanced telecommunications services and find means of encouraging that deployment if it is not proceeding in a reasonable and timely fashion. The *Third Report* (FCC 2002) was recently issued. Other inquiries being conducted by the FCC include *The National Performance Measures NPRM,* the *Incumbent LEC Broadband Notice,* and the *Triennial UNE Review Notice.*

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economic profession still has not reached consensus on this subject otherwise there would be no need to further investigate the issue nor would there have been any justification for producing such a large body of empirical studies. However, the problem with the various studies and the subsequent interpretations is: (1) there seem to be little consensus amongst economists as to exactly what Schumpeter meant; (2) the use of R&D expenditures (or variations on direct expenditures by examining scientific or engineering levels of employment) still begs the question as to the relationship between innovation and market structure. Even more dismaying, is there appears to have been even less focus on the degree of innovation and diffusion and their correlation with market structure.

Schumpeter himself seems to be saying that there is more to competition than merely focusing on price, which he viewed as static competition of existing products. He seems to be advancing an argument that demands focusing on the dynamics of competitive forces, which includes innovation or technical progress in the context of market structure [see Martin (1993, 351-352)].

Cohen and Levin (1989) show, in their review of the literature on innovation, that firms size and concentration may not be the primary independent variables in determining the degree of innovation. Some studies suggest that interaction between firms, firm size and other attributes come into play. This can be demand, technological opportunity, density of the market - i.e., urban versus rural - or even firm characteristics such as marketing.

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[9] The Schumpeter hypotheses will be discussed in Chapter 2.

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What Has Been Learned About the Issue?

More and more is becoming known about the nature of innovation in the telecommunications market post-Telecom Act of 1996. I have discussed the general background on the subject above. But the telecommunications market is unique, as it does not really fit any of the basic paradigms proffered by much of the existing body of empirical literature on market structure and technological innovation. The uniqueness of the telecommunications industry stems from the predominate role regulation has played in its history. One cannot discuss innovation or competition without also discussing regulation. The period of this study also coincides with a move amongst federal and state regulatory commissions to a less rigid form of regulation. Some of the studies that will be reviewed in Chapter Two have tried to address these issues of competition and regulation - usually separately and occasionally simultaneously. Nonetheless Sappington (2002, 81) believes, "Future empirical work must distinguish more clearly between the effects of incentive regulation and the effects of competition."

Past industrial organization studies have found some support for the belief that competition has a positive effect on innovation. However, as mentioned above, the effect of firm size and market structure is still being debated although there are few such studies focused primarily on the telecommunications market. There are additional studies that show that the type of regulation faced by telecommunications providers has an impact on innovation. Despite the insights gained from all of these studies, they are still somewhat limited. The unit of observation of past studies has been the state or the major telecommunications firms. The unit of observation in this study is the wire center serving area. This has never been done. This more granular approach allows for far more

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heterogeneity in the characteristics of market structure - firm size, firm ownership, demand, concentration - in addition to competition and regulation. Thus, this study addresses the particular issues unique to the telecommunications industry while also addressing the more general issues of market structure and innovation of interest in the economics profession.

Study Methodology[10]

This study will focus on the decisions of the ILECs to provide advanced telecommunications services in their markets. The advanced telecommunications services examined are packet switching, high-speed digital transport and synchronous optical networks (SONET).

Data is obtained on the geographical location of ILECs and CLECs from the Local Exchange Routing Guide (LERG), the types of services offered from the NECA 4 Tariff, demographic and market information from the United States Census Bureau and United States Department of Commerce, and information about the forms of regulation faced by each ILEC is derived from a questionnaire developed for this study. The questionnaires were answered by qualified representatives from each state and the District of Columbia.

This collection of information was incorporated in a large database that allows for a qualitative econometric approach to the decision to deploy advanced telecommunications services. For each of the advanced telecommunications services, we

[10] The terms discussed in this section are discussed in Chapter 3.

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examine the decision to adopt. This leads to four related probit analyses of the relevant data.

Findings

The actual findings suggest that once other factors such as competition and firm size are controlled for, incentive regulation may not be a positive catalyst for the adoption of technological innovation - at least in the deployment of the advanced telecommunications services studied here.

Firm size, the level of competition (a proxy for reduced market power or concentration), and demand have a positive effect on the deployment of ATS. However, the role played by mid-size companies as well as small companies is surprising and revealing about the changing structure of the telecommunications market.

Caveats

One of the strengths of this research is its examination of the forms of regulations faced by each of the ILECs. This also creates its own set of problems. As will be seen in Chapter 3, there are many different forms of regulation yet few fit neatly into easy classification - there are numerous variants. The task was to fit the many different regulatory forms into a set of distinct categories that would facilitate analysis but not detract form the inherent heterogeneity of the various types of regulation.

Contents

Chapter 2 is review of the literature on technological innovation. Chapter 3 discusses the technologies chosen for this study, the forms of regulation, and the various data sources. Chapter 4 examines the methodology and the analysis. Conclusions and

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policy implications are presented in Chapter 5. Suggestions for future research are explored in Chapter 6. The Appendix contains the tables and figures as well as a reference list of additional documents examined in order to answer questions about regulatory history. This is followed by a Glossary and finally an annotated Reference List[11]. Hopefully anyone reading this document with the intention of pursuing related research will find this Reference List helpful.

[11] The Literature Review is fairly long. The Annotated Reference List will allow me to shorten the Literature Review, but will afford interested parties a better explanation of some of the more important studies.

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CHAPTER TWO

LITERATURE REVIEW[12]

A. INTRODUCTION

The key to economic growth is technical creativity or technological innovation.[13] According to the *Economist:*

> Innovation has become the industrial religion of the late 20th century. Business sees it as the key to increasing profits and market share. Governments automatically reach for it when trying to fix the economy. Around the world, the rhetoric of innovation has replaced the post-war language of welfare economics. It is the new theology that unites the left and the right of politics.[14]
>
> ... understanding growth is surely the most urgent task in economics.[15]

Yet, despite the growing recognition of its importance, economists do not understand the interplay of economic forces underlying technological change. "R&D is important to economic growth, but just how important is a question economists are not yet fully able to answer."[16] Moreover, there has been no empirical study proving that technology has been the engine of modern-day growth.[17] In other words, the economic profession is looking through a glass darkly. This study of the relationship between innovation and market structure is an attempt to shed some light on this complex subject. According to Dosi (1988, 1165):

> It is hard to doubt, however, that the domain of innovation, with the characteristics discussed in this review, are a major - and still largely unexplored - frontier of economic analysis.

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[12] In what follows, I have tried to add to the existing reviews of the literature on market structure and technological innovation. A list of these critical reviews of the literature is provided in section B.

[13] This is the conclusion reached by Mokyr (1990) in his study of the economic history of technological change from the classical age (around 500 B.C.) to the early twentieth century.

[14] The *Economist* (February 20, 1999), "Survey: Innovation in Industry - Industry Gets Religion", p 5. See all the articles in the survey (pp 5 - 28)

[15] The *Economist* (May 25, 1996), "The Poor and the Rich", p 23.

[16] Boskin and Lau (1996, 17)

[17] Grossman and Helpman (1994)

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Economics of Growth[18]

Although the importance of technology to economic growth did not assume prominence until the 1950s, it has long been of interest to economists. This interest reaches back to Ricardo (1821, Chapter 31), who recognized the economic value of "machinery" to society and, before him, to Adam Smith, who saw the positive impact on economic growth and that the ability of division of labor to increase productivity was in turn due to three forces:

> first, to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and lastly , to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many. (Smith 1776, p 4).

Say (1880), however, attributed even greater significance to technology and felt that Smith underestimated the importance of "machinery" and attributed too great an importance to the division of labor[19].

The interest in technological progress notwithstanding, the primacy of its value to economic growth was not realized until the work of Solow (1956, 1957), which established the neoclassical model of economic growth. Solow introduced technical progress to explain the difference between the rates of growth of capital and labor. Using aggregate United States data from 1909 -1949 he found that only 12 percent of the growth in output per worker could be explained by the growth in capital per worker; the

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[18] Relevant studies on economic growth are Stiroh (2001), and Steindel and Stiroh (2001). For new growth theory see Lucas (1988), Romer (1986, 1990), Aghion and Howitt (1998) and the Symposium on New Growth Theory in the *Journal of Economic Perspectives* 8(1), Winter 1994, 3-72.

[19] See Say (1880, p 18). Although in general agreement with Smith's views, Say found *Wealth of Nations* lacking in "rigorous analysis." One of his goals in his *Treatise*, was to correct these flaws in method and analysis that he found in *Wealth of Nations*. Say was far more appreciative of the value of technological progress (or "machinery") to economic growth than Smith. The essence of this analysis is found in Say (1880, ch VII).

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remaining 88 percent was attributed to the residual, which Solow termed "technical change." Solow's results were confirmed by a more detailed study performed by Edward Denison (1985). Nonetheless, although the residual had been associated with technological progress, it is really only a manifestation of the economic profession's "ignorance" since it is what remains after one has accounted for the "known" inputs.

> ...TFP growth is not observed at all, rather, it is calculated as a residual as the output growth not explained by weighted input growth ... TFP growth is a catch-all term that captures the impact of all growth factors, not explicitly measured. Investment in unmeasured inputs like research and development, or any mis-measured capital and labor inputs, for example, affect the measured TFP residual. [Steindel and Stiroh (2001, 26)]

Schumpeter[20]

Prior to Solow, one of the few voices discussing technological change was Joseph Schumpeter. According to Jacob Schmookler (1966):

> Except for a few economists, largely those of a heterodox stripe preoccupied with economic development, like Marx, Veblen, Schumpeter, and Kuznets, technological change was largely ignored until the last decade or so.

Any study of the economics of technological innovation and market structure must begin with a discussion of Schumpeter's thinking. Schumpeter's writings in this area have engendered the second largest body of empirical literature in the field of industrial organization [Cohen and Levin (1989, 1060)].

The genesis for such a study is directly linked to Schumpeter's *Capitalism, Socialism and Democracy (CSD)*. Kamien and Schwartz (1982, 22), reflecting a broad interpretation of this work by the economic community, have coalesced his thinking on

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[20] An analysis of the man, his life and his work can be found in Robert Allen's *Opening Door: The Life & Work of Joseph Schumpeter*. See also Heilbroner (1993, 1999), McCraw (1991), and Dixon (2000). Lazar (2000) explains why Schumpeter is one of three economists whose ideas altered recent history. Nakamura (2000) explains why Schumpeter is more relevant than Adam Smith in today's economy. The most relevant quote from *CSD* is given at the end of Chapter 6.

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technological innovation and market structure into two tenets termed the *Schumpeterian hypotheses*:[21]

(1) There is a positive relationship between innovation and monopoly power with the concomitant above normal profits.

(2) Large firms are more than proportionately more innovative than small firms.

But even though these hypotheses reflect the general thinking of the economic community, there is still some debate on the correct interpretation of Schumpeter's thinking on the nature and causes of technological innovation. For example, is Schumpeter simply saying that large firms are better suited for innovations? Is he referring to *ex-ante* or *ex-post* market power?

Baldwin and Scott (1987, 2) argue that Schumpeter did not distinguish between size and market power, but saw them "inextricably linked" at least as primary sources of innovation. They support this view by quoting from *Business Cycles* [p 282], "But 'monopoly' really means any large-scale business." The essence of the Schumpeterian argument is that innovation is fraught with uncertainty and that large-scale innovation would be unattractive without the "insurance" of some monopoly power to the entrepreneur.

Markham (1965) found that the economic profession had simply misinterpreted Schumpeter. He argued that Schumpeter was only expressing an obvious realization that "large firms with some market power" were necessary to finance and pursue innovations.[22] Scherer (1992, p 1418) concluded that:

---

[21] Kamien and Schwartz view these two hypotheses as "independent because possession on monopoly power does not imply large size, except in relative terms, ..., large firm size does not imply monopoly power."

[22] According to Markham, Schumpeter's theory should be viewed as a "threshold theory" where "some departure from a state of perfect competition (or the presence of some monopoly) is a necessary

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> Schumpeter went far beyond economists' long-accepted view that the *expectation* of a monopoly position (e.g., through patent protection on inventions) was necessary to make the venture worthwhile. Monopoly power *already held* also supported investment in technological progress.

There are numerous interpretations of Schumpeter's thinking, however, my position resonates with Cohen and Levin (1989, 1060-161) and Dasgupta (1986): By focusing solely on the two tenets of the Schumpeterian hypotheses, the economics profession has failed to realize the full sense of Schumpeter's goal, which is a broader understanding of the economics and determinants of technological progress. The relationship between market structure - i.e., firm size and/or market power - needs to be examined in a more endogenous system of simultaneity along with other variables that are involved in the nature and economics of technological innovation.

This last paragraph is very important in trying to understand the larger context of Schumpeter's thinking on innovation. Many of the interpretations of Schumpeter's views on innovation reflect an assessment of his overall writings. Often, though, the support for the Schumpeterian hypotheses seems to be based on the following passage from *CSD*:

> What we have to accept is that [the large-scale establishment or unit of control] has come to be the most powerful engine of [economic] progress and in particular of the long-run expansion of total output ... In this respect, perfect competition is not only impossible but inferior, and has title to being set up as a model of ideal efficiency.[23]

But in *CSD*, Schumpeter also clarifies some of the terms used in the above quote. For one, the large-scale establishment or unit of control does not necessarily mean mere size:

> There cannot be any reasonable doubt that under the conditions of our epoch such superiority is as a mater of fact the outstanding feature of the typical large-scale unit of control, though mere size is neither necessary nor sufficient for it. These units no only arise in the process of creative destruction and function in a way entirely different from the static schema, but in many cases of decisive importance they provide the necessary form for the achievement. They largely create what they exploit.[24]

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concomitant of innovation, but it does not follow that twice this volume of departures somehow measured, should lead to twice the volume of innovations." (p 325).

[23] *CSD*, p. 106.

[24] *CSD*, p. 101.

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But it is in this statement that we see the connection between the large-scale unit of control and creative destruction.

Capitalism is evolutionary and dynamic and is driven by creative destruction - "incessantly destroying the old [economic structure], incessantly creating the new one."[25] Creative destruction is itself the result of innovation. But innovation is the major tool for competition:

> But in a capitalist reality as distinguished from its textbook picture, it is not [price] competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest-scale unit of control for instance) - competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.[26]

Thus, for Schumpeter, competition and innovation are intertwined in a dynamic oligopolistic structure where monopoly power is temporary and *perfect* competition is an anathema for innovation.

Thus, while there have been innumerable investigations of the Schumpeterian hypotheses as defined in economic literature, Schumpeter's thoughts on innovation are far more complex. Some of that is undoubtedly due the difficulty in understanding his writings:

> The lack of clarity in Schumpeter's writings is most conspicuous when one reflects that an entire generation of researchers has interpreted his views on market structure and innovative activity in *causal* terms, *from* market structure *to* innovative activity. (Dasgupta 1986, 521)

Bauer (1997, 561) provides an insight on why the economic community struggles in its interpretation of Schumpeter:

> Overall, it seems that the funneling of Schumpeter's complex body of arguments into the language of formal economics has impaired the explanatory power of his by and large qualitative analysis.

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[25] *CSD*, p. 83.

[26] *CSD*, p. 84.

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However one interprets the writings of Schumpeter, all are clear that he envisioned a link between market power (or market structure) and innovation. What is not clear is the nature of that link and the role of monopoly (or market structure). According to Scherer (1992, p 1421):

> The only simple conclusion stemming from this and much other theoretical research stimulated by Schumpeter's original conjectures is that the links between market structure, innovation, and economic welfare are extremely complex.

SECTION B - STUDIES[27]

B.1 INTRODUCTION

As discussed briefly in Section A, the impetuous for the study of the relationship between market structure and technological innovation stems from the work of Joseph Schumpeter. Although Schumpeter's thought on the subject is conveyed in the overall body of his work, the genesis for the study of the effect of market structure comes primarily from *Capitalism, Socialism and Democracy*. Schumpeter, however, was long on concepts, but ironically short on rigorous analysis[28]. Thus, much of the analysis that is reviewed can be viewed as an interpretation of his views on the relationship between market structure and technological innovation.

Scherer and Ross (1990, 4-7), building on the Structure-Conduct-Performance paradigm, outline a broad descriptive model of the relationships used in many industrial organization studies. Industry *performance* is dependent on the *conduct* of the market participants. Conduct is dependent upon the *structure* of the market. Structure, is itself,

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[27] Critical surveys of the literature on the economics of technological innovation are provided by Kamien and Schwartz (1975, 1982), Baldwin and Scott (1987), Thirtle and Ruttan (1987), Dosi (1988), Reinganum (1989), Cohen and Levin (1989), Freeman (1994), Cohen (1995), Symeonidis (1996), van Cayseele (1998), and Ahn (2002).

[28] According to Scherer (1992, 1418), Schumpeter's thesis lacked "conceptual precision and empirical support." Such lack of rigor is ironic because he was a strong proponent of econometrics, helped organize the Econometrics Society, and served as its first president, although he was not a first-rate mathematician. (McCraw, 1991). It is also not in accord with his admonishment of the economic profession for not embracing a more scientific-based economic theory (Schumpeter, 1982).

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affected by a host of *basic conditions.* See Figure 1 (Appendix). The authors, however, are clear that this broad model should not be viewed as a one-way causal series of effects leading from *market structure* to *performance*. Rather they envisioned the system as *endogenous* with feedback and where basic conditions and market structure are "determined within the whole system of relationships and not fixed by outside forces." This view is echoed by Symeonidis (1996, 37): "Recent work, however, suggests that both innovation and market structure must be seen as jointly determined endogenous variables."

OUTLINE OF THIS SECTION

As Kamien and Schwartz (1982) and Cohen and Levin (1989) point out, the economic profession has seemingly become mesmerized by the archetypal interpretation of the Schumpeterian hypotheses - the influence of firm size and/or market power[29] on innovation and neglected some of the other economic determinants that might be more "fundamental"[30] in the relationship between market structure and innovation. Thus, following a review of the literature on the effects of firm size and then market power, we examine: diffusion; the debate over the primacy of technological opportunity - the effect of scientific knowledge on innovation - versus demand-pull - the effect of market demand upon innovation; regulation (primarily in the telecommunications industry); and endogeneity of market structure and innovation. Because of the far-reaching scope of its abstract exploration, we will briefly review the work of John Sutton.

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[29] Although seemingly synonymous, market concentration and market power do not have the same economic meaning. An industry could conceivably have a high degree of market concentration, but be limited in its exercise of market power by free entry and/or potential competition

[30] Cohen and Levin (1989, 1060).

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B.2 FIRM SIZE

Firm size is the structural attribute most frequently studied in its effect on technological innovation, (Baldwin and Scott 1987, 75). According to (Cohen 1995, 184) arguments for the advantage of large firms are:

> Capital market imperfections make it easier for larger firms to secure financing for risky R&D projects. Size is correlated with the availability and stability of internally-generated funds.
>
> There are scale economies in the R&D process itself due the greater opportunity, more diversity of thought and more diversity of product lines in which to explore and apply new technological concepts. The larger group will also increase the chance of serendipitous discoveries.
>
> Returns on R&D are greater when there is a larger customer base over which to spread the fixed cost of innovation.
>
> There are alleged complementarities between R&D and other nonmanufacturing activities - e.g., marketing, financial planning, administrative - which are better realized in larger firms.

Scherer and Ross (1990, 652-653) refer to some of the disadvantages of large firms, which are primarily due to bureaucratic sloth and inefficiencies.

Studies investigating the effect of firm size of innovation are mixed[31]. Depending on the study referenced, one can find support for either side of the issue. Symeonidis (1996, 41) captures the general consensus of the economic community:

> The evidence on the relationship between innovative output and size is inconclusive; most authors would probably agree that innovative output rends to rise less than proportionately with firm size, although other patterns have also been suggested for particular industries, periods, or countries.

Yet, despite this and similar pronouncements, more recent studies suggest that size does matter. Its significance is determined by the particular industry under investigation as well as the analytical methodology employed.

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[31] See Kamien and Schwartz (182, 75-84), Baldwin and Scott (1987, 75-88), Cohen and Levin (1989, 1067-1074), Cohen (1995, 184-191), and, in particular, Cohen and Klepper (1996), which includes a more current assessment of prior studies on the effect of firm size on innovation.

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One general finding is that a greater percentage of large firms conduct innovative activity and produced innovations than smaller firms - i.e., the probability that innovative activity will be manifested increases with firm size. See Scherer (1965a), Freeman and Soete (1997), Brower and Kleinknecht (1996), and Bartoloni and Baussola (2001). The extent of innovation - i.e., the number of new or improved products - increases with size (Love and Roper, 1999). However, smaller firms invest a greater percentage of their R&D expenditures relative to their market share than do larger firms - i.e., smaller firms appear to be more R&D intensive than are large firms.[32]

Using OECD data, Freeman and Soete (1997) demonstrate that the vast majority of R&D is performed by firms with the largest R&D programmes. In 1967, the hundred largest R&D programmes performed more than two-thirds of all industrial R&D in all countries except one. The overwhelming majority of small firms in OECD countries still do not perform any organized R&D. In addition, industry type determines the major source of variation in research intensity.

Earlier studies were usually a linear regression of some measure of R&D on some measure of firm size. It was not until Scherer (1965a), however, that a more nuanced interpretation of the relationship between firm size and innovative activity was realized.

Using patent statistics (lagged by four years) on 446 of the Fortune 500 in base year 1955, Scherer developed a log-log, multi-variable linear regression model that used sales as a proxy for firm size. A cubic expression for sales was incorporated to capture the non-linearities in this relationship. Scherer found that after experiencing slightly increasing returns up to approximately $500 million, corporate patenting increases less

[32] This conclusion about small firm advantage in innovative intensity seemed to be a prevailing finding amongst some economists. As example see Love and Roper (1999) and Acs and Audretsch (1988).

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than proportionately with sales, except in the case of a few giant firms who are leaders of their two-digit SIC sectors in sales. In later comments, Scherer (1965b) concluded that, with the exception of the chemical industry and giant leaders in the automobile and steel industries, the analysis implies that inventive activity increased more than proportionately with size up to a threshold and thereafter was basically proportional. This interpretation of the relationship between firm size and innovative activity became the "tentative consensus" of the economic community by the early 1980s (cf. Cohen, 1995).

Bound et al (1984) examined the impact of firm size (sales) on innovative input (R&D expenditure) for approximately 2600 U.S. manufacturing firms and found that the elasticity of R&D with respect to sales was approximately unity. However, they also found significant nonlinearity in the relationship, which suggested that small and large firms were more R&D intensive than average-sized firms were. They concluded "these data cast strong doubt on the existence of any significant R&D threshold." (p. 50).

These were the beginning of studies reflecting the complexities of the relationship between firm size and innovative activity. Cohen et al (1987) found that, once they removed outliers from a sample of business units that conducted R&D, their analysis shows a small but positive effect of firm size on R&D intensity of the business unit. However, by controlling for industry effects, the effect of firm size on R&D intensity was insignificant.

Acs and Audretsch (1987) found support for the modified Schumpeterian hypothesis that the relative innovative advantage of large or small firms is determined by the extent to which a market is characterized by imperfect competition. Large-firm innovative advantage is found in industries that are capital-intensive, concentrated and

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advertising-intensive. Small-firm innovative advantage is found in industries that are in the early stages of the product life-cycle, where total innovation and the use of skilled labor play a large role, and where large firms comprise a high share of the market. The authors suggest that the focus of the Schumpeterian debate should shift from firm size per se to "... which circumstances do large firms or small firms have the relative innovative advantage?"

Bertschek and Entorf's (1996) found that small and large firms are more innovative than intermediate size firms are. Their interpretation is that small firms have a high incentive to innovate in order to gain market share while large firms innovate to retain market share.

Nahm (2001) estimated the elasticity between R&D intensity and firm size in the Korean manufacturing industry. He concludes that his results supports Scherer's (1965b) findings in that R&D expenditure tends to increase faster than firm size up to a point then more slowly among larger firms. Amongst scientific firms, R&D expenditure increase faster than sales among medium-sized firms, but more slowly among larger and smaller firms. However, for non-scientific firms, there is indication of increasing returns amongst the larger firms.

The significance of these studies is the non-linearity of the relationship between innovative activity and firm size. A second observation is the dependency of these results upon the characteristics of the particular market being studied.

A more revealing understanding of the significance of firm size for innovative activity was provided in the works of Cohen and Klepper (1996), Arvantis (1997) and

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Geroski (1998) - i.e., *firms size affects how other economic determinants impact innovative activity.*

Cohen and Klepper developed a mathematical model that incorporated "cost spreading[33]" to explain the stylized facts of the relationship between firm size and R&D intensity / technological innovation over the past thirty years and tested it on FTC data from 1974-1977. Their analysis revealed that cost spreading explains the regularities that have emerged about the relationship between R&D / innovation and firm size. They aver that "no alternative explanation that can accommodate the empirical patterns".[34] More importantly, they challenged the prevailing wisdom on the impact of firm size on innovation. On the contrary, they conclude that there are increasing returns from R&D with firm size and there is a greater incentive by larger firms than smaller firms to undertake R&D

Using a 1993 survey of Swiss manufacturing firms, Arvanitis (1997) tested the effects of four different groups of explanatory variables - demand expectations, market conditions, appropriability, technological opportunities - on two different types of innovative performance - input-oriented measures and output-oriented measures with and without firm size. Firm size was significant as a determinant of innovative activity. However, there was no support for economies of scale with regard to firm size. There is an "inverted U" relationship between size and innovative activity. Innovative intensity increased with firm size up to a particular size than thereafter decreased with firm size. Of importance, firm size is correlated with some of the other determinants of innovative

[33] Cost spreading is essentially spreading the cost and returns from R&D or innovation over the expected output effected by the innovation.

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active - technological opportunity and appropriability. Similarly Geroski found that there is a strong relationship between most indicators of corporate performance and some measure of firm size. The author reasoned that this means that firm size has a *direct effect* on performance and an *indirect effect* on performance that conditions the impact of other effects on performance. Again, the significance in these analyses is that *firm size affects how other economic determinants impact innovative activity.*

More recent studies provide an explanation for some of the regularities we have observed in the relationship between firm size and innovative activity. Audretsch and Elston (2000) show that medium sized German firms faced liquidity constraints in capital investment. Fritsch and Meschede (2001) show that: (1) R&D expenditure rises less than proportional with enterprise size; (2) the availability of financial resources was a major obstacle for innovative activity; (3 industry characteristics such as technology or the marketing environment have a strong influence on innovative activity; (4) small firms tend to spend more resources on the development of new products than on new processes.

In a comprehensive study of innovation determinants and innovation effects, Crepon et al (1998) found that increases in firm size increase the probability to engage in R&D. However, firm size was insignificant in affecting R&D intensity or any of two measures of innovation. But, if the market share variable is excluded from the equation, firm size has a positive impact on research intensity. Like Arvanitis (1997) this suggests the difficulty researchers have had in trying to disaggregate the effects of market power and firm size.

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[34] Cohen and Klepper eliminate such concepts attributable to the presumed advantages of firm size as: large firm superior access to finance; the ability of large firms to pool risk across a greater variety of products and markets; scope economies; scale economies. [See Cohen and Klepper (1996, p 947, n 42)].

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The importance of these more recent studies is that firm size does have a direct effect as well as an indirect effect on innovative activity. The results from these studies, however, highlight the complexities in that relationship[35] as well as point-out other factors such as industry differences[36] that may have an impact on innovation.

B.3 Market Power[37]

The number of empirical studies investigating the relationship between market power and innovative activity is hindered because of the difficulty in devising a measure of market power. Proxies include market share, concentration, number of firms or even profitability and barriers to entry have been employed. In addition, one must make the distinction between seller market concentration and buyer market concentration.

Cohen (1995) points-out that Schumpeter believed that firms required the expectation of some degree of market power if they were to undertake the riskiness associated with innovative activity. This can take the form of *ex-post* market power - which is the basis for patent law - or an *ex-ante* oligopolistic market structure or the possession of *ex-ante* market power. The implication is that *ex-ante* market power would lead to *ex-post* market power.

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[35] As an example see review of Brouwer and Kleinknecht (1996) in the References. The probability of innovation increases with firm size, but firm size has a weak but negative impact on sales of innovative products.

[36] See Cohen et al (1987), Cohen & Klepper (1996), Scherer (1984) and Scott (1984) where their focus is the impact of size of the business unit on innovative activity. Cohen (1995) concludes that it is the size of the business unit that accounts for the correlation between firm size and innovative activity. Many of the studies point to the significance of industry differences. Industry differences are synonymous with technological opportunity, which will be discussed in section B.4.

[37] More extensive reviews of the literature on the effect of market power on innovative activity can be found in Kamien and Schwartz (1982, 84-93), Baldwin and Scott (1987, 89-95), Cohen and Levin (1989, 1074-1078) and Cohen (1995, 191-196).

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Until fairly recently, the majority of studies on the effect of market power have focused on market concentration, which only addresses the issue of *ex-ante market structure* and only indirectly the second issue of *ex-ante market power*. Later studies have tested ex-ante or ex-post market power by measures of *appropriability*.[38]

Porter (1990) and Stern, Porter and Furman (2000) found that rivalry directly stimulates firms to innovate and indirectly to incorporate the benefits of related determinants of innovation and growth. Similar conclusions have arisen in the economic community.[39] Cohen (1995, 196) places this sentiment in the broader context of the difficulty in capturing individual effects:

> Thus, numerous studies underscore the dependence of the relationship between R&D intensity and market structure on other industry-level factors. Although several theoretical explanations have been offered for why appropriability or technological opportunity may condition the relationship, no direct empirical examinations of these explanations have, however, been conducted. Nonetheless, empirical findings leave little support for the view that industrial concentration is an independent, significant, and important determinant of innovative behavior and performance once one controls for firm size.

THEORETICAL STUDIES[40]

In his classic paper, Arrow (1962) developed a simple model comparing the change in profits realized by a monopolist to those obtained in a competitive market as a result of a cost-reducing innovation. He concluded that because the change in profits will

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[38] Appropriability is the ability of innovators to realize a reasonable rate of return on their inventions. The degree to which an innovator can appropriate these returns is a measure of its ex-post market power.

[39] Symeonidis (1996, 59) concludes: "The present literature survey suggests that on the whole, there is little empirical support for the view that large firms or high concentration are factors generally associated with a higher level of innovative activity."

[40] In general, there are few if any definitive summarizations of consensus thinking of theoretical findings. Ahn (2002) does conclude that theoretical models are mixed on the prediction of whether competition is conducive to innovation.. One can consult any of the literature reviews cited above for examples of opposing theoretical views. I have presented what are more nuanced theoretical interpretations of the link between market power and innovation.

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be greater under competition than with a monopoly, there will be a greater incentive for the "inventor" under competition than monopoly.

Many have taken Arrow's results as a refutation of one of Schumpeterian hypotheses. Although Kamien and Schwartz (1982), found that Arrow's analysis has no bearing on the Schumpeterian hypotheses because Arrow's focused on the buyers' market rather than the sellers' market, their own extended analysis based on Arrow's concepts, drew similar conclusions - e.g., the incentive to innovate (for the inventor) increases with the number of firms.

Arrow's analysis became the cornerstone for many subsequent studies that examined variants of his model.[41] Hall (1994, 175), however, avers that, despite its path-breaking analysis, there are shortcoming in Arrow's work - i.e., a failure to incorporate the costs of innovation, the exclusion of uncertainty, the dependency of the conclusions on the assumptions, and the limitation of the analysis to one period. He posits that the clear advantage of the competitive market has not been unequivocally established.

Yi (1999), extends Arrow's analysis to an oligopolistic market and reaches an opposite conclusion: under Cournot competition, the benefits of small process innovations (weakly) decrease with the number firms.

Loury (1979) is one of the first to analyze the effect of concentration on R&D investment in an endogenous setting where the firm's and its rivals' uncertainties affect a firm's R&D investment decisions. His model implies that competition is not necessarily a good thing. For one, where the market structure (number of firms) is given, as the number of firms in the industry increases, the equilibrium level of firm investment in

[41] See surveys by Kamien and Schwartz (1982, 36 -48) and Baldwin and Scott (1987, 14-17).

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R&D declines. Secondly, under conditions of free entry, competition can lead to more firms than is socially warranted - i.e., too much competition - resulting in underused capacity.[42] Loury is suggesting an optimum concentration level intermediate between pure monopoly and perfect (atomistic) competition.

Farber (1981) incorporated buyer market concentration into a simultaneous equations model that determined R&D intensity, advertising intensity, and seller concentration endogenously. The study found that, R&D intensity was effected by both buyer and seller market structures.[43] Boone and van Dijk (1998) find qualified support for the Schumpeterian hypotheses. There are conditions where the industry leader, or bigger firm, will invest more in R&D. More competition leads to more aggregate R&D spending, but eventually to more concentration. Boone (2001) finds that increased competition can either increase or decrease technological progress depending upon the industry's cost history and its level of competition. This results in a non-monotone relationship between competition and innovation and explains why empirical results are mixed

EMPIRICAL STUDIES

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[42] March, 2001 was the official end of the "new economy" boom and the beginning of the recession (NY Times). One of the causes of this recession has been the unrealistic investment in new technologies in too many industries, particularly in telecommunications, where there was *too much competition* resulting in considerable *excess capacity*. See: "Too Much Fibre for the World to Digest: Telecommunications Companies that Invested Heavily in Optical Networks Are Struggling with Over-Capacity and Lack of Demand," *Financial Times*, June 29, 2001, p. 19; "Fiber, Fiber Everywhere: Some Call It Excess Capacity, but Others Say It Is Greatly Needed Inventory," *New York Times*, New Economy column, November 19, 2001, p. C4. Or witness the financial difficulties of one telephone company ("If Not One Problem, It's Another, For the Struggling Giant Qwest," *New York Times*, March 2, 2002, p. C1) and the bankruptcy of another ("Global Crossing Ltd. Files for Bankruptcy," *Wall Street Journal*, January 29, 2002, p. A3).

[43] (1)R&D intensity declines with buyer concentration when seller concentration is below 0.15, but increases with buyer concentration when seller concentration exceeds this threshold. (2)R&D intensity declines with seller concentration when buyer concentration is less than 0.08, but increase with seller concentration when buyer concentration exceeds this level.

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Like the issue of firm size, early studies provided a mixed assessment on the relationship of market power and innovative activity until the Scherer (1967). Scherer "tentatively" concluded that: (1) the relationship between inventive activity and concentration is complex due the underlying correlation between high concentration and rich technological opportunity; (2) after accounting for inter-industry differences in technological opportunity, concentration has a weak, but positive effect on innovation; (3) technological intensity increases with concentration mainly at low levels of concentration. When the four-firm ratio exceeds 50 to 55 percent, the effect of increased market power is probably neutral and may be negative. The third conclusion was taken to mean there was an "inverted-U" shape relationship between concentration and R&D intensity. This became the tenuously accepted view in economics.

Although later studies by Scott (1984) and Levin et al (1985) confirmed the "inverted-U" relationship, the effect of concentration became insignificant once additional variables representing company and industry effects (proxies for technological opportunity and appropriability) were added. Scott found that the company and four-digit industry effects explained 48% of the variation in R&D while concentration and its square explained about 1%. Levin et al noted that these additional variables were correlated with concentration. Thus, earlier positive impacts of concentration only masked the impact of other innovative determinants.

In a study of 4,378 significant innovations introduced in the UK, 1945-83, Geroski (1990) concluded it was "unambiguously" clear that monopoly power is inhibiting for innovation and that rivalry is stimulative. More importantly, technological

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opportunity explained a minimum of 60% (or as much as 75-80%) of the variation in innovations.

Blundell et al (1995) examined British industry from 1972 to 1982.[44] Variables were included to capture firm level effects - e.g., market share, fixed effect dummies, knowledge stock - and industry effects - e.g., concentration, producer knowledge stock. Market share was positive and significant, but its effect is substantially reduced with the addition of the firm fixed effects. Concentration had a negative impact on innovation. Their analysis revealed two seemingly contradictory conclusions: dominant firms tend to innovate more, but industry concentration dampens innovative activity. They conclude:

> ... to the extent that growing dominance increases industrial concentration the level of aggregate innovation will tend to fall. Thus the ant-trust authorities should remain wary of arguments that monopoly power is the price of a dynamically efficient economy.

Other studies by Brower and Kleinknecht (1996)[45], Love and Roper (1999), Vossen (1999), and Madden and Savage (1999) found no support for a significant impact of concentration on innovation. Broadberry and Crafts (2001), in a cross-sectional analysis of British manufacturing firms in the post-war period from 1945 to 1960, however, not only found no support for market power, but they also found no support for competitive markets.

Despite the above studies refuting the significance of market power on innovative activity, studies such as Jaffe (1988)[46] and Crépon et al (1998)[47] found that market share

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[44] The data came from a survey of 4378 innovations in Britain compiled by the Science Policy Research Unit (SPRU) over a fifteen-year period. This was completed in 1984. See Pavitt et al (1987) for further details.

[45] See description in Annotated References.

[46] See description of study in Annotated References.

[47] See description of study in Annotated References.

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had a significantly positive effect on the probability to engage in research and on research intensity.

In a study that better captures the influence of market power, Blundell et al (1999) examined the relationship between technological innovation, *market share* and stock market value with controls for firm specific effects. They found that market share was significant and positive throughout all the various estimates for innovations. Industry competitive measures - including concentration and imports - were significant and supported a positive effect from competition on innovation. The conclusion is that high market share firms have a higher number of innovations.

The market value estimates not only found market share to be positive and significant, but the interaction term of market share and innovation stock is highly significant and positive. This implies that innovations of high market share firms receive a greater value on the stock exchange. The main conclusions drawn from this study:

- Less competitive industries have fewer aggregate innovations.
- Within industries, firms with high market shares tended to commercialize more innovations.
- Firms with higher market shares benefited most from innovations.

In summary, Kamien and Schwartz (1982, p. 104) concluded that:

> The standard hypothesis tested is that R&D activity increases with monopoly power. Little support for this hypothesis has been found. Instead, a new hypothesis has emerged that a market structure intermediate between monopoly and perfect competition would promote the highest rate of inventive activity. Some theoretical support for the hypothesis has been advanced. A defect of the empirical investigations of the relationship between either monopoly or firm size and R&D activity is the failure to deal with the inherent simultaneities.

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B.4 DIFFUSION[48]

According to Stoneman (1991, p. 121):

> ... I tend to feel that diffusion is the poor relation in the technological change literature. It has merited much less attention than R&D, although in reality it is only as diffusion proceeds and new technologies are used that such new technologies have their impact and their benefits are realized.

The factors impacting adoption include the same ones discussed in evaluating the innovation process - e.g., market size, firm size, concentration, learning or human capital, technical knowledge, firm technical ability to imitate, product life cycle, cost, expected profitability, "bandwagon" effect, patents, etc. Diffusion of an innovation begins slowly, accelerates in its spread and follows an S-shaped time path.[49]

The consensus view of theoretical studies is best stated by Stoneman (1991, 130):

> We have explored the relation between diffusion, market structure and firm size in several modeling frameworks. There is no consistent set of findings from these models, but it is too early in the analysis to expect consistency.

Despite this view, there seems to be support for a positive view of firm size and market power. Mansfield (1968) found that larger firms adopt more quickly than smaller firms do. Rose and Joskow (1990) analyzed the adoption of two coal-fired steam-electric generating technologies and found size had a positive and significant effect on adoption probabilities. This was tempered somewhat because larger firms had a greater opportunity to install more plants - i.e., larger firms replaced or installed new plants more frequently regardless of the technology. Here size is associated with greater technological opportunity.

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[48] Relevant sources are Baldwin and Scott (1987, section 4), Reinganum (1989), Karshenas and Stoneman (1995), Geroski (2000), Stoneman (2002), and Hall and Kahn (2002).

[49] Mansfield (1968) determined that adoption of an innovation over time was represented by a logistic function - i.e., an S-shaped growth curve. See Baldwin and Scott (1987, 128-130) for a discussion of Mansfield's studies on diffusion.

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Quirmbach (1986) developed a theoretical model that took into account both the supply and demand sides. He found that market power is a determinant of diffusion rates. Buyer market power leads to the slowest diffusion rate since they are trying to protect the flows from their existing equipment. Supplier market power leads to faster than socially optimal diffusion rates since the supplier is not concerned about protecting existing investment. Competitive diffusion rates are faster than socially optimal, but slower than a market with supplier market power.

Hannan and McDowell's (1984) study of automatic teller machines diffusion seem to give support to the Schumpeterian hypotheses. Coefficients for concentration (three-firm concentration ratio), size (bank size measured in total assets), and dummy for being owned by a bank holding company were all positive and significant.

In their study of the adoption of optical scanners in grocery stores, Levin, Levin and Meisel (1987) show that the impact of economic factors depends upon the product life cycle. In the early phases, it is the large, independent store operating in more affluent areas that will have the greatest probability of adopting. In the later stages, industry concentration, firm market share, and firms size prove to be insignificant and firms adopt more based on industry affirmation or - i.e., the "bandwagon" effect.

In one of the first empirical studies of the influence of network effects on the rate of technology adoption,[50] Saloner and Shepherd (1995) found that the number of branches a bank had increased it propensity to adopt automatic teller machines (ATMs). The number of branches was seen as a proxy for the number of locations and thus the network effects. Thus network effects reduced the time to adoption of ATMs. A by-

[50] See Katz and Shapiro (1986) for a theoretical analysis of technology adoption that accounts for network externalities.

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product of this study was the positive effect of concentration on adoption for banks in states that limited the number of branches.

On the other hand, Goel & Rich (1997) examine the incentives to innovate in the airline industry from 1971 to 1986 and found that product market competition is a significant impact on the incentive to adopt various types of wide-bodied jet aircraft.

Karshenas and Stoneman (1995) discuss the main types of diffusion models - epidemic, rank, stock effects and order effects. *Epidemic* models assume that adoption is constrained by those who know of the technology and thus is dependent on the number of previous adopters. *Rank* (or probit) models assume that there are unique characteristics of an adopter that are independent of the number of users, but make the technology attractive and of benefit to the adopter - e.g., firm size, technological knowledge, financial capability. *Stock effects* models assume that the gross benefit of the innovation decreases with the number of adopters increase. (Of course this raises interesting questions when there are network effects such that the value of the technology increases with the number of users.) *Order effects* models assume that a firm's position in the order of firms that adopt determine its benefits. Early adopters presumably realize greater benefits.

Karshenas and Stoneman (1993) combined these four theoretical concepts in a single model and estimated their significance using data from the adoption of computer numerically controlled machine tools (CNC) in the UK engineering industry from 1968 to 1980. Rank and epidemic effects were significant. There was little support for stock and order effects. Of the individual variables, firm size and output growth in the user

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industry had a positive and significant effect on the adoption. Industry concentration was not significant.

Building Karshenas and Stoneman (1993), Bartoloni and Baussola (2001) investigated the factors influencing adoption of new technologies in Italian manufacturing industries. They found that rank and epidemic effects had a positive and significant influence on the probability of adoption. Firm size had a particularly strong impact.

Three studies by Greenstein et al, Majumdar and Venkatranam, and Shampine analyze diffusion patterns in the telecommunications industry.

Greenstein, McMaster and Spiller (1995) studied the influence of incentive regulation on the deployment of digital technology - fiber[51], ISDN[52], SS7[53], electronic digital switches[54] - telecommunications infrastructure within local telephone companies. Their primary finding was that price cap regulation had a positive and significant effect on the incentive to deploy these technologies. Earnings sharing mechanisms were considerably weaker and, when combined with price regulation, were often negative.

An important outcome of the analysis was that both demographic and regulatory forces impacted deployment patterns. Neither alone can explain infrastructure growth.

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[51] Fiber-optic cable is a high-speed, high-quality transmission path that is limited only by the terminal and repeater technology associated with the system. It is purified silica glass using laser chips.

[52] ISDN refers to integrated services digital network. It is an engineering concept with international standards that allows voice, data, text, and video communications to simultaneously use the same transmission path.

[53] SS7 refers to Signaling System 7. It is an out-of-band (not using the same channel as data being transmitted) signaling system that conforms to an international standard. This is essentially a separate network within the telecommunications firm's overall network that sets-up the path the data will take through the network.

[54] Electronic digital switches are digital stored program controlled switches which are computers that control an assemblage of electronic equipment to established temporary transmission paths that connect lines and/or trunks.

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Of the demographic and economic factors, urban population and measures of income were primary determinants of digital deployment.[55]

The Majumdar and Venkataraman (1998) study of 40 telephone companies over time (representing 99 percent of the lines) demonstrated that many of the conclusions reached in previous studies were applicable in the telecommunications industry. Their examination of the determinants of electronic switch diffusion found that impacts on diffusion differed at different stages of the diffusion process. Physical network size, market share, urban density are important during the early stages but diminish over time. Business demand is positive and significant throughout the study period. The imitation or "bandwagon" becomes significant during the later stages. Their study was based on annual firm-level data.

Shampine (2001), using holding company level information for fifteen companies - RBOCS and independents - examined the diffusion of digital switches[56] in the U.S. telecommunications market from 1983 to 1996[57]. The study produced results similar in kind to earlier diffusion studies. Like Levin, Levin and Meisel (1987), Shampine found that diffusion patterns differed in the early stages as compared to the later stages. In the earlier period (1984-1989), firm size was important. Independents adopted faster. In the later period, firm size, while still positive, is insignificant. This suggests that a firm's own network effects are important in the beginning, but total industry network effects

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[55] It is instructive to note the importance of demand and in particular population density associated with major urban centers as determinants in technology adoption. The effect of demand on innovation will be discussed in a later section.

[56] Shampine divides switches into three generations - e.g., electromechanical, analog electronic, and digital electronic.

[57] The study provides useful information about the history of switch installation - why switch adoption is slow and why RBOC slowness in deploying DSL may be tied to an earlier strategy of installing

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play a larger role as more firms adopt the newer switch. In both periods, firms with the older first generation switches - electromagnetic - would replace them more quickly with the digital switch than would second generation users.

In conclusion, it would appear that rank and epidemic effects matter; that firm and industry characteristics are significant. Networks - contacts with other adopters or other firms or research firms within the industry are important. It is noteworthy, however, that firm size has proven to have a positive and significant impact on adoption. Hannan and McDowell (1984, 334) concluded that their results were "decidedly Schumpeterian." And maybe that should not be so surprising if one examines the entire innovative process from research to invention to innovation to diffusion or adoption. Throughout all of these various phases, there is some correlation with firm size. Innovation does not end with the invention or with the innovation. As suggested by the *Economist,* "Invention is the easy bit. Innovation, by contrast, is the genuinely difficult part."[58] Firms have to market the innovation. And it is here that the advantage of firm size is unambiguous. According to Blundell et al (1999, 551):

> A separate realization of the results is that high market firms have marketing advantages over other firms. These marketing skills are very beneficial in promoting the sales of innovation. Since it is more likely that marketing is a feature of firm size rather than share, as we are inclined against that interpretation. Nevertheless, without direct data on marketing expenditures, investigating this alternative will have to be left for future work.

B.5 Demand-Pull / Technology-Push / Technological Opportunity[59]

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remote terminals to protect their investment in electronic analog switches. It is difficult to deploy DSL technology through a remote terminal.

[58] "Invention Is the Easy Bit," *The Economist* (June 23, 2001), pp. 3.

[59] See Mowery and Rosenberg (1979), Thirtle and Ruttan (1987) and Cohen (1995, 210 - 226) for broader reviews of the technological opportunity versus demand-pull argument. Klevorick et al (1993) thoroughly addresses technological opportunity.

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There is an ongoing argument concerning the primacy of three determinants of innovation - technology-push, technological opportunity or demand-pull. Demand-pull effects are engendered by changes in consumer behavior, the competitive structure of markets and other factors affecting the valuation of inventions or the ability of inventors to appropriate its benefits. In other words, demand and markets are the key drivers of innovative activity. Technology-push views science as the primary driver of innovation. Science drives technology, which, in turn, drives innovation. "Innovations induced mainly by advances in knowledge are called *technology-push innovations.*" (Scherer and Ross 1990, 637). According to Geroski and Walters (1995, 917):

> Technology-push was eventually subsumed by a broader term, 'supply-push', which encompasses a range of determinants of innovative activity that includes the evolution of scientific knowledge, the productivity of research labs, and the opportunity costs of investing in new products or process development

Today, technology-push and supply-push have been incorporated in what has become an all-encompassing term, *technological opportunity*. As Scherer (1992, 1423) states: "The mysterious concept of 'technological opportunity' was originally constructed to reflect the richness of the scientific knowledge base tapped by firms." According to Cohen (1995), the concept of technological opportunity is widely accepted as a determinant of technical advance. However, there is no consensus on "how to make the concept of technological opportunity precise and empirically operational." He then posits what can be viewed as a "definition" of technological opportunity:[60]

> In the framework of the standard neo-classical theory of production, technological opportunity can be regarded as the set of production possibilities for translating research resources into new techniques of production that employ conventional inputs [p. 214].

[60] This "definition" of technological opportunity, like most, is somewhat abstract and is not "operational." A more concrete definition, but also not operational was supplied by Griliches (1979): "one or more parameters in a production function relating their research to increments in the stock of knowledge, with the stock of knowledge entering in turn as an argument along with conventional inputs, in the production of output." [Harabi 1995, 68]. See the next section for a closer examination of the elements that constitute technological opportunity.

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Chidamber and Kon (1994) critically review and compare eight key studies of technology-push and demand-pull. They are skeptical of the importance of the demand-pull argument and view it almost as being "tautological" [p. 106]. Nevertheless they do recognize both approaches as necessary for successful innovation.

B.5.1 DEMAND-PULL

Jacob Schmookler is attributed with presenting the first evidence that demand is a primary diver of innovation. Using patent statistics (primarily from the railroad industry), Schmookler (1962) showed that invention (or innovation) and output moved together with invention lagging output. Based on this data, he argued that the incentive to invent is driven by the need for profits. The argument for the primacy of demand as a determinant of innovation is developed more fully in Schmookler (1966).

Schmookler's work is consistent with the then more advanced view of technological change as being an economic phenomenon that could be explained by economic forces and economic reasoning - i.e., technological progress is an endogenous process:

> While our ignorance may dictate the continued treatment of technological change as an exogenous variable *in our economic models*, it is plain that *in the economic system* it is primarily an endogenous variable. (Schmookler 1966, 209)

Schmookler examined data - particularly patent statistics - from the mid-nineteenth century to the mid-twentieth century in four major industries - petroleum refining, paper making, railroading, and farming. His analysis of these time series revealed:

(1) There was no evidence of a major invention being stimulated by an identifiable scientific discovery.

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(2) If there was a stimulus, it was either a technical problem or an economic opportunity.

(3) Even industries whose success is heavily dependent on scientific discoveries - e.g., electronics, nuclear, chemical, pharmaceutical - actual (corporate) research expenditures are motivated by economically evaluated technical problems and business opportunities.

Further study of the time series data showed a strong positive correlation between investment and capital goods invention where the causality ran from investment to invention. Schmookler concluded that the only plausible explanation that fit this evidence was that invention (or innovation) was engendered by consumer demand. In particular:

> The most reasonable explanation for the relation, an explanation consistent with the kinds of stimuli that led men to make important inventions, is probably the simplest. It is that (1) invention is largely an economic activity which, like other economic activities is pursued for gain; (2) expected gain varies with expected sales of goods embodying the invention; and (3) expected sales of improved capital goods are largely determined by present capital goods sales. (Schmookler 1966, 206)

Note that nowhere in his study did Schmookler deny the value of scientific or engineering knowledge or the technological knowledge base. He saw science as a *necessary, but not sufficient*, driver of innovative activity.

Studies such as Kamien and Schwartz (1970) give further support to the role of demand in engendering innovation. They show that in comparing industries - whether similar in structure (i.e., both competitive or both monopolistic) or one monopolistic and the other competitive - the incentive to invent was at least as great or greater in the industry with the greater elasticity of demand.

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Support for Schmookler's view of innovation can be found in Goldenberg, Lehmann and Mazursky's (2001) study of successful versus failed product innovations. Among the set of features common to some or all of successful innovations was that it met customers' needs and that it was based on tried and tested technologies. Products that were generally cutting-edge or created with no solution in mind were usually failures.

Although the economic profession embraced the concept that economic factors determined technological change, some believe that there is an over-reliance on demand as the primary determinant and that greater emphasis should be placed on technological opportunity or the importance of scientific and technical knowledge. These dissenters begin with a criticism of Schmookler.

Rosenberg (1974), while admiring Schmookler's work and recognizing its importance:

> Perhaps I should anticipate my conclusions by saying that I propose to start off from Schmookler's analysis, not because I am in search of a convenient straw man, but rather because I am in substantial agreement with much that he has to say. Moreover, Schmookler's analysis is so rich and so suggestive that it has to be the starting point for all future attempts to deal with the economics of inventive activity and its relationship to economic growth. (Rosenberg 1974, pp. 91-92)

argued that Schmookler had erred in concluding that demand was the sole determinant of inventive activity. Rosenberg argues that all inventive activity is constrained by first scientific knowledge and then by technical or engineering capabilities. To fully understand the nature of technological advance, the historical sequence of inventive activity must also be analyzed in terms of the scientific discoveries that made them possible.[61]

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[61] Although Rosenberg is seen as being critical of Schmookler, he is really not saying anything that differs substantially from Schmookler's broader themes. Both say that the study of technological advance must examine demand or economic factors as well as the nature of the scientific and technical

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Mowery and Rosenberg (1979) extended Rosenberg's (1974) critique by showing that five frequently referenced empirical studies that purport to support the demand-pull thesis are seriously flawed and actually undermines the argument. Among the flaws are: a failure to clearly to define market demand and distinguish it from needs; a failure to distinguish between influences on the innovative process wrought by such internal events as increased output or improved production technology as opposed to events external to the firm and determined by the market; failure to distinguish between those factors the shift the demand curve (demand-pull) versus those that provide movement along the demand curve (supply-side factors). Like Rosenberg (1974), the authors' primary motivation is to argue that market demand and technological opportunity are complementary forces that must act simultaneously for innovation to be successful.

Although several studies such as Toivanen and Stoneman (1998), Brouwer and Kleinknecht (1999)[62], and Baussola (2000) show that increased demand leads to increased R&D intensity or innovation, most studies give support to the complementary view posited by Rosenberg.

First Stoneman (1979) and then Scherer (1982) and Kleinknecht and Verspagen (1990)[63], in their replication of Schmookler's study, suggested a greater importance for technological opportunity than had been accorded by Schmookler. Geroski and Walters (1995) conclude that although demand is important in stimulating innovative activity, it

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knowledge base. Even in his criticisms. Rosenberg invariably must allude to demand as a motivating influence even if he dismisses it because the invention took many decades or centuries to be realized.

[62] Demand was highly significant on R&D intensity. This was consistent with Schmookler's (1966) hypothesis that demand will stimulate innovation. However, the support for the demand-pull hypothesis does not apply to the small number of really big or "basic innovation" that can lead to paradigm shifts in technology and the creation of entirely industries that may have 'counter-Schmookler' patterns. They find the latter argument consistent with Kleinknecht (1990) and Walsh (1984).

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plays only a modest role compared to unobserved (apparently stochastic) supply side determinants. Jaffe (1988)[64] and Crépon et al (1998)[65] found that both demand-pull and technological opportunity had significantly positive effects on innovative activity.

B.5.2 TECHNOLOGICAL OPPORTUNITY[66]

As discussed earlier, technological opportunity is a broad heading covering numerous economic and market forces effecting innovative activity. Because there are so many dimensions to technological opportunity, each industry will represent a unique assemblage of such forces. Technological opportunities are richer in some industries than in others. However, the almost amorphous nature of technological opportunity makes it difficult to formalize and measure. Thus, most studies try to capture the measure of technological opportunity by a "dummy" variable representing a particular industry.[67]

A survey of R&D managers in 130 lines of business by Klevorick et al (1993) revealed that technological opportunity - in all of its manifestations - was important to their innovative success. The degree of importance varied with industry. Technological opportunity was more important for the innovation phase than the R&D stage. General

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[63] Both Scherer and Kleinknecht and Verspagen found the demand-pull support weaker than in Schmookler's work, but still significant.

[64] See more detailed description in Annotated References.

[65] See more detailed description in Annotated References.

[66] Several studies reviewed in the previous section on demand-pull also address the impact of technological opportunity.

[67] Technological opportunities are affected by scientific knowledge; knowledge gained from industry suppliers, rivals, and customers; knowledge gained from other industries; knowledge gained from university research, government laboratories and agencies, professional and technical societies, independent inventors. This exchange of knowledge can fall under the heading of knowledge spillovers - i.e., situations where knowledge becomes available and no one has proprietary ownership to it. Such contacts are affected by geographic proximity. Silicon Valley and Silicon Alley describe the synergies realized in such geographic clustering.

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scientific knowledge and applied science had greater importance to innovation than research in basic science.[68] Harabi (1995) achieved like results in a similar survey of the Swiss industry. Technological opportunity is important, but its value is primarily due to the knowledge gained from other firms within the industry. Applied science was more relevant to technical progress than basic science.

In the examination of the effect of market power on innovation, there were several studies - Angelmar (1985), Blundell et al (1995), Broadberry and Craft (2001), Brouwer and Kleinknecht (1996), Geroski (1990), Levin et al (1985)[69], Love and Roper (1999), Scherer (1967), Scott (1984) - who discovered that the addition of variables representing technological opportunity accounted for the preponderance of the variance in innovative activity.

Support for the complementary view is revealed by Audretsch (1995) who found that sales growth - i.e., demand - had a positive effect on the innovation rate in low-technological-opportunity industries, but no effect in high-technological-opportunity industries. He reasons that high-technology industries are already in high-growth environments.

B.6 Regulation

The focus of this inquiry is the telecommunications industry[70], which has long been heavily regulated primarily by rate base rate-of-return (ROR) regulation. The form

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[68] The importance of a general pool of scientific knowledge is consistent with Schmookler.

[69] The data used here is from the same data set employed by Klevorick et al (1993). Both rely on the same survey of R&D managers described in Levin et al (1984).

[70] There are many histories of the telecommunications industry. Two of the better ones that also address the economics and policy decisions related to the issues discussed in this research are Evans (1983) and Brock (1994).

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of governance became more flexible in the late 1980s with the introduction of alternative forms of regulation to cope with the rapid introduction of more complex technologies and the advent of competition. Congress' intent to reduce regulation is best reflected in the Telecommunications Act of 1996 (Telecom Act)[71], which was intended to increase competition[72] and encourage infrastructure investment and the introduction of new services - especially advanced telecommunications services.[73]

There is little disagreement among academics that traditional rate-of-return regulation was an inadequate form of governance.[74] According to Alfred Kahn (1988, vol. II, 325-326),

> Regulation is ill-equipped to treat the more important aspects of performance - efficiency, *service innovation*, risk taking, and probing the elasticity of demand. Herein lies the great attraction of competition: it supplies the direct spur and the market test of performance.

Incentive regulation[75] was designed to counter the flaws of ROR by trying to mimic the economic forces of competition. In addition to lower prices, its desirable properties were claimed to be improved productive efficiency, improved dynamic efficiency and *innovations*.[76] Have these claims been realized in practice? Most studies examine the

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[71] Supra

[72] A major goal of the Telecom Act was increased local competition. The issue of local telecommunications competition is a subject onto itself. For a better exposition see Baumol & Sidak (1994), Vogelsang & Mitchell (1997), Laffont & Tirole (2000), and Woroch (2002).

[73] Section 706 of the Act instructs commissions "to encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans" and if the FCC finds that it is not, "it shall take immediate action to accelerate deployment of such capability by removing barriers to infrastructure investment and by promoting competition in the telecommunications market."

[74] The defining study on the infirmities of ROR is provided by Averch and Johnson (1962).

[75] The various types of alternative regulation will be discussed in detail in Chapter 3. See Acton and Vogelsang (1989) for a "Symposium on Price-Cap Regulation. See also Sappington and Weisman (1996), Abel and Clements (1998), Laffont and Tirole (2000), Sappington (2000), and Anthony et al (2001) for detailed discussions on alternative regulation.

[76] See Acton and Vogelsang (1992), Uri (2001) and the *Notice of Inquiry in the Matter of Price Cap Performance Review for AT&T* (7 FCC Rcd No. 17)

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effects of incentive regulation on prices. Few examine the effect on innovations. Recall Schumpeter's (1942, 84) view that (non-price) competition is derived from "...the new technology, the new source of supply."

Studies such as Mayo and Flynn (1988) show that regulatory policy does have an effect on innovation. Lower allowed rate-of-return reduced R&D expenditures. Inclusion of R&D expenditures in the rate base (capitalization), increased R&D expenditures.[77] Chappell (1998) found weak support for the effect of regulation on the adoption of digital central office equipment (COE) and little support for the adoption of fiber optic technology in the local exchange market.

Abel (2001) summarizes several studies assessing the impact of price cap regulation on various characteristics of economic performance. The more current studies generally show a positive effect on network modernization from pure price-cap regulation, but these results must be tempered with an understanding of the particular bargain struck by the local company since carriers often agree to accelerated network modernization in exchange for price-cap or incentive regulation.

In general, more liberal regulatory environments provide greater incentives to deploy new technological innovations. Taylor et al (1992) found that incentive regulation has a positive effect on network modernization. This was stronger for digital switching and fiber optics than for ISDN and SS7. This was also the conclusion reached by Greenstein, McMaster and Spiller (1995)[78] in a study measuring the effectiveness of regulatory policies on the adoption of four technologies - fiber optics, ISDN, SS7 and

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[77] They also found that firm size and profitability (demand) had significantly positive impacts on R&D.

[78] See review of this study in Section B.4.Diffusion.

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electronic digital switches. Price regulation - particularly price caps - is far more effective than the earnings sharing plans. With some minor caution, Prieger (2001) found that reduced regulation - in the form of price caps - had a strong impact on the introduction of new services by the local telephone company. Uri (2001) shows there is consistent improvement in technical efficiency resulting from price cap regulation of interstate access.

In an analysis of RBOCs, Ai & Sappington (2002) find that state incentive regulatory regimes have a general positive effect on network modernization. However price-cap regulation was only statistically significant in the deployment of fiber optic cable; rate case moratorium was significant for both digital switches and fiber optics; earnings sharing was significant for digital switches, fiber optic, and access lines. The distinguishing aspect of the Ai and Sappington study is its effort to disentangle the complementarity between incentive regulation and competition. Few studies control for competition or provide nuanced measures of incentive regulation in their impact on innovation.

Some such as Farrell and Katz (1998) and Darby and Fuhr[79] assert that the Telecom Act was designed to promote innovation. Thus far, there is little evidence on whether that has been achieved. Some such as Jorde, Sidak and Teece (2000) argue that economic analysis shows that mandatory unbundling of the local telecommunications network will discourage local companies from upgrading or investing in new facilities -

[79] Darby and Fuhr study the effect of regulation on investment in telecommunications infrastructure. In Darby and Fuhr (1997) they show that telecommunications stock prices have become less linked to interest rates and reflect acts by the FCC that do not create incentives for investment. In Darby and Fuhr (1998), they discuss the difficulties of crafting regulation that would encourage investment. Darby and Fuhr (2000) argue that one of the primary goals of the Telecom Act was to encourage investment in the telecommunications infrastructure. They aver that the actions by the FCC have been in conflict with that goal.

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i.e., they will not innovate.[80] Others such as Willig et al (2002) argue that economic theory would suggest that lower UNE[81] rates would lead to increased local competition and this in turn would lead to increased ILEC network investment. They found that a 1% decrease in UNE rates leads to approximately a 2.1% to 2.9% increase in ILEC network investment.

Woroch (2000) did show that by reducing entry barriers to allow facilities-based competition, there was an increase in the probability of deployment of urban fiber rings.

B.7. The Effect of Innovation on Market Structure and Endogeneity

Although in *CSD* Schumpeter seemed to stress a relationship wherein market structure impacted innovation, several interpreters of Schumpeter's broader writings argue that in his earlier, more analytic work, Schumpeter reasoned that in the long-run, innovation and diffusion had a greater impact on industrial structure. Their overall reading of Schumpeter is that he advanced an endogenous and evolutionary approach to the economic analysis innovation. See Baldwin and Scott (1987, 3-4). Levin, Cohen and Mowery (1985, 21) also conclude that Schumpeter held that innovation affected market structure and that this view may be more "fundamental" then the widely tested hypothesis of the effect of market structure on innovation.

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[80] A major conflict stemming from the Telecom Act is establishment of equitable prices for the "leasing" of components of the incumbent local exchange carrier's (ILEC's) that the FCC deems should be made available to competitive local exchange carriers (CLECs) - mandatory unbundling. The prices for these elements have been set at total element long-run incremental cost (TELRIC). It simple terms, it is forward looking long-run average cost with an equitable return component.

[81] The FCC's interpretation of the Telecom Act obligated the major ILECs to lease basic elements of their network - unbundled network elements (UNEs) - or a platform or set of elements - UNE-P - at forward-looking economic costs known as (TELRIC). See *First Report and Order, In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, FCC 96-325 (August 1996).

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The emerging literature suggests a more holistic approach to the study of market structure and technological innovation. Levin & Reiss (1984, 1988) found a positive effect of R&D intensity on concentration. Farber (1981) found a positive effect of R&D intensity on seller concentration. Mukhopadhyay (1985) found a negative effect of R&D intensity on the change in concentration in high-intensity R&D industries. Geroski and Pomroy (1990) found a negative effect of innovation counts on concentration change in a study of 73 UK industries from 1970-1979.

Using a panel of 301 West German manufacturing firms, Flaig and Stadler (1994) confirmed many of the facts about the economic of innovation - a positive effect of firm size and the "inverted U-Shaped" relationship between market concentration and innovative activity, support for the demand-pull and cost-push hypotheses, but also found a positive effect on innovation from the previous year's successful innovation - i.e. "success breeds success."

In a study of the determinants of market structure in the U.S tire industry, Klepper and Simons (2000) found increasing returns from technological change were a major force in the shaping of industry market structure.

Aghion, Harris, Howitt and Vickers (2001) developed a sophisticated mathematical model to examine the simultaneous effects of competition, innovation, and imitation on economic growth in a duopolistic setting. This unique examination of the interplay amongst these economic forces indicates that there are conditions where product market competition (PMC) would lead to increased innovation and when PMC would lead to diminished growth, or less innovation. Among the revealing conclusions

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and interpretations of this analysis which were extended and tested empirically in Aghion, Harris, Howitt and Vickers (2002) are:

- With increased PMC, there is a strong motivation for innovation by firms who are in a neck-and-neck state of technological development.
- With increased PMC, a firm that is in a neck-and-neck state of technological development will do more R&D than a firm that is a technological leader.
- With increased PMC, follower technological firms will initially increase their R&D efforts up to a mid-range of competition then decrease their efforts. This results in the inverted horseshoe curve that has been shown to exist between R&D intensity and levels of competition.
- The effect of increasing the ease of imitation is to dampen all R&D efforts.
- When there is a huge technological gap between firms, increased PMC will lead to a reduced R&D effort by both the technological leader as well as the follower (which is in accord with the Schumpeterian hypothesis).
- In general, for realistic values of innovation and R&D expenditures, the analysis argues against the Schumpeterian proposition that competition reduces growth.

From evolutionary theory, Nelson and Winter (1982)[82] developed a dynamic model of technological change that incorporated their interpretation of the relationship between market structure and innovation posited in Schumpeter's *CSD* and that fit with

[82] The work of Nelson and Winter form the basis for a separate school of economic thought known as evolutionary theory, which is a reaction to the perceived faults of neoclassical growth theory and more in common with endogenous growth theory. See the Symposium on New Growth Theory in the *Journal of Economic Perspectives* (1994). See also Dosi and Nelson (1994) and Nelson (1995) for more current views.

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empirical observations. Using this model for a series of simulations, the author's found that successful innovations will lead to more concentrated markets.

B.8. SUTTON'S WORK[83]

Sutton (1998) builds on his previous work to produce a theoretical model where there are low-alpha industries and high-alpha industries. Alpha can be thought of as a measure of the extent to which a firm can raise consumers' demand for its products as function of how much it outspends its rivals on R&D. In essence alpha depends on a firm's profit function and its fixed cost outlay. It also reflects the pattern of technology and tastes as well as the nature of price competition.

Sutton shows that if alpha is high, then the level of concentration must be high - i.e., the one-firm sales concentration ratio is bounded from below by alpha. He further demonstrates that this value of alpha is linked to the level of R&D intensity.

Alpha (α) is an abstract term that is related to two parameters β and σ, neither of which can be observed directly:

$$\alpha = \alpha(\beta, \sigma)$$

β measures the degree to which fixed cost outlays rise as a result of increasing the quality of the product - i.e., the elasticity of fixed cost costs with respect to changes in product quality. σ measures the strength of the linkages between different sub-markets (or technological trajectories). On the demand side, this is reflected in the degree of substitution between products; on the supply side this captures the degree of scope economies between technological trajectories. The link between β and alpha is

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straightforward. A rise in β leads to a fall in alpha. The link between alpha and σ is complicated.

What Sutton shows is that where β is low (implying R&D is effective) and σ is high (advancements along one technological trajectory leads to drawing customers away from rivals' trajectories), then alpha is high. We then have both high R&D intensity and a high level of concentration.

Where β is low but also where there are many independent technically trajectories which produce goods that are poor substitutes for one another, so that σ is low, then we have low concentration and a low-alpha industry.

One should note the crucial role played by σ. A high value indicates that increased spending (R&D investment) on one trajectory will lead to the elimination of low spenders in other trajectories and new trajectories will eliminate older trajectories. A low value of σ will lead to just the opposite results - many trajectories proliferate and new trajectories coexist with older ones.

Thus, Sutton has essentially established a more complex linkage between R&D intensity and market structure - i.e., concentration - one that incorporates the linkages between technologies as well as the relative effectiveness of innovation outlays. This is another way of formalizing what we have witnessed in earlier studies that indicated a positive relationship between market structure and technological innovation under some circumstance but indicating no relationship in studies reflecting a different set of

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[83] I briefly touch on Sutton's work solely to emphasize the complexity of the relationship between market structure and innovation. This has been the underlying theme of this review. Details can be found in Sutton (1991, 1996, 1998)

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circumstances under which the studies were conducted. Support for this theoretical construct is provided by case studies of several industries.

SECTION D - CONCLUSION

The examination of the relationship between technological innovation and market structure engendered by the consensus interpretation of the Schumpeterian hypotheses is in a real sense not only a somewhat narrow view of the nature and economic consequences of technological progress, but it is also a narrow view of the relationship between technological innovation and market structure.[84] The general impression of the studies referenced in this research is that there are a host of factors influencing innovation. Firm size and market power, though important, are part of a holistic system of endogenous economic forces. And despite conclusions reached in some of the referenced surveys, firm size does matter. But to what degree and in which manner? Market power matters. Competition matters. Regulation matters. There are many factors that can influence the innovative process. Measures of their impacts depend upon the industry and the parameters of the studies.

Most studies attempt to examine what appears to be one aspect of the relationship between technological innovation and market structure. However, we were also cautioned by Cohen and Levin (1989) to examine these studies with a wary eye (see Section A on Schumpeter). The nature of this relationship does not appear to be uni-directional - i.e., from market structure to technological innovation - but is one of non-linearity and simultaneity

[84] See the discussion at the end of Section A in this chapter where I provide reasons why the focus on the Schumpeterian hypotheses does not capture the broader interpretation of Schumpeter's thoughts on innovation.

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Some of the studies have begun to reflect this complexity - those that take into account the simultaneity of the relationship; the work of Sutton that seems to be saying there is something here, it is not one-to-one, but size or concentration have an effect but it is either related to something else or we have only captured one aspect of it.[85] Or maybe, in the broader scheme of economic thought, we may be able to explain only a portion of the relationship. In other words:

> We still know far too little about these economic aspects of innovation, but slowly we are beginning to build a body of systematic observations and generalizations, together with explanatory hypotheses, which are supported to a varying extent by the empirical data. (Freeman 1999, 17)

[85] Other highly recommended works that begin to capture the complexity of innovation and market structure include Acs & Audretsch (1987), Cohen & Klepper (1996), Arvantis (1997), Crepon et al (1998), Blundell et al (1999), and Aghion, Harris, Hewitt & Vickers (2001, 2002).

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CHAPTER THREE

TECHNOLOGIES, REGULATION, AND DATA

A. TECHNOLOGIES[86]

The primary focus of FCC studies on the availability of advanced telecommunications services tend to focus on DSL-type services.[87] Clearly this is important if customers are to benefit from the Internet, but there are other advanced telecommunications services (ATS), which, while not as well known, will be crucial to the backbone network of the Internet as well as the facility with which industries conduct business. It is these types of services that form the basis of the growth in productivity. The FCC Third Report (at 9) defines advanced telecommunications services as:

> ... consistent with prior Reports, we will use the terms "advanced telecommunications capability" and "advanced services" to describe services and facilities with an upstream (customer-to-provider) and downstream (provider-to-customer) transmission speed of more than 200 kbps in this Report. We will use the term "high-speed" to describe services with over 200 kbps capability in at least one direction. Thus, high-speed is a larger category than advanced telecommunications. ...

In this study we will focus on those factors effecting the adoption of a subset of those ATS - digital signal level (DS) technologies, packet switching, frame relay, asynchronous transfer mode, and synchronous optical network (SONET) - or optical carrier (OC). Packet switching will subsume frame relay and ATM.

Frame Relay and ATM are the two principal broadband technologies used by large business customers. The majority of these markets (approximately two-thirds) is provided by AT&T, WorldCom, and Sprint. The other one-third is made-up of the

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[86] The source for the material in this section came from Budde (2003), Dodd (2002), Horak (2002), and Newton (1998). See Table 3.3 for an overview of the uses of these advanced technologies.

[87] Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, CC Docket 98-146 (2002) *(Third Report)*

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RBOCs and CLECs. This market is growing and an expected $50 billion in network investment will be needed over the next five years.[88]

A.1. Digital Signal (DS) Level Technologies

T-carrier is a dedicated, digital line that employs time division multiplexing (TDM) in order to derive multiple channels from a single four-wire circuit. The fundamental building block of T-carrier systems is a 64 kbps channel - referred to as DS-0 (Digital Signal level Zero) or voice-grade (VG) equivalent speed. The basic T-carrier transport consists of 24 DS-0 channels and is known as T-1 (or DS-1). In this technology, data is basically sent in frames of 24 bytes wherein each byte represents the data from one of the channels. These frames are constructed so that each "channel's" byte occupies the same time slot in a designated, constant sequence. This is known as Time Division Mutiplexing. The result is an overall transmission speed of 1.544 Mps for T-1 transport. Increases in speeds can allow more bits to be transmitted and thus leads to more DS-0 equivalent "channels" being sent. See Table 3.1 for speeds and T-1 equivalents of the different levels of DS transport. This study will examine the adoption of DS-1 and DS-3 transport.

The ability of T-carrier to accommodate various forms of information - voice, facsimile, data ad video makes it appealing to a variety of users - residential, home office, small business, large corporations. Large user organizations use digital carrier for local loop access. Often this means a cost-effective replacement of PBX trunks. Large corporations can use them for private lines or access to virtual private networks (VPN) or

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[88] See Comments of Verizon, *Appropriate Framework for Broadband Access to the Internet over Wireline Facilities*, CC Docket No. 02-33 (May 3, 2002), Exhibit A (Broadband Fact Report)

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in communications between local area networks (LANs)[89]. Internet service providers (ISP) use channelized T1 to provide access to users requiring speeds of no more than 64 kbps. ISPs also use unchannelized T1 or T3 for access to an Internet backbone provider. In addition, those users of packet-based Frame Relay networks often use unchannelized T-carrier circuits for access.

A.2. PACKET SWITCHING

Essentially there are two ways of making a telephone call. The one most people are familiar with is known as Circuit Switching. Here a temporary but dedicated path is established through the Public Switched Telephone Network from origination to destination. The path is reserved for this call until the two parties hang-up and terminate the call. This call and the path - the routing and the switches - are managed by out-of network Common Channel Signaling, which is a totally separate signaling network. Packet Switching is the other way for information to transverse the network.

Under Packet Switching, data has been digitalized and segmented into packets. Each packet contains header information detailing its size, its origination, destination, and sequence or unique identification. Each packet then becomes an independent set of information that can be sent to its destination be any path that a packet switch deems as efficient. Thus, packets will take different paths to their destination, will each encounter different latencies, and will arrive usually out of sequence. The destination node then reassembles the packets in the correct sequence.

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[89] A LAN (Local Area Network) is a local, shared (packet) network usually associated with computer communications. LANS interconnect computers and peripheral devices over a common medium so that users can share access to databases, files, applications, and peripherals. LANS are usually contained within a building, but are often employed within campus-type environments and industrial parks.

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Packet Switching is essentially the way the Internet exchanges information. However, because the packets often arrive out of sequence and with varying degrees of delay, this is not a good method for transmitting voice.

Frame Relay and Asynchronous Transfer Mode (ATM) fall under the general classification of *Fast Packet Service*. *Packet* is itself a more generic term that indicates the data has been segmented. This segmentation can be in packets, frames, blocks or cells, which can be flexible in length or fixed.

A.2.1 FRAME RELAY

Frame Relay is a connection-oriented service that transmits variable length packets through the public switched network or private networks at speeds from 56 Kbps to 45 Mbps. The packets consist primarily of a fixed-size header and a variable length payload. The header supplies information on its source and destination and the length of the packet. However, Frame Relay does not support error control or protocol conversion. By ceding such responsibility to the user, Frame Relay minimizes cost, latency, and congestion.

The virtual path through the Frame Relay network can either be permanent or switched virtual. With a permanent virtual circuit (PVC), the desired route of the customer is programmed into the carrier's switches and establishes a defined path through the network. Switched Virtual Circuits (SVC) are set-up just seconds prior to transmission by communications between the customer's Frame Relay Access Device (FRAD) and the carrier's switch. The path created is then fixed during the course of the transmission.

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The primary application for Frame Relay is to transmit information between geographically dispersed sights - primarily local area networks (LANs). Thus, it can be used for communications between hospitals and university specialists or between banks or by telecommuters or to send emails. Internet Service Providers (ISPs) and Internet backbone providers use Frame Relay for user access to the ISP and for backbone network applications. Additional users are data centers and airline reservation networks. Access to the network can be via Fractional T1 or DS0 (64 kbps) or DS1 or DS3 between the FRAD on the customer's premise and the Frame Relay Network Device (FRND) which is the link-terminating equipment at the central office.

Although Frame Relay is capable of handling voice, video, and audio, this is limited because of the unpredictable packet delays and losses over a highly shared network.

A.2.2 Asynchronous Transfer Mode

Asynchronous Transfer Mode (ATM) was designed as an over-arching switching and addressing technology to carry all kinds of traffic - voice, data, facsimile, video, multimedia images - over any distance - from one computer to the next or from one company to the next no matter where on Earth. Information is transmitted in fixed-length packets of 53 bytes. Five bytes are reserved for header information to be used for routing and error control. As with Frame Relay, it is the user's responsibility to account for error detection and protocol.

ATM operates at a minimum access speed of DS-1 and DS-3. Internal or backbone speed is up to 622 Mbps (OC-12). The transmission medium is usually SONET fiber optic. Other media can be supported, but it is not ideal. The route taken

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through the network is established when an ATM switch sees the first cell of transmission. This defines the path of transmission.

ATM is a technology that is growing in applicability. It is very good at point-to-point data communications as well as point-to-multipoint data conferencing. It also used heavily for backbone applications. ATM's primary user are expected to local telephone companies as they replace their current circuit-switched technologies, long distance carriers, frame relay networks, Internet service providers, large financial companies, large universities, the entertainment industry. However, because of it speed and flexibility, it is found its way into the local loop via ADSL (Asymmetric Digital Subscriber Line).

A.3. SONET - Optical Fiber

SONET/ SDH (Synchronous Optical Network/Synchronous Digital Hierarchy) is a set of international standards established for broadband communications over single fiber optic transmission systems. These standards define the characteristics of a fiber-optic infrastructure. They do not define the services. Several services depend on a SONET infrastructure including Frame Relay and Asynchronous Transfer Mode (ATM). The basic building block of the SONET digital hierarchy is OC-1 (51.84 Mbps). Thus, SONET transmission begins at the broadband level. See Table 3.2 for SONET/SDH hierarchy.

SONET networks are highly redundant because of the number of transmissions that could be lost due to failure of a single fiber. The optimal physical layout is a dual counter-rotating ring where one fiber transmits in one direction and the other fiber transmits in the other direction. This minimizes the probability that a device on the

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network can be isolated through a catastrophic failure. Thus, SONET is primarily provided as a "ring".

Information on a SONET Ring is transmitted in complex frames of 810 octets , which does not lend itself to easy explanation. SONET supports the transmission of all forms of information - voice, data, video, facsimile and image. It has found use in long-haul networks where carriers can take advantage of its OC-192 capacity. It is also used in local loops for high-speed access to Frame Relay networks. It is also necessary for access to ATM networks with speeds between 155 Mbps and 622 Mbps. Other applications are in campus-type environments and, because of its redundancy, at airports.

B. REGULATION[90]

One of the key economic determinants to be examined is the effect of regulation on the deployment of advanced services. Prior to the mid-1980s, all carriers were under rate base rate-of-return (RBROR) regulation. As mentioned in Chapter 2, the economic community saw this as an inefficient form of regulation[91]. Since then, there have been ongoing discussion and proposals of regulatory forms that could produce the same welfare enhancing effects of competition. Because of the monopoly power once exhibited by AT&T in the long distance market and still manifest in the local telecommunications market by the incumbent local exchange carriers (ILECs), deregulation was not an option. Regulatory reforms needed to be devised that would encourage incumbents' incentives - to reduce prices, lower costs, become more efficient,

[90] For additional perspective on regulation and deregulation, see Vogelsang and Mitchell (1997), Laffont and Tirole (2000), and Crew and Kleindorfer (2002).

[91] See also Crew and Kleindorfer (1996).

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invest in modern infrastructure, introduce new services, improve quality - and foster competition.

The FCC price cap plan designed to govern AT&T (1989) is usually referred to as the beginning of incentive regulation. However, state commissions has already begun experimenting with alternative regulatory forms. New York created an earning-sharing plan for New York Telephone and Rochester Telephone in 1987. California developed the first price cap plan in 1990. Since then, there have been many different alternative regulatory plans developed at the state level. What follows is a summary description of the primary regulatory forms developed at the state level[92].

Rate Base Rate-of-Return

This is the form of regulation that has traditional governed LECs. Operating costs are determined - usually on an embedded basis and rates for services are set to generate revenues that would cover these costs plus a commission-determined fair rate of return on investments.

Banded Rate-of-Return

Similar in construction to rate-of-return regulation, this form of regulation, however, specifies range (or band) of allowed returns. Prices are initially set to generate earnings that would fall at the mid-point of the range. Any earnings that exceed the maximum limit are returned to the consumers. If earnings fall below the minimum, new prices are devised so that projected earnings will fall within the prescribed range.

Rate Case Moratoria

[92] Information for this section came from Sappington and Weisman (1996), Abel and Clements (1998), Sappington (2002).

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This is probably the simplest form of alternative regulation. In its simplest form, these are agreements to suspend investigation of the regulated firm's earnings. This can be viewed as an initial form of alternative regulation and is usually only for a short period of time (about two years) prior to moving to one of the other forms of incentive regulation.

Earnings Sharing

The basis for setting rates is unclear. It could still be RBROR. The difference is that the ILEC is allowed to keep all or a percentage of earnings above a specified return on investment. The variation in plans comes in how earnings will be shared. As an example, a firms is allowed to keep all earnings between 8% and 12%. Earnings between 12% and 14% are shared in some manner with consumers - usually fifty-fifty. Earnings above 14% are considered an excess return and are passed on to the consumer. Earnings below 8% are also shared with the consumer in higher prices.

There are numerous variations on earnings sharing plans. Sharing could be reversed so that the first segment above the expected range of returns is shared, but thereafter, the firm retains all earnings. Or there could gradual level of sharing.

Revenue Sharing

Revenue sharing is similar to earnings sharing with the difference being the focus is on revenues rather than earnings. Advocates of these plans consider them more of an incentive to reduce costs than earnings sharing.

Rate Freeze

A rate freeze is an agreement not to raise or lower prices for a specified period of time. This is a simple way of promoting incentive regulation and encouraging firms to

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reduce costs since during the period of its implementation, the firm keeps all cost savings. A rate freeze is often accompanied by a rate case moratorium.

Non-indexed Price Cap

A price cap set a ceiling on rates for a set of services. This can be similar to a rate freeze except that prices are allowed to decrease. The variation comes in how permanent is the price ceiling. Some price caps are allowed to increase by a specified percentage every year or in any twelve-month period. Another variation allows ceilings to increase in accordance with inflation. The inflation index is usually the percentage change in the GDPPI for the previous year or an average over the previous three or so years.

Indexed Price Cap

Indexed price caps is probably the best known of the alternative regulatory forms. Here prices are allowed to change based on inflation, productivity, and exogenous factors. Here, as opposed to some of the above-mentioned alternative regulatory form, regulatory control has shifted from earnings to prices. The general form of this relationship is:

$$\Delta\%P = \Delta\%GDPPI - X + Z$$

P = price of the regulated service

$GDPPI$ = Gross Domestic Product Price Index

X = productivity

Z = exogenous factors

The change in the GDPPI represents the effect of inflation. A productivity offset, the X *factor*, is defined by the commission to represent the expected productivity in the telecommunications sector over the rest of the economy. The idea is to pass on expected

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productivity to the consumer. Z represents adjustments due to unexpected factors beyond the firm's control.

There are many variations of this plan if only because every plan has a different X-factor or Z-factor. However, some variant of this plan governs the major ILEC in 20 of the states and the District of Columbia.[93]

Pricing Flexibility

Pricing flexibility is usually applied to those services considered competitive. The only requirement is that prices must cover their (incremental) costs.

Deregulation

This is the regime is furthest from RBROR. Deregulation is usually mandated by legislation. Rates and earnings are not regulated. Rate changes and the introduction of new services can take place automatically within days of filing with the commission.

Normative Pricing

This is a regulatory regime that falls outside of the usually definitions of alternative regulation and is not defined anywhere. It represents the experience of this study. This is a more general category that does not rely on specific rules. Here Commissions are obliged by the legislature to set prices usually based on incremental costs (TSLRIC), market considerations and *commission judgement*. Earnings or revenue requirements are explicitly forbidden.

Access - Mirroring

[93] See Table 3.4. Note this differs from reported estimates in other studies. The reported value here represents only those states with indexed price caps. And in one state, the X-factor and Z-factor are set so that both offset inflation to produce an effective plain price cap.

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One of the local services is intrastate switched access. In addition to possibly being governed by any of the traditional forms of alternative regulation, regulation of intrastate access is often just "mirroring" the interstate structure.

The above summary of the primary form of local regulation forms the basic elements of any overall regulatory plan. Different services can be regulated differently. In many states, services are placed in different categories. Typically these categories are: basic, discretionary, potentially competitive, and competitive. Each of the services in these categories could be regulated differently than services in the other categories.

Additional variation can come from: (1) limiting the time between filing of rate changes and the effective implementation date; (2) the imposition of earning-sharing to the basic plan; (3) obligations to invest in a defined amount in modern infrastructure by a specified date; (4) service quality commitments which, if not met, can lead to huge penalties including termination of the plan; (5) social commitments to deploy more modern services to schools, libraries, and hospitals. Thus, the actual form of regulation imposed on an ILEC has a host of variables, can take on a variety of forms, and does not easily fit into a standard structure. In one state, the form of regulation for an ILEC even differed between geographical areas.

C. DATA

The goal of this study is to examine those economic forces that will effect the decisions of ILECs to deploy advanced telecommunications services within a wire center serving area. These determinants will represent one of three sets of economic forces: (1) supply, (2) demand, and (3) the market. Recall Figure 1 (the SCP diagram). In order to

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undertake such an analysis, relevant data must be gathered at the wire center serving area level.

The data to be used in this study is contained in large database that has been developed over time and contains data from many disparate sources such as government reports, census data, academic publications, telecommunications market information, and questionnaires. The actual analysis will use a subset of this information.

SUPPLY

On the supply side, information on the characteristics of the ILEC such as measures of firm size and availability of ATS was needed at the wire center level. Measures of firm size such as number of lines or sales is available from reports such as ARMIS. However, the level of data is not disaggregated enough to be used at the wire center serving area level. Instead ILEC firms were classified as being large, medium or small.[94]

Availability of the advanced telecommunications services (ATS) was obtained from the NECA[95] 4 Tariff. Information is collected on the availability of services at each ILEC's wire center based on information supplied by each ILEC.

Additional data obtained from government reports indicated whether an ILEC: (1) was classified as rural or non-rural, (2) was eligible for Rural Utility Services (RUS)[96] subsidies, (3) was regulated under a federal price-cap or rate-of-return for its interstate

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[94] ILECs, which are part of regional bell operating companies (RBOCs), were one classification. They and GTE were the large firms. Medium size firms were Alltel, Carolina Tel, Century Tel, Cincinnati Bell, Citizens Telecom, Frontier, Sprint, United, TDS Telecom, and Valor. The remaining ILECs were considered small. The only difference with this classification format and the FCC in its *Statistics of Common Carrier* was in classifying CenturyTel, TDS and Valor as mid-sized ILECs.

[95] National Exchange Carrier Association, Inc. (NECA) was founded in 1983 and is responsible for assisting the FCC in administering various tariffs as well as supervising its access services pool. The NECA 4 Tariff contains information on services supplied at each ILEC's wire center as well as its coordinates.

[96] The Rural Utilities Service was founded to encourage deployment of modern infrastructure in rural areas and provides subsidized loans for eligible rural companies.

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services, (4) had received approval under the 271 process[97] to offer inter-LATA service, (5) is a subsidiary of a larger company.

DEMAND

Characteristics of the market that would affect demand were obtained from the U.S. Census Bureau. This information was supplied by zip code, which had to be translated into wire center values. For residential customers, the 1990 and 2000 Census was loaded into the database. This supplied the study with such demographic and economics information as the number of households, the population, the median household income, employment status, statistics on education as well as ethnicity, etc.

Business data was obtained from *Zip Code Business Patterns 1999*.[98] This data set provided information such as total employment, total number of establishments and the number of firms in different sizes based on numbers of employees for nine different SIC codes. The companies were organized into three size categories: small (1- 19 employees), medium (20 - 99 employees), large (≥ 100 employees). The database contains such annual business data from 1996 through 1999.

COMPETITION

Using the Local Exchange Routing Guide (LERG)[99] database, the horizontal and vertical coordinates of each wire center were obtained for each ILEC and each CLEC's

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[97] Under Section 271 of the Telecommunications Act of 1996, RBOCs can file with the FCC for approval to supply in-region interLATA services for any state within its region. The criteria for approval are satistying a series of steps that insures local competition has been established in the selected state. If this checklist of standards has been satisfactorily met, the RBOC is granted approval for that state. The FCC consults with the DOJ and the state commission in making this decision.

[98] *ZIP Code Business Patterns 1999* was published November 2002 and is provided on CD. The data is available on an annual basis. The 2000 data set was only released recently.

[99] The Local Exchange Routing Guide (LERG) produced by Telecordia™ Routing Administration contains detailed routing information to support the local exchange network configuration within the North American Numbering Plan (NANP).

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point of presence. This information was used to determine the number of CLECs within 1, 3, 5, 7, and 10 miles from an ILEC's wire center.

MARKET

To capture the regulatory tone of a state's commission, information was obtained on the UNE loop rate established for each state's RBOC as well as it embedded cost. The ratio of UNE rate to embedded cost could be viewed as a proxy for the state's regulatory leniency and was incorporated in the database.[100]

A more direct method for addressing the effect of regulation/deregulation was obtained initially by examining Abel and Clements (1998)[101], but primarily by developing a questionnaire that was sent to every state commission and the District of Columbia. This questionnaire[102] asked which forms of regulation did each ILEC face for eight broad categories of services: business basic, business other, business competitive, residence basic, residence other, residence competitive, intrastate switched access, and advanced telecommunications services. The forms of regulation were variants of those stated above. It also asked if the ILEC was obligated under Section 251 (c) of the Telecommunications Act to supply UNEs upon request.[103]

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[100] Billy Jack Gregg, *Survey of Unbundled Network Element Prices in the United States (updated January 1, 2002)*, Columbus: National Regulatory Research Institute (NRRI).

[101] A supplement to this report was also referenced - *Forms of Regulation for Major LECs in the U.S. States (as of October 2000)*, Columbus: National Regulatory Research Institute (NRRI).

[102] This was a monumental undertaking. It took over nine months to complete. Not all commissions were able to provide answers so readily. Answers to many questionnaires were achieved by reading numerous state documents and orders. See Appendix C for a list of official documents read.

[103] Section 251(c) of the Telecommunications Act obligated carriers to provide UNEs and UNE-P upon request. However, Section 251(f) of the Act allows for exemptions. The state commission decides if a carrier satisfies the conditions for exemption. All RBOCs are obligated. Usually rural companies are exempt. More recently, some state commissions have eliminated that exemption if a carrier moves to incentive regulation.

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CHAPTER FOUR

EMPIRICAL METHDOLOGY AND ANALYSIS

A. INTRODUCTION

Section B of Chapter 2 (Literature Review) - particularly Sections B.4 (Diffusion) and B.6 (Regulation) - provides much of the overall background of this study's analytical approach. In many ways, the methodological approach has much in common with the work of Greenstein, Masters, and Spiller (1995), Bartolini and Baussola (2001), and Ai and Sappington (2002).[104]

Greenstein, Masters, and Spiller (GMS) and Ai and Sappington (AS) both examine the effects of incentive regulation on network modernization in the telecommunications industry. AS also controls for competition. Both competition and regulation are examined in this study. A major difference in the approaches taken by this study and GMS and AS is that this study has not accounted for time. This study will examine the U.S. telecommunications market for the year 2001 in a manner similar to the cross-sectional approach taken Bartolini and Baussola.

Like Bartolini and Baussola, this study uses its data set to describe technological adoption as a discrete choice typical of qualitative-dependent variable models. We will model the probability of deployment of an advanced telecommunications service as of a given year, 2001, as a function of a set of explanatory variables - i.e., the economic

[104] Other studies that have immediate reference are Hannan and McDowell (1984), Quirmbach (1986), Rose and Joskow (1990), Taylor, Zarkadas and Zona (1992), Saloner and Shephard (1995), Karshenas and Stoneman (1995), Goel and Rich (1997), Majundar and Venkatranam (1998), Bourreau and Dogan (2001), Prieger (2001), Shampine (2001), and Zoinerek, Eisner and Burton (2001).

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determinants of technological innovative adoption. The empirical model can be summarized as follows:

$$y_i = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + \mu_i \qquad (1)$$

where:

y_i ... is a dummy variable that takes on the value of 1 if the advanced service has been deployed in wire center serving area i and 0 otherwise, i = 1, ..., m

β_0 ... is a constant

β_j ... is the coefficient of the explanatory variable x_j, i = 1,..., m

x_{ij} ... is the value of the jth explanatory variable associated with the ith wire center serving area, i = 1, ..., m; j = 1, ..., k

μ_i ... is the error term associated with the observation of y_i

m ... the number of wire centers is the study (approximately 21,000)

k ... the number of explanatory variables.

We assume that $E(\boldsymbol{\mu}|\mathbf{x}) = \mathbf{0}$.

Before one can determine which methodology will be employed in analyzing this model, one must first define the set of (possible) explanatory variables.

B. Explanatory Variables

In defining the set of explanatory variables that will be incorporated in the model, one must recall the discussion on the Schumpeterian hypotheses and the various studies that examined some aspect of those hypotheses on some measure of technological innovation. One must also remember the admonishment of some - like Cohen and Levin (1989) - to look beyond just firm size and or market power to a broader consideration of the economic determinants of technological innovation. With that view in mind, this

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study will include characteristics of the ILEC in addition to firm size. These are elements of the market structure - particularly demand, the competitive presence, the size of the market, the characteristics of the customers - and regulation. The study may even touch on technological opportunity. Since the ratio of UNE loop price to loop cost is state-specific, it may capture both a regulatory effect as well as the technological opportunity for the particular state.

ILEC Firm Size

The ILECs are divided into one of three size categories -small, mid-size, or large - based on the financial strength of its holding company. The large companies are affiliates of RBOCs. Each affiliate is the dominant local telecommunications provider in each state where it provides service. The associated holding companies - i.e., the RBOCs - consist of some of the largest companies in the U.S. Each is a Fortune 500 company. For example, Verizon is the tenth largest company in terms of revenue for the year 2002.[105]

The mid-size ILECs are also subsidiaries of large companies - but not as large s the holding companies of those classified here as large. These mid-size companies are subsidiaries of Alltel, Broadwing (Cincinnati Bell) CenturyTel, Citizens/Frontier, Sprint/United, and Valor. With the exception of Sprint, these holding companies tend to be part of the Fortune 1000. Sprint is a Fortune 500 company with revenues that exceed those of Qwest as well as BellSouth. However, Sprint is not a dominant provider in any of its local markets. In addition, it tends to be the ILEC in second and third tier markets - except for its provision of service in Las Vegas. Valor is the smallest of these mid-size

[105] See Table 4.1 for the financial statistics of those holding companies ranked in the *Fortune 1000*

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firms. It is a privately held company with little available public financial information. All other ILECs are classified as small. Although there are many small companies who are part of holding companies[106], for the most part, the smaller companies tend to be locally-owned operations. Some are cooperatives. None are in the Fortune 1000. Note that this classification comports with the FCC's *Statistics of Common Carriers.* The only difference is this study includes CenturyTel, TDS, and Valor in the mid-size classification. See Table 4.2 for a breakdown of wire centers by size classification.

Based on the Schumpeterian hypothesis, one would expect the firms associated with larger holding companies to have the greater financial resources to undertake the deployment of advanced services. Financial strength also means the company has the marketing and technical resources to support such undertakings. The literature has also shown that larger companies have easier access to financial support from banks and other institutional lenders. However, the literature also indicated that the general consensus in the economic community is that size does not matter. The more recent articles that indicate size does matter have developed more complex formulation than this study to capture the effect of size.

The variables are:

LECSMLL - small ILECs
LECMID - mid-size ILECs
LECLRG - large ILECs

Other ILEC Characteristics[107]

[106] Examples are FairPoint Communications, Madison River Communications and Iowa Telecom all with more than 200,000 access lines. Madison River is the 17th largest local telephone company and the other two are larger. See *Legg-Mason Report (2001)*, www.fairpoint.com, and www.madisonriver.net

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The FCC classifies an ILEC as being a rural or non-rural carrier.[108] One would expect that a rural classification would have a negative impact on the deployment of advantage services. Rural carriers are not located in high-density urban areas that are attractive to the deployment of advanced services due to economies of scale. The associate dummy variable is *RURAL*.

In order to encourage rural companies to invest in modern network infrastructure, the Rural Utilities Services was established under the U.S. Department of Agriculture. Eligible companies can obtain low cost loans to invest in the new technologies. Thus, one would expect those companies who are eligible for these subsidies to be more apt to deploy advanced services in its markets - ceteris paribus. This dummy variable is *RUS*. Note that being eligible does not necessarily mean an ILEC has actually borrowed nor does it mean that such companies are only rural providers.

Two estimation methodologies will replace the firm size variables with eleven dummy variables to represent each of the four RBOCs and each of the seven mid-sized holding companies.

Regulation

The primary forms of local regulation examined will be those related in the provisioning of advanced telecommunications services by the ILEC. A review of the data from the completed questionnaires on the regulatory history in each state and the District of Columbia revealed that only a subset of the primary forms of regulation were

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[107] See Table 4.3 for ILEC Disaggregation by Rural, RUS Support & UNE Obligation

[108] The definition of rural carrier is provided in Section 3(a)(2)(47) of the *Telecommunications Act*. Although there are several criteria, it is essentially any carrier that does not provide service in an "urbanized" area.

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applicable to the provisioning advanced telecommunications services. See Table 3.4 for a breakdown of the forms of regulation that govern the provision of advanced telecommunications services. The major forms of local regulation for advanced services were rate-of-return, pricing flexibility, and deregulation. Other forms were indexed price caps, non-indexed price caps, and price caps/rate freeze occasionally accompanied by service or infrastructure obligations. These are dummy variables where a value of one indicates that this is the form of regulation faced by a particular ILEC in a particular wire center serving area for the provisioning of the advanced service. The variables from most to least regulated:

RBROR - Rate base rate-of-return
CAP - Either a rate freeze or a straight price cap
NONINDX CAP - A non-index price cap
INDXCAP - Indexed price cap
NORMATIV - Normative pricing
CHOICE - The ILEC is given the "choice" of the available forms of alternative regulation.
PFLEX - Flexible pricing for competitive services
DEREG - Deregulated

It is generally widely held by both economists and policy makers that incentive regulation will also provide incentives to invest in more advanced technologies and provided more advanced services. Despite this general belief, the investigations of the effects of regulation have not always controlled for other variables that might effect adoption of new technologies - competition, the obligations of the ILECs to modernize its infrastructure in exchange for incentive regulation. Thus, one cannot make an apriori judgement as to how local regulation might affect deployment of advanced services.

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An ILEC's regulation of interstate services is determined by whether it is under either rate-of-return regulation or federal (indexed) price caps. This is designated by a dummy variable *FEDCAP*, which equals 1 if the ILEC is under a federal price cap and 0 if it is under rate-of-return regulation.

Other regulatory variables include whether an ILEC has received 271 Approval and whether the ILEC is obligated under Section 251 of the Telecommunications Act to provide unbundled network elements as well as resell its retail services to competitive providers upon request. The dummy variable *271 APPROV* is positive if the RBOC affiliate has received approval by the FCC to provide in-region interLATA service. A positive value means the ILEC's markets are viewed as being open to competition. Increased competition or the threat of competition should provide an incentive to deploy more advanced services.

UNE obligation is captured with the dummy variable *UNEOBLIG*. This is a variable which indicates that competition can exist in that market. An ILEC is effectively a monopolist if a firm does not have an obligation to share its network with rivals. Some states seem to recognize this reality. In those states, ILECs, who would normally not be subject to Section 251 of the Telecom Act, are required to accept the Section 251 obligations if they wish to be governed under the state's alternative regulation plan.

Market

A number of demographic variables are included to capture a sense of the market:

HSEHLDS - The number of households
EMPLYEES - The number of workers employed by business establishments
DENSITY - The number of people per square mile
AVGHHINC - Average household income

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Most studies find that new products are deployed more readily in large, densely populated areas - i.e., urban areas. The average household income can be taken as a proxy for the socio-economic status of the wire center serving area. A higher-income neighborhood would suggest a greater probability that advanced services might be deployed there. A higher value also suggests a greater probability of a competitive presence.

The ratio of the loop UNE rate to its embedded cost, *PRATIO* (price ratio), is an indicator of the state's regulatory climate. A higher ratio suggests a regulatory climate more supportive of the state's ILECs and less supportive of competition. It is difficult to predict how this variable will affect deployment. A higher value will enable ILECs to reap a higher return on their investments. However, a lower value will encourage competition. The underlying thesis for policymakers as well as economists is that competition forces firms to innovate.

Since *PRATIO* is state-specific, it is also an indirect measure of an aspect of technological opportunity within a state[109]. From a competitor's perspective, a lower value signals more opportunity vis-à-vis the incumbent to successfully enter the market with new services. A higher value might - in some abstract manner - also be an indicator of the represent a chance for a company to be successful in this state.[110]

One of the key variables in this study is the level of competition faced by the ILEC. The variable *NCOMP* measures the number of competitors operating within three

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[109] Technological opportunity was discussed in Section B.5.2 of Chapter 2. As discussed there, this is a rather amorphous concept, but the *PRATIO* does as have aspects that signal a state's approach to competition and, indirectly, technological innovation.

[110] *PRATIO* could just as easily be classified as a regulatory variable. This is purely subjective on my part as I think this variable captures more than just the ratio of loop UNE price to embedded cost.

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miles of the ILEC's wire center. This could have been extended to ten miles, but the decision was to provide a more conservative effect. Ideally, a competitor would locate closer to the wire center. If the competitor intends to share the ILEC facilities - e.g., the switch or the local loop - then it would be advantageous and less costly to minimize the distance between the ILEC's wire center and the competitors point-of-presence.

The number of competitors within a three mile radius does not provide us with a true measure of market power and only indirectly measure the effect of competition. Ideally one would have liked a measure of the effectiveness of competition - the market share of those competitors as compared to the ILEC. Market share information at this level is not available. And knowing the number of competitors says nothing about which services they are offering. Nonetheless, the number of competitors does provide a viable measure of competitive threat by the number of competitors within a reasonable distance. In other words, the number of competitors is a measure of potential competition. Contestable market theory posits that the threat of competition can be as effective as actual competition.[111]

The one caveat, however, in the use of a measure of competition, is that the effect of competition is non-linear. As discussed in Chapter 2, this was initially established by Scherer (1967). In this study, we will use the natural log of the number of competitors. To circumvent the problem that the Ln(0) is undetermined, the measure of competition is defined as:

$$LNCOMPS = Ln\,(NCOMPS + 1)$$

[111] The Schumpeterian hypotheses would suggest a better measure of market power than just the number of competitors. However, a competitive presence does resound with contestable market theory of Baumol, Panzar and Willig (1988). Thus, competition as measured by the number of competitors -

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Buyers

The services examined in this study are primarily used by business establishments although some residential user such as work-at-home could take advantage of DS lines. However, for the most part, it would seem that larger firms would be more likely to purchase these advanced services. Thus, there is a variable for large firms, *LRGFIRMS.* In addition, studies focusing on the telecommunications market invariably include a variable for the number of firms in industries that are traditionally high users of telecommunications services - finance and insurance (SIC 52), real estate (53). Some also include professional, scientific and technical services (54). In addition to these more traditional industries, this study also adds the information industry (51), education (61) and health care (62). The intention is to capture the effects of major users such as telecommunications resellers, radio and television networks in the information industry, large universities in the education industry, and hospitals in the health industry. Consideration was given to focusing only on the large users in these industries, but there was no large user data for education or health care. In addition, there was concern of possible collinearity between such a variable and the previously defined variable for large users. See Table 4.4 for a summary list of the set of explanatory variables.

C. METHODOLOGY

Estimation of the effects of economic factors affecting the deployment of ATS will utilize four different methodologies. The benchmark will be Scenario 1. The other three scenarios will de discussed in terms of their differences from the initial approach.

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regardless of their immediate market power - does have potential effects that can translate into competitive

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C.1 SCENARIO 1

The model as defined in (1) could be analyzed using linear probability, probit, or logit analysis.

The linear probability model (LPM) is simply the ordinary least squares (OLS) approach to estimating a model where the dependent variable is qualitative. Here we have

$$E(y \mid x_j) = \beta_0 + \sum_{j=1}^{k} \beta_j x_j$$

Also

$$E(y \mid x_j) = P(y = 1 \mid x) \cdot 1 + P(y = 0 \mid x) \cdot 0$$

Thus, when we solve $E(y \mid x)$, we also solve $P(y = 1 \mid x)$.

The drawbacks of the LPM are that the probabilities are not constrained between 0 and 1 and the error term is not constant and depends on both the explanatory variables **x** and the parameters β. The latter leads to heteroskedasticity and problems with the standard errors. Despite these drawbacks, the LPM is easy to use via OLS and works well for values of the explanatory variables near the sample average. We will use the LPM primarily as a benchmark that will provide a general assessment of the impact of the factors.

The assumption of the logit and probit models is that underlying (1) we have a regression model:

$$y_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + \mu_i \qquad (2)$$

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behavior by the market participants. This study measures that effect.

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where y_i^* is unobserved. What we observe is:

$y_i = 1$ if $y_i^* > 0$; 0 otherwise.

Thus,

$$P(y = 1 \mid x) = P(y^* > 0 \mid x)$$

$$P_i = P\left[\mu_i > \left(\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}\right)\right]$$

$$P_i = 1 - F\left[-\left(\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}\right)\right]$$

where F is the cumulative distribution of μ.

If the distribution of μ is symmetric, $1 - F(-Z) = F(Z)$. Then,

$$P_i = F\left(\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}\right)$$

Since the observed process is a binomial process, we can construct the likelihood function:

$$L = \prod_{y_i=1} P_i \prod_{y_i=0} (1 - P_i) \tag{3}$$

The functional form of (3) depends on the assumption made about the error term μ. If the cumulative distribution form of μ is logistic, then the model is called *logit* and

$$F(Z_i) = \frac{\exp(Z_i)}{1 + \exp(Z_i)} = \Lambda(Z_i)$$

If the error μ_I follow a normal distribution, then we have the *probit* model where

$$F(Z_i) = \Phi(Z_i)$$

where $\Phi(z)$ is the standard normal cdf.

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The initial estimation for the deployment of each of the studied services will be by LPM, logit and probit. Since the interpretation of the coefficients of logit and probit models are not straight forward, we will also estimate the marginal effect of each explanatory variable on the probability of deploying the service - i.e., dF/dx.

The above approach assumes (1) is the correct model and the explanatory variables are all exogenous. Problems emerge if one or more of the explanatory variables is not exogenous, but is actually endogenous. This arises if the one of the explanatory variables is also correlated with the error term or we have a system of equations of the form:

$$y_1 = \gamma_1 y_2 + \beta_1' X_1 + \mu_1 \qquad (4)$$

$$y_2 = \gamma_2 y_2 + \beta_2' X_2 + \mu_2$$

where

X_1 and X_2 are sets of exogenous variables with the possibility that they have variables in common

y_2 and μ_1 are correlated

Normal estimation would lead to biased results. The approach to estimation is to find an instrumental variable for y_2 that is highly correlated with y_2 but is not correlated with μ_1. This estimation approach is a form of two stage least squares (2SLS). However it is complicated by the fact that y_1 is a qualitative variable. In this study, the competition variable is believed to be endogenous. The estimation approach was developed by Joe Harkness.[112]

[112] The algorithm used was developed by Joe Harkness, a statistician at John Hopkins University based on Newey (1987) and Maddala (1983). This algorithm is available to Stata users.

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Thus, the approach taken in this study will be to estimate (1) assuming exogeneity of the explanatory variables by LPM, logit, and probit. Then we will estimate the model assuming the competition variable is endogenous. The set of results for each studies service will provide a more substantive evaluation of the impact of the factors than if we had just assumed endogeneity. In addition, both approaches will provide marginal effects comparisons under probit.

C.2 Scenario 2

One can reasonably argue that the adoption decisions made by each ILEC in each wire center serving area are not independent. For the most part, factors that might make these decisions correlated are captured by the various factors that are separately defined for each wire center serving area and included in the model. However, there are other factors unique to each holding company that may be common to each of its affiliate ILECs. These might be financial strength, marketing acumen, strategy or other similar characteristics unique to the holding company. Under this scenario, these common factors will be captured by eleven dummy variables (four for the large ILECs and seven for the mid-sized ILECs). The other ILECs are the same as represented by *LECSMLL*. This form of estimation will remove any estimation of the impact of firm size, but should improve the model's accuracy. In addition, it will provide a sense of which holding companies are more innovative. Nevertheless, it is not expected to markedly change the direction, size or significance of the determinants.

C.3 Scenario 3

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This scenario builds on Scenario 2, but assumes that not only is competition endogenous but also it is simultaneously determined along with the decision to deploy the ATS. In other words, there are two equations which are simultaneously determined - i.e., both the number of competitors and the decision to deploy the advanced telecommunication services are endogenously determined. For example, the situation can be modeled by the following two simultaneously determined equations [see (4) above]:

$$y_1 = \gamma_1 y_2 + \beta_1' X_1 + \mu_1$$

$$y_2 = \gamma_2 y_2 + \beta_2' X_2 + \mu_2$$

where,

y_1 = the decision to deploy an ATS

y_2 = *ln* (no. of competitors)

In this scenario, the first equation in the model will be a LPM (or essentially OLS) and the system of (two OLS) equations will be estimated via three stage least squares (3SLS). This is considered a more straightforward approach than the probit models used in Scenarios 1 and 2 to deal with the simultaneity issue. Considering the large sample size, the LPM via 3SLS approach will produce consistent and unbiased estimates.[113] Each of the simultaneous equations, while different, will include a fairly similar set of variables.

Note that density is included in the competition equation , but not the ATS equation. We do not know which services the competitors are offering, so we do not know how those offerings are affected by density. The ATS being offered here are less

[113] LPM can be provide good estimates of the partial effects near the center of the x distribution (Wooldridge 2002, 455). The very large sample size seems to assure that there will a far greater percentage of observations near the center of samples. Heckman and Macurdy (1985) show why an LPM approach can be justified in estimating simultaneous equations.

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concerned about density and more concerned about the number of available customers reached.

The other change is the elimination of the industry distinctions. Instead we will examine the overall effect of just the large firms from finance and insurance, real estate, technical services, and information. The variable is *LRGFIRE.*

C.4 SCENARIO 4

Scenario 4 is the same as scenario 3 except that the eleven ILEC dummy variables are replaced with the firm size dummy variables used in Scenario 1.

D. RESULTS[114]

We will examine the results from each of the scenarios. Scenario 1 will be explored at length. The other scenarios will be discussed in relation to Scenario 1. This is not that difficult since the effect of the determinants proved remarkably consistent across all four methods of estimation. See the List of Tables for the tables associated with each scenario.

D.1 SCENARIO 1

The results from these estimations are provided in Tables 4.7 through 4.45. There is a set of nine tables for each of the services studied - packet switching, DS1, DS3, and optical carrier (OC). The first seven tables of each set correspond to the detailed regression results for each approach taken - LPM, logit, probit, probit iv[115], probit iv

[114] The econometric analysis was done using Stata /SE 7.0.

[115] Probit IV is the aforementioned probit routine developed to analyze econometric models where one or more of the independent variables is assumed to be endogenous.

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(with a reduced set of variables), probit (dF/dx), probit iv (dF/dx). The exception is that there are two additional regressions for OC. The regressions with a reduced set of variables was to see if the significance of the variables and the prediction of the model improved by dropping insignificant variables. The last two tables of each set will provide summaries of the coefficient estimates and, second, a summary of the two marginal effects estimations. The detailed results are available because many of the quantity or non-dummy variables such as households (*HSEHLDS*) or number of business establishments (*NFIRMS*) appear as .000 because the summaries only provide results to three decimal places. In addition, the results for these variables are related to the impact of a single person or a single firm. In addition, Table 4.45 provides an overall summary of the results across services for probit (iv, dF/dx).

What is interesting about all of the estimates across all services is that the vast majority of the variables are significant at the 1% level. Second, the prediction level[116] of each the models ranged from 71% (for one of the DS1 regressions) to 93% (for one of the OC regressions). This was surprisingly good. The variables whose significance varied most were the industry variables for the expected high telecommunications users. The surprise was they were not always positive nor significant.

Another valuable point was that the various estimation approaches for each service were all similar in determining which variables were significant. This was consistent across all studied services. The value of the coefficients might differ across estimation approaches - as would be expected - but the sign and level of significance

[116] These predictions were based on the predicted probability of each of the models. If the predicted probability was greater than or equal to 50%, the observation was considered to have adopted the ATS.

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were usually the same. Note also that the coefficients for probit and probit(iv) were usually similar.

A glance at the Summary results in Table 4.45 reveals three very strong conclusions: (1) competition has a positive, statistically significant effect on the deployment of ATS; (2) demand, as represented by average household income, also has a consistently positive, statistically significant effect on innovation; (3) many forms of incentive regulation - particularly indexed price cap - produced negative impacts on innovation relative to rate base rate-of-return regulation. This last observation was unexpected.

Other variables that seemed to have generally positive effects on deployment were mid-size ILECs, rural utilities services support, UNE obligations, the loop price to UNE cost ratio (*PRATIO*), the number of firms, the real estate industry, and, of the alternative forms of regulation, normative pricing.[117]

The competition variable was particularly sensitive to the choice of instrument in probit (iv). Based on correlations and a simple OLS regression (see Tables 4.5and 4.6), the strongest correlation would have been with the large firms from the finance, insurance, real estate, technical services, and information industries, but using those variables as instruments for competition, would have produced questionable results.[118] This is an area that needs further exploration. The particular instrument chosen was the natural log of the number of people employed by the firms in the wire center serving area, *LEMPLYEES.*

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[117] The implications of these results will be discussed in the concluding section of this chapter.

[118] The particular insight gained from this simple analysis of competition is how closely competitors seem to be associated with areas where the traditional high users of telecommunications are located. In other words, the competitors know their markets and their customers

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The sensitivity of the choice of instruments was revealed in a regression for DS1 where *EMPLYEES* was inadvertently used as an instrument. The result was that the significancy of many of the market variables was altered and the measure of competition, *LNCOMPS*, became insignificant. This highlights how sensitive the choice of instruments is and how it can effect the econometric results. This will be discussed further in Chapter 6. It is interesting to note that this use of *EMPLYEES* as an instrument had no meaningful effect on the coefficients or the significance of the regulatory variables. This begins to suggest a robustness in the results concerning the regulatory variables.

PACKET SWITCHING

Aside from the regulatory results, the packet switching results are essentially what one would have expected. This was especially true of large ILECs (*LECLRG*). Having a large ILEC as a provider of local services increased the probability of deployment by .218 (22%). What was surprising, however, is that among the highly significant variables, large business establishments (*LRGFIRMS*) and density had negative impacts. This suggests that not all large firms are candidates for packet switching type services. This is confirmed by a preliminary estimation using an LPM approach that indicated that large firms in the financial and information industries had a significant positive impact. These variables were not included in the results presented here.

The negative value due to density may not be so surprising. Density is population per square mile. In other words, it is a measure of residential density as opposed to business density. So the negative value could be seen as consistent with the expectation that packet switching is for medium to large commercial interests that would not be located in densely populated residential areas.

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The results from the regulatory variables are probably the most interesting. All are highly significant, but deregulation, indexed price-caps, and pricing flexibility have negative impacts relative to rate base rate-of-return (RBROR) regulation in the deployment of packet switching. This is significant because it begins to suggest that the importance attached to incentive or alternative regulation as a catalyst for innovation may be overstated - especially when one controls for other variables such as competition.[119]

DIGITAL SIGNAL 1 (DS1)

The estimates suggest that the DS1 market is not for the large providers or the large commercial users. It also suggests that competition is a factor. These are not inconsistent results. DS1 is an older technology. Larger carriers and larger firms may have moved on to more cutting edge technologies. The significant positive result from competition suggests that competitors may be more efficient in supplying this older technology. Note also that mid-size ILECs appear to be the leading provider of DS1 and that small ILECs are more apt to be providers of DS1 than large companies. This begins to highlight a quiet phenomenon in the rural telecommunications market where RBOCs are disposing of exchanges to more efficient, smaller companies.[120]

DS1 is a service that would appeal more to smaller firms and is the one service that would have some residential applicability (see Table 3.3). Note that the number of business establishments and number of households are both highly significant. As expected, the business effect is greater An increase of 100 firms will increase the

[119] Rather than discuss the full meaning of these regulatory results at this point, let us wait unit they are discussed in the context of all of the services in Chapter 5.

[120] This phenomena will be discussed in Chapter 5.

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probability of deployment of DS1 by .0119 while an increase of 1000 households will increase the probability of deployment by .0072.[121]

Again, the regulatory variables are significant and indexed price caps and pricing flexibility have negative impacts. Deregulation, non-indexed price caps, and normative pricing have significantly positive impacts (relative to RBROR).

It is important to note that governance by deregulation can be somewhat misleading at times. Not all ILECs governed by deregulation can be viewed as being in a competitive environment. Deregulation is a legislative act and is often the form of regulation for cooperatives, tribal phone companies, and many very small companies who are on intimate terms with their customers. DS1 is a service that these smaller-type companies could provide. The presence of deregulation increases the probability of deployment by .038 relative to RBROR.[122]

DIGITAL SIGNAL 3 (DS3)

This service seems to have more unexpected results. For one, the smaller and mid-sized companies seem more likely to deploy DS3 than the larger ILECs. Competition is significant. Is it possible that DS3 like DS1 services are being more actively marketed by the smaller ILECs because the large providers are focusing on more advanced services such as (Gigabit) Ethernet? Or does it reflect the more efficient provision of local services in newly acquired rural territories by smaller telecommunications companies such as Madison River or TDS?

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[121] See Table 4.22.

[122] See Table 4.24

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Large firms have a significantly negative impact. While households are insignificant, the number of firms and the real estate industry are significantly positive. This suggest that DS3 is a service the appeals a broad range of business establishments with less appeal exclusively to large firms or the traditional high telephone use industries.

Once again, we are seeing the same negative impacts to deployment of advanced services from indexed price caps, pricing flexibility, and straight price-caps. Deregulation is negative, but insignificant.

OPTICAL CARRIER (OC)

The results for optical carrier seem somewhat at odds with what one would have expected. Large providers, although positive, are statistically insignificant. Mid-sized ILECs are less likely to provide OC than small ILECs. Again, this might be another situation where more efficient smaller companies are doing a better job of responding to need of the rural community.[123] However, competition has a highly significant impact in all of the estimation approaches. Is it possible that another choice of instrument variable(s) would have produced different results?[124]

Out of the original 20,755 records, only 1,352 had deployed OC. Because of missing data in at least one of variable fields, 239 observations were dropped and only 1,113 of those records were included in the analysis. Of those, 992 (or 89%) were in the

[123] Approximately 16% of those wire centers that have adopted Optical Carrier are in rural exchanges served by small companies. Large carriers were responsible for about 83%, mid-size for about .4%, and small carriers in non-rural areas about .4%

[124] The choice of instruments for competition is a very sensitive area of this study. A preliminary examination of OC using LPM showed that large firms from finance, insurance, information, and real estate had highly significant (less than 1%) positive impacts on the deployment of OC. We have shown the strong correlation of the competition variable with the large firms in these industries. This suggests that (1) the results might be different had different instruments been uses and (2) different instruments might be used in different markets.

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wire centers of large providers. However, this only translated to a 16.3% level of significance compared to the other variables. This might suggest a marginal statistical significance.

The following variables were highly significant positively: average household income, number of firms, and the real estate industry. RUS support and UNE rate to embedded cost, although positive, were statistically insignificant. However, many of the variables that one would have expected to have a positive impact - UNE obligations, large firms, the finance, information and technical services industries - either had negative impacts or were insignificant. Among the alternative regulatory variables, only deregulation and normative pricing, had significantly positive impacts.

It is difficult to form a hypothesis that would fit this pattern. Optical Carrier is a relatively more recent technological innovation. And possibly these rather mixed results reflect the uncertainty in this market. Clearly, though, it is a market where a competitive presence accelerates the rollout of this ATS.

Overall Summary Across All Services

Table 4.45 provides an overall view of the factor impacts across all services. Some factors were consistent in their impacts. Rural and RUS eligibility had the desired impacts. Another supplier characteristic, UNE obligations was always positive and highly significant except for OC. This is interesting since all RBOC affiliates have UNE obligations, but RBOC affiliates in general - i.e., large ILECs - do not always have a positive impact on innovation. However, UNE obligations also include many non-RBOC affiliated companies who are upgrading their networks with the latest technologies and are transforming these companies into more modern and efficient enterprises albeit

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somewhat smaller. The positive effect due to *UNEOBLIG* suggests that the impact of these more efficient and innovative ILECs is very significant.[125]

On the demand side, average household income, number of firms, and the real estate industry were consistently positive and statistically significant across services.

PRATIO had positive effects on the deployment of all of the services except DS3. This suggests that high UNE rates do influence the ILEC's deployment of advanced services.[126] This is also consistent with the regulatory effects. There is a greater probability of deployment where the ILEC has some protection from the vagaries of the market. Note the highly significant positive effects from non-indexed price-caps for DS1 and DS3 (the ILEC gets a guaranteed increase in rates each year) and normative pricing versus deregulation, indexed price-caps, and pricing flexibility. Once other factors are controlled for, these latter forms of regulation do not have the desired impact. The implication is that ILECs are more likely to adopt new technologies where the are "protected" from the vagaries of the market. This - and the significantly positive impact of competition - might be the most revealing and surprising insight from this study.

D.2 SCENARIO 2

The results from this set of estimations are found in tables 4.46 to 4.66 (see the List of Tables). Aside from the new variables for the individual ILECs, the sign and significance for each of the other variables are similar to those in Scenario 1. It is interesting that indexed price caps proved positive though insignificant for OC. The results, though, for OC should be viewed with some caution. Many of the individual

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[125] See *Legg-Mason Report (2001) where these issues are explored in greater detail.*

[126] The PRATIO effect, because they are state specific, also suggests that some states provide higher technological opportunities than others do.

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ILECs - such as Alltel and BellSouth - did not offer OC. Thus, the observations on such ILECs were not used. This tends to bias the results in favor of ILECs who provide the service. I suspect this accounts for the positive impact from indexed price caps. Of importance, note that UNE obligations is only positive and significant for Packet Switching and DS1.

D.3 SCENARIO 3

The results from this set of estimations are found in tables 4.67 to 4.71. Again, as in Scenario 2, there is little change in the sign and significance for each of the variables with the possible exception of UNE obligations. Here UNE obligations are similar to its role in Scenario 1.

D.4 SCENARIO 4

These results are very similar in kind to those in Scenario1. See tables 4.72 to 4.76.

D.5 SUMMARY

The effects of the economic determinants on the deployment of ATS were analyzed from four different estimation perspectives and the results remained essentially the same. The conclusions reached under Scenario 1 have been affirmed by the similar results from the other three scenarios. The following variables proved to be generally consistently positive and significant in almost all situations:

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Table 4.77 - Positively Significant Variables Across All Scenarios

Variable	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
AVGHHINC	y	y	y	y	*
century[(a)]	na	y	y	na	
LECMID[(a)]	y	na	na	y	
LNCOMPS	y	y	y	y	*
NFIRMS	y	y	y	y	
NONINDXCAP		y	y	y	
NORMATIV	y	y	y	y	
PRATIO		y	y	y	
REALEST	y	y	na	na	
RUS	y	y	y	y	
UNEOBLIG[(b)]	y	y	y	y	

a = negative coefficient for OC

b = negative coefficient for OC under Scenarios 1, 2 & 3

* = positive and significant in every situation

The two effects that stand out across all situations is the consistently positive and significant effect of the measure of (potential) competition and the relative poor performance of most of the alternative forms of regulation.

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CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

The results of this study suggest three things: (1) Schumpeter and Schmookler were right; (2) analysis and policy needs to be designed to fit the characteristics of the market; (3) the implementation of alternative regulation needs to be re-thought both by economists and policymakers.

One of the Schumpeter hypotheses suggested that large firms with monopoly power were better positioned to provide the new technological innovations. The study tends to support this thesis in those markets where one would expect the larger ILECs to be active. This was particularly true in the deployment of packet switching. The fact that larger providers did not reveal themselves in the DS1 and DS3 markets may not be so surprising. These services have been around since the 1960s. It would be interesting to see what newer services these companies might be marketing such as (Gigabit) Ethernet. Dodd (2002) highlights the many advantages of Ethernet over the other advanced telecommunications services including ease of installation and lower cost.

This qualified support for this aspect of the Schumpeterian hypotheses seems surprising based on the econometric results, but a very simple analysis reveals that 67% of wire centers that adopted DS1, 57% of wire centers that adopted DS3, and 83% of wire centers that adopted OC are served by large ILECs. Large ILECs makeup 54% of the wire centers. Thus, the negative results for DS1 and DS3 and insignificant results for OC need to be qualified and better understood.

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The strong effect due to competition seems to conflict with the second of Schumpeter's hypotheses - i.e., competition has a negative effect on innovation. The problem with that view is that it does not comport with anything Schumpeter said and only reflects the general interpretation of his thought as outlined in Chapter 2. Recall Schumpeter's actual words on competition:

> ...the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest-scale unit of control for instance) - competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.[127]

The results of the study thus support the view advanced in Chapter 1 that Schumpeter was focusing on the dynamics of competitive forces, which includes innovation or technical progress in the context of market structure [see Martin (1993, 351-352)]. See also the extend examination of his thinking in *CSD* in Chapter 2, Section A. Thus, the fact that the measure of competition has a positively significant impact in all situations studied is actually consistent with Schumpeter's thought, but inconsistent with the Schumpeterian hypothesis.

Aghion, Harris, Vickers and Howitt (2002) resolve the apparent inconsistency in Schumpeter's hypothesis and the empirical results. They found that the inverted-U relationship shows a positive effect on innovation at low levels of competition, but the "Schumpeterian effect" dominates at high initial levels of product market competition. Thus, the results of this study are consistent with the findings in the literature. The difference is in how they are being interpreted.

The study also seems to suggest that those companies that are under UNE obligations, but are not RBOC affiliates, may have embraced the above-mentioned

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Schumpeterian definition of marketplace competition by investing in newer technologies. These are not necessarily large companies. These are companies that seem to be transforming some of the rural ILECs into more efficient operations. From a policy point of view, these are the companies that should be supported with more realistic regulation. This thesis is explored in the Legg-Mason Report (2001).[128]Recall that these ideas were presented in Chapter 4.

The Legg-Mason study reveals that RBOCs are disposing of the their rural territories to more efficient smaller telephone companies such as Citizen, CenturyTel, TDS, Iowa Telecom, Madison River, and FairPoint. For one, these companies better understand the rural market and are in a better position to take advantage of rural regulatory benefits - such as subsidies unavailable to RBOCs and their affiliates. This could also explain why the effect of small ILECs was positive for OC and the effect of mid-size ILECs was relative positive and significant for all but OC.

Nonetheless, the aspect of the Schumpeterian hypotheses relating to market power is neither supported nor rejected. The data only allowed use to examine the effect of (potential)competition. Further study needs to determine the level of competition. Or the amount of market power retained by the competing firms.

In many ways, Schmookler is vindicated by this study. Once one accounts for the characteristics of the particular market for a service, it is the demand factors that are highly significant. See Table 4.45. One can argue that different market suggest different demand factors, but several were consistent across the services examined - average

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[127] This passage from Schumpeter (1942, 84) is presented in its entirety at the end of Chapter 6.

[128] See *Reshaping Rural Telephone Markets* by Legg Mason Research, Fall 2001, referred to as the *Legg-Mason Report*

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household income, number of business establishments, and the response of the various individual industries depending on the particular market being studied - i.e., information industry for packet switching and the real estate industry for all services. Thus, "demand" has a consistently positive impact on deployment of advanced services and by implication on technological innovation.

Another important result is that markets matter. The approach to the study of one market may not be valid in the study of second. The market for each of these advanced services is different. The data set used in the analyses was the same, but the results differed. The implication is that policy must be fashioned to fit individual markets if it is to be successful.

Ai and Sappington (2002) suggested future studies should attempt to untangle the complementarity between incentive regulation and competition. In doing so, this study reveals that, aside from normative pricing and non-indexed price caps, incentive regulation does not necessarily lead to the deployment of advanced services. In general, the analysis suggests that the indexed price caps and pricing flexibility have a negative impact relative RBROR. However, deregulation may have some applicability. This promises to be controversial because it seems to go against a widely held belief about the advantages of alternative regulation - i.e., that it will lead to newer services. Once other factors are controlled for, these incentive regulation plans have a negative impact on the deployment of the advanced services examined in this study. The results also suggest that innovation in regulated industries such as telecommunications may be influenced by the Averch-Johnson Effect.

Averch-Johnson Effect[129]

[129] This section relies on Kaserman and Mayo (1995, 471-476).

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With the exception of non-index cap regulation and normative pricing, all of the other alternative forms of regulation had a lesser effect on innovation than RBROR. The fact that almost all of these alternative forms of regulation fair so poorly in their effect on innovation should not be so surprising. The Averch-Johnson (AJ) Effect[130] says that if the allowed rate of return on its capital (s) is greater than the cost of capital (r), a regulated firm's profits are given by:

$$\pi \leq (s-r)K$$

where K is the designated rate base or invested capital. The AJ Effect predicts that, under these circumstances, regulated firms will over-invest in capital. Investment in new technologies merely expands the rate base (K) and consequently its profits. In addition, regulatory lag can lead to situations where the allowed rate of return (s) has not been adjusted with the decline in the cost of capital (r). Thus, the AJ Effect is a logical explanation for why RBROR may have a greater positive effect on the deployment of the ATS studied than any of the alternative forms of regulation except non-indexed price caps and normative pricing.

Non-indexed price cap is a form of price cap that authorizes an explicit increase in prices every year. In a few cases, this increase is tied to change in GDP. Normative pricing allows the state commissioners to set a price - explicitly legislated to be not based on earnings - but one that protects the consumer and protects the company. In both instances, there is element of "making the firm whole" and removing the risk of innovation that is a central component of the other alternative regulatory forms.

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[130] See Averch and Johnson (1962).

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It is instructive to note that only under those forms of regulation where the ILEC is "protected" from the market is there a positive effect on deployment of advanced services - i.e., non-indexed price-caps and normative pricing. What this study does suggest for policymakers is that not only must they reduce the barriers to competition, but that they will have to receive a firm commitment from the ILEC to provide advanced services in exchange for alternative regulation.

An interesting observation is the impact of *PRATIO* - the ratio of loop UNE price to embedded cost. As expected, its value is generally positive and significant in it effect on the deployment of ATS, but it is also positive in its effect on competition (see Scenarios 3 and 4). One would have expected *PRATIO* to have a negative impact on competition. The fact that it is positive suggests it also represents a measure of technological opportunity. States with higher *PRATIO* are better for competition and thus better for innovation.

In summary, the study indicates that the thinking on incentive regulation needs to be re-examined while barriers to entry in the local telecommunication markets need to be eliminated if policy makers want to achieve greater deployment of advanced telecommunications services.

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CHAPTER SIX

SUGGESTIONS FOR FUTURE STUDY

The goal of this study was to examine the effects of various economic determinants on technological innovation. In particular, it was to examine those economic factors involved in the deployment of advanced telecommunications services. The study took into account the pertinent economic factors for the three major economic components of the market - i.e., the supplier, the demand, and the nature of the market. On the supply side, the study included a measure of firm size, the availability of subsidized loans. On the demand side, it included measures of different firm sizes, the availability of firms expected to have a greater demand for telecommunications services, the demographics of the market, the size of the market, the density of the market. The nature of the market was defined by the number of competitors and the forms of regulation faced by ILECs in providing the studied services. The econometric model itself addressed two concerns raised by Ai and Sappington (2002, 134) - i.e., that, in order to better understand the potential complementarity between incentive regulation and competition, more accurate measures of competition and a finer classification of incentive regulation regimes need to be analyzed. These goals were achieved to a great degree by the unique granularity of this study - the wire center serving area. Personally, I believe these are excellent achievements. However, this should be viewed as merely a first step toward a better understanding of the nature of technological innovation.

A first response to the study is to question how it was done because the results were not only unexpected, but they contradict a widely held belief amongst economists and policymakers that incentive regulation will have a positive influence on the adoption

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of advanced services. This only proved consistently true for normative pricing, which is somewhat removed from market-based pricing and has vestiges of "protecting" the ILEC.

Endogeneity

Another area that should be re-examined in more detail is the proper instruments to use for competition. Preliminary results suggest that the impact of competition may be different depending on the instrument(s) selected. An earlier analysis that did not account for the non-linearity of competition led to somewhat different conclusions - especially for OC. The use of *EMPLYEES* as opposed to *LEMPLYEES* as an instrument altered the significance of those market variables that could have been used as instruments for competition.

Although this study tried to account for the endogeneity of competition, an argument can be made for accounting for the endogeneity of both competition and the decision to deploy the advanced telecommunications service. This suggests other alternative forms of econometric analysis such as three stage least squares.

Missing Data

Thirdly, another reason for redoing the study is that approximately one-third of the records - i.e., wire centers were dropped - because of missing data. The data needs to be re-examined and maybe eliminate some of explanatory variables if it will provide a larger sample and not reduce the explanatory power of the model. Preliminary results - see tables were the number of variables were reduced - particularly Table 4.42. This did not seem to have a great impact.

Large FIRE Firms

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There is enough information to suggest that large firms in the finance, insurance, information and real estate industries might have an impact on some of the services - especially optical carrier. This too should be explored in a newer study.

In addition to the above particulars, the present study can be improved upon by: (1) adding the time dimension; (2) including more specificity about the characteristics of the ILECs; (3) including more details about the users of he services - i.e., the customers; (4) including additional measures of competition - e.g., market power; (5) including additional aspects of aspects of the regulatory regimes that might affect the decision-making process; (6) expand the breadth of the study beyond the impact of state regulatory rules to include the federal rules. This is a fairly extensive list, which would require time and data to achieve. However, some of these improvements can be achieved more readily - time and additional regulatory information.

Time

A more revealing study of technological innovation could be achieved by panel data analysis. This had been the original goal of this study. The questionnaire on forms of regulation provided information for the period 1994 to 2002. Information on the availability of advanced services over time was also available. However, the passage of time has made more information accessible. More current information on the economics and demographics of the market has become available. The recent 2000 Census data is now available. All of this information can be translated at the wire center serving area level. Additional data over time would provide information about the growth of a market.

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ILEC Characteristics

The effect of firm size was captured by dividing the ILECs into to three size categories depending on the economic strength and ubiquity of the holding company. However, this form of disaggregation may not be as revealing as a more analog approach to measuring a firm's financial size. For example, subsidiaries of Sprint and Valor were both included in the medium-sized ILECs. In actuality, Sprint is closer in financial strength to one of the RBOCs than it is to Valor. In addition, some of the smaller ILECs also are subsidiaries of holding companies, but they were all treated similarly. Thus, more detail is needed about the actual financial strength of each ILEC or its holding company - e.g., net assets.

An additional characteristic of local companies that is related to knowledge of holding companies is whether local ownership provides a greater incentive for innovation. Anecdotal evidence provided during the course of the survey suggested this, but it was not examined in this study.

Customers

Greater detail about the potential market for each innovation should be analyzed. For example the market for DS services is not the same as that for SONET. The FIRE companies, while major users of telephone service may not also be major users of the advanced telecommunications services studied here. Finer SIC code distinction would provide information on those establishments that might have greater potential for advanced services - universities, hospitals, very large firms, television networks, ISP providers, film studios, etc.

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Competitive Measures

This study was able to capture the number of competitors in the immediate market as measured by the distance of a CLEC's point-of-presence from the ILEC's wire center. However, this approach says nothing about the effectiveness of these competitors. All competitors are not the same. Information is needed to capture the market power of the ILEC as measured against the market power and financial strength of the competitors. Note this is one of the issues raised in Chapter 2 in the discussion on Schumpeter.

Regulatory Regimes

The study provided the direct effect from the actual form of regulation governing the provision of each of the advanced services studied. However, additional insight on the impact of regulation would be provided by the indirect effects from the types of regulation applied to other local services. For example, some of the alternative forms of regulation obligate the ILEC to modernize its infrastructure by a particular date or to make a defined dollar investment sometimes measured in tens of millions of dollars. Might this affect the deployment of advanced services? Thus, an indirect effect of a particular form of alternative regulation on basic services could impact deployment of advanced services.

Interstate Rules

Some of the federal impacts were captured with the RUS eligibility and federal price-cap designation. Are there other federal rules or programs that might impact deployment of advanced services?

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Notice that at no time have we discussed the impact of the prices of these services. One can argue that how a service is priced will be a factor in its marketing success. Nonetheless, one can also argue that, at this stage of the innovative process, pricing is more of an issue of tactics and follows the initial strategic decision to deploy the service. Better that we recall Schumpeter's (1942, 84) admonition about present-day competition, which is essentially the underlying raison d'être for these studies:

> The first thing to go is the traditional conception of the *modus operandi* of competition. Economists are at long last emerging from the stage in which price competition was all they saw. As soon as quality competition and sales effort are admitted into the sacred precincts of theory, the price variable is ousted from its dominant position. However, it is still competition within a rigid pattern of invariant conditions, methods of production and forms of industrial organization in particular, that practically monopolizes attention. But in capitalist reality as distinguished from its textbook picture, it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest-scale unit of control for instance) - competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of existing firms but at their foundations and their very lives. This kind of competition is as much more effective than the other as a bombardment is in comparison with forcing a door, and so much more important that it becomes a matter of comparative indifference whether competition in the ordinary sense functions more or less promptly; the powerful lever that in the long run expands output and brings down prices is in any case made of other stuff.

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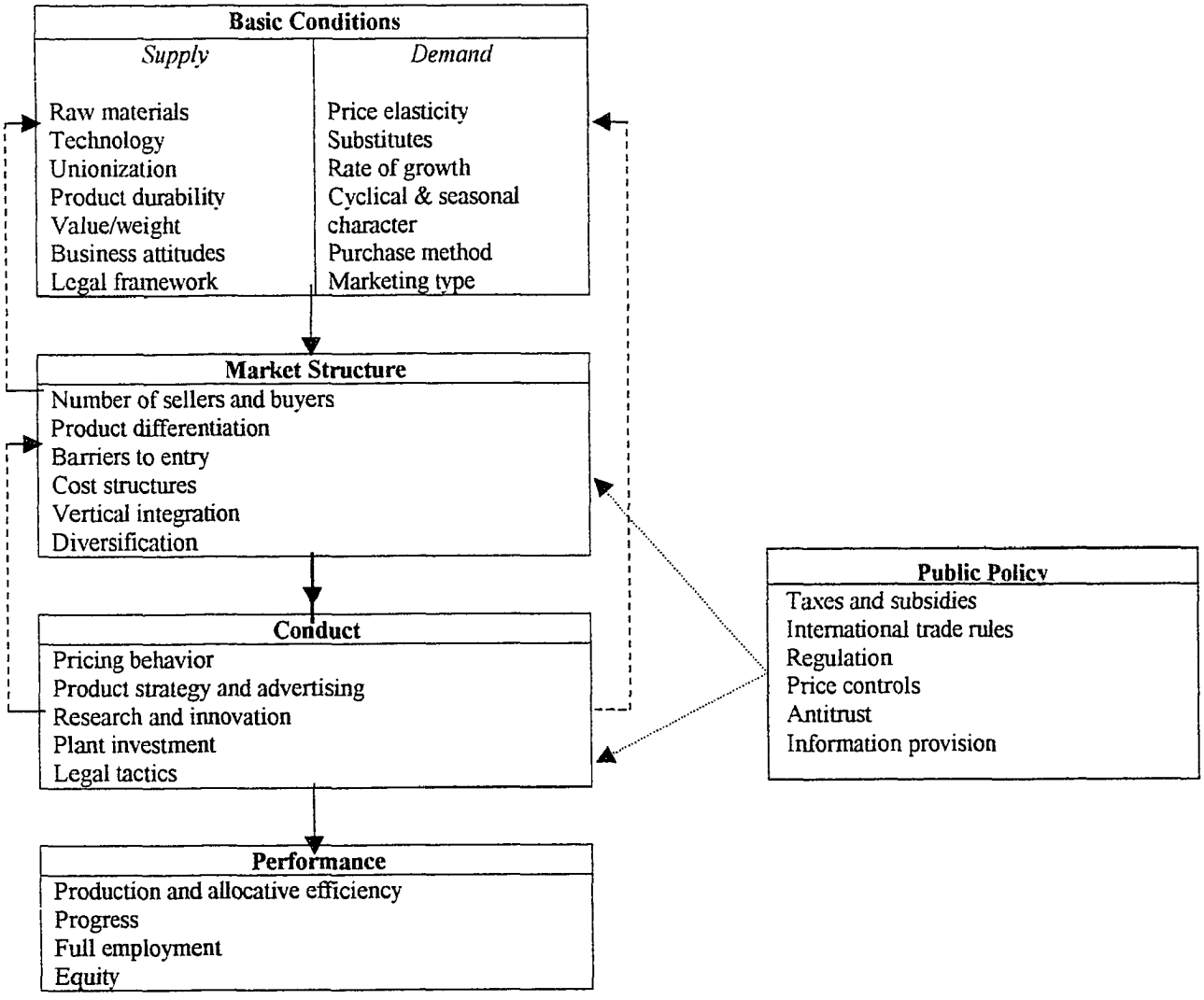
APPENDIX A - FIGURES

Figure 1 - SCP Model



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APPENDIX B - TABLES

Table 3.1 - North American Digital Carrier Hierarchy (T-Carrier)

Digital Signal (DS) Level	Data Rate (Mbps)	Number of 64-Kbps Channels (DS-0s)	Equivalent Number of T Carriers
DS-0	.064	1	
DS-1 (T1)	1.544	24	1 T1
DS-1 C (T1C)	3.152	48	2 T1
DS-2 (T2)	6.312	96	4 T1, 2 T1C
DS-3 (T3)	44.736	672	28 T1, 14 T1C, 7 T2
DS-4 (T4)	274.176	4,032	168 T1, 84 T1C, 42 T2, 6 T3

Table 3.2 - SONET/SDH Signal Hierarchy

Optical Carrier (OC) Level	Signal Level	Equivalent DS-3 (45 Mbps) Channels	Equivalent DS0 (64 Kbps) Channels
OC-1	51.84 Mbps	1	672
OC-2	103.68 Mbps	2	1,344
OC-3	155.52 Mbps	3	2,016
OC-4	207.36 Mbps	4	2,688
OC-9	466.56 Mbps	9	6,048
OC-12	622.08 Mbps	12	8,064
OC-18	933.12 Mbps	18	12,096
OC-24	1.24416 Gbps	24	16,128
OC-36	1.86624 Gbps	36	24,192
OC-48	2.48832 Gbps	48	32,256
OC-96	4.976 Gbps	96	64,512
OC-192	9.953 Gbps	192	129,024
OC-768	39.813 Gbps	768	516,096

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Table 3.3 - An Overview of Specialized Digital Network Services[a]

Network Services	Places Typically Used	How Used
T-1 24 voice or data channels	Commercial organizations	1.54 mbs Internet access, connection to long distance and local telephone companies for voice and data, private lines between company sites
	Internet service providers (ISPs)	Connections to the Internet
T-3 672 voice or data channels	Very large organizations	Access to long distance companies, Internet access, high-speed private lines between company sites
	Local exchange carriers (LECs)	Tandem-to-tandem central office traffic
	Large ISPs	Connections to the Internet
Frame Relay	Medium to large commercial customers	56Kbps to 45 megabits access to data networks for LAN-to-LAN communications and Internet access; mostly data but some voice
ATM, Asynchronous Transfer Mode (ATM), 56 Kbps to 2.5 Gigabits per second	Telephone companies	Switches voice, video and data traffic on high-usage network backbone routes over fiber
	Frame Relay networks	Switches traffic in the core of Frame Relay networks
	Large organizations such as major universities	Primarily to transmit voice, video and data across campuses and between LANs
Synchronous optical network (SONET), up to 129,000 channels on fiber optic cable	Carrier networks	Multiplexes voice and data traffic onto fiber optic cables, provides a backup redundant path in the local loop and in carriers' backbone networks

a Taken from Dodd (2002, 241-242)

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Table 3.4 - Proportion of ILECs Under Incentive Regulation Plans

State	No. of ILECs	All ILECs		RBOCs*	
		Incentive Regulation	Price-Cap Regulation	Incentive Regulation	Price-Cap Regulation
Alabama	31	31	31	y	y
Alaska	32	8			
Arizona	19	5		y	
Arkansas	28	26		y	
California	24	4	4	y	y
Colorado	29	1		y	
Connecticut	3	2	1	y	y
Delaware	1	1	1	y	y
District of Columbia	1	1		y	
Florida	11	10	10	y	y
Georgia	35	26	1	y	y
Hawaii	2				
Idaho	25	7		y	
Illinois	55	55	1	y	y
Indiana	40	15		y	
Iowa	150	150	3	y	y
Kansas	39	2	2	y	y
Kentucky	21	3		y	
Louisiana	20	20	14	y	
Maine	24	1		y	
Maryland	2	1	1	y	y
Massachusetts	5				
Michigan	38	38		y	
Minnesota	90	61		y	
Mississippi	19	1		y	
Missouri	42	11	3	y	y
Montana	19	19		y	
Nebraska	42	42		y	
Nevada	15	3		y	
New Hampshire	11				
New Jersey	3	1	1	y	y
New Mexico	16	16		y	
New York	42	2		y	
North Carolina	26	16	7	y	y
North Dakota	29	28	2	y	y
Ohio	42	3	1	y	y
Oklahoma	39	38		y	
Oregon	34	31		y	
Pennsylvania	37	19	19	y	y
Rhode Island	1	1	1	y	y
South Carolina	26	3		y	
South Dakota	37	37		y	
Tennessee	27	12	3	y	y

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Table 3.4 (continued)

Texas	56	17		y	
Utah	17	1	1	y	y
Vermont	11	1		y	
Virginia	20	10	2	y	
Washington	22	2		y	
West Virginia	8	8		y	
Wisconsin	90	87	2	y	y
Wyoming	16	9		y	
Totals	1472	886	111	47	20
		60.2%	7.5%	92.2%	39.2%

* = SNET was used in Connecticut
Price-Cap regulation refers to indexed price-cap regulation.
Some ILECs represent cooperatives or tribal authorities, which are often deregulated

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Table 3.5

Occurrences of Forms of Regulation for Advanced Telecommunications Services

Name	Occurrences	Pct.
Choice	11	0.1%
Normative Pricing	121	0.6%
Price-Cap - Straight	170	0.8%
Price-Cap - Non-indexed	933	4.5%
Price-Cap - Indexed	1,010	4.9%
Rate Base Rate-of-Return	2,697	13.0%
Deregulation	6,847	33.0%
Pricing Flexibility	8,966	43.2%
	20,755	

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Table 4.1 - Fortune 1000 Rank for 2002[a]

Rank	Company	Rev	Assets	Market Value	Type
10	Verizon	67.225	167.468	95.889	Large
27	SBC	43.138	95.057	69.226	Large
54	Sprint	27.180	45.293	14.535	Mid-Sized
77	BellSouth	22.440	49.479	40.570	Large
121	Qwest	15.487	31.228	6.493	Large
234	Alltel	7.983	16.389	13.608	Mid-Sized
495	TDS	2.985	9.602	2.192	Mid-Sized
541	Citizens	2.674	8.147	2.805	Mid-Sized
627	Broadwing	2.235	3.897	0.871	Mid-Sized
629	CenturyTel	2.219	7.770	3.843	Mid-Sized
	Valor[b]				Mid-Sized

a Results from *Fortune*, April 14, 2003

b Valor is privately held company. For size comparisons it has approximately 590,000 lines in New Mexico and Texas. The next largest is Cincinnati Bell (Broadwing) with approximately 1M access lines.

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Table 4.2 - Wire Centers by Company Size-Category

Size Category	Company	Occurrences	Pct.
Large	BellSouth	1,587	7.6%
	Qwest	1,239	6.0%
	SBC	3,186	15.4%
	Verizon	5,136	24.7%
		11,148	53.7%
Mid-Size	Alltel	743	3.6%
	CenturyTel	840	4.0%
	Cincinnati Bell	56	0.3%
	Citizens	945	4.6%
	Sprint	1,333	6.4%
	TDS	347	1.7%
	Valor	265	1.3%
		4,529	21.8%
Small	Others	5,078	24.5%
Total		20,755	

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Table 4.3 - ILEC Disaggregation by Rural, RUS Support & UNE Obligations

	Rural		RUS Support		UNE Obligations		Total	
Large	238	*2.5%*	206	*5.2%*	10,433	*78.9%*	11,148	*53.7%*
Medium	4,194	*44.2%*	920	*23.0%*	2,343	*17.7%*	4,518	*21.8%*
Small	5,064	*53.3%*	2,871	*71.8%*	443	*3.4%*	5,089	*24.5%*
	9,496	*45.8%*	3,997	*19.3%*	13,219	*63.7%*	20,755	

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Table 4.4 - EXPLANATORY VARIABLES

Name	Type	Dummy	Comments
APPROV271	Supplier	y	RBOC affiliate has satisfied 14 points indicative of sufficient competition in its region to allow in-region interLATA service.
FEDCAP	Supplier	y	ILEC is regulated by an indexed price cap at interstate level
LECLRG	Supplier	y	These are the RBOC affiliates.
LECMID	Supplier	y	Mid-size ILECS.
LECSMLL	Supplier	y	All other ILECs
RURAL	Supplier	y	Indicates the ILEC is considered a rural carrier.
RUS	Supplier	y	Indicates the ILEC is eligible to receive loan subsidies from the Rural Utilities Service
UNEOBLIG	Supplier	y	ILEC is obligated under Section 251(c) of the Act to provide UNEs upon request.
AVGHHINC	Market		Average household income in the wire center serving area
DENSITY	Market		Number of people per square mile
EMPLYEES	Market		Number of employed by the firms in the wire center serving area
LEMPLYEES	Market		*Ln (EMPLYEES)*
HSEHLDS	Market		The number of house holds in the wire center serving area
NCOMPS	Market		The number of competitors whose point-of-presence is within 3 miles of the ILEC wire center.
LNCOMPS	Market		*Ln(NCOMPS + 1)*
PRATIO	Market		This is the ratio of the loop UNE rate to its embedded cost
EDUC	Buyer		Number of firms in the education industry (61)
FINCE	Buyer		Number of firms in the finance and insurance industries (52)
HEALTH	Buyer		Number of firms in the health care industry (62)
INFO	Buyer		Number of firms in the information industry (51)
NFIRMS	Buyer		Number of business establishments
REALEST	Buyer		Number of firms in the real estate industry (53)
TCHSRV	Buyer		Number of firms in the professional, scientific, and technical services industries (54)
LRGFIRE	Buyer		Number of large firms in industries 51 - 54
CAP	Regulation	y	Either a rate freeze or a straight price cap
DEREG	Regulation	y	The ILEC or a set of services has been deregulated by the legislature
INDXCAP	Regulation	y	Traditional indexed price cap.
NONINDXCAP	Regulation	y	Non-indexed price cap. Rates are allowed to rise annually based on a specified percentage
NORMATIV	Regulation	y	Commission sets rates based on economic costs, market conditions and consumer welfare, but precluded by legislation from any rate base or earnings projections.
PFLEX	Regulation	y	The ILEC is given pricing flexibility for competitive services. The only obligation is that prices must exceed economic costs.
RBROR	Regulation	y	Traditional rate base rate-of-return regulation
NONCAPNTWK	Regulation	y	Interactive dummy to capture regulation when there is both a non-indexed price-cap with service obligations
PFLEXNTWK	Regulation	y	Interactive dummy to capture regulation when there is both pricing flexibility along with service obligations

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Table 4.5 - Competition Correlations

```
. corr NCOMP   AVGHHINC DENSITY  EMPLYEES  LRGFIRE
UNEOBLIG
(obs=18586)

|     NCOMP AVGHHINC  DENSITY EMPLYEES  LRGFIRE UNEOBLIG
-------------+------------------------------------------------
---------
NCOMP |    1.0000
AVGHHINC |  0.0494   1.0000
DENSITY |   0.2648   0.1453   1.0000
EMPLYEES |  0.4104   0.3178   0.4477   1.0000
LRGFIRE |   0.4978   0.2273   0.1978   0.6709   1.0000
UNEOBLIG |  0.1119   0.2367   0.1384   0.2662   0.1610
1.0000
```

Table 4.6 - OLS of Competition

```
. regress NCOMP AVGHHINC DENSITY EMPLYEES  HSEHLDS LRGFIRE
NFIRMS

Source |       SS       df       MS              Number of obs =   18586
-------------+------------------------------   F( 6, 18579) = 1301.97
Model |  66791.0704     6  11131.8451           Prob > F      =  0.0000
Residual | 158849.885 18579  8.54996957         R-squared     =  0.2960
-------------+------------------------------   Adj R-squared =  0.2958
Total |  225640.955 18585  12.1410253           Root MSE      =  2.924

------------------------------------------------------------------------------
NCOMP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
AVGHHINC |  -.0000202   1.92e-06   -10.52   0.000    -.000024   -.0000164
DENSITY |    .0001984   9.08e-06    21.85   0.000    .0001806    .0002162
EMPLYEES |   .0001015   6.05e-06    16.78   0.000    .0000897    .0001134
HSEHLDS |    .0000315   4.88e-06     6.46   0.000    .000022     .0000411
LRGFIRE |    .4026475   .0078144    51.53   0.000    .3873306    .4179644
NFIRMS |    -.0018052   .0001126   -16.03   0.000    -.002026   -.0015844
_cons |      .6932093   .0628827    11.02   0.000    .5699534    .8164651
```

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Table 4.7 - Packet Switching - Linear Probability Model

Source	SS	df	MS		
Model	760.954467	28	27.1769452	Number of obs =	14528
Residual	2352.01222	14499	.162218927	F(28, 14499) =	167.53
Total	3112.96669	14527	.214288338	Prob > F =	0.0000
				R-squared =	0.2444
				Adj R-squared =	0.2430
				Root MSE =	.40276

PCKTSW	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
APPRV271	-.004806	.0111818	-0.43	0.667	-.0267237	.0171118
FEDCAP	-.2520869	.0166805	-15.11	0.000	-.2847829	-.219391
LECLRG	.200098	.0248912	8.04	0.000	.1513081	.248888
LECMID	.1037371	.0141225	7.35	0.000	.0760553	.1314189
RURAL	-.0964914	.0214695	-4.49	0.000	-.1385744	-.0544083
RUS	.0424241	.0123757	3.43	0.001	.0181662	.0666821
UNEOBLIG	.1269549	.0126691	10.02	0.000	.1021219	.1517879
AVGHHINC	3.48e-06	2.98e-07	11.67	0.000	2.89e-06	4.06e-06
DENSITY	-5.89e-06	1.59e-06	-3.70	0.000	-9.00e-06	-2.77e-06
HSEHLDS	4.26e-06	8.18e-07	5.21	0.000	2.66e-06	5.87e-06
LNCOMPS	.0675615	.0076762	8.80	0.000	.0525153	.0826078
PRATIO	.5254934	.0199791	26.30	0.000	.4863318	.564655
NFIRMS	.0001986	.0000289	6.88	0.000	.0001421	.0002552
LRGFIRMS	-.0018326	.0004836	-3.79	0.000	-.0027806	-.0008846
EDUC	.0020213	.0012683	1.59	0.111	-.0004648	.0045073
FINCE	.0000208	.0001988	0.10	0.916	-.0003688	.0004105
HEALTH	-.0002117	.0001476	-1.43	0.152	-.0005011	.0000777
INFO	.0005234	.0003803	1.38	0.169	-.000222	.0012687
REALEST	.0008982	.0003108	2.89	0.004	.0002891	.0015073
TCHSRV	-.0008853	.0001164	-7.61	0.000	-.0011134	-.0006572
CAP	.4759757	.0353825	13.45	0.000	.4066215	.5453299
DEREG	-.1817089	.0121437	-14.96	0.000	-.205512	-.1579058
INDXCAP	-.1053643	.0186775	-5.64	0.000	-.1419746	-.0687541
NONINDXCAP	.1667832	.0212881	7.83	0.000	.1250558	.2085106
NORMATIV	.2904324	.0437195	6.64	0.000	.2047366	.3761282
PFLEX	-.1236378	.0121025	-10.22	0.000	-.1473603	-.0999153
NONCAPNTWK	-.3393873	.0309372	-10.97	0.000	-.4000281	-.2787465
PFLEXNTWK	.0500302	.0220854	2.27	0.024	.0067401	.0933204
_cons	-.2056763	.032075	-6.41	0.000	-.2685474	-.1428053

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

       F(  6, 14499) =   12.62
            Prob > F =    0.0000
```

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Table 4.8 - Packet Switching - Logit

Logit estimates — Number of obs = 14528; LR chi2(28) = 3935.23; Prob > chi2 = 0.0000; Log likelihood = -7038.1055; Pseudo R2 = 0.2185

PCKTSW	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.0128943	.0652607	-0.20	0.843	-.1408029	.1150142
FEDCAP	-1.775237	.1185505	-14.97	0.000	-2.007591	-1.542882
LECLRG	1.182425	.1644214	7.19	0.000	.860165	1.504685
LECMID	.535839	.0933313	5.74	0.000	.3529131	.718765
RURAL	-.7739134	.1432338	-5.40	0.000	-1.054646	-.4931802
RUS	.3242695	.0809117	4.01	0.000	.1656855	.4828535
UNEOBLIG	.8955691	.0955742	9.37	0.000	.7082472	1.082891
AVGHHINC	.0000168	1.81e-06	9.25	0.000	.0000132	.0000203
DENSITY	-.0000293	.0000112	-2.61	0.009	-.0000514	-7.31e-06
HSEHLDS	.0000162	5.15e-06	3.14	0.002	6.10e-06	.0000263
LNCOMPS	.3158518	.0450919	7.00	0.000	.2274733	.4042303
PRATIO	3.201506	.1309207	24.45	0.000	2.944906	3.458105
NFIRMS	.0012135	.0002015	6.02	0.000	.0008185	.0016085
LRGFIRMS	-.0153786	.0032157	-4.78	0.000	-.0216813	-.0090759
EDUC	-.0035696	.0086968	-0.41	0.681	-.020615	.0134758
FINCE	-.0024456	.0013269	-1.84	0.065	-.0050462	.000155
HEALTH	-.0011587	.0010391	-1.12	0.265	-.0031953	.0008779
INFO	.0225602	.0052705	4.28	0.000	.0122303	.0328901
REALEST	.0150863	.0026367	5.72	0.000	.0099184	.0202542
TCHSRV	-.0072984	.0008324	-8.77	0.000	-.0089299	-.0056669
CAP	2.899186	.3389039	8.55	0.000	2.234947	3.563426
DEREG	-1.135491	.0753347	-15.07	0.000	-1.283144	-.9878377
INDXCAP	-.6135092	.1159555	-5.29	0.000	-.8407778	-.3862406
NONINDXCAP	.7896256	.1279068	6.17	0.000	.5389329	1.040318
NORMATIV	1.346531	.245422	5.49	0.000	.8655122	1.827549
PFLEX	-.7719921	.0752485	-10.26	0.000	-.9194764	-.6245078
NONCAPNTWK	-1.762007	.1845005	-9.55	0.000	-2.123621	-1.400392
PFLEXNTWK	.2743469	.1224066	2.24	0.025	.0344345	.5142594
_cons	-3.755186	.2089736	-17.97	0.000	-4.164767	-3.345605

note: 0 failures and 1 success completely determined.

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  116.43
         Prob > chi2 =    0.0000
```

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Table 4.9 - Packet Switching - Probit

Probit estimates — Number of obs = 14528
LR chi2(28) = 3899.88
Prob > chi2 = 0.0000
Log likelihood = -7055.7814 — Pseudo R2 = 0.2165

PCKTSW	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.0100622	.0384903	-0.26	0.794	-.0855018	.0653774
FEDCAP	-1.014178	.0651631	-15.56	0.000	-1.141895	-.8864604
LECLRG	.7182874	.0947347	7.58	0.000	.5326108	.9039639
LECMID	.3314961	.0522084	6.35	0.000	.2291696	.4338226
RURAL	-.3991013	.0823714	-4.85	0.000	-.5605463	-.2376564
RUS	.1846874	.0449233	4.11	0.000	.0966394	.2727354
UNEOBLIG	.4774608	.0513321	9.30	0.000	.3768516	.5780699
AVGHHINC	.0000103	1.04e-06	9.87	0.000	8.26e-06	.0000124
DENSITY	-.0000168	6.41e-06	-2.63	0.009	-.0000294	-4.27e-06
HSEHLDS	9.39e-06	2.97e-06	3.16	0.002	3.57e-06	.0000152
LNCOMPS	.193205	.026432	7.31	0.000	.1413994	.2450107
PRATIO	1.801282	.0746081	24.14	0.000	1.655053	1.947511
NFIRMS	.000748	.0001152	6.50	0.000	.0005223	.0009737
LRGFIRMS	-.0086938	.0018626	-4.67	0.000	-.0123445	-.0050431
EDUC	-.00195	.0049903	-0.39	0.696	-.0117308	.0078307
FINCE	-.0012469	.0007241	-1.72	0.085	-.0026661	.0001723
HEALTH	-.0005712	.0006019	-0.95	0.343	-.001751	.0006086
INFO	.011525	.0028959	3.98	0.000	.0058492	.0172009
REALEST	.0077207	.0014439	5.35	0.000	.0048908	.0105507
TCHSRV	-.0042046	.0004609	-9.12	0.000	-.005108	-.0033013
CAP	1.687612	.1695731	9.95	0.000	1.355255	2.019969
DEREG	-.6621775	.0433938	-15.26	0.000	-.7472278	-.5771272
INDXCAP	-.36857	.0677402	-5.44	0.000	-.5013384	-.2358016
NONINDXCAP	.5025641	.0762992	6.59	0.000	.3530204	.6521077
NORMATIV	.7620634	.1453939	5.24	0.000	.4770967	1.04703
PFLEX	-.4416125	.0431541	-10.23	0.000	-.5261931	-.357032
NONCAPNTWK	-1.080642	.1104546	-9.78	0.000	-1.297129	-.8641544
PFLEXNTWK	.1770806	.0723542	2.45	0.014	.0352689	.3188923
_cons	-2.193542	.1190707	-18.42	0.000	-2.426917	-1.960168

note: 0 failures and 7 successes completely determined.

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  118.27
         Prob > chi2 =    0.0000
```

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Table 4.10 - Packet Switching - Probit IV

PCKTSW	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	2.065838	.4371218	4.73	0.000	1.209095	2.922581
APPRV271	-.0468431	.0457096	-1.02	0.305	-.1364322	.0427461
FEDCAP	-1.026618	.0739493	-13.88	0.000	-1.171556	-.8816798
LECLRG	.6888756	.1083034	6.36	0.000	.4766048	.9011463
LECMID	.3475461	.0599718	5.80	0.000	.2300036	.4650887
RURAL	-.3824124	.0938932	-4.07	0.000	-.5664397	-.198385
RUS	.1729383	.0518138	3.34	0.001	.0713851	.2744916
UNEOBLIG	.42888	.0589122	7.28	0.000	.3134143	.5443458
AVGHHINC	.0000169	1.95e-06	8.67	0.000	.0000131	.0000207
DENSITY	-.0001267	.0000266	-4.77	0.000	-.0001788	-.0000746
HSEHLDS	-7.88e-06	5.30e-06	-1.49	0.137	-.0000183	2.49e-06
PRATIO	1.593674	.0979043	16.28	0.000	1.401785	1.785563
NFIRMS	.0009269	.0001361	6.81	0.000	.0006601	.0011938
LRGFIRMS	-.0309894	.0056161	-5.52	0.000	-.0419967	-.0199821
EDUC	.0006138	.0056539	0.11	0.914	-.0104676	.0116952
FINCE	-.0034133	.0009734	-3.51	0.000	-.0053211	-.0015055
HEALTH	-.0021465	.0007669	-2.80	0.005	-.0036496	-.0006435
INFO	.0079926	.0030793	2.60	0.009	.0019573	.0140278
REALEST	.0180163	.002879	6.26	0.000	.0123736	.0236589
TCHSRV	-.00681	.000803	-8.48	0.000	-.0083839	-.0052361
CAP	1.674428	.1846612	9.07	0.000	1.312498	2.036357
DEREG	-.6295658	.0507593	-12.40	0.000	-.7290522	-.5300795
INDXCAP	-.4287482	.0792682	-5.41	0.000	-.5841109	-.2733854
NONINDXCAP	.3365592	.0960179	3.51	0.000	.1483676	.5247509
NORMATIV	.7897264	.1713596	4.61	0.000	.4538677	1.125585
PFLEX	-.4348071	.0499438	-8.71	0.000	-.5326952	-.3369191
NONCAPNTWK	-1.138671	.1285042	-8.86	0.000	-1.390535	-.8868074
PFLEXNTWK	.036435	.091571	0.40	0.691	-.143041	.2159109
_cons	-2.209061	.136521	-16.18	0.000	-2.476638	-1.941485

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   81.02
         Prob > chi2 =    0.0000
```

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Table 4.11 - Packet Switching - Probit IV

Reduced number of variables

```
ivprob  PCKTSW, endog(LNCOMPS) iv( LEMPLYEES) exog(FEDCAP LECLRG LECMID RURAL
RUS UNEOBLIG AVGHHINC DENSITY PRATIO NFIRMS LRGFIRMS FINCE HEALTH INFO REALEST
TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK)
(2202 real changes made)
```

PCKTSW	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	2.696714	.5175825	5.21	0.000	1.682271	3.711157
FEDCAP	-1.11179	.0667592	-16.65	0.000	-1.242635	-.980944
LECLRG	.7140285	.100229	7.12	0.000	.5175834	.9104737
LECMID	.323096	.0523537	6.17	0.000	.2204846	.4257075
RURAL	-.311969	.089011	-3.50	0.000	-.4864273	-.1375106
RUS	.1539171	.0453295	3.40	0.001	.0650729	.2427613
UNEOBLIG	.483713	.0544854	8.88	0.000	.3769236	.5905024
AVGHHINC	.0000185	2.06e-06	9.00	0.000	.0000145	.0000225
DENSITY	-.0001723	.0000342	-5.04	0.000	-.0002393	-.0001054
PRATIO	1.259914	.0918228	13.72	0.000	1.079945	1.439884
NFIRMS	.0008425	.0001243	6.78	0.000	.0005988	.0010861
LRGFIRMS	-.0388341	.0065435	-5.93	0.000	-.0516591	-.0260091
FINCE	-.0042894	.0010364	-4.14	0.000	-.0063206	-.0022581
HEALTH	-.0034561	.0009259	-3.73	0.000	-.0052707	-.0016414
INFO	.0082163	.0029324	2.80	0.005	.0024688	.0139638
REALEST	.0224883	.0034411	6.54	0.000	.0157439	.0292327
TCHSRV	-.0072382	.0007421	-9.75	0.000	-.0086927	-.0057837
CAP	1.791219	.182071	9.84	0.000	1.434366	2.148071
DEREG	-.6169527	.0456623	-13.51	0.000	-.7064491	-.5274563
INDXCAP	-.5105505	.0762915	-6.69	0.000	-.6600791	-.3610218
NONINDXCAP	.237156	.0951576	2.49	0.013	.0506507	.4236614
NORMATIV	.86896	.1645673	5.28	0.000	.546414	1.191506
PFLEX	-.4118915	.0448139	-9.19	0.000	-.499725	-.3240579
NONCAPNTWK	-1.103306	.1300839	-8.48	0.000	-1.358266	-.8483458
PFLEXNTWK	.0767727	.0909747	0.84	0.399	-.1015344	.2550799
_cons	-2.053397	.1279594	-16.05	0.000	-2.304193	-1.802602

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Table 4.12 - Packet Switching - Probit (dF/dx)

```
Probit estimates                                  Number of obs =  14528
                                                  LR chi2(28)   =3899.88
                                                  Prob > chi2   = 0.0000
Log likelihood = -7055.7814                       Pseudo R2     = 0.2165

------------------------------------------------------------------------------
  PCKTSW |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
---------+--------------------------------------------------------------------
APPRV271*|  -.0033896   .0129379    -0.26   0.794   .130162  -.028747  .021968
  FEDCAP*|  -.3697033   .0236254   -15.56   0.000   .750619  -.416008 -.323398
  LECLRG*|   .2275978   .0276674     7.58   0.000   .615226   .173371  .281825
  LECMID*|   .1174476   .0192213     6.35   0.000   .204433   .079775  .155121
   RURAL*|  -.1303821   .0258825    -4.85   0.000   .380162  -.181111 -.079653
     RUS*|    .064519   .0161681     4.11   0.000   .149986    .03283  .096208
UNEOBLIG*|   .1504679   .0148632     9.30   0.000   .712211   .121337  .179599
AVGHHINC |   3.48e-06   3.52e-07     9.87   0.000   34086.3   2.8e-06  4.2e-06
 DENSITY |  -5.68e-06   2.16e-06    -2.63   0.009   758.198  -9.9e-06 -1.4e-06
 HSEHLDS |   3.17e-06   1.00e-06     3.16   0.002   5784.11   1.2e-06  5.1e-06
 LNCOMPS |   .0652238   .0089286     7.31   0.000   .209153   .047724  .082723
  PRATIO |   .6080925   .0250625    24.14   0.000   .776367   .558971  .657214
  NFIRMS |   .0002525   .0000389     6.50   0.000   417.247   .000176  .000329
LRGFIRMS |  -.0029349   .0006299    -4.67   0.000   9.81701   -.00417   -.0017
    EDUC |  -.0006583   .0016847    -0.39   0.696   3.98764   -.00396  .002644
   FINCE |  -.0004209   .0002445    -1.72   0.085   24.1928    -.0009  .000058
  HEALTH |  -.0001928   .0002032    -0.95   0.343   39.5493  -.000591  .000205
    INFO |   .0038907   .0009803     3.98   0.000     7.052   .001969  .005812
 REALEST |   .0026064   .0004887     5.35   0.000   17.6652   .001649  .003564
  TCHSRV |  -.0014194   .0001563    -9.12   0.000   40.8547  -.001726 -.001113
     CAP*|   .5868075   .0373645     9.95   0.000   .010187   .513574  .660041
   DEREG*|  -.2053487   .0120905   -15.26   0.000   .321104  -.229046 -.181652
 INDXCAP*|  -.1113604   .0178914    -5.44   0.000   .054447  -.146427 -.076294
NONIND~P*|   .1866028    .030044     6.59   0.000   .054309   .127718  .245488
NORMATIV*|   .2911185   .0570322     5.24   0.000    .00647   .179337  .402899
   PFLEX*|  -.1459242   .0138508   -10.23   0.000   .437706  -.173071 -.118777
NONCAP~K*|  -.2376612   .0123212    -9.78   0.000   .017965   -.26181 -.213512
PFLEXN~K*|   .0624714   .0265257     2.45   0.014   .025606   .010482  .114461
---------+--------------------------------------------------------------------
  obs. P |   .3109857
 pred. P |   .2816634  (at x-bar)
------------------------------------------------------------------------------
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  118.27
         Prob > chi2 =    0.0000
```

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Table 4.13 - Packet Switching - Probit IV (dF/dx)

Probit estimates — Number of obs = 14528
chi2(28) =3876.46
Prob > chi2 = 0.0000
Log likelihood = -7067.4901 — Pseudo R2 = 0.2152

PCKTSW	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
LNCOMPS	.6956232	.1469397	4.73	0.000	.209153	.407627	.98362
APPRV271*	-.0156117	.0150735	-1.02	0.305	.130162	-.045155	.013932
FEDCAP*	-.3737515	.0267999	-13.88	0.000	.750619	-.426278	-.321225
LECLRG*	.2183491	.0318079	6.36	0.000	.615226	.156007	.280691
LECMID*	.1231109	.0221098	5.80	0.000	.204433	.079776	.166445
RURAL*	-.1247851	.0295355	-4.07	0.000	.380162	-.182674	-.066897
RUS*	.0601572	.0185508	3.34	0.001	.149986	.023798	.096516
UNEOBLIG*	.1358247	.0173518	7.28	0.000	.712211	.101816	.169834
AVGHHINC	5.69e-06	6.54e-07	8.67	0.000	34086.3	4.4e-06	7.0e-06
DENSITY	-.0000427	8.93e-06	-4.77	0.000	758.198	-.00006	-.000025
HSEHLDS	-2.65e-06	1.78e-06	-1.49	0.137	5784.11	-6.1e-06	8.4e-07
PRATIO	.536633	.0330645	16.28	0.000	.776367	.471828	.601438
NFIRMS	.0003121	.0000458	6.81	0.000	417.247	.000222	.000402
LRGFIRMS	-.010435	.0018889	-5.52	0.000	9.81701	-.014137	-.006733
EDUC	.0002067	.0019038	0.11	0.914	3.98764	-.003525	.003938
FINCE	-.0011494	.0003278	-3.51	0.000	24.1928	-.001792	-.000507
HEALTH	-.0007228	.0002581	-2.80	0.005	39.5493	-.001229	-.000217
INFO	.0026913	.0010389	2.60	0.009	7.052	.000655	.004728
REALEST	.0060666	.0009692	6.26	0.000	17.6652	.004167	.007966
TCHSRV	-.0022931	.0002705	-8.48	0.000	40.8547	-.002823	-.001763
CAP*	.5843626	.0414756	9.07	0.000	.010187	.503072	.665653
DEREG*	-.1956003	.0143121	-12.40	0.000	.321104	-.223652	-.167549
INDXCAP*	-.1264458	.0198287	-5.41	0.000	.054447	-.165309	-.087582
NONINDXCAP*	.1218215	.0367616	3.51	0.000	.054309	.04977	.193873
NORMATIV*	.3017004	.0669203	4.61	0.000	.00647	.170539	.432862
PFLEX*	-.1433563	.0160246	-8.71	0.000	.437706	-.174764	-.111949
NONCAPNTWK*	-.2425909	.0130964	-8.86	0.000	.017965	-.268259	-.216922
PFLEXNTWK*	.0123904	.0314431	0.40	0.691	.025606	-.049237	.074018
obs. P	.3109857						
pred. P	.2801777	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   81.02
         Prob > chi2 =    0.0000
```

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Table 4.14 - Packet Switching - Summary 1

	LPM	Logit	Probit	ProbitIV	ProbitIV
APPRV271	-0.005	-0.013	-0.010	-0.047	
	(0.43)	(0.20)	(0.26)	(1.02)	
FEDCAP	-0.252	-1.775	-1.014	-1.027	-1.112
	(15.11)**	(14.97)**	(15.56)**	(13.88)**	(16.65)**
LECLRG	0.200	1.182	0.718	0.689	0.714
	(8.04)**	(7.19)**	(7.58)**	(6.36)**	(7.12)**
LECMID	0.104	0.536	0.331	0.348	0.323
	(7.35)**	(5.74)**	(6.35)**	(5.80)**	(6.17)**
RURAL	-0.096	-0.774	-0.399	-0.382	-0.312
	(4.49)**	(5.40)**	(4.85)**	(4.07)**	(3.50)**
RUS	0.042	0.324	0.185	0.173	0.154
	(3.43)**	(4.01)**	(4.11)**	(3.34)**	(3.40)**
UNEOBLIG	0.127	0.896	0.477	0.429	0.484
	(10.02)**	(9.37)**	(9.30)**	(7.28)**	(8.88)**
AVGHHINC	0.000	0.000	0.000	0.000	0.000
	(11.67)**	(9.25)**	(9.87)**	(8.67)**	(9.00)**
DENSITY	-0.000	-0.000	-0.000	-0.000	-0.000
	(3.70)**	(2.61)**	(2.63)**	(4.77)**	(5.04)**
HSEHLDS	0.000	0.000	0.000	-0.000	
	(5.21)**	(3.14)**	(3.16)**	(1.49)	
LNCOMPS	0.068	0.316	0.193	2.066	2.697
	(8.80)**	(7.00)**	(7.31)**	(4.73)**	(5.21)**
PRATIO	0.525	3.202	1.801	1.594	1.260
	(26.30)**	(24.45)**	(24.14)**	(16.28)**	(13.72)**
NFIRMS	0.000	0.001	0.001	0.001	0.001
	(6.88)**	(6.02)**	(6.50)**	(6.81)**	(6.78)**
LRGFIRMS	-0.002	-0.015	-0.009	-0.031	-0.039
	(3.79)**	(4.78)**	(4.67)**	(5.52)**	(5.93)**
EDUC	0.002	-0.004	-0.002	0.001	
	(1.59)	(0.41)	(0.39)	(0.11)	
FINCE	0.000	-0.002	-0.001	-0.003	-0.004
	(0.10)	(1.84)	(1.72)	(3.51)**	(4.14)**
HEALTH	-0.000	-0.001	-0.001	-0.002	-0.003
	(1.43)	(1.12)	(0.95)	(2.80)**	(3.73)**
INFO	0.001	0.023	0.012	0.008	0.008
	(1.38)	(4.28)**	(3.98)**	(2.60)**	(2.80)**
REALEST	0.001	0.015	0.008	0.018	0.022
	(2.89)**	(5.72)**	(5.35)**	(6.26)**	(6.54)**
TCHSRV	-0.001	-0.007	-0.004	-0.007	-0.007
	(7.61)**	(8.77)**	(9.12)**	(8.48)**	(9.75)**
CAP	0.476	2.899	1.688	1.674	1.791
	(13.45)**	(8.55)**	(9.95)**	(9.07)**	(9.84)**
DEREG	-0.182	-1.135	-0.662	-0.630	-0.617
	(14.96)**	(15.07)**	(15.26)**	(12.40)**	(13.51)**
INDXCAP	-0.105	-0.614	-0.369	-0.429	-0.511
	(5.64)**	(5.29)**	(5.44)**	(5.41)**	(6.69)**
NONINDXCAP	0.167	0.790	0.503	0.337	0.237
	(7.83)**	(6.17)**	(6.59)**	(3.51)**	(2.49)*

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Table 4.14 (continued)

NORMATIV	0.290	1.347	0.762	0.790	0.869
	(6.64)**	(5.49)**	(5.24)**	(4.61)**	(5.28)**
PFLEX	-0.124	-0.772	-0.442	-0.435	-0.412
	(10.22)**	(10.26)**	(10.23)**	(8.71)**	(9.19)**
NONCAPNTWK	-0.339	-1.762	-1.081	-1.139	-1.103
	(10.97)**	(9.55)**	(9.78)**	(8.86)**	(8.48)**
PFLEXNTWK	0.050	0.274	0.177	0.036	0.077
	(2.27)*	(2.24)*	(2.45)*	(0.40)	(0.84)
Constant	-0.206	-3.755	-2.194	-2.209	-2.053
	(6.41)**	(17.97)**	(18.42)**	(16.18)**	(16.05)**
Observations	14528	14528	14528	14528	18553
Correct pred.	77.5%	78.5%	78.1%	74.7%	76.3%
R-squared	0.24				

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.15 - Packet Switching - Summary 2 (dF/dx)

	Probit	Probit IV
APPRV271	-0.003	-0.016
	(0.26)	(1.02)
FEDCAP	-0.370	-0.374
	(15.56)**	(13.88)**
LECLRG	0.228	0.218
	(7.58)**	(6.36)**
LECMID	0.117	0.123
	(6.35)**	(5.80)**
RURAL	-0.130	-0.125
	(4.85)**	(4.07)**
RUS	0.065	0.060
	(4.11)**	(3.34)**
UNEOBLIG	0.150	0.136
	(9.30)**	(7.28)**
AVGHHINC	0.000	0.000
	(9.87)**	(8.67)**
DENSITY	-0.000	-0.000
	(2.63)**	(4.77)**
HSEHLDS	0.000	-0.000
	(3.16)**	(1.49)
LNCOMPS	0.065	0.696
	(7.31)**	(4.73)**
PRATIO	0.608	0.537
	(24.14)**	(16.28)**
NFIRMS	0.000	0.000
	(6.50)**	(6.81)**
LRGFIRMS	-0.003	-0.010
	(4.67)**	(5.52)**
EDUC	-0.001	0.000
	(0.39)	(0.11)
FINCE	-0.000	-0.001
	(1.72)	(3.51)**
HEALTH	-0.000	-0.001
	(0.95)	(2.80)**
INFO	0.004	0.003
	(3.98)**	(2.60)**
REALEST	0.003	0.006
	(5.35)**	(6.26)**
TCHSRV	-0.001	-0.002
	(9.12)**	(8.48)**
CAP	0.587	0.584
	(9.95)**	(9.07)**
DEREG	-0.205	-0.196
	(15.26)**	(12.40)**
INDXCAP	-0.111	-0.126
	(5.44)**	(5.41)**
NONINDXCAP	0.187	0.122
	(6.59)**	(3.51)**

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Table 4.15 (continued)

NORMATIV	0.291	0.302
	(5.24)**	(4.61)**
PFLEX	-0.146	-0.143
	(10.23)**	(8.71)**
NONCAPNTWK	-0.238	-0.243
	(9.78)**	(8.86)**
PFLEXNTWK	0.062	0.012
	(2.45)*	(0.40)
Observations	14528	14528

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.16 - DS1 - Linear Probability Model

Source	SS	df	MS	Number of obs =	14528
Model	836.995792	28	29.8927069	F(28, 14499) =	155.35
Residual	2789.87418	14499	.192418386	Prob > F =	0.0000
Total	3626.86998	14527	.249664072	R-squared =	0.2308
				Adj R-squared =	0.2293
				Root MSE =	.43866

DS1	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
APPRV271	-.2157082	.0121782	-17.71	0.000	-.2395791	-.1918374
FEDCAP	-.1707887	.0181669	-9.40	0.000	-.2063982	-.1351791
LECLRG	-.0683854	.0271093	-2.52	0.012	-.1215231	-.0152477
LECMID	.1069044	.0153809	6.95	0.000	.0767558	.1370531
RURAL	-.3690315	.0233827	-15.78	0.000	-.4148647	-.3231984
RUS	.050275	.0134785	3.73	0.000	.0238554	.0766946
UNEOBLIG	.1357592	.013798	9.84	0.000	.1087133	.162805
AVGHHINC	2.36e-06	3.25e-07	7.28	0.000	1.73e-06	3.00e-06
DENSITY	-5.32e-06	1.73e-06	-3.07	0.002	-8.71e-06	-1.92e-06
HSEHLDS	8.59e-06	8.91e-07	9.64	0.000	6.85e-06	.0000103
LNCOMPS	.048605	.0083602	5.81	0.000	.0322179	.064992
PRATIO	.2222291	.0217595	10.21	0.000	.1795777	.2648805
NFIRMS	.0001328	.0000314	4.22	0.000	.0000712	.0001944
LRGFIRMS	.0004889	.0005267	0.93	0.353	-.0005436	.0015214
EDUC	-.0032234	.0013813	-2.33	0.020	-.0059311	-.0005158
FINCE	.0004767	.0002165	2.20	0.028	.0000523	.000901
HEALTH	-.0000993	.0001608	-0.62	0.537	-.0004145	.0002158
INFO	-.000266	.0004141	-0.64	0.521	-.0010778	.0005458
REALEST	.0006049	.0003384	1.79	0.074	-.0000585	.0012683
TCHSRV	-.0006158	.0001267	-4.86	0.000	-.0008642	-.0003673
CAP	-.0712379	.0385355	-1.85	0.065	-.1467724	.0042966
DEREG	.0290738	.0132258	2.20	0.028	.0031495	.054998
INDXCAP	-.1004091	.0203419	-4.94	0.000	-.1402818	-.0605364
NONINDXCAP	.3279784	.0231851	14.15	0.000	.2825326	.3734243
NORMATIV	.3963258	.0476154	8.32	0.000	.3029934	.4896581
PFLEX	-.033911	.013181	-2.57	0.010	-.0597475	-.0080746
NONCAPNTWK	-.5191602	.033694	-15.41	0.000	-.5852048	-.4531156
PFLEXNTWK	.0105217	.0240534	0.44	0.662	-.0366261	.0576695
_cons	.3466432	.0349332	9.92	0.000	.2781697	.4151168

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

       F(  6, 14499) =    7.86
            Prob > F =    0.0000
```

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Table 4.17 - DS1 - Logit

Logit estimates — Number of obs = 14528
LR chi2(28) = 4272.31
Prob > chi2 = 0.0000
Log likelihood = -7923.626 — Pseudo R2 = 0.2123

DS1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-1.10902	.0655891	-16.91	0.000	-1.237572	-.9804678
FEDCAP	-.825896	.0940578	-8.78	0.000	-1.010246	-.6415461
LECLRG	-.5416495	.1561164	-3.47	0.001	-.847632	-.235667
LECMID	.4477174	.0767336	5.83	0.000	.2973223	.5981124
RURAL	-1.909548	.141905	-13.46	0.000	-2.187677	-1.631419
RUS	.2362759	.0680837	3.47	0.001	.1028342	.3697175
UNEOBLIG	.5359021	.0716349	7.48	0.000	.3955003	.6763039
AVGHHINC	6.05e-06	1.88e-06	3.22	0.001	2.37e-06	9.74e-06
DENSITY	-.0000817	.000015	-5.46	0.000	-.000111	-.0000524
HSEHLDS	.0000601	7.21e-06	8.33	0.000	.0000459	.0000742
LNCOMPS	.2238802	.0573816	3.90	0.000	.1114142	.3363461
PRATIO	1.124035	.1129028	9.96	0.000	.9027491	1.34532
NFIRMS	.000018	.0002868	0.06	0.950	-.0005442	.0005802
LRGFIRMS	.000394	.0044941	0.09	0.930	-.0084143	.0092024
EDUC	-.0567	.0113627	-4.99	0.000	-.0789704	-.0344296
FINCE	.0037217	.0023548	1.58	0.114	-.0008936	.0083371
HEALTH	.0005234	.0015419	0.34	0.734	-.0024986	.0035453
INFO	.0215309	.007694	2.80	0.005	.0064509	.0366108
REALEST	.0373204	.0042134	8.86	0.000	.0290622	.0455786
TCHSRV	-.0053736	.0012218	-4.40	0.000	-.0077683	-.0029788
CAP	-.3448125	.1941452	-1.78	0.076	-.7253301	.0357051
DEREG	.1388555	.0673893	2.06	0.039	.0067749	.2709361
INDXCAP	-.5538457	.1079505	-5.13	0.000	-.7654248	-.3422665
NONINDXCAP	3.300266	.292145	11.30	0.000	2.727672	3.872859
NORMATIV	1.855195	.2668606	6.95	0.000	1.332158	2.378232
PFLEX	-.1562767	.0680775	-2.30	0.022	-.2897061	-.0228473
NONCAPNTWK	-4.299178	.3200058	-13.43	0.000	-4.926378	-3.671978
PFLEXNTWK	-.0398499	.1250571	-0.32	0.750	-.2849574	.2052576
_cons	-.4636016	.1966981	-2.36	0.018	-.8491228	-.0780805

note: 0 failures and 5 successes completely determined.

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  129.42
         Prob > chi2 =    0.0000
```

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Table 4.18 - DS1 - Probit

Probit estimates — Number of obs = 14528
LR chi2(28) = 4204.68
Prob > chi2 = 0.0000
Log likelihood = -7957.4386 — Pseudo R2 = 0.2090

DS1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.6499521	.0386276	-16.83	0.000	-.7256608	-.5742434
FEDCAP	-.494083	.0554788	-8.91	0.000	-.6028193	-.3853466
LECLRG	-.3079426	.0902281	-3.41	0.001	-.4847864	-.1310988
LECMID	.2732	.0460873	5.93	0.000	.1828706	.3635294
RURAL	-1.137718	.0799757	-14.23	0.000	-1.294468	-.9809686
RUS	.1387524	.0408595	3.40	0.001	.0586692	.2188356
UNEOBLIG	.3283714	.0427411	7.68	0.000	.2446004	.4121425
AVGHHINC	3.73e-06	1.10e-06	3.40	0.001	1.58e-06	5.88e-06
DENSITY	-.0000426	8.01e-06	-5.32	0.000	-.0000583	-.0000269
HSEHLDS	.0000307	3.86e-06	7.96	0.000	.0000232	.0000383
LNCOMPS	.1327358	.0319024	4.16	0.000	.0702082	.1952634
PRATIO	.6971553	.0680042	10.25	0.000	.5638696	.830441
NFIRMS	.0001898	.0001525	1.24	0.213	-.0001091	.0004887
LRGFIRMS	.0003225	.0024671	0.13	0.896	-.004513	.0051579
EDUC	-.0308926	.0061951	-4.99	0.000	-.0430348	-.0187505
FINCE	.0016489	.0011272	1.46	0.144	-.0005603	.0038582
HEALTH	.0003013	.0008208	0.37	0.714	-.0013075	.0019101
INFO	.0095842	.0039091	2.45	0.014	.0019225	.0172459
REALEST	.0178735	.0021506	8.31	0.000	.0136584	.0220887
TCHSRV	-.0029579	.0006468	-4.57	0.000	-.0042256	-.0016903
CAP	-.2084138	.1198191	-1.74	0.082	-.4432549	.0264274
DEREG	.0694448	.0403499	1.72	0.085	-.0096395	.1485291
INDXCAP	-.3399971	.0640468	-5.31	0.000	-.4655266	-.2144676
NONINDXCAP	1.796555	.1330044	13.51	0.000	1.535872	2.057239
NORMATIV	1.115491	.1533226	7.28	0.000	.8149845	1.415998
PFLEX	-.0981737	.0403647	-2.43	0.015	-.177287	-.0190603
NONCAPNTWK	-2.396856	.1546528	-15.50	0.000	-2.69997	-2.093742
PFLEXNTWK	-.0043764	.074764	-0.06	0.953	-.1509111	.1421583
_cons	-.3029161	.1133055	-2.67	0.008	-.5249908	-.0808413

note: 0 failures and 33 successes completely determined.

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  119.78
         Prob > chi2 =    0.0000
```

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Table 4.19 - DS1 - Probit IV

```
. ivprob  DS1, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP LECLRG LECMID
RURAL RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS  EDUC  FINCE
HEALTH INFO REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX
NONCAPNTWK PFLEXNTWK)
(6227 real changes made)
```

DS1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	1.520179	.4008293	3.79	0.000	.7345684	2.30579
APPRV271	-.6769359	.0424573	-15.94	0.000	-.7601507	-.5937211
FEDCAP	-.4988673	.0603904	-8.26	0.000	-.6172303	-.3805044
LECLRG	-.3342292	.0972707	-3.44	0.001	-.5248764	-.1435821
LECMID	.2877028	.0504926	5.70	0.000	.1887391	.3866664
RURAL	-1.130391	.0856535	-13.20	0.000	-1.298269	-.9625136
RUS	.1266779	.0446342	2.84	0.005	.0391965	.2141594
UNEOBLIG	.293162	.0475521	6.17	0.000	.1999615	.3863625
AVGHHINC	8.62e-06	1.83e-06	4.72	0.000	5.04e-06	.0000122
DENSITY	-.0001234	.0000247	-4.99	0.000	-.0001719	-.000075
HSEHLDS	.0000182	5.42e-06	3.35	0.001	7.54e-06	.0000288
PRATIO	.5444514	.0857626	6.35	0.000	.3763597	.7125431
NFIRMS	.0002778	.000159	1.75	0.081	-.0000339	.0005894
LRGFIRMS	-.0163186	.0054153	-3.01	0.003	-.0269323	-.0057049
EDUC	-.0279488	.0064772	-4.31	0.000	-.040644	-.0152537
FINCE	-3.26e-06	.001247	-0.00	0.998	-.0024473	.0024407
HEALTH	-.0008661	.0009055	-0.96	0.339	-.0026407	.0009086
INFO	.0064057	.0040016	1.60	0.109	-.0014373	.0142486
REALEST	.0254224	.0030887	8.23	0.000	.0193687	.0314761
TCHSRV	-.0046859	.0008402	-5.58	0.000	-.0063326	-.0030392
CAP	-.2227262	.1300903	-1.71	0.087	-.4776984	.0322461
DEREG	.0958967	.044582	2.15	0.031	.0085176	.1832758
INDXCAP	-.3810294	.0703733	-5.41	0.000	-.5189586	-.2431002
NONINDXCAP	1.679583	.1408589	11.92	0.000	1.403505	1.955662
NORMATIV	1.136998	.1655012	6.87	0.000	.8126214	1.461374
PFLEX	-.0918319	.0439535	-2.09	0.037	-.1779791	-.0056846
NONCAPNTWK	-2.443229	.161681	-15.11	0.000	-2.760118	-2.12634
PFLEXNTWK	-.1085429	.0864405	-1.26	0.209	-.2779631	.0608773
_cons	-.3069427	.1221731	-2.51	0.012	-.5463975	-.0674878

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  110.29
         Prob > chi2 =    0.0000
```

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Table 4.20 - DS1 - Probit IV

Reduced number of variables

```
. ivprob  DS1, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP LECLRG LECMID
RURAL RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO LRGFIRMS EDUC REALEST TCHSRV
CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK)
(6145 real changes made)
```

DS1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	1.712628	.4217624	4.06	0.000	.8859891	2.539267
APPRV271	-.6776687	.0431945	-15.69	0.000	-.7623283	-.593009
FEDCAP	-.5017041	.0611245	-8.21	0.000	-.6215058	-.3819023
LECLRG	-.3417184	.0983925	-3.47	0.001	-.5345641	-.1488726
LECMID	.2924031	.0511886	5.71	0.000	.1920752	.3927309
RURAL	-1.133361	.0866297	-13.08	0.000	-1.303152	-.9635695
RUS	.1208825	.0451976	2.67	0.007	.0322969	.2094681
UNEOBLIG	.290815	.0481012	6.05	0.000	.1965384	.3850917
AVGHHINC	9.34e-06	1.92e-06	4.86	0.000	5.57e-06	.0000131
DENSITY	-.0001367	.0000248	-5.52	0.000	-.0001853	-.0000881
HSEHLDS	.0000177	5.42e-06	3.26	0.001	7.07e-06	.0000283
PRATIO	.5253733	.0881049	5.96	0.000	.3526909	.6980557
LRGFIRMS	-.0152531	.0056127	-2.72	0.007	-.0262538	-.0042524
EDUC	-.025025	.0060371	-4.15	0.000	-.0368576	-.0131925
REALEST	.0280847	.0025879	10.85	0.000	.0230126	.0331568
TCHSRV	-.0043803	.0009107	-4.81	0.000	-.0061653	-.0025954
CAP	-.2131229	.1322417	-1.61	0.107	-.4723119	.046066
DEREG	.0970353	.0451102	2.15	0.031	.008621	.1854497
INDXCAP	-.3867728	.0716843	-5.40	0.000	-.5272714	-.2462741
NONINDXCAP	1.669436	.1412229	11.82	0.000	1.392644	1.946228
NORMATIV	1.149952	.167094	6.88	0.000	.8224539	1.47745
PFLEX	-.0923217	.0444754	-2.08	0.038	-.179492	-.0051515
NONCAPNTWK	-2.456034	.1631061	-15.06	0.000	-2.775716	-2.136352
PFLEXNTWK	-.1121255	.0870229	-1.29	0.198	-.2826873	.0584363
_cons	-.2901453	.1236194	-2.35	0.019	-.5324349	-.0478558

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Table 4.21 - DS1 - Probit (dF/dx)

Probit estimates — Number of obs = 14528
LR chi2(28) =4204.68
Prob > chi2 = 0.0000
Log likelihood = -7957.4386 — Pseudo R2 = 0.2090

DS1	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
APPRV271*|	-.2510644	.0138364	-16.83	0.000	.130162	-.278183	-.223946
FEDCAP*|	-.1917299	.0206367	-8.91	0.000	.750619	-.232177	-.151283
LECLRG*|	-.1217511	.0352664	-3.41	0.001	.615226	-.190872	-.05263
LECMID*|	.1075055	.0178161	5.93	0.000	.204433	.072587	.142424
RURAL*|	-.4295786	.0268324	-14.23	0.000	.380162	-.482169	-.376988
RUS*|	.0549522	.0160677	3.40	0.001	.149986	.02346	.086444
UNEOBLIG*|	.1304139	.0168176	7.68	0.000	.712211	.097452	.163376
AVGHHINC |	1.48e-06	4.36e-07	3.40	0.001	34086.3	6.3e-07	2.3e-06
DENSITY |	-.000017	3.19e-06	-5.32	0.000	758.198	-.000023	-.000011
HSEHLDS |	.0000122	1.54e-06	7.96	0.000	5784.11	9.2e-06	.000015
LNCOMPS |	.0528407	.0127005	4.16	0.000	.209153	.027948	.077733
PRATIO |	.2775301	.0270717	10.25	0.000	.776367	.224471	.33059
NFIRMS |	.0000755	.0000607	1.24	0.213	417.247	-.000043	.000195
LRGFIRMS |	.0001284	.0009821	0.13	0.896	9.81701	-.001797	.002053
EDUC |	-.012298	.0024652	-4.99	0.000	3.98764	-.01713	-.007466
FINCE |	.0006564	.0004487	1.46	0.144	24.1928	-.000223	.001536
HEALTH |	.00012	.0003268	0.37	0.714	39.5493	-.00052	.00076
INFO |	.0038154	.0015558	2.45	0.014	7.052	.000766	.006865
REALEST |	.0071153	.0008547	8.31	0.000	17.6652	.00544	.00879
TCHSRV |	-.0011775	.0002574	-4.57	0.000	40.8547	-.001682	-.000673
CAP*|	-.0829393	.0473328	-1.74	0.082	.010187	-.17571	.009831
DEREG*|	.0276151	.0160234	1.72	0.085	.321104	-.00379	.05902
INDXCAP*|	-.1344945	.0247679	-5.31	0.000	.054447	-.183039	-.08595
NONIND~P*|	.4739893	.0130118	13.51	0.000	.054309	.448487	.499492
NORMATIV*|	.3565334	.0309913	7.28	0.000	.00647	.295792	.417275
PFLEX*|	-.0390812	.0160616	-2.43	0.015	.437706	-.070561	-.007601
NONCAP~K*|	-.5321375	.0081477	-15.50	0.000	.017965	-.548107	-.516168
PFLEXN~K*|	-.0017424	.0297705	-0.06	0.953	.025606	-.060092	.056607
obs. P |	.4812087						
pred. P |	.5260831	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  119.78
         Prob > chi2 =    0.0000
```

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Table 4.22 - DS1 - Probit IV (dF/dx)

Probit estimates — Number of obs = 14528
chi2(28) =4202.13
Prob > chi2 = 0.0000
Log likelihood = -7958.7172 — Pseudo R2 = 0.2089

DS1	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
LNCOMPS	.6053812	.1596734	3.79	0.000	.209153	.292427	.918335
APPRV271*	-.2603983	.0150051	-15.94	0.000	.130162	-.289808	-.230989
FEDCAP*	-.1937077	.0224736	-8.26	0.000	.750619	-.237755	-.14966
LECLRG*	-.1320865	.0379434	-3.44	0.001	.615226	-.206454	-.057719
LECMID*	.1131973	.0194949	5.70	0.000	.204433	.074988	.151407
RURAL*	-.4269598	.0287743	-13.20	0.000	.380162	-.483356	-.370563
RUS*	.0502308	.0175935	2.84	0.005	.149986	.015748	.084713
UNEOBLIG*	.1165369	.0187649	6.17	0.000	.712211	.079758	.153315
AVGHHINC	3.43e-06	7.28e-07	4.72	0.000	34086.3	2.0e-06	4.9e-06
DENSITY	-.0000492	9.85e-06	-4.99	0.000	758.198	-.000068	-.00003
HSEHLDS	7.23e-06	2.16e-06	3.35	0.001	5784.11	3.0e-06	.000011
PRATIO	.216817	.0341439	6.35	0.000	.776367	.149896	.283738
NFIRMS	.0001106	.0000633	1.75	0.081	417.247	-.000014	.000235
LRGFIRMS	-.0064985	.002157	-3.01	0.003	9.81701	-.010726	-.002271
EDUC	-.0111301	.0025785	-4.31	0.000	3.98764	-.016184	-.006076
FINCE	-1.30e-06	.0004966	-0.00	0.998	24.1928	-.000975	.000972
HEALTH	-.0003449	.0003606	-0.96	0.339	39.5493	-.001052	.000362
INFO	.0025509	.0015933	1.60	0.109	7.052	-.000572	.005674
REALEST	.010124	.0012293	8.23	0.000	17.6652	.007715	.012533
TCHSRV	-.0018661	.0003347	-5.58	0.000	40.8547	-.002522	-.00121
CAP*	-.0885642	.0512385	-1.71	0.087	.010187	-.18899	.011861
DEREG*	.0381297	.0176901	2.15	0.031	.321104	.003458	.072802
INDXCAP*	-.1501939	.0268957	-5.41	0.000	.054447	-.202909	-.097479
NONINDXCAP*	.4628788	.0161568	11.92	0.000	.054309	.431212	.494546
NORMATIV*	.3619592	.0328662	6.87	0.000	.00647	.297543	.426376
PFLEX*	-.0365693	.0174964	-2.09	0.037	.437706	-.070862	-.002277
NONCAPNTWK*	-.5316314	.0081194	-15.11	0.000	.017965	-.547545	-.515718
PFLEXNTWK*	-.0432796	.0344477	-1.26	0.209	.025606	-.110796	.024237
obs. P	.4812087						
pred. P	.5238335	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

```
. outreg using eftable4.doc, nolabel append

. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =  110.29
         Prob > chi2 =    0.0000
```

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Table 4.23 - DS1 - Summary 1

	LPM	Logit	Probit	ProbitIV	ProbitIV
APPRV271	-0.216	-1.109	-0.650	-0.677	-0.678
	(17.71)**	(16.91)**	(16.83)**	(15.94)**	(15.69)**
FEDCAP	-0.171	-0.826	-0.494	-0.499	-0.502
	(9.40)**	(8.78)**	(8.91)**	(8.26)**	(8.21)**
LECLRG	-0.068	-0.542	-0.308	-0.334	-0.342
	(2.52)*	(3.47)**	(3.41)**	(3.44)**	(3.47)**
LECMID	0.107	0.448	0.273	0.288	0.292
	(6.95)**	(5.83)**	(5.93)**	(5.70)**	(5.71)**
RURAL	-0.369	-1.910	-1.138	-1.130	-1.133
	(15.78)**	(13.46)**	(14.23)**	(13.20)**	(13.08)**
RUS	0.050	0.236	0.139	0.127	0.121
	(3.73)**	(3.47)**	(3.40)**	(2.84)**	(2.67)**
UNEOBLIG	0.136	0.536	0.328	0.293	0.291
	(9.84)**	(7.48)**	(7.68)**	(6.17)**	(6.05)**
AVGHHINC	0.000	0.000	0.000	0.000	0.000
	(7.28)**	(3.22)**	(3.40)**	(4.72)**	(4.86)**
DENSITY	-0.000	-0.000	-0.000	-0.000	-0.000
	(3.07)**	(5.46)**	(5.32)**	(4.99)**	(5.52)**
HSEHLDS	0.000	0.000	0.000	0.000	0.000
	(9.64)**	(8.33)**	(7.96)**	(3.35)**	(3.26)**
LNCOMPS	0.049	0.224	0.133	1.520	1.713
	(5.81)**	(3.90)**	(4.16)**	(3.79)**	(4.06)**
PRATIO	0.222	1.124	0.697	0.544	0.525
	(10.21)**	(9.96)**	(10.25)**	(6.35)**	(5.96)**
NFIRMS	0.000	0.000	0.000	0.000	
	(4.22)**	(0.06)	(1.24)	(1.75)	
LRGFIRMS	0.000	0.000	0.000	-0.016	-0.015
	(0.93)	(0.09)	(0.13)	(3.01)**	(2.72)**
EDUC	-0.003	-0.057	-0.031	-0.028	-0.025
	(2.33)*	(4.99)**	(4.99)**	(4.31)**	(4.15)**
FINCE	0.000	0.004	0.002	-0.000	
	(2.20)*	(1.58)	(1.46)	(0.00)	
HEALTH	-0.000	0.001	0.000	-0.001	
	(0.62)	(0.34)	(0.37)	(0.96)	
INFO	-0.000	0.022	0.010	0.006	
	(0.64)	(2.80)**	(2.45)*	(1.60)	
REALEST	0.001	0.037	0.018	0.025	0.028
	(1.79)	(8.86)**	(8.31)**	(8.23)**	(10.85)**
TCHSRV	-0.001	-0.005	-0.003	-0.005	-0.004
	(4.86)**	(4.40)**	(4.57)**	(5.58)**	(4.81)**
CAP	-0.071	-0.345	-0.208	-0.223	-0.213
	(1.85)	(1.78)	(1.74)	(1.71)	(1.61)
DEREG	0.029	0.139	0.069	0.096	0.097
	(2.20)*	(2.06)*	(1.72)	(2.15)*	(2.15)*
INDXCAP	-0.100	-0.554	-0.340	-0.381	-0.387
	(4.94)**	(5.13)**	(5.31)**	(5.41)**	(5.40)**
NONINDXCAP	0.328	3.300	1.797	1.680	1.669
	(14.15)**	(11.30)**	(13.51)**	(11.92)**	(11.82)**

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Table 4.23 (continued)

NORMATIV	0.396	1.855	1.115	1.137	1.150
	(8.32)**	(6.95)**	(7.28)**	(6.87)**	(6.88)**
PFLEX	-0.034	-0.156	-0.098	-0.092	-0.092
	(2.57)*	(2.30)*	(2.43)*	(2.09)*	(2.08)*
NONCAPNTWK	-0.519	-4.299	-2.397	-2.443	-2.456
	(15.41)**	(13.43)**	(15.50)**	(15.11)**	(15.06)**
PFLEXNTWK	0.011	-0.040	-0.004	-0.109	-0.112
	(0.44)	(0.32)	(0.06)	(1.26)	(1.29)
Constant	0.347	-0.464	-0.303	-0.307	-0.290
	(9.92)**	(2.36)*	(2.67)**	(2.51)*	(2.35)*
Observations	14528	14528	14528	14528	14610
Correct pred.	72.7%	73.7%	73.7%	71.0%	70.6%
R-squared	0.23				

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.24 - DS1 - Summary 2 (dF/dx)

	Probit	Probit IV
APPRV271	-0.251	-0.260
	(16.83)**	(15.94)**
FEDCAP	-0.192	-0.194
	(8.91)**	(8.26)**
LECLRG	-0.122	-0.132
	(3.41)**	(3.44)**
LECMID	0.108	0.113
	(5.93)**	(5.70)**
RURAL	-0.430	-0.427
	(14.23)**	(13.20)**
RUS	0.055	0.050
	(3.40)**	(2.84)**
UNEOBLIG	0.130	0.117
	(7.68)**	(6.17)**
AVGHHINC	0.000	0.000
	(3.40)**	(4.72)**
DENSITY	-0.000	-0.000
	(5.32)**	(4.99)**
HSEHLDS	0.000	0.000
	(7.96)**	(3.35)**
LNCOMPS	0.053	0.605
	(4.16)**	(3.79)**
PRATIO	0.278	0.217
	(10.25)**	(6.35)**
NFIRMS	0.000	0.000
	(1.24)	(1.75)
LRGFIRMS	0.000	-0.006
	(0.13)	(3.01)**
EDUC	-0.012	-0.011
	(4.99)**	(4.31)**
FINCE	0.001	-0.000
	(1.46)	(0.00)
HEALTH	0.000	-0.000
	(0.37)	(0.96)
INFO	0.004	0.003
	(2.45)*	(1.60)
REALEST	0.007	0.010
	(8.31)**	(8.23)**
TCHSRV	-0.001	-0.002
	(4.57)**	(5.58)**
CAP	-0.083	-0.089
	(1.74)	(1.71)
DEREG	0.028	0.038
	(1.72)	(2.15)*
INDXCAP	-0.134	-0.150
	(5.31)**	(5.41)**
NONINDXCAP	0.474	0.463
	(13.51)**	(11.92)**

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Table 4.24 (continued)

NORMATIV	0.357	0.362
	(7.28)**	(6.87)**
PFLEX	-0.039	-0.037
	(2.43)*	(2.09)*
NONCAPNTWK	-0.532	-0.532
	(15.50)**	(15.11)**
PFLEXNTWK	-0.002	-0.043
	(0.06)	(1.26)
Observations	14528	14528

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.25 - DS3 - Linear Probability Model

Source	SS	df	MS		
Model	360.289605	28	12.8674859	Number of obs	= 14528
Residual	1740.17894	14499	.120020618	F(28, 14499)	= 107.21
				Prob > F	= 0.0000
				R-squared	= 0.1715
				Adj R-squared	= 0.1699
Total	2100.46854	14527	.144590662	Root MSE	= .34644

DS3	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
APPRV271	-.0070711	.0096181	-0.74	0.462	-.0259237	.0117816
FEDCAP	-.070275	.0143478	-4.90	0.000	-.0983986	-.0421514
LECLRG	-.2896218	.0214103	-13.53	0.000	-.3315887	-.2476548
LECMID	.0060235	.0121475	0.50	0.620	-.0177872	.0298341
RURAL	-.2442387	.0184671	-13.23	0.000	-.2804366	-.2080407
RUS	.0463505	.010645	4.35	0.000	.0254848	.0672161
UNEOBLIG	.0691401	.0108974	6.34	0.000	.0477798	.0905003
AVGHHINC	3.94e-06	2.56e-07	15.35	0.000	3.43e-06	4.44e-06
DENSITY	1.60e-06	1.37e-06	1.17	0.242	-1.08e-06	4.28e-06
HSEHLDS	7.63e-06	7.04e-07	10.84	0.000	6.25e-06	9.01e-06
LNCOMPS	.0116205	.0066027	1.76	0.078	-.0013216	.0245627
PRATIO	.0283343	.0171852	1.65	0.099	-.0053508	.0620194
NFIRMS	-.0000166	.0000248	-0.67	0.503	-.0000653	.000032
LRGFIRMS	.0036879	.000416	8.86	0.000	.0028725	.0045033
EDUC	.0026803	.001091	2.46	0.014	.0005419	.0048187
FINCE	-.0000819	.000171	-0.48	0.632	-.000417	.0002533
HEALTH	-.0001031	.000127	-0.81	0.417	-.000352	.0001458
INFO	.0009282	.0003271	2.84	0.005	.0002871	.0015693
REALEST	-.000565	.0002673	-2.11	0.035	-.001089	-.0000411
TCHSRV	-.0001442	.0001001	-1.44	0.150	-.0003404	.0000521
CAP	-.1151457	.0304345	-3.78	0.000	-.1748011	-.0554902
DEREG	-.0280783	.0104454	-2.69	0.007	-.0485527	-.0076039
INDXCAP	-.0813557	.0160656	-5.06	0.000	-.1128463	-.0498652
NONINDXCAP	.1428941	.0183111	7.80	0.000	.1070021	.1787862
NORMATIV	.2532622	.0376056	6.73	0.000	.1795504	.3269739
PFLEX	-.0138946	.0104101	-1.33	0.182	-.0342997	.0065104
NONCAPNTWK	-.2194348	.0266108	-8.25	0.000	-.2715953	-.1672743
PFLEXNTWK	-.1476964	.0189969	-7.77	0.000	-.1849327	-.1104601
_cons	.233126	.0275895	8.45	0.000	.1790471	.2872049

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

       F(  6, 14499) =    3.06
            Prob > F =    0.0055
```

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Table 4.26 - DS3 - Logit

Logit estimates

Number of obs	= 14528
LR chi2(28)	= 2265.94
Prob > chi2	= 0.0000
Pseudo R2	= 0.1680

Log likelihood = -5611.1762

DS3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	.0107604	.081028	0.13	0.894	-.1480516	.1695724
FEDCAP	-.6947885	.1220548	-5.69	0.000	-.9340115	-.4555655
LECLRG	-2.382977	.17861	-13.34	0.000	-2.733046	-2.032908
LECMID	-.0329947	.0992697	-0.33	0.740	-.2275597	.1615703
RURAL	-1.975476	.1585139	-12.46	0.000	-2.286157	-1.664794
RUS	.4392675	.0863538	5.09	0.000	.2700172	.6085178
UNEOBLIG	.7029975	.1040975	6.75	0.000	.49897	.9070249
AVGHHINC	.0000281	1.90e-06	14.78	0.000	.0000244	.0000318
DENSITY	.00001	9.77e-06	1.02	0.305	-9.14e-06	.0000292
HSEHLDS	.0000452	5.07e-06	8.92	0.000	.0000353	.0000551
LNCOMPS	.1038501	.0456661	2.27	0.023	.0143462	.193354
PRATIO	.2545076	.1456014	1.75	0.080	-.0308659	.539881
NFIRMS	.0001075	.0001829	0.59	0.556	-.0002509	.0004659
LRGFIRMS	.0206189	.0030199	6.83	0.000	.0147	.0265378
EDUC	.009283	.0078283	1.19	0.236	-.0060602	.0246262
FINCE	-.0007949	.0012368	-0.64	0.520	-.003219	.0016292
HEALTH	-.0011735	.0009523	-1.23	0.218	-.00304	.000693
INFO	.0088249	.0031448	2.81	0.005	.0026611	.0149886
REALEST	-.0028549	.0019341	-1.48	0.140	-.0066456	.0009359
TCHSRV	-.0018003	.0007219	-2.49	0.013	-.0032153	-.0003853
CAP	-1.431209	.414546	-3.45	0.001	-2.243705	-.6187141
DEREG	-.1900258	.0874892	-2.17	0.030	-.3615014	-.0185501
INDXCAP	-.6979878	.1520474	-4.59	0.000	-.9959953	-.3999804
NONINDXCAP	.8503525	.1293722	6.57	0.000	.5967876	1.103917
NORMATIV	1.349362	.2355155	5.73	0.000	.88776	1.810964
PFLEX	-.1197819	.0883321	-1.36	0.175	-.2929097	.0533459
NONCAPNTWK	-1.804271	.3007526	-6.00	0.000	-2.393735	-1.214806
PFLEXNTWK	-1.748909	.262953	-6.65	0.000	-2.264287	-1.23353
_cons	-1.06988	.2287867	-4.68	0.000	-1.518293	-.6214661

```
. test  EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   18.58
         Prob > chi2 =    0.0049
```

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Table 4.27 - DS3 - Probit

Probit estimates — Number of obs = 14528
LR chi2(28) = 2288.10
Prob > chi2 = 0.0000
Log likelihood = -5600.0932 — Pseudo R2 = 0.1696

DS3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.0240223	.0451518	-0.53	0.595	-.1125181	.0644736
FEDCAP	-.4215502	.0669748	-6.29	0.000	-.5528183	-.290282
LECLRG	-1.30393	.1023016	-12.75	0.000	-1.504437	-1.103423
LECMID	-.0136269	.0547716	-0.25	0.804	-.1209772	.0937234
RURAL	-1.091244	.0911246	-11.98	0.000	-1.269845	-.9126434
RUS	.2215462	.0472681	4.69	0.000	.1289024	.3141901
UNEOBLIG	.3971679	.0567545	7.00	0.000	.2859311	.5084046
AVGHHINC	.0000161	1.07e-06	14.95	0.000	.0000139	.0000182
DENSITY	7.20e-06	5.78e-06	1.25	0.213	-4.13e-06	.0000185
HSEHLDS	.0000261	2.91e-06	8.98	0.000	.0000204	.0000318
LNCOMPS	.0583527	.0264305	2.21	0.027	.0065498	.1101555
PRATIO	.1396225	.0818064	1.71	0.088	-.0207152	.2999601
NFIRMS	.0000413	.0001043	0.40	0.692	-.0001632	.0002458
LRGFIRMS	.0122704	.0017354	7.07	0.000	.0088691	.0156716
EDUC	.0060399	.0044736	1.35	0.177	-.0027282	.014808
FINCE	-.0004232	.0007208	-0.59	0.557	-.0018359	.0009894
HEALTH	-.0006158	.0005468	-1.13	0.260	-.0016874	.0004558
INFO	.0047259	.0016042	2.95	0.003	.0015818	.00787
REALEST	-.001648	.0011403	-1.45	0.148	-.0038829	.000587
TCHSRV	-.0010029	.0004113	-2.44	0.015	-.0018091	-.0001967
CAP	-.6816592	.1913532	-3.56	0.000	-1.056704	-.3066139
DEREG	-.117931	.0477056	-2.47	0.013	-.2114323	-.0244297
INDXCAP	-.4076116	.0812582	-5.02	0.000	-.5668747	-.2483486
NONINDXCAP	.4771718	.0744355	6.41	0.000	.3312809	.6230626
NORMATIV	.7983244	.1384741	5.77	0.000	.5269202	1.069729
PFLEX	-.0690065	.0478375	-1.44	0.149	-.1627662	.0247532
NONCAPNTWK	-.9850778	.1499917	-6.57	0.000	-1.279056	-.6910995
PFLEXNTWK	-.8337099	.1225867	-6.80	0.000	-1.073975	-.5934444
_cons	-.6594766	.1295082	-5.09	0.000	-.9133079	-.4056453

note: 0 failures and 1 success completely determined.

```
. test  EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   18.19
         Prob > chi2 =    0.0058
```

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Table 4.28 - DS3 - Probit IV

```
ivprob  DS3, endog(LNCOMPS) iv( LEMPLYEES) exog(APPRV271 FEDCAP LECLRG LECMID
RURAL RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS  EDUC FINCE
HEALTH INFO REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX
NONCAPNTWK PFLEXNTWK)
(6227 real changes made)
```

DS3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	4.143052	.6365345	6.51	0.000	2.895467	5.390637
APPRV271	-.1124351	.0684993	-1.64	0.101	-.2466912	.021821
FEDCAP	-.4449285	.1004118	-4.43	0.000	-.6417321	-.248125
LECLRG	-1.402857	.1517302	-9.25	0.000	-1.700243	-1.105472
LECMID	.0234707	.0837442	0.28	0.779	-.1406649	.1876064
RURAL	-1.079436	.132325	-8.16	0.000	-1.338789	-.8200843
RUS	.1850168	.0730966	2.53	0.011	.0417502	.3282835
UNEOBLIG	.2797089	.0824415	3.39	0.001	.1181264	.4412913
AVGHHINC	.0000305	2.80e-06	10.91	0.000	.000025	.000036
DENSITY	-.0002324	.0000383	-6.06	0.000	-.0003076	-.0001573
HSEHLDS	-.0000124	7.58e-06	-1.63	0.102	-.0000273	2.47e-06
PRATIO	-.297445	.1391882	-2.14	0.033	-.570249	-.0246411
NFIRMS	.0005509	.0001804	3.05	0.002	.0001973	.0009044
LRGFIRMS	-.0374873	.0081646	-4.59	0.000	-.0534897	-.021485
EDUC	.0104654	.0072041	1.45	0.146	-.0036545	.0245852
FINCE	-.0051728	.0013581	-3.81	0.000	-.0078346	-.002511
HEALTH	-.0040781	.0010051	-4.06	0.000	-.006048	-.0021082
INFO	-.0021499	.0025281	-0.85	0.395	-.0071048	.002805
REALEST	.0207364	.0039452	5.26	0.000	.013004	.0284688
TCHSRV	-.0070495	.0011404	-6.18	0.000	-.0092845	-.0048144
CAP	-.7276658	.2484251	-2.93	0.003	-1.21457	-.2407616
DEREG	-.037426	.0732877	-0.51	0.610	-.1810672	.1062152
INDXCAP	-.5284465	.1180483	-4.48	0.000	-.7598169	-.2970761
NONINDXCAP	.1298946	.1321739	0.98	0.326	-.1291616	.3889508
NORMATIV	.8670714	.2388006	3.63	0.000	.3990309	1.335112
PFLEX	-.051471	.0722595	-0.71	0.476	-.1930971	.0901551
NONCAPNTWK	-1.135071	.2060519	-5.51	0.000	-1.538925	-.7312171
PFLEXNTWK	-1.149739	.1646782	-6.98	0.000	-1.472503	-.8269759
_cons	-.7000176	.1930401	-3.63	0.000	-1.078369	-.3216659

```
. test  EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   45.75
         Prob > chi2 =    0.0000
```

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Table 4.29 - DS3 - Probit IV

Reduced number of variables

```
ivprob   DS3, endog(LNCOMPS) iv( LEMPLYEES) exog(APPRV271 FEDCAP LECLRG  RURAL
RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS FINCE HEALTH
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)
(1971 real changes made)
```

DS3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	5.777245	.9113947	6.34	0.000	3.990944	7.563546
APPRV271	-.1633345	.072751	-2.25	0.025	-.3059239	-.0207452
FEDCAP	-.4591836	.0897852	-5.11	0.000	-.6351594	-.2832079
LECLRG	-1.561626	.1296568	-12.04	0.000	-1.815749	-1.307503
RURAL	-1.275465	.1315713	-9.69	0.000	-1.53334	-1.01759
RUS	.1936388	.0686172	2.82	0.005	.0591517	.328126
UNEOBLIG	.2212144	.0795368	2.78	0.005	.0653252	.3771036
AVGHHINC	.0000345	3.37e-06	10.25	0.000	.0000279	.0000411
DENSITY	-.000328	.0000546	-6.01	0.000	-.000435	-.0002211
HSEHLDS	-.0000248	9.63e-06	-2.58	0.010	-.0000437	-5.98e-06
PRATIO	-.4401837	.147055	-2.99	0.003	-.7284062	-.1519612
NFIRMS	.0007599	.0002085	3.64	0.000	.0003512	.0011686
LRGFIRMS	-.0587315	.0116921	-5.02	0.000	-.0816475	-.0358155
FINCE	-.0066368	.0015869	-4.18	0.000	-.0097471	-.0035265
HEALTH	-.0050532	.0011843	-4.27	0.000	-.0073744	-.0027319
REALEST	.0288517	.0051974	5.55	0.000	.018665	.0390384
TCHSRV	-.009585	.0015836	-6.05	0.000	-.0126888	-.0064811
CAP	-.7637001	.2608598	-2.93	0.003	-1.274976	-.2524244
DEREG	-.0706089	.0708114	-1.00	0.319	-.2093968	.0681789
INDXCAP	-.5517556	.1217615	-4.53	0.000	-.7904038	-.3131075
NONINDXCAP	.0337933	.1457805	0.23	0.817	-.2519312	.3195178
NORMATIV	1.062188	.2430198	4.37	0.000	.5858781	1.538498
PFLEX	-.0358939	.070571	-0.51	0.611	-.1742106	.1024228
NONCAPNTWK	-1.220995	.2239766	-5.45	0.000	-1.659981	-.7820088
PFLEXNTWK	-1.233154	.1776315	-6.94	0.000	-1.581306	-.8850031
_cons	-.4990179	.1848044	-2.70	0.007	-.8612278	-.1368079

```
. test   FINCE HEALTH  REALEST TCHSRV

 ( 1)  FINCE = 0.0
 ( 2)  HEALTH = 0.0
 ( 3)  REALEST = 0.0
 ( 4)  TCHSRV = 0.0

           chi2(  4) =   41.29
         Prob > chi2 =    0.0000
```

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Table 4.30 - DS3 - Probit (dF/dx)

```
dprobit  DS3 APPRV271 FEDCAP LECLRG LECMID RURAL RUS UNEOBLIG AVGHHINC DENSITY
HSEHLDS LNCOMPS PRATIO NFIRMS LRGFIRMS  EDUC FINCE HEALTH INFO REALEST TCHSRV
CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK
```

Probit estimates — Number of obs = 14528; LR chi2(28) = 2288.10; Prob > chi2 = 0.0000; Log likelihood = -5600.0932; Pseudo R2 = 0.1696

DS3	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
APPRV271*	-.0053356	.0099319	-0.53	0.595	.130162	-.024802	.014131
FEDCAP*	-.1052406	.0183079	-6.29	0.000	.750619	-.141124	-.069358
LECLRG*	-.3355137	.0286388	-12.75	0.000	.615226	-.391645	-.279383
LECMID*	-.0030426	.0121756	-0.25	0.804	.204433	-.026906	.020821
RURAL*	-.2150201	.016082	-11.98	0.000	.380162	-.24654	-.1835
RUS*	.0538299	.0123523	4.69	0.000	.149986	.02962	.07804
UNEOBLIG*	.0812491	.0104854	7.00	0.000	.712211	.060698	.1018
AVGHHINC	3.60e-06	2.40e-07	14.95	0.000	34086.3	3.1e-06	4.1e-06
DENSITY	1.62e-06	1.30e-06	1.25	0.213	758.198	-9.3e-07	4.2e-06
HSEHLDS	5.85e-06	6.52e-07	8.98	0.000	5784.11	4.6e-06	7.1e-06
LNCOMPS	.0130854	.0059214	2.21	0.027	.209153	.00148	.024691
PRATIO	.0313098	.0183394	1.71	0.088	.776367	-.004635	.067254
NFIRMS	9.25e-06	.0000234	0.40	0.692	417.247	-.000037	.000055
LRGFIRMS	.0027516	.0003909	7.07	0.000	9.81701	.001985	.003518
EDUC	.0013544	.0010033	1.35	0.177	3.98764	-.000612	.003321
FINCE	-.0000949	.0001616	-0.59	0.557	24.1928	-.000412	.000222
HEALTH	-.0001381	.0001226	-1.13	0.260	39.5493	-.000378	.000102
INFO	.0010598	.0003604	2.95	0.003	7.052	.000353	.001766
REALEST	-.0003695	.0002556	-1.45	0.148	17.6652	-.00087	.000131
TCHSRV	-.0002249	.0000922	-2.44	0.015	40.8547	-.000406	-.000044
CAP*	-.1028895	.0168282	-3.56	0.000	.010187	-.135872	-.069907
DEREG*	-.0258506	.0102167	-2.47	0.013	.321104	-.045875	-.005826
INDXCAP*	-.0742761	.0115785	-5.02	0.000	.054447	-.096969	-.051583
NONIND~P*	.1311107	.02402	6.41	0.000	.054309	.084032	.178189
NORMATIV*	.2492587	.0529503	5.77	0.000	.00647	.145478	.353039
PFLEX*	-.0154035	.0106275	-1.44	0.149	.437706	-.036233	.005426
NONCAP~K*	-.1249192	.0081236	-6.57	0.000	.017965	-.140841	-.108997
PFLEXN~K*	-.1167275	.0088218	-6.80	0.000	.025606	-.134018	-.099437
obs. P	.1753166						
pred. P	.1415502	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

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Table 4.31 - DS3 - Probit IV (dF/dx)

```
divprob  DS3, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP LECLRG LECMID
RURAL RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS  EDUC FINCE
HEALTH INFO REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX
NONCAPNTWK PFLEXNTWK)

Probit estimates                                  Number of obs =  14528
                                                   chi2(28)     =2373.76
                                                  Prob > chi2   = 0.0000
Log likelihood = -5557.2636                       Pseudo R2     = 0.1760

------------------------------------------------------------------------------
         DS3 |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
-------------+----------------------------------------------------------------
    LNCOMPS  |    .912089   .1399115     6.51   0.000   .209153   .637867  1.18631
  APPRV271*  |  -.0236383   .0137271    -1.64   0.101   .130162  -.050543  .003266
    FEDCAP*  |  -.1098873    .027423    -4.43   0.000   .750619  -.163635 -.056139
    LECLRG*  |  -.3585471   .0425499    -9.25   0.000   .615226  -.441943 -.275151
    LECMID*  |   .0052062   .0187161     0.28   0.779   .204433  -.031477  .041889
     RURAL*  |  -.2089861   .0232027    -8.16   0.000   .380162  -.254463  -.16351
       RUS*  |   .0436231   .0183867     2.53   0.011   .149986   .007586   .07966
  UNEOBLIG*  |   .0576766   .0158967     3.39   0.001   .712211    .02652  .088834
  AVGHHINC   |   6.72e-06   6.18e-07    10.91   0.000   34086.3   5.5e-06  7.9e-06
    DENSITY  |  -.0000512   8.42e-06    -6.06   0.000   758.198  -.000068 -.000035
    HSEHLDS  |  -2.73e-06   1.67e-06    -1.63   0.102   5784.11  -6.0e-06  5.4e-07
    PRATIO   |  -.0654822   .0306346    -2.14   0.033   .776367  -.125525  -.00544
    NFIRMS   |   .0001213   .0000397     3.05   0.002   417.247   .000044  .000199
  LRGFIRMS   |  -.0082528   .0017927    -4.59   0.000   9.81701  -.011766 -.004739
       EDUC  |   .0023039   .0015864     1.45   0.146   3.98764  -.000805  .005413
      FINCE  |  -.0011388    .000299    -3.81   0.000   24.1928  -.001725 -.000553
    HEALTH   |  -.0008978   .0002213    -4.06   0.000   39.5493  -.001331 -.000464
       INFO  |  -.0004733   .0005562    -0.85   0.395     7.052  -.001563  .000617
    REALEST  |   .0045651   .0008679     5.26   0.000   17.6652   .002864  .006266
    TCHSRV   |  -.0015519   .0002508    -6.18   0.000   40.8547  -.002044  -.00106
       CAP*  |  -.1043064   .0197255    -2.93   0.003   .010187  -.142968 -.065645
     DEREG*  |  -.0081793   .0159012    -0.51   0.610   .321104  -.039345  .022987
    INDXCAP* |  -.0882906   .0141292    -4.48   0.000   .054447  -.115983 -.060598
  NONINDXCAP*|   .03041    .0328135     0.98   0.326   .054309  -.033903  .094723
  NORMATIV*  |   .2729171   .0925481     3.63   0.000    .00647   .091526  .454308
     PFLEX*  |  -.0112919   .0157982    -0.71   0.476   .437706  -.042256  .019672
  NONCAPNTWK*|-.1285791   .0086642    -5.51   0.000   .017965  -.145561 -.111598
  PFLEXNTWK* | -.1308211   .0073669    -6.98   0.000   .025606   -.14526 -.116382
-------------+----------------------------------------------------------------
    obs. P   |   .1753166
   pred. P   |   .1377633  (at x-bar)
------------------------------------------------------------------------------
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0
```

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Table 4.32 - DS3 - Summary 1

	LPM	Logit	Probit	Probit IV	Probit IV
APPRV271	-0.007	0.011	-0.024	-0.112	-0.163
	(0.74)	(0.13)	(0.53)	(1.64)	(2.25)*
FEDCAP	-0.070	-0.695	-0.422	-0.445	-0.459
	(4.90)**	(5.69)**	(6.29)**	(4.43)**	(5.11)**
LECLRG	-0.290	-2.383	-1.304	-1.403	-1.562
	(13.53)**	(13.34)**	(12.75)**	(9.25)**	(12.04)**
LECMID	0.006	-0.033	-0.014	0.023	
	(0.50)	(0.33)	(0.25)	(0.28)	
RURAL	-0.244	-1.975	-1.091	-1.079	-1.275
	(13.23)**	(12.46)**	(11.98)**	(8.16)**	(9.69)**
RUS	0.046	0.439	0.222	0.185	0.194
	(4.35)**	(5.09)**	(4.69)**	(2.53)*	(2.82)**
UNEOBLIG	0.069	0.703	0.397	0.280	0.221
	(6.34)**	(6.75)**	(7.00)**	(3.39)**	(2.78)**
AVGHHINC	0.000	0.000	0.000	0.000	0.000
	(15.35)**	(14.78)**	(14.95)**	(10.91)**	(10.25)**
DENSITY	0.000	0.000	0.000	-0.000	-0.000
	(1.17)	(1.02)	(1.25)	(6.06)**	(6.01)**
HSEHLDS	0.000	0.000	0.000	-0.000	-0.000
	(10.84)**	(8.92)**	(8.98)**	(1.63)	(2.58)**
LNCOMPS	0.012	0.104	0.058	4.143	5.777
	(1.76)	(2.27)*	(2.21)*	(6.51)**	(6.34)**
PRATIO	0.028	0.255	0.140	-0.297	-0.440
	(1.65)	(1.75)	(1.71)	(2.14)*	(2.99)**
NFIRMS	-0.000	0.000	0.000	0.001	0.001
	(0.67)	(0.59)	(0.40)	(3.05)**	(3.64)**
LRGFIRMS	0.004	0.021	0.012	-0.037	-0.059
	(8.86)**	(6.83)**	(7.07)**	(4.59)**	(5.02)**
EDUC	0.003	0.009	0.006	0.010	
	(2.46)*	(1.19)	(1.35)	(1.45)	
FINCE	-0.000	-0.001	-0.000	-0.005	-0.007
	(0.48)	(0.64)	(0.59)	(3.81)**	(4.18)**
HEALTH	-0.000	-0.001	-0.001	-0.004	-0.005
	(0.81)	(1.23)	(1.13)	(4.06)**	(4.27)**
INFO	0.001	0.009	0.005	-0.002	
	(2.84)**	(2.81)**	(2.95)**	(0.85)	
REALEST	-0.001	-0.003	-0.002	0.021	0.029
	(2.11)*	(1.48)	(1.45)	(5.26)**	(5.55)**
TCHSRV	-0.000	-0.002	-0.001	-0.007	-0.010
	(1.44)	(2.49)*	(2.44)*	(6.18)**	(6.05)**
CAP	-0.115	-1.431	-0.682	-0.728	-0.764
	(3.78)**	(3.45)**	(3.56)**	(2.93)**	(2.93)**
DEREG	-0.028	-0.190	-0.118	-0.037	-0.071
	(2.69)**	(2.17)*	(2.47)*	(0.51)	(1.00)
INDXCAP	-0.081	-0.698	-0.408	-0.528	-0.552
	(5.06)**	(4.59)**	(5.02)**	(4.48)**	(4.53)**
NONINDXCAP	0.143	0.850	0.477	0.130	0.034
	(7.80)**	(6.57)**	(6.41)**	(0.98)	(0.23)

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Table 4.32 (continued)

NORMATIV	0.253	1.349	0.798	0.867	1.062
	(6.73)**	(5.73)**	(5.77)**	(3.63)**	(4.37)**
PFLEX	-0.014	-0.120	-0.069	-0.051	-0.036
	(1.33)	(1.36)	(1.44)	(0.71)	(0.51)
NONCAPNTWK	-0.219	-1.804	-0.985	-1.135	-1.221
	(8.25)**	(6.00)**	(6.57)**	(5.51)**	(5.45)**
PFLEXNTWK	-0.148	-1.749	-0.834	-1.150	-1.233
	(7.77)**	(6.65)**	(6.80)**	(6.98)**	(6.94)**
Constant	0.233	-1.070	-0.659	-0.700	-0.499
	(8.45)**	(4.68)**	(5.09)**	(3.63)**	(2.70)**
Observations	14528	14528	14528	14528	18784
Prediction	83.6%	83.7%	83.6%	78.2%	80.5%
R-squared	0.17				

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.33 - DS3 - Summary 2 (dF/dx)

	Probit	Probit IV
APPRV271	-0.005	-0.024
	(0.53)	(1.64)
FEDCAP	-0.105	-0.110
	(6.29)**	(4.43)**
LECLRG	-0.336	-0.359
	(12.75)**	(9.25)**
LECMID	-0.003	0.005
	(0.25)	(0.28)
RURAL	-0.215	-0.209
	(11.98)**	(8.16)**
RUS	0.054	0.044
	(4.69)**	(2.53)*
UNEOBLIG	0.081	0.058
	(7.00)**	(3.39)**
AVGHHINC	0.000	0.000
	(14.95)**	(10.91)**
DENSITY	0.000	-0.000
	(1.25)	(6.06)**
HSEHLDS	0.000	-0.000
	(8.98)**	(1.63)
LNCOMPS	0.013	0.912
	(2.21)*	(6.51)**
PRATIO	0.031	-0.065
	(1.71)	(2.14)*
NFIRMS	0.000	0.000
	(0.40)	(3.05)**
LRGFIRMS	0.003	-0.008
	(7.07)**	(4.59)**
EDUC	0.001	0.002
	(1.35)	(1.45)
FINCE	-0.000	-0.001
	(0.59)	(3.81)**
HEALTH	-0.000	-0.001
	(1.13)	(4.06)**
INFO	0.001	-0.000
	(2.95)**	(0.85)
REALEST	-0.000	0.005
	(1.45)	(5.26)**
TCHSRV	-0.000	-0.002
	(2.44)*	(6.18)**
CAP	-0.103	-0.104
	(3.56)**	(2.93)**
DEREG	-0.026	-0.008
	(2.47)*	(0.51)
INDXCAP	-0.074	-0.088
	(5.02)**	(4.48)**
NONINDXCAP	0.131	0.030
	(6.41)**	(0.98)

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Table 4.333 (continued)

NORMATIV	0.249	0.273
	(5.77)**	(3.63)**
PFLEX	-0.015	-0.011
	(1.44)	(0.71)
NONCAPNTWK	-0.125	-0.129
	(6.57)**	(5.51)**
PFLEXNTWK	-0.117	-0.131
	(6.80)**	(6.98)**
Observations	14528	14528

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.34 - OC - Linear Probability Model

Source	SS	df	MS		
Model	177.320083	28	6.3328601	Number of obs	= 14528
Residual	854.6444	14499	.058945058	F(28, 14499)	= 107.44
				Prob > F	= 0.0000
Total	1031.96448	14527	.071037687	R-squared	= 0.1718
				Adj R-squared	= 0.1702
				Root MSE	= .24279

OC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
APPRV271	-.0585573	.0067404	-8.69	0.000	-.0717693	-.0453453
FEDCAP	-.0117583	.010055	-1.17	0.242	-.0314674	.0079508
LECLRG	.0222163	.0150044	1.48	0.139	-.0071943	.0516268
LECMID	-.0246202	.008513	-2.89	0.004	-.0413067	-.0079336
RURAL	-.0162381	.0129418	-1.25	0.210	-.0416057	.0091296
RUS	.0128154	.0074601	1.72	0.086	-.0018073	.0274381
UNEOBLIG	.001679	.0076369	0.22	0.826	-.0132903	.0166483
AVGHHINC	3.63e-06	1.80e-07	20.23	0.000	3.28e-06	3.99e-06
DENSITY	-1.50e-06	9.58e-07	-1.56	0.118	-3.38e-06	3.80e-07
HSEHLDS	5.36e-06	4.93e-07	10.86	0.000	4.39e-06	6.32e-06
LNCOMPS	.008366	.0046272	1.81	0.071	-.0007038	.0174359
PRATIO	.069303	.0120434	5.75	0.000	.0456964	.0929096
NFIRMS	-.0000454	.0000174	-2.61	0.009	-.0000795	-.0000112
LRGFIRMS	.001989	.0002915	6.82	0.000	.0014176	.0025605
EDUC	.0021506	.0007645	2.81	0.005	.000652	.0036492
FINCE	-.0003029	.0001198	-2.53	0.011	-.0005378	-.000068
HEALTH	.0002294	.000089	2.58	0.010	.000055	.0004038
INFO	.0013129	.0002292	5.73	0.000	.0008636	.0017622
REALEST	-.0004136	.0001873	-2.21	0.027	-.0007808	-.0000464
TCHSRV	-.0001037	.0000702	-1.48	0.140	-.0002412	.0000339
CAP	-.0840916	.0213286	-3.94	0.000	-.1258983	-.0422849
DEREG	.0620752	.0073202	8.48	0.000	.0477266	.0764237
INDXCAP	-.0229555	.0112588	-2.04	0.041	-.0450242	-.0008869
NONINDXCAP	.0407715	.0128325	3.18	0.001	.0156182	.0659248
NORMATIV	.0304184	.0263541	1.15	0.248	-.021239	.0820758
PFLEX	-.0220383	.0072954	-3.02	0.003	-.0363382	-.0077385
NONCAPNTWK	-.092844	.0186489	-4.98	0.000	-.1293982	-.0562897
PFLEXNTWK	-.043046	.0133131	-3.23	0.001	-.0691412	-.0169507
_cons	-.1379302	.0193348	-7.13	0.000	-.1758288	-.1000316

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

       F(  6, 14499) =   10.65
            Prob > F =    0.0000
```

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Table 4.35 - OC - Logit

Logit estimates

Number of obs	= 14119
LR chi2(26)	= 2097.36
Prob > chi2	= 0.0000
Pseudo R2	= 0.2684

Log likelihood = -2859.0652

OC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.6064439	.1272874	-4.76	0.000	-.8559227	-.356965
FEDCAP	-3.127672	.8582645	-3.64	0.000	-4.809839	-1.445504
LECLRG	1.764637	.8487916	2.08	0.038	.101036	3.428238
LECMID	-4.183449	1.040268	-4.02	0.000	-6.222337	-2.144561
RURAL	-1.813657	.4540468	-3.99	0.000	-2.703573	-.9237421
RUS	.4710907	.1739326	2.71	0.007	.1301892	.8119923
UNEOBLIG	.1798864	.2574779	0.70	0.485	-.324761	.6845339
AVGHHINC	.0000377	2.28e-06	16.56	0.000	.0000333	.0000422
DENSITY	-5.30e-06	.0000114	-0.47	0.641	-.0000276	.000017
HSEHLDS	.0000438	5.42e-06	8.07	0.000	.0000332	.0000544
LNCOMPS	.1642229	.0543927	3.02	0.003	.0576151	.2708306
PRATIO	1.434268	.209026	6.86	0.000	1.024584	1.843951
NFIRMS	-.0000259	.0001914	-0.14	0.893	-.0004011	.0003494
LRGFIRMS	.0159473	.0032424	4.92	0.000	.0095924	.0223023
EDUC	.01167	.0083129	1.40	0.160	-.0046229	.027963
FINCE	-.0006947	.0012458	-0.56	0.577	-.0031363	.001747
HEALTH	.0004717	.0009654	0.49	0.625	-.0014205	.0023639
INFO	.0043056	.0025347	1.70	0.089	-.0006623	.0092735
REALEST	-.0039471	.0019948	-1.98	0.048	-.0078567	-.0000374
TCHSRV	-.0019816	.0007512	-2.64	0.008	-.003454	-.0005092
DEREG	.8693013	.161179	5.39	0.000	.5533963	1.185206
INDXCAP	-.8525642	.3118062	-2.73	0.006	-1.463693	-.2414354
NONINDXCAP	.7323033	.2120817	3.45	0.001	.3166309	1.147976
NORMATIV	4.16334	1.134135	3.67	0.000	1.940476	6.386204
PFLEX	-.3752718	.175076	-2.14	0.032	-.7184144	-.0321292
PFLEXNTWK	-.2835332	.2494346	-1.14	0.256	-.772416	.2053496
_cons	-4.34241	.5041986	-8.61	0.000	-5.330621	-3.354199

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   17.21
         Prob > chi2 =    0.0085
```

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Table 4.36 - OC - Probit

Probit estimates — Number of obs = 14119
LR chi2(26) = 2114.68
Prob > chi2 = 0.0000
Log likelihood = -2850.404 — Pseudo R2 = 0.2706

OC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.3182634	.062144	-5.12	0.000	-.4400634	-.1964634
FEDCAP	-1.605866	.4369136	-3.68	0.000	-2.462201	-.749531
LECLRG	.7887865	.4477678	1.76	0.078	-.0888224	1.666395
LECMID	-1.873689	.5052759	-3.71	0.000	-2.864011	-.8833662
RURAL	-.8767052	.2404543	-3.65	0.000	-1.347987	-.4054234
RUS	.1391439	.0777	1.79	0.073	-.0131452	.2914331
UNEOBLIG	.0843072	.1258697	0.67	0.503	-.162393	.3310073
AVGHHINC	.0000211	1.23e-06	17.08	0.000	.0000186	.0000235
DENSITY	-6.11e-06	6.28e-06	-0.97	0.331	-.0000184	6.20e-06
HSEHLDS	.0000253	3.05e-06	8.30	0.000	.0000193	.0000313
LNCOMPS	.0994238	.0298149	3.33	0.001	.0409876	.1578599
PRATIO	.7051328	.1116797	6.31	0.000	.4862447	.9240209
NFIRMS	-.0000151	.000109	-0.14	0.889	-.0002288	.0001985
LRGFIRMS	.008868	.0017799	4.98	0.000	.0053795	.0123565
EDUC	.0063083	.0046312	1.36	0.173	-.0027687	.0153852
FINCE	-.0005758	.0007029	-0.82	0.413	-.0019536	.0008019
HEALTH	.0003255	.0005397	0.60	0.546	-.0007324	.0013834
INFO	.0022451	.0013926	1.61	0.107	-.0004843	.0049744
REALEST	-.0020834	.0011405	-1.83	0.068	-.0043188	.0001521
TCHSRV	-.0009915	.000415	-2.39	0.017	-.0018048	-.0001782
DEREG	.457279	.0780567	5.86	0.000	.3042907	.6102673
INDXCAP	-.3524045	.1427783	-2.47	0.014	-.6322449	-.0725642
NONINDXCAP	.4049349	.109082	3.71	0.000	.1911382	.6187316
NORMATIV	1.928434	.5426596	3.55	0.000	.8648409	2.992028
PFLEX	-.1466225	.0827984	-1.77	0.077	-.3089044	.0156593
PFLEXNTWK	-.2052053	.1247482	-1.64	0.100	-.4497072	.0392967
_cons	-2.339341	.2670936	-8.76	0.000	-2.862835	-1.815848

note: 29 failures and 0 successes completely determined.

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   16.12
         Prob > chi2 =    0.0131
```

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Table 4.37 - OC - Probit IV

```
. ivprob  OC, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP LECLRG LECMID
RURAL RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS  EDUC  FINCE
HEALTH INFO REAL EST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX
NONCAPNTWK PFLEXNTWK)
(6636 real changes made)
```

OC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	5.394663	.9347112	5.77	0.000	3.562663	7.226664
APPRV271	-.4291072	.0929854	-4.61	0.000	-.6113552	-.2468591
FEDCAP	-1.557308	.4478276	-3.48	0.001	-2.435034	-.6795824
LECLRG	.6576608	.4714545	1.39	0.163	-.2663731	1.581695
LECMID	-1.843539	.5056998	-3.65	0.000	-2.834692	-.8523854
RURAL	-.8151903	.2750946	-2.96	0.003	-1.354366	-.2760148
RUS	.1163572	.1080449	1.08	0.282	-.095407	.3281214
UNEOBLIG	-.121141	.151053	-0.80	0.423	-.4171994	.1749174
AVGHHINC	.0000406	3.98e-06	10.20	0.000	.0000328	.0000484
DENSITY	-.0003157	.0000558	-5.66	0.000	-.000425	-.0002063
HSEHLDS	-.000024	.0000104	-2.30	0.021	-.0000444	-3.55e-06
PRATIO	.1412651	.1921724	0.74	0.462	-.2353859	.5179162
NFIRMS	.0007689	.0002413	3.19	0.001	.0002961	.0012418
LRGFIRMS	-.0552065	.0117923	-4.68	0.000	-.0783189	-.0320941
EDUC	.00729	.0088926	0.82	0.412	-.0101393	.0247192
FINCE	-.0066947	.001756	-3.81	0.000	-.0101364	-.003253
HEALTH	-.0040342	.0012877	-3.13	0.002	-.0065579	-.0015104
INFO	-.0057393	.0030052	-1.91	0.056	-.0116294	.0001508
REALEST	.0266914	.0055504	4.81	0.000	.0158127	.03757
TCHSRV	-.0093045	.0016407	-5.67	0.000	-.0125203	-.0060888
DEREG	.5658457	.1085061	5.21	0.000	.3531776	.7785138
INDXCAP	-.4933217	.182816	-2.70	0.007	-.8516345	-.1350089
NONINDXCAP	-.0365361	.1850652	-0.20	0.843	-.3992573	.3261851
NORMATIV	2.008259	.5962533	3.37	0.001	.8396238	3.176894
PFLEX	-.1301635	.1103256	-1.18	0.238	-.3463977	.0860708
PFLEXNTWK	-.5985557	.1941388	-3.08	0.002	-.9790607	-.2180508
_cons	-2.507381	.3314534	-7.56	0.000	-3.157017	-1.857744

```
. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   36.18
         Prob > chi2 =    0.0000
```

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Table 4.38 - OC - Probit IV

Reduced number of variables

```
ivprob  OC, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP  LECMID RURAL
AVGHHINC DENSITY HSEHLDS NFIRMS LRGFIRMS FINCE HEALTH INFO REALEST TCHSRV CAP
DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK)
(2653 real changes made)
```

OC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	7.613248	1.347654	5.65	0.000	4.971895	10.2546
APPRV271	-.4983003	.1007521	-4.95	0.000	-.6957709	-.3008298
FEDCAP	-1.274913	.2071402	-6.15	0.000	-1.6809	-.8689252
LECMID	-1.848877	.3874826	-4.77	0.000	-2.608329	-1.089425
RURAL	-.9128588	.2074246	-4.40	0.000	-1.319404	-.506314
AVGHHINC	.0000456	4.82e-06	9.46	0.000	.0000362	.0000551
DENSITY	-.0004463	.0000799	-5.58	0.000	-.000603	-.0002897
HSEHLDS	-.0000438	.0000143	-3.05	0.002	-.0000718	-.0000157
NFIRMS	.0010554	.0002929	3.60	0.000	.0004813	.0016295
LRGFIRMS	-.0829469	.0168186	-4.93	0.000	-.1159109	-.049983
FINCE	-.0093742	.0022821	-4.11	0.000	-.0138471	-.0049013
HEALTH	-.0055917	.001628	-3.43	0.001	-.0087825	-.0024008
INFO	-.0085124	.0037992	-2.24	0.025	-.0159588	-.0010661
REALEST	.0389962	.0078639	4.96	0.000	.0235832	.0544092
TCHSRV	-.0122309	.0021716	-5.63	0.000	-.016487	-.0079747
DEREG	.4650491	.1033791	4.50	0.000	.2624299	.6676684
INDXCAP	-.5809997	.1840541	-3.16	0.002	-.941739	-.2202604
NONINDXCAP	-.2851128	.2098371	-1.36	0.174	-.6963859	.1261603
NORMATIV	1.95274	.5125179	3.81	0.000	.9482235	2.957257
PFLEX	-.1433724	.1060119	-1.35	0.176	-.351152	.0644072
PFLEXNTWK	-.7535407	.2191071	-3.44	0.001	-1.182983	-.3240987
_cons	-2.25525	.2695693	-8.37	0.000	-2.783597	-1.726904

```
. test FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  FINCE = 0.0
 ( 2)  HEALTH = 0.0
 ( 3)  INFO = 0.0
 ( 4)  REALEST = 0.0
 ( 5)  TCHSRV = 0.0

           chi2(  5) =   34.90
         Prob > chi2 =    0.0000
```

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Table 4.39 - OC - Probit (dF/dx)

```
. dprobit  OC APPRV271 FEDCAP LECLRG LECMID RURAL RUS UNEOBLIG AVGHHINC DENSITY
HSEHLDS LNCOMPS PRATIO NFIRMS LRGFIRMS  EDUC FINCE HEALTH INFO REALEST TCHSRV
CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK

Probit estimates                                  Number of obs =  14119
                                                  LR chi2(26)   =2114.68
                                                  Prob > chi2   = 0.0000
Log likelihood =  -2850.404                       Pseudo R2     = 0.2706
```

OC	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
APPRV271*	-.0090947	.0027951	-5.12	0.000	.133933	-.014573	-.003616
FEDCAP*	-.155511	.0721238	-3.68	0.000	.743395	-.296871	-.014151
LECLRG*	.0264594	.0140563	1.76	0.078	.605425	-.00109	.054009
LECMID*	-.0361335	.0050188	-3.71	0.000	.209009	-.04597	-.026297
RURAL*	-.0292239	.0104809	-3.65	0.000	.389829	-.049766	-.008682
RUS*	.0056456	.0037293	1.79	0.073	.154331	-.001664	.012955
UNEOBLIG*	.0029633	.0043019	0.67	0.503	.703874	-.005468	.011395
AVGHHINC	7.68e-07	2.01e-07	17.08	0.000	34246.8	3.7e-07	1.2e-06
DENSITY	-2.23e-07	2.36e-07	-0.97	0.331	772.855	-6.9e-07	2.4e-07
HSEHLDS	9.23e-07	2.61e-07	8.30	0.000	5797.34	4.1e-07	1.4e-06
LNCOMPS	.0036249	.0014255	3.33	0.001	.207764	.000831	.006419
PRATIO	.0257085	.0075988	6.31	0.000	.776823	.010815	.040602
NFIRMS	-5.52e-07	3.98e-06	-0.14	0.889	417.724	-8.3e-06	7.2e-06
LRGFIRMS	.0003233	.0001049	4.98	0.000	9.87265	.000118	.000529
EDUC	.00023	.0001788	1.36	0.173	3.98548	-.000121	.00058
FINCE	-.000021	.0000262	-0.82	0.413	24.2042	-.000072	.00003
HEALTH	.0000119	.0000199	0.60	0.546	39.6393	-.000027	.000051
INFO	.0000819	.0000551	1.61	0.107	7.05837	-.000026	.00019
REALEST	-.000076	.0000459	-1.83	0.068	17.6812	-.000166	.000014
TCHSRV	-.0000361	.0000177	-2.39	0.017	41.003	-.000071	-1.5e-06
DEREG*	.0202857	.0063722	5.86	0.000	.330406	.007796	.032775
INDXCAP*	-.0092231	.0035569	-2.47	0.014	.056024	-.016194	-.002252
NONIND~P*	.0223007	.0098214	3.71	0.000	.037396	.003051	.04155
NORMATIV*	.3789488	.1781939	3.55	0.000	.006658	.029695	.728203
PFLEX*	-.0052792	.003264	-1.77	0.077	.450386	-.011676	.001118
PFLEXN~K*	-.0060647	.0033483	-1.64	0.100	.026347	-.012627	.000498
obs. P	.0791841						
pred. P	.0143522	(at x-bar)					

```
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   16.12
         Prob > chi2 =    0.0131
```

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Table 4.40 - OC - Probit (dF/dx)

Reduced number of variables

```
. dprobit  OC APPRV271 FEDCAP  LECMID RURAL AVGHHINC HSEHLDS LNCOMPS PRATIO
LRGFIR MS INFO REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX
NONCAPNTWK PFLEXNTWK

Probit estimates                                  Number of obs =  18133
                                                  LR chi2(18)   =2363.07
                                                  Prob > chi2   = 0.0000
Log likelihood = -3249.5689                       Pseudo R2     = 0.2666

------------------------------------------------------------------------------
      OC |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
---------+--------------------------------------------------------------------
APPRV271*|  -.0088884   .0021289    -5.90   0.000   .122043  -.013061 -.004716
  FEDCAP*|  -.0704108   .0182379    -6.42   0.000   .691943  -.106156 -.034665
  LECMID*|  -.0355251   .0025818    -5.04   0.000   .223956  -.040585 -.030465
   RURAL*|  -.0406626   .0091119    -6.31   0.000   .452159  -.058522 -.022804
AVGHHINC |   7.22e-07   1.45e-07    18.62   0.000   32639.2   4.4e-07  1.0e-06
 HSEHLDS |   9.63e-07   2.03e-07    12.55   0.000   4720.05   5.7e-07  1.4e-06
 LNCOMPS |   .0030916   .0011097     3.30   0.001   .164517   .000917  .005266
  PRATIO |   .0197004   .0049997     5.92   0.000   .785905   .009901    .0295
LRGFIRMS |   .0002913   .0000701     6.89   0.000   7.81804   .000154  .000429
    INFO |   .0000768   .0000463     1.76   0.078   5.66858  -.000014  .000168
 REALEST |  -.0000719   .0000313    -2.58   0.010    14.031  -.000133 -.000011
  TCHSRV |  -.0000279   .0000119    -2.63   0.008   32.4278  -.000051 -4.7e-06
   DEREG*|   .0148598   .0040454     5.66   0.000   .340539   .006931  .022789
 INDXCAP*|  -.0090508   .0027104    -2.92   0.004   .051839  -.014363 -.003739
NONIND~P*|   .0163972   .0071173     3.40   0.001   .031876   .002448  .030347
NORMATIV*|   .3579654   .1334368     4.59   0.000   .006232   .096434  .619497
   PFLEX*|  -.0054682   .0025906    -2.31   0.021   .443391  -.010546 -.000391
PFLEXN~K*|  -.0058884   .0027592    -1.83   0.067   .022556  -.011296  -.00048
---------+--------------------------------------------------------------------
  obs. P |   .0664534
 pred. P |   .0129273  (at x-bar)
------------------------------------------------------------------------------
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0


. test  INFO REALEST TCHSRV

 ( 1)  INFO = 0.0
 ( 2)  REALEST = 0.0
 ( 3)  TCHSRV = 0.0

           chi2(  3) =   24.83
         Prob > chi2 =    0.0000
```

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Table 4.41 - OC - Probit IV (dF/dx)

```
. divprob   OC, endog(LNCOMPS) iv(LEMPLYEES)  exog(APPRV271 FEDCAP LECLRG
LECMID RURAL RUS UNEOBLIG AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS  EDUC
FINCE HEALTH INFO REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX
NONCAPNTWK PFLEXNTWK)

Probit estimates                                  Number of obs =  14119
                                                   chi2(26)     =2171.18
                                                  Prob > chi2   = 0.0000
Log likelihood = -2822.1537                       Pseudo R2     = 0.2778

------------------------------------------------------------------------------
      OC |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
---------+--------------------------------------------------------------------
 LNCOMPS |   .1809457   .0557148     5.77   0.000   .207764   .071747  .290145
APPRV271*|  -.0103823   .0032655    -4.61   0.000   .133933  -.016783 -.003982
  FEDCAP*|  -.1385112    .069204    -3.48   0.001   .743395  -.274148 -.002874
  LECLRG*|   .0203076   .0134381     1.39   0.163   .605425  -.006031  .046646
  LECMID*|  -.0327687   .0050729    -3.65   0.000   .209009  -.042711 -.022826
   RURAL*|  -.0249882    .010272    -2.96   0.003   .389829  -.045121 -.004856
     RUS*|   .0042739   .0044437     1.08   0.282   .154331  -.004436  .012983
UNEOBLIG*|  -.0043016   .0058083    -0.80   0.423   .703874  -.015686  .007082
AVGHHINC |   1.36e-06   3.76e-07    10.20   0.000   34246.8   6.3e-07  2.1e-06
 DENSITY |  -.0000106   3.28e-06    -5.66   0.000   772.855  -.000017 -4.2e-06
 HSEHLDS |  -8.04e-07   4.02e-07    -2.30   0.021   5797.34  -1.6e-06 -1.6e-08
  PRATIO |   .0047383   .0065596     0.74   0.462   .776823  -.008118  .017595
  NFIRMS |   .0000258   .0000104     3.19   0.001   417.724   5.4e-06  .000046
LRGFIRMS |  -.0018517   .0006138    -4.68   0.000   9.87265  -.003055 -.000649
    EDUC |   .0002445   .0003051     0.82   0.412   3.98548  -.000353  .000842
   FINCE |  -.0002246   .0000823    -3.81   0.000   24.2042  -.000386 -.000063
  HEALTH |  -.0001353   .0000551    -3.13   0.002   39.6393  -.000243 -.000027
    INFO |  -.0001925   .0001116    -1.91   0.056   7.05837  -.000411  .000026
 REALEST |   .0008953   .0002939     4.81   0.000   17.6812   .000319  .001471
  TCHSRV |  -.0003121   .0000967    -5.67   0.000    41.003  -.000502 -.000123
   DEREG*|    .024488   .0083509     5.21   0.000   .330406    .00812  .040855
 INDXCAP*|  -.0104239   .0036582    -2.70   0.007   .056024  -.017594 -.003254
NONINDXCAP*|-.0011803   .0057618    -0.20   0.843   .037396  -.012473  .010113
NORMATIV*|   .3962893   .2045066     3.37   0.001   .006658  -.004536  .797115
   PFLEX*|  -.0043156   .0038098    -1.18   0.238   .450386  -.011783  .003151
PFLEXNTWK*| -.0110765   .0035657    -3.08   0.002   .026347  -.018065 -.004088
---------+--------------------------------------------------------------------
  obs. P |   .0791841
 pred. P |   .0130298  (at x-bar)
------------------------------------------------------------------------------
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

. test EDUC FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  EDUC = 0.0
 ( 2)  FINCE = 0.0
 ( 3)  HEALTH = 0.0
 ( 4)  INFO = 0.0
 ( 5)  REALEST = 0.0
 ( 6)  TCHSRV = 0.0

           chi2(  6) =   36.18
         Prob > chi2 =    0.0000
```

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Table 4.42 - OC - Probit IV (dF/dx)

Reduced number of variables

```
. divprob   OC, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP LECMID RURAL
AVGHHINC DENSITY HSEHLDS NFIRMS LRGFIRMS FINCE HEALTH INFO REALEST TCHSRV CAP
DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK)

Probit estimates                                  Number of obs =  18102
                                                   chi2(21)     =2394.90
                                                  Prob > chi2   = 0.0000
Log likelihood = -3231.5193                       Pseudo R2     = 0.2704
```

OC	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
LNCOMPS	.2351894	.0624669	5.65	0.000	.164798	.112757	.357622
APPRV271*	-.0103911	.0026523	-4.95	0.000	.122196	-.015589	-.005193
FEDCAP*	-.0799657	.0228146	-6.15	0.000	.692575	-.124682	-.03525
LECMID*	-.0322114	.003276	-4.77	0.000	.224064	-.038632	-.025791
RURAL*	-.0293145	.0083641	-4.40	0.000	.451718	-.045708	-.012921
AVGHHINC	1.41e-06	3.21e-07	9.46	0.000	32642.5	7.8e-07	2.0e-06
DENSITY	-.0000138	3.68e-06	-5.58	0.000	611.622	-.000021	-6.6e-06
HSEHLDS	-1.35e-06	5.13e-07	-3.05	0.002	4727.25	-2.4e-06	-3.5e-07
NFIRMS	.0000326	.0000111	3.60	0.000	336.129	.000011	.000054
LRGFIRMS	-.0025624	.0007246	-4.93	0.000	7.83109	-.003983	-.001142
FINCE	-.0002896	.0000911	-4.11	0.000	19.4153	-.000468	-.000111
HEALTH	-.0001727	.0000607	-3.43	0.001	31.6578	-.000292	-.000054
INFO	-.000263	.0001279	-2.24	0.025	5.67763	-.000514	-.000012
REALEST	.0012047	.00034	4.96	0.000	14.0541	.000538	.001871
TCHSRV	-.0003778	.0001005	-5.63	0.000	32.4819	-.000575	-.000181
DEREG*	.0175209	.0057739	4.50	0.000	.340515	.006204	.028838
INDXCAP*	-.0103578	.0028408	-3.16	0.002	.051928	-.015926	-.00479
NONINDXCAP*	-.0065586	.0037141	-1.36	0.174	.03193	-.013838	.000721
NORMATIV*	.3624586	.1746216	3.81	0.000	.006242	.020206	.704711
PFLEX*	-.004364	.0033316	-1.35	0.176	.443542	-.010894	.002166
PFLEXNTWK*	-.0110285	.0027636	-3.44	0.001	.022594	-.016445	-.005612
obs. P	.0665672						
pred. P	.0118488	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

```
. test FINCE HEALTH INFO REALEST TCHSRV

 ( 1)  FINCE = 0.0
 ( 2)  HEALTH = 0.0
 ( 3)  INFO = 0.0
 ( 4)  REALEST = 0.0
 ( 5)  TCHSRV = 0.0

           chi2(  5) =   34.90
         Prob > chi2 =    0.0000
```

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Table 4.43 - OC - Summary 1

	LPM	Logit	Probit	ProbitIV	ProbitIV
APPRV271	-0.059	-0.606	-0.318	-0.429	-0.498
	(8.69)**	(4.76)**	(5.12)**	(4.61)**	(4.95)**
FEDCAP	-0.012	-3.128	-1.606	-1.557	-1.275
	(1.17)	(3.64)**	(3.68)**	(3.48)**	(6.15)**
LECLRG	0.022	1.765	0.789	0.658	
	(1.48)	(2.08)*	(1.76)	(1.39)	
LECMID	-0.025	-4.183	-1.874	-1.844	-1.849
	(2.89)**	(4.02)**	(3.71)**	(3.65)**	(4.77)**
RURAL	-0.016	-1.814	-0.877	-0.815	-0.913
	(1.25)	(3.99)**	(3.65)**	(2.96)**	(4.40)**
RUS	0.013	0.471	0.139	0.116	
	(1.72)	(2.71)**	(1.79)	(1.08)	
UNEOBLIG	0.002	0.180	0.084	-0.121	
	(0.22)	(0.70)	(0.67)	(0.80)	
AVGHHINC	0.000	0.000	0.000	0.000	0.000
	(20.23)**	(16.56)**	(17.08)**	(10.20)**	(9.46)**
DENSITY	-0.000	-0.000	-0.000	-0.000	-0.000
	(1.56)	(0.47)	(0.97)	(5.66)**	(5.58)**
HSEHLDS	0.000	0.000	0.000	-0.000	-0.000
	(10.86)**	(8.07)**	(8.30)**	(2.30)*	(3.05)**
LNCOMPS	0.008	0.164	0.099	5.395	7.613
	(1.81)	(3.02)**	(3.33)**	(5.77)**	(5.65)**
PRATIO	0.069	1.434	0.705	0.141	
	(5.75)**	(6.86)**	(6.31)**	(0.74)	
NFIRMS	-0.000	-0.000	-0.000	0.001	0.001
	(2.61)**	(0.14)	(0.14)	(3.19)**	(3.60)**
LRGFIRMS	0.002	0.016	0.009	-0.055	-0.083
	(6.82)**	(4.92)**	(4.98)**	(4.68)**	(4.93)**
EDUC	0.002	0.012	0.006	0.007	
	(2.81)**	(1.40)	(1.36)	(0.82)	
FINCE	-0.000	-0.001	-0.001	-0.007	-0.009
	(2.53)*	(0.56)	(0.82)	(3.81)**	(4.11)**
HEALTH	0.000	0.000	0.000	-0.004	-0.006
	(2.58)**	(0.49)	(0.60)	(3.13)**	(3.43)**
INFO	0.001	0.004	0.002	-0.006	-0.009
	(5.73)**	(1.70)	(1.61)	(1.91)	(2.24)*
REALEST	-0.000	-0.004	-0.002	0.027	0.039
	(2.21)*	(1.98)*	(1.83)	(4.81)**	(4.96)**
TCHSRV	-0.000	-0.002	-0.001	-0.009	-0.012
	(1.48)	(2.64)**	(2.39)*	(5.67)**	(5.63)**
CAP	-0.084				
	(3.94)**				
DEREG	0.062	0.869	0.457	0.566	0.465
	(8.48)**	(5.39)**	(5.86)**	(5.21)**	(4.50)**
INDXCAP	-0.023	-0.853	-0.352	-0.493	-0.581
	(2.04)*	(2.73)**	(2.47)*	(2.70)**	(3.16)**
NONINDXCAP	0.041	0.732	0.405	-0.037	-0.285
	(3.18)**	(3.45)**	(3.71)**	(0.20)	(1.36)

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Table 4.43 (continued)

NORMATIV	0.030	4.163	1.928	2.008	1.953
	(1.15)	(3.67)**	(3.55)**	(3.37)**	(3.81)**
PFLEX	-0.022	-0.375	-0.147	-0.130	-0.143
	(3.02)**	(2.14)*	(1.77)	(1.18)	(1.35)
NONCAPNTWK	-0.093				
	(4.98)**				
PFLEXNTWK	-0.043	-0.284	-0.205	-0.599	-0.754
	(3.23)**	(1.14)	(1.64)	(3.08)**	(3.44)**
Constant	-0.138	-4.342	-2.339	-2.507	-2.255
	(7.13)**	(8.61)**	(8.76)**	(7.56)**	(8.37)**
Observations	14528	14119	14119	14119	18102
Prediction	92.5%	92.4%	92.3%	85.6%	87.3%
R-squared	0.17				

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.44 - OC - Summary 2 (dF/dx)

	Probit	Probit	Probit IV	Probit IV
APPRV271	-0.009	-0.009	-0.010	-0.010
	(5.12)**	(5.90)**	(4.61)**	(4.95)**
FEDCAP	-0.156	-0.070	-0.139	-0.080
	(3.68)**	(6.42)**	(3.48)**	(6.15)**
LECLRG	0.026		0.020	
	(1.76)		(1.39)	
LECMID	-0.036	-0.036	-0.033	-0.032
	(3.71)**	(5.04)**	(3.65)**	(4.77)**
RURAL	-0.029	-0.041	-0.025	-0.029
	(3.65)**	(6.31)**	(2.96)**	(4.40)**
RUS	0.006		0.004	
	(1.79)		(1.08)	
UNEOBLIG	0.003		-0.004	
	(0.67)		(0.80)	
AVGHHINC	0.000	0.000	0.000	0.000
	(17.08)**	(18.62)**	(10.20)**	(9.46)**
DENSITY	-0.000		-0.000	-0.000
	(0.97)		(5.66)**	(5.58)**
HSEHLDS	0.000	0.000	-0.000	-0.000
	(8.30)**	(12.55)**	(2.30)*	(3.05)**
LNCOMPS	0.004	0.003	0.181	0.235
	(3.33)**	(3.30)**	(5.77)**	(5.65)**
PRATIO	0.026	0.020	0.005	
	(6.31)**	(5.92)**	(0.74)	
NFIRMS	-0.000		0.000	0.000
	(0.14)		(3.19)**	(3.60)**
LRGFIRMS	0.000	0.000	-0.002	-0.003
	(4.98)**	(6.89)**	(4.68)**	(4.93)**
EDUC	0.000		0.000	
	(1.36)		(0.82)	
FINCE	-0.000		-0.000	-0.000
	(0.82)		(3.81)**	(4.11)**
HEALTH	0.000		-0.000	-0.000
	(0.60)		(3.13)**	(3.43)**
INFO	0.000	0.000	-0.000	-0.000
	(1.61)	(1.76)	(1.91)	(2.24)*
REALEST	-0.000	-0.000	0.001	0.001
	(1.83)	(2.58)**	(4.81)**	(4.96)**
TCHSRV	-0.000	-0.000	-0.000	-0.000
	(2.39)*	(2.63)**	(5.67)**	(5.63)**
DEREG	0.020	0.015	0.024	0.018
	(5.86)**	(5.66)**	(5.21)**	(4.50)**
INDXCAP	-0.009	-0.009	-0.010	-0.010
	(2.47)*	(2.92)**	(2.70)**	(3.16)**
NONINDXCAP	0.022	0.016	-0.001	-0.007
	(3.71)**	(3.40)**	(0.20)	(1.36)

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Table 4.44 (continued)

NORMATIV	0.379	0.358	0.396	0.362
	(3.55)**	(4.59)**	(3.37)**	(3.81)**
PFLEX	-0.005	-0.005	-0.004	-0.004
	(1.77)	(2.31)*	(1.18)	(1.35)
PFLEXNTWK	-0.006	-0.006	-0.011	-0.011
	(1.64)	(1.83)	(3.08)**	(3.44)**
Observations	14119	18133	14119	18102

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.45 - Summary of Probit (IV, dF/dx) for all Services

	PCKTSW	DS1	DS3	OC
APPRV271	-0.016	-0.260	-0.024	-0.010
	(1.02)	(15.94)**	(1.64)	(4.61)**
FEDCAP	-0.374	-0.194	-0.110	-0.139
	(13.88)**	(8.26)**	(4.43)**	(3.48)**
LECLRG	0.218	-0.132	-0.359	0.020
	(6.36)**	(3.44)**	(9.25)**	(1.39)
LECMID	0.123	0.113	0.005	-0.033
	(5.80)**	(5.70)**	(0.28)	(3.65)**
RURAL	-0.125	-0.427	-0.209	-0.025
	(4.07)**	(13.20)**	(8.16)**	(2.96)**
+ RUS	0.060	0.050	0.044	0.004
	(3.34)**	(2.84)**	(2.53)*	(1.08)
UNEOBLIG	0.136	0.117	0.058	-0.004
	(7.28)**	(6.17)**	(3.39)**	(0.80)
☆AVGHHINC	0.000	0.000	0.000	0.000
	(8.67)**	(4.72)**	(10.91)**	(10.20)**
DENSITY	-0.000	-0.000	-0.000	-0.000
	(4.77)**	(4.99)**	(6.06)**	(5.66)**
HSEHLDS	-0.000	0.000	-0.000	-0.000
	(1.49)	(3.35)**	(1.63)	(2.30)*
☆LNCOMPS	0.696	0.605	0.912	0.181
	(4.73)**	(3.79)**	(6.51)**	(5.77)**
PRATIO	0.537	0.217	-0.065	0.005
	(16.28)**	(6.35)**	(2.14)*	(0.74)
+ NFIRMS	0.000	0.000	0.000	0.000
	(6.81)**	(1.75)	(3.05)**	(3.19)**
LRGFIRMS	-0.010	-0.006	-0.008	-0.002
	(5.52)**	(3.01)**	(4.59)**	(4.68)**
EDUC	0.000	-0.011	0.002	0.000
	(0.11)	(4.31)**	(1.45)	(0.82)
FINCE	-0.001	-0.000	-0.001	-0.000
	(3.51)**	(0.00)	(3.81)**	(3.81)**
HEALTH	-0.001	-0.000	-0.001	-0.000
	(2.80)**	(0.96)	(4.06)**	(3.13)**
INFO	0.003	0.003	-0.000	-0.000
	(2.60)**	(1.60)	(0.85)	(1.91)
☆REALEST	0.006	0.010	0.005	0.001
	(6.26)**	(8.23)**	(5.26)**	(4.81)**
TCHSRV	-0.002	-0.002	-0.002	-0.000
	(8.48)**	(5.58)**	(6.18)**	(5.67)**
CAP	0.584	-0.089	-0.104	
	(9.07)**	(1.71)	(2.93)**	
DEREG	-0.196	0.038	-0.008	0.024
	(12.40)**	(2.15)*	(0.51)	(5.21)**
INDXCAP	-0.126	-0.150	-0.088	-0.010
	(5.41)**	(5.41)**	(4.48)**	(2.70)**

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Table 4.45 (continued)

NONINDXCAP	0.122	0.463	0.030	-0.001
	(3.51)**	(11.92)**	(0.98)	(0.20)
☆NORMATIV	0.302	0.362	0.273	0.396
	(4.61)**	(6.87)**	(3.63)**	(3.37)**
PFLEX	-0.143	-0.037	-0.011	-0.004
	(8.71)**	(2.09)*	(0.71)	(1.18)
NONCAPNTWK	-0.243	-0.532	-0.129	
	(8.86)**	(15.11)**	(5.51)**	
PFLEXNTWK	0.012	-0.043	-0.131	-0.011
	(0.40)	(1.26)	(6.98)**	(3.08)**
Observations	14528	14528	14528	14119

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%
☆ positive and statistically significant impact across all services
+ positive, but not always statistically significant impact across all services

Note that values of less than .0005 are listed here as .000. This is usually associated with variables where the marginal impact of say another dollar in average household income (AVGHHINC) or another household (HSEHLDS) would not be expected to be large. See individual regression output for exact value.

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Table 4.46 - Scenario 2 - Packet Switching - Probit

```
probit  PCKTSW  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK

note: alltel~=0 predicts failure perfectly
      alltel dropped and 464 obs not used


Probit estimates                                  Number of obs   =      14064
                                                  LR chi2(36)     =    5442.48
                                                  Prob > chi2     =     0.0000
Log likelihood = -6108.2072                       Pseudo R2       =     0.3082

------------------------------------------------------------------------------
      PCKTSW |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    APPRV271 |    .294452   .0440313     6.69   0.000     .2081522    .3807519
      FEDCAP |  -1.146744   .1843284    -6.22   0.000    -1.508021   -.7854671
       RURAL |  -.7762422   .1026723    -7.56   0.000    -.9774761   -.5750082
         RUS |   .4405271   .0499065     8.83   0.000     .3427122     .538342
    UNEOBLIG |   .2928849   .0579604     5.05   0.000     .1792847    .4064852
      bellso |   .6549036   .2025553     3.23   0.001     .2579026    1.051905
     century |   1.264864   .0743085    17.02   0.000     1.119222    1.410506
    cinnbell |  -1.173451   .4720146    -2.49   0.013    -2.098583   -.2483194
    citizens |   .2820061   .1948056     1.45   0.148    -.0998058     .663818
       qwest |   1.896749   .2019608     9.39   0.000     1.500913    2.292585
         sbc |  -.2816032   .2019432    -1.39   0.163    -.6774046    .1141982
      sprint |   .8792617   .1888339     4.66   0.000      .509154    1.249369
         tds |   -1.36189   .1931995    -7.05   0.000    -1.740554   -.9832262
       valor |   1.203618   .2268164     5.31   0.000      .759066     1.64817
     verizon |   .7190249   .1984432     3.62   0.000     .3300833    1.107966
    AVGHHINC |   .0000149   1.14e-06    13.09   0.000     .0000127    .0000171
     DENSITY |  -.0000219   6.86e-06    -3.20   0.001    -.0000354   -8.49e-06
     HSEHLDS |   .0000221   3.18e-06     6.95   0.000     .0000159    .0000284
     LNCOMPS |   .1696225   .0277526     6.11   0.000     .1152285    .2240165
      PRATIO |   1.131377   .0863311    13.11   0.000     .9621711    1.300583
      NFIRMS |   .0005911    .000121     4.88   0.000     .0003539    .0008283
    LRGFIRMS |  -.0025751   .0019527    -1.32   0.187    -.0064024    .0012522
        EDUC |  -.0022432   .0051839    -0.43   0.665    -.0124035    .0079171
       FINCE |  -.0011269   .0007548    -1.49   0.135    -.0026062    .0003523
      HEALTH |  -.0001111   .0006342    -0.18   0.861    -.0013542     .001132
        INFO |   .0096185   .0027136     3.54   0.000        .0043    .0149371
     REALEST |   .0076582   .0015131     5.06   0.000     .0046924    .0106239
      TCHSRV |  -.0043824   .0004765    -9.20   0.000    -.0053163   -.0034486
         CAP |   1.464366   .1804987     8.11   0.000     1.110595    1.818137
       DEREG |  -.4878906   .0468562   -10.41   0.000     -.579727   -.3960542
     INDXCAP |  -.2919753   .0754033    -3.87   0.000     -.439763   -.1441875
  NONINDXCAP |   .3927224   .0860216     4.57   0.000     .2241232    .5613216
    NORMATIV |   .2089676   .1715336     1.22   0.223    -.1272321    .5451672
       PFLEX |  -.4148408   .0466695    -8.89   0.000    -.5063114   -.3233703
  NONCAPNTWK |  -1.228033   .1228104   -10.00   0.000    -1.468737   -.9873287
   PFLEXNTWK |  -.1030402   .0778655    -1.32   0.186    -.2556537    .0495734
       _cons |  -1.595057   .1398657   -11.40   0.000    -1.869189   -1.320926
------------------------------------------------------------------------------

note: 0 failures and 8 successes completely determined.
```

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Table 4.47 - Scenario 2 - Packet Switching - Probit (dF/dx)

```
dprobit  PCKTSW  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK

note: alltel~=0 predicts failure perfectly
      alltel dropped and 464 obs not used

Probit estimates                                  Number of obs =  14064
                                                  LR chi2(36)   =5442.48
                                                  Prob > chi2   = 0.0000
Log likelihood = -6108.2072                       Pseudo R2     = 0.3082
```

PCKTSW	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
APPRV271*	.1048443	.0164012	6.69	0.000	.134457	.072699	.13699
FEDCAP*	-.4198478	.0657814	-6.22	0.000	.770478	-.548777	-.290919
RURAL*	-.2420634	.0289517	-7.56	0.000	.366112	-.298808	-.185319
RUS*	.1598952	.0190311	8.83	0.000	.138225	.122595	.197195
UNEOBLIG*	.0947653	.0178737	5.05	0.000	.723265	.059733	.129797
bellso*	.2445272	.0792058	3.23	0.001	.100611	.089287	.399768
century*	.4728841	.0241686	17.02	0.000	.036761	.425515	.520254
cinnbell*	-.2425187	.0412638	-2.49	0.013	.003271	-.323394	-.161643
citizens*	.1014461	.073741	1.45	0.148	.040671	-.043083	.245976
qwest*	.643629	.0416105	9.39	0.000	.069966	.562074	.725184
sbc*	-.0896287	.060212	-1.39	0.163	.177403	-.207642	.028385
sprint*	.3333028	.0723021	4.66	0.000	.072739	.191593	.475012
tds*	-.2615663	.0130559	-7.05	0.000	.016638	-.287155	-.235977
valor*	.4526659	.0749301	5.31	0.000	.008675	.305806	.599526
verizon*	.2574378	.0728946	3.62	0.000	.287543	.114567	.400309
AVGHHINC	5.03e-06	3.84e-07	13.09	0.000	34227.7	4.3e-06	5.8e-06
DENSITY	-7.40e-06	2.31e-06	-3.20	0.001	779.343	-.000012	-2.9e-06
HSEHLDS	7.46e-06	1.07e-06	6.95	0.000	5899.23	5.4e-06	9.6e-06
LNCOMPS	.0572405	.0093695	6.11	0.000	.21568	.038877	.075604
PRATIO	.3817925	.0290394	13.11	0.000	.779359	.324876	.438709
NFIRMS	.0001995	.0000409	4.88	0.000	425.597	.000119	.00028
LRGFIRMS	-.000869	.0006592	-1.32	0.187	10.0214	-.002161	.000423
EDUC	-.000757	.0017493	-0.43	0.665	4.07655	-.004186	.002672
FINCE	-.0003803	.0002548	-1.49	0.135	24.6951	-.00088	.000119
HEALTH	-.0000375	.000214	-0.18	0.861	40.4084	-.000457	.000382
INFO	.0032459	.0009175	3.54	0.000	7.21732	.001448	.005044
REALEST	.0025843	.0005122	5.06	0.000	18.0776	.00158	.003588
TCHSRV	-.0014789	.0001617	-9.20	0.000	41.8198	-.001796	-.001162
CAP*	.531693	.0493638	8.11	0.000	.010523	.434942	.628444
DEREG*	-.1550216	.0138565	-10.41	0.000	.319895	-.18218	-.127863
INDXCAP*	-.0904519	.0211374	-3.87	0.000	.054252	-.13188	-.049023
NONIND~P*	.1436422	.0333512	4.57	0.000	.054608	.078275	.209009
NORMATIV*	.0743503	.0638507	1.22	0.223	.006684	-.050795	.199495
PFLEX*	-.137192	.0150323	-8.89	0.000	.43622	-.166655	-.107729
NONCAP~K*	-.251952	.0111693	-10.00	0.000	.018558	-.273843	-.230061
PFLEXN~K*	-.0337546	.0247207	-1.32	0.186	.026451	-.082206	.014697
obs. P	.3212457						
pred. P	.2814377	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

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Table 4.48 - Scenario 2 - Packet Switching - Probit IV

```
. ivprob  PCKTSW, endog(LNCOMPS)  iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)
(6691 real changes made)
```

PCKTSW	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	2.562565	.4763527	5.38	0.000	1.628931	3.496199
APPRV271	.1926867	.0576701	3.34	0.001	.0796553	.305718
FEDCAP	-1.165023	.207613	-5.61	0.000	-1.571937	-.7581088
RURAL	-.6777454	.1255613	-5.40	0.000	-.9238411	-.4316498
RUS	.4134184	.0617267	6.70	0.000	.2924363	.5344004
UNEOBLIG	.2189092	.0721843	3.03	0.002	.0774305	.3603878
bellso	.5316813	.2335412	2.28	0.023	.0739489	.9894137
century	1.249256	.094579	13.21	0.000	1.063884	1.434627
cinnbell	-.8051058	.515667	-1.56	0.118	-1.815795	.205583
citizens	.285165	.2187201	1.30	0.192	-.1435185	.7138486
qwest	1.982225	.2318345	8.55	0.000	1.527838	2.436613
sbc	-.112773	.2333155	-0.48	0.629	-.570063	.344517
sprint	.8757669	.2122932	4.13	0.000	.4596799	1.291854
tds	-1.35231	.2081287	-6.50	0.000	-1.760235	-.9443849
valor	1.244927	.2629165	4.74	0.000	.7296205	1.760234
verizon	.7689672	.2268448	3.39	0.001	.3243596	1.213575
AVGHHINC	.0000228	2.09e-06	10.91	0.000	.0000187	.0000269
DENSITY	-.0001612	.0000288	-5.59	0.000	-.0002177	-.0001047
HSEHLDS	-1.07e-06	6.03e-06	-0.18	0.859	-.0000129	.0000108
PRATIO	.916721	.1132566	8.09	0.000	.6947421	1.1387
NFIRMS	.000842	.0001516	5.55	0.000	.0005448	.0011392
LRGFIRMS	-.0315135	.0062196	-5.07	0.000	-.0437037	-.0193233
EDUC	.0007882	.0062074	0.13	0.899	-.0113781	.0129546
FINCE	-.0038791	.0010711	-3.62	0.000	-.0059785	-.0017797
HEALTH	-.002167	.0008497	-2.55	0.011	-.0038323	-.0005016
INFO	.0048465	.0030032	1.61	0.107	-.0010397	.0107327
REALEST	.0208778	.0031558	6.62	0.000	.0146926	.027063
TCHSRV	-.0076713	.000871	-8.81	0.000	-.0093784	-.0059643
CAP	1.444653	.2042794	7.07	0.000	1.044272	1.845033
DEREG	-.4617526	.0580415	-7.96	0.000	-.5755119	-.3479932
INDXCAP	-.3077536	.092585	-3.32	0.001	-.4892169	-.1262904
NONINDXCAP	.2344014	.1093548	2.14	0.032	.0200699	.4487329
NORMATIV	.2771976	.2101996	1.32	0.187	-.134786	.6891813
PFLEX	-.4082647	.0574841	-7.10	0.000	-.5209315	-.2955979
NONCAPNTWK	-1.253737	.1492927	-8.40	0.000	-1.546345	-.9611286
PFLEXNTWK	-.2885154	.1048186	-2.75	0.006	-.493956	-.0830748
_cons	-1.706015	.1717444	-9.93	0.000	-2.042628	-1.369403

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Table 4.49
Scenario 2 - Packet Switching - Probit IV (dF/dx)

```
divprob  PCKTSW, endog(LNCOMPS)  iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)

Probit estimates                                  Number of obs =  14064
                                                   chi2(36)     =5448.40
                                                  Prob > chi2   = 0.0000
Log likelihood = -6105.2463                       Pseudo R2     = 0.3085
```

PCKTSW	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
LNCOMPS	.8616619	.1598857	5.38	0.000	.21568	.548292	1.17503
APPRV271*	.0672713	.0208399	3.34	0.001	.134457	.026426	.108117
FEDCAP*	-.4257467	.0738608	-5.61	0.000	.770478	-.570511	-.280982
RURAL*	-.2129985	.0363135	-5.40	0.000	.366112	-.284172	-.141825
RUS*	.1491676	.0234288	6.70	0.000	.138225	.103248	.195087
UNEOBLIG*	.0713636	.0227483	3.03	0.002	.723265	.026778	.115949
bellso*	.1959111	.0909157	2.28	0.023	.100611	.01772	.374103
century*	.4677772	.0311512	13.21	0.000	.036761	.406722	.528832
cinnbell*	-.1975583	.0789108	-1.56	0.118	.003271	-.352221	-.042896
citizens*	.1023597	.0827094	1.30	0.192	.040671	-.059748	.264467
qwest*	.6612402	.0440817	8.55	0.000	.069966	.574842	.747639
sbc*	-.0370851	.0749644	-0.48	0.629	.177403	-.184013	.109842
sprint*	.3315647	.081451	4.13	0.000	.072739	.171924	.491206
tds*	-.2592004	.0143667	-6.50	0.000	.016638	-.287359	-.231042
valor*	.4662147	.0849864	4.74	0.000	.008675	.299645	.632785
verizon*	.2751241	.0831402	3.39	0.001	.287543	.112172	.438076
AVGHHINC	7.66e-06	7.01e-07	10.91	0.000	34227.7	6.3e-06	9.0e-06
DENSITY	-.0000542	9.67e-06	-5.59	0.000	779.343	-.000073	-.000035
HSEHLDS	-3.59e-07	2.03e-06	-0.18	0.859	5899.23	-4.3e-06	3.6e-06
PRATIO	.3082473	.0381092	8.09	0.000	.779359	.233555	.38294
NFIRMS	.0002831	.000051	5.55	0.000	425.597	.000183	.000383
LRGFIRMS	-.0105964	.0020891	-5.07	0.000	10.0214	-.014691	-.006502
EDUC	.000265	.0020873	0.13	0.899	4.07655	-.003826	.004356
FINCE	-.0013043	.0003601	-3.62	0.000	24.6951	-.00201	-.000599
HEALTH	-.0007286	.0002856	-2.55	0.011	40.4084	-.001288	-.000169
INFO	.0016296	.0010109	1.61	0.107	7.21732	-.000352	.003611
REALEST	.0070202	.0010615	6.62	0.000	18.0776	.00494	.009101
TCHSRV	-.0025795	.0002932	-8.81	0.000	41.8198	-.003154	-.002005
CAP*	.5265916	.0571148	7.07	0.000	.010523	.414649	.638534
DEREG*	-.1466604	.0172648	-7.96	0.000	.319895	-.180499	-.112822
INDXCAP*	-.0944323	.025516	-3.32	0.001	.054252	-.144443	-.044422
NONINDXCAP*	.0831771	.0406336	2.14	0.032	.054608	.003537	.162818
NORMATIV*	.0997717	.0798852	1.32	0.187	.006684	-.0568	.256344
PFLEX*	-.134572	.0184881	-7.10	0.000	.43622	-.170808	-.098336
NONCAPNTWK*	-.2524908	.0129456	-8.40	0.000	.018558	-.277864	-.227118
PFLEXNTWK*	-.0885846	.0289345	-2.75	0.006	.026451	-.145295	-.031874
obs. P	.3212457						
pred. P	.2793601	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

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Table 4.50 - Scenario 2 - Packet Switching - Summary

	Probit	Probit (dF/dx)	ProbitIV	ProbitIV (dF/dx)
APPRV271	0.294	0.105	0.193	0.067
	(6.69)**	(6.69)**	(3.34)**	(3.34)**
FEDCAP	-1.147	-0.420	-1.165	-0.426
	(6.22)**	(6.22)**	(5.61)**	(5.61)**
RURAL	-0.776	-0.242	-0.678	-0.213
	(7.56)**	(7.56)**	(5.40)**	(5.40)**
RUS	0.441	0.160	0.413	0.149
	(8.83)**	(8.83)**	(6.70)**	(6.70)**
UNEOBLIG	0.293	0.095	0.219	0.071
	(5.05)**	(5.05)**	(3.03)**	(3.03)**
bellso	0.655	0.245	0.532	0.196
	(3.23)**	(3.23)**	(2.28)*	(2.28)*
century	1.265	0.473	1.249	0.468
	(17.02)**	(17.02)**	(13.21)**	(13.21)**
cinnbell	-1.173	-0.243	-0.805	-0.198
	(2.49)*	(2.49)*	(1.56)	(1.56)
citizens	0.282	0.101	0.285	0.102
	(1.45)	(1.45)	(1.30)	(1.30)
qwest	1.897	0.644	1.982	0.661
	(9.39)**	(9.39)**	(8.55)**	(8.55)**
sbc	-0.282	-0.090	-0.113	-0.037
	(1.39)	(1.39)	(0.48)	(0.48)
sprint	0.879	0.333	0.876	0.332
	(4.66)**	(4.66)**	(4.13)**	(4.13)**
tds	-1.362	-0.262	-1.352	-0.259
	(7.05)**	(7.05)**	(6.50)**	(6.50)**
valor	1.204	0.453	1.245	0.466
	(5.31)**	(5.31)**	(4.74)**	(4.74)**
verizon	0.719	0.257	0.769	0.275
	(3.62)**	(3.62)**	(3.39)**	(3.39)**
AVGHHINC	0.000	0.000	0.000	0.000
	(13.09)**	(13.09)**	(10.91)**	(10.91)**
DENSITY	-0.000	-0.000	-0.000	-0.000
	(3.20)**	(3.20)**	(5.59)**	(5.59)**
HSEHLDS	0.000	0.000	-0.000	-0.000
	(6.95)**	(6.95)**	(0.18)	(0.18)
LNCOMPS	0.170	0.057	2.563	0.862
	(6.11)**	(6.11)**	(5.38)**	(5.38)**
PRATIO	1.131	0.382	0.917	0.308
	(13.11)**	(13.11)**	(8.09)**	(8.09)**
NFIRMS	0.001	0.000	0.001	0.000
	(4.88)**	(4.88)**	(5.55)**	(5.55)**
LRGFIRMS	-0.003	-0.001	-0.032	-0.011
	(1.32)	(1.32)	(5.07)**	(5.07)**
EDUC	-0.002	-0.001	0.001	0.000
	(0.43)	(0.43)	(0.13)	(0.13)

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Table 4.50 (continued)

FINCE	-0.001	-0.000	-0.004	-0.001
	(1.49)	(1.49)	(3.62)**	(3.62)**
HEALTH	-0.000	-0.000	-0.002	-0.001
	(0.18)	(0.18)	(2.55)*	(2.55)*
INFO	0.010	0.003	0.005	0.002
	(3.54)**	(3.54)**	(1.61)	(1.61)
REALEST	0.008	0.003	0.021	0.007
	(5.06)**	(5.06)**	(6.62)**	(6.62)**
TCHSRV	-0.004	-0.001	-0.008	-0.003
	(9.20)**	(9.20)**	(8.81)**	(8.81)**
CAP	1.464	0.532	1.445	0.527
	(8.11)**	(8.11)**	(7.07)**	(7.07)**
DEREG	-0.488	-0.155	-0.462	-0.147
	(10.41)**	(10.41)**	(7.96)**	(7.96)**
INDXCAP	-0.292	-0.090	-0.308	-0.094
	(3.87)**	(3.87)**	(3.32)**	(3.32)**
NONINDXCAP	0.393	0.144	0.234	0.083
	(4.57)**	(4.57)**	(2.14)*	(2.14)*
NORMATIV	0.209	0.074	0.277	0.100
	(1.22)	(1.22)	(1.32)	(1.32)
PFLEX	-0.415	-0.137	-0.408	-0.135
	(8.89)**	(8.89)**	(7.10)**	(7.10)**
NONCAPNTWK	-1.228	-0.252	-1.254	-0.252
	(10.00)**	(10.00)**	(8.40)**	(8.40)**
PFLEXNTWK	-0.103	-0.034	-0.289	-0.089
	(1.32)	(1.32)	(2.75)**	(2.75)**
Constant	-1.595		-1.706	
	(11.40)**		(9.93)**	
Observations	14064	14064	14064	14064

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.51 - Scenario 2 - DS1 - Probit

```
probit   DS1  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK

note: cinnbell~=0 predicts success perfectly
      cinnbell dropped and 46 obs not used

Probit estimates                                  Number of obs   =      14482
                                                  LR chi2(36)     =    6375.11
                                                  Prob > chi2     =     0.0000
Log likelihood = -6838.4981                       Pseudo R2       =     0.3179
```

DS1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.8590885	.0437706	-19.63	0.000	-.9448773	-.7732998
FEDCAP	.3616917	.1036991	3.49	0.000	.1584452	.5649382
RURAL	-.753961	.0880667	-8.56	0.000	-.9265686	-.5813535
RUS	.3170434	.0429307	7.38	0.000	.2329007	.4011861
UNEOBLIG	.0813935	.0483476	1.68	0.092	-.013366	.176153
alltel	.7069913	.0715128	9.89	0.000	.5668288	.8471537
bellso	-1.047463	.1232146	-8.50	0.000	-1.288959	-.8059671
century	.6865582	.0703691	9.76	0.000	.5486373	.8244791
citizens	-.3333787	.1107666	-3.01	0.003	-.5504773	-.11628
qwest	2.247667	.2233204	10.06	0.000	1.809967	2.685367
sbc	.263995	.1220142	2.16	0.030	.0248516	.5031383
sprint	-.6996989	.1118737	-6.25	0.000	-.9189673	-.4804305
tds	-1.082004	.1331501	-8.13	0.000	-1.342974	-.8210347
valor	.3487011	.1511805	2.31	0.021	.0523926	.6450095
verizon	-.8941481	.1166455	-7.67	0.000	-1.122769	-.6655272
AVGHHINC	7.03e-06	1.20e-06	5.86	0.000	4.68e-06	9.38e-06
DENSITY	-.0000226	7.95e-06	-2.84	0.005	-.0000382	-6.99e-06
HSEHLDS	.0000271	4.18e-06	6.48	0.000	.0000189	.0000353
LNCOMPS	.1807721	.0337604	5.35	0.000	.1146029	.2469413
PRATIO	.6774597	.0809682	8.37	0.000	.5187649	.8361546
NFIRMS	.0004628	.000163	2.84	0.005	.0001433	.0007824
LRGFIRMS	.0001096	.0027428	0.04	0.968	-.0052662	.0054854
EDUC	-.0323595	.006724	-4.81	0.000	-.0455383	-.0191808
FINCE	.0009298	.0011846	0.78	0.432	-.0013919	.0032515
HEALTH	.0013867	.000882	1.57	0.116	-.000342	.0031154
INFO	.0102074	.0041283	2.47	0.013	.0021161	.0182988
REALEST	.0104724	.0021558	4.86	0.000	.0062471	.0146977
TCHSRV	-.0028022	.0006903	-4.06	0.000	-.0041552	-.0014491
CAP	-1.073521	.2042425	-5.26	0.000	-1.473829	-.6732128
DEREG	-.1181106	.0428217	-2.76	0.006	-.2020396	-.0341816
INDXCAP	-.0785545	.0683581	-1.15	0.250	-.212534	.055425
NONINDXCAP	2.118523	.1418881	14.93	0.000	1.840427	2.396619
NORMATIV	.9270543	.1695406	5.47	0.000	.5947608	1.259348
PFLEX	-.1287485	.04253	-3.03	0.002	-.2121057	-.0453913
NONCAPNTWK	-2.900327	.1786306	-16.24	0.000	-3.250436	-2.550217
PFLEXNTWK	.0910225	.0852255	1.07	0.286	-.0760165	.2580614
_cons	-.8058292	.1230452	-6.55	0.000	-1.046993	-.5646651

```
note: 0 failures and 65 successes completely determined.
```

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Table 4.52 - Scenario 2 - DS1 - Probit (dF/dx)

```
dprobit  DS1  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX  NONCAPNTWK PFLEXNTWK

note: cinnbell~=0 predicts success perfectly
      cinnbell dropped and 46 obs not used


Probit estimates                                  Number of obs =  14482
                                                  LR chi2(36)   =6375.11
                                                  Prob > chi2   = 0.0000
Log likelihood = -6838.4981                       Pseudo R2     = 0.3179

------------------------------------------------------------------------------
     DS1 |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
---------+--------------------------------------------------------------------
APPRV271*|  -.3293976   .0151513   -19.63   0.000   .130576  -.359094 -.299701
  FEDCAP*|   .1429826   .0408605     3.49   0.000   .749827   .062897  .223068
   RURAL*|  -.2927459   .0328557    -8.56   0.000    .38137  -.357142  -.22835
     RUS*|   .120894   .0157361     7.38   0.000   .150463   .090052  .151736
UNEOBLIG*|   .032052   .0190832     1.68   0.092   .711297  -.00535  .069454
  alltel*|   .244171   .0200922     9.89   0.000    .03204   .204791  .283551
  bellso*|  -.3887804   .0377722    -8.50   0.000   .097707  -.462812 -.314748
 century*|   .2387067    .020138     9.76   0.000   .035699   .199237  .278177
citizens*|  -.1323501   .0437222    -3.01   0.003   .039497  -.218044 -.046656
   qwest*|   .4788597   .0101028    10.06   0.000   .067946   .459059  .498661
     sbc*|   .1014571   .0455984     2.16   0.030   .172283   .012086  .190828
  sprint*|  -.2715479   .0401678    -6.25   0.000   .070639  -.350275  -.19282
     tds*|  -.3896722    .036035    -8.13   0.000   .016158  -.460299 -.319045
   valor*|   .1303497   .0526996     2.31   0.021   .008424    .02706  .233639
 verizon*|  -.3451097   .0419374    -7.67   0.000   .279243  -.427305 -.262914
AVGHHINC |   2.76e-06   4.71e-07     5.86   0.000   34069.5   1.8e-06  3.7e-06
 DENSITY |  -8.87e-06   3.12e-06    -2.84   0.005   755.605  -.000015 -2.7e-06
 HSEHLDS |   .0000107   1.64e-06     6.48   0.000   5763.05   7.4e-06  .000014
 LNCOMPS |   .0709998   .0132619     5.35   0.000   .208707   .045007  .096993
  PRATIO |   .2660782   .0317914     8.37   0.000   .777068   .203768  .328388
  NFIRMS |   .0001818   .0000641     2.84   0.005   416.108   .000056  .000307
LRGFIRMS |    .000043   .0010773     0.04   0.968   9.76697  -.002068  .002154
    EDUC |  -.0127095   .0026388    -4.81   0.000   3.97374  -.017881 -.007537
   FINCE |   .0003652   .0004653     0.78   0.432   24.1116  -.000547  .001277
  HEALTH |   .0005446   .0003464     1.57   0.116   39.4505  -.000134  .001224
    INFO |   .0040091   .0016201     2.47   0.013   7.03878   .000834  .007184
 REALEST |   .0041131   .0008449     4.86   0.000   17.6194   .002457  .005769
  TCHSRV |  -.0011006   .0002711    -4.06   0.000   40.7375  -.001632 -.000569
     CAP*|  -.3865904     .05562    -5.26   0.000    .01022  -.495604 -.277577
   DEREG*|  -.0465249   .0169047    -2.76   0.006   .322124  -.079658 -.013392
 INDXCAP*|  -.0310175   .0271116    -1.15   0.250    .05462  -.084155   .02212
NONIND~P*|   .4609116   .0095131    14.93   0.000   .054481   .442266  .479557
NORMATIV*|    .296067   .0373276     5.47   0.000   .006491   .222906  .369228
   PFLEX*|  -.0506052   .0167194    -3.03   0.002    .43592  -.083375 -.017836
NONCAP~K*|  -.5867984   .0083187   -16.24   0.000   .018022  -.603103 -.570494
PFLEXN~K*|   .0354334   .0328405     1.07   0.286   .025687  -.028933    .0998
---------+--------------------------------------------------------------------
  obs. P |   .4795608
 pred. P |   .5701503  (at x-bar)
------------------------------------------------------------------------------
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0
```

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Table 4.53 - Scenario 2 - DS1 - Probit IV

```
ivprob   DS1, endog(LNCOMPS)  iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)
(6273 real changes made)
```

DS1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	2.790997	.5037686	5.54	0.000	1.803629	3.778365
APPRV271	-.9660316	.0579543	-16.67	0.000	-1.07962	-.8524433
FEDCAP	.3798645	.1332504	2.85	0.004	.1186985	.6410306
RURAL	-.6909145	.1095588	-6.31	0.000	-.9056459	-.4761832
RUS	.2866742	.0554385	5.17	0.000	.1780166	.3953317
UNEOBLIG	.0068998	.0636826	0.11	0.914	-.1179158	.1317154
alltel	.8229227	.0947855	8.68	0.000	.6371466	1.008699
bellso	-1.25523	.1598039	-7.85	0.000	-1.56844	-.9420201
century	.6677592	.091794	7.27	0.000	.4878462	.8476723
citizens	-.3516175	.142281	-2.47	0.013	-.6304831	-.0727519
qwest	2.267655	.2415338	9.39	0.000	1.794258	2.741053
sbc	.3725895	.1536986	2.42	0.015	.0713458	.6738332
sprint	-.7338197	.1422343	-5.16	0.000	-1.012594	-.4550457
tds	-1.062862	.1537232	-6.91	0.000	-1.364154	-.7615703
valor	.3568151	.1964254	1.82	0.069	-.0281717	.7418019
verizon	-.9122605	.146275	-6.24	0.000	-1.198954	-.6255669
AVGHHINC	.0000156	2.18e-06	7.15	0.000	.0000113	.0000198
DENSITY	-.0001743	.0000306	-5.70	0.000	-.0002343	-.0001144
HSEHLDS	2.56e-06	6.74e-06	0.38	0.704	-.0000107	.0000158
PRATIO	.4456879	.110002	4.05	0.000	.2300879	.6612879
NFIRMS	.0006604	.0001854	3.56	0.000	.0002971	.0010237
LRGFIRMS	-.032252	.0068915	-4.68	0.000	-.0457591	-.0187449
EDUC	-.0280929	.0075495	-3.72	0.000	-.0428896	-.0132962
FINCE	-.0020943	.0014136	-1.48	0.138	-.004865	.0006764
HEALTH	-.0008083	.0010492	-0.77	0.441	-.0028647	.0012481
INFO	.0039891	.0043259	0.92	0.356	-.0044895	.0124678
REALEST	.0249736	.0036317	6.88	0.000	.0178556	.0320917
TCHSRV	-.0059904	.0009992	-6.00	0.000	-.0079487	-.004032
CAP	-1.119113	.2274205	-4.92	0.000	-1.564849	-.6733772
DEREG	-.0883434	.0548282	-1.61	0.107	-.1958047	.0191179
INDXCAP	-.0822739	.0867193	-0.95	0.343	-.2522406	.0876928
NONINDXCAP	1.958438	.1577591	12.41	0.000	1.649236	2.26764
NORMATIV	1.007275	.2092927	4.81	0.000	.5970688	1.417481
PFLEX	-.1208021	.0542939	-2.22	0.026	-.2272161	-.0143881
NONCAPNTWK	-2.941074	.1986996	-14.80	0.000	-3.330518	-2.55163
PFLEXNTWK	-.1140665	.1117431	-1.02	0.307	-.3330789	.104946
_cons	-.8790208	.153973	-5.71	0.000	-1.180802	-.5772394

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Table 4.54 - Scenario 2 - DS1 - Probit IV (dF/dx)

```
divprob  DS1, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)

Probit estimates                                  Number of obs =  14482
                                                   chi2(36)     =6388.27
                                                  Prob > chi2   = 0.0000
Log likelihood =  -6831.917                       Pseudo R2     = 0.3186
```

DS1	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
LNCOMPS	1.097946	.1984219	5.54	0.000	.208707	.709046	1.48685
APPRV271*	-.364813	.0189896	-16.67	0.000	.130576	-.402032	-.327594
FEDCAP*	.1502466	.0524301	2.85	0.004	.749827	.047485	.253008
RURAL*	-.2693022	.0413171	-6.31	0.000	.38137	-.350282	-.188322
RUS*	.1099927	.0205724	5.17	0.000	.150463	.069671	.150314
UNEOBLIG*	.0027149	.025064	0.11	0.914	.711297	-.04641	.05184
alltel*	.2763807	.0244275	8.68	0.000	.03204	.228504	.324258
bellso*	-.4468895	.0422485	-7.85	0.000	.097707	-.529695	-.364084
century*	.2343274	.0267862	7.27	0.000	.035699	.181827	.286827
citizens*	-.1395537	.0559403	-2.47	0.013	.039497	-.249195	-.029913
qwest*	.4833929	.0116964	9.39	0.000	.067946	.460468	.506317
sbc*	.1417876	.0558623	2.42	0.015	.172283	.032299	.251276
sprint*	-.2833469	.0501239	-5.16	0.000	.070639	-.381588	-.185106
tds*	-.3833306	.0419757	-6.91	0.000	.016158	-.465601	-.30106
valor*	.1335977	.0685049	1.82	0.069	.008424	-.000669	.267865
verizon*	-.3515148	.0522155	-6.24	0.000	.279243	-.453855	-.249174
AVGHHINC	6.12e-06	8.58e-07	7.15	0.000	34069.5	4.4e-06	7.8e-06
DENSITY	-.0000686	.0000121	-5.70	0.000	755.605	-.000092	-.000045
HSEHLDS	1.01e-06	2.65e-06	0.38	0.704	5763.05	-4.2e-06	6.2e-06
PRATIO	.1753284	.0432542	4.05	0.000	.777068	.090552	.260105
NFIRMS	.0002598	.000073	3.56	0.000	416.108	.000117	.000403
LRGFIRMS	-.0126876	.0027133	-4.68	0.000	9.76697	-.018006	-.007369
EDUC	-.0110514	.0029682	-3.72	0.000	3.97374	-.016869	-.005234
FINCE	-.0008239	.0005562	-1.48	0.138	24.1116	-.001914	.000266
HEALTH	-.000318	.0004128	-0.77	0.441	39.4505	-.001127	.000491
INFO	.0015693	.0017013	0.92	0.356	7.03878	-.001765	.004904
REALEST	.0098243	.0014279	6.88	0.000	17.6194	.007026	.012623
TCHSRV	-.0023565	.0003933	-6.00	0.000	40.7375	-.003127	-.001586
CAP*	-.3974358	.0589604	-4.92	0.000	.01022	-.512996	-.281876
DEREG*	-.0348295	.0216537	-1.61	0.107	.322124	-.07727	.007611
INDXCAP*	-.0325339	.0344371	-0.95	0.343	.05462	-.100029	.034961
NONINDXCAP*	.4540452	.0122579	12.41	0.000	.054481	.43002	.47807
NORMATIV*	.3147159	.0426387	4.81	0.000	.006491	.231146	.398286
PFLEX*	-.0475542	.0213752	-2.22	0.026	.43592	-.089449	-.005659
NONCAPNTWK*	-.5839832	.0090367	-14.80	0.000	.018022	-.601695	-.566272
PFLEXNTWK*	-.0451904	.0444959	-1.02	0.307	.025687	-.132401	.04202
obs. P	.4795608						
pred. P	.5664915	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

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Table 4.55 - Scenario 2 - DS1 - Summary

	Probit	Probit (dF/dx)	Probit IV	Probit IV (dF/dx)
APPRV271	-0.859	-0.329	-0.966	-0.365
	(19.63)**	(19.63)**	(16.67)**	(16.67)**
FEDCAP	0.362	0.143	0.380	0.150
	(3.49)**	(3.49)**	(2.85)**	(2.85)**
RURAL	-0.754	-0.293	-0.691	-0.269
	(8.56)**	(8.56)**	(6.31)**	(6.31)**
RUS	0.317	0.121	0.287	0.110
	(7.38)**	(7.38)**	(5.17)**	(5.17)**
UNEOBLIG	0.081	0.032	0.007	0.003
	(1.68)	(1.68)	(0.11)	(0.11)
alltel	0.707	0.244	0.823	0.276
	(9.89)**	(9.89)**	(8.68)**	(8.68)**
bellso	-1.047	-0.389	-1.255	-0.447
	(8.50)**	(8.50)**	(7.85)**	(7.85)**
century	0.687	0.239	0.668	0.234
	(9.76)**	(9.76)**	(7.27)**	(7.27)**
citizens	-0.333	-0.132	-0.352	-0.140
	(3.01)**	(3.01)**	(2.47)*	(2.47)*
qwest	2.248	0.479	2.268	0.483
	(10.06)**	(10.06)**	(9.39)**	(9.39)**
sbc	0.264	0.101	0.373	0.142
	(2.16)*	(2.16)*	(2.42)*	(2.42)*
sprint	-0.700	-0.272	-0.734	-0.283
	(6.25)**	(6.25)**	(5.16)**	(5.16)**
tds	-1.082	-0.390	-1.063	-0.383
	(8.13)**	(8.13)**	(6.91)**	(6.91)**
valor	0.349	0.130	0.357	0.134
	(2.31)*	(2.31)*	(1.82)	(1.82)
verizon	-0.894	-0.345	-0.912	-0.352
	(7.67)**	(7.67)**	(6.24)**	(6.24)**
AVGHHINC	0.000	0.000	0.000	0.000
	(5.86)**	(5.86)**	(7.15)**	(7.15)**
DENSITY	-0.000	-0.000	-0.000	-0.000
	(2.84)**	(2.84)**	(5.70)**	(5.70)**
HSEHLDS	0.000	0.000	0.000	0.000
	(6.48)**	(6.48)**	(0.38)	(0.38)
LNCOMPS	0.181	0.071	2.791	1.098
	(5.35)**	(5.35)**	(5.54)**	(5.54)**
PRATIO	0.677	0.266	0.446	0.175
	(8.37)**	(8.37)**	(4.05)**	(4.05)**
NFIRMS	0.000	0.000	0.001	0.000
	(2.84)**	(2.84)**	(3.56)**	(3.56)**
LRGFIRMS	0.000	0.000	-0.032	-0.013
	(0.04)	(0.04)	(4.68)**	(4.68)**
EDUC	-0.032	-0.013	-0.028	-0.011
	(4.81)**	(4.81)**	(3.72)**	(3.72)**

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Table 4.55 (continued)

FINCE	0.001	0.000	-0.002	-0.001
	(0.78)	(0.78)	(1.48)	(1.48)
HEALTH	0.001	0.001	-0.001	-0.000
	(1.57)	(1.57)	(0.77)	(0.77)
INFO	0.010	0.004	0.004	0.002
	(2.47)*	(2.47)*	(0.92)	(0.92)
REALEST	0.010	0.004	0.025	0.010
	(4.86)**	(4.86)**	(6.88)**	(6.88)**
TCHSRV	-0.003	-0.001	-0.006	-0.002
	(4.06)**	(4.06)**	(6.00)**	(6.00)**
CAP	-1.074	-0.387	-1.119	-0.397
	(5.26)**	(5.26)**	(4.92)**	(4.92)**
DEREG	-0.118	-0.047	-0.088	-0.035
	(2.76)**	(2.76)**	(1.61)	(1.61)
INDXCAP	-0.079	-0.031	-0.082	-0.033
	(1.15)	(1.15)	(0.95)	(0.95)
NONINDXCAP	2.119	0.461	1.958	0.454
	(14.93)**	(14.93)**	(12.41)**	(12.41)**
NORMATIV	0.927	0.296	1.007	0.315
	(5.47)**	(5.47)**	(4.81)**	(4.81)**
PFLEX	-0.129	-0.051	-0.121	-0.048
	(3.03)**	(3.03)**	(2.22)*	(2.22)*
NONCAPNTWK	-2.900	-0.587	-2.941	-0.584
	(16.24)**	(16.24)**	(14.80)**	(14.80)**
PFLEXNTWK	0.091	0.035	-0.114	-0.045
	(1.07)	(1.07)	(1.02)	(1.02)
Constant	-0.806		-0.879	
	(6.55)**		(5.71)**	
Observations	14482	14482	14482	14482

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.56 - Scenario 2 - DS3 - Probit

```
probit    DS3  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX  NONCAPNTWK PFLEXNTWK

note: cinnbell~=0 predicts success perfectly
      cinnbell dropped and 46 obs not used


Probit estimates                                  Number of obs   =      14482
                                                  LR chi2(36)     =    2983.58
                                                  Prob > chi2     =     0.0000
Log likelihood = -5171.9187                       Pseudo R2       =     0.2239
```

DS3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
APPRV271	-.2543648	.0466698	-5.45	0.000	-.345836	-.1628936
FEDCAP	-.1321324	.1287186	-1.03	0.305	-.3844162	.1201515
RURAL	-1.248864	.1211741	-10.31	0.000	-1.486361	-1.011367
RUS	.3147541	.0494079	6.37	0.000	.2179163	.4115918
UNEOBLIG	.0950708	.0629229	1.51	0.131	-.0282558	.2183975
alltel	.0653518	.0840346	0.78	0.437	-.0993529	.2300566
bellso	-2.124923	.1513899	-14.04	0.000	-2.421641	-1.828204
century	.5141264	.0772079	6.66	0.000	.3628017	.6654511
citizens	-.6948643	.1484996	-4.68	0.000	-.9859181	-.4038104
qwest	-2.660626	.1624335	-16.38	0.000	-2.97899	-2.342262
sbc	-.8268435	.1389078	-5.95	0.000	-1.099098	-.5545892
sprint	.1193151	.1334976	0.89	0.371	-.1423354	.3809656
tds	-.9226412	.1587824	-5.81	0.000	-1.233849	-.6114334
valor	-1.518257	.3869973	-3.92	0.000	-2.276758	-.7597566
verizon	-1.403109	.1372107	-10.23	0.000	-1.672037	-1.134181
AVGHHINC	.0000137	1.13e-06	12.12	0.000	.0000115	.0000159
DENSITY	6.79e-07	5.97e-06	0.11	0.909	-.000011	.0000124
HSEHLDS	.0000224	3.02e-06	7.42	0.000	.0000165	.0000283
LNCOMPS	.0919245	.0275884	3.33	0.001	.0378522	.1459968
PRATIO	.8646197	.0919976	9.40	0.000	.6843077	1.044932
NFIRMS	.0001472	.0001096	1.34	0.179	-.0000675	.0003619
LRGFIRMS	.0113293	.0018434	6.15	0.000	.0077163	.0149423
EDUC	.0133145	.0047286	2.82	0.005	.0040466	.0225823
FINCE	.0002292	.0007751	0.30	0.767	-.0012898	.0017483
HEALTH	-.0017487	.0005747	-3.04	0.002	-.0028751	-.0006224
INFO	.0044705	.0017049	2.62	0.009	.001129	.007812
REALEST	.0000119	.0012066	0.01	0.992	-.002353	.0023768
TCHSRV	-.001506	.0004335	-3.47	0.001	-.0023557	-.0006563
CAP	-.2271709	.2035613	-1.12	0.264	-.6261437	.1718019
DEREG	-.2256899	.0504396	-4.47	0.000	-.3245497	-.1268302
INDXCAP	-.1831193	.0856761	-2.14	0.033	-.3510413	-.0151973
NONINDXCAP	.886639	.0830248	10.68	0.000	.7239134	1.049365
NORMATIV	.4916652	.1483007	3.32	0.001	.2010012	.7823291
PFLEX	-.0859296	.0499162	-1.72	0.085	-.1837635	.0119043
NONCAPNTWK	-.6060121	.1598627	-3.79	0.000	-.9193372	-.292687
PFLEXNTWK	-.4879162	.1201122	-4.06	0.000	-.7233318	-.2525006
_cons	-1.051871	.1508635	-6.97	0.000	-1.347559	-.7561844

```
note: 0 failures and 1 success completely determined.
```

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Table 4.57 - Scenario 2 - DS3 - Probit (dF/dx)

```
dprobit   DS3  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX  NONCAPNTWK PFLEXNTWK

note: cinnbell~=0 predicts success perfectly
      cinnbell dropped and 46 obs not used


Probit estimates                                  Number of obs =  14482
                                                  LR chi2(36)   =2983.58
                                                  Prob > chi2   = 0.0000
Log likelihood = -5171.9187                       Pseudo R2     = 0.2239
```

DS3	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
APPRV271*	-.0457637	.0074671	-5.45	0.000	.130576	-.060399	-.031128
FEDCAP*	-.0276462	.0279342	-1.03	0.305	.749827	-.082396	.027104
RURAL*	-.2180702	.018947	-10.31	0.000	.38137	-.255206	-.180935
RUS*	.071686	.0125495	6.37	0.000	.150463	.047089	.096282
UNEOBLIG*	.0186997	.0120796	1.51	0.131	.711297	-.004976	.042375
alltel*	.0136338	.0181526	0.78	0.437	.03204	-.021945	.049212
bellso*	-.1670907	.0052413	-14.04	0.000	.097707	-.177363	-.156818
century*	.1328198	.0242322	6.66	0.000	.035699	.085326	.180314
citizens*	-.0936302	.0117947	-4.68	0.000	.039497	-.116747	-.070513
qwest*	-.161315	.0042181	-16.38	0.000	.067946	-.169582	-.153048
sbc*	-.1203526	.0139022	-5.95	0.000	.172283	-.1476	-.093105
sprint*	.0254808	.0301436	0.89	0.371	.070639	-.0336	.084561
tds*	-.1052689	.0079011	-5.81	0.000	.016158	-.120755	-.089783
valor*	-.1199954	.0053867	-3.92	0.000	.008424	-.130553	-.109438
verizon*	-.2038254	.0150641	-10.23	0.000	.279243	-.233351	-.1743
AVGHHINC	2.76e-06	2.28e-07	12.12	0.000	34069.5	2.3e-06	3.2e-06
DENSITY	1.37e-07	1.20e-06	0.11	0.909	755.605	-2.2e-06	2.5e-06
HSEHLDS	4.51e-06	6.10e-07	7.42	0.000	5763.05	3.3e-06	5.7e-06
LNCOMPS	.0185114	.0055484	3.33	0.001	.208707	.007637	.029386
PRATIO	.1741137	.0185406	9.40	0.000	.777068	.137775	.210453
NFIRMS	.0000296	.0000221	1.34	0.179	416.108	-.000014	.000073
LRGFIRMS	.0022814	.0003726	6.15	0.000	9.76697	.001551	.003012
EDUC	.0026812	.0009519	2.82	0.005	3.97374	.000816	.004547
FINCE	.0000462	.0001561	0.30	0.767	24.1116	-.00026	.000352
HEALTH	-.0003522	.0001157	-3.04	0.002	39.4505	-.000579	-.000125
INFO	.0009003	.000344	2.62	0.009	7.03878	.000226	.001574
REALEST	2.39e-06	.000243	0.01	0.992	17.6194	-.000474	.000479
TCHSRV	-.0003033	.0000873	-3.47	0.001	40.7375	-.000474	-.000132
CAP*	-.0399728	.0308185	-1.12	0.264	.01022	-.100376	.02043
DEREG*	-.0433718	.0092448	-4.47	0.000	.322124	-.061491	-.025252
INDXCAP*	-.0334366	.0140803	-2.14	0.033	.05462	-.061033	-.00584
NONIND~P*	.2586461	.030357	10.68	0.000	.054481	.199147	.318145
NORMATIV*	.1274897	.0468194	3.32	0.001	.006491	.035725	.219254
PFLEX*	-.0171949	.0099228	-1.72	0.085	.43592	-.036643	.002253
NONCAP~K*	-.0845205	.0138713	-3.79	0.000	.018022	-.111708	-.057333
PFLEXN~K*	-.0736652	.012754	-4.06	0.000	.025687	-.098663	-.048668
obs. P	.1726971						
pred. P	.1211394	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

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Table 4.58 - Scenario 2 - DS3 - Probit IV

```
ivprob  DS3, endog(LNCOMPS)  iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG allel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP  NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)
(6273 real changes made)
```

DS3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	4.88939	.7378609	6.63	0.000	3.443209	6.335571
APPRV271	-.4577242	.0833009	-5.49	0.000	-.620991	-.2944573
FEDCAP	-.0556729	.2066058	-0.27	0.788	-.4606128	.3492669
RURAL	-1.158032	.1744773	-6.64	0.000	-1.500001	-.8160631
RUS	.256209	.0837741	3.06	0.002	.0920148	.4204033
UNEOBLIG	-.0694282	.1008135	-0.69	0.491	-.2670189	.1281626
alltel	.2637335	.1434554	1.84	0.066	-.017434	.544901
bellso	-2.571289	.2445413	-10.51	0.000	-3.050581	-2.091997
century	.4846731	.1371718	3.53	0.000	.2158213	.753525
citizens	-.8009015	.2281763	-3.51	0.000	-1.248119	-.3536842
qwest	-2.739414	.2420526	-11.32	0.000	-3.213828	-2.265
sbc	-.7054502	.2260906	-3.12	0.002	-1.14858	-.2623207
sprint	.0208351	.2155823	0.10	0.923	-.4016985	.4433687
tds	-.8864359	.2167876	-4.09	0.000	-1.311332	-.46154
valor	-1.588726	.4473696	-3.55	0.000	-2.465554	-.7118975
verizon	-1.518587	.2196442	-6.91	0.000	-1.949082	-1.088092
AVGHHINC	.0000295	3.07e-06	9.61	0.000	.0000235	.0000355
DENSITY	-.0002792	.0000441	-6.33	0.000	-.0003656	-.0001927
HSEHLDS	-.0000248	8.97e-06	-2.77	0.006	-.0000424	-7.25e-06
PRATIO	.4581277	.1607568	2.85	0.004	.1430501	.7732052
NFIRMS	.0007982	.0002086	3.83	0.000	.0003894	.0012069
LRGFIRMS	-.0485145	.0096346	-5.04	0.000	-.067398	-.0296309
EDUC	.0161202	.008132	1.98	0.047	.0001817	.0320587
FINCE	-.0053715	.0015575	-3.45	0.001	-.0084241	-.0023189
HEALTH	-.0057962	.0011444	-5.07	0.000	-.0080391	-.0035533
INFO	-.0043289	.0029046	-1.49	0.136	-.0100218	.0013641
REALEST	.0266005	.0045963	5.79	0.000	.0175918	.0356091
TCHSRV	-.0084329	.0012906	-6.53	0.000	-.0109624	-.0059035
CAP	-.2848846	.2781735	-1.02	0.306	-.8300946	.2603255
DEREG	-.169754	.0828468	-2.05	0.040	-.3321307	-.0073772
INDXCAP	-.192073	.134175	-1.43	0.152	-.4550511	.0709051
NONINDXCAP	.5873005	.1490501	3.94	0.000	.2951677	.8794334
NORMATIV	.6329571	.2785163	2.27	0.023	.0870751	1.178839
PFLEX	-.0762543	.0820592	-0.93	0.353	-.2370874	.0845788
NONCAPNTWK	-.685819	.2302607	-2.98	0.003	-1.137122	-.2345162
PFLEXNTWK	-.8569683	.1772723	-4.83	0.000	-1.204416	-.5095211
_cons	-1.208397	.2336299	-5.17	0.000	-1.666303	-.7504908

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Table 4.59 - Scenario 2 - DS3 - Probit IV (dF/dx)

```
divprob  DS3, endog(LNCOMPS) iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)

Probit estimates                                  Number of obs =  14482
                                                   chi2(36)     =3078.79
                                                  Prob > chi2   = 0.0000
Log likelihood = -5124.3135                       Pseudo R2     = 0.2310
```

DS3	dF/dx	Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
LNCOMPS	.9604031	.1452745	6.63	0.000	.208707	.67567	1.24514
APPRV271*	-.0730017	.0106396	-5.49	0.000	.130576	-.093855	-.052148
FEDCAP*	-.0111177	.0419345	-0.27	0.788	.749827	-.093308	.071072
RURAL*	-.1987259	.0273164	-6.64	0.000	.38137	-.252265	-.145187
RUS*	.0557955	.0200833	3.06	0.002	.150463	.016433	.095158
UNEOBLIG*	-.0138773	.0205014	-0.69	0.491	.711297	-.054059	.026305
alltel*	.0595707	.0366944	1.84	0.066	.03204	-.012349	.13149
bellso*	-.1735981	.0083596	-10.51	0.000	.097707	-.189983	-.157213
century*	.1212496	.0416355	3.53	0.000	.035699	.039645	.202854
citizens*	-.0982578	.0149219	-3.51	0.000	.039497	-.127504	-.069011
qwest*	-.1575334	.0066438	-11.32	0.000	.067946	-.170555	-.144512
sbc*	-.1045594	.0243835	-3.12	0.002	.172283	-.15235	-.056769
sprint*	.0041362	.0432508	0.10	0.923	.070639	-.080634	.088906
tds*	-.1002019	.0112707	-4.09	0.000	.016158	-.122292	-.078112
valor*	-.116754	.006188	-3.55	0.000	.008424	-.128882	-.104626
verizon*	-.210576	.0234075	-6.91	0.000	.279243	-.256454	-.164698
AVGHHINC	5.80e-06	6.11e-07	9.61	0.000	34069.5	4.6e-06	7.0e-06
DENSITY	-.0000548	8.68e-06	-6.33	0.000	755.605	-.000072	-.000038
HSEHLDS	-4.88e-06	1.76e-06	-2.77	0.006	5763.05	-8.3e-06	-1.4e-06
PRATIO	.0899882	.0316726	2.85	0.004	.777068	.027911	.152065
NFIRMS	.0001568	.000041	3.83	0.000	416.108	.000076	.000237
LRGFIRMS	-.0095295	.0018918	-5.04	0.000	9.76697	-.013237	-.005822
EDUC	.0031664	.0015985	1.98	0.047	3.97374	.000033	.006299
FINCE	-.0010551	.0003062	-3.45	0.001	24.1116	-.001655	-.000455
HEALTH	-.0011385	.0002254	-5.07	0.000	39.4505	-.00158	-.000697
INFO	-.0008503	.00057	-1.49	0.136	7.03878	-.001968	.000267
REALEST	.005225	.0009048	5.79	0.000	17.6194	.003452	.006998
TCHSRV	-.0016565	.0002543	-6.53	0.000	40.7375	-.002155	-.001158
CAP*	-.0470571	.0377164	-1.02	0.306	.01022	-.12098	.026866
DEREG*	-.032171	.015162	-2.05	0.040	.322124	-.061888	-.002454
INDXCAP*	-.0339835	.0212172	-1.43	0.152	.05462	-.075568	.007601
NONINDXCAP*	.1519034	.0475635	3.94	0.000	.054481	.058681	.245126
NORMATIV*	.1710707	.0946613	2.27	0.023	.006491	-.014462	.356603
PFLEX*	-.0148928	.0159376	-0.93	0.353	.43592	-.04613	.016344
NONCAPNTWK*	-.088219	.0169301	-2.98	0.003	.018022	-.121401	-.055037
PFLEXNTWK*	-.0999093	.0102835	-4.83	0.000	.025687	-.120065	-.079754

obs. P	.1726971	
pred. P	.1169438	(at x-bar)

(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0

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Table 4.60 - Scenario 2 - DS3 - Summary

	Probit	Probit (dF/dx)	Probit IV	Probit IV (dF/dx)
APPRV271	-0.254	-0.046	-0.458	-0.073
	(5.45)**	(5.45)**	(5.49)**	(5.49)**
FEDCAP	-0.132	-0.028	-0.056	-0.011
	(1.03)	(1.03)	(0.27)	(0.27)
RURAL	-1.249	-0.218	-1.158	-0.199
	(10.31)**	(10.31)**	(6.64)**	(6.64)**
RUS	0.315	0.072	0.256	0.056
	(6.37)**	(6.37)**	(3.06)**	(3.06)**
UNEOBLIG	0.095	0.019	-0.069	-0.014
	(1.51)	(1.51)	(0.69)	(0.69)
alltel	0.065	0.014	0.264	0.060
	(0.78)	(0.78)	(1.84)	(1.84)
bellso	-2.125	-0.167	-2.571	-0.174
	(14.04)**	(14.04)**	(10.51)**	(10.51)**
century	0.514	0.133	0.485	0.121
	(6.66)**	(6.66)**	(3.53)**	(3.53)**
citizens	-0.695	-0.094	-0.801	-0.098
	(4.68)**	(4.68)**	(3.51)**	(3.51)**
qwest	-2.661	-0.161	-2.739	-0.158
	(16.38)**	(16.38)**	(11.32)**	(11.32)**
sbc	-0.827	-0.120	-0.705	-0.105
	(5.95)**	(5.95)**	(3.12)**	(3.12)**
sprint	0.119	0.025	0.021	0.004
	(0.89)	(0.89)	(0.10)	(0.10)
tds	-0.923	-0.105	-0.886	-0.100
	(5.81)**	(5.81)**	(4.09)**	(4.09)**
valor	-1.518	-0.120	-1.589	-0.117
	(3.92)**	(3.92)**	(3.55)**	(3.55)**
verizon	-1.403	-0.204	-1.519	-0.211
	(10.23)**	(10.23)**	(6.91)**	(6.91)**
AVGHHINC	0.000	0.000	0.000	0.000
	(12.12)**	(12.12)**	(9.61)**	(9.61)**
DENSITY	0.000	0.000	-0.000	-0.000
	(0.11)	(0.11)	(6.33)**	(6.33)**
HSEHLDS	0.000	0.000	-0.000	-0.000
	(7.42)**	(7.42)**	(2.77)**	(2.77)**
LNCOMPS	0.092	0.019	4.889	0.960
	(3.33)**	(3.33)**	(6.63)**	(6.63)**
PRATIO	0.865	0.174	0.458	0.090
	(9.40)**	(9.40)**	(2.85)**	(2.85)**
NFIRMS	0.000	0.000	0.001	0.000
	(1.34)	(1.34)	(3.83)**	(3.83)**
LRGFIRMS	0.011	0.002	-0.049	-0.010
	(6.15)**	(6.15)**	(5.04)**	(5.04)**
EDUC	0.013	0.003	0.016	0.003
	(2.82)**	(2.82)**	(1.98)*	(1.98)*

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Table 4.60 (continued)

FINCE	0.000	0.000	-0.005	-0.001
	(0.30)	(0.30)	(3.45)**	(3.45)**
HEALTH	-0.002	-0.000	-0.006	-0.001
	(3.04)**	(3.04)**	(5.07)**	(5.07)**
INFO	0.004	0.001	-0.004	-0.001
	(2.62)**	(2.62)**	(1.49)	(1.49)
REALEST	0.000	0.000	0.027	0.005
	(0.01)	(0.01)	(5.79)**	(5.79)**
TCHSRV	-0.002	-0.000	-0.008	-0.002
	(3.47)**	(3.47)**	(6.53)**	(6.53)**
CAP	-0.227	-0.040	-0.285	-0.047
	(1.12)	(1.12)	(1.02)	(1.02)
DEREG	-0.226	-0.043	-0.170	-0.032
	(4.47)**	(4.47)**	(2.05)*	(2.05)*
INDXCAP	-0.183	-0.033	-0.192	-0.034
	(2.14)*	(2.14)*	(1.43)	(1.43)
NONINDXCAP	0.887	0.259	0.587	0.152
	(10.68)**	(10.68)**	(3.94)**	(3.94)**
NORMATIV	0.492	0.127	0.633	0.171
	(3.32)**	(3.32)**	(2.27)*	(2.27)*
PFLEX	-0.086	-0.017	-0.076	-0.015
	(1.72)	(1.72)	(0.93)	(0.93)
NONCAPNTWK	-0.606	-0.085	-0.686	-0.088
	(3.79)**	(3.79)**	(2.98)**	(2.98)**
PFLEXNTWK	-0.488	-0.074	-0.857	-0.100
	(4.06)**	(4.06)**	(4.83)**	(4.83)**
Constant	-1.052		-1.208	
	(6.97)**		(5.17)**	
Observations	14482	14482	14482	14482

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.61 - Scenario 2 - OC - Probit

```
probit     OC  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK

note: alltel~=0 predicts failure perfectly
      alltel dropped and 464 obs not used

note: bellso~=0 predicts failure perfectly
      bellso dropped and 1415 obs not used

note: cinnbell~=0 predicts failure perfectly
      cinnbell dropped and 46 obs not used

note: citizens~=0 predicts failure perfectly
      citizens dropped and 572 obs not used

note: sprint~=0 predicts failure perfectly
      sprint dropped and 1023 obs not used

note: tds~=0 predicts failure perfectly
      tds dropped and 234 obs not used

note: valor~=0 predicts failure perfectly
      valor dropped and 122 obs not used

note: CAP~=0 predicts failure perfectly
      CAP dropped and 148 obs not used

note: NONCAPNTWK~=0 predicts failure perfectly
      NONCAPNTWK dropped and 61 obs not used

Probit estimates                                  Number of obs   =      10443
                                                  LR chi2(28)     =    2524.18
                                                  Prob > chi2     =     0.0000
Log likelihood = -2291.8534                       Pseudo R2       =     0.3551

------------------------------------------------------------------------------
          OC |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     APPRV271 |  -.7229156   .0678806   -10.65   0.000    -.8559592   -.5898721
       FEDCAP |    -1.9483   .7418955    -2.63   0.009    -3.402388   -.4942114
        RURAL |  -.9407359   .2576219    -3.65   0.000    -1.445666   -.4358062
          RUS |    .244762   .0810101     3.02   0.003      .085985    .4035389
     UNEOBLIG |  -.2452924   .1473057    -1.67   0.096    -.5340064    .0434215
      century |    -1.3675   .5874548    -2.33   0.020     -2.51889   -.2161095
        qwest |   .1740209   .7466149     0.23   0.816    -1.289317    1.637359
          sbc |   2.304173    .747188     3.08   0.002     .8397117    3.768635
      verizon |   1.240749   .7465411     1.66   0.097    -.2224444    2.703943
     AVGHHINC |   .0000192   1.43e-06    13.45   0.000     .0000164     .000022
      DENSITY |  -.0000177   7.64e-06    -2.31   0.021    -.0000326   -2.69e-06
      HSEHLDS |    .000018   3.49e-06     5.17   0.000     .0000112    .0000249
      LNCOMPS |   .2244684   .0345312     6.50   0.000     .1567885    .2921484
       PRATIO |   1.798751   .1333818    13.49   0.000     1.537328    2.060175
       NFIRMS |   .0003201   .0001242     2.58   0.010     .0000765    .0005636
     LRGFIRMS |   .0036952   .0020681     1.79   0.074    -.0003582    .0077486
         EDUC |   .0100795   .0053914     1.87   0.062    -.0004875    .0206464
        FINCE |   .0001316   .0008046     0.16   0.870    -.0014454    .0017087
       HEALTH |  -.0009738   .0006344    -1.53   0.125    -.0022173    .0002697
```

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Table 4.61 (continued)

INFO	-4.35e-06	.001618	-0.00	0.998	-.0031756	.0031669
REALEST	.000192	.0012949	0.15	0.882	-.0023459	.0027299
TCHSRV	-.0015771	.0004921	-3.20	0.001	-.0025416	-.0006126
DEREG	.2069144	.0820681	2.52	0.012	.0460638	.3677651
INDXCAP	.2842652	.1666234	1.71	0.088	-.0423108	.6108411
NONINDXCAP	1.653445	.1354897	12.20	0.000	1.38789	1.919
NORMATIV	1.4655	.6172112	2.37	0.018	.2557881	2.675211
PFLEX	-.2592419	.0850953	-3.05	0.002	-.4260257	-.0924582
PFLEXNTWK	.3404259	.127891	2.66	0.008	.0897642	.5910876
_cons	-3.113672	.2871733	-10.84	0.000	-3.676521	-2.550823

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Table 4.62 - Scenario 2 - OC - Probit IV

```
dprobit      OC  APPRV271 FEDCAP  RURAL RUS UNEOBLIG alltel bellso century
cinnbell citizens qwest sbc sprint tds valor verizon  AVGHHINC DENSITY HSEHLDS
LNCOMPS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO REALEST TCHSRV CAP DEREG
INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK

note: alltel~=0 predicts failure perfectly
      alltel dropped and 464 obs not used

note: bellso~=0 predicts failure perfectly
      bellso dropped and 1415 obs not used

note: cinnbell~=0 predicts failure perfectly
      cinnbell dropped and 46 obs not used

note: citizens~=0 predicts failure perfectly
      citizens dropped and 572 obs not used

note: sprint~=0 predicts failure perfectly
      sprint dropped and 1023 obs not used

note: tds~=0 predicts failure perfectly
      tds dropped and 234 obs not used

note: valor~=0 predicts failure perfectly
      valor dropped and 122 obs not used

note: CAP~=0 predicts failure perfectly
      CAP dropped and 148 obs not used

note: NONCAPNTWK~=0 predicts failure perfectly
      NONCAPNTWK dropped and 61 obs not used


Probit estimates                                  Number of obs =  10443
                                                  LR chi2(28)   =2524.18
                                                  Prob > chi2   = 0.0000
Log likelihood = -2291.8534                       Pseudo R2     = 0.3551

------------------------------------------------------------------------------
      OC |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
---------+--------------------------------------------------------------------
APPRV271*|  -.0450284   .0040186   -10.65   0.000    .181078  -.052905 -.037152
  FEDCAP*|  -.3577543   .2027943    -2.63   0.009    .714737  -.755224  .039715
   RURAL*|  -.0672453   .0158317    -3.65   0.000    .313703  -.098275 -.036216
     RUS*|   .0253621   .0096237     3.02   0.003    .162884     .0065  .044224
UNEOBLIG*|   -.024001   .0157324    -1.67   0.096    .695011  -.054836  .006834
 century*|  -.0472826   .0039814    -2.33   0.020    .049507  -.055086 -.039479
   qwest*|   .0177084   .0851851     0.23   0.816    .081777  -.149251  .184668
     sbc*|   .4992246   .2288027     3.08   0.002    .238916    .05078   .94767
 verizon*|   .1552059   .1251159     1.66   0.097     .37968  -.090017  .400429
AVGHHINC |   1.72e-06   1.58e-07    13.45   0.000    35221.3   1.4e-06  2.0e-06
 DENSITY |  -1.59e-06   6.92e-07    -2.31   0.021    921.788  -2.9e-06 -2.3e-07
 HSEHLDS |   1.62e-06   3.26e-07     5.17   0.000    6112.12   9.8e-07  2.3e-06
 LNCOMPS |   .0201532   .0032674     6.50   0.000    .218587   .013749  .026557
  PRATIO |   .1614957   .0143885    13.49   0.000    .789596   .133295  .189697
  NFIRMS |   .0000287   .0000112     2.58   0.010     435.92   6.7e-06  .000051
LRGFIRMS |   .0003318   .0001865     1.79   0.074    10.2721  -.000034  .000697
    EDUC |    .000905   .0004862     1.87   0.062    4.29077  -.000048  .001858
   FINCE |   .0000118   .0000722     0.16   0.870    24.8281   -.00013  .000153
  HEALTH |  -.0000874   .0000571    -1.53   0.125     42.009  -.000199  .000024
```

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Table 4.62 (continued)

INFO	-3.91e-07	.0001453	-0.00	0.998	7.61989	-.000285	.000284
REALEST	.0000172	.0001163	0.15	0.882	18.5889	-.000211	.000245
TCHSRV	-.0001416	.0000448	-3.20	0.001	43.4567	-.000229	-.000054
DEREG*	.0195997	.0082776	2.52	0.012	.35823	.003376	.035824
INDXCAP*	.0322035	.023147	1.71	0.088	.017619	-.013164	.077571
NONIND~P*	.4183579	.0526837	12.20	0.000	.019918	.3151	.521616
NORMATIV*	.3517086	.2295819	2.37	0.018	.00699	-.098264	.801681
PFLEX*	-.0231561	.0076951	-3.05	0.002	.476108	-.038238	-.008074
PFLEXN~K*	.0399391	.0188891	2.66	0.008	.035622	.002917	.076961
obs. P	.1070574						
pred. P	.0420752	(at x-bar)					

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

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Table 4.63 - Scenario 2 - OC - Probit IV

```
ivprob   OC, endog(LNCOMPS)  iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)
(10312 real changes made)
```

OC	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LNCOMPS	6.105481	.9832277	6.21	0.000	4.17839	8.032572
APPRV271	-.9185627	.1125915	-8.16	0.000	-1.139238	-.6978874
FEDCAP	-1.843566	.7907754	-2.33	0.020	-3.393457	-.2936747
RURAL	-.7795259	.3361605	-2.32	0.020	-1.438388	-.1206634
RUS	.1940566	.1273829	1.52	0.128	-.0556093	.4437224
UNEOBLIG	-.689655	.2017052	-3.42	0.001	-1.08499	-.2943201
century	-1.36529	.6067113	-2.25	0.024	-2.554423	-.1761581
qwest	.0632082	.8132711	0.08	0.938	-1.530774	1.65719
sbc	2.611707	.8148635	3.21	0.001	1.014604	4.20881
verizon	1.260204	.8098549	1.56	0.120	-.3270825	2.84749
AVGHHINC	.0000387	4.14e-06	9.35	0.000	.0000306	.0000469
DENSITY	-.0003503	.0000573	-6.11	0.000	-.0004627	-.0002379
HSEHLDS	-.00004	.000012	-3.33	0.001	-.0000636	-.0000165
PRATIO	1.494818	.2222833	6.72	0.000	1.059151	1.930485
NFIRMS	.0015158	.0003151	4.81	0.000	.0008982	.0021334
LRGFIRMS	-.071728	.0132761	-5.40	0.000	-.0977486	-.0457074
EDUC	-.0013156	.0111448	-0.12	0.906	-.0231591	.0205278
FINCE	-.0055172	.0019482	-2.83	0.005	-.0093355	-.0016988
HEALTH	-.0054683	.0014948	-3.66	0.000	-.008398	-.0025386
INFO	-.0135675	.0039037	-3.48	0.001	-.0212186	-.0059164
REALEST	.0320323	.0059469	5.39	0.000	.0203767	.043688
TCHSRV	-.0098304	.0016864	-5.83	0.000	-.0131357	-.0065252
DEREG	.2807839	.1275949	2.20	0.028	.0307024	.5308654
INDXCAP	.2264546	.2823456	0.80	0.423	-.3269326	.7798418
NONINDXCAP	1.781542	.2574629	6.92	0.000	1.276924	2.28616
NORMATIV	1.49984	.7131705	2.10	0.035	.1020517	2.897629
PFLEX	-.3564568	.1312767	-2.72	0.007	-.6137543	-.0991593
PFLEXNTWK	.0290848	.2090005	0.14	0.889	-.3805486	.4387183
_cons	-3.561069	.4073789	-8.74	0.000	-4.359517	-2.762621

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Table 4.64 - Scenario 2 - OC - Probit IV (dF/dx)

```
divprob  OC, endog(LNCOMPS)  iv(LEMPLYEES) exog(APPRV271 FEDCAP  RURAL RUS
UNEOBLIG alltel bellso century cinnbell citizens qwest sbc sprint tds valor
verizon  AVGHHINC DENSITY HSEHLDS PRATIO NFIRMS LRGFIRMS EDUC FINCE HEALTH INFO
REALEST TCHSRV CAP DEREG INDXCAP  NONINDXCAP NORMATIV PFLEX NONCAPNTWK
PFLEXNTWK)

Probit estimates                                  Number of obs =  10443
                                                   chi2(28)     =2578.46
                                                  Prob > chi2   = 0.0000
Log likelihood = -2264.7161                       Pseudo R2     = 0.3628

------------------------------------------------------------------------------
      OC |      dF/dx   Std. Err.      z    P>|z|     x-bar  [    95% C.I.   ]
---------+--------------------------------------------------------------------
 LNCOMPS |   .4933899   .0843515     6.21   0.000   .218587   .328064  .658716
APPRV271*|  -.0469886   .0053795    -8.16   0.000   .181078  -.057532 -.036445
  FEDCAP*|  -.3090475   .2053044    -2.33   0.020   .714737  -.711437  .093342
   RURAL*|   -.051363   .0192127    -2.32   0.020   .313703  -.089019 -.013707
     RUS*|   .0176431   .0129944     1.52   0.128   .162884  -.007826  .043112
UNEOBLIG*|   -.072595   .0272875    -3.42   0.001   .695011  -.126078 -.019113
 century*|  -.0417502   .0044765    -2.25   0.024   .049507  -.050524 -.032976
   qwest*|    .005355   .0720812     0.08   0.938   .081777  -.135922  .146632
     sbc*|   .5715857   .2437372     3.21   0.001   .238916    .09387   1.0493
 verizon*|   .1456392   .1288567     1.56   0.120    .37968  -.106915  .398194
AVGHHINC |   3.13e-06   3.94e-07     9.35   0.000   35221.3   2.4e-06  3.9e-06
 DENSITY |  -.0000283   4.92e-06    -6.11   0.000   921.788  -.000038 -.000019
 HSEHLDS |  -3.23e-06   9.81e-07    -3.33   0.001   6112.12  -5.2e-06 -1.3e-06
  PRATIO |   .1207977   .0201186     6.72   0.000   .789596   .081366  .160229
  NFIRMS |   .0001225   .0000265     4.81   0.000    435.92   .000071  .000174
LRGFIRMS |  -.0057964   .0011202    -5.40   0.000   10.2721  -.007992 -.003601
    EDUC |  -.0001063   .0009005    -0.12   0.906   4.29077  -.001871  .001659
   FINCE |  -.0004458   .0001595    -2.83   0.005   24.8281  -.000758 -.000133
  HEALTH |  -.0004419   .0001235    -3.66   0.000    42.009  -.000684   -.0002
    INFO |  -.0010964   .0003206    -3.48   0.001   7.61989  -.001725 -.000468
 REALEST |   .0025886   .0005028     5.39   0.000   18.5889   .001603  .003574
  TCHSRV |  -.0007944   .0001441    -5.83   0.000   43.4567  -.001077 -.000512
   DEREG*|   .0245077   .0121668     2.20   0.028    .35823   .000661  .048354
 INDXCAP*|   .0221981   .0329545     0.80   0.423   .017619  -.042392  .086788
NONINDXCAP*| .4494766   .1010725     6.92   0.000   .019918   .251378  .647575
NORMATIV*|   .3468547   .2651412     2.10   0.035    .00699  -.172812  .866522
   PFLEX*|  -.0287021   .0108398    -2.72   0.007   .476108  -.049948 -.007457
PFLEXNTWK*|  .0024078   .0177201     0.14   0.889   .035622  -.032323  .037139
---------+--------------------------------------------------------------------
  obs. P |   .1070574
 pred. P |   .0369679  (at x-bar)
------------------------------------------------------------------------------
(*) dF/dx is for discrete change of dummy variable from 0 to 1
    z and P>|z| are the test of the underlying coefficient being 0
```

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Table 4.65 - Scenario 2 - OC - Summary

	Probit	Probit (dF/dx)	Probit IV	Probit IV (dF/dx)
APPRV271	-0.723	-0.045	-0.919	-0.047
	(10.65)**	(10.65)**	(8.16)**	(8.16)**
FEDCAP	-1.948	-0.358	-1.844	-0.309
	(2.63)**	(2.63)**	(2.33)*	(2.33)*
RURAL	-0.941	-0.067	-0.780	-0.051
	(3.65)**	(3.65)**	(2.32)*	(2.32)*
RUS	0.245	0.025	0.194	0.018
	(3.02)**	(3.02)**	(1.52)	(1.52)
UNEOBLIG	-0.245	-0.024	-0.690	-0.073
	(1.67)	(1.67)	(3.42)**	(3.42)**
century	-1.367	-0.047	-1.365	-0.042
	(2.33)*	(2.33)*	(2.25)*	(2.25)*
qwest	0.174	0.018	0.063	0.005
	(0.23)	(0.23)	(0.08)	(0.08)
sbc	2.304	0.499	2.612	0.572
	(3.08)**	(3.08)**	(3.21)**	(3.21)**
verizon	1.241	0.155	1.260	0.146
	(1.66)	(1.66)	(1.56)	(1.56)
AVGHHINC	0.000	0.000	0.000	0.000
	(13.45)**	(13.45)**	(9.35)**	(9.35)**
DENSITY	-0.000	-0.000	-0.000	-0.000
	(2.31)*	(2.31)*	(6.11)**	(6.11)**
HSEHLDS	0.000	0.000	-0.000	-0.000
	(5.17)**	(5.17)**	(3.33)**	(3.33)**
LNCOMPS	0.224	0.020	6.105	0.493
	(6.50)**	(6.50)**	(6.21)**	(6.21)**
PRATIO	1.799	0.161	1.495	0.121
	(13.49)**	(13.49)**	(6.72)**	(6.72)**
NFIRMS	0.000	0.000	0.002	0.000
	(2.58)**	(2.58)**	(4.81)**	(4.81)**
LRGFIRMS	0.004	0.000	-0.072	-0.006
	(1.79)	(1.79)	(5.40)**	(5.40)**
EDUC	0.010	0.001	-0.001	-0.000
	(1.87)	(1.87)	(0.12)	(0.12)
FINCE	0.000	0.000	-0.006	-0.000
	(0.16)	(0.16)	(2.83)**	(2.83)**
HEALTH	-0.001	-0.000	-0.005	-0.000
	(1.53)	(1.53)	(3.66)**	(3.66)**
INFO	-0.000	-0.000	-0.014	-0.001
	(0.00)	(0.00)	(3.48)**	(3.48)**
REALEST	0.000	0.000	0.032	0.003
	(0.15)	(0.15)	(5.39)**	(5.39)**
TCHSRV	-0.002	-0.000	-0.010	-0.001
	(3.20)**	(3.20)**	(5.83)**	(5.83)**
DEREG	0.207	0.020	0.281	0.025
	(2.52)*	(2.52)*	(2.20)*	(2.20)*

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Table 4.65 (continued)

INDXCAP	0.284	0.032	0.226	0.022
	(1.71)	(1.71)	(0.80)	(0.80)
NONINDXCAP	1.653	0.418	1.782	0.449
	(12.20)**	(12.20)**	(6.92)**	(6.92)**
NORMATIV	1.465	0.352	1.500	0.347
	(2.37)*	(2.37)*	(2.10)*	(2.10)*
PFLEX	-0.259	-0.023	-0.356	-0.029
	(3.05)**	(3.05)**	(2.72)**	(2.72)**
PFLEXNTWK	0.340	0.040	0.029	0.002
	(2.66)**	(2.66)**	(0.14)	(0.14)
Constant	-3.114		-3.561	
	(10.84)**		(8.74)**	
Observations	10443	10443	10443	10443

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.66
Scenario 2 - Summary of All Services - Probit IV (dF/dx)

	PCKTSW	DS1	DS3	OC
LNCOMPS	0.862	1.098	0.960	0.493
	(5.38)**	(5.54)**	(6.63)**	(6.21)**
APPRV271	0.067	-0.365	-0.073	-0.047
	(3.34)**	(16.67)**	(5.49)**	(8.16)**
FEDCAP	-0.426	0.150	-0.011	-0.309
	(5.61)**	(2.85)**	(0.27)	(2.33)*
RURAL	-0.213	-0.269	-0.199	-0.051
	(5.40)**	(6.31)**	(6.64)**	(2.32)*
RUS	0.149	0.110	0.056	0.018
	(6.70)**	(5.17)**	(3.06)**	(1.52)
UNEOBLIG	0.071	0.003	-0.014	-0.073
	(3.03)**	(0.11)	(0.69)	(3.42)**
bellso	0.196	-0.447	-0.174	
	(2.28)*	(7.85)**	(10.51)**	
century	0.468	0.234	0.121	-0.042
	(13.21)**	(7.27)**	(3.53)**	(2.25)*
cinnbell	-0.198			
	(1.56)			
citizens	0.102	-0.140	-0.098	
	(1.30)	(2.47)*	(3.51)**	
qwest	0.661	0.483	-0.158	0.005
	(8.55)**	(9.39)**	(11.32)**	(0.08)
sbc	-0.037	0.142	-0.105	0.572
	(0.48)	(2.42)*	(3.12)**	(3.21)**
sprint	0.332	-0.283	0.004	
	(4.13)**	(5.16)**	(0.10)	
tds	-0.259	-0.383	-0.100	
	(6.50)**	(6.91)**	(4.09)**	
valor	0.466	0.134	-0.117	
	(4.74)**	(1.82)	(3.55)**	
verizon	0.275	-0.352	-0.211	0.146
	(3.39)**	(6.24)**	(6.91)**	(1.56)
AVGHHINC	0.000	0.000	0.000	0.000
	(10.91)**	(7.15)**	(9.61)**	(9.35)**
DENSITY	-0.000	-0.000	-0.000	-0.000
	(5.59)**	(5.70)**	(6.33)**	(6.11)**
HSEHLDS	-0.000	0.000	-0.000	-0.000
	(0.18)	(0.38)	(2.77)**	(3.33)**
PRATIO	0.308	0.175	0.090	0.121
	(8.09)**	(4.05)**	(2.85)**	(6.72)**
NFIRMS	0.000	0.000	0.000	0.000
	(5.55)**	(3.56)**	(3.83)**	(4.81)**
LRGFIRMS	-0.011	-0.013	-0.010	-0.006
	(5.07)**	(4.68)**	(5.04)**	(5.40)**
EDUC	0.000	-0.011	0.003	-0.000
	(0.13)	(3.72)**	(1.98)*	(0.12)

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Table 4.66 (continued)

FINCE	-0.001	-0.001	-0.001	-0.000
	(3.62)**	(1.48)	(3.45)**	(2.83)**
HEALTH	-0.001	-0.000	-0.001	-0.000
	(2.55)*	(0.77)	(5.07)**	(3.66)**
INFO	0.002	0.002	-0.001	-0.001
	(1.61)	(0.92)	(1.49)	(3.48)**
REALEST	0.007	0.010	0.005	0.003
	(6.62)**	(6.88)**	(5.79)**	(5.39)**
TCHSRV	-0.003	-0.002	-0.002	-0.001
	(8.81)**	(6.00)**	(6.53)**	(5.83)**
CAP	0.527	-0.397	-0.047	
	(7.07)**	(4.92)**	(1.02)	
DEREG	-0.147	-0.035	-0.032	0.025
	(7.96)**	(1.61)	(2.05)*	(2.20)*
INDXCAP	-0.094	-0.033	-0.034	0.022
	(3.32)**	(0.95)	(1.43)	(0.80)
NONINDXCAP	0.083	0.454	0.152	0.449
	(2.14)*	(12.41)**	(3.94)**	(6.92)**
NORMATIV	0.100	0.315	0.171	0.347
	(1.32)	(4.81)**	(2.27)*	(2.10)*
PFLEX	-0.135	-0.048	-0.015	-0.029
	(7.10)**	(2.22)*	(0.93)	(2.72)**
NONCAPNTWK	-0.252	-0.584	-0.088	
	(8.40)**	(14.80)**	(2.98)**	
PFLEXNTWK	-0.089	-0.045	-0.100	0.002
	(2.75)**	(1.02)	(4.83)**	(0.14)
alltel		0.276	0.060	
		(8.68)**	(1.84)	
Observations	14064	14482	14482	10443

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

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Table 4.67 - Scenario 3 - Packet Switching

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
PCKTSW	18564	31	.3661761	0.3305	9231.823	0.0000
LNCOMPS	18564	29	.4654275	0.2521	11245.62	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PCKTSW						
LNCOMPS	.0992684	.0223665	4.44	0.000	.0554308	.143106
APPRV271	.0986813	.0101005	9.77	0.000	.0788847	.118478
FEDCAP	-.2418184	.0228167	-10.60	0.000	-.2865383	-.1970984
RURAL	-.1768896	.0189679	-9.33	0.000	-.214066	-.1397132
RUS	.0652952	.0088217	7.40	0.000	.048005	.0825854
UNEOBLIG	.1141208	.0113806	10.03	0.000	.0918153	.1364262
AVGHHINC	3.75e-06	2.50e-07	15.03	0.000	3.26e-06	4.24e-06
EMPLYEES	8.89e-06	1.08e-06	8.26	0.000	6.78e-06	.000011
PRATIO	.1974591	.0174384	11.32	0.000	.1632804	.2316378
NFIRMS	.0001659	.0000117	14.13	0.000	.0001429	.0001889
LRGFIRMS	-.0072238	.0005117	-14.12	0.000	-.0082268	-.0062207
LRGFIRE	.0004684	.0000641	7.30	0.000	.0003427	.0005941
alltel	-.162858	.0162365	-10.03	0.000	-.194681	-.131035
bellso	.0923414	.0266265	3.47	0.001	.0401544	.1445285
century	.3593174	.0160458	22.39	0.000	.3278683	.3907666
cinnbell	-.2190986	.0578244	-3.79	0.000	-.3324323	-.1057648
citizens	.0821269	.0243783	3.37	0.001	.0343463	.1299074
qwest	.4895924	.0262564	18.65	0.000	.4381307	.5410541
sbc	-.1234911	.0257064	-4.80	0.000	-.1738746	-.0731076
sprint	.1246977	.0240807	5.18	0.000	.0775005	.1718949
tds	-.1944744	.021828	-8.91	0.000	-.2372565	-.1516922
valor	.1944039	.0324382	5.99	0.000	.1308262	.2579817
verizon	.130379	.0246281	5.29	0.000	.0821089	.1786492
CAP	.3274354	.0303317	10.80	0.000	.2679864	.3868844
DEREG	-.1234186	.0096386	-12.80	0.000	-.1423098	-.1045273
INDXCAP	-.0879186	.0161386	-5.45	0.000	-.1195496	-.0562876
NONINDXCAP	.1006919	.0185165	5.44	0.000	.0644002	.1369836
NORMATIV	.1487929	.0369029	4.03	0.000	.0764646	.2211212
PFLEX	-.1001857	.009681	-10.35	0.000	-.1191601	-.0812113
NONCAPNTWK	-.3183223	.0272624	-11.68	0.000	-.3717557	-.2648889
PFLEXNTWK	-.0368305	.0193437	-1.90	0.057	-.0747436	.0010825
_cons	.1010421	.0267588	3.78	0.000	.0485958	.1534884
LNCOMPS						
PCKTSW	-.625676	.063875	-9.80	0.000	-.7508687	-.5004832
APPRV271	.1056334	.0142831	7.40	0.000	.077639	.1336278
FEDCAP	-.1710004	.0340596	-5.02	0.000	-.2377559	-.1042448
RURAL	-.1119658	.0272461	-4.11	0.000	-.1653671	-.0585644
UNEOBLIG	.1016163	.0165549	6.14	0.000	.0691693	.1340633
DENSITY	.0000452	1.45e-06	31.20	0.000	.0000424	.0000481
EMPLYEES	.0000283	5.99e-07	47.29	0.000	.0000271	.0000295
PRATIO	.1900769	.0260113	7.31	0.000	.1390957	.2410581
HSEHLDS	6.63e-06	9.16e-07	7.24	0.000	4.84e-06	8.43e-06
LRGFIRE	.0007513	.0000893	8.41	0.000	.0005763	.0009264

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Table 4.67 (continued)

alltel	-.1437746	.0235987	-6.09	0.000	-.1900273	-.0975219
bellso	.1176622	.0346221	3.40	0.001	.0498041	.1855202
century	.2094298	.0289704	7.23	0.000	.1526489	.2662108
cinnbell	-.277445	.0762818	-3.64	0.000	-.4269546	-.1279353
citizens	.0466766	.0318809	1.46	0.143	-.0158088	.109162
qwest	.285081	.045745	6.23	0.000	.1954223	.3747396
sbc	-.1095201	.0342636	-3.20	0.001	-.1766755	-.0423647
sprint	.0550946	.0321709	1.71	0.087	-.0079593	.1181485
tds	-.1168808	.0300897	-3.88	0.000	-.1758554	-.0579061
valor	.0961078	.0434735	2.21	0.027	.0109014	.1813143
verizon	.0889839	.033071	2.69	0.007	.024166	.1538019
CAP	.2030598	.044273	4.59	0.000	.1162864	.2898332
DEREG	-.0823525	.0147243	-5.59	0.000	-.1112115	-.0534935
INDXCAP	-.050661	.0217431	-2.33	0.020	-.0932766	-.0080454
NONINDXCAP	.1153742	.0248007	4.65	0.000	.0667657	.1639826
NORMATIV	.0995529	.0486945	2.04	0.041	.0041135	.1949923
PFLEX	-.0511362	.014227	-3.59	0.000	-.0790205	-.0232519
NONCAPNTWK	-.1541117	.0411099	-3.75	0.000	-.2346856	-.0735378
PFLEXNTWK	.042955	.0249291	1.72	0.085	-.0059052	.0918152
_cons	.084018	.0358255	2.35	0.019	.0138012	.1542347

Endogenous variables: PCKTSW LNCOMPS
Exogenous variables: APPRV271 FEDCAP RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE alltel bellso century cinnbell citizens *qwest sbc sprint* tds valor verizon CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.68 - Scenario 3 - DS1

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
DS1	18564	31	.4119228	0.3124	8638.807	0.0000
LNCOMPS	18564	29	.4285482	0.3660	13339.98	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
DS1						
LNCOMPS	.1861519	.0253736	7.34	0.000	.1364206	.2358832
APPRV271	-.2677864	.0113743	-23.54	0.000	-.2900795	-.2454933
FEDCAP	.0685929	.0257597	2.66	0.008	.0181048	.1190811
RURAL	-.2175891	.0213626	-10.19	0.000	-.259459	-.1757192
RUS	.0983403	.0106601	9.23	0.000	.0774469	.1192337
UNEOBLIG	.0804977	.0128182	6.28	0.000	.0553744	.1056209
AVGHHINC	3.06e-06	2.89e-07	10.57	0.000	2.49e-06	3.63e-06
EMPLYEES	4.43e-07	1.28e-06	0.34	0.730	-2.07e-06	2.96e-06
PRATIO	.1254791	.0196431	6.39	0.000	.0869793	.1639788
NFIRMS	.0001656	.0000141	11.73	0.000	.0001379	.0001933
LRGFIRMS	-.0035049	.0006159	-5.69	0.000	-.004712	-.0022978
LRGFIRE	-.0000795	.0000723	-1.10	0.271	-.0002212	.0000621
alltel	.2885331	.0182844	15.78	0.000	.2526964	.3243698
bellso	-.2341144	.0299847	-7.81	0.000	-.2928832	-.1753455
century	.182522	.0181254	10.07	0.000	.1469968	.2180473
cinnbell	.3467241	.0651141	5.32	0.000	.2191029	.4743454
citizens	-.0708353	.0274543	-2.58	0.010	-.1246446	-.0170259
qwest	.2957811	.0295712	10.00	0.000	.2378226	.3537396
sbc	.1584964	.0289494	5.47	0.000	.1017566	.2152363
sprint	-.1513532	.0271184	-5.58	0.000	-.2045043	-.0982021
tds	-.2268307	.0245971	-9.22	0.000	-.2750401	-.1786214
valor	.2137596	.0365304	5.85	0.000	.1421614	.2853579
verizon	-.2231229	.0277326	-8.05	0.000	-.2774779	-.168768
CAP	-.1884601	.0341593	-5.52	0.000	-.255411	-.1215091
DEREG	-.0423123	.010856	-3.90	0.000	-.0635896	-.0210351
INDXCAP	-.0599935	.018175	-3.30	0.001	-.0956159	-.0243711
NONINDXCAP	.3508171	.0208576	16.82	0.000	.309937	.3916972
NORMATIV	.3829053	.0415892	9.21	0.000	.3013919	.4644188
PFLEX	-.0369016	.0109043	-3.38	0.001	-.0582737	-.0155295
NONCAPNTWK	-.5655384	.0307074	-18.42	0.000	-.6257238	-.505353
PFLEXNTWK	.0216682	.0217835	0.99	0.320	-.0210267	.064363
_cons	.2469582	.0301898	8.18	0.000	.1877872	.3061291
LNCOMPS						
DS1	-.3507043	.0701351	-5.00	0.000	-.4881667	-.213242
APPRV271	-.0474123	.0218225	-2.17	0.030	-.0901836	-.004641
FEDCAP	.0141994	.0262555	0.54	0.589	-.0372603	.0656592
RURAL	-.0688349	.0271712	-2.53	0.011	-.1220895	-.0155803
UNEOBLIG	.0550803	.0147175	3.74	0.000	.0262344	.0839261
DENSITY	.0000444	1.35e-06	32.99	0.000	.0000418	.0000471
EMPLYEES	.0000261	5.73e-07	45.46	0.000	.0000249	.0000272
PRATIO	.1056721	.0224274	4.71	0.000	.0617153	.1496289
HSEHLDS	5.94e-06	9.46e-07	6.28	0.000	4.09e-06	7.80e-06
LRGFIRE	.0004345	.0000753	5.77	0.000	.0002869	.0005821

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Table 4.68 (continued)

alltel	.059761	.027142	2.20	0.028	.0065636	.1129583
bellso	-.0199968	.0356366	-0.56	0.575	-.0898432	.0498496
century	.0537617	.0207806	2.59	0.010	.0130324	.094491
cinnbell	-.0178609	.0709894	-0.25	0.801	-.1569975	.1212757
citizens	-.0361687	.0291041	-1.24	0.214	-.0932116	.0208743
qwest	.0799873	.0368325	2.17	0.030	.0077969	.1521777
sbc	.0198141	.031859	0.62	0.534	-.0426284	.0822565
sprint	-.0858513	.030247	-2.84	0.005	-.1451343	-.0265684
tds	-.0781648	.0291103	-2.69	0.007	-.13522	-.0211097
valor	.046456	.0406246	1.14	0.253	-.0331667	.1260787
verizon	-.0790141	.0324452	-2.44	0.015	-.1426054	-.0154227
CAP	-.0682831	.0380601	-1.79	0.073	-.1428796	.0063134
DEREG	-.0196224	.0117049	-1.68	0.094	-.0425635	.0033187
INDXCAP	-.0109021	.0195391	-0.56	0.577	-.049198	.0273938
NONINDXCAP	.1693835	.0334683	5.06	0.000	.1037869	.2349801
NORMATIV	.1351875	.0527047	2.56	0.010	.0318882	.2384869
PFLEX	.0029568	.0116802	0.25	0.800	-.0199361	.0258496
NONCAPNTWK	-.1394123	.0514149	-2.71	0.007	-.2401836	-.038641
PFLEXNTWK	.0687526	.0228006	3.02	0.003	.0240642	.113441
_cons	.0601977	.0399378	1.51	0.132	-.0180789	.1384743

Endogenous variables: DS1 LNCOMPS
Exogenous variables: APPRV271 FEDCAP RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE alltel bellso century cinnbell citizens qwest sbc sprint tds valor verizon CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.69 - Scenario 3 - DS3

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
DS3	18564	31	.3289634	0.1762	4663.629	0.0000
LNCOMPS	18564	29	.4055372	0.4322	15018.66	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
DS3						
LNCOMPS	.1786604	.020284	8.81	0.000	.1389046	.2184162
APPRV271	-.0950272	.0090713	-10.48	0.000	-.1128067	-.0772478
FEDCAP	.0236392	.0205519	1.15	0.250	-.0166417	.0639201
RURAL	-.2327721	.0170383	-13.66	0.000	-.2661665	-.1993776
RUS	.0647257	.0086069	7.52	0.000	.0478565	.081595
UNEOBLIG	.0078449	.0102233	0.77	0.443	-.0121924	.0278823
AVGHHINC	3.44e-06	2.34e-07	14.70	0.000	2.98e-06	3.90e-06
EMPLYEES	-1.24e-06	1.04e-06	-1.19	0.233	-3.28e-06	8.00e-07
PRATIO	.131751	.0156665	8.41	0.000	.1010454	.1624567
NFIRMS	.0000685	.0000115	5.97	0.000	.000046	.000091
LRGFIRMS	.0004886	.0005019	0.97	0.330	-.0004951	.0014723
LRGFIRE	.0002888	.0000576	5.01	0.000	.0001759	.0004018
alltel	.0482882	.0145818	3.31	0.001	.0197083	.0768681
bellso	-.4033577	.023913	-16.87	0.000	-.4502264	-.3564891
century	.1212336	.014462	8.38	0.000	.0928886	.1495786
cinnbell	.5312274	.051928	10.23	0.000	.4294503	.6330045
citizens	-.1238687	.0218956	-5.66	0.000	-.1667834	-.0809541
qwest	-.435097	.023584	-18.45	0.000	-.4813208	-.3888733
sbc	-.1195139	.0230876	-5.18	0.000	-.1647647	-.0742631
sprint	.0057585	.021628	0.27	0.790	-.0366317	.0481486
tds	-.1231955	.0196182	-6.28	0.000	-.1616464	-.0847446
valor	-.1396471	.0291332	-4.79	0.000	-.196747	-.0825471
verizon	-.2808799	.0221169	-12.70	0.000	-.3242281	-.2375317
CAP	-.0394508	.0272426	-1.45	0.148	-.0928453	.0139438
DEREG	-.0515108	.0086581	-5.95	0.000	-.0684804	-.0345413
INDXCAP	-.0479549	.0144953	-3.31	0.001	-.0763652	-.0195446
NONINDXCAP	.1937165	.0166354	11.64	0.000	.1611117	.2263214
NORMATIV	.2391319	.0331713	7.21	0.000	.1741174	.3041464
PFLEX	-.014862	.0086971	-1.71	0.087	-.031908	.0021839
NONCAPNTWK	-.1716303	.0244918	-7.01	0.000	-.2196333	-.1236273
PFLEXNTWK	-.1050478	.0173724	-6.05	0.000	-.1390971	-.0709984
_cons	.1407222	.0240869	5.84	0.000	.0935128	.1879316
LNCOMPS						
DS3	-.2525335	.0718307	-3.52	0.000	-.3933192	-.1117479
APPRV271	.0220315	.0127974	1.72	0.085	-.0030509	.047114
FEDCAP	.0071361	.0247276	0.29	0.773	-.0413291	.0556013
RURAL	-.0502754	.0271242	-1.85	0.064	-.1034378	.002887
UNEOBLIG	.0279253	.0126142	2.21	0.027	.003202	.0526486
DENSITY	.0000429	1.28e-06	33.51	0.000	.0000404	.0000454
EMPLYEES	.0000255	6.24e-07	40.82	0.000	.0000243	.0000267
PRATIO	.0936098	.0216179	4.33	0.000	.0512395	.1359802
HSEHLDS	5.31e-06	7.58e-07	7.00	0.000	3.82e-06	6.79e-06
LRGFIRE	.0005292	.0000769	6.88	0.000	.0003785	.00068

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Table 4.69 (continued)

alltel	-.0281912	.0181275	-1.56	0.120	-.0637204	.0073379
bellso	-.0418645	.0417757	-1.00	0.316	-.1237434	.0400144
century	.0275591	.0184319	1.50	0.135	-.0085667	.063685
cinnbell	.0010349	.0732813	0.01	0.989	-.1425937	.1446636
citizens	-.0430236	.0283624	-1.52	0.129	-.0986129	.0125656
qwest	-.1358825	.0433327	-3.14	0.002	-.2208129	-.050952
sbc	-.0663358	.0299208	-2.22	0.027	-.1249795	-.0076922
sprint	-.0329999	.0266339	-1.24	0.215	-.0852014	.0192015
tds	-.0343113	.0251433	-1.36	0.172	-.0835913	.0149686
valor	-.0637297	.0375681	-1.70	0.090	-.1373618	.0099023
verizon	-.0745602	.0333466	-2.24	0.025	-.1399183	-.0092022
CAP	-.0143158	.0337396	-0.42	0.671	-.0804441	.0518125
DEREG	-.0184461	.0113348	-1.63	0.104	-.0406618	.0037696
INDXCAP	-.0010094	.0182814	-0.06	0.956	-.0368402	.0348214
NONINDXCAP	.0891722	.0248573	3.59	0.000	.0404528	.1378915
NORMATIV	.05336	.0451724	1.18	0.238	-.0351763	.1418963
PFLEX	.0127439	.0107492	1.19	0.236	-.0083241	.0338118
NONCAPNTWK	.0206901	.0326344	0.63	0.526	-.0432721	.0846523
PFLEXNTWK	.0315231	.0225073	1.40	0.161	-.0125903	.0756366
_cons	-.0081481	.0338426	-0.24	0.810	-.0744784	.0581822

Endogenous variables: DS3 LNCOMPS
Exogenous variables: APPRV271 FEDCAP RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE alltel bellso century cinnbell citizens qwest sbc sprint tds valor verizon CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.70 - Scenario 3 - OC

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
OC	18564	31	.2164613	0.2280	5772.26	0.0000
LNCOMPS	18564	29	.4041337	0.4361	15123.62	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
OC						
LNCOMPS	.0937951	.0133497	7.03	0.000	.0676302	.1199601
APPRV271	-.1352222	.0059706	-22.65	0.000	-.1469244	-.1235201
FEDCAP	-.0898089	.0135265	-6.64	0.000	-.1163203	-.0632974
RURAL	-.0531432	.0112143	-4.74	0.000	-.0751229	-.0311635
RUS	.0163355	.0056611	2.89	0.004	.00524	.027431
UNEOBLIG	-.0142267	.0067288	-2.11	0.034	-.027415	-.0010384
AVGHHINC	3.04e-06	1.54e-07	19.71	0.000	2.73e-06	3.34e-06
EMPLYEES	-4.66e-06	6.85e-07	-6.80	0.000	-6.00e-06	-3.32e-06
PRATIO	.1774508	.0103114	17.21	0.000	.1572409	.1976608
NFIRMS	.000076	7.55e-06	10.06	0.000	.0000612	.0000908
LRGFIRMS	.0017075	.0003302	5.17	0.000	.0010604	.0023546
LRGFIRE	-.0004081	.0000379	-10.76	0.000	-.0004825	-.0003338
alltel	-.0108977	.0095975	-1.14	0.256	-.0297085	.0079131
bellso	-.0419051	.0157392	-2.66	0.008	-.0727533	-.0110568
century	-.017416	.0095183	-1.83	0.067	-.0360716	.0012396
cinnbell	-.0006527	.0341783	-0.02	0.985	-.0676409	.0663355
citizens	.0479713	.0144114	3.33	0.001	.0197255	.076217
qwest	-.0276699	.0155226	-1.78	0.075	-.0580936	.0027539
sbc	.2501312	.0151959	16.46	0.000	.2203478	.2799147
sprint	.0723285	.0142352	5.08	0.000	.044428	.1002291
tds	-.0465862	.0129123	-3.61	0.000	-.0718938	-.0212786
valor	.1057459	.019175	5.51	0.000	.0681635	.1433282
verizon	.0673573	.014557	4.63	0.000	.0388261	.0958884
CAP	-.0206283	.0179307	-1.15	0.250	-.0557718	.0145152
DEREG	.0334326	.0056986	5.87	0.000	.0222635	.0446016
INDXCAP	.0141086	.0095406	1.48	0.139	-.0045906	.0328078
NONINDXCAP	.0824945	.0109492	7.53	0.000	.0610345	.1039545
NORMATIV	.0204186	.0218326	0.94	0.350	-.0223726	.0632097
PFLEX	-.0169892	.0057243	-2.97	0.003	-.0282086	-.0057698
NONCAPNTWK	-.0487159	.0161201	-3.02	0.003	-.0803106	-.0171211
PFLEXNTWK	-.0117683	.0114343	-1.03	0.303	-.034179	.0106425
_cons	-.1580134	.015853	-9.97	0.000	-.1890847	-.1269422
LNCOMPS						
OC	-.3179019	.0778783	-4.08	0.000	-.4705405	-.1652633
APPRV271	.0028865	.0150469	0.19	0.848	-.0266048	.0323778
FEDCAP	-.0222955	.0259433	-0.86	0.390	-.0731435	.0285524
RURAL	-.0094681	.0214291	-0.44	0.659	-.0514684	.0325322
UNEOBLIG	.0219007	.0124998	1.75	0.080	-.0025983	.0463998
DENSITY	.0000426	1.27e-06	33.52	0.000	.0000401	.0000451
EMPLYEES	.0000251	5.23e-07	48.04	0.000	.0000241	.0000261
PRATIO	.1162378	.0237642	4.89	0.000	.0696608	.1628149
HSEHLDS	5.06e-06	7.10e-07	7.14	0.000	3.67e-06	6.45e-06
LRGFIRE	.0003226	.0000748	4.31	0.000	.000176	.0004692

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Table 4.70 (continued)

alltel	-.043205	.0179438	-2.41	0.016	-.0783743	-.0080358
bellso	.046508	.0296257	1.57	0.116	-.0115574	.1045733
century	-.0046435	.0174351	-0.27	0.790	-.0388157	.0295287
cinnbell	-.1302241	.0637595	-2.04	0.041	-.2551904	-.0052579
citizens	.0049703	.027197	0.18	0.855	-.0483349	.0582754
qwest	-.0338538	.0290819	-1.16	0.244	-.0908533	.0231457
sbc	.0456048	.0343667	1.33	0.185	-.0217527	.1129623
sprint	-.0101556	.0271803	-0.37	0.709	-.0634281	.0431168
tds	-.02053	.0241353	-0.85	0.395	-.0678343	.0267743
valor	.0061547	.0365588	0.17	0.866	-.0654992	.0778087
verizon	.0184019	.0278335	0.66	0.509	-.0361508	.0729545
CAP	-.0112957	.0335215	-0.34	0.736	-.0769965	.0544052
DEREG	.0045204	.0108686	0.42	0.677	-.0167817	.0258226
INDXCAP	.0145022	.0177852	0.82	0.415	-.0203562	.0493606
NONINDXCAP	.0664616	.021394	3.11	0.002	.0245303	.108393
NORMATIV	-.004975	.0405442	-0.12	0.902	-.0844402	.0744903
PFLEX	.0102913	.0107695	0.96	0.339	-.0108166	.0313991
NONCAPNTWK	.0454646	.0303654	1.50	0.134	-.0140504	.1049796
PFLEXNTWK	.0542246	.0213022	2.55	0.011	.012473	.0959761
_cons	-.0953573	.0277819	-3.43	0.001	-.1498088	-.0409058

Endogenous variables: OC LNCOMPS
Exogenous variables: APPRV271 FEDCAP RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE alltel bellso century cinnbell citizens qwest sbc sprint tds valor verizon CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.71 - Scenario 3 - Summary

	PCKTSW	LNCOMPS	DS1	LNCOMPS	DS3	LNCOMPS	OC	LNCOMPS
LNCOMPS	0.099		0.186		0.179		0.094	
	(4.44)**		(7.34)**		(8.81)**		(7.03)**	
APPRV271	0.099	0.106	-0.268	-0.047	-0.095	0.022	-0.135	0.003
	(9.77)**	(7.40)**	(23.54)**	(2.17)*	(10.48)**	(1.72)	(22.65)**	(0.19)
FEDCAP	-0.242	-0.171	0.069	0.014	0.024	0.007	-0.090	-0.022
	(10.60)**	(5.02)**	(2.66)**	(0.54)	(1.15)	(0.29)	(6.64)**	(0.86)
RURAL	-0.177	-0.112	-0.218	-0.069	-0.233	-0.050	-0.053	-0.009
	(9.33)**	(4.11)**	(10.19)**	(2.53)*	(13.66)**	(1.85)	(4.74)**	(0.44)
RUS	0.065		0.098		0.065		0.016	
	(7.40)**		(9.23)**		(7.52)**		(2.89)**	
UNEOBLIG	0.114	0.102	0.080	0.055	0.008	0.028	-0.014	0.022
	(10.03)**	(6.14)**	(6.28)**	(3.74)**	(0.77)	(2.21)*	(2.11)*	(1.75)
AVGHHINC	0.000		0.000		0.000		0.000	
	(15.03)**		(10.57)**		(14.70)**		(19.71)**	
EMPLYEES	0.000	0.000	0.000	0.000	-0.000	0.000	-0.000	0.000
	(8.26)**	(47.29)**	(0.34)	(45.46)**	(1.19)	(40.82)**	(6.80)**	(48.04)**
PRATIO	0.197	0.190	0.125	0.106	0.132	0.094	0.177	0.116
	(11.32)**	(7.31)**	(6.39)**	(4.71)**	(8.41)**	(4.33)**	(17.21)**	(4.89)**
NFIRMS	0.000		0.000		0.000		0.000	
	(14.13)**		(11.73)**		(5.97)**		(10.06)**	
LRGFIRMS	-0.007		-0.004		0.000		0.002	
	(14.12)**		(5.69)**		(0.97)		(5.17)**	
LRGFIRE	0.000	0.001	-0.000	0.000	0.000	0.001	-0.000	0.000
	(7.30)**	(8.41)**	(1.10)	(5.77)**	(5.01)**	(6.88)**	(10.76)**	(4.31)**
alltel	-0.163	-0.144	0.289	0.060	0.048	-0.028	-0.011	-0.043
	(10.03)**	(6.09)**	(15.78)**	(2.20)*	(3.31)**	(1.56)	(1.14)	(2.41)*
bellso	0.092	0.118	-0.234	-0.020	-0.403	-0.042	-0.042	0.047
	(3.47)**	(3.40)**	(7.81)**	(0.56)	(16.87)**	(1.00)	(2.66)**	(1.57)
century	0.359	0.209	0.183	0.054	0.121	0.028	-0.017	-0.005
	(22.39)**	(7.23)**	(10.07)**	(2.59)**	(8.38)**	(1.50)	(1.83)	(0.27)
cinnbell	-0.219	-0.277	0.347	-0.018	0.531	0.001	-0.001	-0.130
	(3.79)**	(3.64)**	(5.32)**	(0.25)	(10.23)**	(0.01)	(0.02)	(2.04)*

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Table 4.71 (continued)

citizens	0.082	0.047	-0.071	-0.036	-0.124	-0.043	0.048	0.005
	(3.37)**	(1.46)	(2.58)**	(1.24)	(5.66)**	(1.52)	(3.33)**	(0.18)
qwest	0.490	0.285	0.296	0.080	-0.435	-0.136	-0.028	-0.034
	(18.65)**	(6.23)**	(10.00)**	(2.17)*	(18.45)**	(3.14)**	(1.78)	(1.16)
sbc	-0.123	-0.110	0.158	0.020	-0.120	-0.066	0.250	0.046
	(4.80)**	(3.20)**	(5.47)**	(0.62)	(5.18)**	(2.22)*	(16.46)**	(1.33)
sprint	0.125	0.055	-0.151	-0.086	0.006	-0.033	0.072	-0.010
	(5.18)**	(1.71)	(5.58)**	(2.84)**	(0.27)	(1.24)	(5.08)**	(0.37)
tds	-0.194	-0.117	-0.227	-0.078	-0.123	-0.034	-0.047	-0.021
	(8.91)**	(3.88)**	(9.22)**	(2.69)**	(6.28)**	(1.36)	(3.61)**	(0.85)
valor	0.194	0.096	0.214	0.046	-0.140	-0.064	0.106	0.006
	(5.99)**	(2.21)*	(5.85)**	(1.14)	(4.79)**	(1.70)	(5.51)**	(0.17)
verizon	0.130	0.089	-0.223	-0.079	-0.281	-0.075	0.067	0.018
	(5.29)**	(2.69)**	(8.05)**	(2.44)*	(12.70)**	(2.24)*	(4.63)**	(0.66)
CAP	0.327	0.203	-0.188	-0.068	-0.039	-0.014	-0.021	-0.011
	(10.80)**	(4.59)**	(5.52)**	(1.79)	(1.45)	(0.42)	(1.15)	(0.34)
DEREG	-0.123	-0.082	-0.042	-0.020	-0.052	-0.018	0.033	0.005
	(12.80)**	(5.59)**	(3.90)**	(1.68)	(5.95)**	(1.63)	(5.87)**	(0.42)
INDXCAP	-0.088	-0.051	-0.060	-0.011	-0.048	-0.001	0.014	0.015
	(5.45)**	(2.33)*	(3.30)**	(0.56)	(3.31)**	(0.06)	(1.48)	(0.82)
NONINDXCAP	0.101	0.115	0.351	0.169	0.194	0.089	0.082	0.066
	(5.44)**	(4.65)**	(16.82)**	(5.06)**	(11.64)**	(3.59)**	(7.53)**	(3.11)**
NORMATIV	0.149	0.100	0.383	0.135	0.239	0.053	0.020	-0.005
	(4.03)**	(2.04)*	(9.21)**	(2.56)*	(7.21)**	(1.18)	(0.94)	(0.12)
PFLEX	-0.100	-0.051	-0.037	0.003	-0.015	0.013	-0.017	0.010
	(10.35)**	(3.59)**	(3.38)**	(0.25)	(1.71)	(1.19)	(2.97)**	(0.96)
NONCAPNTWK	-0.318	-0.154	-0.566	-0.139	-0.172	0.021	-0.049	0.045
	(11.68)**	(3.75)**	(18.42)**	(2.71)**	(7.01)**	(0.63)	(3.02)**	(1.50)
PFLEXNTWK	-0.037	0.043	0.022	0.069	-0.105	0.032	-0.012	0.054
	(1.90)	(1.72)	(0.99)	(3.02)**	(6.05)**	(1.40)	(1.03)	(2.55)*
PCKTSW		-0.626						
		(9.80)**						
DENSITY		0.000		0.000		0.000		0.000
		(31.20)**		(32.99)**		(33.51)**		(33.52)**

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Table 4.71 (continued)

HSEHLDS		0.000		0.000		0.000		0.000
		(7.24)**		(6.28)**		(7.00)**		(7.14)**
DS1				-0.351				
				(5.00)**				
OC								-0.318
								(4.08)**
Constant	0.101	0.084	0.247	0.060	0.141	-0.008	-0.158	-0.095
	(3.78)**	(2.35)*	(8.18)**	(1.51)	(5.84)**	(0.24)	(9.97)**	(3.43)**
DS3						-0.253		
						(3.52)**		
Observations		18564	18564	18564	18564	18564	18564	18564 18564

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

Table 4.72 - Scenario 4 - Packet Switching

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
PCKTSW	18564	22	.3923778	0.2312	5607.033	0.0000
LNCOMPS	18564	20	.5399986	-0.0067	7927.59	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PCKTSW						
LNCOMPS	.0982267	.0236355	4.16	0.000	.051902	.1445515
APPRV271	-.008162	.0100887	-0.81	0.419	-.0279354	.0116114
FEDCAP	-.2682179	.013383	-20.04	0.000	-.2944482	-.2419876
LECLRG	.2003008	.0209904	9.54	0.000	.1591604	.2414412
LECMID	.0888953	.0112471	7.90	0.000	.0668513	.1109393
RURAL	-.0802276	.0185097	-4.33	0.000	-.1165059	-.0439493
RUS	.0153102	.0077201	1.98	0.047	.000179	.0304413
UNEOBLIG	.142264	.0106108	13.41	0.000	.1214672	.1630608
AVGHHINC	2.90e-06	2.41e-07	12.00	0.000	2.42e-06	3.37e-06
EMPLYEES	9.64e-06	1.05e-06	9.19	0.000	7.59e-06	.0000117
PRATIO	.4052063	.0169947	23.84	0.000	.3718972	.4385153
NFIRMS	.0001646	.0000114	14.39	0.000	.0001421	.000187
LRGFIRMS	-.008015	.0005026	-15.95	0.000	-.0090001	-.0070299
LRGFIRE	.0006186	.000067	9.23	0.000	.0004872	.00075
CAP	.5017891	.0320117	15.68	0.000	.4390472	.5645309
DEREG	-.1777549	.010077	-17.64	0.000	-.1975054	-.1580043
INDXCAP	-.1167768	.0162734	-7.18	0.000	-.1486721	-.0848814
NONINDXCAP	.1554376	.0191138	8.13	0.000	.1179751	.1929
NORMATIV	.3313274	.0384939	8.61	0.000	.2558807	.4067741
PFLEX	-.113235	.0100814	-11.23	0.000	-.1329941	-.0934759
NONCAPNTWK	-.3333475	.0287834	-11.58	0.000	-.3897621	-.276933
PFLEXNTWK	.0724271	.0204117	3.55	0.000	.0324208	.1124333
_cons	-.0938732	.0269257	-3.49	0.000	-.1466465	-.0410999
LNCOMPS						
PCKTSW	-.8913771	.0854779	-10.43	0.000	-1.058911	-.7238436
APPRV271	.0215623	.0143819	1.50	0.134	-.0066258	.0497503
FEDCAP	-.2426661	.0297069	-8.17	0.000	-.3008905	-.1844416
LECLRG	.2022737	.0348158	5.81	0.000	.134036	.2705113
LECMID	.0629032	.0176976	3.55	0.000	.0282165	.0975899
RURAL	-.062716	.0275112	-2.28	0.023	-.116637	-.0087951
UNEOBLIG	.1501206	.0196236	7.65	0.000	.1116589	.1885822
DENSITY	.0000478	1.65e-06	29.01	0.000	.0000446	.000051
EMPLYEES	.0000295	7.12e-07	41.36	0.000	.0000281	.0000309
PRATIO	.4450869	.0434352	10.25	0.000	.3599555	.5302182
HSEHLDS	7.05e-06	9.71e-07	7.27	0.000	5.15e-06	8.96e-06
LRGFIRE	.0011132	.0001119	9.95	0.000	.000894	.0013324
CAP	.4393841	.0632656	6.95	0.000	.3153859	.5633824
DEREG	-.1715373	.0213055	-8.05	0.000	-.2132952	-.1297794
INDXCAP	-.08582	.0259088	-3.31	0.001	-.1366003	-.0350396
NONINDXCAP	.211506	.0308513	6.86	0.000	.1510385	.2719735
NORMATIV	.2968012	.0622161	4.77	0.000	.1748598	.4187425
PFLEX	-.0958994	.0177921	-5.39	0.000	-.1307712	-.0610276
NONCAPNTWK	-.239251	.0514254	-4.65	0.000	-.3400428	-.1384591
PFLEXNTWK	.136162	.0302721	4.50	0.000	.0768299	.1954942
_cons	-.0901138	.0362964	-2.48	0.013	-.1612534	-.0189743

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Table 4.72 (continued)

Endogenous variables: PCKTSW LNCOMPS
Exogenous variables: APPRV271 FEDCAP LECLRG LECMID RURAL RUS UNEOBLIG
AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE CAP DEREG INDXCAP
NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.73 - Scenario 4 - DS1

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
DS1	18564	22	.4403969	0.2140	5135.657	0.0000
LNCOMPS	18564	20	.4340653	0.3495	12382.49	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
DS1						
LNCOMPS	.0901593	.0267987	3.36	0.001	.0376347	.1426838
APPRV271	-.2262571	.0113323	-19.97	0.000	-.2484679	-.2040462
FEDCAP	-.1645008	.0152713	-10.77	0.000	-.1944321	-.1345695
LECLRG	-.0797814	.0235723	-3.38	0.001	-.1259822	-.0335806
LECMID	.1124095	.0126482	8.89	0.000	.0876195	.1371995
RURAL	-.3774168	.0207848	-18.16	0.000	-.4181543	-.3366794
RUS	.0536127	.010622	5.05	0.000	.0327941	.0744314
UNEOBLIG	.161589	.0119216	13.55	0.000	.1382231	.1849549
AVGHHINC	2.17e-06	2.93e-07	7.38	0.000	1.59e-06	2.74e-06
EMPLYEES	3.61e-06	1.33e-06	2.70	0.007	9.92e-07	6.23e-06
PRATIO	.1912088	.0190983	10.01	0.000	.1537768	.2286408
NFIRMS	.0001907	.0000146	13.10	0.000	.0001621	.0002192
LRGFIRMS	-.0034624	.0006301	-5.50	0.000	-.0046973	-.0022274
LRGFIRE	-.0005042	.0000753	-6.69	0.000	-.0006519	-.0003565
CAP	-.0949834	.0359578	-2.64	0.008	-.1654594	-.0245074
DEREG	.0231394	.0113219	2.04	0.041	.0009489	.0453299
INDXCAP	-.1251565	.0182789	-6.85	0.000	-.1609825	-.0893305
NONINDXCAP	.3358538	.0214855	15.63	0.000	.2937429	.3779647
NORMATIV	.4440422	.0432581	10.26	0.000	.3592579	.5288265
PFLEX	-.025956	.0113257	-2.29	0.022	-.0481541	-.003758
NONCAPNTWK	-.5511259	.0323195	-17.05	0.000	-.6144709	-.4877809
PFLEXNTWK	.0140359	.0229196	0.61	0.540	-.0308858	.0589575
_cons	.3691902	.0306133	12.06	0.000	.3091892	.4291911
LNCOMPS						
DS1	-.3678091	.0996104	-3.69	0.000	-.5630419	-.1725762
APPRV271	-.0538294	.0249922	-2.15	0.031	-.1028132	-.0048456
FEDCAP	-.0690201	.0236138	-2.92	0.003	-.1153023	-.022738
LECLRG	-.0091732	.0251452	-0.36	0.715	-.0584569	.0401104
LECMID	.0242335	.0164111	1.48	0.140	-.0079316	.0563986
RURAL	-.1237035	.0425336	-2.91	0.004	-.2070679	-.0403391
UNEOBLIG	.0785447	.0199546	3.94	0.000	.0394344	.117655
DENSITY	.0000444	1.44e-06	30.91	0.000	.0000416	.0000472
EMPLYEES	.000027	7.40e-07	36.49	0.000	.0000256	.0000285
PRATIO	.1426201	.0275672	5.17	0.000	.0885895	.1966507
HSEHLDS	5.16e-06	1.30e-06	3.98	0.000	2.62e-06	7.70e-06
LRGFIRE	.0003622	.0000869	4.17	0.000	.0001919	.0005325
CAP	-.0458432	.0374498	-1.22	0.221	-.1192434	.027557
DEREG	-.0016818	.0116158	-0.14	0.885	-.0244483	.0210847
INDXCAP	-.0182566	.0228943	-0.80	0.425	-.0631286	.0266154
NONINDXCAP	.1861048	.0404774	4.60	0.000	.1067705	.2654391
NORMATIV	.1668237	.0633404	2.63	0.008	.0426788	.2909687
PFLEX	.0018191	.0118123	0.15	0.878	-.0213326	.0249709
NONCAPNTWK	-.1244118	.0653747	-1.90	0.057	-.2525438	.0037202
PFLEXNTWK	.0628479	.023315	2.70	0.007	.0171514	.1085444
_cons	.0820417	.0533844	1.54	0.124	-.0225898	.1866731

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Table 4.73 (continued)

Endogenous variables: DS1 LNCOMPS
Exogenous variables: APPRV271 FEDCAP LECLRG LECMID RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.74 - Scenario 4 - DS3

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
DS3	18564	22	.3394323	0.1230	3359.836	0.0000
LNCOMPS	18564	20	.4055272	0.4322	14966.33	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
DS3						
LNCOMPS	.1846602	.0207866	8.88	0.000	.1439192	.2254012
APPRV271	-.0176261	.0087346	-2.02	0.044	-.0347457	-.0005065
FEDCAP	-.0681091	.0118239	-5.76	0.000	-.0912836	-.0449347
LECLRG	-.2927539	.0181661	-16.12	0.000	-.3283588	-.2571491
LECMID	.0078865	.0097505	0.81	0.419	-.0112242	.0269972
RURAL	-.2655287	.0160193	-16.58	0.000	-.296926	-.2341314
RUS	.0436094	.0085709	5.09	0.000	.0268109	.060408
UNEOBLIG	.0601511	.00919	6.55	0.000	.042139	.0781632
AVGHHINC	3.96e-06	2.37e-07	16.71	0.000	3.50e-06	4.43e-06
EMPLYEES	-1.38e-06	1.07e-06	-1.29	0.199	-3.48e-06	7.23e-07
PRATIO	.0006875	.0147185	0.05	0.963	-.0281603	.0295353
NFIRMS	.0000561	.0000118	4.75	0.000	.000033	.0000793
LRGFIRMS	.0011934	.0005162	2.31	0.021	.0001817	.0022051
LRGFIRE	2.86e-06	.0000581	0.05	0.961	-.000111	.0001167
CAP	-.1177673	.0277139	-4.25	0.000	-.1720855	-.0634491
DEREG	-.0290501	.0087274	-3.33	0.001	-.0461554	-.0119447
INDXCAP	-.0827252	.014092	-5.87	0.000	-.1103451	-.0551052
NONINDXCAP	.1208234	.0165657	7.29	0.000	.0883552	.1532916
NORMATIV	.3110311	.0333411	9.33	0.000	.2456838	.3763784
PFLEX	-.0120603	.0087314	-1.38	0.167	-.0291734	.0050529
NONCAPNTWK	-.2200868	.0249138	-8.83	0.000	-.268917	-.1712566
PFLEXNTWK	-.1526261	.017663	-8.64	0.000	-.187245	-.1180072
_cons	.2735309	.0236623	11.56	0.000	.2271536	.3199083
LNCOMPS						
DS3	-.2456327	.0648793	-3.79	0.000	-.3727938	-.1184715
APPRV271	.0255853	.010359	2.47	0.014	.0052821	.0458885
FEDCAP	-.0206987	.0144151	-1.44	0.151	-.0489518	.0075544
LECLRG	-.0535889	.0287954	-1.86	0.063	-.1100268	.0028491
LECMID	-.0152554	.0115924	-1.32	0.188	-.0379762	.0074654
RURAL	-.0495275	.0257661	-1.92	0.055	-.1000281	.0009732
UNEOBLIG	.0337728	.0117302	2.88	0.004	.0107819	.0567636
DENSITY	.0000429	1.27e-06	33.84	0.000	.0000404	.0000454
EMPLYEES	.0000254	6.11e-07	41.50	0.000	.0000242	.0000266
PRATIO	.0722096	.0174529	4.14	0.000	.0380025	.1064168
HSEHLDS	5.36e-06	7.54e-07	7.11	0.000	3.88e-06	6.84e-06
LRGFIRE	.0005622	.0000697	8.07	0.000	.0004257	.0006987
CAP	-.0453332	.0341507	-1.33	0.184	-.1122673	.021601
DEREG	-.0185068	.0106681	-1.73	0.083	-.0394158	.0024023
INDXCAP	.0074008	.0179138	0.41	0.680	-.0277095	.0425111
NONINDXCAP	.0826183	.021062	3.92	0.000	.0413375	.1238991
NORMATIV	.0785862	.0450967	1.74	0.081	-.0098017	.1669742
PFLEX	.0093795	.0104345	0.90	0.369	-.0110717	.0298307
NONCAPNTWK	.0334798	.0332241	1.01	0.314	-.0316382	.0985978
PFLEXNTWK	.0170361	.0229528	0.74	0.458	-.0279505	.0620228
_cons	.0107235	.0370409	0.29	0.772	-.0618753	.0833223

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Table 4.74 (continued)

Endogenous variables: DS3 LNCOMPS
Exogenous variables: APPRV271 FEDCAP LECLRG LECMID RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.75 - Scenario 4 - OC

Three-stage least squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
OC	18564	22	.2271618	0.1498	3575.635	0.0000
LNCOMPS	18564	20	.4028696	0.4397	15167.73	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
OC						
LNCOMPS	.0911113	.0139144	6.55	0.000	.0638396	.118383
APPRV271	-.0544532	.0058471	-9.31	0.000	-.0659133	-.0429932
FEDCAP	-.0163154	.0079148	-2.06	0.039	-.0318281	-.0008026
LECLRG	.0162695	.0121606	1.34	0.181	-.0075648	.0401038
LECMID	-.0191994	.0065271	-2.94	0.003	-.0319923	-.0064065
RURAL	-.0233829	.0107235	-2.18	0.029	-.0444006	-.0023651
RUS	.0124967	.0057356	2.18	0.029	.0012552	.0237383
UNEOBLIG	.0016195	.0061519	0.26	0.792	-.010438	.013677
AVGHHINC	3.49e-06	1.59e-07	22.01	0.000	3.18e-06	3.81e-06
EMPLYEES	-4.70e-06	7.18e-07	-6.54	0.000	-6.10e-06	-3.29e-06
PRATIO	.060055	.0098528	6.10	0.000	.0407439	.079366
NFIRMS	.0000699	7.91e-06	8.84	0.000	.0000544	.0000854
LRGFIRMS	.0023627	.0003455	6.84	0.000	.0016855	.0030398
LRGFIRE	-.0006965	.0000389	-17.91	0.000	-.0007727	-.0006202
CAP	-.0834564	.018552	-4.50	0.000	-.1198177	-.0470952
DEREG	.0542312	.0058422	9.28	0.000	.0427807	.0656817
INDXCAP	-.0249212	.0094334	-2.64	0.008	-.0434103	-.0064321
NONINDXCAP	.0140392	.0110893	1.27	0.206	-.0076954	.0357738
NORMATIV	.0262563	.0223189	1.18	0.239	-.0174879	.0700006
PFLEX	-.0189474	.0058449	-3.24	0.001	-.0304031	-.0074916
NONCAPNTWK	-.0767354	.0166776	-4.60	0.000	-.1094229	-.0440479
PFLEXNTWK	-.0522241	.0118239	-4.42	0.000	-.0753984	-.0290497
_cons	-.1121436	.0158396	-7.08	0.000	-.1431886	-.0810986
LNCOMPS						
OC	-.2786198	.0676636	-4.12	0.000	-.411238	-.1460016
APPRV271	.0148002	.0107694	1.37	0.169	-.0063074	.0359078
FEDCAP	-.0054605	.0133521	-0.41	0.683	-.0316302	.0207092
LECLRG	.0233352	.021578	1.08	0.280	-.0189569	.0656273
LECMID	-.0214854	.0116393	-1.85	0.065	-.044298	.0013273
RURAL	.0084489	.0190821	0.44	0.658	-.0289514	.0458493
UNEOBLIG	.0199023	.0108801	1.83	0.067	-.0014222	.0412269
DENSITY	.0000424	1.26e-06	33.61	0.000	.0000399	.0000449
EMPLYEES	.0000249	5.18e-07	48.16	0.000	.0000239	.0000259
PRATIO	.0872503	.0178059	4.90	0.000	.0523515	.1221492
HSEHLDS	5.04e-06	7.09e-07	7.11	0.000	3.65e-06	6.42e-06
LRGFIRE	.0003576	.0000799	4.48	0.000	.0002011	.0005141
CAP	-.0398657	.0334883	-1.19	0.234	-.1055015	.02577
DEREG	.0035401	.0108059	0.33	0.743	-.017639	.0247193
INDXCAP	.0196755	.0169047	1.16	0.244	-.013457	.052808
NONINDXCAP	.056336	.0195563	2.88	0.004	.0180064	.0946655
NORMATIV	.0076749	.0395405	0.19	0.846	-.069823	.0851729
PFLEX	.0063927	.0104424	0.61	0.540	-.014074	.0268594
NONCAPNTWK	.0632025	.0301426	2.10	0.036	.0041241	.1222809
PFLEXNTWK	.0392146	.0211259	1.86	0.063	-.0021913	.0806205
_cons	-.0891908	.025947	-3.44	0.001	-.140046	-.0383355

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Table 4.75 (continued)

Endogenous variables: OC LNCOMPS
Exogenous variables: APPRV271 FEDCAP LECLRG LECMID RURAL RUS UNEOBLIG AVGHHINC EMPLYEES PRATIO NFIRMS LRGFIRMS LRGFIRE CAP DEREG INDXCAP NONINDXCAP NORMATIV PFLEX NONCAPNTWK PFLEXNTWK DENSITY HSEHLDS

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Table 4.76 - Scenario 4 - Summary

	PCKTSW	LNCOMPS	DS1	LNCOMPS	DS3	LNCOMPS	OC	LNCOMPS
LNCOMPS	0.098		0.090		0.185		0.091	
	(4.16)**		(3.36)**		(8.88)**		(6.55)**	
APPRV271	-0.008	0.022	-0.226	-0.054	-0.018	0.026	-0.054	0.015
	(0.81)	(1.50)	(19.97)**	(2.15)*	(2.02)*	(2.47)*	(9.31)**	(1.37)
FEDCAP	-0.268	-0.243	-0.165	-0.069	-0.068	-0.021	-0.016	-0.005
	(20.04)**	(8.17)**	(10.77)**	(2.92)**	(5.76)**	(1.44)	(2.06)*	(0.41)
LECLRG	0.200	0.202	-0.080	-0.009	-0.293	-0.054	0.016	0.023
	(9.54)**	(5.81)**	(3.38)**	(0.36)	(16.12)**	(1.86)	(1.34)	(1.08)
LECMID	0.089	0.063	0.112	0.024	0.008	-0.015	-0.019	-0.021
	(7.90)**	(3.55)**	(8.89)**	(1.48)	(0.81)	(1.32)	(2.94)**	(1.85)
RURAL	-0.080	-0.063	-0.377	-0.124	-0.266	-0.050	-0.023	0.008
	(4.33)**	(2.28)*	(18.16)**	(2.91)**	(16.58)**	(1.92)	(2.18)*	(0.44)
RUS	0.015		0.054		0.044		0.012	
	(1.98)*		(5.05)**		(5.09)**		(2.18)*	
UNEOBLIG	0.142	0.150	0.162	0.079	0.060	0.034	0.002	0.020
	(13.41)**	(7.65)**	(13.55)**	(3.94)**	(6.55)**	(2.88)**	(0.26)	(1.83)
AVGHHINC	0.000		0.000		0.000		0.000	
	(12.00)**		(7.38)**		(16.71)**		(22.01)**	
EMPLYEES	0.000	0.000	0.000	0.000	-0.000	0.000	-0.000	0.000
	(9.19)**	(41.36)**	(2.70)**	(36.49)**	(1.29)	(41.50)**	(6.54)**	(48.16)**
PRATIO	0.405	0.445	0.191	0.143	0.001	0.072	0.060	0.087
	(23.84)**	(10.25)**	(10.01)**	(5.17)**	(0.05)	(4.14)**	(6.10)**	(4.90)**
NFIRMS	0.000		0.000		0.000		0.000	
	(14.39)**		(13.10)**		(4.75)**		(8.84)**	
LRGFIRMS	-0.008		-0.003		0.001		0.002	
	(15.95)**		(5.50)**		(2.31)*		(6.84)**	
LRGFIRE	0.001	0.001	-0.001	0.000	0.000	0.001	-0.001	0.000
	(9.23)**	(9.95)**	(6.69)**	(4.17)**	(0.05)	(8.07)**	(17.91)**	(4.48)**
CAP	0.502	0.439	-0.095	-0.046	-0.118	-0.045	-0.083	-0.040
	(15.68)**	(6.95)**	(2.64)**	(1.22)	(4.25)**	(1.33)	(4.50)**	(1.19)
DEREG	-0.178	-0.172	0.023	-0.002	-0.029	-0.019	0.054	0.004
	(17.64)**	(8.05)**	(2.04)*	(0.14)	(3.33)**	(1.73)	(9.28)**	(0.33)

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Table 4.76 (continued)

INDXCAP	-0.117	-0.086	-0.125	-0.018	-0.083	0.007	-0.025	0.020
	(7.18)**	(3.31)**	(6.85)**	(0.80)	(5.87)**	(0.41)	(2.64)**	(1.16)
NONINDXCAP	0.155	0.212	0.336	0.186	0.121	0.083	0.014	0.056
	(8.13)**	(6.86)**	(15.63)**	(4.60)**	(7.29)**	(3.92)**	(1.27)	(2.88)**
NORMATIV	0.331	0.297	0.444	0.167	0.311	0.079	0.026	0.008
	(8.61)**	(4.77)**	(10.26)**	(2.63)**	(9.33)**	(1.74)	(1.18)	(0.19)
PFLEX	-0.113	-0.096	-0.026	0.002	-0.012	0.009	-0.019	0.006
	(11.23)**	(5.39)**	(2.29)*	(0.15)	(1.38)	(0.90)	(3.24)**	(0.61)
NONCAPNTWK	-0.333	-0.239	-0.551	-0.124	-0.220	0.033	-0.077	0.063
	(11.58)**	(4.65)**	(17.05)**	(1.90)	(8.83)**	(1.01)	(4.60)**	(2.10)*
PFLEXNTWK	0.072	0.136	0.014	0.063	-0.153	0.017	-0.052	0.039
	(3.55)**	(4.50)**	(0.61)	(2.70)**	(8.64)**	(0.74)	(4.42)**	(1.86)
PCKTSW		-0.891						
		(10.43)**						
DENSITY		0.000		0.000		0.000		0.000
		(29.01)**		(30.91)**		(33.84)**		(33.61)**
HSEHLDS		0.000		0.000		0.000		0.000
		(7.27)**		(3.98)**		(7.11)**		(7.11)**
DS1				-0.368				
				(3.69)**				
OC								-0.279
								(4.12)**
Constant	-0.094	-0.090	0.369	0.082	0.274	0.011	-0.112	-0.089
	(3.49)**	(2.48)*	(12.06)**	(1.54)	(11.56)**	(0.29)	(7.08)**	(3.44)**
DS3						-0.246		
						(3.79)**		
Observations		18564	18564	18564	18564	18564	18564	18564 18564

Absolute value of z statistics in parentheses

* significant at 5%; ** significant at 1%

APPENDIX C

REFERENCES FOR QUESTIONNAIRE ON FORMS OF REGULATION

State	Document
AK	Regulatory Commission of Alaska 2001 Annual Report - Statistical Section
AZ	Arizona Corporate Commission Docket No. T-01051B-99-0105 In the Matter of the Application of U.S. West Communications, Inc. a Colorado Corporation, for a Hearing to Determine the Earnings of the Company, the Fair Value of the Company for Ratemaking Purposes, to Fix a Just and Reasonable Rate of Return thereon and to Approve Rate Schedules Designed to Develop Such Return, Decision No. 63487 Opinion and Order
CT	Connecticut Department of Public Utility and Control (March 16, 2001) *Docket No. 00-07-17, DPUC Investigation of the Southern New England Telephone Company's Alternative Regulation*
CT	Connecticut Department of Public Utility and Control (January 10, 2001) *Docket No. 99-03-06 Application of New York Telephone for Alternative Rate Regulation*
DC	Public Service Commission of the District of Columbia Opinion and Order: *Formal Case No. 814, Phase IV, In the Matter of the Investigation into the Impact of the AT&T Divestiture and Decisions of the Federal Communications Commission on Bell Atlantic - Washington, D.C., Inc.'s Jurisdictional Rates, Order No. 11545*
DC	Public Service Commission of the District of Columbia Opinion and Order: *Formal Case No. 1005, In the Matter of Verizon Washington, D.C., Inc.'s Price Cap Plan 2002 for the Provision of Local Telecommunications Services in the District of Columbia, Order No. 12338*
DC	Public Service Commission of the District of Columbia Opinion and Order: *Formal Case No. 1005, In the Matter of Verizon Washington, D.C., Inc.'s Price Cap Plan 2002 for the Provision of Local Telecommunications Services in the District of Columbia, Order No. 12368*
Federal	Bureau of Economic Analysis, Gross Domestic Product
FL	The 2002 Florida Statutes - Chapter 364 - Telecommunications Companies
FL	BellSouth General Subscriber Service Tariff
FL	Florida Public Service Commission's Division of Competitive Services, *Competition in Telecommunications Markets in Florida*, December 2001
IL	Illinois Commerce Commission (January 31, 2001) *Annual Report on Telecommunications - 2000*
IL	Illinois Commerce Commission (May 22, 2001) *Hearing Examiner's Proposed Order in Docket # 98-0252*
IL	Illinois Commerce Commission (October 23, 2002) *Annual Report on Telecommunications Markets in Illinois: Submitted to the Illinois General Assembly Pursuant to 13-407 of the Illinois Public Utility Act*
IL	Illinois Telecommunications Association *List of Category I Members*

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IN	Indiana Utility Regulatory Commission *In the Matter of the Investigation on the Commission's Own Motion, Under Indiana Code §8-1-2-72, Into and Any and All Matters Relating to the Commission's Mirroring Policy Articulated in Cause No. 40785 and the Effect of the FCC's MAG Order on Such Policy, Access Charge Reform, Universal Service Reform, and High Cost or Universal Service Funding Mechanisms Relative to Telephone and Telecommunications Services within the State of Indiana*
KS	Kansas Corporation Commission (January 5, 2000) *Telecommunications Report to the 2000 Legislature*
KY	Bell South Telecommunications, Inc. Kentucky (October 31, 2000) *General Subscribers Service Tariff Section A36*
KY	Kentucky Regulatory Statutes Section 278.516
LA	Louisiana Public Service Commission (September 4, 1997) *Special Order 15-97: Adoption of a Price Cap Plan by the Century Companies*
LA	Louisiana Public Service Commission (May 20, 1998) *Order No. U-22614: In re: Consumer Price Protection Plan Service Category Classification Report as per Docket U-20883.*
LA	Louisiana Public Service Commission (April 13, 1999) *Order No. U-23933: In re: Three Year Review of BellSouth's Price Cap Plan under the Regulations for Competition in the Local Telecommunications Market, as Amended 8/6/98 to Address Whether the Cap on Interconnections Offerings Should Continue*
LA	Louisiana Public Service Commission (January 14, 2000) *Special Order No. 2-2000: Kaplan Telephone Company, Inc. ex parte. In re: Request to be Regulated Pursuant to Consumer Price Protection Plan, in lieu of the Traditional Rate Base, Rate of Return Regulation..*
LA	Louisiana Public Service Commission (January 21, 2000) *Official Bulletin #689*
LA	Louisiana Public Service Commission (April 5, 2000) *General Order (contains Louisiana Public Service Commission Regulations for Competition in the Local Telecommunications Market as amended 3/22/2000)*
LA	Louisiana Public Service Commission (May 2, 2000) *Order No. U-24802: In re: Extension of BellSouth's Consumer Protection Plan through April 1, 2004.*
LA	Louisiana Public Service Commission (August 7, 2000) *Special Order No. 10-2000: CenturyTel of Louisiana Ex Parte. In re: Three Year Review of the Price Protection Plan Established by CenturyTel of Louisiana Pursuant to Commission Special Order No. 15-97.*
LA	Louisiana Public Service Commission (August 7, 2000) *Special Order No. 11-2000: Star Telephone Company, Inc. Ex Parte. Docket No. S-25027 - In re: Three Year Review of the Price Protection Plan Established by Star Telephone Company, Inc. Pursuant to Commission Special Order No. 13-97.*
LA	Louisiana Public Service Commission (August 7, 2000) *Special Order No. 12-2000: East Ascension Telephone Company, Inc. Ex Parte. Docket No. S-25028 - In re: Three Year Review of the Price Protection Plan Established by East Ascension Telephone Company, Inc. Pursuant to Commission Special Order No. 14-97.*
LA	Louisiana Public Service Commission (October 16, 2000) *Special Order No. 17-2000: Lafourche Telephone Company, Inc. Ex Parte. Docket No. U-25007 - In re: Proposal for Implementation of a Price Protection Plan.*
LA	Louisiana Public Service Commission (May 16, 2001) *Minutes of Open Session.*

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MD	Public Service Commission of Maryland (November 8, 1996) *Order No. 73011 In the Matter of the Inquiry into Alternative Forms of Regulating Telephone Companies (Case No. 8715)*
MD	Public Service Commission of Maryland (October, 2001) *Petition of WorldCom , Inc. to Terminate the Price Cap Plan*
MD	Letter to Maryland Public Service Commission from Verizon Maryland Inc. summarizing the various regulatory forms that the Commission has used since 1984, April 26, 2002.
MD	Public Service Commission of Maryland (July 17, 2002) *Case No. 8745 - In the Matter of the Provision of Universal Service to Telecommunications Consumers - Order No. 77913*
MD	Public Service Commission of Maryland (August 8, 2002) *Case No. 8918 - In the Matter of the Review of Verizon Maryland Inc.'s Price Cap regulatory Plan - Direct Testimony of David Brevitz on behalf of the Office of Public Counsel.*
MD	Public Service Commission of Maryland (August 8, 2002) *Case No. 8918 - In the Matter of the Review of Verizon Maryland Inc.'s Price Cap regulatory Plan - Direct Testimony of Carlos Candelario on behalf of the Maryland PSC Staff.*
MD	Public Service Commission of Maryland (September 12, 2002) *Case No. 8918 - In the Matter of the Review of Verizon Maryland Inc.'s Price Cap regulatory Plan - Rebuttal Testimony of David Brevitz on behalf of the Office of Public Counsel.*
MO	Missouri Revised Statutes: Chapter 392 - Telephone and Telegraph Companies Section 392.245, August 28, 2002
NC	GTE (June 3, 1996) *Letter to North Carolina Utilities Commission Re: Docket No. P-19, Sub 277 - In the Matter of Application of GE South Incorporated for, and Election of, Price Regulation (includes Copy of the Modified Price Regulation Plan)*
NC	Concord Telephone Company (April 8, 1998) *Letter to North Carolina Utilities Commission Re: Commission Approved Price Regulation Plan*
NC	Alltel (November 24, 1998) *Letter to North Carolina Utilities Commission Re: Small Carrier Local Exchange Carrier Price Regulation Plan for ALLTEL Carolina, Inc.*
NC	North Carolina Utilities Commission (August 3, 1999) *Docket No. P-55, Sub 1013: In the Matter of Application of BellSouth Telecommunications, Inc. for, and Election of, Price Regulation; Docket No. P-7, Sub 825, Docket No. P-10, Sub 479: In the Matter of Petition of Carolina Telephone and Telegraph Company and Central Telephone Company for Approval of Price Regulation Plan Pursuant to G.S. 62-133.5, Docket No. P-19, Sub 277: In the Matter of Application of GTE South, Inc. for, and Election of, Price Regulation - Order Regarding Fourth Year Price Plan Filings*
NC	MEBTEL (May 10, 2000) *Letter to North Carolina Utilities Commission, Re: Price Regulation Plan*
NC	Sprint (November 1, 200) *Letter to North Carolina Utilities Commission, Re: Docket No. P-7, Sub 825 and Docket No. P-10, Sub 479, Re: Amended Price Regulation Plan for Carolina Telephone and Telegraph, and Central Telephone Company Effective November 1. 2000*
NC	BellSouth (October 11, 2001) *Letter from BellSouth to the North Carolina Utilities Commission containing BellSouth Telecommunications, Inc.'s Price Regulation Plan*
NJ	State of New Jersey Board of Public Utilities (December 22, 2000) *Telecommunications Order in Docket No. TO99120934: In the Matter of the*

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	Application of Bell Atlantic - New Jersey, Inc. for Approval of a Modified Plan for an Alternative Form of Regulation and to Reclassify All Rate Regulated Services as Competitive Services and Docket Nos. TO92030358 and TO00120955: In the Matter of the Application of Verizon New Jersey, Inc. for Approval of an Extension of Its Plan for an Alternative Form of Regulation.
OH	Public Utilities Commission of Ohio (January 7, 1993*) Finding and Order in Case No. 92-1149-TP-COI In the Matter of the Commission's Promulgation of Rules for Establishment of Alternative Regulation for Large Local Exchange Telephone Companies*
OH	Public Utilities Commission of Ohio (November 23, 1994) *Opinion and Order in Case No. 93-487-TP-ALT: In the Matter of the Application of The Ohio Bell Telephone Company for Approval of an Alternative Form of Regulation and Case No. 93-576-TP-CSS: In the Matter of the Complaint of the Office of the Consumers' Counsel*
OH	Public Utilities Commission of Ohio (April 9, 1998*) Opinion and Order in Case No. 96-899-TP-ALT: In the Matter of the Application of Cincinnati Bell Telephone Company for Approval of a Retail Pricing Plan Which May Result in Future Rate Increases and for a New Alternative Regulation Plan*
OH	Public Utilities Commission of Ohio (April 27, 2000) Opinion and Order in Case No. 93-487- TP-ALT *In the Matter of the Application of Ameritech Ohio (Formerly known as The Ohio Bell Telephone Company) for Approval of an Alternative Form of Regulation*
OH	Public Utilities Commission of Ohio (June 21, 2000) *Finding and Order in Case No. 93-487-TP-ALT In the Matter of the Application of Ameritech Ohio for Approval of an Alternative Form of Regulation*
OH	Public Utilities Commission of Ohio (December 6, 2001) Opinion and Order In Case No. 00-1532-TP-COI *In the Matter of the Commission Ordered Investigation of an Elective Alternative Regulatory Framework for Incumbent Local Exchange Companies.*
OH	Public Utilities Commission of Ohio (December 6, 2001) Opinion and Order in Case No. 99-998-TP-COI *In the Matter of the Commission Ordered Investigation of the Existing Local Exchange Competition Guidelines* and Case No. 99-563-TP-COI *In the Matter of the Commission Review of the Regulatory Framework for Competitive Telecommunications Services Under Chapter 4927, Revised Code*
OH	Public Utilities Commission of Ohio (November 21, 2002) *Entry on Rehearing in Case No. 99-998-TP-COI In the Matter of the Commission Ordered Investigation of the Existing Local Exchange Competition Guidelines and Case No. 99-563-TP-COI In the Matter of the Commission Review of the Regulatory Framework for Competitive Telecommunications Services Under Chapter 4927, Revised Code*
OK	Oklahoma Corporate Commission (July 7, 2002) *Oklahoma Administrative Code Title 165 (Corporate Commission), Chapter 55 (Telecommunications Services), Subchapter 5 (Rates and Tariffs)*
OK	Oklahoma Telephone Association (1999) *The Oklahoma Telephone Association Directory 1999-2000*
SC	Code of Laws for South Carolina, Title 58, Chapter 9 - Telephone, Telegraph and Express Companies
SC	Public Service Commission of South Carolina (January 30, 1996) *Docket No. 95-720-*

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	C, Order No. 96-19, In Re: Application of BellSouth for Alternative Regulation (Consumer Price Protection Plan)
SC	Public Service Commission of South Carolina (February 18, 1999) *Docket No. 95-82-862-C, Order No. 1999-135 in Re: BellSouth Telecommunications, Inc. - Investigation of Level of Earnings*
SC	Public Service Commission of South Carolina (February 19, 1999) *Docket No. 98-294-C, Order No. 1999-140 In Re: Application of United Telephone Company of the Carolinas for Approval of Administrative Guidelines to Supplement United's Price Regulation Plan.*
SC	Public Service Commission of South Carolina (June 21, 1999) *Docket No. 95-862-C, Order No. 1999-411 In Re: BellSouth Telecommunications, Inc. - Investigation of Level of Earnings.*
SC	Public Service Commission of South Carolina (February 21, 2000) *Docket No. 1999-178-C, Order No. 2000-030 In Re: Petition to Review the Earnings of BellSouth Telecommunications, Inc. for Calendar Years 1996, 1997, and 1998.*
SC	Public Service Commission of South Carolina (September 26, 2000) *Docket No. 1999-469-C, Order No. 2000-676 In Re: Proceeding to Review BellSouth Telecommunications, Inc.'s Guidelines for Alternate Form of Regulation.*
TX	Public Utility Commission of Texas (January, 2001*Report to the 77th Texas Legislature: Scope of Competition in Telecommunications Markets of Texas*
VT	State of Vermont Public Service Board (March 24, 2000) *Docket No. 6167:Investigation into an Alternative Regulation Plan for New England Telephone and Telegraph Company d/b/a Bell Atlantic- Vermont*
WY	Wyoming Public Service Commission (January 10, 2002) *2002 Annual Telecommunications Report*
WY	Wyoming Public Service Commission (December 2, 2002) *The Pricing of Basic Telecommunications Service under the Wyoming Telecommunications Act of 1995*
WY	Wyoming Statutes Title 37 - Public Utilities, Chapter 15 - Telecommunications

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TERMS / GLOSSARY FOR TECHNOLOGICAL INNOVATION

Absorptive capacity - The ability to evaluate and exploit outside knowledge.

Asymmetrical digital subscriber line (ADSL) – Local loop attached to digital compressional encoding equipment that permits simultaneous delivery of a compressed video signal to a subscriber and use of the line for telephone and limited data service.

Asynchronous transport mode – A protocol for very high-speed transport and switching of voice, video, and data communications over common fiber-optic links.

Basket of services – A collection of products, often grouped together because they receive similar regulatory treatment. To illustrate, price cap regulation plans often designate different baskets of services and place a separate cap on the average price charged for the products in each basket.

Central office – Usually a local switching system that connects lines and trunks. Sometimes used also to refer to a telephone company building in which switching system and telephone equipment are installed.

Common-channel signaling – A signaling system (for example, SS7) in which the control signals for all calls travel on a separate digital network that is interconnected with the voice network at switches and other signal transfer points.

Demand-pull inventions - Inventions rendered attractive by rising demand

Demand pull influences on innovative activity include a range of effects driven by changes in consumer behavior, the competitive structure of markets and other factors which affect the valuation of inventions and / or the ability of inventors to appropriate the benefits created by them.

Divided technical leadership (DTL) - DTL is the supply of key platform components by multiple firms. A single firm participates in DTL if its technologies are widely distributed (either in its own products or others) to gain the platform's network effects.

DS1 (digital signal level 1) – The initial level of multiplexing in the time division multiplexing hierarchy of a telephone network.

DS3 – A digital transmission system that carries twenty-eight DS1 channels at 44.736 million bits per second.

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End office – LEC switching system within a LATA or market area where local loops serving individual customers are terminated for purposes of interconnection at each other and at trunks.

FCC – Federal Communications Commission.

Fiber-optic network – A network made of glass or plastic cables that employ pulses of light to transport large quantities of information.

Innovation - An innovation in the economic sense is accomplished only with the first commercial transaction involving the new product, process system or device, although the word "innovation" is often used to also to describe the whole process.

Innovation input - R&D employment intensity and innovation expenditure per unit of sales.

Innovation output - Realization of product and process innovations.

InterLATA – Telecommunications services, revenues, and functions originating in one LATA and terminating in another LATA or at another location.

IntraLATA – Telecommunications services, revenues, and functions that originate and terminate within the same LATA.

Invention - Is an idea, a sketch or model for a new or improved device, product or system. Such inventions may often (not always) be patented but they do not necessarily lead to technical innovations. In fact the majority do not.

Invention is interpreted broadly in this paper as the production of knowledge.

IXC – Interexchange carrier.

Liquidity constraint - Many households, e.g. young ones, cannot borrow to consume or invest as much as they would want, but are constrained to current income by imperfect capital markets.

Local access and transport area (LATA) – Geographically defined exchange area, created by the AT&T divestiture decree, beyond which a local Bell operating company would not carry telephone calls; generally centered in a metropolitan area.

Local exchange – Generally the first switch to which a customer is connected plus the transport from that customer to the switch. In technical usage, only the first switch.

Local exchange carrier (LEC) – Company that provides transport and exchange service within a LATA.

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Local loop – Set of services comprising a common line, dial tone (access to local switching), and a telephone number.

Market power - Is the ability of a single, or group of buyer(s) or seller(s) to influence the price of the product or service in which it is trading. A perfectly competitive market in equilibrium ensures the complete absence of market power.

The ability to price profitably above the competitive level (marginal cost) is referred to as market power, and such conduct leads to welfare losses by society.

Meta-analysis - A meta-analysis is a critical overview or a quantitative aggregation of several different studies.

Multifactor productivity growth - Defined as the residual after subtracting out the growth attributable to increases in inputs, derived by weighting the growth rate of each factor by its share of output.

Point of presence – Physical location within a LATA at which an access customer establishes itself for the purpose of obtaining LATA access and to which a LEC provides access services.

Productivity growth - Defined as output per hour in the nonfarm business sector.

R&D intensity - Is used to mean (R&D spending)/(firm size), since firms with higher values are in a sense doing research and development more intensively.

R&D effort divided by a measure of firm size (usually sales).

R&D productivity - Innovations per unit of R&D.

Regional Bell operating company (RBOC) – One of seven regional companies that assumed ownership, following the AT&T divestiture, of the local exchange activities of the former Bell System.

Servicing wire center (SWC) – Termination point for subscribers' lines at a central LEC office and a point of interconnection for other carriers.

Supply push - Supply push summarizes a range of determinants of innovative activity, including the evolution of scientific knowledge, the productivity of research labs, the opportunity costs of investing in new product or process development, and so on. One rather intuitively appealing (and commonly held) supply push view is that increases in the stock of knowledge occur randomly over time, causing the production of innovations to vary exogenously and unpredictably over time.

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Switched access – Transport over a local loop to a central office, where calls are switched and then transported to the point-of-presence of an IXC either via direct trunk or over a trunk to a LEC tandem office and then by direct trunk.

T1 – Copper-based digital transmission facility that carries twenty-four voice channels.

Technical innovation or innovation - The introduction or spread of new and improved products and processes in the economy.

Technological change - A sustained, cost-reducing, output-augmenting, change in knowledge.

Technological innovation - Advances in knowledge.

Technological opportunity - The rate at which more or less exogenous and cumulative advances in science and technology generate profitable new innovative possibilities.

In the framework of the standard neo-classical theory of production, technological opportunity can be regarded as the set of production possibilities for translating research resources into new techniques of production that employ conventional inputs.

Technology - A body of knowledge about techniques.

Technology-push innovations - Innovations advanced mainly by advances in knowledge.

Tier 1 LECS – LECS with annual revenues exceeding $100 million.

Tier 2 and tier 3 LECS – Medium and small-sized LECS.

Total element long-run incremental cost (TELRIC) – The long-run incremental cost of a network element, including element-specific costs that do not vary with output of the network.

Total factor productivity - Given the macro model: $Y_t = Z_tF(K_t,L_t)$, Total Factor Productivity (TFP) is defined to be $Y_t/F(K_t,L_t)$

Likewise, given $Y_t = Z_tF(K_t,L_t,E_t,M_t)$, TFP is $Y_t/F(K_t,L_t,E_t,M_t)$

The Solow residual is a measure of TFP. TFP presumably changes over time. There is disagreement in the literature over the question of whether the Solow residual measures technology shocks. Efforts to change the inputs, like K_t, to adjust for utilization rate and so forth, have the effect of changing the Solow residual and thus the measure of TFP. But the idea of TFP is well defined for each model of this kind.

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TFP is not necessarily a measure of technology since the TFP could be a function of other things like military spending, or monetary shocks, or the political party in power.

"Growth in total-factor productivity (TFP) represents output growth not accounted for by the growth in inputs." -- Hornstein and Krusell (1996).

Total service long-run incremental cost (TSLRIC) – The long-run incremental cost of a service, including service-specific costs that do not vary with output of the service.

Wire Center – Location of one or more local switching systems; point at which customers' loops converge.

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REFERENCES

ABEL, JASON. 2000. *The performance of the state telecommunications industry under price-cap regulation: An assessment of the empirical evidence.* NRRI 00-14 (September). Columbus, OH: The National Regulatory Research Institute.

ABEL, JASON R., AND MICHAEL E. CLEMENTS. 1998. *A time-series and cross-sectional classification of state regulatory policy adopted for local exchange carriers.* NRRI 98025. Columbus, OH: The National Regulatory Research Institute.

ACS, ZOLTAN, AND DAVID AUDRETSCH.1987. Innovation, market structure, and firm size. *The Review of Economics & Statistics* 69(4): 567-574.

This is a significant piece. It complements Sutton's work. In a sense, this work begins to move in a direction that suggests the complexities of the relationship between technological innovation and market structure - non-linearity, simultaneity, industry peculiarities. Using regression analysis and SIC data from the Small Business Administration, the authors were able to develop their own innovation index and then test the Schumpeterian hypothesis. They found that there is some support for the Schumpeterian hypotheses in industries that are concentrated

ACS, ZOLTAN AND DAVID AUDRETSCH. 1988. Innovation in large and small firms: an empirical analysis. *American Economic Review* 78(4): 678-690.

ACTON, JAN, AND INGO VOGELSANG, eds. 1989. Symposium: Price-Cap regulation. *RAND Journal of Economics* 20(3) (Autumn): 369 - 472.

AGHION, PHILIPPE, AND PETER HOWITT. 1998. *Endogenous growth theory.* Cambridge: MIT Press.

AGHION, PHILIPPE, CHRISTOPHER HARRIS, PETER HOWITT, AND JOHN VICKERS. 2001. Competition, imitation and growth with step-by-step innovation. *Review of Economic Studies* 68: 467-492.

A valuable piece similar in spirit to Sutton (1998) in that the authors explore the inter-relationships amongst competition, innovation, imitation, degree of technological development, and economic growth. One begins to grasp how the relative technological proficiency of firms as well as the degree of imitation can effect the relationship of industry competition, their relative R&D intensities and why. These are non-linear relationships of more than two variables. Although the mathematical modeling is complex, the authors' use of three-dimensional graphs and numerical simulation add greatly to one's understanding.

AGHION, PHILIPPE, CHRISTOPHER HARRIS, PETER HOWITT, AND JOHN VICKERS. 2002. Competition and innovation: an inverted U relationship. *National Bureau of Economic Research* Working Paper No. w29262.

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AI, CHUNRUNG, AND DAVID SAPPINGTON. 2002. The impact of state incentive regulation on the U.S. telecommunications industry. *Journal of Regulatory Economics* 22(2): 133-160.

AHN, SANHOON. 2002. Competition, innovation and productivity growth: A review of theory and evidence. *OECD Economics Department Working Papers No. 317.*

ALLEN, ROBERT LORING. 1991. *Opening doors: The life & work of Joseph Schumpeter.* New Brunswick: Transaction.

ANGELMAR, REINHARD. 1985. Market structure and research intensity in high-technological-opportunity industries. *Journal of Industrial Economics* 34(1) (September): 69-79.

ANTHONY, SCOTT, ERIK ROTH, AND CLAYTON CHRISTENSEN. 2001. Innovation in the telecommunications industry: separating hype from reality. Working Paper.

ARROW, KENNETH. 1962. Economic welfare and the allocation of resources for invention. In *Rate and direction of inventive activity,* edited by R. Nelson, Princeton, NJ: Princeton University Press.

ARVANITIS, SPYROS. 1997. The impact of firm size on innovative activity - an empirical analysis based on Swiss firm data. *Small Business Economics* 9: 473-490.

Based on the hypothesis that firm size might be a proxy for various economic effects associated with innovation, the author examines not only the effect of firm size on innovative activity, but also the effect of firm size on other determinants of innovative activity. Innovative activity consists of two groups - innovative inputs and innovative outputs - each consisting of several different indicators of innovative activity. These are each regressed on a broad spectrum of innovative determinants that can be divided into four different groups - demand, market conditions, appropriability, technological opportunity. And each of these regressions - ordered probit and tobit - are performed with and without firm size measures. The result is a rich assessment of the simultaneous effect of different determinants on different indicators of innovative activity. Try to read this one.

AUDRETSCH, DAVID. 1995. Firm profitability, growth, and innovation. *Review of Industrial Organization* 10(5) (October): 579-588.

AUDRETSCH, DAVID, AND JULIE ELSTON. 2002. Does firm size matter? Evidence on the impact of liquidity constraints on firm investment behavior in Germany. *International Journal of Industrialization* 20(1) (January): 1-17.

AVERCH, HARVEY, AND LELAND JOHNSON.1962. Behavior of the firm under regulatory constraint. *American Economic Review* 52: 1053 - 1069.

BALDWIN, WILLIAM, AND JAMES T. SCOTT. 1987. *Market structure and technological change.* Chichester: Harwood Academic Publishers.

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This is one of the two standards - along with (Kamien and Schwatz, 1982) - usually referenced as an authoritative and extensive examination of the economic literature on the subject of market structure and technological innovation. I would add a third - Dosi (1988).

BARTOLONI, ELEONORA, AND MAURIZIO BAUSSOLA. 2001. The determinants of technology adoption in Italian manufacturing industries. *Review of Industrial Organization* 19(3) (November): 305-328.

BAUER, JOHANNES. 1997. Market power, innovation, and efficiency in telecommunications: Schumpeter reconsidered. *Journal of Economic Issues* 31(2) (June): 557-565.

To be read as applying Schumpeter thought to issues in telecommunications, regulation and innovation.

BAUMOL, WILLIAM. 2002. *The free-market innovation machine: analyzing the growth miracle of capitalism.* Princeton: Princeton University Press.

BAUMOL, WILLIAM, JOHN PANZAR AND ROBERT WILLIG. 1988. *Contestable markets and the theory of industry structure.* Revised ed. New York: Harcourt Brace Jovanovich.

BAUMOL, WILLIAM, AND J. GREGORY SIDAK. 1994. *Toward competition in local telephony*. Cambridge: MIT Press.

BAUSSOLA, MAURIZIO. 2000. The causality between R&D and investment. *Economics of Innovation and New Technology* 9: 385-399.

BERTSCHEK, IRENE, AND HORST ENTORF. 1996. On nonparametric estimation of the Schumpeterian link between innovation and firm size: evidence from Belgium, France, and Germany. *Empirical Economics* 21: 401-426.

BLUNDELL, RICHARD, RACHEL GRIFFITH, AND JOHN VAN REENAN. 1995. Dynamic count data models of technological innovation. *Economic Journal* 1105 (March): 333-344.

BLUNDELL, RICHARD, RACHEL GRIFFITH, AND JOHN VAN REENEN. 1999. Market share, market value and innovation in a panel of British manufacturing firms. *The Review of Economic Studies* 66(228) (July): 529-554.

BOONE, JAN. 2001. Intensity of competition and the incentive to innovate. *International Journal of Industrial Organization* 19(5) (April): 705-726.

A theoretical paper whose assumptions are far more realistic than many of the classical papers and thus is worthwhile to examine if only to read the conclusion. Note that his analysis parallels the findings of Nelson and Winter (1982).

BOONE, JAN AND THEON VAN DIJK. 1998. Competition and innovation. *De Economist* 146(3): 445 - 461.

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BOSKIN, MICHAEL, AND LAWRENCE LAU. 1996. Contributions of R&D to economic growth. In *Technology, R&D, and the economy*, edited by B. Smith and C. Barfield. Washington, D.C.: Brookings Institution and American Enterprise Institute.

BOUND, JOHN, CLINT CUMMINS, ZVI GRILICHES, BRONWYN HALL, AND ADAM JAFFE. 1984. Who does R&D and who patents? In *R&D, patents, and productivity*, edited by Z. Griliches. Chicago: University of Chicago Press for the National Bureau of Economic Research.

BOURREAU, MARC AND PINAR DOGAN. 2001. Regulation and innovation in the telecommunications industry. *Telecommunications Policy* 25: 167-184.

BROADBERRY, STEPHEN, AND NICHOLAS CRAFTS. 2001. Competition and innovation in 1950s Britain. *Business History* 43(1) (January): 97-118.

The study's purpose was to investigate the relationship between market power and innovation. Multiple regression was indicated and several additional variables representing industry characteristics - e.g., capital stock, industry size, technological opportunity, collective bargaining, cartelization - were included. Technological opportunity was consistently significant across OLS and Tobit regressions. Little support was found for market power

BROCK, GERALD. 1994. *Telecommunications policy for the information age: from monopoly to competition.* Cambridge: Harvard University Press.

BROUWER, ERIK, AND ALFRED KLEINKECHT. 1996. Determinants of innovation: a microeconometric analysis of three alternative innovation output indicators. In *Determinants of innovatio: the message from new indicators*, edited by A.H. Kleinknecht. London: Macmillian Press.

This is a very rich analysis of the determinants of innovation - i.e., the output side of the innovative process. Data on innovations is gathered from:

- *product announcements in trade journals in the Netherlands in 1989*
- *a survey questionnaire where firms reported their percentage of sales derived new or improved products during 1990-1992.*

This process led to three indicators of innovative output:

(1) patents
(2) trade journal reports
(3) sales of innovative products
  (a) new to the firm - measure of imitation
  (b) new to the industry sector - truly 'new' innovation.

The analysis was essentially a two-step process wherein first a Tobit analysis was performed to determine which factors where significant in determining the probability that an innovation was produced. Second, given that a firm has some sales of innovative products, OLS regression was performed to determine which variables influence the share of innovative products in total sales.

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A host of variables were incorporated to capture such factors as firm size, market size, concentration, degree of competition, technological opportunity, demand, etc.

Amongst the conclusions relevant to this study:

The probability that a firm will innovate increases with increasing firm size.
Given that a firm will innovate, the share of sales of innovative products is fairly similar between large and small firms.
Concentration was insignificant and mainly with a negative sign.
The demand-pull effects are positive and significant. They are particularly important to innovation in small and medium-sized firm.
Diffusion and imitation are positively influence by stronger competition from smaller firms.
High-technological opportunity industries tend to have higher innovation output.
Technical knowledge as represented by permanency of R&D activity has a positive effect on innovation.

BROUWER, ERIK, AND ALFRED KLEINKNECHT. 1999. Keynes-plus? Effective demand and changes in firm-level R&D: an empirical note. *Cambridge Journal of Economics* 23(3) (May): 385-391.

Elegant in its simplicity, this paper clearly sets forth more recent interpretations of Schmookler's demand-pull hypothesis via their empirical study of Dutch manufacturing and services.

BUDDE, PAUL. 2003. Data technology: Introduction and frame relay. Database online. http://www22.verizon.com/about/community/learningcenter/articles/displayarticle1/0, 4065,1134z1,00.html. Accessed 2 April.

CHAPPELL, LINDA. 1998. The effects of regulation on the diffusion of technological innovation in the local telephone industry in the United States. Ph.D. diss., North Carolina State University.

CHIDAMBER, SHYAM R., AND HENRY B KON. 1994. A research retrospective of innovation inception and success: the technology-push, demand-pull question. *International Journal of Technology Management* 9(1): 94-112.

The value of this paper is its examination of eight major studies focused on the technology-push versus demand-pull argument. Although its purpose is to discuss the flaws and inconsistencies in these studies, it nevertheless provides an insightful overview on the subject. In particular, read pages 107-108 for a preliminary discussion of the complementary aspects of the two arguments. Unfortunately, this discussion is unsupported by any references.

COHEN, WESLEY. 1995. Empirical studies of innovative activity. In *Handbook of the economics of innovation and technological change,* edited by P. Stoneman. Cambridge: Blackwell Publishers.

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Essential reading. This work builds on an earlier review of the empirical literature (Cohen and Levin, 1989). It touches on many of the earlier and even seminal pieces in the field. Its strength is stated in its title. It is an examination of innovative activity. Thus, it not only reviews the literature on the traditional influences on innovation associated with firm size and market power, but it takes in the broader influences due to industry-level factors such as technological opportunity and firm-level characteristics such as cash-flow. It also provides an apt assessment of the value of game-theoretic models to the study of innovation.

COHEN, WESLEY M., AND STEVEN KLEPPER. 1996. A reprise of size and R&D. *Economic Journal* 106 (July): 925-951.

This is an extremely important paper on the effect of firm size on innovation (or R&D). The authors summarize the studies on the subject to establish four stylized facts and then re-analyze these findings to conclude that, with few exceptions, large size does confer an advantage in the conduct of R&D and thus there is a greater inducement for conducting R&D with large firms. The basis for their argument is a concept known as cost spreading - i.e., larger firms have more output over which to spread the fixed cost of R&D or innovative effort.

COHEN, WESLEY, AND RICHARD LEVIN. 1989. Empirical studies of innovation and market structure. In *Handbook of industrial organization*, edited by R. Schmalensee and R. Willig. Amsterdam: North Holland. Volume II: 1059-1107.

Regarded as the definitive review of the empirical literature on innovation and market structure. See Cohen (1995) as a supplement to this study.

COHEN, WESLEY, RICHARD LEVIN, AND DAVID MOWERY. 1987. Firm size and R&D intensity: A reexamination. In *The empirical renaissance in industrial economics*, edited by T. Bresnahan and R. Schmalensee. Oxford: Basil Blackwell.

This article can also be found in Journal of Industrial Economics 35(4) (June): 543-563.

CRANDALL, R.W. 1999. Managed competition in U.S. telecommunications. AEI-Brookings Joint Center for Regulatory Studies. Working Paper 99-1.

CRÉPON, BRUNO, EMMANUEL DUGUET, AND JACQUES MAIRESSE. 1998. Research, innovation and productivity: an econometric analysis at the firm level. *Economic of Innovation and New Technology* 7: 115-158.

Crépon et al (1998) have conducted a very comprehensive study of technological innovation - its determinants and its effect on productivity - based on French data on manufacturing firms. This data is from several sources. Key data sources were the annual Survey on Research and the 1990 French Survey on Innovation. The latter data source enabled them to construct "demand-pull" and "technology-push" indicators.

Their analytic process was essentially centered on the estimation of four equations: (1) to determine what causes a firm to innovate - i.e., the decision to engage in innovation; (2) an R&D intensity equation - given that a firm innovates; (3) an innovation equation as represented by the effects on patents per employee or fraction of sales coming from

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innovation: (4) a productivity equation. Model estimation was done by asymptotic least squares method (ALS).

Note this form of analysis is similar to, but more comprehensive than, the study by Jaffe (1988).

The probability of performing R&D increases with ***firm size*** *(number of employees). It was insignificant in the other estimations.* ***Market share*** *and* ***diversity*** *were both positive and significant in the probability to engage in R&D and in impacting R&D intensity (R&D capital per employee).* ***Demand-pull*** *and* ***technological opportunity*** *both had positive and significant effects on the probability to engage in R&D, on R&D intensity, and on innovation output - whether measured by patents per employee or by innovation percent of sales (innovation intensity). Research effort (R&D capital per employee) had a positive impact on innovation output. Measures of skill - percentage of engineers and percentage of administrators - both had a significantly positive effect on productivity.*

Several of the findings in this study confirm the "stylized" facts advanced by Cohen and Klepper (1996).

CREW, MICHAEL AND PAUL KLEINDORFER. 1996. Price caps and revenue caps: incentives and disincentives for efficiency. In *Pricing and regulatory innovations under increasing competition*, edited by M. Crew. Boston: Kluwer Academic Publishers.

CREW, MICHAEL AND PAUL KLEINDORFER. 2002. Regulatory economics: twenty years of progress? *Journal of Regulatory Economics* 21(1): 5 - 22.

DARBY, LARRY, AND JOSEPH FUHR. 1997. Impacts of the 1996 Act on investment and innovation. *New Telecom Quarterly* (2nd Quarter).

DARBY, LARRY, AND JOSEPH FUHR. 1998. Regulatory perspectives on investment and innovation in U.S. telecommunications. *New Telecom Quarterly* (2nd Quarter).

DARBY, LARRY, AND JOSEPH FUHR. 2000. Investment incentives and local competition at the FCC. *Media Law and Policy* 9(1) (Fall): 1-18.

DASGUPTA, PARTH. 1986. The Theory of Technological Competition. In *New Developments in the analysis of market structure*, edited by G.F. Mathewson and J. Stiglitz.

Dasgupta builds a mathematical model similar to Dasgupta and Stiglitz (1980) to explain one set of empirical observations based on another set of empirical observations. The value of the paper is primarily in defining these sets of empirical observations and Dasgupta's general comments in the first section.

DASGUPTA, P., AND J. STIGLITZ. 1980. Industry structure and the nature of innovative activity. *Economic Journal* 90: 266-293.

DENISON, EDWARD. 1985. *Trends in American growth, 1929-82*. Washington, D.C.: The Brookings Institution,

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DIXON, DONALD. 2000. Schumpeter--fifty years later. *Journal of Macromarketing* 20(1): 82 - 88.

DODD, ANNABEL. 2002. *The essential guide to telecommunications*. 3rd ed. Upper Saddle-River, NJ: Prentice-Hall.

DOSI, GIOVANNI. 1988. Sources, procedures, and the microeconomic effects of innovation. *Journal of Economic Literature* 26(3) (September): 1120-1171.

A broad ranging survey of the empirical literature on the microeconomic nature of innovative activity, including its determinants as well as its effects.

DOSI, GIOVANNI, AND RICHARD NELSON. 1994. An introduction to evolutionary theories in economics. *Journal of Evolutionary Economics* 4: 153-172.

Economist. 1999a. Survey: Innovation in industry, 20 February.

The survey contains several relevant articles that capture pertinent aspects of technological innovation both from an economist's standpoint and as a picture of how industry market structure as well as behavior affect, and are effected, by technological innovation. A picture of the real world.

Economist. 1999b. Millennium Special Edition, 31 December.

This reference is included primarily for the article, "The Road to Riches" (p 10). The article reads almost as a synopsis of Mokyr (1990) or parts of Landes (1969). However, the entire issue is worthwhile as an historical review of the previous millennium.

EVANS, DAVID (ED). 1983. *Breaking up bell: essays on industrial organization and regulation.* New York: Elsevier Publishing.

FARBER, STEPHEN. 1981. Buyer, market structure and R&D effort: a simultaneous-equations model. *Review of Economics and Statistics* 63(3) (August): 336-345.

This study, although primarily focused on the effect of buyer market structure on innovation, provides interesting insights about the influence of other determinants of innovation. R&D intensity, advertising intensity and 'seller' concentration are determined endogenously in a simultaneous equations model where each of the aforementioned variables is a function of each of the other two variables. The results obtain from the simultaneous equations model developed in this analysis provide a more nuanced interpretation of earlier results on the 'nature' of market structure and innovation. The view that 'seller' concentration may have a positive (or even negative) effect must be tempered of by the level of buyer concentration. This model also shed light on the effect on R&D intensity of other factors such as price-cost margins, technological opportunity, entry barriers, financial barriers, and industry growth rate. Oddly, the measure of technological opportunity had no significant effect.

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FARRELL, JOSEPH AND MICHAEL KATZ. 1998. Public policy and private investment in advanced telecommunications infrastructure. Working Paper. University of California at Berkeley.

FCC. 2003. FCC adopts new rules for network unbundling obligations of incumbent local phone carriers. *FCC News*, 20 February.

FLAIG, GEBHARD, AND MANFRED STADLER. 1994. Success breeds success. The dynamics of the innovation process. *Empirical Economics* 19(1): 55-68.

FREEMAN, CHRIS. 1994. Critical survey: The economics of technical change. *Cambridge Journal of Economics* 18: 463-514.

FREEMAN, CHRIS, AND LUC SOETE. 1997. *The economics of industrial innovation.* 3rd ed. Cambridge: MIT Press.

A complete text on the economic of innovation including economic growth. The approach depends less on math and more on description, graphs, and tables. Also provides complete history of technological change in Part One (which is a book by itself of approximately 200 pages). Also a good source of the literature.

FRITSCH, MICHAEL, AND MONIKA MESCHEDE. 2001. Product innovation, process innovation, and size. *Review of Industrial Organization* 19(3) (November): 335-350.

Important for additional insights besides just the relationship between firm size and process- and product innovation.

GEROSKI, PAUL. 1990. Innovation, technological opportunity, and market structure. *Oxford Economic Papers* 42: 586-602.

One of the earlier papers that examines the effect of concentration on innovative activity in a more complete economic setting by the inclusion of additional determinants of innovation. He shows why earlier studies had found a positive relationship between concentration and innovative activity and why such studies were misleading. He also finds evidence that although "monopoly has an unambiguously inhibiting effect and that rivalry has an unambiguously stimulating effect on innovativeness," rivalry is far less important than the effect of technological opportunity on innovative activity.

GEROSKI, PAUL. 1998. An applied econometrician's view of large company performance. *Review of Industrial Organization* 13(3) (June): 271-293.

GEROSKI, PAUL. 2000. Models of technology diffusion. *Research Policy* 29: 603 - 625.

GEROSKI, PAUL, AND RICHARD POMROY. 1990. Innovation and the evolution of market structure. *Journal of Industrial Economics* 38(3) (March): 299-314.

GEROSKI, P.A. AND C.F. WALTERS. 1995. Innovative activity over the business cycle. *The Economic Journal* 105(431) (July): 916-928.

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Of interest to those wishing to explore a time series analysis of the relationship between innovation and demand, but dread being overwhelmed by the overwhelming weight of statistical detail in such an analysis. Clean. Well written.

GOEL, RAJEEV, AND DANIEL RICH. 1997. On the adoption of new technologies. *Applied Economic Letters* 29: 513 - 518.

GOLDBERG, JACOB, DONALD LEHMANN AND DAVID MAZURSKY. 2001. The idea itself and the circumstances of its emergence as predictors of new product success. *Management Science* 47(1): 69 - 84.

GREENSTEIN, SHANE, SUSAN MCMASTER, AND PABLO SPILLER. 1995. The effect of incentive regulation on infrastructure modernization: local exchange companies' deployment of digital technology. *Journal of Economics & Management Strategy* 4(2): 187-236.

GROSSMAN, GENE, AND ELHANAN HELPMAN. 1994. Endogenous innovation in the theory of growth. *Journal of Economic Perspectives* 8(1) (Winter): 23-44.

HALL, BRONWYN AND BENITA KAHN. 2003. Adoption of new technology. In *Handbook of economics in the electronic age*, edited by Derek C. Jones. New York: Academic Press

HALL, PETER. 1994. *Innovation, economics and evolution: theoretical perspectives on changing technology in economic systems*. New York: Harvester – Wheatsheaf.

This can be viewed as the basic text on technological innovation. It examines the economics and related mathematics of all aspects of innovation building on the microeconomic and extending to the macro treatment in growth theory. It also provides a sound introduction to evolutionary theory and the work of Nelson and Winter (1982). All in all, it is a one-stop-shopping text for understanding the scope of technological innovation. It is long.

HANNAN, TIMOTHY, AND JOHN MCDOWELL. 1984. The determinants of technology adoption: the case of the banking firm. *Rand Journal of Economics* 15(3) (Autumn): 328-335.

HARABI, NAJIB. 1995. Sources of technical progress: empirical evidence from Swiss industry. *Economics of Innovation and New Technology* 4: 67-76.

HECKMAN, JAMES AND THOMAS MACURDY. 1985. A simultaneous equations linear probability model. *Canadian Journal of Economics* 18(1): 28 -37.

HEILBRONER, ROBERT. 1993. Was Schumpeter right after all? *Journal of Economic Perspectives* 7(3): 87 - 96.

HEILBRONER, ROBERT. 1999. *The worldly philosophers: the lives, times and ideas of the great economic thinkers*. 7th ed. New York: Simon and Schuster.

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HORAK, RAY. 2002. *Communications systems and networks.* 3rd ed. Indianapolis: Wiley Publishing.

JAFFE, ADAM. 1988. Demand and supply influences in R&D intensity and productivity growth. *The Review of Economics and Statistics* 70(3): 431-437.

This is a paper that one should read. It is shorter than most, but highly informative, succinct, and clear in its exposition.

Jaffe goal is to determine the relative importance of market conditions or the "pull" of market forces (demand-pull), the "push" of technological positions (technological opportunity), and spillover effects on first the allocation of resources to innovation (R&D intensity) and, secondly, in innovative success (productivity growth). He designs a model that incorporates a technological position vector (the proportion of research effort devoted to diverse technological areas), a market position vector (the fraction of sales from several distinct markets), and two indices to capture the effects of spillovers. These factors are included long with other variables to estimate a R&D intensity equation (annual firm R&D) and a total factor productivity (TFP) growth rate equation.

The market and technological position effects are both positive and significant, whether individually or when included together, in the effects on R&D intensity. They are both significant individually in TFP growth, but indistinguishable and relatively less significant, though still positive.

The spillover effects are positive and significant in the R&D equation with more than half of the effect coming from firms outside the receiving firm's cluster. There is also evidence of spillover effects in the TFP equation, but only marginally significant. Most of that is local.

An unemphasized aspect of the analysis is the strong positive effect of market share in the R&D estimate. It was robust across the various forms of model estimation.

JORDE, THOMAS, J. GREGORY SIDAK, AND DAVID TEECE. 2000. Innovation, investment, and unbundling. *Yale Journal on Regulation* 17(1) (Winter): 1-38.

JOURNAL OF ECONOMIC PERSPECTIVES. 1994. Symposium on new growth theory. *Journal of Economic Perspective,* 8(1) (Winter): 3-72.

KAHN, ALFRED. 1988. *The economics of regulation.* Cambridge: The MIT Press.

KAMIEN, MORTON, AND NANCY SCHWARTZ. 1970. Market structure, elasticity of demand and incentive to invent. *Journal of Law and Economics* 13(1) (April): 241-252.

KAMIEN, MORTON, AND NANCY SCHWARTZ. 1975. Market structure and innovative activity: a survey. *Journal of Economic Literature* 13: 1-37.

Discusses the basic principles associated with technological innovation and market structure including the Schumpeterian hypotheses and the taxonomy of the area of technological

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innovation. Primarily examines the theoretical and empirical literature and summarizes their import.

This paper as been subsumed in Kamien & Schwartz (1975). If one is constrained for time, one can limit oneself to this paper and have a more than satisfactory understanding of economic thought on technological innovation and market structure.

KAMIEN, MORTON, AND NANCY SCHWARTZ. 1982. *Market structure and innovation.* Cambridge: Cambridge University Press.

A definitive work that is usually referenced in almost every piece on the subject. The authors provide a thorough examination of the then-current economic literature as well as an explanation (both introductory and detailed) of the economics and the mathematics underlying both decision theory as well as game theory. They also discuss and explain the Schumpeterian hypotheses. Builds on their work in Kamien & Schwartz (1975) with additional studies.

KARSHENAS, MASSOUD, AND PAUL STONEMAN. 1993. Rank, stock, order, and epidemic effects in the diffusion of new process technologies: an empirical model. *Rand Journal of Economics* 24(4) (Winter): 503-528.

KARSHENAS, MASSOUD, AND PAUL STONEMAN. 1995. Technological diffusion. In *Handbook of the economics of innovation and technological change*, edited by P. Stoneman. Oxford: Blackwell Publishers.

KASERMAN, DAVID AND JOHN MAYO. 1995. *The economics of antitrust and regulation.* New York: Dryden Press.

KATZ, MICHAEL, AND CARL SHAPIRO. 1986. Technology adoption in the presence of network externality. *Journal of Political Economy* 94(4) (August): 822-841.

KLEINKNECHT, ALFRED. 1990. Are there Schumpeterian waves of innovation? *Cambridge Journal of Economics* 14: 81-92.

KLEINKNECHT, ALFRED, AND BART VERSPAGEN. 1990. Demand and innovation: Schmookler re-examined. *Research Policy* 19: 387-394.

KLEPPER, STEVEN, AND KENNETH SIMONS. 2000. The making of an oligopoly: firm survival and technological change in the evolution of the U.S. tire industry. *Journal of Political Economy* 108(4) (August): 728-60.

This study can be seen as a verification of Klepper 's (1996) theoretical work.

KLEVORICK, ALVIN, RICHARD LEVIN, RICHARD NELSON, AND SIDNEY WINTER. 1993. On the sources and significance of interindustry differences in technological opportunities. Cowles Foundation Working Paper No. 1052. Yale University.

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LAFFONT, JEAN-JACQUES, AND JEAN TIROLE. 2000. *Competition in telecommunications.* Cambridge: MIT Press.

LANDES, DAVID. 1969. *The unbound Prometheus: technological change and industrial development in Western Europe from 1750 to the present.* Cambridge: Cambridge University Press.

Considered a seminal history of industrial development in Western Europe from the beginnings of the industrial revolution until shortly after World War II.

LAZAR, FRED. 2000. Schumpeter foresaw today's economy. *Financial Post - Canada,* 24 January.

LEGG-MASON RESEARCH. 2001. *Reshaping rural telephone markets: financial perspectives on integrating acquired access lines,* Baltimore, Maryland, Legg Mason Research.

LEVIN, R., W. COHEN, AND D.MOWERY. 1985. R&D, appropriability, and market structure: new evidence on some Schumpeterian hypotheses. *American Economic Review* 75(2) (March): 20-24.

LEVIN, RICHARD, ALVIN KLEVORICK, RICHARD NELSON, AND SIDNEY WINTER. 1984. Survey research on R&D appropriability and technological opportunity: Part 1. Working Paper, July, Yale University.

LEVIN, R.C., AND P.C. REISS. 1984. Tests of the Schumpeterian model of R&D and market structure. In *R&D, patents and productivity* edited by Z. Griliches. Chicago: University of Chicago Press.

LEVIN, R.C., AND P.C. REISS. 1988. Cost-reducing and demand-creating R&D with spillovers. *RAND Journal of Economics* 19: 538-556.

LEVIN, SHARON, STANFORD LEVIN, AND JOHN MEISEL. 1987. A dynamic analysis of the adoption of a new technology: the case of optical scanners. *Review of Economics and Statistics* 69 (1): 12-17.

LOURY, G.C. 1979. Market structure and innovation. *Quarterly Journal of Economics* 93: 395-410.

Considered one of the classic articles on innovation. This is one of he first treatments of R&D investment decision-making in a rivalrous setting where a firm must take into account the aggregate effect of rivals' R&D investment decisions and market uncertainty.

LOVE, JAMES, AND STEPHEN ROPER. 1999. The determinants of innovation: R&D, technology transfer and networking effects. *Review of Industrial Organization* 15(1) (August): 43-64.

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Although the study is about the effect of the three factor intensities on innovation, the process meant examining the effects of 22 other variables via three-stage process the tested for the substitutability of the factors - there was - the endogeneity of the factors in the innovation equation - they were - and the estimation of the model via several different forms of estimation - Tobit, logit, negative binomial. Valuable for the process and the conclusions about the different determinants of innovation: R&D, technology transfer and networking are substitutes; there is no support for a positive effect of market power on innovation; larger plants tend to innovate more than smaller plants up to a limit of about 1800 employees; demand (sales growth) has a positive influence on the extent of innovation -but not on the likelihood of innovation; foreign ownership will lead to more transfer of technology, but less in-plant innovativeness.

LUCAS, ROBERT. 1988. On the mechanics of economic development. *Journal of Monetary Economics* 22(1) (June): 3-42.

MADDALA, G.S. 1983. *Limited-dependent and qualitative variables in econometrics.* Cambridge: Cambridge University Press.

MADDEN, GARY, AND SCOTT SAVAGE. 1999. Telecommunications productivity, catch-up and innovation. *Telecommunications Policy* 23(1) (February): 65-81.

MAJUMDAR, SUMIT AND S. VENKATARAMAN. 1998. Network effects and the adoption of new technology: evidence from the U.S. telecommunications industry. *Strategic Management Journal* 19: 1045 - 1062.

MANSFIELD, EDWIN. 1968. *Industrial research and technological innovation: an econometric analysis.* New York: W.W. Norton & Company.

See Part IV for examination of diffusion.

MARKHAM, JESSE. 1965. Market structure, business conduct, and innovation. *American Economic Review* 55(2) (May): 323-332.

This is an excellent piece on the "correct" interpretation of Schumpeter - i.e., that Schumpeter envisaged a "threshold" of size and market power necessary to conduct innovation. What has been tested bears small resemblance to Schumpeter's real hypothesis.

MARTIN, STEPHEN. 1993. *Advanced industrial economics.* Cambridge: Blackwell Publishers.

MAYO, JOHN, AND JOSEPH FLYNN. 1988. The effects of regulation on research and development: theory and evidence. *Journal of Business* 6(3): 322-336.

MCCRAW, THOMAS. 1991. Schumpeter ascending. *American Scholar* 60(3) (Summer): 371-388.

This is an easily read condensed history of Schumpeter and his work. An interesting aspect is Schumpeter's influence on Japanese economic thought and policy.

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MOKYR, JOEL. 1990. *The lever of riches.* Oxford University Press.

An economic history study of technological progress over the past two millennia ending with the advent of WW I. Explains why some societies have been technological progressive and others have stagnated; examines themes concerning the relationship between technological progress and its determinants; studies the links between theory and practice (as well as its disconnects). He closes with an examination of the evolutionary concepts of economic theory. The book won the Schumpeter Prize[131] *for economics and is considered "an important book, both for its substance and its intellectual demands"*[132].

MOWERY, DAVID, AND DAVID ROSENBERG. 1979. The influence of market demand upon innovation: a critical review of some recent empirical studies. *Research Policy* 8: 102-153.

MUKHOPADHYAY, A.K. 1985. Technological progress and change in market concentration in the U.S., 1963-1977. *Southern Economic Journal* 52: 141-149.

NAHM, JOON-WOO. 2001. Nonparametric quantile regression analysis of R&D-sales relationship for Korean firms. *Empirical Economics* 26(1) (March): 259-270.

NAKAMURA, LEONARD. 2000. Economics and the new economy: the invisible hand meets creative destruction. Federal Reserve Bank of Philadelphia *Business Review*, (July/August): 15 - 30.

NELSON, RICHARD. 1995. Recent evolutionary theorizing about economic change. *Journal of Economic Literature* 33(1) (March): 48-90.

A succinct account of evolutionary theory by a pioneer.

NELSON, RICHARD, AND SIDNEY WINTER. 1982. *An evolutionary theory of economic change*. Cambridge and London: The Belknap Press of Harvard University Press.

The primary reference in evolutionary theory. Takes some time. Have to broaden one's thinking. Begin the see the economic world of technological innovation in a more holistic sense.

NEWTON, HARRY. 1998. *Newton's telecom dictionary.* 14th ed. New York: Flatiron Publishing.

NEWEY, WHITNEY. 1987. Efficient estimation of limited dependent variable models with endogenous explanatory variables. *Journal of Econometrics* 36: 231 - 250.

New York Times, various issues.

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[131] Awarded by the International Joseph A. Schumpeter Society, 1990.

[132] Landes, David. "Rewarding the Better Mousetrap," *NY Times Book Review*, January 6, 1991.

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PAVITT, K., M. ROBISON, AND J. TOWNSEND. 1987. The size distribution of innovating firms in the UK: 1945-1983. *Journal of industrial Economics* 35(3) (March): 297-316.

PORTER, MICHAEL. 1990. *The competitive advantage of nations*. New York: Free Press.

PRIEGER, JAMES. 2001. Telecommunications regulation and new services: a case study at the state level. *Journal of Regulatory Economics* 20(3): 285-305.

QUIRMBACH, HERMAN. 1986. The diffusion of new technology and the market for an innovation. *Rand Journal of Economics* 15(1) (Spring): 33-47.

REINGANUM, JENNIFER. 1989. The timing of new innovation: Research, development and diffusion. In *Handbook of industrial organization* Vol. I, Chapter 14, edited by R. Schmalensee and R. Willig. Amsterdam: North-Holland.

RICARDO, DAVID. 1821. *On the principles of political economy and taxation*. 3rd ed. London: John Murray, Albemarle-Street.

ROMER, PAUL. 1986. Increasing returns and long-run growth. *Journal of Political Economy* 94(5) (October): 1002-37.

ROMER, PAUL. 1990. Endogenous technological change. *Journal of Political Economy* 98: S71-102.

ROSE, NANCY, AND PAUL JOSKOW. 1990. The diffusion of new technologies: evidence from the electric utility industry. *Rand Journal of Economics* 21(3) (Autumn): 354-373.

ROSENBERG, NATHAN. 1974. Science, invention and economic growth. *The Economic Journal* 84(333) (March): 90-108.

One can read this piece and gain a fair summarization of Schmookler's (1996 analysis. However, Rosenberg's difference with Schmookler are really more of degree than kind and hint at a slightly different interpretation than mine of exactly what Schmookler said about the importance of scientific and engineering knowledge versus demand or economic factors. Rosenberg supplies a more detailed assessment of the importance of scientific discoveries without really refuting the importance of economic or demand factors.

SALONER, GARTH, AND ANDREA SHEPHERD. 1995. Adoption of technologies with network effects: an empirical examination of the adoption of automated teller machines. *Rand Journal of Economics* 26(3) (Autumn): 479-501.

SAPPINGTON, DAVID, AND DENNIS WEISMAN. 1996. *Designing incentive regulation for the telecommunications industry*. Washington, D.C.: AEI Press.

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SAPPINGTON, DAVID. 2002. Price regulation and incentives. In *Handbook of telecommunications economic.* edited by Martin Cave, Sumit Majumdar and Ingo Vogelsang. New York: North-Holland.

SAY, JEAN-BAPTISTE. 1880. *A treatiste on political economy or the production, distribution and consumption of wealth.* (Translated from French fourth edition by Prinsep, C.R., with notes by the translator. Sixth American edition containing a translation of the introduction and notes by Biddle, C.C. of Claxton, Remsen and Haffelfinger) Philadelphia, PA. (reprint by Batoche Books, Ontario, Canada, 2001).

This treatise by Say is valuable as an example of early economic thought on technological innovation. Most pieces that do acknowledge the early thinkers will mention Smith, but very few reference Say. Say attaches far greater importance to innovation than does Smith. See Book I, Chapter VII, in particular, for Say's views on technological innovation (or "machinery"). See also the Book I, Introduction for Say's criticisms of Smith's approach and analysis in Wealth of Nations.

SCHERER, F.M. 1965a. Firm size, market structure, opportunity, and the output of patented inventions. *American Economic Review* 55(5) (December): 1097-1125.

One of the first studies to capture the nonlinear relationship between firm size and innovative activity. This study also has relevance for clarification of other determinants of innovative activity such as technological opportunity, demand-push, market power, and diversity.

SCHERER, F.M. 1965b. Size of firm, oligopoly, and research: a comment. *Canadian Journal of Economics and Political Science* 31: 256-266.

SCHERER, F.M. 1967. Market structure and the employment of scientists and engineers. *American Economic Review* 57 (June): 524-531.

SCHERER, F.M. 1982. Demand-pull and technological innovation: Schmookler revisited. *Journal of Industrial Economics* 30(3) (March): 225-237.

SCHERER, F.M. 1984. Market structure and innovation: statistical studies. In *Innovation and growth: Schumpeterian perspectives,* edited by F.M. Scherer, 169 -173. Cambridge: MIT Press.

SCHERER, F.M. 1992. Schumpeter and plausible capitalism. *Journal of Economic Literature* 30(3) (September): 1416-1433.

Examines the impact, meaning and relevance of Joseph Schumpeter's Capitalism, Socialism, and Democracy after fifty years. Introduces the Schumpeterian influence on Japanese economic thinking and policy.

SCHERER, F.M., AND DAVID ROSS. 1990. *Industrial market structure and economic performance.* 3rd ed. Boston: Houghton Mifflin.

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SCHMOOKLER, JACOB. 1962. Economic sources of inventive activity. *Journal of Economic History*, 22(1) (March): 1-20.

SCHMOOKLER, JACOB. 1966. *Invention and economic growth.* Cambridge: Harvard University Press

This becomes a necessary read in its entirety if one is to truly understand Schmookler's thinking on technological progress and innovative activity. Surveys and reviews do not convey the rich sense of Schmookler's thinking on this subject Yes, it does set forth an argument for demand as the primary force in innovative activity. However, one needs to read what Schmookler wrote and wade through his economic reasoning to appreciate the basis for his conclusions. (It does have the sense of rambling in some areas which necessitates rereads of several sections.) It is not a choice of demand versus technological opportunity or technological knowledge. According to Schmookler, knowledge is necessary but not sufficient as driver of innovative activity.

SCHUMPETER, JOSEPH. 1942. *Capitalism, socialism and democracy.* 1976 edition. New York: Harper Torchbooks.

SCHUMPETER, JOSEPH. 1982. The 'crisis' in economic - fifty years ago. *Journal of Economic Literature* 20(3) (September): 1049-1059.

Handwritten paper discovered amongst Schumpeter's papers at Harvard University Archives by Dr. Loring Allen while preparing a biography on Schumpeter. Dr. Allen believes it was written after Schumpeter's lecture at Tokyo University, January 28, 1931. Here Schumpeter is arguing for a more scientific approach to economics.

SCOTT, JOHN. 1984. Firm versus industry variability in R&D intensity. In *R&D patents and productivity* edited by Z. Griliches. Chicago: University of Chicago Press for the NBER.

SHAMPINE, ALLAN. 2001. Determinants of the diffusion of U.S. digital telecommunications. *Journal of Evolutionary Economics* 11: 249-261.

SMITH, ADAM. 1776. *An inquiry into the nature and causes of the wealth of nations.* In *Great Books of the Western World.* Vol. 39, edited by Robert M. Hutchins. Chicago: Encyclopedia Britannica, Inc. 1952.

SOLOW, ROBERT. 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70 (February): 65-94.

SOLOW, ROBERT. 1957. Technical change and the aggregate production function. *Review of Economics and Statistics* 39 (August): 312-320.

STENDEL, CHARLES, AND KEVIN STIROH. 2001. Productivity: What is it, and why do we care about it? *Business Economics* 36(4) (October): 13-31.

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STERN, SCOTT, MICHAEL PORTER, AND JEFFREY FURMAN. 2000. The determinants of national innovative capacity. *National Bureau of Economic Research* Working Paper No. W7876, September.

STIROH, KEVIN. 2001. What drives productivity growth? *Economic Policy Review.* Federal Reserve Bank of New York 7(1) (March): 37-60.

A lucid account of the distinctions between neoclassical and new growth models in explaining the link between investment and productivity. An excellent source of the literature on both theories of growth.

STONEMAN, PAUL. 1979. Patenting activity: a re-evaluation of the influence of demand pressures. *Journal of Industrial Economics* 27(4) (June): 385-401.

STONEMAN, PAUL. 1991. Technological diffusion, firm size and market structure. In *Innovation and technological change: an international comparison*, edited by Z. Acs and D. Audretsch. New York: Harvester Wheatsheaf.

STONEMAN, PAUL. 2002. *The economics of technological diffusion.* Oxford: Blackwell Publishers.

SUTTON, JOHN. 1991. *Sunk costs and market structure: price competition, advertising, and the evolution of concentration.* Cambridge, Mass. and London: MIT Press.

A study of the relationship between sunk costs (primarily advertising outlays) from three methodological perspectives: game theory, econometrics, industry case studies. Very complex and dense reading, but fairly straightforward. Its value to this paper lies in its broadening view of the determinants of market structure and its concomitant relationship to R&D. Highly praised within the economic community (Shapiro, 1993) although not without some criticism (Scherer, 1992).

SUTTON, JOHN. 1996. Technology and market structure. *European Economic Review* 40: 511-530.

Extends the work in Sutton (1991) to focus on R&D intensity. Provides a brief sketch of the more fully developed argument set forth in Sutton (1998). One would do better to try and understand this piece rather than wade through the denseness of the later work.

SUTTON, JOHN. 1998. *Technology and market structure: Theory and history.* Cambridge, Mass. And London: MIT Press.

SYMEONIDIS, GEORGE. 1996. Innovation firm size and market structure: Schumpeterian hypotheses and some new themes. *OECD Economic Studies* No. 27 /II.

A fairly current survey of the empirical literature on the link between innovation, market structure and firm size. In addition to reviewing studies that examine the impact of market structure on innovation and hypotheses on why a positive effect might exist, he also explores studies concerning the endogeneity of the links between market structure and innovation. An

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interesting aspect of the paper is the author's interpretation of Sutton (1996) since he was once Dr. Sutton's student. The author provides a clear exposition of this area of study.

TAYLOR, WILLIAM, CHARLES ZARKADAS, AND J. DOUGLAS ZONA. 1992. Incentive regulation and the diffusion of new technology in telecommunications. Paper presented at the Ninth International Conference of the International Telecommunications Society, 11-17 June.

THIRTLE, COLIN, AND VERNON RUTTAN. 1987. *The role of demand and supply in the generation and diffusion of technical change.* Chichester: Harwood Academic Publishers.

TIROLE, JEAN. 1988. *The theory of industrial organization.* Cambridge: MIT Press.

TOIVANEN, OTTO AND PAUL STONEMAN. Dynamics of R&D and investment: UK evidence. *Economics Letters* 58(1): 119 - 126.

URI, NOEL. 2001. Technical efficiency, allocative efficiency, and the implementation of a price cap plan in telecommunications in the United States. *Journal of Applied Economics* 4(1): 163-186.

U.S. CONGRESS. HOUSE OF REPRESENTATIVES. COMMITTEE ON SCIENCE. 1998. *Unlocking our future: Toward a new national science policy.* Washington, D.C.: U.S. Congress.

VAN CAYSEELE, P.J.G. 1998. Market structure and innovation. *De Economist* 146(3) (October): 391-417.

The author primarily surveys the theoretical literature on the relationship between market structure and innovation covering the last two decades since 1975. There is little discussion of empirical results per se. Nevertheless this is a far ranging survey that touches on the major themes of research during this period. He discusses studies that are more recent and unknown. This study examines works that explore complexities in the determinants of innovation via the modeling process.

VOGELSANG, INGO, AND BRIDGER MITCHELL. 1997. *Telecommunications competition: The last ten miles.* Cambridge: MIT Press.

VOSSEN, ROBERT. 1999. Market power, industrial concentration and innovative activity. *Review of Industrial Organization* 15(4) (December): 367-278.

Wall Street Journal, various issues.

WALSH, V. 1984. Invention and innovation in the chemical industry: demand-pull or discovery-push? *Research Policy* 13: 211-234.

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WILLIG, ROBERT, WILLIAM LEHR, JOHN BIGELOW, AND STEVE LEVINSON.. 2002. Stimulating investment and the Telecommunications Act of 1996, 11 October, Working Paper.

WOOLDRIDGE, JEFFREY. 2002. *Econometric analysis of cross section and panel data.* Cambridge: MIT Press.

WOROCH, GLENN. 2002. Local network competition. Forthcoming in *Handbook of telecommunication,* edited by M. Cave, I. Vogelsang, S, Majumdar. Elsevier Publishing.

WOROCH, GLENN. 2000. Competition's effect on investment in digital infrastructure. Working Paper, University of California at Berkeley.

YI, SANG SEUNG. 1999. Market structure and incentives to innovate: the case of Cournot Oligopoly. *Economics Letters* 65(3) (December): 379-88.

ZOLNIEREK, J., J. EISNER, AND E. BURTON. 2000. *An empirical examination of entry patterns in local telephone markets.* Federal Communications Commission.

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