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Regulating Dynamic Markets: Progress in Theory and Practice

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Abstract

A key question facing regulators is how to create an economic environment that encourages appropriate investment and innovation. In this paper we analyze the importance of technological change for both competition and regulation, with a particular focus on the regulation of telecommunications and the Internet. We recommend that dynamic efficiency should be used as the appropriate benchmark for judging the effectiveness of different regulatory approaches. Contrary to conventional wisdom, we find that incentive regulation, such as price caps, is not particularly good at promoting dynamic efficiency. Neither is traditional cost-of-service regulation. As an alternative, we suggested that antitrust, judiciously applied, is likely to be better at promoting dynamic efficiency.

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1. Introduction

Rapid technological change acts as a competitive force over time. Markets characterised by high rates of innovation fit Schumpeter's (1942) process of "creative destruction", whereby competition occurs through more efficient firms entering the market and displacing existing technologies or less efficient firms. It is an evolutionary process that is Darwinian in nature through the survival of the fittest, where over time relatively "weaker" technologies, firms, and production processes are replaced by relatively "stronger" substitutes. In these markets, innovation, new technologies, and cost reductions have similar implications for incumbent firms to contestable entry, while the associated stranding of existing technologies is a form of exit. In addition, rapid technological change inhibits affiliated actions among incumbents.[1] Dynamic technological change is therefore part of competition.

For many modern-economy products competitive effects may be tempered with the influence of network effects associated with connectivity. However, competition may also be enhanced because first mover advantage in these products is valuable and network effects thus engender tournament competition that is all the more intense because of the rapidity of change. The consequence of network effects is that there is a tendency for a market to "tip" to a single dominant product, technology or standard.[2] In modern economies the contemporary, almost instant, availability of geographically separate but deep and connected markets also enhances the vigor of competition; as compared to the past where innovations recovered their cost over time in a limited array of horizontally segmented markets.[3]

These features of technical change characterise telecommunications[4] and explain why it has been at the forefront in the evolution of regulatory arrangements. In the 1970s the advent of competition arising from new technology was an important force in the breakdown of cost-

[1] Kaplow and Shapiro (2007) argue that the more likely it is that a market will experience a disruptive technological innovation, the harder it is to sustain collusion.

[2] See for example, Katz and Shapiro (1998). could also cite: Shapiro and Varian - Information Rules LE/NERA

[3] The almost instant worldwide diffusion of 1G, 2G and 3G mobile telecommunications technologies (Gruber (2005)) – need cite at end is a good example of rapid horizontal diffusion of technology in the modern world.

[4] Technical change in telecommunications is described in the Appendix.

of-service regulation that explicitly prevented entry in the USA since 1934 (Hausman, Tardiff and Belinfante (1993)). This entry-limiting cost-of-service regulation inhibited the uptake of technological advancements and produced inefficient pricing. At least from the break up of American Telephone and Telegraph (AT&T) in 1984, industry-specific regulation in the U.S. used incentive regulation that enabled entry.[5] The switch to industry-specific incentive regulation, such as price or revenue caps set in advance, was widespread in other industries and in other countries in the closing three decades of the 20th century.[6]

Regulation of (near) natural monopoly industries evolved during this period from state-ownership and cost-of-service regulation,[7] to more private ownership and incentive regulation.[8] Since that time much has been learned about the theory and practice of incentive regulation. This learning has entailed developments in the political economy of regulation and it has been informed by developments in the application of modern finance to regulation. This application is especially germane because it incorporates decision-making under uncertainty[9], and because the switch from entry-limited cost-of-service regulation to incentive regulation shifts competitive and technological risks away from consumers to the firm. Modern investment theory combined with the theory of regulation helps to explain why incentive regulation has, as traditionally implemented, not performed well. It also provides lessons for improved approaches to regulation.

A key issue addressed in this paper is the optimal form of regulation in a dynamically evolving industry, such as telecommunications. We argue, contrary to conventional wisdom, that incentive regulation is not particularly good at promoting dynamic efficiency; nor is traditional cost-of-service regulation. As an alternative, we suggest that antitrust, judiciously applied, is likely to be better at promoting such efficiency.

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5 Competition continued to be managed however: Shin and Ying (1992) illustrate this in its analysis of 1980s mobile phone regulation that limited entry across states beyond duopoly.

6 The industries included Transport, Energy, Communications and Finance, and occurred in varying degrees across most countries of the OECD (Littlechild (2003)).

7 We use the term rate-of-return regulation interchangeably with cost-of-service regulation.

8 The key distinguishing principle of incentive regulation is that it seeks to set regulatory parameters – e.g. price caps – on the basis of factors that are independent of the firm and in this way assign the firm autonomy to maximize profits against these parameters without there being feedback to the setting of parameters. Such feedback engenders a game between the regulator and the firm that is likely to cost efficiency. In general regulatory practice the ideal of incentive regulation has been compromised as (near) monopoly industries typically hold much of the information about that industry, and because regulators and regulated firms necessarily interact among each other in industry-specific regulation. An implication of incentive regulation is that firms subject to increasing autonomy under regulation carry more industry risk than they would under cost-of-service regulation.

9 We do not distinguish between risk and uncertainty.

Section 2 of the paper examines the basis of dynamic efficiency and what the theory of regulation predicts for regulating dynamic markets. Section 3 examines variations in telecommunications regulation across countries, and their effects. Section 4 concludes.

2. Regulation for dynamic efficiency in dynamic markets

2.1. The Dynamic Efficiency Framework

Dynamic efficiency is widely accepted as the appropriate criterion for market regulation.[10] Dynamic efficiency can be measured as "the outcomes from the sequence of future decision-making relating to the allocation of resources, production technologies of firms, and investment in new knowledge".[11] It is intrinsically related to efficiency in the process of innovation and encompasses all its pertinent dimensions (Baumol (2002, p.30, footnote 1)) – for example, the processes of invention and of successive improvement before introduction, as well as the act of introduction itself. It is distinguished from static (allocative and productive)[12] efficiency by its emphasis on factors that affect future welfare, such as investment and innovation.

To examine the linkages between regulation and welfare it is useful to set out quite precisely the generic connection between static and dynamic efficiency. We introduce a definition of dynamic efficiency that is both flexible and firmly grounded in traditional welfare economics. It is flexible in the sense that it includes uncertainty, and allows changes in technology and demand over time. It is firmly grounded and tightly linked to conventional cost-benefit analysis in that it builds on the idea of static efficiency and extends that idea across time, allowing for investment and innovation. We will use this formulation to show why some approaches to regulation are likely to be suboptimal in certain settings. Static efficiency at date *t* is conventionally measured as the sum of producers' and consumers' surplus (i.e. total surplus) for the relevant market at that date. It is affected by the factors affecting supply and demand up to and in time *t*, including regulatory settings. It is static welfare that is total surplus we denote $W_t(p_t, \theta)$ where p symbolizes market price, and θ contains relevant

[10] Dynamic efficiency is accepted by the OECD as the basis for policy assessment: see Ahn (2002, s.1) for an example.

[11] Evans, Quigley and Zhang (2000), p.2.

[12] A market at a point in time is statically efficient if it is allocatively and productively efficient, which holds if the level of output in that market and supply costs are such that the total surplus at that time is at a maximum.

regulatory policy settings. For example, θ may include a cap on the level of the price, in which case p_t and W_t will reflect the effect of the cap.

$W_t(p_t, \theta)$ is a snapshot of the consumer plus producer surplus of a market at a point in time, in the next point of time it will be $W_{t+1}(p_{t+1}, \theta)$. The difference between the *W's* of the two dates will reflect a) technology change (supply curve) b) demand change (demand curve) and c) investment. At each time *W* reflects investment and innovation decisions of the past. If prices are held too low in period t (and are expected to be low in the future) there will be reduced investment/innovation and the value of *W* in future periods will be lower.

Dynamic efficiency is the sum of total surplus generated by the market over time, and it is expressed as the expected present value of the market's total surplus into the indefinite future.[13] Dynamic efficiency can be represented looking forward from the present ($t = 0$) as:

$$DE_0 = E_0\left(\sum_{t=0}^{\infty} \frac{W_t(p_t,\theta)}{(1+r)^t} \mid I_0,\ \sigma,\ \theta\right) \qquad (1.1)$$

$$= W_t(p_t,\theta) + E_0\left(\sum_{t=1}^{\infty} \frac{W_t(p_t,\theta)}{(1+r)^t} \mid I_0,\ \sigma,\ \theta\right) \qquad (1.2)$$

where $DE_{0\,DE\ t=0}$ is dynamic efficiency of the indefinite future assessed at the present time (i.e. when $t=0$), $E_0(.\mid I_0,\sigma,\theta)$ is the expectation of the future based upon information at $t=0$. The term *I* denotes relevant market specific information including technology, σ represents variation in prospective outcomes arising from technological and all other sources of market uncertainty, and the regulatory policy settings are summarised in θ; all available at the date from which expectations of the future are taken. The term *r* is the relevant social discount rate. The variance and policy settings are available at the present time, but may be anticipated to change over time. Both (1.1) and (1.2) describe dynamic efficiency, but (1.2) expresses it as the sum of immediate total surplus plus the present value of the total surpluses (dynamic efficiency) expected to occur in the future.[14] We shall assume that this immediate total surplus, as well as later surpluses, may be manipulated by regulation, at date $t=0$ by settings of the policy parameters of θ_0. Whereas the social planner seeks to maximise dynamic

[13] We take the view that dynamic efficiency as expressed in (1) is the appropriate goal for regulation of industry; and that equity considerations should be left to other policy instruments. Regulation is a very clumsy tool for effecting income re-distribution for reasons that include identification of the incidence of regulatory interventions. Without understanding the incidence the equity cannot be linked to welfare. While incidence is problematic enough in a static world it is impossible to assess in a dynamic setting. These issues are discussed in the context of antitrust and regulation by Evans (2004) and Katz (2004).

[14] Note that cost-benefit analysis typically has the same objective as dynamic efficiency.

efficiency, the regulated firm has the same inter-temporal structure for its objective but with total surplus replaced by profit and with the social discount rate replaced by their private discount rate.

To maximise dynamic efficiency by regulation requires choosing the policy settings that make the weighted sum of (1.1) as large as possible. It entails choosing policies that anticipate effects of policies on present and future total surpluses. There is generally a trade-off between future and present total surpluses. Future surpluses are affected by investment, innovation and the utilisation of innovation, while maximising immediate welfare $W_0(p_{0,}\theta_0)$ typically entails regulating firm behaviour in ways that restrict investment and innovation, and thereby future total surpluses. The goal of price regulation in this setting is to increase dynamic efficiency by first affecting the level of immediate total surplus, $W_0(p_{0,}\theta_0))$, and secondly investment and innovation that increases total surplus in later periods. The second dynamic effect will not, in general, be adequately addressed under pure monopoly because the monopolist gains just the incremental profit from innovation and investment whereas society has the higher payoff of gains in total surplus. However, the effect of price controls on future surpluses is also problematic because pure monopoly is rare and regulation tends to place a greater emphasis on current, relative to future, total surplus. Furthermore, the effect of setting a price too low will typically have a more pronounced effect on total welfare than setting a price too high, because setting a price too low will suppress efficient innovation.

It is apparent from (1) that restricting future total surpluses may be very socially costly, in absolute terms as well as relative to effects on static efficiency. Regulation that delays investment and innovation may delay beneficial effects on future surpluses that can arise from such things as lower costs and new products. It is clear from (1) that regulation that induces missing markets as would occur when a socially viable product is not introduced implies that the total surplus from that market is absent for all periods. More commonly, where there is delay induced by regulation the market's total surplus is missing for the period of delay. In contrast, effects on immediate total surplus are often relatively small because that total surplus is determined largely by past events – e.g. investment – that will not be altered much by contemporary policy settings. Goolsbee (2006, p.4) explains it as "the entire surplus in a market usually dwarfs a traditional DWL triangle".[15]

[15] The acronym DWL represents Dead Weight Loss the common expression for the amount by which present (static) surplus is below its maximum.

There is strong empirical support for the claim that dynamic efficiency is much more important for economic performance than static efficiency. For example, in his study of the determinants of economic growth, Solow (1957) concluded that approximately 87 percent of the source of economic growth in the United States in the first half of the 20th century could be explained by technical change, rather than by increases in capital and labour. Gilbert and Sunshine (1995) and Baumol (2002) argue that, while other researchers disagree about the exact quantitative effects of technical change on economic activity, there is general agreement that such effects are substantial. Related empirical studies include those of Goolsbee *op cit*, who finds that the dynamic efficiency losses from a hypothetical tax applied to broadband Internet in the U.S. exceed the allocative efficiency losses by a factor of two or three.[16] Romer (1994) compares the allocative and dynamic efficiency losses from an import tariff, and finds that the dynamic efficiency losses could be as much as 20 times allocative efficiency losses.

The dynamic efficiency representation (1) illustrates that neglect of the future will adversely affect dynamic efficiency most where the market is subject to rapid technological change. In these markets, missing or delayed application of innovation will mean large forgone future total surpluses. Also in these dynamic markets there is much intrinsic uncertainty about future costs, products, demand and entry.[17] In (1) the variance, σ, represents this uncertainty: it incorporates volatility in potential outcomes in relation to demand, cost and technology. It is larger for dynamic industries with open entry than it is for industries where there is less technical change and entry is restricted. It incorporates systemic risk as well as industry-specific risk for the influence of both these may vary across industries. The variance is important for designing regulatory institutions because, as modern finance and regulatory theories, it plays a central role in agents' decisions in uncertain economic environments.[18]

Unfortunately, the key role of the variance is rarely considered in the actual design of regulatory institutions and in the selection of key regulatory parameters. In some regulatory settings, prospective technical change may be considered to adjust for changes in costs and

[16] For the welfare cost of the regulatory induced delayed introduction of cell-phones see Hausman (2002).

[17] The variance includes volatility in demand as well as demand changes that accompany new technology. Both sources of demand change are uncertain and intersect with technological change and have similar implications for investment decision-making under uncertainty..

[18] This is the central point of Dixit and Pindyck (1994).

products in setting prices;[19] however, this is usually done without taking adequate account of uncertainty.

Finance teaches that the variance will be at least as important for decision-making as the point estimates themselves. It needs to be considered carefully in the design of regulatory policy. While there may be little uncertainty about what determines present total surplus $W_0(p_0, \theta_0)$, there is typically much uncertainty about future components of dynamic efficiency. In what follows it is explained that the variance, σ, is a critical element of agents' behaviour in dynamic markets. If dynamic efficiency is to be optimised, policies should be functions of the variance so that $\theta = \theta(\sigma)$. The policy settings represented by θ include institutional settings, such as the timing of reviews, and whether regulation is enforced after or before regulated parties have acted (i.e., *ex ante* or *ex post* regulation); The settings also include specific rules such as price caps. If one does not consider volatility in the choice of regulatory institution, the benefits of using incentive regulation will be overstated.

2.2 Alternative Approaches to Regulating Dynamic Markets

The broad forms of regulation we consider are antitrust and industry-specific regulation, where the latter subsumes cost-of service and incentive regulation. Under industry-specific regulation, we will generally be concerned with price regulation that is applied to limit natural monopoly powers.[20]

The impact of technological change on dynamic efficiency in antitrust and industry-specific regulation is affected by the difference in philosophy of the two approaches. It is also affected by the economic modelling used under the two policy approaches. Technological change is important for both regulatory forms, in part because rapid technological change reduces the number of firms that are required, all else equal, for a workably competitive market.

2.2.1 The importance of understanding workably competitive markets

The definition of a workably competitive market will affect how we define optimal decisions for the firm and the regulator. It is not commonly understood that a workably competitive

[19] For example, in some jurisdictions account is taken of technical change by allowing accelerated depreciation of assets by a calculation known as "tilted annuity". This approach assumes a path of cost reductions, but does not consider uncertainty in the path.

[20] We do not consider political economy explanations of regulatory institutions that, for example, are proposed by Stigler (1971) and Peltzman (1976). Nor do we consider papers such as Lewis and Sappington (1988) that explicitly address the setting of regulatory parameters when the firm holds more information than the regulator.

market must enable decision-making under uncertainty, where, for example, firms can benefit from delaying decisions and observing how key uncertainties get resolved. Modelling such decision-making under uncertainty allows for a sharper comparison of various regulatory institutions.

A workably competitive market is the basic environment of antitrust regulation. It may be defined as:[21]

> *"….. a market framework in which the pressures of other participants (or the existence of potential new entrants) is sufficient to ensure that each participant is constrained to act efficiently and in its planning to take account of those other participants or likely entrants as unknown quantities. To that end there must be an opportunity for each participant or new entrant to achieve an equal footing with the efficient participants in the market by having equivalent access to the means of entry, sources of supply, outlets for product, information, expertise and finance."*

It is a market that is taken to have no market power issues under antitrust law, and it is the practical representation of theoretical constructs that allow for various kinds of rivalry among firms. According to Markham (1950), workable competition is not some minor relaxation of perfect competition, but should enable dynamic efficiency. As such it must admit inter-temporal decision-making by participants under risk and uncertainty and irreversible investment.[22]

Modern investment decision-making processes can be usefully modelled by explicitly considering investment decision alternatives. These include options to choose the timing of investment as well as the nature and size of projects. These models enable the desired timing of investment to be incorporated in decisions, and thus for decisions to reflect the benefit of information acquired by waiting before investing.[23]

Novy-Marx (2007) demonstrates that for many investments delay options are present in workable competition.[24] Novy-Marx (op cit, 1462) states

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21 Heydon (1989, p.1548) *Trade Practices Law*.

22 Irreversible investments are typical and not special to networks with substantial physical infrastructure. Examples include advertising, product differentiation and development investment.

23 Dixit and Pindyck op cit provide a comprehensive discussion of the place of real options in inter-temporal decision-making.

24 Put another way, delay options would be recognized and affect the decisions of a social planner.

> *"The analysis presented in this article shows that in a competitive industry firms can actually appear to deviate more from neoclassical behavior than the standard real options analysis predicts. In particular, firms may invest only at significantly positive option premia, and delay irreversible investment longer than predicted by a standard, partial-equilibrium model calibrated to the observed price data."*

Uncertainty, irreversible investment and heterogeneity of firms combine to generate this result. Workably competitive markets have sufficient competition that rents due to near monopoly positions are eliminated, but investment options and associated premia remain.[25] In these markets, prices and quantities reflect the creation and extinction of real options by decision-makers. By way of illustration, standard application of investment models cannot explain the persistent presence of an empty lot in a thriving downtown city: the standard net present value criterion would be to assess if building is profitable and, if so, build immediately. Waiting to assess evolving opportunity costs resulting from demand and supply conditions is typically superior for building and, in workably competitive settings, for dynamic efficiency.[26]

There has been significant growth in modelling applications of the options-decision approach because it offers the possibility of empirical models that better match decision-making under uncertainty when there is irreversible investment.[27] Further, it provides a reasonably tractable way of modelling flexible inter-temporal decision-making so that institutional settings and theories can be explored systematically in a dynamic setting. But its importance lies in the finding that even in workably competitive markets the desirability of waiting to make irreversible investments increases with uncertainty or risk. This is a consequence of the bad news principle (Bernanke (1983)) where there is a waiting option. This principle provides that of the two forms of error--waiting when the investment turns out to be profitable; and investing when the investment turns out to be unprofitable--it is the latter that is more costly where there is the opportunity to delay. An increase in uncertainty – in models measured as

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[25] Novy-Marx (2007, 1462) discusses particular situations where the option premia are small. They are situations where investment has no economies or dis-economies and no lump sum elements.

[26] This example is discussed by Novy-Marx op cit, but originates from Titman (1985). While real estate is a very competitive industry owners often do not to build on property that could be immediately developed profitably. The option to develop in the future is valuable and reflected in decisions about the timing of development. It illustrates that options exist in workably competitive markets in part because even in a competitive market individuals hold monopoly positions on their intra-firm decisions.

[27] See, for example, Pindyck (1991).

an increase in the variance –increases the desirability of delay because it pays to be relatively more cautious in situations of high variance of potential returns.

Markets that are dynamically changing add more uncertainty about future costs and products than markets that are relatively stable. It follows that the timing of dynamically efficient investment in workably competitive markets will demand more flexibility for delay and higher premia for investment thresholds when there is more rapid technological change.

The ability of firms to take actions as uncertainty unfolds increases dynamic efficiency.[28] Rules that limit the actions of the regulated firm to respond to changing circumstances will inhibit dynamic efficiency: such rules may be product-specific price caps and rigid quality of performance measures. The improved management of risk associated with more flexibility, and lower transactions costs associated with firm decision making, will enhance dynamic efficiency.

2.2.2 Antitrust or Industry-Specific Regulation?

The speed of technical change has implications for the desirable form of regulation of dynamic markets. While there is some overlap, we adopt the broad classification that antitrust regulation seeks to affect the competitive *behaviour* of market participants by examining and ruling on behaviour *ex post*; in contrast, industry-specific regulation tries to define appropriate *outcomes ex ante* and seeks to implement these outcomes by means of ongoing rule setting and monitoring.[29] Antitrust regulation has the general task of maintaining workable competition, whereas industry-specific regulation tries to produce outcomes that mimic workable competition in situations where it is deemed infeasible for workable competition to thrive.

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[28] One manifestation of the benefits of such flexibility is provided by the arguments for liquid markets: see the finance text of Lengwiler (2004, s.6.2) on the dynamic finance economy. The ability to frequently (desirably continuously) trade assets substitutes for the absence of complete markets: in these there is one market for each state of the world, which is the financial economists' representation of perfect competition in the presence of uncertainty. In particular settings, frequent low-cost actions or trades allow the consumers' portfolios to adjust quickly to new information (outcomes of technological change) and thereby enable the consumer welfare that would exist in complete markets even with markets that are much fewer. Even if complete markets are not attained, quasi-complete markets may arise from active response over time to the arrival of new information, which have the potentiality of improving efficiency.

[29] Spulber (1989, p.624) makes a similar distinction. He states that regulation "refers to general rules and specific actions imposed by administrative agencies on consumers, firms, and the market allocation mechanism…By contrast, antitrust is generally viewed as action by the antitrust agencies and the courts to promote competition through enforcement of antitrust law". Geradin and Sidak (2005) also make the distinction between *ex ante* regulation and *ex post* antitrust. Newbery (2005) also makes this distinction in his analysis of competition law and industry specific regulation, that focusses on electricity markets.

When competition is dynamic and materially affected by technological change, there is a fundamental distinction between regulating *ex ante* for outcomes and regulating *ex post* to maintain workable competition. The distinction exists when technology is relatively stable, but it is more evident with dynamic markets. Antitrust law and industry-specific regulation represent polar cases. Antitrust involves *ex post* application and enforcement of the law, and is about maintaining/enhancing the process of competition. It is concerned about competitive behaviour. In contrast, industry-specific regulation involves *ex ante* intervention and seeks a particular outcome (e.g. normal profits, particular indicators of competition, a specific tariff structure). Accordingly, while the focus of regulation is more on outcomes, the focus of antitrust is on enhancement of the competitive process. This distinction is particularly stark for dynamically changing markets. In a dynamic market, industry-specific regulation, by setting expectations for particular outcomes and specific rules or prices *ex ante*, risks regulatory settings that quickly become inconsistent with the way the market and competition would desirably evolve. In such cases, there may be significant efficiency losses.

Carlton and Picker (2007) identify the relative advantages and disadvantages of antitrust and regulation, offering a similar perspective to the one provided here. One advantage of regulation is that it can specify prices and rules for how firms should deal with each other; on the other hand it is likely to produce cross-subsidies and favor particular interest groups. The authors contrast this instrument with antitrust, which they suggest has the advantage that it promotes competition and avoids favoring special interests. It is not good, however, at formulating or enforcing rules, such as setting prices.

Another potential drawback with industry-specific regulation for dynamic efficiency is that it monitors and adjusts regulatory settings *ex post* as well as *ex ante.* Industry-specific regulatory actions taking place *ex post* to enforce views about desirable outcomes is a significant difference from antitrust, and one that detracts from the ability of industry-specific regulation to mimic a workably competitive market.

An important difference between *ex ante* rules and *ex post* behavioural limits is that the latter will tend to provide firms with more flexibility, which is likely to enhance welfare—especially in dynamic markets. The key to this result is that firms (and consumers) can benefit when they have the ability to react quickly and at low cost to the arrival of new information on markets. Because antitrust regulation is limited in its *ex ante* rule making and generally relies on *ex post* intervention about market behaviour, it will generally promote

dynamic efficiency more than will industry-specific regulation, particularly in markets where there is significant technological change.

2.2.3 Static and Dynamic Regulation: Lessons

Static Approach: Traditional forms of regulation employ static models, which often lead to decisions that sacrifice dynamic efficiency. Prior to 1984, rate of return regulation was the dominant approach to the regulation of public utilities in the US.[30] In the past 30 years, incentive regulation has been introduced often with the objective of mimicking workably competitive markets by setting prices to reflect the ongoing efficient costs of providing services: prices which are no higher than a firm would expect in a competitive market. Effective rate of return regulation is most plausible when entry is prevented and technology is changing slowly; in contrast incentive regulation can co-exist with entry and new technologies.

Rate of return regulation specifies the regulated firm's rates in such a way that revenues cover an estimate of the firm's variable and fixed costs, where the latter reflects an allowable rate of return on the firm's rate base.[31] In order to account for capital costs inter-temporal models are employed that use the weighted average cost of capital and an estimate of the capital stock. But these approaches generally do not explicitly include models of decision-making under risk where there are irreversible investments.[32] Estimation of variable costs and the cost of the rate base generally rely on historical costs. While such estimates may incorporate specific, forward-looking adjustments for inflation or fuel costs (Joskow and Noll, 1991), the approach is largely static. Spulber (1989) reports that estimation of variable costs from past operating expenses does not take account of possible future changes in relative prices, output, consumer demand and demand elasticity. Alleman (1999) finds telecommunications cost models have "fundamental methodological flaws" that include no reflection of dynamics, no allowance for changes in demand or factor prices over time, and no accounting for risk and sunk investments. It shows that incorporating real options can make a significant difference in the estimated regulated price. Using a simple comparison of a real options model with a traditional cost model, the analysis shows that a traditional model may underestimate the regulated price by as much as 60%.

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30 Littlechild (2003).

31 See Spulber (1989), p. 269-279 for a more detailed outline of the process of rate of return regulation.

32 The weighted average cost of capital is itself a static concept.

Static economic models embody a-temporal decision-making and, while they may be informative about immediate total surplus, $W_0(p_0,\theta_0)$, they are seldom useful in forecasting outcomes in dynamic markets. However, where they provide qualitative lessons for total surplus that is applicable for every period's total surplus, static models may make a useful contribution to regulating in a dynamically efficient manner. An example is the static theory of two-sided markets.[33] It assumes networks are platforms that facilitate consumer-to-consumer transactions, and recognises that certain interactions among consumer demands imply that cost-based pricing is not welfare enhancing. Assessing the welfare of regulated prices requires joint consideration of demands on both sides of the market, and of the potential for waterbed effects -- whereby constraining prices through regulation on one side of the market leads to an increase in prices on the other side of the market.[34] While such a result is static, in the sense that it pertains to allocative efficiency in a given period, it is qualitatively applicable any period, and thus is relevant to dynamic efficiency.

Dynamic Approach: Dynamic efficiency under rapid technological change requires considering future states of the world that are possible outcomes of a dynamic process that reflects decisions made under uncertainty. Dynamic models seek to achieve this by incorporating risk, irreversible investments, and the potential for assets losing their value as new technologies arrive. They generally have some element of incentive regulation present, in that the regulated firm controls its production and investment decisions. These models adopt the general structure for dynamic efficiency described in (1) and include measures of volatility that are critical in the performance of regulation.

Dobbs (2004) and Evans and Guthrie (2005, 2006) are recent examples of dynamic models developed to address questions of regulation. They variously use stochastic processes for demand and capital prices to capture the effects of dynamic technological change and seek to optimize dynamic efficiency incorporating decision-making that is cognizant of risk and irreversible investment.[35] A key result of this research is that setting the price below the optimal level will, potentially drastically, reduce dynamic efficiency much more than setting it above the optimal level. The reason is that is that price caps limit the upside for the firm,

[33] See, for example, Rochet and Tirole (2004).

[34] For an analysis of the theoretical conditions for the existence of a waterbed effect, see Schiff (2008). Genakos and Valletti (2009) consider empirical evidence for the existence of a waterbed effect from the regulation of mobile termination rates.

[35] Pindyck (2007) provides an analysis of these effects into models of telecommunications investment under cost-based regulation.

but leave the downside of payoffs from investment with the firm. Further, the optimal level of a price cap is higher than it would be if uncertainty were ignored in regulatory price setting, and it increases with uncertainty: i.e., with the variance, σ.

This result is accentuated by economies of scale in investment. It arises because scale economies add an incentive to invest in anticipation of demand in order that, at the time of building, more is constructed thereby lowering the per unit cost of supply. Evans and Guthrie (2006) find that, for demand uncertainty and minor economies of scale, incentive regulation that sets prices at intervals based on actual demand and at the level an efficient firm would require to enter the industry, would yield inordinately prices if it were to yield dynamically efficient behavior. This comes about because the firm making an investment decision looks forward, taking into account both demand uncertainty and the periodic re-setting of prices. It knows that at the time prices are reset, the regulator observes actual demand. If demand turns out to be relatively low, it will set a relatively low price. Economies of scale accentuate the cost of stranding induced by the price re-set, because there is an incentive for the firm to invest in advance on the likelihood of relatively rapid demand growth. The high prices that preserve efficient incentive regulation are required to compensate the firm for the resultant risk. This result is an important illustration of the effect of ex ante rules that are monitored ex post: the regulator has the benefit of hindsight, and thus information that the firm cannot have when it makes investment decisions

This example illustrates that "revisiting" *ex post* settings made *ex ante* under industry specific incentive regulation will accentuate the risk that the firm faces and adversely affect investment: again because of the asymmetry. If at a re-hearing about the level of a price cap, demand and hence profits turn out to be higher (lower) than anticipated when the regulatory rules were set, the price will be lowered (left the same). Evans and Guthrie (2005) show that this has the effects of a) accentuating the risk of stranding investment, and b) affecting the systemic risk of the firm and thereby its weighted average cost of capital, where demand is correlated to the business cycle. Both effects imply an optimally higher price cap under incentive regulation.

The timing of regulatory hearings is also a regulatory choice of particular importance in dynamic markets. Guthrie's (2006) review of this issue considers the impact of the frequency of regulatory hearings on the regulated firm's investment incentives. It finds that more infrequent hearings can lead to more efficient investment behaviour, as a longer period

between hearings awards the firm a relatively higher proportion of the social benefits from investment, but distortions remain (as the firm has an incentive to invest immediately after a hearing to maximize the length of time that it enjoys the benefits). In markets with rapid technological change, investment would occur more frequently than in less dynamic markets. Thus, the welfare benefits of efficient investment behaviour generated by more infrequent hearings are likely to be substantially greater in more dynamic markets.

Evans and Guthrie (2006) find that, in the presence of irreversible investments, resetting the regulated price more frequently can increase the risk faced by the regulated firm from more frequent exposure to demand and technology shocks. Such shocks are likely to be a more common occurrence in dynamically changing markets, and thus the risks will be higher for regulated firms in these markets. The result is that shortening review periods of fixed length accentuates the asymmetric effect on the regulated firm: on the downside, more frequent review periods expose the firm to more risk, but there is no counteracting upside opportunity in comparison to less frequent review periods.

Ultimately, it may be that the optimal timing of regulatory hearings in a dynamic market may be no fixed review period. Reviews could instead be considered endogenous, with review dates determined by evolving problems.[36] Guthrie (2006, 935) reports that the efficacy of this approach will depend upon the activism of the consumers. If these were active and sought to enforce expectations of outcomes such as level of profits) there may be no gain in security of investment for the firm.

2.3 Implications for the Form of Regulation

The preceding analysis suggest that the ability of firms to act as information arrives enhances dynamic efficiency; and that is particularly true in circumstances where the variability of prospective outcomes is high, as in industries undergoing rapid technological change. We summarize key findings below for industry specific *ex ante* regulation:

> Prices should be set higher than the level static models would suggest;
>
> Other things constant, regulated prices should be set higher when there is more scope for error in rule setting;

[36] Guthrie (2006) notes that under rate of return regulation the timing of hearings was determined endogenously by the evolution of the regulated firm's profitability.

Ongoing monitoring against target outcomes can induce additional uncertainty for the firm and be very costly to dynamic efficiency,[37] particularly with economies of scale in irreversible investment (which is common);

In situations of high uncertainty, it is less likely that *ex ante* regulation with fixed length review periods is superior to regulation that is *ex post.* In the latter approach, reviews are instigated by materially changed circumstances.

These findings imply that industry-specific regulation in its textbook form is unlikely to compatible with dynamic efficiency. It may explain why there has been much criticism of the cost-based telecommunications measure of long run incremental cost (TELRIC) calculations and their effects, as well as of the cost-based pricing of a firm as a whole (ODV regulation).[38] These pricing methods sought forward looking pricing rules: TELRIC for the pricing of connection and universal service, and ODV regulation for pricing a firm as a whole. As a matter of practice, regulatory prices are now very often based upon historical cost instead of a forward looking cost estimate, perhaps using ODV as a starting point where historical cost is not available.

The limitations of industry-specific incentive regulation as initially promulgated are real. Regulation by government ownership and cost-of-service regulation also have limitations, and some compromise approach is often the outcome. Littlechild (2006)[39] also questions the ability of industry-specific regulation to mimic workable competition. It goes on to examine a model of "trilateral governance" where the regulator is the third party overseeing bilateral bargaining between the firm and representatives of its customers in the context of an ongoing relational contract about services, prices and investments.[40] A relational contract depends for its credibility on the ongoing relationship between supply-side and demand-side parties, and not on specific details. As such it could be expected to have fewer forward-looking fixed

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37 Alleman and Rappoport (2002) discuss the constraints imposed by regulation on the ability of a firm to exercise its real options e.g., universal service provisions limiting the firm's flexibility to exercise its option to delay rollout to an unprofitable customer, or to abandon provision of the service. In its model these regulatory constraints have a significant cost.

38 Hausman (1997) argues that telecommunications long run incremental costs (TELRIC) should include the cost of potential stranding, but that this was not admitted under FCC regulation. Optimised deprival value (ODV) regulation may be described as applying the TELRIC approach to the regulated firm as a whole. It was advocated for regulation of electricity and gas-pipe lines by the New Zealand Commerce Commission in the period 2001-2007 but has not been implemented.

39 Address "Beyond Regulation" *ESNIE, The European School on New Institutional Economics* (accessed 3 January 2010 at *http://esnie.u-paris10.fr/en/archives/index.php?req=101*)

40 For a review of the nature of relational contracts see Milgrom and Roberts, (1992, at 131-132).

rules than incentive regulation. Such a contract, particularly when there is a single party (the regulated firm) on one side and many parties (customers) on the other side, could be expected to have "trilateral governance" with the regulator as the third party.[41] Clearly, such an institutional setting will have many variations and, indeed, might well span the range from cost-of-service to incentive regulation.[42]

In summary, when there is rapid technical change neither cost-of-service regulation nor incentive regulation are *per se* superior in enhancing dynamic efficiency. In both cases uncertainty associated with demand and supply render the achievement of dynamic efficiency by means of industry-specific regulation problematic. If there is one lesson, it is that industry-specific regulation adversely affects dynamic efficiency. The relational contract approach may entail fewer rigid rules, but may not operate well in all settings.

The preceding discussion about the value of antitrust in an industry subject to rapid technological change sidesteps an important question: how does a decision maker know before the fact whether an industry is likely to be subject to rapid technological change? While we do not give a full response to that question here, suffice it to note that even if a decision maker cannot make this judgment, antitrust is still likely to be preferable to industry-specific regulation because we believe the net expected benefits are likely to be higher. That is, there is relatively little downside in selecting antitrust in the case where industry-specific regulation is optimal; in contrast, there could be significant losses in choosing industry-specific regulation if antitrust were optimal (i.e., in the case of a dynamically changing market such as the market for mobile phone services).

These findings suggest that antitrust regulation should be a serious alternative. It has the significant advantage of not defining specific, outcome oriented rules in advance and thereby preserving flexibility for the firm. They also suggest that industry-specific regulation should be used sparingly – and with minimal *ex ante* outcome-oriented rule setting: only in circumstances where total surplus cannot be expected to change much over time as a consequence of technical change or fluctuations in demand should industry specific regulation be preferred.

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41 Trilateral governance, as explained by Williamson (1979, 233-261, at 249-250) is a situation where it saves transactions costs for an agency – in this case the government – to act as the arbitrator to an ongoing contract that may have idiosyncratic features.

42 Vertical integration is an extreme version of the relational approach.

In general it will not be possible for industry-specific regulation to closely mimic workable competition. For the reasons given, this form of regulation limits entry and/or reduces flexibility for firms to take voluntary actions; in particular, to invest or respond to competition. Antitrust regulation is the only form of regulation that is consistent with workable competition.[43] This strengthens the argument that industry-specific regulation should be very selectively applied.

3 Application of Regulation in Telecommunications

In this section we provide an empirical examination of telecommunications regulation to gain insights into the effectiveness and efficiency of various regulatory regimes. We consider the approaches of the US, UK and EU, the application of antitrust regulation in New Zealand, the effect of imposing the EU telecommunications model in Finland, and the link between telecommunications development and regulation in developing economies.

3.1 US, UK and European Union Telecommunications Regulation

A few key features of industry-specific regulation have served as the basis of telecommunications regulation in many countries, such as the USA, UK and EU. They include the static natural monopoly model of regulation, the cross subsidisation of some consumers, and access regulation.

The basis for industry-specific price control regulation has long been the static natural monopoly model. In the basic model, economies of scale enable a single firm to supply the entire market at a lower average cost than two or more firms. Telecommunications networks were typically thought to be natural monopolies on the basis of their high fixed (and sunk) costs of establishing the network and the low marginal costs of carrying calls. Because entrants would have difficulty entering the market, the incumbent would price above average cost; thus, providing a rationale for regulation.[44] This static theory has not been translated into a dynamic counterpart, although it is implicit in the general approach of (1) utilized by Dobbs *op cit* and others.

[43] Notwithstanding access regulation is a form of industry-specific regulation that is designed to foster competition.

[44] This reasoning does not explain why entry should be prevented by regulation; unless it is that telecommunications is assumed to be a non-sustainable natural monopoly (Waterson (1978,63)), which requires at some level diseconomies of scale.

It is not clear, however, whether telecommunications networks should have been approximated by the static natural monopoly model. Economides (1998) reports that as early as 1900 in the U.S., telecommunications firms competed prior to their absorption into the Bell System. Using data from 1976 to 1983 to estimate cost functions, Shin and Yang (1992) estimate that prior to the divestiture, AT&T was not a natural monopoly. Recently, technological change and accompanying demand expansion in telecommunications have made these networks anything but natural monopolies. New technologies have emerged that allow intermodal competition with legacy copper networks for the provision of voice services, as well as a wide range of data services. These cellular, wireless, satellite and cable technologies have transformed the industry from (an arguable) natural monopoly into one of dynamic oligopoly.

Regulation based on the model of natural monopoly is not consistent with the current state of the industry. Neither was it an appropriate basis for regulation in the 1990s.[45] At that time, new technologies that provide intermodal competition were well developed and operational, and any reasonable forward-looking analysis would have expected these technologies to be potential competitive alternatives to the fixed-wire voice network.[46]

The second key feature of the regulatory template of the US, UK and EU is access regulation. Actual and potential facilities competition over the past 20 years has reduced the rationale for natural monopoly regulation. Yet, there has been an upsurge in access regulation. Opening telecommunications networks to competitors through, for example, mandatory unbundling of local loops, is typically justified on the basis of yielding efficiency improvements arising from increases in the number of competitors and concomitant lower prices. This rationale, however, is static. It heavily weights immediate total surplus. In dynamic economic environments, mandatory access can undermine the investment incentives of both incumbents and entrants, lowering future total surpluses and thereby reducing dynamic efficiency. Mandatory access at cost-based access prices has the same implications as TELRIC and ODV pricing. It also grants the access seeker a "free option." The access seeker can use the incumbent's network in favourable conditions, but will not access it if conditions are unfavourable.[47] As a result, the incumbent is under-compensated under cost-based access. It bears the entire cost of unfavourable conditions, but shares the benefits during favourable

[45] See Spulber (1995), noting that, at that time, the natural monopoly argument was often raised as a justification for maintaining regional restrictions on local exchange carriers in the U.S.
[46] See the analysis of Spulber (1995).
[47] Pindyck (2007).

conditions. Hausman (2000) and Pindyck (2007) argue that this deters investment because the incumbent does not expect to be fully compensated for the risk arising from uncertainty. Jorde, Sidak and Teece (2000) find that this also decreases incentives for the access seeker to invest in its own new network.

Grajek and Röller (2009) estimate the effects of access regulation on investment using a dataset covering more than 70 fixed-line telecommunications operators in 20 EU member states over the period 1997-2006. It estimates how "regulatory intensity" impacts on investment of fixed-line operators, where regulatory intensity is measured by various indices related to access regulation.[48] It finds that increases in regulatory intensity reduce investment by both incumbents and individual entrants, although entrants' total investment increases. Grajek and Röller estimate that reduced infrastructure investment attributable to access regulation in the EU was €16.4 billion over the 1997-2006 period.

Crandall, Ingraham and Singer (2004) study the impact of unbundled access regulation in the US on the investment incentives of access seekers. Using US state-wide data from 2000 and 2001, it finds that investment by access seekers in their own facilities-based networks is lower in states where regulated access charges are lower. It concludes that access regulation decreases facilities-based competition in the short-term; a finding consistent that is consistent with the theoretical finding of Jorde, Sidak and Teece (2000) noted above.

A wider study covering the US, UK, New Zealand, Canada and Germany by Hausman and Sidak (2005) finds similar results. It reviews the regulated unbundling experience in each of these countries, focusing on key metrics such as prices and investment. Its findings include that unbundling regulation led to either flat or increasing retail prices in most countries, contrary to the often-claimed rationale for regulation that it will increase retail competition and lead to lower prices. It also finds that there was no support in any of these countries for the proposition that unbundling regulation would lead to greater facilities-based investment by access seekers. Instead, access seekers appear to have "chased retail margins" on the incumbent's unbundled network, rather than developed their own competing networks.

The third common feature of US, UK and EU regulation is universal service obligation (USO), which typically involves cross subsidies. Many countries require that all users have

[48] Specifically, the indices relate to the vertical separation, unbundling, line sharing, bitstream access, subloop unbundling, and regulatory asymmetry between digital subscriber line and cable.

access to telecommunications services at an "affordable" price.[49] USOs on incumbent network providers are often justified on the basis of cost of service and network externalities.[50] In the case of network externalities, the rationale is that the benefits of having the additional users on the network exceeds the costs of the USO cross-subsidy.

Telecommunications markets (or at least those fixed-wire calling markets of developed economies typically covered by USOs) are now relatively mature, and thus the importance of network externalities, and any benefit-cost rationale for the USO, is diminished. While an additional user on the network will remain valuable to all other existing network users, the incremental value is likely to be very small. Rochet and Tirole (2004) argue that in mature telecommunications markets (and also payment systems) network externalities will be at the level of individual transactions, rather than overall decisions to join the network. Likewise, Katz (2001), in considering credit card networks (although the point is also applicable to telecommunications) notes that as the number of users on the network reaches a sufficiently high level, marginal changes in users will generate smaller or no benefits to other users.

In the context of an industry shaped by rapid technological change, the rationale for USOs is even less persuasive. Technology has evolved so that new methods of communication have become available to those that would be considered "not commercially viable" for the provision of fixed line services. Digitization of communication now means that voice calls can be carried over any network, and thus cellular, satellite and wireless services can provide alternative means by which consumers can utilize telecommunications networks. This intermodal competition largely eliminates the need for a specific USO. Rather, to the extent that a universal service is socially beneficial, universality is likely to evolve naturally, as Gillet (1994) argues:

> *Therefore, the most important universal service question is now: what structural market and technology guidelines will allow "universal interconnect" so that anyone can get to any service—new or old, essential or frivolous—from anywhere? Establishing and following such guidelines creates a process by which multiple worthwhile services can become ubiquitous without requiring separate government involvement in each case—much as the U.S. antitrust laws establish a framework for competitive markets that sustains itself without day-to-day government intervention.*

[49] Crandall and Waverman (2000).
[50] *Ibid.*

We discuss below some examples of emerging economies using new technology that has provided ubiquitous telecommunications services without a USO requirement.

The rationale for universal service is a static one, but its implementation has dynamic costs. The cross subsidy lowers the incentive for competition for the consumers that are taxed under the USO, though this depends upon the source of the subsidy. Furthermore, by instituting a low price for those that receive the subsidy, it reduces the incentive for investment in services on a commercial basis. Both of these distortions are potentially costly sources of missing markets that inhibit dynamic efficiency[51]. The first of these is discussed in Baumol (1999) and Armstrong (2001), among others. When the USO cross-subsidy is funded internally by the incumbent, rivals have an incentive to engage in "cream skimming" by targeting the relatively more profitable consumers that fund the USO subsidy and ignoring the consumers that are subsidised under the USO.

These characteristics of US, UK and EU telecommunications regulation illustrate that their template is a static one and that in dynamically changing industries it is are unlikely to foster dynamic efficiency.[52]

3.2 Antitrust Telecommunications Regulation: New Zealand

New Zealand telecommunications regulation has sequentially entailed government ownership, antitrust regulation with a universal service constraint, and industry-specific regulation since 2001. Most recently, this regulation has been quite intrusive. It prescribes organizational structures, connection arrangements, and is proposed to enable government competition in funding broadband.[53] The New Zealand experience is of most interest for the 10-year period in which the incumbent was investor owned and subject only to antitrust regulation and universal service requirements. This period of antitrust regulation was unique to New Zealand and it occurred in the presence of very rapid technical change. This section points out that there is no evidence that final consumers were disadvantaged by this regime, or that the industry-specific regime that followed has enhanced final consumer welfare. The antitrust regulatory regime spanned the period of conversion from analogue to digital communication and the unanticipated explosion in demand for digital communications

[51] This point is made by Alleman and Rappoport op cit.

[52] In some countries regulation of telecommunications has moved further towards central planning. In the UK, Australia and New Zealand changes organizational structure of the incumbent telecommunications firm have been imposed and the governments of the latter two countries are financing the roll out of broadband.

[53] Howell (2008).

services arising from the internet. Research suggests that the rapid development and diffusion of new technology that occurred would not have happened had there been industry-specific regulation.

Telecommunications services were provided and regulated by the Post Office as a government department until 1987. Then, it became a state-owned enterprise and the incumbent operator. The Telecommunications Act 1987 opened the telecommunications market to competition without any regulatory restriction apart from competition law (the Commerce Act 1986). However, upon privatization in 1991 Telecom, was subjected to the "Kiwi Share" obligation. This required Telecom to cap residential line rental prices at the rate of inflation, provide universal service, and offer at least one plan without calling charges on local calling. The period of antitrust regulation ended in 2001 with the passing of an Act that established a Telecommunications Commissioner, residing in the Commerce Commission, with the power to make regulatory determinations. While regulation initially focused on access obligations for the copper local loop, it has progressively been extended to other, more contestable, parts of fixed and wireless networks. It now includes unbundling of the local loop and operational separation of the incumbent Telecom.

There was entry in the New Zealand telecommunications market by Clear Communications (Clear), partly owned by MCI, in 1991. Clear provided long distance service using alternative backbone infrastructure held by other infrastructure firms. Entry by Bell South in 1992 provided a GSM mobile network in competition with the analogue and then the TDMA digital mobile network of Telecom. Ownership of both these entrants has varied over time. Over the past two decades there has been further entry in fixed line and mobile providers, particularly evident prior to 2000.

Comparisons of the performance of telecommunications regimes is difficult because it is hard to measure all key variables that could help explain the differences, and because there are few observations.[54] [55] There was a protracted legal dispute between Clear and Telecom about interconnection for local service that was heard by various courts. At that time

[54] For example, a detailed study by Alger and Leung (1999) using a TELRIC model showed that New Zealand costs of telecommunications service could be as much as 15% higher than that of certain other countries simply on the grounds of the population density and distribution. Additional differences included an absence of cable services that reflected New Zealand's population density and also its history of state ownership and regulation of much (communications) infrastructure meant there was no possibility of competition until 1987.

[55] For example, in the 1990s price comparisons made by the OECD used posted prices rather that transaction prices that reflected quantity-discounting promotions. The difference was substantial in some cases

interconnection contract approaches were being debated worldwide, and there were also protracted disputes under prevailing regulatory regimes in the US and elsewhere. Nevertheless, Howell (2008) analyses some of the key implications of the move from light-handed regulation in 1987-2001 to industry-specific regulation post-2001 in New Zealand. It finds that the period of light-handed regulation brought falling prices at a rate faster than the OECD average, early and extensive investment in ADSL relative to the OECD, and low transaction costs (only two were contracts contested in the courts). In contrast, in the 2002-2007 period, the rate of decline in New Zealand prices slowed relative to declining prices in the OECD. Furthermore, giving competitors access to the local loop stalled their investment in fiber-optic networks. Under industry-specific regulation, virtually every contract between market participants has been contested before the Telecommunications Commissioner, increasing the transaction costs of the regime relative to those of the light-handed period.

During the period of antitrust regulation there was entry of infrastructure providers that bypassed Telecom's networks in various ways and to various extents, and long distance providers that arbitraged price differentials. There was thus competition for the field as well as on the field, with quite positive results (Crandall (2004)). Boles de Boer, Enright and Evans (2000) evaluate the performance of the Australian and New Zealand market for internet service providers (ISPs) in 1999. At that time Australia had three times as many ISPs per capita, and its telecommunication incumbent's ISP had a much lower market share than did the New Zealand incumbent ISP. Despite this, average prices to consumers were considerably higher in Australia: in 1999 purchasing power parity terms, ranging from 8% to 18% higher using arithmetic averages and 25% to 74% higher using weighted averages for different internet user groups. Boles de Boer et al (2000) suggest that the difference was attributable to the different regulatory environments. In Australia, the regulatory regime used industry-specific regulation, where competitors (in this case ISPs) have the right of access. The right and the terms of access are determined by the regulator. The access services included inter-city broadband transmission, which was declared available for access to competitors, despite the existence of both actual and potential competition. Providing such access limited the incentive for bypass and facilities competition. Competition was limited to a static "me too" form with common charges for the platform. In contrast, there were strong incentives for facilities competition competition in New Zealand. Under antitrust regulation, ISPs there used a mix of their own and the incumbent's network.

The rapid growth of the internet, universal service requirements, and competition between ISPs were key to a decision made by the incumbent Telecom, known as "0867" after the calling prefix used. This decision was challenged in higher New Zealand courts by the competition law authority. The decision and its aftermath illustrate the flexibility that all agents have under antitrust regulation to adjust to rapidly evolving technological change that they would not have under industry-specific regulation.

Telecom's decision in 1999, referred to as the "0867 action," was to introduce a new 0867 prefix for dial-up internet calls, and shift ISP calls to an internet protocol. Residential customers dialing the 0867 number for internet calls would not be charged for those calls, whereas those who dialed other numbers to ISPs would be charged two cents per minute beyond 10 hours of internet use per month. This created incentives for residential customers to join an ISP that accepted the 0867 prefix, but by doing so the ISP also had to agree that it would no longer claim termination revenues on dial-up internet calls. Thus, ISPs on Clear's network required Clear to reach an agreement with Telecom; otherwise, they would be required to move to Telecom's network or potentially lose customers faced with the two cents per minute charge. The decision was allowed by the Government of the day, as overseer of the universal service constraint, provided Telecom maintained a free local calling option, which it did. The decision entailed variations of contracts, for which parties were compensated by Telecom.

The 0867 action was deemed by the New Zealand High Court and Appeals Court to meet the test of acceptable behaviour under antitrust law, and the efficiency of the result was sanctioned by its inclusion in the Telecommunications Act of 2001 that established industry-specific regulation. The Commerce Commission, however, has continued to argue before the courts that the action was an abuse of market power.[56] Had there been industry-specific regulation, Telecom would likely have had limited ability to respond to changing industry circumstances. In particular the 0867 action, subsequently deemed efficient, could not have been implemented.

The 0867 action was taken by Telecom in 1999 as the result of the rapid growth of dial-up internet traffic and the consequent increase in one-way call volumes (consumers "dialing" ISPs) that led to rapidly increasing pressure on the capacity of Telecom's fixed network. This pressure was accompanied by a rapidly growing financial deficit Telecom was incurring

[56] The Commerce Commission has appealed the Appeal Court decision to the New Zealand Supreme Court.

on interconnection payments. These payments were the result of an interconnection agreement between Telecom and Clear, finalized just before internet growth exploded. One party would pay the other per-minute amounts for calls terminating on the other's network. Since Telecom had a relatively large number of residential customers, any ISPs that Clear could sign up to its network would provide large termination revenues. The situation was not symmetric because Clear had only a small number of residential customers; thus, dial-up internet calls from these customers to ISPs on Telecom's network would not generate large revenues to Telecom. In addition, Telecom was constrained by universal service obligations to offer a free local call option. The situation led to what the High Court subsequently referred to as "perverse incentives".[57] Clear could share its termination revenue with its own ISP customers and with other ISPs on its network, inducing ISPs to shift to Clear's network and generating even higher termination revenues. The result was that a number of ISPs on Clear's network marketed free internet services subsidized by the interconnection fee, further increasing the termination revenue obtained by Clear, and creating congestion on Telecom's network.[58]

In 2000 the Commerce Commission announced that it would prosecute Telecom for the 0867 action, and the case was heard in the High Court in 2007. The basis of the Commission's case was that Telecom had abused its dominant position by incentivising customers to use an ISP with an 0867 number, for which no termination charges could be claimed. The High Court held that Telecom's introduction of the 0867 service was not a breach of competition law, as a firm in Telecom's position in a competitive market would have profitably been able to introduce the 0867 service in response to the termination charge and network capacity issues. The High Court also held that, by removing the "perverse incentives", the 0867 service could have led to dynamic efficiency gains. The High Court's decision was upheld on appeal.[59] [60]

The 0867 case illustrates dramatically the difference between antitrust and industry-specific regulation. Were the Commerce Commission to have regulated the removal of the 0867

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[57] Commerce Commission v Telecom Corporation of New Zealand Limited and Anor, HC AK CIV 2000-485-673, 18 April 2008.

[58] Detail is provided in Karel (2003).

[59] Commerce Commission v Telecom Corporation of NZ Ltd and Anor, CA CA288/2008, 4 August 2009.

[60] The Commission has appealed the Appeal Court's decision to the Supreme Court seemingly suggesting that it disagrees with the test for abuse of market power being whether a dominant firm took actions it could not have profitably conducted were the market workably competitive. For discourse on variants of tests of abuse of dominance see Vickers (2005).

service *ex ante*, it would almost certainly have led to continued inefficient use of Telecom's network by ISPs charging low or zero prices to consumers. Furthermore, Telecom would likely have been required to make additional network investments that were uneconomic. The telecommunications sector was changing rapidly at the time, with the move from dial-up internet to broadband. Not only would regulation have distorted network investment, it would surely have slowed the rate of broadband take-up, as consumers would have little incentive to move from low-priced or free dial-up plans to broadband. Flexibility under antitrust allowed the industry to evolve through technological change accompanied by changes in contractual positions. In 2001 Telecom and Clear renegotiated their interconnection agreement on a bill-and-keep basis. Ultimately this agreement was embedded in industry-specific regulation with the passing of the Telecommunications Act in 2001.[61]

3.3 Forcing the EU Telecommunications Model on Finland

The evolution of telecommunications in Finland illustrates the contrast between light-handed, self-regulatory approaches and relatively more heavy-handed industry-specific regulation that is represented by the standard regulatory model of the EU.[62] It also illustrates that imposing a common regulatory template on institutional settings that are themselves evolving in response to technology and associated demands may not improve static or dynamic efficiency.

The dominant business model of Finnish telecommunications providers in the early twentieth century was one of consumer-owned cooperatives. These cooperatives – of which there were 815 by 1938 – provided local telephone services in areas in which they generally enjoyed a local monopoly. The cooperative structure of these providers constituted natural monopoly regulation by ownership since it eliminated the incentive for excessive monopoly profits as these were returned to the customers. The structure also allowed self-regulation to develop, wherein consumer-owners had incentives to benchmark prices and service levels of their own local cooperative against those of comparable co-operatives nearby. Moreover, consumer-owners could initiate mergers with neighboring cooperatives as a means of sanctioning the performance of managers and garnering the benefit of scale economies. Mergers and

[61] Howell (2008).
[62] This section is based on Howell and Sangekar (2008).

acquisitions occurring after World War 2 produced 49 firms providing local telephony services in 2007.[63]

Over time, consolidation also led to "mega-cooperatives" with the local cooperatives as members. The local cooperatives remained owned by local consumers, and continued to independently provide local telephony services (which ensured that competitive rivalry by benchmarking continued), but the mega-cooperative structure allowed the smaller firms to jointly undertake activities such as determining interconnection agreements and setting uniform industry standards. In the late 1990s some of the mega-cooperates restructured as listed for-profit companies, as a means of providing capital for investment in new technologies. Cooperatives remained – e.g., Finnet – but their membership base of local cooperatives was substantially reduced.

The cooperative structure of the industry facilitated the development of a self-regulatory framework. This is illustrated by arrangements for fixed network termination charges for mobile phones. In 1994 the mobile operators agreed to an arrangement where the originating network charged a local calling charge covering both origination and termination of fixed and mobile calls termination charges that were independent of the operator's costs were also set, at a level about half the calling charge. The revenue obtained from the calling charge was used to pay termination charges. This approach was essentially self-regulatory, since the calling charge placed a cap on the termination charge.

The approach taken by the Finnish mobile operators did not comply with European Union requirements. The EU required termination charges to be set based on costs, and included in calling charges where applicable. Howell and Sangekar (2008) argue that meeting these requirements removed the self-regulatory features from the previously agreed approach, forcing co-operative members to become commercial opponents in interconnection. It also required additional regulation to set cost-based termination rates, and accordingly imposed significant transaction costs on firms. Howell and Sangekar (2008, p.27-28) state that "[t]he EU arrangements appear to penalise the Finnet companies for their federated structure without considering the benefits of benchmark competition that are not available in markets where a single large firm dominates". The result was immediate increases in interconnection

[63] It is well-known that cooperative organizations perform best when the service they provide is homogeneous (Hansmann (1996)). Telecommunications services are generally measurable and relatively homogenous.

rates and pass-through into retail charges, in some cases more than doubling the previous charges.

The Finnish experience of adopting the EU regulatory model highlights two important lessons. First, "one-size fits all" models of regulation are not always efficient, as they neglect to take into account the particular features of different markets and the regulatory governance structures that have evolved through time, which may be relatively efficient.[64] Indeed it is the basis of the new institutional economics[65] that institutions evolve through time generally efficiently--reflecting the institutional state of the market the structure of the economy, transactions costs and technological change. This point does not appear to be widely accepted by government policy analysts or regulators. A standard model of cost-based regulation of mobile termination rates has been implemented in a number of countries in recent years.[66] This general approach includes forward-looking rule setting—an approach that has problematic outcomes in dynamic markets.

Second, the change in prices resulting from the imposition of the EU model illustrates that cost-of service industry-specific regulation can often lead to higher prices and be detrimental to economic welfare, relative to less rule-bound approaches that rely on self-regulation or antitrust to constrain anticompetitive behavior. The result of higher prices from regulation is consistent with Hausman's (2002) finding that regulated mobile prices in the U.S. were higher than unregulated prices. It finds that regulated states had prices that were approximately 15% higher than unregulated states. When deregulation occurred, prices were not significantly different across states. The key implication is that regulation by antitrust alone may yield lower prices, and thus considerably greater consumer benefits, than those achieved by more rule-bound regulatory approaches.

3.4 Telecommunications Regulation in Other Economies

Other markets have had telecommunications regulatory structures that range from negligible regulation – including no antitrust law – to regulation by means of government ownership. In this section we discuss some of these variations and the consumer welfare impacts. Our focus is on mobile telephony because, as we shall see, it has had a particularly substantial

[64] The Finnish cooperative governance model might be interpreted as a form of the trilateral governance regulatory model.

[65] See for example, North (1990).

[66] Including most countries in the EU, Israel, South Korea, Malaysia, Peru, Australia and New Zealand (Albon and York, 2006).

impact on welfare in emerging economies. In some cases, it has leap-frogged the provision of ubiquitous fixed wire service. The welfare impacts of mobile go well beyond substitution for fixed wire services, because mobile enables significantly reduced transactions costs that include timely communication and multi-tasking even for the same services.[67]

The growth of mobile telephones in emerging economies has been rapid; in many countries, penetration quickly surpassed that of fixed-wire telephony. Waverman, Meschi and Fuss (2005) present data on fixed and mobile penetration rates in 102 emerging countries. They show that in 1995, after many years of investment in fixed line networks, the average penetration rate was 2.5 percent, rising to 5 percent by 2003. In contrast, mobile penetration was zero in all the countries surveyed in 1995, but had risen to an average of 8 percent in 2003, with 22 countries reaching double digit mobile penetration and 7 having at least 25 percent mobile penetration by this year. Waverman et al (2005) attribute this to cost advantages and faster rollout for mobile relative to fixed telephone networks; but it also likely reflects the wider benefits of cell phones.

Waverman et al (2005) and Qiang (2009) report that there has been a positive association between per capita GDP growth and mobile phone penetration that is significantly larger for developing countries than developed countries. We accept Faulhaber's (2009) comment that it is very difficult to obtain definitive estimates of this association. Nonetheless, given the low penetration rates of fixed wire telephony in many developing economies we believe there will be very substantial welfare benefits from penetration of mobile telephones in emerging economies. Mobile phones have provided significant benefits to emerging economies not just because of the mobility they provide, which is a benefit in common with developed countries, but also by providing basic communication services in the absence of fixed wire telephony.[68] In emerging economies communication in isolated rural areas in these countries has traditionally been through walking to the nearby village, but the mobile phone has revolutionized this situation.[69]

Mobile telephones also generate significant value-added in emerging economies because they provide other services that are sometimes provided by completely different means in developed countries. Rapid technological change has led to a depth of services, particularly in

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67 Hausman (1997) estimates that the consumer surplus from the introduction of mobile phone services in the U.S. was a substantial U.S.$50 billion per year.

68 Faulhaber (2009).

69 *Ibid.*

mobile telecommunications, that is unlike anything available on fixed wire. Services such as mobile email and mobile Internet browsing are now commonplace, while mobile phone transaction services that include banking are increasingly being utilised, particularly in emerging economies. "Mobile money" allows mobile users to credit their mobile account at particular retail outlets, and then transfer funds to other mobile users by way of text message, which can then be withdrawn by the latter at a registered retail outlet. Mobile money provides a fast, cheap and safe way to transfer money.[70] Faulhaber (2009) states that mobile money is occurring in countries where retail banking is "costly" and the reach of traditional banks is limited. Faulhaber (2009) also provides the example of "telemedicine" in Africa, where mobile phones are used to share medical records and other health information among relatively remote locations.

Given the significant benefits to be achieved by consumers from the introduction and rapid diffusion of mobile phones in emerging economies, the costs of delay in that introduction and/or diffusion are likely to be substantial. As noted earlier, Hausman (1997) has found substantial costs of delay in introducing mobile phones in the U.S. in the early 1980s. At that time, there was near universal penetration of fixed telephones, and the mobiles that were introduced were relatively limited in the services they could provide. It follows that delay in emerging economies today would likely generate even greater consumer welfare losses, as pre-existing communications networks are far from ubiquitous and mobile phones now offer a wide range of services.

Faulhaber (2009) argues that dynamic efficiency in emerging economies will be fostered by light-handed regulation.[71] Such regulation will allow technology to emerge and diffuse relatively rapidly, with benefits for consumers. Galpaya and Samarajiva (2009) support a relatively light-handed approach to regulation. Its survey of stakeholder perceptions about the telecommunications regulatory environment in emerging economies [72] finds that in Pakistan, stakeholders are highly satisfied with mobile market entry, the allocation of mobile spectrum and the regulation of interconnection charges. They attribute this to Pakistan having a licensing regime with little regulatory risk, an expeditious process for allocating

[70] At the same time, it provides a safer way of saving for those in developing economies, where often the only alternatives are corrupt savings schemes or cash "under the mattress" ("The Power of Money", *The Economist*, 24 September 2009).

[71] Faulhaber (2009) reaches a similar conclusion.

[72] The survey was conducted in 2006 and 2008 in India, Pakistan, Sri Lanka, Indonesia, Philippines, Maldives, Bangladesh and Thailand.

spectrum, and a process of negotiated interconnection rates. In contrast, India is perceived to be a poor performer in spectrum allocation, due to its highly administrative approach, while Thailand is considered unsatisfactory in interconnection regulation, due to "conflicting rules and regulations". India is found to be the best performer in tariff regulation, as tariffs are not regulated but left to market forces. This has led to some of the lowest tariffs in the world. The Galpaya and Samarajiva *op cit* analysis indicates that more highly regulated environments are likely to be perceived more poorly by stakeholders, which could produce inferior outcomes for consumers.

4 Conclusion

A key question facing regulators is how to create an economic environment that encourages appropriate investment and innovation. In this paper we analyzed the importance of technological change for both competition and regulation, with a particular focus on the regulation of telecommunications and the Internet. We suggested that technological change is an important part of competition.

We recommended that dynamic efficiency should be used as the appropriate benchmark for judging the effectiveness of different regulatory approaches. Contrary to conventional wisdom, we found that incentive regulation, such as price caps, is not particularly good at promoting dynamic efficiency. Neither is traditional cost-of-service regulation. As an alternative, we suggested that antitrust, judiciously applied, is likely to be better at promoting dynamic efficiency.

Antitrust is particularly desirable in industries that are likely to be subject to rapid technological change. If such industries are hard to identify for decision makers before the fact, we would suggest erring on the side of using more antitrust and less industry-specific regulation. We believe there is relatively little downside in selecting antitrust in the case where industry-specific regulation is optimal; in contrast, there could be significant losses in choosing industry-specific regulation if antitrust were optimal.

Our findings rely heavily on recent work in finance that has been applied to regulation. In addition they rely on a case study of regulation of telecommunications and the Internet in different regions throughout the world. A review of recent research in selected countries suggests that antitrust may be better for promoting dynamic efficiency than industry-specific regulation.

Future areas for research would include a more careful assessment of different regulatory regimes in a number of different areas, such as transportation and energy. Furthermore, the theoretical modeling could benefit from a more rigorous consideration of how competition and technological change interact in different regulatory environments.

Appendix: Technical Change in Telecommunications Is Continuing

In the last 40 years the telecommunications industry has been fundamentally and rapidly reshaped as a result of technological change. As recently as the 1990s it was dominated by analogue voice services over the fixed PSTN. This network was vertically integrated with the services provided, and competition was of the form of static "me too" access competition, often facilitated by access regulation.

The shift from this, relatively static, structure of the industry has been significant. Today telecommunications services are digitized and provided over a range of technologies, including mobile, satellite, cable and the Internet. Moreover, voice communication over these networks is complemented by non-voice communication over mobile networks (e.g., short-message-services and multimedia-message-services) and the Internet (email, and other internet-based communication such as instant messaging). The quantum of information that can be transferred over telecommunications networks is substantial, with vast amounts of data able to be transferred around the world over short periods of time: in many cases instantaneously.

Competition now occurs across a wide range of dimensions. For example, in mobile telephony, competition occurs across (but is not limited to) network technology, geographic coverage and roaming. Evidence of competition in network technology is shown by the range of different cellular technologies, and the different global rates of diffusion. Gruber (2005) identifies seven different analogue 1G technologies, three of which became the most widespread (NMT, AMPS and TACS), and four different 2G technologies, where GSM has been the preferred system relative to competing JDC, DAMPS and CDMA technologies. Similarly, competition occurs to increase the extent of national geographic coverage and international roaming coverage. For example, Valletti (2003) points to evidence of operators in the U.S., U.K. and Germany competing to provide full population coverage.

Modern telecommunications services have also become separated from the network itself. Under present systems, many service providers contract directly with consumers, with no underlying arrangement with the network provider needed. This is the case for internet content providers (e.g., Google), but also for those who provide communication over the internet (e.g., web-based email and VOIP). Concomitantly, since the 1990s there has been no real distinction in supply between local and long distance communication.

The rapid shifts in telecommunications have been driven by dynamic technological change that has occurred both through the introduction of entirely new technologies, such as the mobile phone, and through improvements to existing technologies, such as the change from analogue to digital, from 2G to 3G mobile networks, and from ADSL to ADSL2 data communications technology. Technological change has also been the source of improvements in existing services, and new services. For example, services such as voicemail, caller ID and call waiting emerged for fixed voice lines in the 1970s and early 1980s following the introduction of digitized switches.[73] Improved existing services are illustrated by Google that did not offer any basic service that could be considered "new", as internet search engines already existed at the time. Instead, it offered an improved approach to searching for, and presenting, information available on the internet.

[73] Spulber and Yoo (2008).

Rapid technological change appears to be showing no signs of abating. New technologies continue to be developed for mobile telephony and the internet. Mobile networks are in the process of transitioning to 3G technology, and in some parts of the world the technology is under development for fourth generation (4G) networks.[74] Internet technology is also moving towards "very high bit-rate DSL" (VDSL) that is capable of supporting high bandwidth applications such as VOIP at much faster speeds than traditional ADSL. Contrast this with the technology used to provide voice communication services over the PSTN which, according to Dalum and Villumsen (2003), evolved in a more gradual process.[75]

The speed of technological change is also matched by the growth in services supported by this technology, with this growth being much more rapid for new telecommunications services (e.g., mobile) than for legacy technologies (e.g., fixed voice) and other electronic innovations. Faulhaber (2009) reports that color televisions were introduced in the U.S. during the 1960s, and over the ensuing years grew to approximately 235 million TV sets in the U.S. in 2009. Wireline telephones were invented in 1876, and by 2009 there were approximately 186 million wireline telephones in the U.S. Contrast these figures with mobile phones, where there are approximately 263 million mobile phones currently in the U.S., and this growth has occurred in a period of only 20 years.

Dynamic change has also led to a depth of services, particularly in mobile telecommunications, that is unlike anything available on the fixed PSTN. Services such as mobile email and mobile Internet browsing are commonplace, while new services such as mobile banking and transactions are showing signs of increasing take-up, particularly in emerging economies (Faulhaber op cit).

[74] For example, Japan's NTT DoCoMo is aiming to introduce a 4G service in 2010 (http://www.nttdocomo.com/technologies/future/toward/index.html).

[75] Dalum and Villumsen contrast the gradual evolution of the fixed telephone network with the more rapid technological changed experienced with computers. However, the contrast is no less different between fixed telephony and mobile telephony.

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