# Monopoly Quality Degradation in Cable Television*


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**Abstract**

Using an empirical framework derived from models of nonlinear pricing, we estimate the degree of quality degradation in cable television markets. We find lower bounds of quality degradation ranging from 11 to 45% of observed service qualities. Furthermore, cable operators in markets with local regulatory oversight tend to offer significantly higher quality products, and engage in less quality degradation. While prices are also higher in markets with local regulatory oversight, we find that consumers experienced greater quality per dollar in these markets, compared to consumers in markets without regulatory oversight.
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## 1 Introduction

In many markets, firms choose not only the prices, but also the qualities of their products. In many cases, this is the primary dimension on which firms compete (e.g. pharmaceutical, media, professional services, and many high-technology markets). Theorists have long recognized that in the presence of imperfect competition, offered qualities can be distorted from the social optimum (Dixit and Stiglitz (1977),Spence (1976)) because firms equate private instead of social marginal benefits and marginal costs. This induces a welfare loss analogous to that from price distortions. Indeed, aspects of firm's product offerings, and *not* pricing, have been the focus of recent highly contested antitrust cases (e.g. Microsoft, GE/Honeywell).

The tendency of firms with market power to distort quality has been most clearly formulated in the monopoly nonlinear pricing literature, where it is shown that the firm's products suffer from *quality degradation* (Mussa and Rosen (1978),Maskin and Riley (1984)). Because products of different qualities are substitutes, a monopolist cannot simultaneously offer each consumer his efficient quality and also extract his full surplus, even with a fully nonlinear tariff. Instead, under standard assumptions, quality to all but consumers with the highest tastes for quality is distorted downwards. Furthermore, consumers with low preferences for quality may be excluded entirely from the market. Regulation, by either minimum quality standards or price caps, generally reduces distortions, but can have ambiguous effects on prices and welfare (Besanko, Donnenfeld and White (1987),(1988)).

Despite the widespread acknowledgment of the potential for quality degradation, estimates of its extent and implications for outcomes in real-world markets are few. In this paper, we analyze quality degradation in a market long thought subject to its effects: the cable television industry. To do so, we introduce an empirical framework based on the standard monopoly nonlinear pricing model that critically integrates the quality choice problem into the econometric estimation. This permits us to use estimates of consumer preferences in each market to infer the qualities of offered cable products and therefore directly measure how much cable monopolies degrade quality relative to a competitive alternative. It also allows us to analyze the determinants of a cable system's quality decisions, focusing especially on the impact of local regulatory oversight to ameliorate monopoly quality distortion.

Our results provide evidence of substantial quality degradation in the cable television industry. While some firms offer 2 or 3 goods, most offer just a single product quality. Furthermore, offered quality is *at least* an estimated 10.7% and 25.6% less in 3-good markets and

44.7% less in 2-good markets than what would be provided in a competitive market offering the same number of goods. Further analysis of quality variation across markets shows that local regulatory oversight - in the form of certification by the local franchise authority to cap cable prices - has important ameliorative effects. Systems in franchise areas where the local franchise authority was certified offer an estimated 26.2% more services. Furthermore, certification, while having a relatively small effect on high-quality goods, is associated with 25.9% higher quality for low- and medium-quality goods (where offered).

Expanding the analysis to prices yields further suggestive results: cable systems in markets with local regulatory oversight offered more services of higher quality, mitigated quality degradation on low-quality services, and offered greater quality per dollar to consumers (despite higher prices). These results are generally consistent with the effects of regulation proposed by Besanko, Donnenfeld, and White (1987) and could be of significant interest to policymakers concerned about the effectiveness of past regulatory interventions in the industry but troubled by continued growth in cable prices.[1]

The rest of this paper is organized as follows. In Section 2, we survey the canonical model of monopoly quality choice, and present the model based on Mussa and Rosen (1978) that forms the foundation of the empirical analysis. In Section 3, we describe the cable television industry and discuss its suitability for this empirical analysis, followed in Section 4 by the empirical model and estimation algorithm. Section 5 presents the results. Section 6 concludes.

## 2 The Incentives to Degrade Quality

In this section, we discuss the quality degradation result from the theory of monopoly nonlinear pricing using a simple, two-type version of the model of Mussa and Rosen (1978).[2]

Consider a monopolist selling two goods, $q_1, q_2$ whose qualities can be freely varied over $Q = [0, \bar{Q}]$. Consumers are assumed to be differentiated by a type parameter which takes on three distinct values, $t_0, t_1, t_2$, with respective probabilities, $f_i$, and associated cumulative distribution function, $F_k \equiv \sum_{j=0}^{k} f_i$, where type 0, $t_0$, is included to allow for the possibility that some consumers prefer not to purchase either of the firm's products.[3] Without loss

[1] The most recent report on ca le prices y the FCC found prices increased y 8.2% etween July 1, 2001 and July 1, 2002, higher even than the 5-year compound annual increase of 7.1% from 1997 to 2002 and far higher than the 1.5% increase in the Consumer Price Index over the same period (FCC (2003)).

[2] Since the derivations in this section are standard, we omit a num er of technical details; see, for example, Laffont and Tirole (1993), ch. 2, for complete details.

[3] This "outside type" is generally not included in the typical theoretical exposition. We include it here to

of generality, we adopt the ordering that $t_0 < t_1 < t_2$. The monopolist is assumed to be able to offer a nonlinear tariff specifying a different total price per quality variant offered, $P_1, P_2$. The firm knows the distribution of types in the population and selects the tariff that maximizes his expected profit (with the expectation taken over consumers types).

Consumer preferences are assumed to be quasilinear in money, $u_i \equiv u(q, t_i) = v(q, t_i) - P(q)$. A consumer of type $t_i$ is assumed to choose that bundle, $q(t_i)$, which maximizes her utility, so that

$$q_i \equiv \text{argmax}_{q \in \{q_1, q_2\}} u(q, t_i), \; i = 1, 2. \tag{1}$$

Furthermore, given that no consumer can be forced to participate in the contract, the monopolist's choice of qualities and prices must be such that the consumer voluntarily chooses to accept the contract, which requires

$$u(q_i, t_i) \geq 0, \; i = 1, 2. \tag{2}$$

The conditions (1) and (2) are the well-known incentive-compatibility (hereafter IC) and individual rationality (IR) constraints.

The firms optimization problem is then to maximize expected profits:

$$\max_{P(q)} E[\pi] = \sum_{i=1}^{2} f_i \{P(q_i) - C(q_i)\} \tag{3}$$

subject to optimal behavior by consumers, as encompassed in the IC and IR constraints. $C(q_i)$ is the firm's cost function, which is assumed purely additive across consumers.[4] Under standard assumptions, we can use the IC constraint to rewrite the objective function, yielding:

$$\max_{q_i, u_1} E[\pi] = \sum_{i=1}^{2} f_i \{S(q_i, t_i) - \frac{1 - F_i}{f_i}[v_q(q_i, t_{i+1}) - v_q(q_i, t_i)] - u_1\} \tag{4}$$

where $S(q, t_i) \equiv v(q, t_i) - C(q)$ is the total surplus function, and $v_q \equiv \frac{\partial v}{\partial q}$. If the monopolist were able to perfectly price discriminate, it would obtain the whole surplus $S(q_i, t_i)$ resulting from each sale to a consumer. Given the private information of each consumer, however,

facilitate empirical implementation of the model, where there are always some consumers who purchase the "outside good".

[4]We make the usual curvature assumptions: $v_1 > 0, \; v_{11} < 0, \; v_2 > 0, \; c' > 0, c'' > 0$. Furthermore, we maintain the standard single-crossing condition that $u_{qt} > 0$, which implies higher types have greater willingness-to-pay for quality at any price, or that consumers may e ordered y their type, $t$.

the monopolist must allow the consumer to gain some "informational rent", which is equal to $\frac{1-F_i}{f_i}[v_q(q_i,t_{i+1}) - v_q(q_i,t_i)] + u_1$.

This problem may easily be solved by setting the utility of the lowest type to zero, $u_1 = 0$, and maximizing the resulting unconstrained objective function w.r.t. $q_i$. This solution is described by the following equation:

$$S_q(q_i,t_i) = \frac{1-F_i}{f_i}[v_q(q_i,t_{i+1}) - v_q(q_i,t_i)] \tag{5}$$

Quality degradation for the low type ($i = 1$) is visible from equation (5). The socially optimal quality for each type, denoted $q_i^{**}$, is that which sets the derivative of the total surplus function to zero, $S_q(q,t_i) = 0$. In equation (5), however, we see that $q_1$ is chosen so that $S_q(q,t_1) > 0$, implying that $q_1^* < q_1^{**}$: quality is degraded to low types. Only for the highest type, $t_2$, where $F_2 = 1$, is the right-hand side of equation (5) equal to zero, so that there is no degradation "at the top".[5]

[Figure 1 about here.]

Figure 1, adapted from Maskin and Riley (1984), demonstrates graphically the solution for the one-dimensional case with $N = 2$. At this point, we focus only on the solid curves in that figure. The monopolist would like to extract all consumer surplus by offering product qualities $q_1^{**}$ and $q_2^{**}$ and charging prices $p_1^{**}$ and $p_2^{**}$, but with such an offering the high type would prefer to mimic the low and select $q_1^{**}$ (note for a given quality, consumer utility is higher the lower on the figure they can locate). The constrained optimum is given by variables with single $*$'s. As above, the high type continues to consume the efficient quality (and pays a lower price), but quality to the low type is degraded, from $q_1^{**}$ to $q_1^*$.

### 2.1 Continuous Types but Discrete Qualities

The theory described in the previous subsection applies also to the case of continuous types, but discrete qualities. To see this, suppose instead that consumer types are continuously distributed on $[\underline{T}, \bar{T}]$ with pdf, $f(t)$, but that the monopolist has decided to offer just two qualities regardless. She may do so for a number of reasons. The most obvious is that of fixed costs associated with the design, production, or marketing of products of different

[5] The solution descri ed a ove ignores an additional second-order necessary condition for optimality: that $q(t)$ is non-decreasing in $t$, ruling out local minima. It also ignores a sufficient condition for optimality: that $t(q)$ is non-decreasing in $q$. Wilson (1994, Chapter 8.1) presents a detailed discussion of the conditions under which these are likely to e violated.

qualities. Or there may be incremental (esp. marketing) costs of offering numerous goods. If these are large, the monopolist will only offer those products that can cover their fixed costs, limiting the number of products in the market (Spence (1976), Dixit and Stiglitz (1977)).

Suppose the firm offered arbitrary qualities, $\bar{q}_1, \bar{q}_2$. Who would buy these goods? All consumers for whom $u(\bar{q}_2, t) \geq u(\bar{q}_1, t)$ and $u(\bar{q}_2, t) \geq 0$ would buy good 2. Because of the structure of the problem – notably the single-crossing condition – only the first of these constraints would bind. Let $\bar{t}_2$ denote the consumer type that is just indifferent between purchasing the two goods, and $\bar{t}_1$ denote the analogous consumer type just indifferent between purchasing good 1 and the outside (i.e. no) good. Then the share of the distribution of consumer types that purchase each good, $\bar{f}_i$, is given by the integral under the distribution between the type cut-points: $\bar{f}_i = \int_{\bar{t}_i}^{\bar{t}_{i+1}} f(t)dt$ (defining $\bar{t}_0 = \underline{T}$ and $\bar{t}_3 = \bar{T}$). Figure 2 presents a graphical representation of this framework. In that picture, type $t_A$ lies between the cut-types $\bar{t}_1$ and $\bar{t}_2$, and so consumes the lower bundle. Type $t_B$ lies above the larger cut-type $\bar{t}_2$, and also consumes the higher bundle. For both types $t_A$ and $t_B$ (and for all types other than the cut-types $\bar{t}_1$ and $\bar{t}_2$), both the participation and incentive constraints hold strictly. Given these qualities, $\bar{q}_1, \bar{q}_2$, and associated shares, $\bar{f}_0, \bar{f}_1, \bar{f}_2$, the monopolists profit is again described by equation 4 from the discrete-type case described above.

[Figure 2 about here.]

An important consequence of continuous consumer types is that quality distortion will generally occur for almost all consumers. In particular, only the higher cut-type $\bar{t}_2$ will consume an efficient quality (i.e. $\bar{q}_2^* = \bar{q}_2^{**}$). All other types $t > \bar{t}_2$ that also purchase the high-quality good (like $t_B$) will necessarily receive inefficiently low qualities. Similarly, while quality will still be degraded to the lower cut-type (i.e. $\bar{q}_1^* < \bar{q}_1^{**}$), it will be lower still for other, higher, types (like $t_A$) that also purchase the low-quality good, i.e. $\bar{t}_1 < t < \bar{t}_2$. This is also illustrated in Figure 1, where the two dashed curves are indifference curves for the types $t_A$ and $t_B$ in Figure 2. Type $t_A$, who consumes the same bundle as type $\bar{t}_1$, has an efficient bundle which lies to the right of type $\bar{t}_1$'s efficient bundle, implying that the quality distortion to type $t_A$ is higher than that to type $\bar{t}_1$. Similarly, there is a positive distortion to type $t_B$, even though he consumes the same bundle as type $\bar{t}_2$, to whom there is no distortion. As this illustrates, quality degradation will generally be higher in a continuous-type, discrete-goods setting than the comparable discrete-type, discrete-goods problem.

The theory described above applies analogously for an arbitrary number, $n$, of offered qualities. For any $n$, Equation (5) continues to hold, with associated degradation for all but the highest offered quality, $q_n$. However, when the type distribution is continuous but the monopolist offers only discrete qualities, the cut-types $\bar{t}_1$ and $\bar{t}_2$, as well as $n$, the number of offered qualities, are also choice variables. In this paper, while we do not use the monopolist's optimality conditions for these variables in estimation, we do briefly analyze the number of goods offered by firms in the empirical section below.

## 3 The Cable Television Industry

Cable television systems bundle television networks into services and offer these services to households in local (geographically separate) cable markets. The largest and most popular services are called Basic and Expanded Basic services (or tiers) and contain broadcast and (so-called) cable television networks.[6] To buy any cable services, all households must first purchase Basic Service. In practice, the vast majority also purchase one or more Expanded Basic and/or Premium services.[7]

Cable systems have almost complete control over the content and prices of their services. While certain regulations mandate they carry all broadcast television stations available over the air in their service area (so-called Must-Carry requirements), beyond these restrictions they may select and package whatever television networks they like for sale to households. With respect to prices, cable systems have been subject to cyclical regulatory oversight. The most recent price regulations were imposed by the 1992 Cable Act, the intent of which was to limit the prices charged for Basic and Expanded Basic Services. Due to a combination of factors, including strategic responses by cable systems and relatively weak cost pass-through ("going-forward") requirements, these provided little price relief to households. Furthermore, the 1996 Telecommunications Act recently removed most of the remaining price controls on systems.[8] The only remaining current constraint is optional local control of prices for the lowest level of Basic Services.

[6] Broadcast networks are television signals  roadcast in the local ca le market and then collected and retransmitted  y ca le systems. Examples include the major, national  roadcast networks - ABC, CBS, NBC, and FOX - as well as pu lic and independent television stations. Ca le networks are advertising-supported general and special-interest networks distri uted nationally to systems via satellite, such as MTV, CNN, and ESPN.

[7] Premium Services are advertising-free entertainment networks, typically offering full-length feature films and original programming, and offered on a stand-alone  asis. Examples include HBO and Showtime. Due to data limitations, we focus our analysis on Basic and Expanded Basic services.

[8] See Hazlett and Spitzer (1997) and Crawford (2000) for more details on the consequences to ca le television prices and qualities of the these regulations.

There are two dimensions to systems' choice of service quality: the quality of the program networks to offer and the allocation of those networks into service bundles. This paper focuses on the quality of a given set of program bundles.[9] The institutional and economic environment in the industry suggest the design of Basic and Expanded Basic Services map well to the theory. Since households that buy Expanded Basic Services must necessarily first purchase Basic Service, these services are by construction increasing in overall quality. As such, consumer preferences may be adequately described by a single, vertical dimension measuring overall tastes for multi-channel television. Furthermore, since they consist of generally large bundles of individual networks, the range of qualities possibly chosen is plausibly continuous, but the offered qualities are clearly discrete. Finally, they are the largest and most important source of revenue for cable systems (Kagan (2002)). In the balance of the paper, we therefore focus on measuring quality degradation for these cable television services.

Consumer dissatisfaction with various aspects of cable television services is common. Fuelling demands for regulatory oversight is the persistent growth in cable prices over time. Between 1986 and 1991, 1992 and 1996, and 1996 and 2002, respectively, cable prices rose 11.6%, 2.2%, and 7.1% annually, far faster than rates of price inflation for comparable consumer non-durables in the same period (GAO (1991),FCC (1997),FCC (2003)).[10] Of course, the quality of cable services has also increased. While difficult to quantify directly, the number of cable networks, expenditure on cable programming, and viewership of cable networks have all grown substantially over this period (Hazlett and Spitzer (1997)). That being said, the independent American Consumer Satisfaction Index concludes that cable "is one of the worst-performing industry in the ACSI" and that "people are very dissatisfied" (Consumer Reports (2002)). Consumers regularly complain that price increases outstrip quality increases, particularly for new channels they feel they will not watch (Horn (2001)). Many appear to want "fewer channels [and] lower rates" (Fowler (2002)). Absent direct measures of product quality like those developed in this paper, this is the most credible evidence of quality degradation by systems.

### 3.1 Data

We have compiled a market-level dataset on a cross-section of United States cable systems to evaluate quality degradation in the industry. The primary source of data for these systems

[9] In related work, Crawford (2003) analyzes the undling decision in the ca le television industry.

[10] And despite price regulations mandating 17% price reductions y the 1992 Ca le Act for the middle period.

is Warren Publishing's Television and Cable Factbook Directory of Cable Systems. The data for this paper consists of the population of cable systems recorded in the 1996 edition of the Factbook for which complete information was available.[11] A sample of 1,042 systems remained.[12]

Table 1 presents sample statistics for selected variable from these systems. Systems in the sample offer at most 3 Basic and Expanded Basic services.[13] While all systems offer Basic service, 37% offer at least one Expanded Basic and 14% offer two.[14]

Cable services contain an increasing set of stations, with the smallest packages offering a subset of the stations offered in the larger packages. For example, for markets offering 3 goods, we define a system's high-quality product to contain all 3 Basic and Expanded Basic services, with associated prices and market shares indexed by the number 3. We similarly define a system's medium quality products, indexed by 2, to contain the 1st two offered services and its low-quality products, indexed by 1, to contain just the 1st offered service. Products are defined analogously (i.e. from the top) in 2- and 1-good markets. In what follows, then, we order the quality levels in increasing order: $q_{4-n} < \cdots < q_3$.[15] As can be seen across columns in Table 1, most households purchase all offered Expanded Basic services, although there are significant sales of lower-quality services in 3-good markets.

[Table 1 about here.]

Table 1 presents the average number of cable, broadcast, and other channels offered on each offered Basic service.[16] Aggregating over all Basic and Expanded Basic Services, systems

[11] While there are over 11,000 systems in the sample, persistence in non-response over time as well as incomplete reporting of critical varia les required imposing a large num er of conditions in order for a system to e included in each sample. Missing information on prices, quantities, and reporting dates were responsi le for the majority of the exclusions. See Crawford (2000) for more information a out the sampling procedure.

[12] We also excluded 122 o servations which in estimation yielded non-monotonic estimated qualities. This was largely driven y very small market shares (e.g. some less than 0.1%) for low-quality goods. It is likely that such services represented a compromise etween systems and regulators seeking services afforda le to low-income households. As this is outside the scope of our model, we dropped these systems from the analysis.

[13] With the rise of digital ca le since 1996, many ca le systems now offer more Expanded Basic tiers.

[14] Designations for Expanded Services have little meaning. The data report Expanded Services in the order input y systems. In practice, Expanded Basic I tends to have more programming, a higher price, and a higher market share than Expanded Basic II.

[15] Because the theory implies no distortion at the top, it is convenient to adopt this indexing convention over the alternative $q_1 < \cdots < q_n$.

[16] Note that reported ca le networks are the num er of networks among the top 40 most popular as of 1998 ("top-40 networks"), reported roadcast networks are offered only on the lowest quality (Basic) service, and

typically offer almost 6 broadcast networks, more than 17 cable networks, and almost 14 other networks. Of the cable networks, most are among the top 15 available to systems.[17] The top 15 cable programming networks available in the United States in 1998 are listed in Table 2.

[Table 2 about here.]

Measuring service quality is notoriously difficult in the cable television industry. Much of the existing empirical literature has proxied for quality with the number of channels offered on each service (Mayo and Otsuka (1991),Rubinovitz (1993), Hazlett and Spitzer (1997)). While important, elsewhere we find that the *identities* of the offered channels matter more in describing cable service quality and demand (Crawford (2000)). In this paper, we approach these difficulties in measuring quality by exploiting the restrictions of the theoretical nonlinear pricing model in order to directly recover quality measures for each offered cable service, which are consistent with the observed price and market share data.

## 4 Empirical model and Estimation Algorithm

### 4.1 Empirical Model

The starting point of our empirical model is a parameterization of the surplus function $S(q,t)$. We assume that total surplus for a consumer of type $t$ for each offered quality, $q_i$ is quadratic in quality, $S(q_i,t) \equiv tq_i - 0.5q_i^2$. As total surplus is the difference in consumer's utility and firm's costs, the two typical justifications for this specification are quadratic utility with linear costs or linear utility with quadratic costs. In either case, $t$ measures consumer willingness-to-pay (WTP) for quality *net of* firm's marginal cost for quality.[18] For convenience, we refer to the type parameter, $t$, as "net WTP". This specification is also convenient as the socially optimal quality for any type $t$ is given by $S_q(q_i,t) = 0$, implying $q_i^{**} = t$. Therefore, given estimates of cut-types, $\bar{t}_i$, and qualities, $q_i$, one can immediately measure the extent of quality distortion (for the cut-type) as the difference $(\bar{t}_i - q_i)$.

other networks are pu lic, educational, and government (PEG) channels and other ca le networks outside the top-40.

[17] This is not reported in the ta le.

[18] In other words, for this specification preference levels cannot e separately identified from marginal cost levels. This is a typical pro lem in the empirical analysis of product markets (Bresnahan (1989)). This isn't a great concern in this paper as we focus on o serva le outcomes (prices, qualities, and market shares) that are invariant to the composition of $t$. It would matter, however, in calculating the profit and welfare consequences of o serva le price/quality schedules and/or associated regulatory interventions. In Crawford and Shum (2002), we extend the framework presented here to separately identify preferences and costs.

Given the natural match between the available data and the model of monopoly nonlinear pricing, we impose as few restrictions as possible on the data to identify the model. In particular, we treat each cable market in isolation and estimate the distribution of types (i.e. net preferences) in that market consistent with observed market shares and prices. Given that we only observe a fixed number of bundles $n$ being offered in any given market, it is clear that we would not be able to identify (nonparametrically) any continuous type distribution completely, but rather only the indifferent consumers $\bar{t}_{4-n}, \ldots, \bar{t}_3$, and the corresponding percentiles $\bar{f}_{4-n} \equiv F(\bar{t}_{4-n}), \ldots, \bar{f}_3 \equiv F(\bar{t}_3)$. For these reasons, we do not exploit the model to predict the optimal number of services to offer.[19]

### 4.2 Estimation

As described earlier, to allow for as much flexibility as possible, we consider each cable market in isolation and estimate parameters separately for each market. In each market $c$, the unknown parameters to be estimated are the cut types in the distribution of net consumer preferences, $\bar{t}_{ic}$, and the associated mass between these types, $\bar{f}_{ic}$, for $i = 4 - n, \ldots, 3$ and $c = 1, \ldots, C$. Let $\theta_c \equiv \left\{\bar{f}_{ic}, \bar{t}_{ic}; i = 4 - n_c, \ldots, 3\right\}$ describe the vector of parameters in market $c$. Note there are $2n_c$ parameters per market, where $n_c$ is the number of services offered by the system in market $c$.

The available data in each market consists of market shares and prices of the $n_c$ bundles $\{s_{ic}, p_{ic}; i = 4 - n, \ldots, 3\}$. In the case of 3-good markets, for example, we have 6 parameters and 6 observed variables, so that the economic model is just identified in each market. For convenience, in the description to follow, we omit the market subscript, $c$.

For each market, the parameters $\bar{f}_i; i = 4 - n, \ldots, 3$ can be immediately estimated from the observed market shares, as:

$$s_i = \bar{f}_i, \ i = 4 - n, \ldots, 3. \tag{6}$$

so that the market share of the outside good given by $s_0 = 1 - \sum_{i=4-n}^{3} \bar{f}_i$. In order to solve for the $n$ cut-types $\bar{t}_i, \ i = 4 - n, 3$, we note that the prices are characterized as

$$p_i = u_i - v(q_i, \bar{t}_i) = \bar{u}_i - \bar{t}_i q_i - \frac{1}{2} q_i^2. \tag{7}$$

where $q_i$ is endogenously determined by the firm. Given estimates of $\bar{f}_i$ from Eq. (6) above,

[19] To do so would require simulating the profit associated with other offered qualities. This in turn requires information a out the type distri ution etween the estimated cut types. We do, however, ensure that for our estimated types it is not more profita le to offer *fewer* services (i.e. y pooling our estimated types).

the (unknown) quality levels $q_i$ are given by the first-order conditions given in Eq. (5):

$$q_i = \left\{ \begin{array}{ll} \bar{t}_n & \text{if } i = n \\ \bar{t}_i - \sum_{i'=i+1}^{n} \Delta\bar{t}_{i'} \frac{\bar{f}_{i'}}{\bar{f}_i} & \text{else,} \end{array} \right\} \tag{8}$$

where $\Delta\bar{t}_i \equiv \bar{t}_{i+1} - \bar{t}_i$. Moreover, the associated utility levels for the marginal types, $\bar{u}_i, i = 4-n, \ldots, 3$, are:

$$\begin{aligned} \bar{u}_i \equiv u(q_i, \bar{t}_i) &= u(q_{i-1}, \bar{t}_i) \\ &= u(q_{i-1}, \bar{t}_{i-1}) + u(q_{i-1}, \bar{t}_i) - u(q_{i-1}, \bar{t}_{i-1}) \\ &= u(q_{i-1}, \bar{t}_{i-1}) + \Delta\bar{t}_{i-1} q_{i-1} = \ldots = \\ &= u(q_1, \bar{t}_1) + \sum_{i'=1}^{i-1} \Delta\bar{t}_{i'} q_{i'} = \sum_{i'=1}^{i-1} \Delta\bar{t}_{i'} q_{i'} \end{aligned} \tag{9}$$

where the final equality obtains from the indifferent condition for cut type $\bar{t}_1$, which is $u(q_1, \bar{t}_1) = 0$.

By plugging Equation (8) into Equation (9), and then substituting the implied forms of $q_i$ and $u_i$ into the price equations (7), we obtain a system of $n$ nonlinear equations which can be solved for the $n$ unknowns $\bar{t}_i, i = 4-n, 3$. Note that since our estimates of $\bar{f}_i, \bar{t}_i,\ i = 4-n, 3$ are just transformations of the observed data (albeit very nonlinear ones in the case of the $\bar{t}_i$'s), there are no standard errors for these estimates.

**Discussion** This paper differs from the recent empirical literature analyzing quality choice in several respects. First, the majority of the existing literature focuses on prices and not quality. For example, Verboven (2002), Cohen (2001), and Clerides (2002) compare prices (or markups) for various qualities of cars, books, and paper towels, respectively, to see if there is evidence of price discrimination by quality. Similarly, Leslie (1997) simulates alternative pricing policies for different (but fixed) qualities of a Broadway show. Closest in spirit to our paper is recent work by McManus (2001) which compares estimated marginal benefits and observed marginal costs of quality variants in specialty coffees and finds evidence of degradation for low-quality variants. As he does not specify the quality choice equation, however, he can only measure the presence but not the magnitude of the quality distortion.

The most important difference between this paper and previous work, however, it that our econometric algorithm embeds the monopolist's quality choice problem into the econometric

estimation. While the importance of heterogeneity in consumer preferences has been recognized in existing approaches for estimating demand models using aggregate data (such as Berry (1994) and Berry, Levinsohn, and Pakes (1995)), in our model we explicitly allow the characteristics of the products to be endogenously chosen by firms in response to the heterogeneous consumer preferences.[20] For our utility specification, incorporating endogenous quality choice implies that consumer type $i$ obtains utility $u(q_i, t_i) = t_i q_i - P_i = t_i q_i(\bar{f}, \bar{t}) - P_i$. The functional relationship between quality, $q_i$, and the distribution of preferences, $(\bar{f}, \bar{t})$, imposes important restrictions on the relationship between observed variables (prices and shares) and the model parameters. Ignoring this relationship can substantially bias the estimated distribution of preferences (as we show in Crawford and Shum (2002)). Furthermore, by accommodating endogenous quality choice, we can recover estimates of the qualities of observed goods in order to evaluate quality degradation in the industry.

## 5 Results

### 5.1 Type Parameters, Quality, and Quality Degradation

The results of the econometric estimation yield vectors of fundamental demand parameters: $\theta_c \equiv \{\bar{f}_{ic}, \bar{t}_{ic}; i = 4-n, \ldots, 3\}$, for each market $c = 1, \ldots, C$. The three columns in Table 3 report the estimated net type distributions, $(\bar{f}_i, \bar{t}_i)$, for markets offering 1, 2, and 3 goods. As expected, the estimated share of the distribution of consumer types that purchase each good, $\bar{f}_i$, matches exactly the corresponding average market share from Table 1. The estimated willingness-to-pay for the cut types, i.e. those consumers just willing to purchase each of the offered goods, $\bar{t}_i$, varies across products but is on the order of \$4–\$5 dollars per unit of quality.[21] There is also variation in the estimated type distribution across systems offering different numbers of goods, with markets offering more goods populated by households with greater tastes for cable service quality. We present further results to assist interpreting these magnitudes in what follows.

[Table 3 about here.]

[20] Methodologically, this approach is most closely related to the related to a recent literature applying principal-agent models of adverse selection to other pro lems like nonlinear price-quantity schedules (Bousquet and Ivaldi (1997), Miravete (1997)) and informational asymmetries in the design of regulatory mechanisms (Wolak (1994)).

[21] In 1995 dollars.

**Quality Degradation in the Cable Television Industry** These estimates and equation (8) permit us to calculate the implied quality of each offered cable service in each market. These qualities are given in the bottom panel of Table 3, along with the estimated percentage degradation. There is significant estimated quality degradation in cable markets: offered qualities for medium- and low-quality goods is *at least* 10.7% and 25.6% less in 3-good markets and 44.7% less in 2-good markets than what would be provided in a competitive market offering the same number of goods.[22]

As discussed in Section 2.3, because we estimate the quality degradation for the lowest consumer type to purchase each good, these estimates are a lower bound on the actual degradation facing consumers. Calculating a measure of the quality degradation to the *average* consumer is difficult, however, without more information (or assumptions) about the distribution of consumer types. A very crude estimate of the quality degradation to the average consumer may be obtained by assuming a uniform (within products) distribution of types and particular values (or a range of values) for the upper bound of the type distribution.[23] We estimate the upper bound to be between 5.90 to 8.77 in 3-good markets, 5.64 to 9.50 in 2-good markets, and 5.36 to 9.77 in 1-good markets. The implied quality degradation to the *average* consumer is then 29.6%, 12.1%, and between [5.9%, 25.2%] in 3-good markets; 47.6% and between [8.3%, 33.1%] in 2-good markets; and between [10.1%, 38.3%] in 1-good markets. While only capable of a broad range of estimates, these average effects suggest non-negligible quality degradation throughout the cable product line. Because more cannot be said without estimating the full distribution of consumer types, however, we treat these results as merely suggestive and analyze in the balance of the paper the lower bound on degradation we can confidently estimate from the data.

**Interpreting Estimated Quality Levels** From Table 3, the average estimated qualities vary from a low of 2.57 to a high of 5.23 units across products and markets. To assist the interpretation of these magnitudes, Table 4 presents a simple regression of implied qualities on the characteristics of the cable services whose quality they measure. Since cable services are bundles of programming networks, this amounts to a regression of implied qualities on

[22] One cannot say more than that, as a competitive market may not offer as many goods as would the monopolist (Spence (1975)). Evaluating the welfare effects of imperfect competition on the qualities offered consumers would have to take that into account. See Crawford and Shum (2002) for more.

[23] In what follows, we estimate a range of upper ounds y assuming the density of consumers a ove the highest cut-type ranges from the low to the high of the three estimates availa le for the density of consumers purchasing low- and medium-quality goods in 2- and 3-good markets.

indicators of the programming offered on each cable service:

$$q_{ic}^{*} = \beta' X_{ic} + \epsilon_{ic},\ \forall i, c. \tag{10}$$

where $X_{ic}$ are the indicators of the programming offered on service $i$ in market $c$. Included in this specification are dummy variables for the top-15 networks (cf. Table 2), additional cable networks, and measures of broadcast network availability. Note the coefficient estimates need not be interpreted as causal effects, but just a quantification of the association between estimated cable service quality and the networks offered on that service.

[Table 4 about here.]

The 1st column of Table 4 presents the results of this regression.[24] The interpretation of, e.g., the coefficient on ESPN is that adding ESPN to a cable service is estimated to increase the quality of that service by 0.94 “utils”. The 2nd column of Table 4 transforms this effect into the willingness-to-pay for the average consumer just willing to purchase the high-quality good, i.e. the average $\bar{t}_3$ across markets. This equals 4.51 and implies an average WTP (for this consumer type) for ESPN of \$4.22.[25] The resulting estimates are generally reasonable in sign and magnitude: 12 of 15 are positive and significant, ranging from \$0.34 to \$4.22.[26] This is very much in line with previous results reported in Crawford (2000). This suggests our econometric estimation is not badly mis-specifying either estimated preferences or associated qualities: higher quality cable services are those with more (and more popular) cable networks.

Figure 3 orders the estimated qualities and illustrates the results graphically. It also facilitates the interpretation of our estimates of cable service quality and quality degradation presented earlier. To see this, compare Figure 3 with Figure 4, illustrates the quality degradation results from Table 3. In particular, the regression results illustrated in Figure 3 translate the raw quality estimates into comparable bundles of cable networks. For example, the average quality of a low-quality good in a 3-good market (3.52) is slightly less desirable than a service incorporating the 10 highest quality cable networks, as estimated in Table 4 (3.89).[27] It also translates the estimated degradation into comparable bundles of

[24]For simplicity, we present here results pooling o servations across oth markets and services.

[25]If we knew more a out the distri ution of consumer preferences, we could calculate the distri ution of WTP in the population of consumers in each market. This is addressed in Crawford and Shum (2002).

[26]Recall that we actual estimate “net” preferences, i.e. willingness-to-pay for quality less its marginal cost. As such, the reported estimates are lower ounds on the true underlying willingness-to-pay.

[27]This should not strike the reader as high, as even low-quality ca le services in 3-good markets have on average 6.5 local roadcast networks (average estimated quality = 1.04), almost 11 ”other networks” (average estimated quality = 0.00), and almost 12 top-40 ca le networks.

networks. For example, the average degradation of medium-quality goods in 3-good markets is 0.54, or about the value of a single high-quality cable network like TBS or the Family Channel. At the other extreme, the average degradation for a low-quality good in a 2-good market is 2.2, or a little less than the combined value of TBS, the Family Channel, USA, the Nashville Network, A&E, CNN, *and* the Discovery Channel!

[Figure 3 about here.]

[Figure 4 about here.]

### 5.2 Cable Quality and the Benefits of Regulation

We turn next to exploring the variation in cable service quality across markets. To address these issue, we consider reduced-form regressions of estimated cable service quality, quality degradation, and number of services offered on characteristics of cable systems and the markets they serve. A number of variables were considered; Table 5 presents a summary of the most relevant results.[28] Before presenting the results, we note that since our dataset consists of only a single cross-section of cable markets, there may be important time-invariant unobservables correlated with cable systems choice of quality and the explanatory variables described above, which we cannot control for. As such, we interpret these as correlations of interest and not necessarily causal effects.

[Table 5 about here.]

We begin by regressing estimated service qualities on a set of core system characteristics (homes passed and channel capacity), market characteristics (median income), and regulatory characteristics (certification to regulate prices of Basic Cable Services). Homes passed measures the set of households for whom cable service is available in a cable market and is therefore a very good measure of local market size. This could be important as systems in larger markets may have greater incentives to invest in higher quality services.[29] Channel capacity measures the capacity of a system's technical infrastructure. Since more networks necessarily implies higher quality service, having larger channel capacity prevents capacity limitations that could hold down offered service qualities. Median Income was included as

[28] Varia les other than the ones presented in the ta le ut also considered included measures of system age, presence of fi er-optic ca le, other demographic characteristics, and the degree of ur anization in the market. Including these varia les did not change the qualitative findings presented here.

[29] This phenomenon is common in media markets. See, e.g., Owen and Wildman (1992).

heterogeneity in willingness-to-pay for goods is often thought to be driven by heterogeneity in income.[30] Finally, certification is a dummy variable measuring the degree of local regulatory oversight in a system's market area. Specifically, it measures whether the local regulatory authority had certified with the FCC to regulate the lowest-quality cable service offered in the market, as permitted by the 1992 Cable Act, at the time the data were sampled.[31]

The first column of Table 5 presents the estimated relationship between these factors and service quality.[32] As expected, systems with larger market areas and greater channel capacity offer higher quality cable services. Median income is not estimated have a significant association.[33] Finally, cable service quality is *significantly* larger (0.55 units, equal to a top-3 cable network) in markets with local regulatory oversight.

The second and third columns of Table 5 provide further insights into the relationship between regulatory oversight and offered cable service quality. While the pooled results in the first column suggests a strong positive relation across all services, decomposing the effect between high versus low- and medium-quality services (if offered) yields a *much* stronger association at the low end of the quality spectrum. For example, the quality of the high-quality services is higher by 0.17, or 3.8% of the average quality of high-quality goods, in markets with local regulatory oversight. Moreover, low- and medium-quality services are higher by 0.74, or 25.9% of the average quality of such goods.

The remaining columns of Table 5 investigate the determinants of two measures of quality degradation in cable services. The first are our estimates of quality degradation for existing low- and medium-quality services presented in Table 3. We also, however, examine another measure of quality degradation. Recall that the presence of low-quality services limits the ability of the monopolist to extract rents on high-quality services. It is therefore in the firm's interest to offer low-quality services only if the profit earned from the households that buy

[30] We also ran many specifications that tried to incorporate richer information a out the *distribution* of income within ca le markets, ut these were inconclusive.

[31] The 1992 Ca le Act introduced a split regulatory structure, with local franchise authorities permitted – ut not required – to regulate rates of the lowest-quality services and federal regulators (the Federal Communications Commission, or FCC) mandated to regulate rates of higher-quality services if consumers in the market filed a formal complaint with the FCC. Franchise authorities wanting to regulate rates of the lowest-quality service were required to certify with the FCC. As such, the certification varia le likely measures not only the act of regulating low-quality services, ut also the presence of active local interest in ca le rates and services. See Johnson (1994) and Crandall and Furchtgott-Roth (1996) for more details a out the 1992 Ca le Act.

[32] As earlier, the results report pooled estimates.

[33] This is perhaps not surprising. The relationship etween income and ca le services often appears to e non-monotonic. See Crawford (2003).

them more than offsets the lost profits on high-quality purchasers. Another measure, then, of service degradation is the *absence* of low- and medium-quality services.

The fourth and fifth column of Table 5 present reduced form regressions of these measures of quality degradation. System variables like homes passed and channel capacity have competing effects across specifications: they appear to increase degradation where low- and medium-quality services are offered, but also increase the likelihood of offering such services. Local regulatory certification, however, has a strong positive association: estimated quality degradation is lower by 0.083, or an estimated 21.5% of the average degradation, in certified markets, and the number of services offered is higher by 0.359, or 26.2% of the average number of services.

**Regulation and Quality Degradation** Taken together, Table 5 demonstrates that local regulatory oversight is consistently associated with more and higher quality services with less degradation to consumers. These are strong results for an industry for which regulation has recently been considered an ineffective counter to cable system's market power. Is then cable regulation beneficial to consumers? Does it translate into consumer welfare benefits? While we cannot answer this question directly, we present here what our results suggest about this important public policy issue.

In a pair of papers in the late 1980's, Besanko, Donnenfeld, and White (1987), (1988) (hereafter BDW) address the impact of various forms of regulation on quality offerings of a discriminating monopolist.[34] Most relevant for our purposes are price caps, as they were the centerpiece of the regulations imposed by the 1992 Cable Act. BDW find that price caps squeeze the monopolist's nonlinear tariff from above, increasing quality for low-quality goods and decreasing quality and prices for high-quality goods, with ambiguous effects for prices on low-quality goods.[35]

[Table 6 about here.]

To test these implications, we ran reduced-form regressions of cable prices and quality-price ratios on the same characteristics of cable systems and the markets they serve. Table 6 presents the results. Several interesting patterns emerge. First, prices are demonstrated to

[34] They analyze three cases: minimum quality standards, price caps, and rate of return regulation.

[35] The inding price ceiling reduces the incentive for the monopolist to increase quality to the high type. It also reduces the a ility to extract rents and therefore increases the incentives to increase quality to low types. While prices to low types could rise ( ecause of the higher quality), their surplus generally increases.

be higher in markets subject to local regulatory oversight, with a higher certification coefficient for low- and medium-quality goods (3.644) relative to high-quality goods (1.267). As their nominal purpose was to reduce prices, this has been taken as evidence that the regulations imposed by the 1992 Cable Act did not work (Crawford (2000), Hazlett and Spitzer (1997)). In practice, however, the regulations introduced by the Cable Act capped prices on a *per-channel* basis, making the quality-price ratio the relevant unit of analysis. Despite the higher prices, quality-price ratios are *substantially* higher for low- and medium-quality goods (0.037 or 17.6%) and marginally lower (by 0.006 or 2.1%) for high-quality goods. These results suggest consumers may well have benefited from the price caps introduced by the 1992 Cable Act, not due to lower prices, but instead due to significantly increased quality for a slightly higher price. While a detailed welfare analysis is beyond the scope of this study, this suggests at worst a distributional impact from the regulations, with low-taste (presumably low-income) consumers benefiting at the expense of high-taste (high-income) consumers.

## 6 Conclusions

In this paper, we measure the extent of quality degradation in cable television markets. Using an empirical framework taken from the standard theoretical nonlinear pricing models, we estimate the quality levels of the offered cable services, as well as features of the distribution of consumer preferences. These estimates allow us to directly measure cable service quality and thus the degree of quality degradation in cable markets. We find lower bounds of quality degradation ranging from 11% to 45% of observed service qualities. Furthermore, local regulatory oversight is associated with significantly higher quality and lower quality degradation.

Several extensions of the existing analysis are suggested. On institutional grounds, by developing techniques to accurately measure product quality in the cable television industry, the "failure" of early-1990's cable regulatory experience seems not so obvious. In light of continued consumer frustration over increasing cable prices and consequent calls for re-regulation, if not of prices then perhaps of product offerings (e.g. ConsumersUnion (2003)), our results suggest both a more detailed analysis of the effects of past regulations and careful consideration of the consequences to *both* prices and qualities of new regulatory solutions.

On methodological grounds, while the existing specification flexibly estimates the distribution of consumer tastes in each cable market, it does not admit controlling for observed or unobserved heterogeneity in cost and demand. Extending it would require pooling infor-

mation about preferences and costs across markets, but would permit greater confidence in the estimated effects of endogenous quality as well as measurement of the consumer and social welfare consequences of endogenous quality choice. Each of these extensions is the topic of ongoing research (Crawford and Shum (2002)).

Furthermore, while the data and industry we study necessitate the analysis of the monopoly problem, we think the lessons we learn here might apply much more broadly. First, research into competition with prices *and* qualities (so-called "Competitive Non-Linear Pricing") finds rivalry generally reduces distortions in both dimensions (Stole (2002)). As such, our findings provide evidence of "how bad the problem can be." More important, however, is that the methodological approach we take here – based on the screening literature analyzing nonlinear pricing – has enormous potential to generalize both to larger, multidimensional, quality (i.e. characteristic) spaces as well as competitive settings. Thus it has the potential to solve the long-standing problem of endogenous product characteristics acknowledged in many recent empirical analysis of oligopolistic markets (e.g. Berry, Levinsohn, and Pakes (1995, p.854), Nevo (2001, p.322),Petrin (2002, p.24)). While there are significant computational burdens involved in both cases (cf. Rochet and Stole (2002), Stole (2002)), the approach we take here of allowing *continuous* distributions of consumer preferences but *discrete* goods offered by firms, is both empirically realistic and tractably extensible in one or both dimensions.

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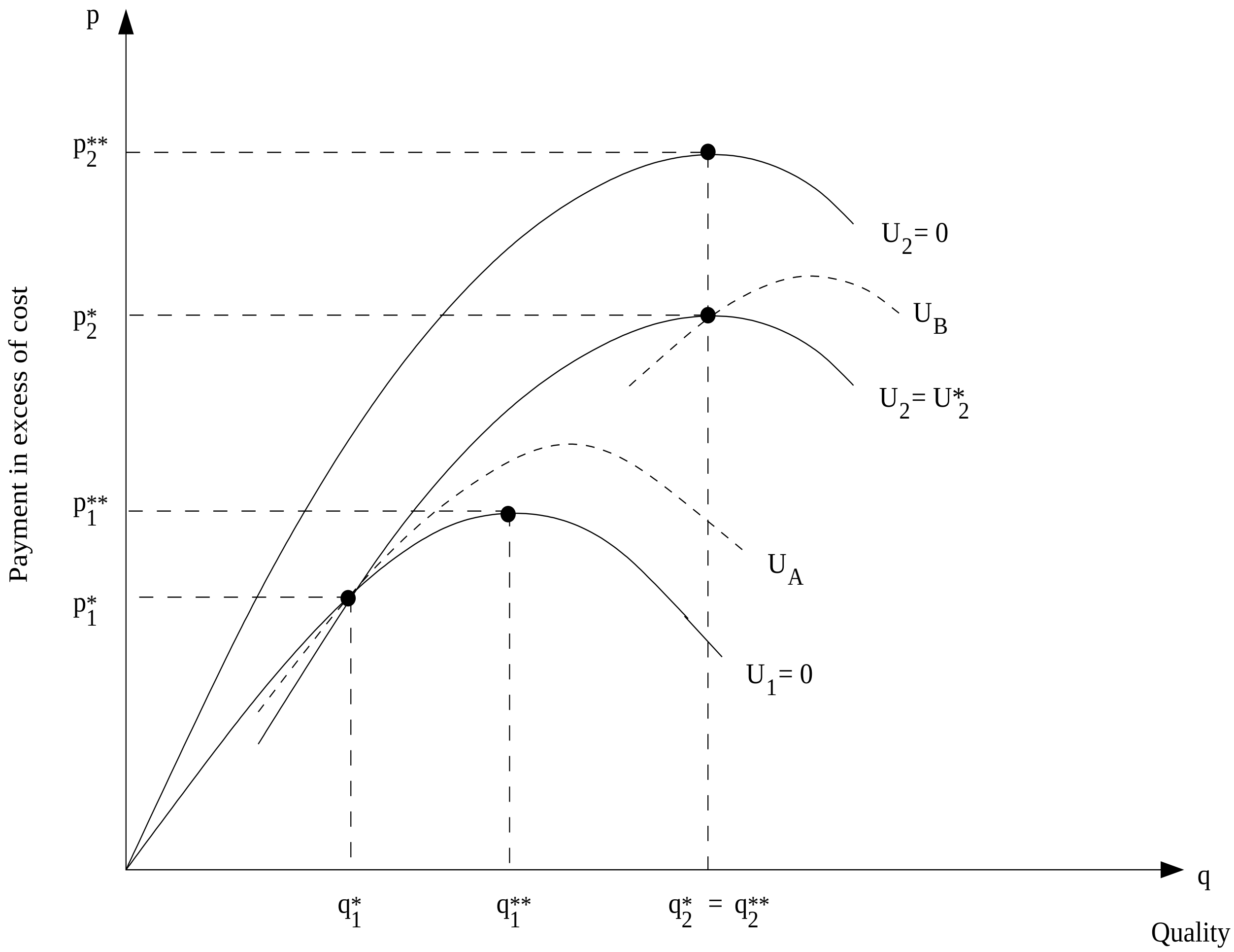
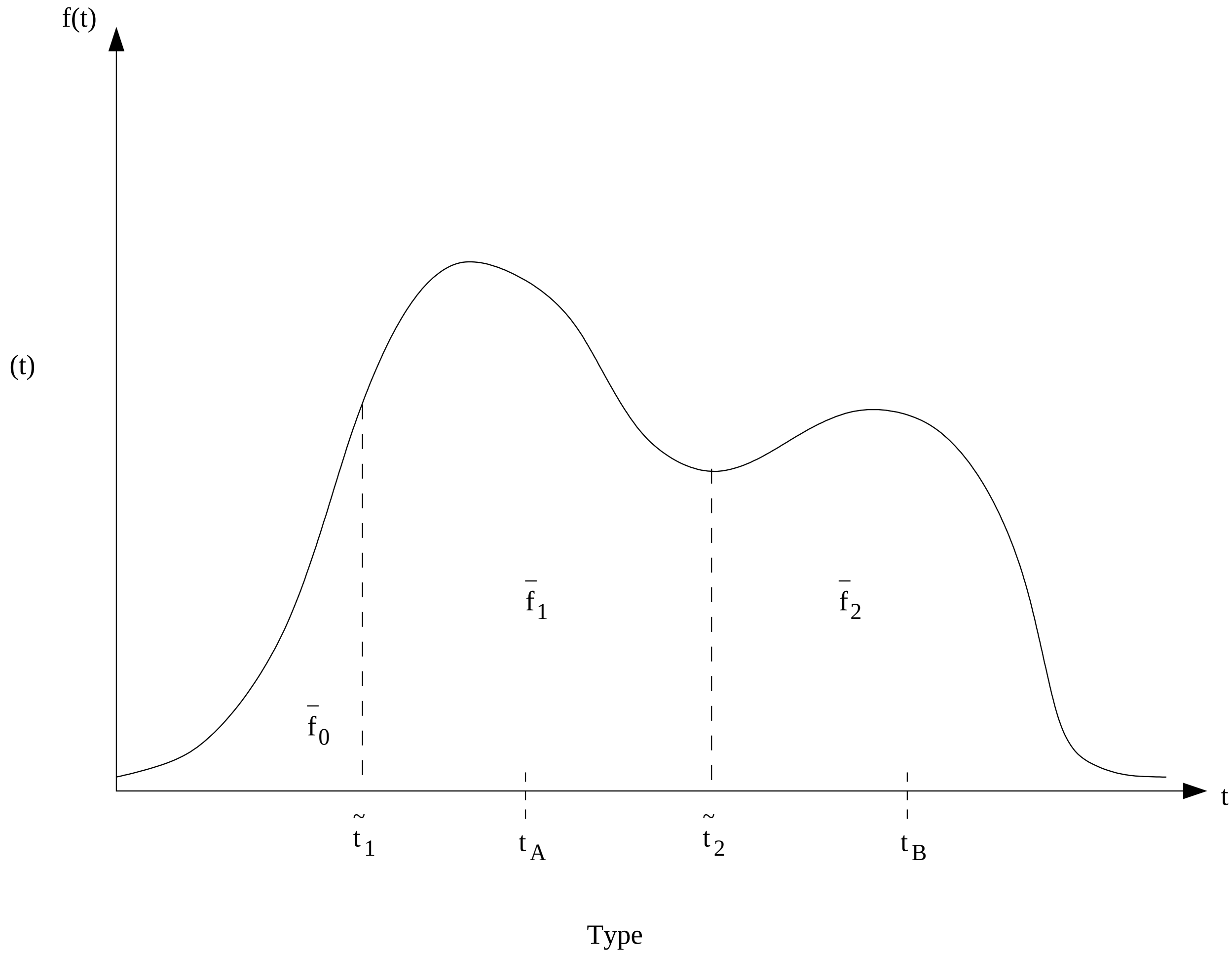
Figure 1: Quality Degradation with Two Types




Adapted from Maskin and Riley (1984).

Figure 2: Continuous Types and Discrete Qualities



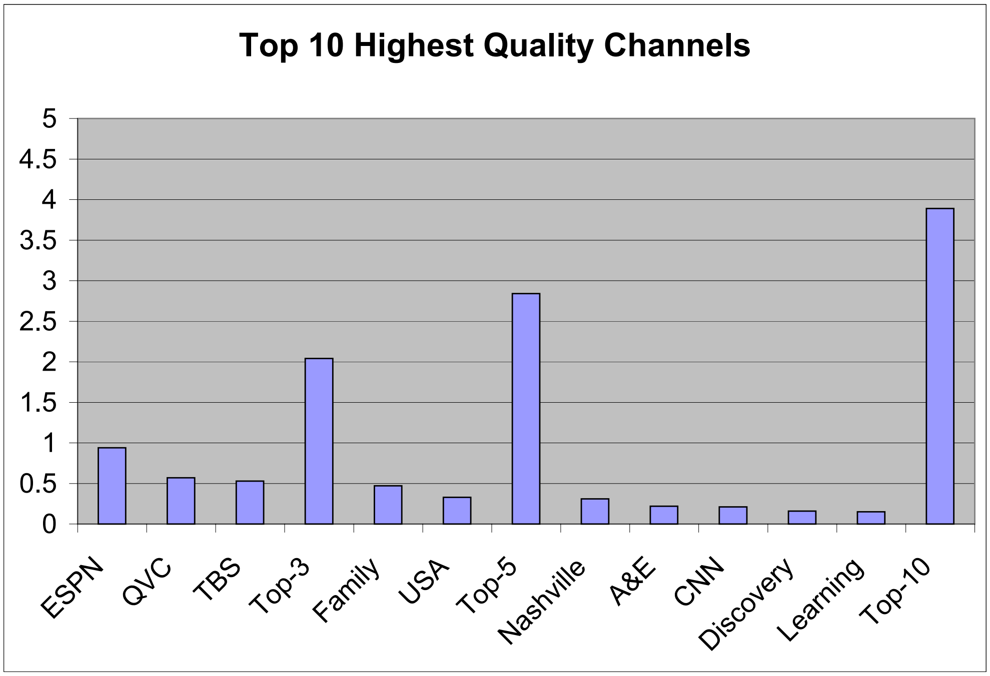



Figure 3: Estimated quality levels for top networks
Ranked and plotted using regression results from Table 4.

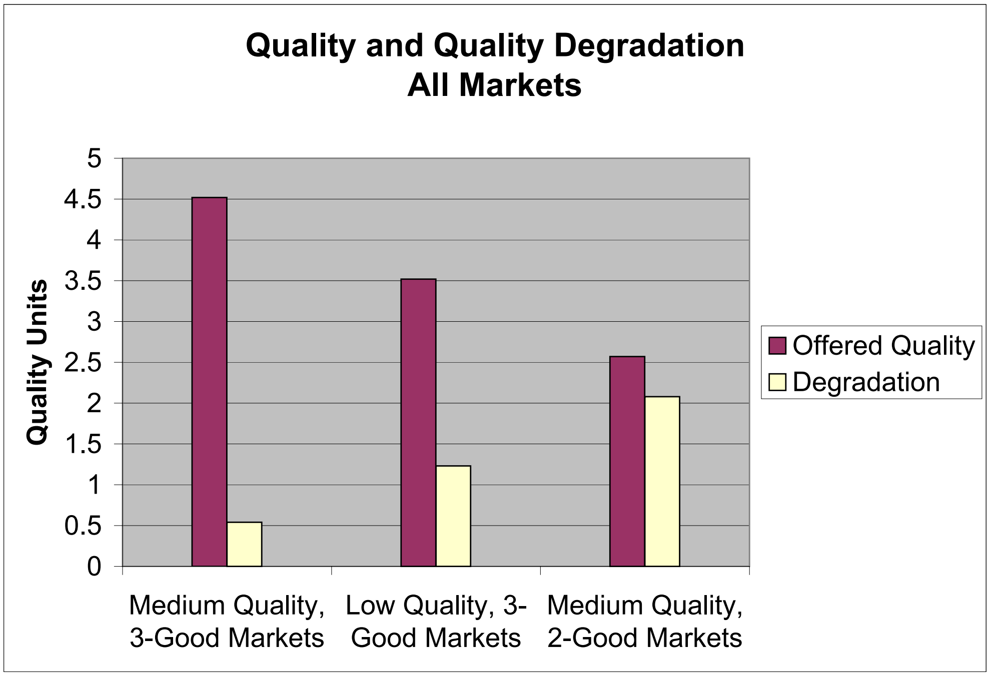



Figure 4: Estimated Quality and Quality Degradation by Market
Results from Table 3.

Table 1: Sample Statistics
Selected Characteristics

| Variable | All Markets | 3-Good Markets | 2-Good Markets | 1-Good Markets |
|---|---|---|---|---|
| Expanded Basic Services | | | | |
| Any Exp. Basic Svcs. | 0.30 | 1.00 | 1.00 | 0.00 |
| One Exp. Basic Svc. | 0.23 | 0.00 | 1.00 | 0.00 |
| Two Exp. Basic Svcs. | 0.07 | 1.00 | 0.00 | 0.00 |
| Market Shares | | | | |
| $w_3$ | 0.66 | 0.47 | 0.61 | 0.70 |
| $w_2$ | 0.02 | 0.12 | 0.04 | — |
| $w_1$ | 0.00 | 0.04 | — | — |
| Prices | | | | |
| $p_3$ | 20.40 | 25.64 | 22.69 | 19.13 |
| $p_2$ | 4.29 | 21.86 | 12.05 | — |
| $p_1$ | 1.16 | 16.78 | — | — |
| Programming | | | | |
| Top-40 Cable Networks | | | | |
| On service 3 | 16.55 | 22.29 | 20.85 | 14.57 |
| On service 2 | 2.74 | 18.15 | 6.44 | — |
| On service 1 | 0.83 | 11.94 | — | — |
| Broadcast Networks | | | | |
| Over-the-Air | 2.54 | 3.19 | 2.85 | 2.37 |
| On Cable | 5.74 | 6.57 | 6.51 | 5.40 |
| Other Networks on Basic | 14.36 | 10.85 | 13.18 | 15.09 |
| System and Market Characteristics | | | | |
| Homes Passed (millions) | 0.005 | 0.010 | 0.012 | 0.002 |
| Channel Capacity | 38.87 | 43.21 | 43.55 | 36.91 |
| Median Income | 23.51 | 24.32 | 24.57 | 23.09 |
| Certification | 0.12 | 0.36 | 0.15 | 0.08 |
| Observations | 1042 | 72 | 240 | 730 |

*Notes:* Data on ca le systems, including service, market share, price, and programming data from Warren (1996). Data on demographic information from Census (1994). Certification is a dummy varia le indicating the local franchise authority registered with the Federal Communications Commission (FCC) to regulate Basic ca le rates as of April, 1996. Data on certification from Ca le Services Bureau, FCC, April, 1996.

Table 2: Top-15 Cable Programming Networks

| **Rank** | **Network** | **Subscribers (millions)** | **Programming Format** |
|---|---|---|---|
| 1 | TBS Superstation | 77.0 | General Interest |
| 2 | Discovery Channel | 76.4 | Nature |
| 3 | ESPN | 76.2 | Sports |
| 4 | USA Network | 75.8 | General Interest |
| 5 | C-SPAN | 75.7 | Public Affairs |
| 6 | TNT | 75.6 | General Interest |
| 7 | FOX Family Channel | 74.0 | General Interest/Kids |
| 8 | TNN (The Nashville Network) | 74.0 | General Interest/Country |
| 9 | Lifetime Television | 73.4 | Women's |
| 10 | CNN (Cable News Network) | 73.0 | News |
| 11 | A&E | 73.0 | General Interest |
| 12 | The Weather Channel | 72.0 | Weather |
| 13 | QVC | 70.1 | Home Shopping |
| 14 | The Learning Channel (TLC) | 70.0 | Science |
| 15 | MTV: Music Television | 69.4 | Music |

*Notes:* Data on network su scri ers from NCTA (1998). Data on programming formats from individual network promotional material (availa le from http://www.ncta.com), NCTA (1998), or industry sources.

Table 3: Parameter Estimates and Implied Qualities

| Variable | 3-Good Markets | 2-Good Markets | 1-Good Markets |
|---|---|---|---|
| Net Type Distribution | | | |
| $\bar{f}_3$ | 0.47 | 0.61 | 0.70 |
| $\bar{f}_2$ | 0.12 | 0.04 | — |
| $\bar{f}_1$ | 0.04 | — | — |
| $f_0$ | 0.37 | 0.35 | 0.30 |
| $\bar{t}_3$ | 5.23 | 4.77 | 4.35 |
| $\bar{t}_2$ | 5.06 | 4.65 | — |
| $\bar{t}_1$ | 4.75 | — | — |
| Qualities | | | |
| $q_3$ | 5.23 | 4.77 | 4.35 |
| $q_2$ | 4.52 | 2.57 | — |
| $q_1$ | 3.52 | — | — |
| % degradation | | | |
| $(\bar{t}_3 - q_3)/\bar{t}_3$ | 0.00 | 0.00 | 0.00 |
| $(\bar{t}_2 - q_2)/\bar{t}_2$ | 0.11 | 0.45 | — |
| $(\bar{t}_1 - q_1)/\bar{t}_1$ | 0.26 | — | — |
| Price-quality ratio | | | |
| $q_3/p_3$ | 0.20 | 0.21 | 0.23 |
| $q_2/p_2$ | 0.21 | 0.21 | — |
| $q_1/p_1$ | 0.21 | — | — |
| Observations | 72 | 240 | 730 |

*Notes:* Parameters of net type distri ution are estimates o tained using the procedure in Section 4.2. Estimated qualities are calculated using these estimates and Eq. (8). Percentage degradation evaluated at cut types, i.e. marginal type just inclined to purchase that quality. See discussion in text for estimates of degradation for average consumer type.

Table 4: Interpreting Quality Estimates

| Variable | Estimate[a] (StdErr) | Implied Mean WTP[b] |
|---|---|---|
| WTBS | 0.53 | 2.39 |
| | (0.03) | |
| Discovery | 0.16 | 0.73 |
| | (0.04) | |
| ESPN | 0.94 | 4.22 |
| | (0.04) | |
| USA | 0.33 | 1.49 |
| | (0.03) | |
| CSPAN | 0.08 | 0.34 |
| | (0.03) | |
| TNT | -0.13 | -0.59 |
| | (0.04) | |
| Family | 0.47 | 2.13 |
| | (0.03) | |
| Nashville | 0.31 | 1.38 |
| | (0.03) | |
| Lifetime | 0.02 | 0.09 |
| | (0.03) | |
| CNN | 0.21 | 0.94 |
| | (0.03) | |
| A&E | 0.22 | 1.01 |
| | (0.03) | |
| Weather | 0.02 | 0.10 |
| | (0.03) | |
| QVC | 0.57 | 2.57 |
| | (0.04) | |
| Learning | 0.15 | 0.67 |
| | (0.04) | |
| MTV | 0.08 | 0.37 |
| | (0.03) | |
| Other Nets. | 0.04 | 0.18 |
| | (0.00) | |

[a] Coefficient estimates from regression of estimated quality levels on  roadcast and ca le programming varia les. Reported are results for top-15 ca le networks listed in Ta le 2. Pooled across all markets, and across all  undles within a market. Standard errors in parentheses.

[b] Authors' calculations; estimated WTP is product of regression coefficient in first column multiplied  y the average (across all markets) estimated willingness-to-pay for quality of the consumer just willing to purchase the high-quality  undle., $\bar{t}_3$ (=4.52)

Table 5: Determinants of Cable Service Quality

| Dependent Variable | Quality | | | Quality Degradation | Number of Services |
|---|---|---|---|---|---|
| | All Qualities | High Quality | Low and Medium Qualities | Low and Medium Qualities | All Qualities |
| Variable | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) |
| System Characteristics | | | | | |
| Homes Passed | 3.750 | 2.160 | 4.540 | 0.748 | 4.590 |
| | (1.100) | (0.859) | (1.580) | (0.386) | (1.060) |
| Channel Capacity | 0.009 | 0.011 | 0.008 | 0.002 | 0.006 |
| | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) |
| Market Characteristics | | | | | |
| Median Income | 0.001 | -0.002 | 0.002 | 0.002 | 0.002 |
| | (0.004) | (0.003) | (0.005) | (0.002) | (0.003) |
| Regulatory Characteristics | | | | | |
| Certification | 0.553 | 0.169 | 0.744 | -0.083 | 0.359 |
| | (0.058) | (0.046) | (0.084) | (0.026) | (0.056) |
| Observations | 1426 | 1042 | 384 | 384 | 1042 |

*Notes:* Reported are coefficient estimates from OLS regressions. Dependent varia les in the regressions reported in top row. Parameters pooled across services as listed in column headings. Standard errors in parentheses.

Table 6: Further Effects of Certification

| Dependent Variable | Total Price | | | Quality-Price Ratio | | |
|---|---|---|---|---|---|---|
| | All Quality Prices | High Quality Price | Low and Medium Quality Prices | All Quality Ratios | High Quality Price | Low and Medium Quality Ratios |
| Variable | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) | Estimate (StdErr) |
| System Characteristics | | | | | | |
| Homes Passed | 21.300 | 18.900 | 22.600 | 0.303 | -0.048 | 0.478 |
| | (5.670) | (7.410) | (7.630) | (0.070) | (0.045) | (0.100) |
| Channel Capacity | 0.055 | 0.091 | 0.038 | 0.000 | -0.001 | 0.001 |
| | (0.008) | (0.010) | (0.010) | (0.000) | (0.000) | (0.000) |
| Market Characteristics | | | | | | |
| Median Income | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Regulatory Characteristics | | | | | | |
| Certification | 2.852 | 1.267 | 3.644 | 0.023 | -0.006 | 0.037 |
| | (0.302) | (0.395) | (0.406) | (0.004) | (0.002) | (0.005) |
| Observations | 1426 | 1042 | 384 | 1426 | 1042 | 384 |

*Notes:* Reported are coefficient estimates from OLS regressions. Dependent varia les in the regressions reported in top row. Parameters pooled across services as listed in column headings. Standard errors in parentheses.