Regulatory Versus Natural Endogenous Sunk Costs: Observational Equivalence In Rationalizing Lower Bounds On Industry Concentration

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Abstract: We propose a theory of 'regulatory endogenous sunk costs' (RESC), in which a captured regulator raises minimum quality standards when market size increases in order to protect incumbent firms. Our RESC theory's predictions that market size is unrelated to industry concentration and positively related to product quality are observationally equivalent to those of Sutton's theory of 'natural endogenous sunk costs' (NESC), in which incumbents increase quality investments to compete for a share of a growing market. The NESC theory suggests that, with higher entry costs, incumbents jockey for increased market shares by increasing quality investments. The RESC theory, however, predicts that product quality should be lower with higher entry costs. Entry costs and minimum quality standards each provide incumbents with protection from profit erosions that entry otherwise would produce. A key implication of our analysis is the possibility that some industries might be misclassified as natural oligopolies. We provide a few examples of candidate RESC industries.

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1 Introduction

Could some industries be natural oligopolies? Shaked and Sutton (1982) and Shaked and Sutton (1987) provided a theoretical rationale for an affirmative answer to this question, based on an argument that Sutton (2007) refers to as a bounds approach. The fundamental idea is that certain industries have endogenous sunk fixed costs—typically modeled as arising from a requirement to precommit to investments in quality-generating technologies—as a defining feature. When the size of the market available to such an industry increases, the number of firms that can earn non-zero profits cannot rise beyond an upper limit. This upper limit arises as a consequence of vertical product differentiation and firm competition partly on the basis of quality. As market size increases, firms respond partially by boosting product quality, which pushes up the fixed costs to which they already precommitted themselves to incur through their technological investments when they entered the industry. If more firms were to enter the industry in response to a rise in the market's size, therefore, the resulting increase in intensity of price competition among too many rivals would drive down the market price and consequently push individual firms' revenues too low in relation to their now-higher fixed costs. Only a few firms, therefore, will emerge in a long-run steady state applying to industries in which endogenous sunk fixed costs were a natural characteristic. Such industries are natural oligopolies arising because of natural endogenous sunk costs (NESC).

In recent years, several studies of industries in which endogenous sunk costs appear to be present have offered support for two key predictions: (1) that observed product quality should increase with an expansion in the size of an industry's market and (2) that the number of firms in the industry should approach an upper bound. Examples include Sutton's (1991) and Bronnenberg, Dhar, and Dubé's (2011) studies of advertising-intensive industries, Sutton's (1998) analysis of R&D-intensive industries, Ellickson's (2007) analysis of the supermarket industry, Berry and

Wadfolgel's (2010) study of the newspaper industry, and Dick's (2007) analysis of the banking industry. The result has been a growing recognition among economists of the importance of endogenous sunk costs in potentially a wide array of industries and of the possibility that a number of oligopolies may indeed be "natural."

This paper offers an alternative rationale for the observation of a positive relationship between product quality and a non-relationship between industry concentration and market size. The alternative theory relies on endogeneity of product quality and of sunk fixed costs introduced by actions of a captured industry regulator. In the regulatory-endogenous-sunk-costs (RESC) model that we exposit below, incumbent firms essentially seek a "quiet life" in which they earn positive profits under the protection of a regulator. The objective of the regulator is to protect the incumbents from entry that would reduce their profitability. The regulator does so by varying, as needed, a minimum quality standard for the industry. When market size increases, therefore, the regulator responds by ratcheting up the required quality threshold to ensure that the incumbents' profits do not rise above a level that would generate entry. Thus, the RESC model produces predictions that are virtually observationally equivalent to the outcomes forthcoming from the NESC theory: a positive relationship between product quality and market size coupled with the absence of a relationship between concentration and market size.

In a sense, the RESC model is a variant of the theory of raising rivals' costs—see, for instance, Salop and Scheffman (1983, 1987); Krattenmaker and Salop (1986); and Scheffman and Higgins (2003). The literature on this subject emphasizes incumbents' strategic problem of foreclosing new entry via establishing credible threats to engaging in actions that raise the costs incurred by potential entrants. The RESC theory that we suggest in this paper achieves credibility via Stigler (1971)-style regulatory capture, with the captured regulator manipulating a minimum-quality-standard instrument so as to assure that no potential entrant could anticipate earning non-negative profits. The result, we show, is endogeneity of sunk fixed costs of generating quality that are superficially analogous to those contemplated by the NESC theory. The nature of the process by which quality, sunk costs, and market size and structure interact is much different, however. Thus, the paper suggests that there may be pitfalls in relying on solely on observations of how an industry's product quality and concentration adjust when market size expands. Finding that product quality rises while concentration remains nearly unchanged could be consistent with either NESC or RESC interpretations. Assuming that an NESC interpretation applies could be inappropriate for a number of regulated industries, resulting in misclassification of those industries as natural oligopolies.

In the next section, we briefly review a specific model of exogenous and endogenous sunk fixed costs that we find useful for expositing the NESC theory and, in Section 3, explaining the RESC alternative and illustrating the dimensions along with the two approaches yield observationally equivalent predictions. Section 4 identifies regulated industries in which the RESC approach could offer a plausible alternative interpretation of the observed evolution of product quality and concentration, which suggests that some industries that heretofore have been classified as NESC industries may be misclassified. This section of the paper also reviews possible ways in which researchers might seek to try to differentiate between the NESC versus RESC explanations—and pitfalls that might be encountered in the process. Section 5 concludes with suggestions for future research on this topic.

2 Exogenous and Natural Endogenous Sunk Costs

There are several alternative approaches to expositing the hypothesized lower bound on industry concentration forthcoming from the NESC theory; see, for instance, Sutton (1991), Sutton (2000), Carlton and Perloff (2005), and Shiman (2007). To review the NESC argument and provide a basis for an RESC theory, we build closely on the exposition by Belleflamme and Peitz (2010), in which consumers spend a fraction γ of their income, denoted y, on a particular industry's good, with a quantity denoted q, and receive utility $V(q_0, q) = q_0^{1-\gamma}(uq)^{\gamma}$, where u is the quality of the industry's good and q_0 is the quantity of an outside industry's good. With mass of industry consumers M, therefore, total consumer expenditure in the industry—and hence total industry revenue—is $R = M\gamma y$, and for any two firms i and j among the n incumbent firms in the industry, it must be true that the price-quality ratio is equalized, so that $\frac{p_i}{u_i} = \frac{p_j}{u_j} = \lambda$, which in turn implies that industry revenues are equal to $R = \sum_{i=1}^{n} p_i q_i = \lambda \sum_{i=1}^{n} u_i q_i$. In a two-stage-game with an entry cost e and an exogenous sunk fixed cost of delivering a quality level u_i given by $C(u_i)$, Belleflamme and Peitz show that in a symmetric Cournot equilibrium with $u_i = u$ for all i, the net profit of a firm facing constant per-unit variable cost c is equal to

$$\frac{M\gamma y}{n^2} - C(u) - e.$$

Consequently, as the mass of consumers increases in magnitude—that is, as market size expands—so will the number of firms n in a zero-profit equilibrium for an industry with exogenous sunk fixed costs.

The NESC approach expands the entry game to three stages. Firms determine in advance a quality investment and associated cost to be incurred post-entry. In addition, they decide whether to incur the entry cost e in light of the fixed cost their optimal quality investment will generate under anticipated Cournot quantity rivalry. Following entry of n firms, the then-incumbent firms proceed to incur the costs associated with their quality investments and finally to engage in actual Cournot competition by determining outputs, the market price, and profits.

Belleflamme and Peitz demonstrate that if a given firm i's endogenous sunk fixed costs are determined according to $C(u_i) = \alpha u_i^{\beta}$, in advance of entry the variable profits that firm i would anticipate earning post-entry are given by

$$\left(1 - \frac{n-1}{u_i \sum_{j=1}^{n} \frac{1}{u_j}}\right)^2 R - \alpha u_i^{\beta},$$

which yields as the optimal quality choice in a symmetric equilibrium for the n firms that become industry incumbents:

$$u^* = \left(\frac{M\gamma y(n-1)^2)}{\alpha\beta n^3}\right)^{\frac{1}{\beta}}. \tag{1}$$

Thus, the Cournot-equilibrium industry quality depends positively on market size and the share of consumer income spent on the industry good. This quality level depends negatively on the number of firms in the industry and the parameters governing the magnitude of endogenous sunk fixed costs of generating quality.

The equilibrium quality choice yields a firm-level post-entry profit for firm i, Π_i equal to

$$\Pi_i = \frac{M\gamma y}{n^3}\left(n - \frac{2}{\beta}(n-1)^2\right) - e \tag{2}$$

which can feasibly be positive only if $n - \frac{2}{\beta}(n-1)^2 > 0$, a condition that is independent of the market-size measure M. Consequently, there is an upper bound on the number of firms given by

$$n < \bar{n} = 1 + \frac{\beta + (\beta(\beta+8))^{0.5}}{4}, \tag{3}$$

and hence the NESC lower bound on industry concentration.

Figure 1 depicts equilibrium in an NESC industry. In the space with number of firms n in the horizontal and quality level u in the vertical axis, the thick curve labeled $u^*(n|M_1)$ denotes the equilibrium quality level given in equation (1) as a function of n drawn for a given market size M_1. The curve slopes downward because as the number of firms increase, firm i's market share falls and thus marginal revenue of quality falls which lowers the quality investment of all n firms in equilibrium.[1] The thinner curve denotes the locus of points (n, u) for which post-entry profit for firm i, given in equation (2), equals zero. This is the zero-profit or no-entry/no-exit locus. Profits are positive to the left of the curve, and we have firms entering the industry while firms exit for points to the right of this curve. This $\Pi_i = 0$ locus is downward sloping because when the number of firms increase, a firm's market share falls and thus quality investment must also fall for profit to be zero. The fact that the zero-profit locus $\Pi_i = 0$ cuts the quality curve $u^*(n)$ from above ensures an interior solution (n^*, u^*).

Suppose the market expands to a level M_2 ($> M_1$). Both curves shift upward as revenue and marginal revenue of quality investment both rise. The NESC equilibrium moves from point E_1 to point E_2. However, it is possible that the equilibrium shift is mostly a vertical one. That is, n need not increase as the expanded market size only generates an increase in quality u^*. The idea is that if the cost of quality investments does not increase too quickly with quality (is not too convex) relative to the increase in revenue associated with unilateral quality investments, then incumbent firms will choose to make higher quality investments in

[1]For very low values of n, the $u^*(n)$ slopes upward. In this region, when n increases, as firms go from very little competition to more competition in u. This effect disappears quickly however, as firms see less market share with more entry which reduces the incentive to invest in quality. This latter mechanism drives the NESC story and thus we only consider the region where $u^*(n)$ slopes downward.

response to the expansion of the market. In doing so, the incumbent firms raise the sunk fixed cost necessary to operate in the industry sufficiently that entry is deterred. Figure 2 shows that n^* increases with M but is bounded from above.

3 Regulatory Endogenous Sunk Costs

Suppose that we observe that the number of firms in an industry remains constant over time even as the market size expands consistent with the NESC theory described above. In this section, we describe an alternative model that is also consistent with these observations but in which the observed n is not a *natural* upper bound. Instead, the unchanging number of firms is a *regulation-induced* upper bound arising from a captured regulator imposing a quality standard that rises with market size.

Consider the NESC industry described in the previous section. In this industry, the *potential* equilibrium is denoted as point E_1 in Figure 3. We depict a situation where the potential equilibrium number of firms n^* is well below the NESC upper bound $\overline{n}$. Suppose that n_c ($< n^*$) incumbent firms collude to set quality at u_c ($> u^*$). By investing in this higher quality level, the incumbent firms raise fixed cost sufficiently to deter entry and keep the market to the n_c incumbents.

The collusive quality level, however, is not supported as a Nash equilibrium. To see this, note that second-stage profit for firm i can be written as:

$$\Pi_i(u_i) = \left(1 - \frac{n-1}{u_i(\frac{1}{u_i} + \frac{n-1}{\sum_{j\neq i}^{n} \frac{1}{u_j}})}\right)^2 M\gamma y - C(u_i).$$

Suppose $n-1$ other firms choose the same level of quality investment, which we denote as $\hat{u}$. Define $\psi\left(\frac{u_i}{\hat{u}}\right) \equiv \left(1 - \frac{1}{\frac{1}{n-1} + \frac{u_i}{\hat{u}}}\right)^2$. Firm i's choice of the level of quality investment satisfies the first order condition:

$$\frac{M\gamma y}{\hat{u}}\psi'\left(\frac{u_i}{\hat{u}}\right) = C'(u_i). \tag{4}$$

Given the quality investment other firms make, $\hat{u}$, a marginal increase in u_i by firm i increases revenue through the marginal increase in market share $\psi'(\cdot)$, which at the optimum is equated to marginal cost $C'(\cdot)$. At the symmetric Nash equilibrium, $u_i = \hat{u}$, which we subsitute into equation (4) to solve for u^* as shown in equation (1).

Now consider the situation when the other $n-1$ firms set $\hat{u} = u_c$ $(> u^*)$ via the collusive agreement to deter entry. What is firm i's best response as defined in equation (4)? If firm i does as the other incumbent firms and sets $u_i = u_c$, then compared with the symmetric equilibrium level u^*, it will have higher marginal cost $C'(u_c)$ but lower marginal revenue $\frac{1}{u_c}\psi'(1)$. The best response for firm i, therefore, would be to deviate to a level of quality lower than the collusive level. Firm i sees that by lowering its quality level it can earn higher profits because the cost saving exceeds the loss in revenue from setting lower quality than its competitors. The collusive agreement to set u_c in order to maintain n_c in the industry thus breaks down. This situation is shown in Figure 4, in which marginal revenue and marginal cost of quality is graphed against the ratio $\frac{u_i}{\hat{u}}$. The symmetric Nash equilibrium is shown as point A. Suppose that other firms raise quality level from u^* to u_c. If firm i matches, thereby keeping the same ratio $\frac{u_i}{\hat{u}}$, then it will have higher marginal cost. This is seen as a shift upward of the $C'(\cdot)$ curve.

The collusive agreement can be sustained, however, if there is an externally imposed floor on quality. A minimum quality standard set by a captured regulator can serve this purpose. In the case of regulatory capture, the industry's firms seek to obtain the maximum feasible industry (joint cartel) variable profits,

$$\Pi(n_c) = n_c\pi^*(n_c) = \frac{M\gamma y}{n_c} - n_c C(u_c) \tag{5}$$

where $\pi^*(n_c)$ is maximized variable profit less the sunk fixed costs generated by production of the quality level prescribed by the regulator.[2] We consider a captured regulator a là Stigler (1971) willing to acquiesce to this objective. The regulator does not, however, have the authority to regulate entry into the industry, which is feasible for any prospective entrant willing to incur the entry cost e. In this setting, the best that a captured regulator can do is to set the minimum quality standard to ensure a positive flow of economic profits to each (identical) incumbent that is just insufficiently large to generate new entry by a prospective entrant. In this way, the regulator ensures attaining a maximum feasible level of "limit profits" (Geroski 1995). This requires setting u to satisfy the no-entry/positive-variable-profits constraint,

$$e \geq \pi^*(n_c) = \frac{M\gamma y}{n_c^2} - C(u_c) > 0, \text{ or}$$

$$C(u_c) > \frac{M\gamma y}{n_c^2} - e.$$

That is, the regulator must set a minimum quality standard sufficiently high to discourage entry but maintain positive economic profits flowing to incumbents, which would entail making the inequality in the above expression an equality to just make the prospective entrant indifferent about entering the industry. Hence, in the hypothesized RESC environment, the captured regulator selects the minimum quality standard in advance, taking into account the cost of entry and

[2]For simplicity, we do not consider what would amount to a one-time fixed cost to put a captured regulator in place plus any variable cost of maintaining the arrangement. Inclusion of these costs would not change the qualitative results of the model.

post-Cournot-rivalry variable profits in order to preserve the current number of incumbents, who then determine their outputs, the market price, and profits—which again are just sufficiently positive to discourage any entry by non-incumbents facing the entry cost e. In the case in which $C(u) = \alpha u^{\beta}$, this implies that the appropriate minimum quality standard is

$$u_c = \left(\frac{M\gamma y}{\alpha n^2} - \frac{e}{\alpha} \right)^2 . \tag{6}$$

Comparing equation (6) with equation (1) indicates a surface observational equivalence regarding the predicted quality responses under the NESC and RESC theories. For instance, in both cases the level of quality is increasing in market size M. In the NESC model, this is because an increase in market size induces more intense quality competition among firms, whereas in this alternative setting with a captured regulator establishing a minimum permitted quality threshold, the regulatory quality standard must be ratcheted up as market size expands in order to prevent entry and ensure a continuing flow of positive economic profits to incumbents. Figure 5 depicts the adjustment process to an increase in M in the RESC model. The schedule labeled $u^*(n|M_1)$ depicts quality choice of unregulated firms given by equation 1 for a market size M_1. Quality u falls with n to the minimum standard $u_c(M_1)$. The $\pi^*(u|M_1) = e$ locus depicts combinations of u and n at market size M_1 beneath which entry would take place. Equilibrium in the RESC model is denoted as point A, at which there is no incentive for potential entrants to seek to join the industry. When market expands to M_2, both curves shift upward to $u^*(n|M_2)$ and $\pi^*(u|M_2) = e$. If the regulatory quality standard were held unchanged, point B would result, with new firms entering the industry. Preventing such entry requires boosting the minimum quality threshold specified by the regulator to level $u_c(M_2)$, moving the equilibrium to point C.

In addition, holding market size and other parameters unchanged, observed quality depends positively on γ and y and negatively on α, β, and the number of firms. Consequently, although the effects of exogenous changes in the magnitudes in the parameters are not equiproportionate, there also is observational equivalence in terms of their predicted qualitative impacts on observed industry quality.

The two theories, however, differ in their predictions of the effect of the size of entry cost on observed quality. In the RESC quality expression in equation (6), product quality depends negatively on the size of entry costs, because the higher entry costs already are, the lower the minimum quality standard has to be to maintain the maximum feasible flow of profits to each firm. In the NESC model, lower entry cost could induce entry which reduces market share and lowers incentive of incumbents to invest in quality. Thus, we should observe lower quality with lower entry cost, unless the industry is already near the upper bound number of firms, $\overline{n}$, in which case we should observe no change in observed quality. Figure 6 displays the effects of lower entry cost. At the higher entry cost, e_1, a NESC equilibrium is shown as point C while a RESC equilibrium is point A. A reduction in entry cost to e_2 shifts the $\pi^* = e$ locus leftward while leaving unchanged the position of the $u^*(n)$ schedule. The NESC equilibrium moves to point D with lower quality. The RESC equilibrium moves to point B as the minimum quality standard must rise to maintain n_c firms in the industry.

4 Candidate RESC Industries and Implications

As discussed in Section 1, authors have proposed a role for natural endogenous sunk costs to influence the evolution of product quality and market structure in a variety of industries. The theory of regulatory endogenous sunk costs discussed in the previous section suggests, however, that there is a potential for industries supervised by captured regulators to be misclassified as NESC industries.

Consider, for instance, the banking industry. Recently, Dick (2007) has provided strong evidence of what she suggests might be a NESC-motivated lower bound on concentration in U.S. banking, an industry in which Pilloff (2009) reports that the average urban-market Herfindahl-Hirschman Index fell within a 1,800-2,000 range between 1990 and the late 2000s—that is, within the standard threshold for antitrust concerns to apply in other industries. Dick contemplates an array of measures of bank quality, including advertising intensity proxied by advertising expenditures as a percentage of bank assets, branch density measured as branches per square mile in a regional market, and additional measures including employees per branch, salary per employee, and number of states in which individual banks operate. She concludes that each of these potential measures of quality increases with market size. In addition, she examines how U.S. bank market concentration varies with market size and, as shown in Figure 7, finds little variation. Dick suggests that both of sets of findings are consistent with the NESC model.

Banking is, however, a very heavily regulated industry. Although state and federal bank agencies can vary requirements for bank charters and, as discussed by Walter and Wescott (2008), exercise some degree of discretion regarding application of antitrust law to mergers and acquisitions, regulatory specification of an array of minimum quality standards is the primary means of bank regulation. Bank regulators in the United States (Federal Reserve, Office of the Comptroller of the Currency, and Federal Deposit Insurance Corporation) establish these standards and enforce them in part via judgmental "CAMELS" ratings, an the acronym that refers to supervisory standards based on a bank's capital adequacy, asset quality, managerial expertise, earnings, liquidity, and sensitivity to risks. A survey by Elliehausen (1998) concludes that application of regulatory minimum quality standards in U.S. banking has necessitated flows of expenditures equal to as much as 13 percent of an average bank's non-interest costs, or about 5 percent of total expenses. In addition, increased quality regulations slated for gradual implementation through the remainder of this decade promise to bring about a further rise in banks' costs of satisfying quality-regulation requirements (see, for instance, VanHoose, 2010). Furthermore, a number of researchers have suggested that banking may be particularly prone to regulatory capture. Although Hardy (2006) views the ultimate impacts of regulatory capture in banking as relatively benign, he views banking as satisfying several of Laffont and Tirole's (1991) criteria for industries prone to regulatory capture: heavy industry concentration, considerable resources at stake, a number of sources of informational asymmetries, and complexity of regulations from an outsider's point of view. Evidence potentially favoring a regulatory-capture perspective on bank regulation has also been provided by Rosenbluth and Schaap (2003), Stiroh and Strahan (2003), and Masciandaro and Quintyn (2008). Masciandaro and Quintyn suggest that the tendency to consolidate authority within a small number of supervisors enlarges the scope for capture, a perspective echoed by the recent analysis of Boyer and Ponce (2012).

These considerations support a RESC interpretation for the banking industry. The nearly flat relationships between bank market size and product quality and concentration documented by Dick need not necessarily reflect the existence of natural endogenous sunk costs. Instead, the market size-quality and market size-concentration relationships actually could result from a concerted effort by the various U.S. banking regulators to vary minimum quality standards as required to maintain stable—but sufficiently small to discourage entry—economic profits in the banking industry.

An RESC-based interpretation could explain the evolution of quality and market structure in a variety of industries. Among these are other financial industries subjected to economic regulation, such as securities trading industries, in which past concerns of potential for regulatory capture have been raised regarding the Securities and Exchange Commission and the Commodity Futures Trading Commission. Even though Sutton (1998) provides strong arguments for viewing industries that intensively rely on research-and-development activities as candidates for classification as NESC industries, a number of these industries are also heavily regulated. In the telecommunications industry, Cohen (1986) and Smart (1994) have provided evidence of channels through which regulatory capture of the Federal Communications Commission could take place, and Gruber (2002) has examined how the FCC could utilize license fees as an RESC-style incumbent-protecting mechanism. Even though Ollinger and Fernandez-Cornejo's (1998) analysis of endogenous sunk costs in the pesticide industry is intended to provide a NESC interpretation of the industry's evolution, Ollinger and Fernandez-Cornejo note that between the early 1970s and early 1990s, the share of research-and-development expenses of pesticide firms that were attributable to meeting regulatory quality standards rose from 17.5 percent to 47 percent.

The RESC model also suggests the feasibility of transforming an exogenous-sunk-costs industry into one governed by endogenous sunk costs generated by a regulatory process. Consider, for instance, Hotz and Xiao's (2011) analysis of regulation of the child-care industry, which on the basis of the technology involved in caring for children would arguably be classified, *ceteris paribus*, as an exogenous-sunk-costs industry. Hotz and Xiao find that the establishment of minimum quality standards generated an initial narrowing of profits to many providers that ultimately stabilized at levels sufficiently low to inhibit market entry considerably. The results were smaller core groups of providers within geographic areas, decreased intensities of competition, and reductions in industry exits. Additionally, Hotz and Xiao find that under regulation, product quality in the child-care industry is increasing in aggregate market income, consistent with the

RESC prediction of a positive relationship between required minimum quality standards and market size. Indeed, a RESC-based interpretation of the evidence they provide is that this positive relationship between regulatory quality standards and market size is necessary to achieve the industry's own goal of minimal market entry and low-intensity rivalry.

Furthermore, the RESC framework could apply more broadly to the implementation of certain forms of social regulation across all industries. One example discussed frequently in this context—see, for instance, Barrett (1991) and Helland and Matsuno (2003)—is the set of industries particularly singled out for pollution-abatement regulation, which Ryan (Forthcoming) finds add substantially to firms' sunk costs. Puller (2006) provides a model describing a regulatory equilibrium in which oligopolistic incumbents could seek to induce tougher pollution regulations as a means of raising the costs of potential rivals and thereby deterring market entry. In Puller's analysis, incumbents already possess a cost advantage associated with satisfying a ratcheting up of regulatory standards. In the RESC model, the advantage accruing to firms already in the industry is simpler: A captured regulator uses minimum quality standards to protect their incumbency. In principle, therefore, the RESC analysis could apply when social regulations are applied in particular ways for specific industries that may be able to find ways to capture their "division" of the agency charged with implementing such regulations.

The fact that NESC and RESC outcomes are observationally equivalent over several dimensions means that there is a potential for economists to misclassify regulated industries as NESC industries. Relying solely on evidence of a positive relationship between industry quality and market size and apparent "natural bounds" on industry concentration is insufficient to separate which theory might explain these relationships. Indeed, the possibility exists that economists could fall into a trap of rationalizing tougher regulation of some natural oligopolies by appealing to NESC-based arguments when in fact existing regulation already explains existing data patterns.

How could economists seek to distinguish empirically between the NESC and RESC theories? Certainly, it would be useful to be able to determine whether an industry's regulator is captured. Unfortunately, as discussed by Dal Bó (2006), such a determination is difficult to make. Most efforts to assess regulatory capture must rely on indirect measures, such as index measures of corruption, campaign contributions, lobbying expenditures, and characteristics of individuals who work at regulatory institutions, including the degree to which such individuals move back and forth between industry and regulatory positions or their extent of exposure to channels of influence from regulated firms.

The analysis provided in Section 3 suggests one dimension along which the NESC and RESC theories are not observationally equivalent: an NESC-indicated positive- or non-relationship between industry product quality and an RESC-predicted negative relationship between regulatory minimum quality thresholds and non-regulatory, non-quality-related industry entry costs. Hence, in theory it might be possible to test for whether estimated entry costs—which would have to be carefully disentangled from entry costs caused by actions of regulators or associated with generating quality—are related to levels of quality. The hypothesis would be that quality levels should be significantly negatively related to entry costs in captured-regulator industries but not in other industries. One difficulty, of course, is that product quality is notoriously difficult to measure objectively, although Crespi and Marette (2009) have suggested one possible approach to this problem that might be feasible for cross-industry studies. Another problem in performing cross-industry studies relates to measures of entry costs. These would have to meet a number of criteria. In addition to excluding both quality-related entry expenses and regulatory contributions, the entry-cost measures would also have to be consistently constructed across the industries considered. Although some researchers have attempted to amass comparable cross-industry data on entry costs [see, for instance, Burton, Kaserman, and Mayo (1999), Lambson and Jensen (1998), and Gschwandtner and Lambson (Forthcoming)], in most cases the measures arguably include expenses influenced by quality provision and costs imposed by regulations. In the absence of comparable entry-cost estimates across a sufficiently large number of industries, a researcher's only other option would be to contemplate time-series or event studies of specific industries utilizing industry-specific quality and entry-cost measures [examples of the latter include Fan (2006) for video-rental outlets, Xiao and Orazem (2005) for broadband service providers, and Dunne, Klimek, Roberts, and Xu (2011) for dental and chiropractic service providers] with an aim to determine if regulatory capture might lie behind an observed shift toward an altered relationship between product quality and entry costs. Such single-industry studies, however, also would have to utilize measures of entry costs exclusive of quality expenses and regulatory costs.

Gschwandtner and Lambson (2002) provide cross-country evidence of the importance of sunk costs in influencing the numbers of firms in industries. A key implication of the NESC theory is that the number of firms in an industry should be less variable when sunk costs are endogenous rather that exogenous. In both the NESC and RESC models, there is an upper bound on the number of firms—the upper bound for the NESC model in equation (3) above versus the theoretically constant-valued number, n_c, of regulation-protected incumbents in the RESC model. Consequently, the NESC model actually suggests more variation should be observed in the number of firms in an NESC industry relative to its upper limit as market size varies as compared with considerably less variation in n relative to in a captured-regulator industry. This reasoning suggests another possible means of trying to test for the relevance of NESC versus RESC rationales for endogenous sunk costs in regulated industries—at least, under an assumption that regulators are successful in maintaining core groups of protected incumbents in captured industries. Coupling tests along these lines with examinations of whether non-quality/regulation-related entry costs play a role could provide joint means of checking for robustness in efforts to distinguish appropriate classifications of endogenous-sunk-cost industries.

5 Conclusion

Clearly, there would be high empirical barriers to jump in order to distinguish RESC industries from NESC industries. Nevertheless, our conclusion is that efforts must begin to move in the direction of either leaping these barriers or finding ways around them. Otherwise, the analysis in this paper suggests that economists confront a danger of improperly misclassifying RESC industries as NESC industries and thereby sometimes incorrectly providing support for arguments favoring toughened supervision of industries that already are protected by captured regulators.

The RESC theory developed in this paper involved a straightforward reorientation of a basic exposition of exogenous and natural endogenous sunk fixed costs under a maintained presumption that a captured regulator aims to attain maximum feasible profits for incumbents, as in Stigler (1971). More realistically, of course, are intermediate cases such as those suggested by the work of Peltzman (1976), in which industry regulators seek to attain mixed objectives. While we suspect that the basic RESC analysis would hold true in a more general setting, with the relative importance of endogenously determined required quality standards increasing as a regulator's preferences shift more in favor of the industry incumbents' objectives, this is one area worthy of additional theoretical study. Nevertheless, our conclusion is that the main issues related to endogenous sunk costs generated by regulation are empirical. Before these issues can be adequately addressed, however, much more work must be accomplished to develop improved measures of industry product quality and entry costs.

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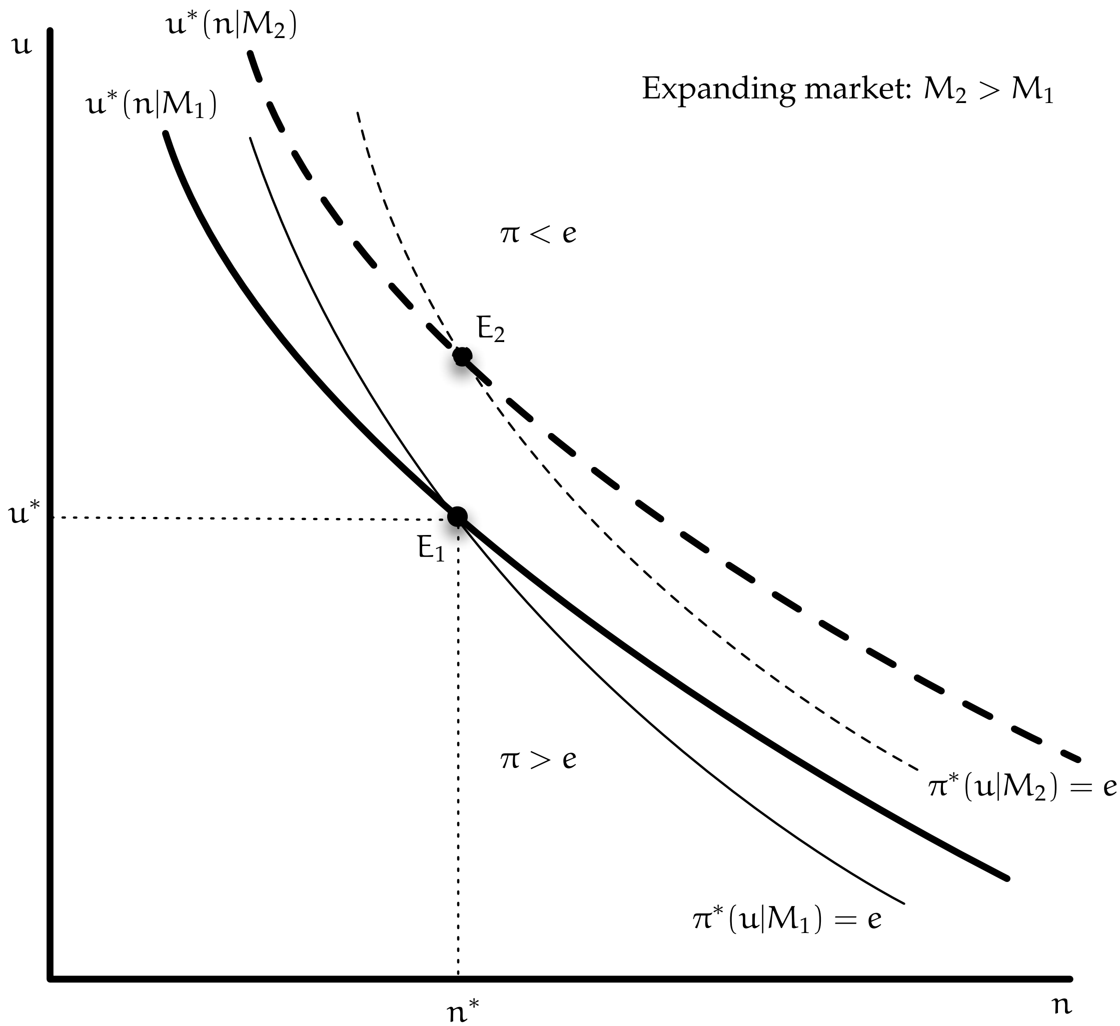


Figure 1. In an industry with natural endogenous fixed costs (NESC), when the market expands ($M_2 > M_1$), the number of firms *might not* increase.

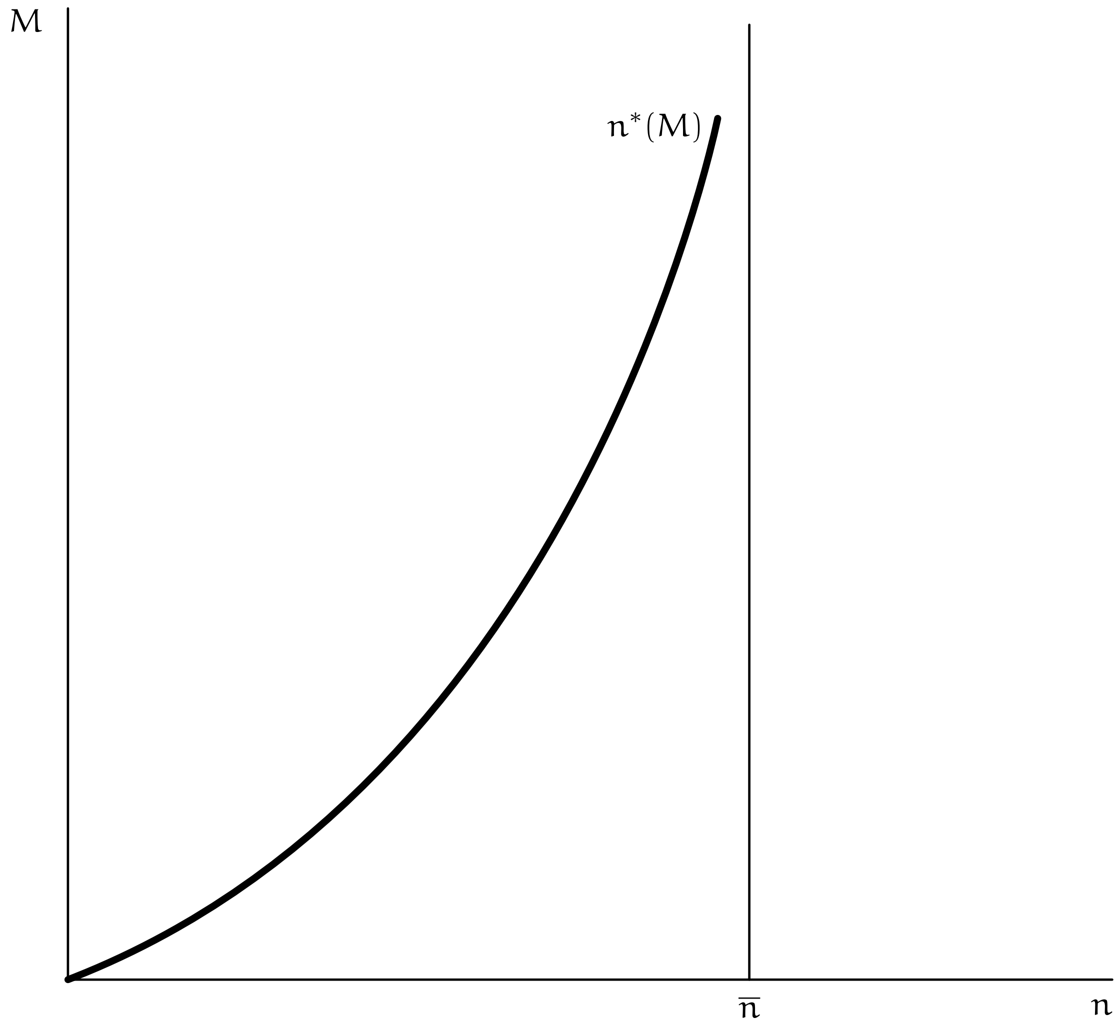


Figure 2. In an industry with natural endogenous fixed costs (NESC), the equilibrium number of firms n^* increases with market size M but there is an upper bound on n^*.

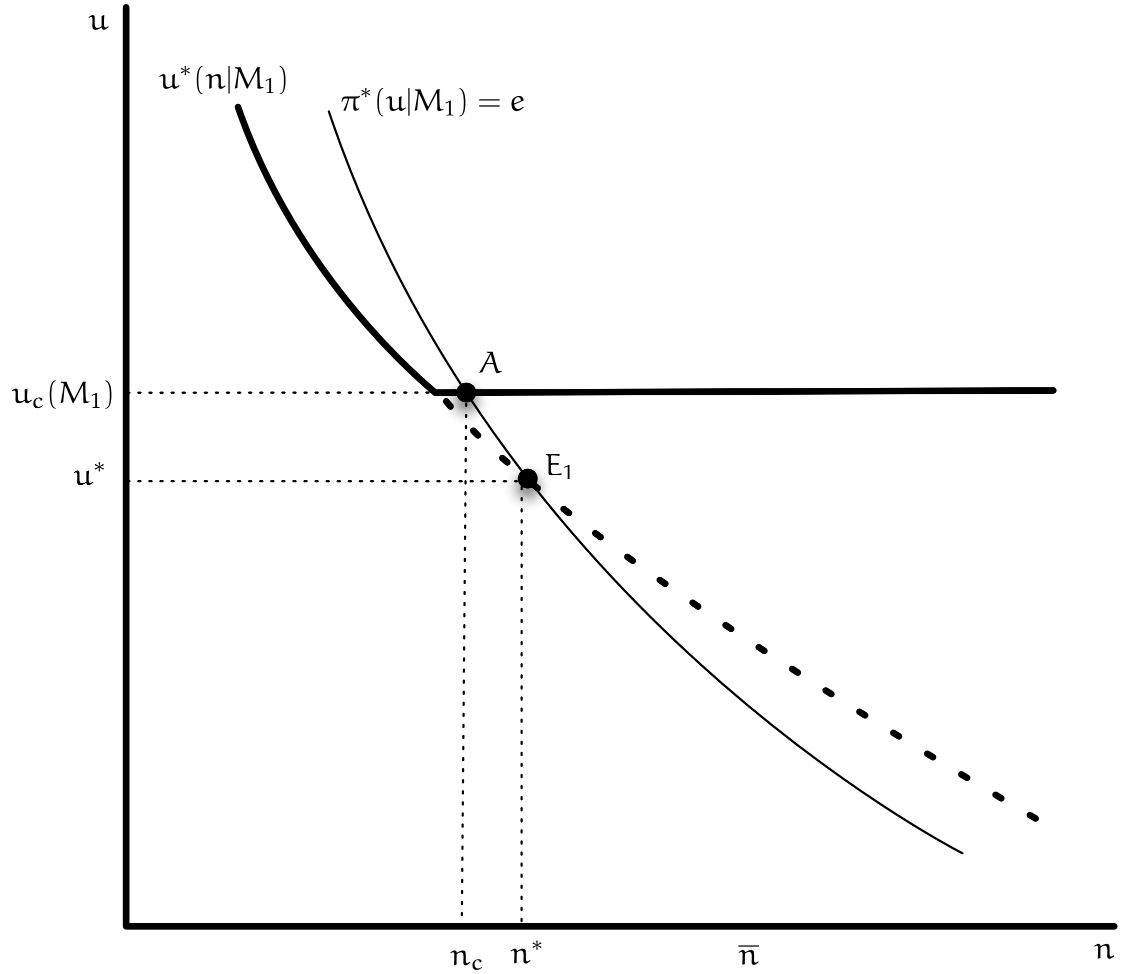


Figure 3. Even in an industry with natural endogenous fixed costs (NESC), a smaller number of firms n_c ($< n^*$) could keep potential entrants out of the market with the aid of a captured regulator setting a minimum quality standard u_c. Point A denotes a regulated endogenous sunk cost (RESC) equilibrium.

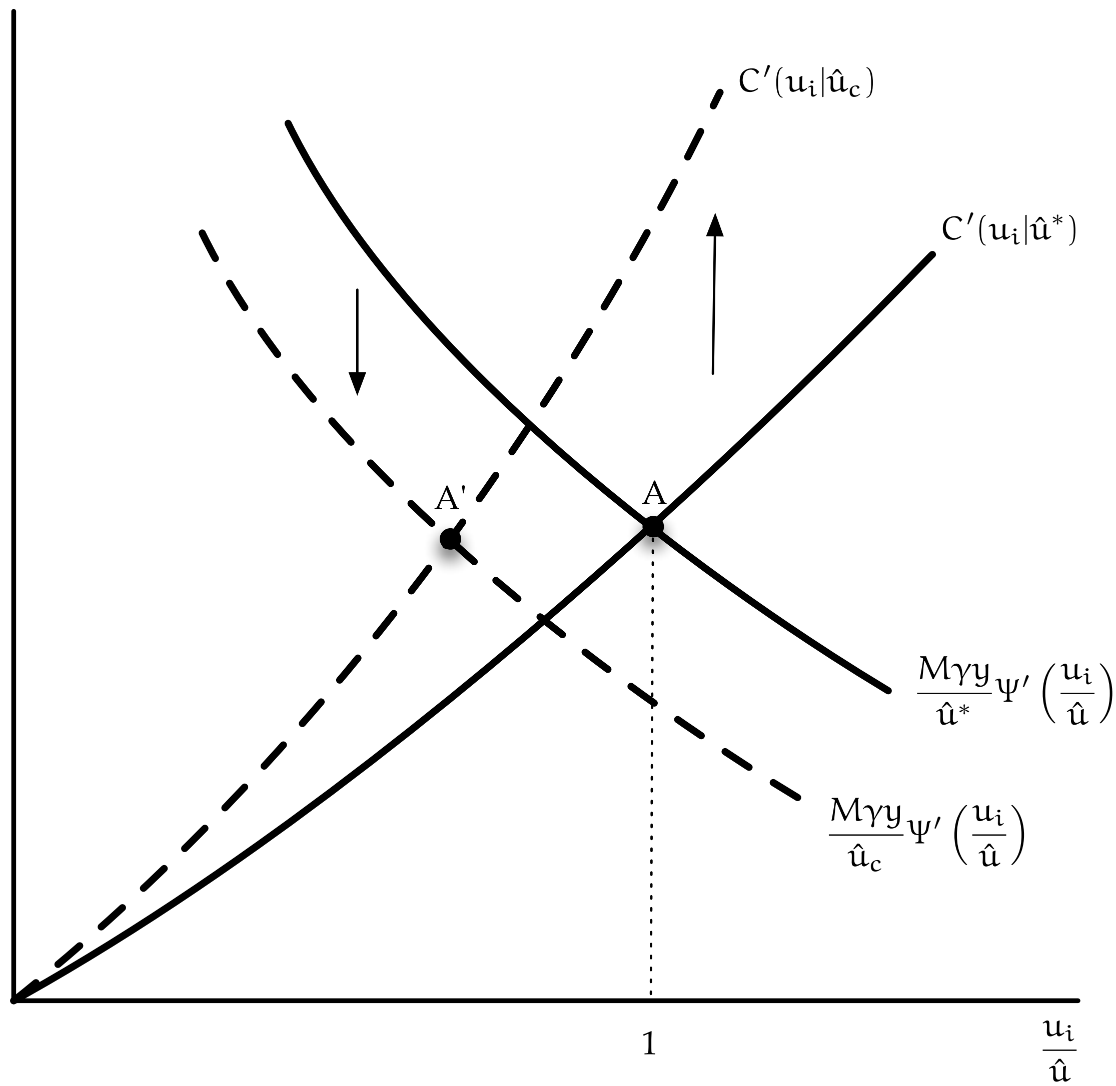


Figure 4. A collusive outcome where n_c firms agree to set quality level u_c is not sustainable in equilibrium since firm i has an incentive to deviate to a level $u_i < u_c$.

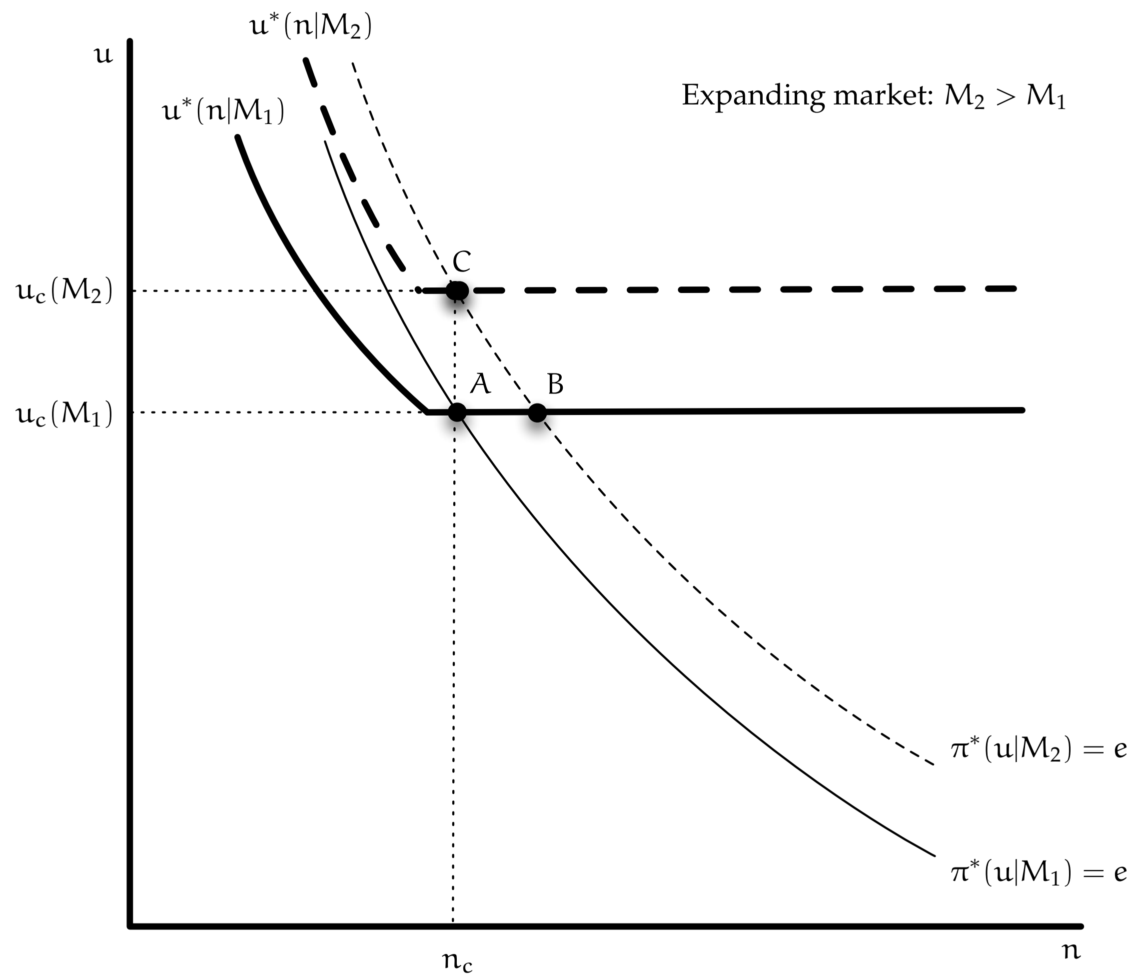


Figure 5. In an industry with regulated endogenous sunk cost (RESC), when the market expands, the minimum quality standard rises to maintain the number of firms at n_c.

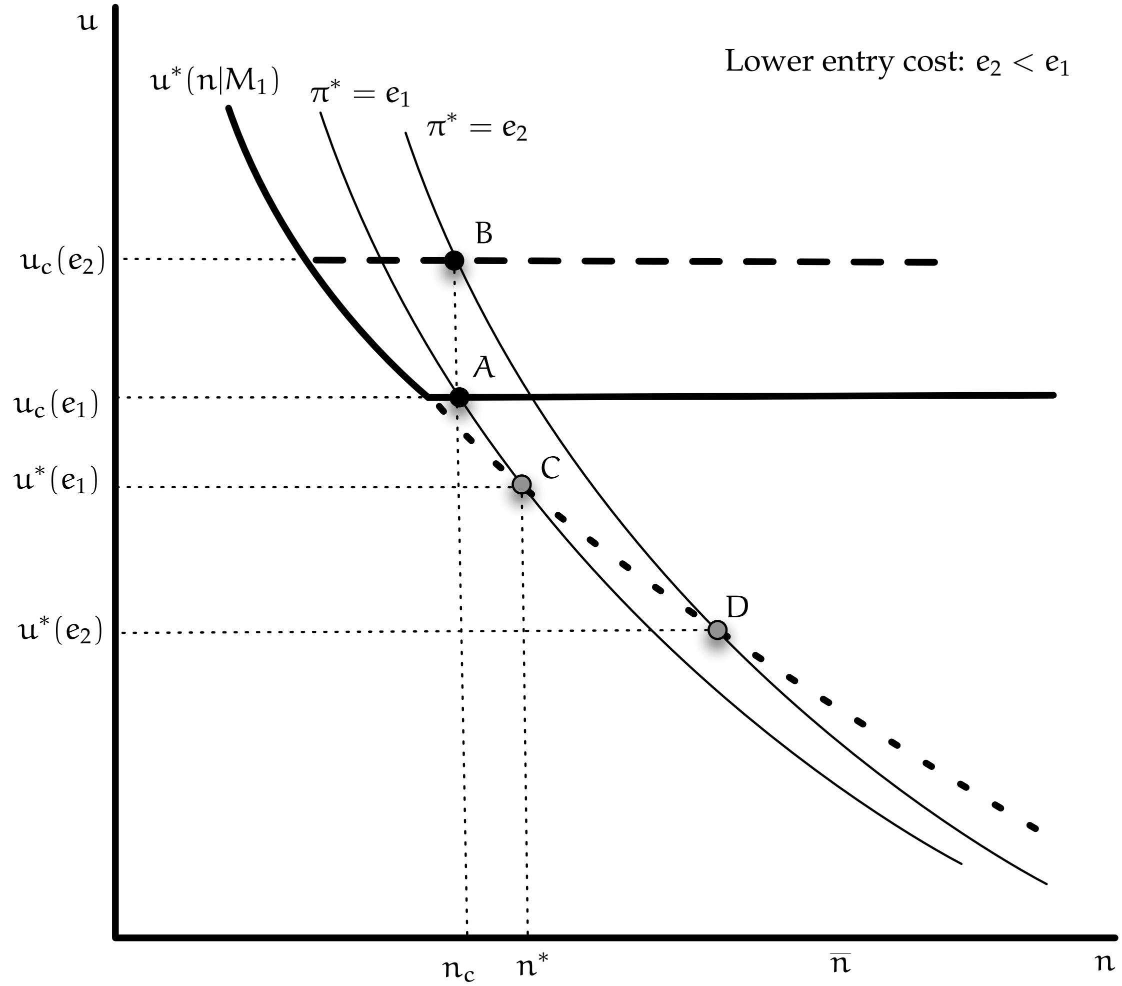
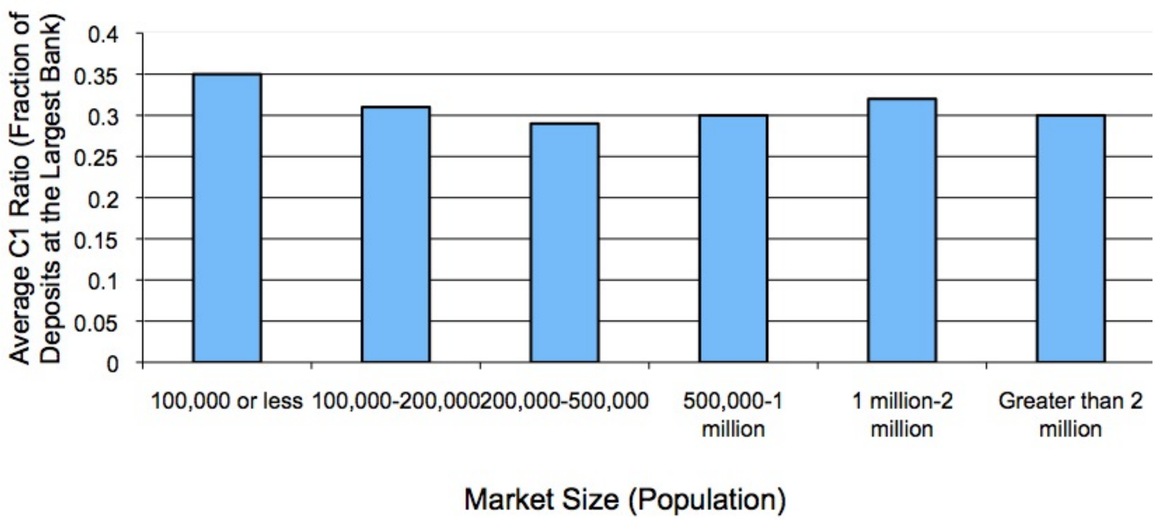
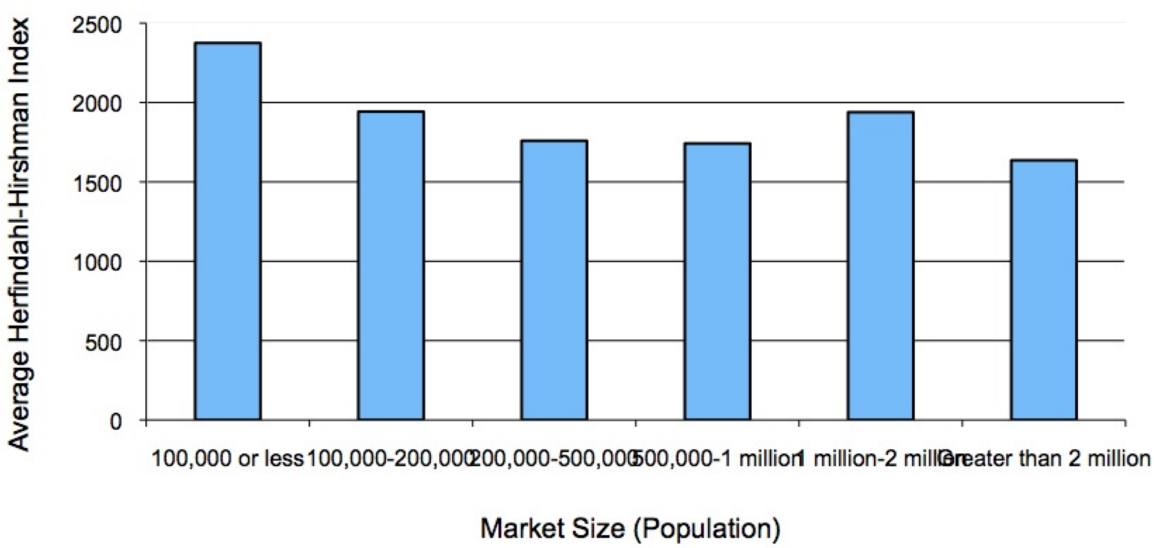


Figure 6. When entry cost, e, falls, in a NESC industry, observed quality, u^*, falls while in a RESC industry, observed quality, u_c, rises.



(a) Concentration measured as average C1 ratio.



(b) Concentration measured as Herfindahl-Hirschman Index.

Figure 7. Concentration and Market Size. Source: VanHoose (2010), based on estimates in Dick (2007).