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**Industry Performance Gradient Indexes and Market Entrance:  
an empirical tool for market researchers**

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**Abstract:** This paper introduces the Industry Performance Gradient Index as an analytical tool for market researchers. Specifically for screening markets for potential entrance. The identification of the Industry Performance Gradient Index is examined empirically on the banking industry in Tennessee. This highlights the potential benefits to using the Index to identify potential profits from incumbent profits, market structure and output sensitivity to price changes in the market. An outline for employing this Index and potential uses for incumbent firms are also suggested.

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## **Introduction**

For a firm, entrance into an existing market is typically preceded by much analysis centered on the existing competition in the market, as well as other demand and cost issues. Based on these analytics various strategic objectives may then be followed. Traditional economics has been silent on this issue, in part because guiding a firm's market entrance decision is outside the realm of traditional economic research. However, studies of firm entrance decisions, market conditions and especially the competitive environment are the stock and trade of industrial economics. Recently the discussion of strategic games offered by microeconomists to the general business public has focused on theory, exemplified not by statistics but by case studies (e.g. Dixit and Nalebuff, 1993). This is a good start to linking modern economic theory to practical business decision making. This approach is theoretical and extremely helpful. However, there is lacking in the management literature a set of useful empirical tools which bridge economic theory with market entrance strategy. Fortunately, within the body of industrial economics research lay several empirical methods that permit quantitative comparison of markets and guide more targeted market research into potential market entrance.

Chief among the quantitative economic tools that can guide market entrance is the Industry Performance Gradient Index (Dansby and Willig, 1979). The Index, though no longer new, presented an important and enduring method of measuring the net benefits to government intervention in markets, primarily within the realm of anti-trust enforcement. The Index offered a method of estimating market structure employing basic tools of concentration such as the Herfindahl-Hirschman index and market share. The authors linked these measures to specific theoretical market models and, through estimating the magnitude of the concentration in a market, provided an anti-trust screening tool. In essence, the paper provided both demand and supply side measures for targeting anti-trust enforcement. We are only worried about the supply side—as we shall explain. This paper will introduce how effectively the Index identifies markets where strategic entrance decisions may be focused, and it provides an empirical example of this type of market screening device. The emphasis is on providing a useful empirical tool for sorting markets by competitive conditions. This is intended to provide a screening device for firm strategic decision making, especially as it applies to market entrance.

## **The Strategic Use of Industry Performance Gradient Indexes**

The Industry Performance Gradient Index was offered as a guide for government intervention into markets where regulatory effects would generate the highest increases in social welfare. The Index was both highly theoretical in its construct of a social welfare function and very practical. It employs the types of simple data collected as part of industry census and surveys. For the latter reason, the Index offers great potential in screening markets for potential entrance. The Index uses data from a cross section (rather than time series) making its computation especially accessible to firms. The Index is flexible, can be used in very large markets and can guide strategic behavior even after an entrance decision has been made.

The Industry Performance Gradient Index is especially sensitive to market definition, which is not a limitation, but a guide in its strategic implementation to firm size and product target area. This is especially important for firms that wish to enter markets with franchises, branches or offices that compete directly with other firms. Finally, the Index is useful not only for directing or screening entrance, but also for formulating long run strategic plans, and identifying regional competitors.

These considerable claims made on behalf of the Industry Performance Gradient Index are based on the simple information content of the Index and its ease of computation. The Index also provides a vehicle for the analysis of the benefits to entrance and strategic options open to new entrants into the markets. The Index serves as a component, not a complete market analysis tool. However, given the flood of information available to businesses, and the difficulty in culling that data, the use of the Index should be a welcomed addition to business strategists.

## **A Summary of the Industry Performance Gradient Index**

Dansby and Willig's original paper focused on combining the cost-benefit approach of government intervention with the use of readily available market concentration data. The first half of the index, the social welfare function, is dependent upon the size of the market under scrutiny and the incremental improvement that could be generated from government intervention. The use of this part of the Index, though critical for the economist, is not an important part of the entrance analysis since other

demand side analytics are more useful to business strategists. The result of focusing on the supply side is a set of index numbers that represent the “competitiveness” of a market given a set of easily quantifiable market characteristics. A condensed version of the index method is presented here. We have elected to omit most of the algebra of the Index calculation itself in order to simplify an already difficult discussion. Interested readers are encouraged to read the original work. We have included (in endnotes) the algebraic manipulations performed to approximate the Index. The result is a thumbnail sketch of the Index calculation, that has been slightly modified to ease data collection difficulties.

The Industry Performance Gradient Index (Dansby & Willig, 1979) is approximated as:

$$f = \left[ \sum \left( \frac{P - MC}{P} \right)^2 \right]^{\frac{1}{2}} \quad (1)$$

where  $P$  is the current price of the good in the market, and  $MC$  is the marginal cost of production. This generic index formula is the screening figure for market entrance.<sup>1</sup> However, the known costs (and price) may be difficult to ascertain, so some quick calculations permit a more data friendly approach to calculating the index. To begin with we will employ a simple profit function for a firm ( $B = P(Q) \cdot Q - C(Q) \cdot Q$ ), whose maximization through the first order conditions is:

$$P + q_i \left( 1 + \sum_{i \neq j} \frac{dq_j}{dq_i} \right) P'(Q) - MC = 0 \quad (2)$$

where  $P$  is the price,  $P'(Q)$  is the marginal revenue of a price change and  $MC$  is marginal cost. The component following the summation sign is the effect of a change in the quantity sold of a firm’s product on the quantity of all other firm’s sales, which we will call “ $\epsilon_i$ ”. The well known definition of market elasticity of demand,  $\epsilon$ , is  $-P/(P' \cdot Q)$ . Likewise, we identify the market share of firm  $i$  as  $s_i$  which is simply  $q_i/Q$ . Rewriting (2) above and rearranging the terms gives us the price-cost margin in terms of price, elasticity and market share:

$$P - C'_i(q_i) = \frac{P}{\epsilon} s_i (1 + \epsilon_i) \quad (3)$$

In matrix form this provides a gradient of observations for firms.<sup>2</sup> Our empirical investigation will focus on the value of each of the firms' Index numbers *and* the average values for markets. The former value identifies firms within a market that have certain characteristics that affect strategy options for the entering firm. It is the latter value we wish to examine for identifying potential market entrance.

Before applying our empirical investigation, it is necessary to rewrite this expression into a form that employs available data. By combining (1) and (3) above, we have a reduced form of the gradient index:

$$f = \frac{1}{e} \left[ \sum s_i (1 + a_i)^2 \right]^{\frac{1}{2}} \quad (4)$$

which can be generalized to a number of easily calculable market structures.

In a monopoly, the market share is one, and the rival response is zero, which gives us simply the Index as the inverse of the price elasticity of demand, which can be written as the inverse of the Lerner Index, a well known anti-trust analysis tool.<sup>3</sup> The original authors provide an important insight here that the Industry Performance Gradient Index is simply a generalization of the Lerner Index to a wide variety of market structures.

Moving from monopoly along the competitive spectrum we encounter the two firm duopoly, where, in equilibrium,  $\pi_i=0$ , gives us:<sup>4</sup>

$$f = \frac{1}{e} \sqrt{HHI} \quad (5)$$

where HHI is the Herfindahl-Hirschman Index of concentration.<sup>5</sup> This can be extended further to a market with a dominant firm and a competitive fringe:

$$f = \frac{1}{e} \left( \sum s_i^2 \right)^{\frac{1}{2}} \quad (6)$$

where there are  $i$  smaller fringe firms. This can also be extended to a market with  $m$  dominant firms, and a fringe market, where the numerator of the elasticity component of (6) is replaced by the square root of  $m$ .

These elegant measures of market structure are easily translated into empirical screening of a market, using readily available data on pricing and structure. The Industry Performance Gradient Index excels in the empirical comparison and screening of markets for potential entrance.

### **An Empirical Application**

We chose to examine the state bank market in Tennessee to exemplify this process. Data for 1994 were collected from *The 1998 Tennessee Statistical Abstract* including average price of loans, location and capitalization. For a complete description of these markets see Hicks [1999]. We sought to identify markets for potential entrance. We used the city of location as the market definition, from which we could examine a number of values of the Industry Performance Gradient Index for evidence of the competitive environment. From the market definition we can determine market share and thus the HHI. Again, it is worth noting that this Index is a tool for identifying markets for entrance based on the type of market the firm would like to extend operations into, not a decision making tool for potential entrance. Therefore, data proxies, such as price of the main product for average price, or errors in the market definition should be corrected after the screening in the more costly market analysis.

In this market we consider a state or national bank considering opening additional branches based on the competitive environment. This simplistic strategy is used as a pedagogical device only. We envision the Index giving firms multiple strategy options. These options may include: prioritizing entrance decisions, screening areas for more costly and detailed market studies and examining the strength of incumbent firms.

The screening statistics by market structure are described in Table 1.

**Table 1, Industry Performance Gradient Statistics**

Index	Mean	Median	Standard Deviation	Number of Firms
Monopoly	0.61	0.61	0.05	100

2-Firm Duopoly	0.46	0.45	0.04	92
1 Dominant Firm w/ Fringe	0.13	0.11	0.07	30
<i>m</i> Dominant w/ Fringe	0.06	0.02	0.11	31

The lower the value of the statistic, the more competitive (less monopolized) the market environment. These statistics illustrate the mean, median, standard deviation and number of markets that fit the Index description. The Index is bound by [0,1] and presents an important tool for measuring the firms. Let us examine the market for the *m* dominant firm Index numbers, to see what we have to screen.

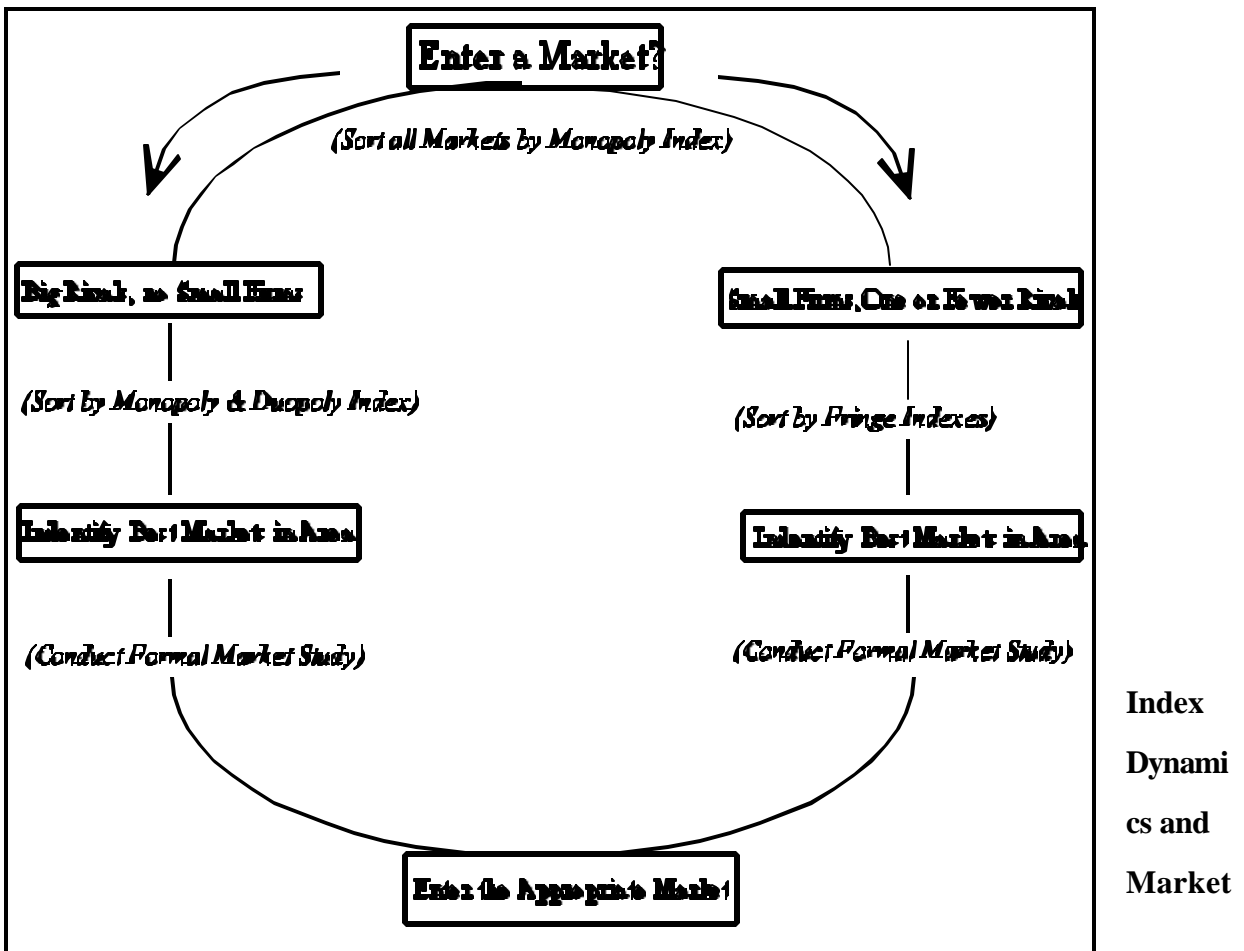
These thirty one firms represent four markets with between 4 and 13 firms each. The markets range in size (ranked by capital) from \$26.4 million to \$166.9 million. The smallest bank in any of the markets has \$4 million capital. So, we have markets where small banks have a foothold, and which contain two of the three largest banks in the state. This is an environment having very competitive firms in the fringe, but with a dominant bank. The strategic use of this type of market analysis should be an obvious adjunct to firm market research.

### **Practical Use of the Index**

Firms planning entrance into several markets can make use of the index even while pursuing multiple strategies. For example, if a firm with a dual strategy wants to enter competitive markets while also entering against very profitable monopolies, then this Index would be very useful. The *m* firm fringe Index provides both an analytical and a screening tool. The market with the highest Index number in this category will have the highest potential for profit, based upon the mathematical description of the Index number. That market provides a high opportunity target for potential entrance. Among the monopoly markets, the index numbers rank existing profit. This again is an attractive area for entrance based on the existing firm strategy. The Index numbers categorize firms and rank them (and their markets) within categories. These calculations are easily performed in a spreadsheet, and represent the first part of the data that a good market researcher will employ. This is an extremely useful tool, but does have its limitations. Regulated firms (i.e. natural monopolies such as electricity producers and local telephone providers) have a different profit maximization function, so the use of this

index for screening may be biased. Also, as with any empirical study, sensitivities to data error exist. These limitations show why this is merely a screening method for an entrance decision made in a more formal (and costly) study. Figure 1 illustrates the role of the Index in making strategic decisions regarding firm entrance.

Figure 1, Entrance Decisions with Markets Sorted by Industry Performance Gradient Indexes.



## **Entrance**

By design, the Industry Performance Gradient Index is a static tool. It was intended to be used for easy identification of markets that yield high payoff regulatory intervention. It appears equally well suited as a tool to analyze market entrance. It also benefits from minimal small data requirements. However, a dynamic examination of the markets included in the calculations also provides a strong indicator of the markets in which entrance is likely to be effective.

Markets where entrance has not occurred, but the index numbers remain high are ripe for entrance strategies. Markets where entrance has occurred, but has not been successful must be analyzed more carefully for additional factors discouraging entrance (e.g. limit pricing, etc.) Markets where entrance has been successful, but where the Index has not dropped are ripe for easy (and profitable) entrance. Markets where entrance has occurred and the Index declined (perhaps near zero) may be poor choices for potential entrance due to a highly competitive environment. Market researchers who maintain data and conduct periodic analysis for new branches or expanded retail facilities are well positioned to use this tool.

One final claim for the Index is its benefit *after* firm entrance. Incumbent firms can use this tool to assess the competitive nature of the markets in which they currently operate. This can be critical to assess the probability of rival entrance and to assess firm performance based on competition in the market. This allows the Index to be extended to part of periodic market analysis conducted by the firm.

## **Conclusions**

This paper has presented, in a more friendly form, a useful market analysis tool—the Industry Performance Gradient Index. From this Index, market research for potential entrance may be focused. The measures of incumbent profits and market structure as they represent price sensitivity of the market are an invaluable tool in analyzing potential entrance into a market. We envision this tool being of special interest to firms that mix franchise and centrally owned retail outlets. The benefits to firms employing this retail method is that they can share the risk of entrance with franchise holders. Of

course, the final determination of this method's is determined by how quickly researchers adopt them.

## Endnotes

1. Note that this index is similar to the Lerner Index, but which larger firms more heavily in the original calculation (the squared value) prior to the aggregation of the index. The square root value returns the value back to within the [0,1] range.

2. A vector of derivatives is known as a gradient.

3. See Kaserman and Mayo, 1995 for an expansion of this result:

$$MR = \frac{dTR}{dQ} = \frac{d(P \cdot Q)}{dQ} = P + Q \frac{dP}{dQ}$$

which reduces to:

$$MR = P \left( 1 + \frac{Q}{P} \cdot \frac{dP}{dQ} \right)$$

with , being also:

$$e = - \frac{P}{Q} \cdot \frac{dP}{dQ}$$

the Lerner Index,  $l$ , being (definitionally),  $(P-MC)/P$ , substituting marginal revenue (MR) for marginal cost (MC) at the profit maximizing level of output we have:

$$l = \frac{P - MR}{P} = \frac{P - P(1 - 1/e)}{P} = \frac{1}{e}$$

4. This is the two-firm quantity setting Cournot Duopoly.

5. HHI is the sum of the squared market share of each firm (expressed as a range between 0 and 100). So, the HHI for a monopolist is 10,000. We employ the Herfindahl-Hirschman Index as the sum of the squared market shares of each of the firms in the market (where market share is expressed as a fraction). The HHI is bound [0,1] with zero being the value calculated for the theoretical model of perfect competition and 1 the theoretical monopoly model. This provides the Index range bound under unity. These indices are functionally equivalent.

## References

- Bain, Joe S. "A note on pricing in monopoly and oligopoly" *American Economic Review*, 39, pp. 448-64.
- Baumol, William J., and Robert D. Willig. "Fixed costs, sunk costs, entry barriers, and sustainability of monopoly." *Quarterly Journal of Economics*, 95, pp 405-31.
- Carow, Kenneth A. and Glen A. Larsen "Bank Branching Laws as Determinants of Industry Concentration" *Southern Business and Economics Journal* October, 1998 pg 35-44
- Dansby, Robert E. and Robert D. Willig. "Industry Performance Gradient Indexes" *American Economic Review* v 69 no. 3, 1979, pp. 249-260.
- Davies, Brian and Paul Downward "Competition and Contestability in the UK Package Tour Industry: Some Econometric Observations" *Tourism Economics* vol 4(3) September 1998, pp. 241-51.
- Demsetz, Harold., "Industry structure, market rivalry , and public policy." *The Journal of Law and Economics*, 16, 1973, pp. 1-9.
- Dufwenberg, Martin and Uri Gneezy "Price Competition and Market Concentration: An Experimental Study" Tilburg Center for Economic Research Discussion Paper 9827, March 1998. pp. 20.
- Hannan, Timothy, H. "Bank Commercial loan markets and the role of market structure: Evidence from surveys of commercial lending." *Journal of Banking and Finance*, 15, 1991, pp. 133-149.
- Hicks, Michael J. "Entrance, Exit and Merger Activity in Tennessee's Banks: A Multivariate Analysis of Market Behavior and The Business Cycle, *Journal of the Tennessee Economic Association*, Fall 1999, forthcoming.
- Holtz-Eakin, Douglas, David Joulfaian and Harvey S. Rosen "Sticking It Out: Entrepreneurial Survival and Liquidity Constraints" *Princeton Industrial Relations Section Working Paper 319, July 1993.*

Mayo, J. W. and J. E. Flynn .*Firm Entry and Exit: Economic Linkages in Tennessee*, Center for Business and Economic Research, University of Tennessee, Knoxville, Tennessee. 1988.