SHOULD WE EXPECT LESS PRICE RIGIDITY IN THE DIGITAL ECONOMY?

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ABSTRACT
Price rigidity involves prices that do not change with the regularity predicted by standard economic theory. It is a topic of long-standing interest for firms, industries and the economy as a whole. As information technology (IT) changes the process by which strategic pricing decisions are made and implemented in business operations, there is a need to develop a more substantial managerial understanding of firm pricing in “production function” terms. In the 1990s, technology-driven pricing was largely the domain of the airlines, hotels and rental car companies, with the practice of revenue yield management. However, now it is possible for bricks-and-clicks firms, and even traditional retailers, to implement systems that permit significant adjustments to be made to prices in situations where menu costs previously made rapid price changes difficult to achieve in an economical way. So, we believe that the issue of price rigidity in the digital economy should be considered with a broader, more deeply insightful perspective.

This paper draws upon theoretical perspectives that are largely new to the field of Information Systems (IS), but that offer rich opportunities for theory building and empirical research in settings that will be of high interdisciplinary interest. Such interdisciplinary studies, we believe, will provide a distinctive foundation for IS research and serve as a guide to research for a variety of new economic phenomena in economies that are influenced by firm investments in Internet technology.

KEYWORDS: Economic analysis, electronic commerce, interfirm competition, information technology, Internet-based selling, Internet technologies, price rigidity, pricing strategy.

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I. INTRODUCTION

*Price rigidity*, the inability of firms to adjust prices, is important enough to occupy a central stage in the research agenda of new Keynesian macroeconomics (Ball and Mankiw, 1994; Blinder et al., 1998; Rotemberg and Saloner, 1987) and industrial organization (Carlton, 1989; Stiglitz, 1984). This is in stark contrast to the traditional assumption that firms flexibly adjust prices, which lies at the heart of classical economic models used in microeconomics, and in many areas of business such as finance, marketing, and strategy.

Information technology (IT) has changed the process by which strategic pricing decisions are made and implemented in business operations. As a result, there is a need to develop a more substantial managerial understanding of firm pricing in “production function” terms. In the 1990s, technology-driven pricing was largely the domain of the airlines, hotels and rental car companies, with the practice of revenue yield management. However, now it is possible for bricks-and-clicks firms, and even traditional retailers, to implement systems that permit significant adjustments to be made to prices in situations where menu costs previously made frequent price changes difficult to achieve in an economical way.

In this context, IT and Internet technologies also offer opportunities to inform our understanding of how rigid prices are and the nature of price adjustment in two fundamental ways. First, firms may adjust prices differently on the Internet than in traditional commercial settings, and being able to detect this kind of behavior may change our conventional wisdom about price rigidity. Many observers have commented that physical price adjustment costs (i.e., menu costs) are almost entirely absent in e-commerce because they primarily consist of the costs of simple database updates, which may be easily programmed (Bailey, 1998; Brynjolfsson and Smith, 2000). This suggests that Internet-based retailers have the capability through the intensive use of technologies to adjust prices more flexibly than traditional retailers, almost as in financial markets (e.g., foreign exchange and equity trading)—all pure supply and demand plays (Bergen et al., 2005). Second, the ability of IS researchers to collect transaction price data using software agents now offers the ability to explore price adjustment patterns at a level of microeconomic detail that was previously unimaginable (Allen and Wu, 2004; Kauffman and Wood, 2003). Although this kind of data has been used to study other aspects of pricing, such as price dispersion (e.g., Bailey, 1998; Clay et al., 2001; Clemons et al., 2002; Lee, 1998), price levels
(e.g., Brynjolfsson and Smith, 2000; Clay et al., 2002a) and price-setting behavior (e.g., Clay et al., 2002b; Kauffman and Wood, 2004), there are still only a few studies that have focused on price adjustment and price rigidities in e-commerce (Bergen et al., 2005; Kauffman and Lee, 2004a, 2004b; Oh and Lucas, 2004). Most empirical evidence shows lower price levels and the failure of the “one price” Bertrand price competition that is predicted in electronic markets. Table 1 summarizes selected empirical research on strategic pricing in e-commerce environments.

Table 1. Empirical Research on Price Dispersion, Price Levels and Price-Setting

<table>
<thead>
<tr>
<th>Research</th>
<th>Period</th>
<th>Data</th>
<th>Findings</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Lowest prices in pure Internet retailers</td>
</tr>
<tr>
<td>Bailey (1998)</td>
<td>1997/02–1997/03</td>
<td>Prices of books, CDs, and SW sold online and offline</td>
<td>□ Price dispersion not less online.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>□ Higher prices online</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>□ Lower prices online</td>
</tr>
<tr>
<td>Brynjolfsson and Smith (2000)</td>
<td>1998/02–1999/05</td>
<td>Prices of books and CDs sold online and offline</td>
<td>□ Less price dispersion online</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Lower prices online</td>
</tr>
<tr>
<td>Clay et al. (2001)</td>
<td>1999/08–2000/01</td>
<td>Prices of books sold online</td>
<td>□ Less price dispersion online</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>□ Competition led to lower prices</td>
</tr>
<tr>
<td>Clay et al. (2002a)</td>
<td>1999/08–2000/01</td>
<td>Prices of books sold online</td>
<td>□ Timing and direction of price changes correlated across firms</td>
</tr>
<tr>
<td>Clemons et al. (2002)</td>
<td>1997/04</td>
<td>Prices for online airline tickets</td>
<td>□ More price dispersion online</td>
</tr>
<tr>
<td>Kauffman and Wood (2004)</td>
<td>2000/02–2000/03</td>
<td>Prices of books and CDs sold online</td>
<td>□ Evidence of follow-the-leader pricing online</td>
</tr>
<tr>
<td>Lee (1998)</td>
<td>1986–1995</td>
<td>Prices of used cars in offline and online auctions</td>
<td>□ Higher prices in online auctions</td>
</tr>
<tr>
<td>Morton et al. (2001)</td>
<td>1999/01–2000/02</td>
<td>Prices of cars sold online and offline</td>
<td>□ Less price dispersion online</td>
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<td></td>
<td></td>
<td></td>
<td>□ Lower prices online</td>
</tr>
<tr>
<td>Pan et al. (2001)</td>
<td>2000/11</td>
<td>Prices of books, CDs, electronics sold online</td>
<td>□ More price dispersion online</td>
</tr>
<tr>
<td>Tang and Xing (2001)</td>
<td>2000/07–2000/08</td>
<td>Prices of DVDs sold online and in other channels</td>
<td>□ Less price dispersion online</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>□ Lower prices online</td>
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</table>

With the new retailing activities on the Internet, we expect to see changes that reflect different technological underpinnings of the firm’s production process for prices (Dutta et al., 2003). Not only do the new technologies far surpass the capabilities that are available in traditional bricks-and-mortar stores to adjust their own prices (Kauffman and Lee, 2004a) and
track competitors’ prices (Kauffman and Wood, 2004), they provide the basis for consumers to make to-the-cent price comparisons (Bakos, 1998). The reduction in search costs for attractive prices and bargains is accompanied by opportunities for sellers to implement algorithmic price discrimination approaches, to segment customers based on customer relationship management systems information and new data mining techniques. It is natural, then, that Internet-based firms will create new ways to set prices in e-commerce.

However, we believe that the issue of price rigidity on the Internet should be given more scrutiny than the literature has provided to date. There may be factors that can explain the price-changing behaviors that Internet-based firms demonstrate other than menu costs. For example, there still seems to be a role for market forces to play in price adjustment—even for Internet-based firms. For example, firms may make use of non-price elements, such as customer service, product information, reputation, or free shipping, instead of price adjustments (Kauffman and Lee, 2004b). In addition, certain price points may be observed (e.g., 99¢)—even on the Internet—due to consumers’ rational inattention to the last digit of the price, and sellers’ interest to exploit their decision-making behavior (Bergen et al., 2004; Levy et al., 2004). Furthermore, there may be differences in price adjustment tactics that are observed for different firms relative to the different products (Bergen et al. 2005). Similar explanations may also occur at the level of industries, as well as within or between sales channels.

With this concern about the pervasive expectation of declining price rigidity on the Internet, information systems (IS) researchers such as ourselves have an important opportunity to address research questions from the unique perspective of our academic field:

□ Should we expect less price rigidity in e-commerce compared to traditional, non-Internet channels?
□ Are there any differences in price changing-behaviors within and between products, channels, and industries?
□ In addition to the menu cost explanation, what other theories can explain what we observe, and why?

To answer these questions, we draw upon perspectives that are largely new to the IS field, but offer rich opportunities for theory-building and empirical research in settings that will be closely-related to IS research. We believe that the previous IS literature has failed to identify the central role of IT in the marketing function to explain the rigidity of prices on the Internet.
Instead, it has offered only very limited explanations, such as the menu cost explanation (Brynjolfsson and Smith, 2000; Bailey, 1998) and tacit collusion (Kauffman and Wood, 2004). Although this work has been both commendable and innovative in its efforts to open up a meaningful dialogue between Marketing and IS, from a theoretical perspective, it also has been limited in its scope. We have been making an effort to achieve progress and deepen this dialogue by develop our thinking in the context of IS and e-commerce. We have been pursuing a number of theories of price rigidity drawn from IS, economics, psychology, and marketing. Also, from an empirical perspective, and likely due to the difficulty of measuring the extent of price rigidity directly, only a few studies have attempted to provide empirical evidence for explanatory theories from marketing and economics. However, data collection software agents now offer new capabilities to explore price-related information on the Internet, since online retail prices can be sampled in a manner that yields almost identical information as scanner data analysis on transaction prices which consumers pay at the cash register in traditional channels. We provide additional commentary on a revolutionary new empirical research approach that Kauffman and Wood (2003) have called the massive quasi-experimental data mining method, which employs time-series data to examine price adjustment patterns and price rigidity on the Internet, and other related phenomena. Taken together, we believe that such interdisciplinary studies have the potential to provide a distinctive foundation for IS research and can also serve as a guide to research on other economic phenomena in e-commerce.

The remainder of this paper is organized as follows. We first present a detailed, broad-based literature review from the perspectives of economics, psychology, and marketing that help to position this work with respect to strategic pricing in marketing as an important new direction for IS research. Then, we present new ways for IS researchers to understand price rigidity and price adjustment on the Internet based on the interdisciplinary theories. Specifically, we propose a research framework to examine different theories on price rigidity and develop a new theory to explain the observed empirical regularities of firms’ price-changing strategies on the Internet. Finally, we draw conclusions based on our assessment of the proposed theory and new empirical research methodology opportunities, and discuss a number of implications of our study for future IS research. With this research, we establish a new perspective for IS research: the newly-important central role of IT in terms of strategic pricing on the Internet, and the need for IS researchers to seize the opportunity to create new knowledge that pertains to it.
II. PRICE RIGIDITY THEORIES IN ECONOMICS AND MARKETING

For IS researchers to appreciate the new opportunities that we have with respect to the study of IT-driven phenomena in strategic pricing in the marketing function, it is necessary for us to accept the fact that we need to master the vast, theoretically complex and methodologically mature literature on price rigidity and price adjustment in economics and marketing. Price rigidity is an essential component of new-Keynesian economic and macroeconomic theory. Economists refer to this as the economics of nominal rigidities (Andersen, 1994; Blinder et al., 1998). Some other terms are also used, including price inertia, price stickiness, and price inflexibility. Rigid prices occur when prices do not adequately change in response to underlying cost and demand shocks. Once set, prices often remain unchanged, in spite of changes in the underlying conditions of supply and demand. Price rigidity has the potential to prevent Walrasian market clearing that leads to equilibrium in supply and demand and market inefficiency (Carlton and Perloff, 2000).

An early influential study of price rigidity was conducted by Means (1935), who found that some prices are “administered,” and consequently, are insensitive to the fluctuations of supply and demand. Subsequently, a wide range of partial equilibrium theories, such as those based on price adjustment costs, market interactions, asymmetric information, and demand and contract-based explanations have been proposed to obtain a reading on why price changes might be sluggish. They provide a basis for the macroeconomic assumptions of rigid prices (Andersen, 1994; Blinder et al., 1998). Table 2 shows brief descriptions on these price rigidity theories.

Table 2. An Overview of the Multiple Theories of Price Rigidity

<table>
<thead>
<tr>
<th>THEORIES</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Cost of Price Adjustment</td>
<td>Changing prices is costly; prices unchanged even with changes in supply and demand.</td>
</tr>
<tr>
<td></td>
<td>□ Menu Cost: Firms face a lump sum cost whenever they change their prices.</td>
</tr>
<tr>
<td></td>
<td>□ Convex Adjustment Cost: The costs of changing prices rise at an increasing rate.</td>
</tr>
<tr>
<td></td>
<td>□ Managerial Cost: Time and attention required by managers for price decision making slow down price changes.</td>
</tr>
<tr>
<td></td>
<td>□ Synchronization and Staggering: Stores tend to change the price of different products either together or independently.</td>
</tr>
<tr>
<td>Market Structure</td>
<td>Monopoly power (or a limited number of sellers) as well as coordination failure in markets are the primary sources of price rigidity</td>
</tr>
<tr>
<td></td>
<td>□ Industry Concentration: The sluggishness of price changes is a demonstration of monopoly power.</td>
</tr>
<tr>
<td></td>
<td>□ Coordination Failure: Absence of an effective coordinating mechanism for market clearing is the cause of the price rigidity.</td>
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THEORIES

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<tr>
<th>THEORIES</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>Asymmetric Information</strong></td>
<td>The fact that one party to a transaction has more information provides an explanation.</td>
</tr>
<tr>
<td>□ Price as Signal of Quality: Firms are reluctant to lower prices for fear that their customers may misinterpret price cuts as reductions in quality.</td>
<td></td>
</tr>
<tr>
<td>□ Search and Kinked Demand Curve: Customer search costs lead to firms facing a kinked demand curve.</td>
<td></td>
</tr>
<tr>
<td><strong>Demand-Based</strong></td>
<td>Firms react to other changes than price changes: inventories, non-price competition.</td>
</tr>
<tr>
<td>□ Procyclical Elasticity of Demand: Demand curves become less elastic (responsive) to price changes as they shift in.</td>
<td></td>
</tr>
<tr>
<td>□ Inventories: Inventories are used by firms to buffer demand shocks.</td>
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<tr>
<td>□ Psychological Pricing: Prices have the tendency to be stuck at certain ending prices.</td>
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<tr>
<td>□ Non-Price Competition: Instead of price competition, firms use non-price elements such as delivery lags, service, or product quality.</td>
<td></td>
</tr>
<tr>
<td><strong>Contract-Based</strong></td>
<td>Prices remain unchanged by nominal or implicit contracts.</td>
</tr>
<tr>
<td>□ Explicit Contracts: Prices are fixed for limited time periods under nominal contracts.</td>
<td></td>
</tr>
<tr>
<td>□ Implicit Contracts: As price changes may antagonize customers, implicit agreements between firms and customers are used to stabilize prices.</td>
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THEORIES OF PRICE ADJUSTMENT COST

One explanation for price rigidity is based on theories of price adjustment cost: it is costly for firms to change prices (Blinder et al., 1998; Carlton, 1989). A profit-maximizing firm facing price adjustment costs will change its prices less often than an identical firm without such costs. They include the real costs associated with price changes: printing new catalogs, new price lists, new packaging, etc; informing sales people and customers; obtaining sales force cooperation; antagonizing customers resulting in lost future sales; and spending the time and obtaining the attention required of managers to gather and process the relevant information and to make and implement decisions (Blinder et al., 1998; Levy et al., 1997). An important aspect of price adjustment cost is its relationship with the magnitude of the price change (Zbaracki et al., 2004). The previous literature shows that price adjustment costs are, in general, modeled in one of two ways: in a menu cost model or using a convex adjustment cost model (Blinder et al., 1998; Carlson, 1992).

*The Theory of Menu Costs*

*Menu cost theory* assumes that the cost of price adjustment is a fixed cost that must be paid whenever a price is changed, and thus, is independent of the magnitude of the price change (Andersen, 1994; Barro, 1972; Blinder et al., 1998; Sheshinski and Weiss, 1977). Menu costs drive firms to make relatively large and infrequent price changes, and thus make prices less
flexible by deterring recurrent price changes (Blinder et al., 1998; Zbaracki et al., 2004).

Interestingly, however, prior to the studies by Mankiw (1985) and Akerlof and Yellen (1985),
menu costs were thought to be too small to rationalize any substantial effects of price rigidity.
Mankiw (1985) states that in monopoly competition a firm’s increased return from changing
prices is smaller than the increased social welfare. So prices may not change—even with
inefficient allocations. Introducing real rigidities in the face of aggregate demand shocks, Ball
and Romer (1990) argue that even with small costs of nominal price changes firms do not change
their prices and real prices remain unaffected. Fluet and Phaneuf (1997), using a model where
the production technology in the monopolistic firm is endogenous to the menu cost, claim that
price adjustment costs have the same effect as an increase in the randomness of demand.

Testing menu cost theory directly has been hard due to the lack of cost-related data
(Blinder et al., 1998). In many settings, the costs of collecting such data would be prohibitive.
So, empirical studies have used *indirect proxies* (e.g., frequency of price changes and time
between changes) to provide evidence supporting this theory (Levy et al., 2002). Liebermann
and Zilberfard (1985), using data obtained from Israeli food retail chains, examine three possible
price adjustment strategies in a highly inflationary situation: cost minimization (i.e., menu cost),
market power (i.e., industry concentration), and institutional (customer antagonization)
approaches. However, they do not find any empirical evidence that supports these three
approaches. Using data on actual transactions prices, Carlton (1986) finds that the fixed cost of
price adjustment differs across buyers and sellers. Cecchetti (1986) analyzes the frequency and
size of price changes in the newsstand magazines and shows that higher inflation causes more
frequent price changes and price adjustment costs are not fixed; instead they vary with the size of
real price changes. Kashyap (1995) notes that, for twelve selected retail items sold through
catalogs over 35 years, heterogeneity exists in both frequency and amount of price changes.
Wilson (1998) finds large price rigidities in the short run in a static experimental study of the
effects of menu costs. Slade (1999), in her study on pricing of a single product by grocery
stores, provides some estimates of the implied price adjustment cost magnitude. Studies
involving gasoline (Borenstein et al., 1997) and bank deposit rates (Hannan and Berger, 1991;
Jackson, 1997) show the evidence of asymmetric price adjustment, in which retail prices respond
more quickly to input price increases than decreases. Based on survey data from New Zealand
businesses, Buckle and Carlson (2000) assert that larger firms change price more often than
smaller firms due to the menu costs, which fall systematically as firm size increases. On the
other hand, Powers and Powers’ (2001) analysis on price data from grocery stores shows
symmetric pattern in both frequency and size of price changes for price rises and declines.

To directly measure menu costs, Levy and his colleagues (Dutta et al., 2002; Dutta et al.,
1999; Levy et al., 1997; Levy et al., 2002; Levy et al., 1998) take into account four components
of menu costs: the labor cost of changing grocery shelf prices; the cost of printing and delivering
new price tags; the cost of mistakes made during the price change process; and the cost of in-
store supervision of price changes. They find non-trivial costs of price adjustments for large
food and drugstore chains and point out that prices are less flexible in response to cost shocks
that are smaller and less persistent, and for cost shocks about which market participants have less
information.

Convex Adjustment Cost Theory

Convex adjustment cost theory assumes that the cost of changing prices is convex and
quadratic, increasing in the size of the change. Convex adjustment costs tend to discourage large
price changes and lead to relatively small, frequent partial price adjustments that move toward a
target price level (Andersen, 1994; Blinder et al., 1998; Carlson, 1992). Rotemberg (1982a and
1982b) combines the microeconomic model of gradual price adjustment with a simple
macroeconomic model in which the money supply drives aggregate demand. By introducing a
model of monopoly firms with quadratic price adjustment costs, Rotemberg asserts that it is
more expensive to make a large change than several smaller changes of the same total
reports that a large percentage of firms leave their prices unchanged and make larger, more
frequent price changes when inflation is higher. Zbaracki et al. (2004) find that the managerial
and customer parts of the price adjustment costs are convex, while the physical costs of price
adjustment, such as the costs related to printing and distributing new catalog and new price lists,
and notifying suppliers, are non-convex. Why? The decision and internal discussion costs, as
well as customer negotiation costs, are higher for larger price changes. Blinder et al. (1998)
argue that while the quadratic cost assumption may be in doubt, it is not unreasonable. However,
some empirical studies show evidence that is consistent with the menu cost model rather than the
convex cost model (Blinder et al., 1998; Carlson, 1992; Levy et al., 1997).
The Theory of Managerial Costs

Managerial costs, also called decision costs (Sheshinski and Weiss, 1992), are defined as the managerial time and effort dedicated for relevant information gathering and the price decision-making (Ball and Mankiw, 1994; Blinder et al., 1998; Carlton, 1997; Levy et al., 1997). The theory of managerial costs (also called hierarchy theory) assumes that firms cannot change their prices promptly in response to changes in the firm’s economic situation if many individuals’ decisions in a hierarchical organization are required to process a price change (i.e., many levels of authorization) (Bergen et al., 2003; Blinder et al., 1998). Both (physical) menu costs and managerial costs give rise to price adjustment barriers within a firm (Bergen et al., 2003; Zbaracki et al., 2004) though some consider managerial cost a special kind of menu cost (Blinder et al., 1998).

Sheshinski and Weiss (1992) distinguish managerial costs from menu costs as the more critical component by arguing that these costs induce price staggering by firms. Mankiw and Reis (2002) incorporate managerial costs into a formal macroeconomic model, called the sticky information model. The model assumes that the costs of information gathering and processing lead to slower information acquisition and price adjustment. Through the direct measurement of the size of the managerial and customer costs in a single large manufacturing firm, Zbaracki et al. (2004) analyze several types of managerial and customer costs, including costs of information gathering, decision-making, negotiation, and communication. They find that the managerial costs are over six times the menu costs associated with changing prices.

The Theory of Price Synchronization and Price Staggering

New-Keynesian macroeconomists assume that firms change prices step-by-step over time in a process that is called price staggering. Not all firms change them simultaneously. For example, some used price synchronization, the process of aligning strategic price changes in time, instead. In oligopolistic markets, each firm takes into account the actions of its competitors, and thus pricing policies will be interdependent, preventing the firm from changing its own products’ prices (Lach and Tsiddon, 1996; Sheshinski and Weiss, 1992; Taylor, 1980).

Blanchard (1982) argues that staggered price-setting leads to inertia in the aggregate price level. Staggering and synchronization are also proposed by Ball and Cecchetti (1988), who develop a model in which firms have imperfect information of the current state of the economy and obtain information by observing the prices set by others. This gives each firm an incentive
to set its price shortly after other firms set theirs. Ball and Romer (1989) state that staggered price-setting has the advantage in that it permits rapid adjustment to firm-specific shocks, but the disadvantages include unwanted fluctuations in relative prices. By creating price-level inertia, staggering price-setting can increase aggregate fluctuations. Sheshinski and Weiss (1992) study optimal pricing strategy for a multiproduct monopolist when the timing of price adjustment is endogenous. They argue for a further source for interdependence, namely, increasing returns in the costs of price adjustment (i.e., economies of scope). They observe that pricing decisions are influenced by interactions in the profit function between the prices of the products and the nature of menu or decision costs. So, synchronization is induced when there are positive interactions between prices in the profit function and menu costs, where the cost of changing prices is independent of the number of products. Similarly, the price change process should be staggered over time under negative interactions in the profit function, and decision costs, where the cost of changing prices is proportional to the number of products (i.e., constant returns to scale).

There are few empirical studies because much of the work on price rigidity has primarily concentrated on single product firms (Fisher and Konieczny, 2000). Lach and Tsiddon (1996), using multiproduct pricing data from Israeli retail stores, find that price changes of the same product are staggered across firms (across-store staggering) while the price changes of different products are synchronized within the same firm (within-store synchronization). Fisher and Konieczny (2000), in their empirical work on Canadian newspapers, present evidence of synchronization within the same firm, as well as staggering across independent firms in price-setting of newspapers.

THEORIES BASED ON MARKET STRUCTURE

In industrial economics, it is commonly noted that the sluggishness of prices to demand is basically a demonstration of market power (Okun, 1981). For example, a duopoly with fixed costs of price adjustment is more flexible in price changes than a monopoly under certain conditions (Rotemberg and Saloner, 1987). In many industries, pricing strategies are interdependent because each firm takes into account the actions of its competitors. Without an effective coordinating mechanism (e.g., an intermediary) for market clearing, each firm hesitates to change prices until other firms move first, and thus prices may remain fixed (Blinder et al., 1998).
The Theory of Industry Concentration

Economists have emphasized monopoly power or a limited number of sellers in markets as the primary cause of price rigidity or inflexibility (Dixon, 1983; Ginsburgh and Michel, 1988; Qualls, 1979). Due to the difficulty in measuring the competitive conditions in a given market, most of the studies have focused on a proxy measure for market competitiveness, especially industry (or market) concentration (e.g., Herfindahl index), which iteratively measures what share of a market is held by the first x-number of the largest firms (Tirole, 1988). It provides a rudimentary indicator of the extent of monopoly power. Numerous studies have investigated the theory of industry concentration and have generated three different observations on the relationship between the degree of industry concentration and price rigidity: a positive relationship, a negative relationship, and no significant relationship.

The notion behind a positive relationship is that highly-concentrated industries behave as oligopolies with attendant problems of pricing coordination. An oligopolistic firm expects its competitors to react differently to a price increase and decrease. Although a price decrease will be followed, a price increase will not be followed (Qualls, 1979; Sweezy, 1939). Another explanation for this relationship is limit pricing (i.e., pricing to prevent entry), where firms in concentrated industries are able to enjoy increasing returns to scale (i.e., economies of scale), and thus they tend to keep their prices lower than they otherwise would in order to discourage or delay new firm entry (Stiglitz, 1984). Rotemberg and Saloner (1987), in a comparison of monopoly and duopoly markets, develop a theoretical explanation of market power for price rigidity, showing that firms in less competitive markets change prices less often. Ginsburgh and Michel (1988) find a negative link between the degree of industry concentration and the speed of quantity adjustment in an oligopolistic industry with quadratic cost functions.

The studies that suggest the existence of a positive relationship show that highly concentrated industries behave as oligopolies with price coordination problems. Carlton (1986) reports a positive relationship between rigid prices and the degree of industry concentration: the more highly concentrated an industry, the less rapidly will cost variations be transmitted into prices. Hannan and Berger (1991) find evidence from the banking industry of a significant positive relationship between industry concentration and price rigidity, and limited level of asymmetric behavior. Neumark and Sharpe (1992), using panel data on bank deposit behavior,
find an asymmetric relationship between industry concentration and price rigidity: downward price rigidity and upward price flexibility in concentrated markets.

The justification for a negative relationship between industry concentration and price rigidity, as claimed by Stigler (1964), is that it is easier for other competitors to identify secret price cutting when there exist fewer number of firms in an industry. Thus, firms avoid the secret cutting of prices. Domberger (1979), in his study on 21 industries using the Herfindahl index of concentration, shows a negative relationship between price rigidity and industry concentration. Powers and Powers (2001), analyzing grocery store price data, find that higher degrees of industry concentration lead to frequent and large price changes.

The third perspective of no significant relationship between industry concentration and price rigidity is based on the argument that industrial concentration is not a key determinant of industrial pricing behavior. Without perfect monopoly or explicit pricing collusion, firms tend to behave as price competitors and the degree of industrial concentration is inconsequential (Qualls, 1979). Starting with a slightly adapted version of the model from Ginsburg and Michel (1988), Worthington (1989) demonstrates the possibility of an uncertain relationship between industry concentration and pricing behavior. Higher industry concentration may result in an increase, a decrease, or no change in price rigidity. Dixon (1983), using Australian economic data, reports no significant relationship between industry concentration and price rigidity. Jackson (1997), using rational distributed lag and price adjustment models, provides empirical evidence of a non-monotonic relationship between industry concentration and price rigidity.

**The Theory of Coordination Failure**

*Coordination failure theory* states that the inability of firms to plan and implement pricing is due to externalities or a lack of coordination mechanism that may affect firms in different ways. Potential coordination failures can be explained by many sources of heterogeneity among firms, such as differences in relative size, cost structure, product differentiation, and information (Tirole, 1988). A recent study by Blinder et al. (1998) suggests two kinds of solutions to such coordination problems: price leadership and implicit collusion. He finds coordination failure theory to be the most revealing, ranking first in his list of theories.

Several studies on coordination failure have characterized firms’ pricing behavior in markets of imperfect competition by *price leadership* (Rotemberg and Saloner, 1990; Tyagi, 1999). Price leadership occurs when one of the firms in an industry sets the price or announces a
price change, and the other firms then take the price as given. The price leadership model is solved just like the Stackelberg model (i.e., a leader-follower model), where one firm, the Stackelberg leader, can commit to its output first, and then, the second mover, the Stackelberg follower, produces its quantity knowing the output of the leader. Applying the Stackelberg model in pricing patterns of firms, Tyagi (1999) proposes the Stackelberg pricing model, which shows leader-follower pricing behavior in markets. The kinked demand curve (Hall and Hitch, 1939; Sweezy, 1939), the classic explanation for price rigidity in oligopolistic industries, explains the firm’s reluctance to cut prices because competitors match price reductions and consequently the first firm cannot gain market share. In the case of cost increases affecting several rival firms, each individual firm may be unwilling to remain the price leader out of fear that its competitors will not follow and the firm will then lose their market share (Blinder et al., 1998; Okun, 1981). Without a price leader to efficiently coordinate price changes, therefore, prices may remain unchanged.

Another explanation for the coordination failures is based on firms’ implicit collusion. Chamberlin (1929) argued that oligopolistic firms can maintain the monopoly price by cooperating with their competitors even without a formal agreement to avoid intense price competition. However, such collusion can be very difficult to sustain in the following situations: when large business fluctuations occur (e.g., boom and bust cycles), in the presence of minimal punishment for collusion, when large gains from cheating at possible, and when detection lags make it difficult to apprehend the transgressors (Blinder et al., 1998; Rotemberg and Saloner, 1986; Stiglitz, 1984; Tirole, 1988). Stiglitz (1984) argues that firms’ collusive agreements are non-cooperative equilibria which lead to price rigidities. Rotemberg and Saloner (1986), offering a supergame-theoretic model of oligopolistic behavior during booms, point out that collusion is more difficult to sustain because the gain from defection increases in current demand, while the loss from punishment increases in future demand.

Cooper and John (1988) propose that strategic complementarity in prices will lead to multiple equilibria that are superior to low-activity equilibria. So an agent’s optimal level of price flexibility will depend positively on other agents’ strategies. Ball and Romer (1991), by combining this notion of strategic complementarity with menu costs in deciding prices under imperfect competition, show that price flexibility in one firm encourages other firms to make their prices flexible. Andersen (1994) also argues that strategic complementarity between the
prices charged by different firms can increase the price rigidity. According to the collusion theory, therefore, prices could be rigid because there may be incentives for firms to sustain prices at higher levels through implicit agreements.

THEORIES OF ASYMMETRIC INFORMATION

Asymmetric information theory assumes that one party to a transaction (e.g., a firm) is better informed than the other (e.g., a customer). It gives new insights about why market failures such as price rigidities occur (Blinder et al., 1998). Stiglitz (1979) argues that under asymmetric information customers tend to transact with firms providing relatively stable price paths and avoid firms which make frequent and/or large price adjustments. Since the theory always involves unobserved information, such as product quality and search costs, there are few empirical studies to explain the causes of price rigidity (Blinder et al., 1998). Under asymmetric information, customers tend to transact with firms providing relatively stable price paths and avoid firms which make frequent and/or large price adjustments (Stiglitz, 1979). We next consider several related theories.

The Theory of Quality Signaling

With many products, it is difficult for customers to observe quality even at the time of purchase because they are imperfectly informed about the product characteristics (Stiglitz, 1984 and 1987). Most people typically believe that higher-priced products are of higher quality. Thus, firms may have an incentive to sell low quality items at high-quality prices, and the products will be traded at a price which reflects their customers’ beliefs about the average quality of the products (Riley, 1989). The theory of quality signaling assumes adverse selection (Akerlof, 1970), where firms are reluctant to decrease prices in economic recessions for fear that customers may incorrectly interpret the lowering of prices as a signal that the product quality has been reduced (Blinder et al., 1998). But if cutting prices is interpreted as a quality reduction, then demand may actually decrease rather than increase (Stiglitz, 1984). This theory, however, appears only to be relevant for the luxury product market (e.g., automobiles), or perhaps certain niche markets for clothes or food. It is not of widespread importance for most products. Allen (1988) proposes a formal model of price rigidities based on the idea that the variations of unobservable quality make prices inflexible as long as demand shocks are sufficiently serially
correlated. In Blinder et al.’s survey (1998), this theory is the least significant because the quality differences on which this theory is based are unobservable.

**The Theory of Search and Kinked Demand**

Since Stigler (1961)’s inventive work on search theory, a number of studies have analyzed the impact of search costs and asymmetric information on price rigidity. They argue that search is costly to customers (Stiglitz, 1999) and a firm’s price changes are observed by the firm’s current customers, but not by other customers due to the search costs (Ball and Romer, 1990; Stiglitz, 1979). If the firm raises its price by more than its customers expect, it may lose customers. Why? Because its regular customers instantaneously recognize the price change and search for other sellers with more attractive prices. If the firm lowers its price, on the other hand, it sells more to current customers but does not attract new customers due to search costs (i.e., they do not observe the lower price without search) (Stiglitz, 1987 and 1999). Thus, this theory assumes that search costs make the demand curve more inelastic for price decreases than for price increases. As a result, firms will face *kinked demand curves*: the returns from price decreases may be less than the sales loss from price increases.

**DEMAND-BASED THEORIES**

We next consider price rigidity theories, which explain how firms react to demand fluctuations other than price changes: procyclical elasticity, inventories, psychological pricing, and non-price competition.

**Theory of Procyclical Elasticity of Demand**

Firm-level price-changing behavior over the business cycle necessitates that consideration be given to the roles of demand and supply shocks in the causes of business cycles (Blinder et al., 1998). When economic fortunes wane, some companies may go out of business. Others may lose their least loyal customers, but retain their most loyal ones. If the number of companies falls significantly, this may increase the remaining companies’ ability to coordinate their prices, reducing price competition. In addition, companies will not reduce prices because the remaining customers may be insensitive to price changes (Blinder et al., 1998). This trend is known as *procyclical elasticity of demand*. It explains why the responsiveness or elasticity of prices to changes in demand may be dampened in a cyclical downturn. Stiglitz (1984) argues that prices become invariant across the business cycle even in the presence of a decline in the
marginal costs of production. This is because anti-cyclical price markups may increase even if the elasticity of demand decreases (Bils, 1987; Blinder et al., 1998).

Warner and Barsky (1995) find strong empirical evidence of procyclical elasticity of demand just prior to the Christmas holidays and also on three-day weekend holidays. These are times when consumers are engaged in more intense shopping or search activities. This phenomenon is also called as the thick market effect. The idea is that firms have a somewhat counterintuitive tendency to charge lower prices during periods of peak demand (which contradicts the high demand $\Rightarrow$ high price rule). This illustrates the will of firms to compete more aggressively on the basis of prices in markets with high demand, when there are also significant opportunities to generate revenues and earn a profit based on a high volume of sales. Chevalier et al. (2003) provide contradicting evidence that prices do not fall during Thanksgiving or Christmas holiday seasons, however. Instead, they find significant procyclical pricing patterns over seasonal cycles due to retail margin changes, which is consistent with retailers’ “loss-leader” strategies for competition. Loss-leader advertising, for example, is a strategy in which retailers offer a big discount in order to attract customers for future profits.

**The Theory of Inventories**

Achieving the right level of inventory is a key success factor for businesses and their supply chain management activities. The level of inventory must be sufficient to meet consumer demand but also be low enough to minimize storage costs. Economists have considered inventories as buffers or inter-temporal substitutes which companies use to smooth fluctuations in demand and production (Blinder et al., 1998; Okun, 1981). The theory of inventories asserts that firms use inventories rather than price changes to cushion demand shocks. When demand falls (or rises), firms increase (or draw down) their inventories rather than decrease (or increase) prices (Blinder et al., 1998). The degree of price smoothing caused by inventories depends upon whether the demand shocks are perceived as short-run or long-run shocks (Blinder et al., 1998). Firms are more likely to use inventory adjustments for temporary changes of demand. With permanent changes of demand though, real price changes are inevitable.

Amihud and Mendelson (1983) find that the degree of price flexibility and asymmetric price responses by firms to economic shocks is explained by the relationship between the cost of holding positive inventory and negative inventory (i.e., backlog). Irvine (1980) shows that a short-run inventory-based pricing policy is observed in retail department stores: the price is
above (below) its equilibrium level when the inventory is below (above) its optimal level. Borenstein et al. (1997) find that there may be temporary asymmetries in the adjustment of spot gasoline prices to spot crude oil prices due to production and inventory adjustment lags.

**The Theory of Psychological Pricing Points**

One of the recent additions to the list of theories of price rigidity is Kashyap’s (1995) *psychological pricing point theory*, which builds on work in both economics and marketing. A nine-ending price is a good example of a price point, for example $9.99 or $279.99. This theory offers an explanation of price rigidity based on the idea of *rational inattention* (Sims, 2003). This theory has been referred to with different labels, such as thinking costs (Shugan, 1980), reoptimization costs (Roufagalas, 1994), information processing costs (Sims, 1998), and information gathering costs (Ball and Mankiw, 1994). Kashyap (1995) argues that pricing managers attach great psychological importance to the price point thresholds. He shows that catalog prices tend to have rigid ending prices. Blinder et al. (1998) also provide evidence on the importance of pricing points. They find that 88% of firms in the retail industry and 47% of firms in non-retail industries report some importance of psychological price points in their pricing decisions.

As Blinder et al. (1998) note, however, there are two difficulties with pricing point theory. First, not much is known on the practical importance of psychological threshold pricing. Second, no satisfactory economic explanation has been offered for pricing point theory. To fill this gap in the literature, Levy et al. (2004) explore the empirical relevance of pricing points in the United States retail food industry. They find that more than 65% of prices are observed to end in 9¢, and among those, the most prices end in 99¢ (e.g., $9.99). They argue that it may be rational for consumers to be inattentive to the rightmost digits. They often face large amounts of costly and hard-to-process information but are constrained by time, resources, and information processing constraints. Since many consumers ignore the last digit in the price, firms have an incentive to make the last digit as large as possible (i.e., equal to 9¢ or $9).

**The Theory of Non-Price Competition**

Prices are generally considered the primary means for market clearing and resource allocation in economics (Carlton and Perloff, 2000). Price competition occurs when a seller emphasizes the lower price of a product and sets a price that matches or beats the competitors’
prices. However, firms hesitate to cut prices in times of reduced demand out of fear that customers will misinterpret any price cut as a reduction in quality (Blinder et al., 1998). Carlton (1989) points out that markets often clear through means other than price. He views price as only one of many dimensions of the terms on which products are exchanged. *Non-price competition*, thus, can be used most effectively when a seller can make its product stand out from the competition by enhancing product quality, setting delivery lags (i.e., the lag between order placement and shipment), stressing customer service, conducting promotional efforts, expanding advertising expenditures, etc.

Carlton (1983) views delivery lags as one of means for market clearing, which determines market demand. For example, in response to an increase in demand, prices may remain relatively unchanged, but consumers may have to wait a little longer for delivery. Thus, he argues that many markets may have instability in delivery dates but only small fluctuations in price. Blinder et al. (1998) also state that firms are willing to decrease (increase) delivery lags or provide more (less) customer services rather than cut (raise) prices when demand is low (high). Zbaracki et al. (2004) argue that any price change that does not make sense for the customer can cause customer antagonism, which damages customer perceptions of the firm’s reputation, integrity, and reliability. Consumers generally are less antagonized by changing non-price aspects of goods or services than by changing their prices.

Non-price competition seems to be especially prevalent where firms perceive that there are implicit long-term contracts with their customers that help to stabilize prices, and where firms believe that their customers judge quality by price (Blinder et al., 1998; Okun, 1981). Thus, prices may appear rigid if other variables are also used to clear markets (Blinder et al., 1998; Carlton, 1983).

**CONTRACT-BASED THEORIES**

*Contract-based theories* provide an explanation of rigid prices in the context of transactions between firms and customers who enter into either explicit or implicit contracts that fix prices over a given period. Such contracts may provide insurance against uncertainty or risk in market conditions by delivering stable prices (Blinder et al., 1998). However, there is relatively little work on the contract-based explanation because the explanatory variables are either unobservable by traditional methods or unobserved in practice (Renner and Tyran, 2003).
The Theory of Explicit Contracts

Most firms that trade goods and services (e.g., labor) have nominal contracts that fix prices for finite periods of time to avoid uncertainties or transaction costs (Carlton, 1979). *Explicit contract theory* assumes that prices are not free to adjust to either demand or cost shocks under written contracts. Thus, firms cannot raise prices for existing customers without any contract renegotiation, even with cost shocks or demand shocks. Carlton (1979) examines the relationship between price changes and contracts of different durations (i.e., short-term and long-term) in industrial purchases and finds that the two prices move in the same direction—but by different magnitudes—in response to supply shocks. Hubbard and Weiner (1992) also analyze the role of contracts in industrial product markets (i.e., copper) and argue that contracts have different effects on price flexibility, depending on the relative impacts of demand and supply shocks. This theory appears to explain sources of price rigidities for firms that do most of their business with other firms. But it is less useful for firms that use implicit contracts (Blinder et al., 1998).

The Theory of Implicit Contracts

If the customer and seller trade with one another for long periods of time, they develop some attachment to making transactions involving the product (Okun, 1981). Any price changes for the product can be a nuisance to customers when they think the changes are unreasonable (Bergen et al., 2003; Zbaracki et al., 2004). Customers may be antagonized, and complain or react negatively whenever a price change exceeds the expected range or violates established pricing patterns from past periods (Bergen et al., 2003; Blinder et al., 1998; Okun, 1981; Stiglitz, 1999; Zbaracki et al., 2004). Customers may be less antagonized if price increases can be justified by increases in sellers’ costs (Blinder et al., 1998; Kahneman et al., 1986; Okun, 1981; Renner and Tyran, 2003). Thus, the customer and seller rely not only on established prices, but also on mutual trust, reciprocal fairness, and “fair play” for efficient allocation of products.

Okun (1981) proposes the concept of the “invisible handshake” as a possible source of price rigidity in the product market. He argues that both firms and customers in long-term relationships are stimulated to become involved in implicit agreements that make prices rigid. Carlton (1986) posits that prices tend to be more flexible the longer the buyer-seller association. He argues that customers involved in shorter relationships with suppliers are more likely to use fixed-price contracts because of the fear that they may be exploited by competitors’ price
changes. Kahneman et al. (1986) also find that consumers feel cheated when firms exploit shifts in demand by raising prices. Silby (1996), in his model of customer loss aversion, looks upon demand as a decreasing function of both price and customer disenchantment, which implies that a decrease in the elasticity of demand increases the extent of price rigidity. Blinder et al. (1998) show evidence that implicit contracts exist within two-thirds of the purchasing economy. Powers and Powers (2001), in their study on pricing by grocery stores, find that large firms lose more customers to their rivals when they change prices. And finally, Zbaracki et al. (2004) provide additional qualitative evidence of managers’ fear of “antagonizing” customers. They argue that price changes call attention to prices and may damage the firm’s reputation, integrity, and reliability.

In this section of the paper, we attempted to provide the IS audience with an overview of the bare bones of the competing theories of price rigidity and price adjustment from the point of view of economics and marketing research. We have argued that this large body of knowledge that is positioned across two different academic disciplines outside our own discipline of IS are “must read” material. They will enable IS researchers who would like to make contributions to knowledge that will require a fuller understanding of the dynamics of strategic pricing in marketing function of the firm, especially as it relates to Internet-based selling and brick-and-clicks firms. Moreover, we believe that broader awareness of this literature will help IS researchers to begin to tackle some of the more difficult problems that relate to technology as an engine of production for price strategy within the firm and in the competitive marketplace. We now turn to developing to our own efforts: to reconceptualize our understanding as IS researchers of the precursors and outcomes associated with price adjustment and price rigidity in Internet-based selling.

III. RECONCEPTUALIZING PRICE RIGIDITY ON THE INTERNET: NEW THEORETICAL PERSPECTIVES FOR IS RESEARCH

From our daily lives to commercial transactions between businesses, Internet technologies have created new forms of socio-economic organizations, and have profoundly impacted the scope and efficiency of markets (Brynjolfsson and Kahin, 2000). The Internet enhances firm performance by reducing transaction costs necessary to produce and market goods
and services in various ways. They include: increasing managerial efficiencies; enabling firms to connect their supply chains with suppliers and buyers; offering new means to collect detailed data about buyers’ purchasing behaviors; making prices and costs more transparent; lowering technological barriers to entry; and creating more competitive markets (Baker et al., 2001; Litan and Rivlin, 2001; Sinha, 2000). From the customer’s perspective, the Internet reduces search costs and switching costs between competitive sellers, enabling buyers to compare products and their prices by using search engines or shopbots (Bakos 1997; Brynjolfsson and Smith 2000; Daripa and Kapur 2001). These function as price comparison agents, and are seen on the Internet at such popular Web sites as mySimon.com and BizRate.com. From the firm’s perspective, the Internet enables firms to adjust prices differently, which may change our conventional wisdom about price rigidity. Many observers have commented that physical price adjustment costs are almost entirely absent in e-commerce because they primarily consist of the costs of simple database updates, which may be easily programmed (Bailey, 1998; Brynjolfsson and Smith, 2000). This suggests that Internet-based retailers have the capability to adjust prices more flexibly than traditional retailers, like financial markets (e.g., foreign exchange and equity trading—all pure supply and demand plays) (Bergen et al., 2005).

With these observations about the new economy in mind, we now turn to the application of the new theoretical perspectives for price rigidity and price adjustment in the context of IS and e-commerce sector issues. Based on the interdisciplinary theories discussed so far, we propose a research framework to examine different theories on price rigidity that will be observed in e-commerce environment at the different levels of analysis: product/consumer, firm and market. (See Figure 1.) We will further explain each level of analysis in the following subsections.

**PRODUCT/CONSUMER-LEVEL ANALYSIS**

*Price* can be viewed as only one of many dimensions of the terms through which products are exchanged (Carlton and Perloff, 2000). Blinder, et al. (1998, p. 302) report that “about 85% of all goods and services in the United States’ non-farm business sector are sold to ‘regular customers’ with whom sellers have an ongoing relationship. And about 70% of sales are business-to-business rather than business-to-consumers.” Explicit contracts may explain rigid prices in supply chain e-procurement. Buyers and sellers may benefit from price rigidity because it facilitates risk sharing. But, transparent prices and costs on the Internet make it hard to sustain
stable prices using long-term contracts. Fluctuations in cost and price create pressures on pre-negotiated contract prices, leading to a shift from a stable contractual environment to greater price uncertainty. Overall, explicit contracts don’t explain the observed price rigidities in Internet-based selling well enough.

Figure 1. Research Framework for Price Rigidity on the Internet

However, according to Kauffman and Lee (2004a), unexpected price changes in the terms of implicit contracts may antagonize customers and diminish the firm’s reputation—even in the digital economy. For example, Amazon.com experimented with a price discrimination policy to sell the exact same DVD titles for different amounts to different customers in 2000. However, the outraged responses from consumers were swift and clear in their message to Amazon: don’t do this! As a result, the online retailer put its price experimentation policy on hold, and also refunded money to consumers who paid the higher prices (Bergen et al., 2003). Instead of raising or lowering prices, therefore, firms can make effective use of non-price elements by enhancing product quality, conducting promotional efforts (e.g., coupons, free shipping, etc.), and stressing customer services. When we move our attention to the Internet retailing context, we can observe such price and non-price competition even more frequently. This is because online consumers and sellers can easily access to more information about products as well as competitors’ prices (Clay et al., 2002a). So with these ideas in mind, we propose a research model with several propositions to predict how price elements (e.g., price level, price discount, and price points) and non-price elements (e.g., product popularity, product information quality, and promotional
efforts) of the product are likely to affect Internet-based firms’ decisions about adjusting their prices, as well as consumer purchasing decisions online.

**Price Elements in E-Commerce**

Just as in the traditional market, online consumers also have difficulties with examining the quality of products or product and service delivery capabilities of stores. At the time of purchase of some good from an Internet-based seller, the consumer is unable to see or feel the actual product. As a result, the consumer’s assessment of the actual features or true quality of a product that is to be purchased online may be inaccurate. A number of marketing studies suggest, however, that consumers may use prices as a cue for assessing quality, if they are imperfectly informed about the product or store characteristics (Rao and Monroe, 1989; Monroe, 2003).

Another interpretation is due to Stiving and Winer (1997), who argue that *image effects* transmit signals that enable consumers to infer something (in terms of “images”) about a product or store based on price. So, a favorable impression of a product’s or a store’s quality might occur as a result of *high price image* (Monroe, 2003). Blinder et al. (1998) argue that firms are reluctant to decrease prices even in economic downturns for fear that customers may misinterpret the lowering of prices as a signal for the quality reduction of the product. So, prices are less flexible for high-priced products to sustain and signal their high quality images. In addition, unexpected price changes, especially price increases when implicit contracts exist, may antagonize customers and diminish the firm’s reputation. We illustrated this earlier with Amazon’s brief foray into computer-based price discrimination for its existing customers (Bergen et al., 2003).

Notice that the Internet gives consumers access to different information about products and firms than has ever been available before. Moreover, it has changed the composition of firms in the marketplace, and the ways customers interact with Internet-based firms, as well. In general, higher quality firms tend to have higher product quality, service levels, product assortments and support. As such they may face higher costs and/or charge higher margins for their products. This leads to higher prices for higher quality firms. Varian (2000) also predicted that Internet-based firms would be grouped into two types: those with low service levels and low prices, and those with high service levels and high prices. With reduced search and switching costs for the consumers on the Internet, they can easily detect such violation of implicit rules for
price changes unlike in traditional channels. So, firms may lose more of their profits when they break consumer expectations about pricing patterns for high-priced products. In addition, high quality firms that signal the market with their higher prices are more sensitive to consumers’ responses to the unexpected price changes. Baylis and Perloff (2002) find evidence that the price ranking of Internet-based firms selling electronics products (e.g., digital cameras and scanners) does not change frequently: high-price firms usually keep their prices high over long periods. So with these ideas in mind, we present the following propositions on the relative prices of products and firms:

**Proposition 1 (The Relative Product Price Proposition):** Due to reduced search and switching costs on the Internet, Internet-based firms change the prices of high-priced products less frequently than those of low-priced products.

**Proposition 2 (The Relative Firm Price Proposition):** In order to signal high-quality store images successfully, high-price Internet-based firms change the prices of products less frequently than low-price Internet-based firms.

Darke et al. (1995) posit that consumers may utilize price discount information as a heuristic cue to determine the amount of search that is appropriate to find a better price. Bergen et al. (2003) argue that excessive use of sales promotions can create customer norms in which sales promotions are expected. These customer norms are also a cause of falling prices in the computer and other high technology industries today. From a long-term perspective, however, sales promotions not only sacrifice profits, but also the sales increase stops when the promotion stops (Jones, 1990). Thus, firms may be forced to lower regular prices when discounts have been offered in the past. Using more than nine million retail supermarket weekly transaction data, Levy et al. (2004) compare the effects of the sale prices and the regular prices on the likelihood of price changes. They find that sale prices show positive and significant correlation with the price changes. Therefore, price discounts on products can be thought of as a proxy to measure the frequencies of price adjustment. With this idea in mind, we propose the following proposition:

**Proposition 3 (The Price Discount Proposition):** Internet-based sellers’ prior product discounting, which can be easily observed compared to that in the traditional non-Internet channel, is positively related to the likelihood of future price adjustments.

*Rational inattention theory* posits that it may be rational for consumers to be inattentive to the rightmost digit(s) because they are constrained by time, resources, and information
processing constraints (Levy et al., 2004; Sims, 2003). Since many consumers appear to ignore the last digit of the price, firms have an incentive to make it as high as possible at $9 or 9¢ (Basu, 1997). Given the firm’s reaction to its customers’ inattention to the last digit of the price, rational consumers expect that firms will set it equal to 9. Thus, 9-endings may be a rational expectations equilibrium outcome (Basu, 1997). Consumers on the Internet can easily compare prices as well as trace product information through price comparison sites or search engines. The technology itself provides a basis for the consumer being able to achieve a higher level of attention to price—if they use it. So, in spite of the earlier arguments in favor of rational inattention to price endings, shopbots may actually “flatten” some of the potential behaviors that would support this theory. However, in their study on the Internet-based bookselling industry, Kauffman and Lee (2004b) offer evidence that online consumers may be also rationally inattentive to the last digit of the price, and so sellers may take advantage of this and make the price ending as high as possible to achieve the highest level of profit. Despite the lack of generalized evidence, we expect that rational inattention will be a source of price rigidity in e-commerce due to the fact that online sellers also have an incentive to sustain prices at a higher level to maximize profits. So we suggest the following proposition:

**Proposition 4 (The Price Points Proposition):** Similar to traditional firms, Internet-based sellers have an incentive to make the price endings equal to $9 or 9¢; they change the prices with “9”-endings less frequently than those with other price-endings.

**Non-Price Elements in E-Commerce**

As Clay et al. (2002a) point out, online consumers care about other non-price aspects, such as seller reputation, delivery locations and times, contract lengths, and so on. Internet-based sellers, as a result, may charge higher shipping costs instead of higher product prices, even if the underlying market conditions get worse. Such adjustments to non-price elements are likely to offer new ways to compete and will require firms to formulate new business rules, too. We also observe that the competition that motivates the use of non-price elements may not focus on obtaining specific transactions or purchases. Instead, the more important emphasis may be the competition to obtain new customers and to maintain high customer loyalty. Kauffman and Lee (2004b) also provide case study and empirical evidence that an online retailer, Buy.com, makes use of shipping costs, instead of direct price adjustments in its approach to strategic pricing. (See Figure 2.) Apparently non-price elements causing price rigidity can be used effectively by the
Proposition 5 (The Non-Price Promotions Proposition): Internet-based sellers make use of non-price promotional efforts (e.g., free shipping or coupons) instead of price changes for competition; the use of non-price promotions is negatively related to the observed price changes.

Figure 2: Evidence of Non-Price Competition for a Bestselling Book

Note: The figure depicts the aggregate price trajectories over time of seven competing booksellers on the Internet for one bestselling book. By comparing the price without shipping cost to the price with shipping cost for each bookseller, it is possible to see the extent to which one competitor, Buy.com, is manipulating shipping cost while it simultaneously adjusts the price of the book (without the shipping cost). This provides an illustration of non-price competition.

Blinder et al. (1998) and Okun (1981) point out that firms operating with little inventory are not able to avoid the impacts of unexpected demand shocks. In today’s environment, a foundational level of firm inventory is necessary to serve and retain customers. To increase sales with customers, firms must be responsive to their special needs and requests for supply chain and logistics support. Compared to traditional channels which require firms to keep the highest inventories, Internet-based retailers are able to more accurately control inventory and costs, and sample demand any time they need to. They also possess significant price-changing capabilities. The new technologies associated with the Internet also provide traditional bricks-and-mortar retailers with opportunities to adopt bricks-and-clicks retail capabilities, such as leveraging logistical and operational expertise with traditional distribution channels, as well as connecting their technology infrastructures with the Internet. As a result, it is now possible to integrate a firm’s Internet channel with traditional distribution channels while ensuring product, price and promotion consistency (Gulati and Carino, 2000). And, with the move to the sale of information
goods (e.g., e-books or MP3 music), retail businesses can be designed with virtually no physical inventory. So, price changes are more likely to be driven by demand considerations than inventory levels. As the demand (i.e., popularity) of the product increases, firms have an incentive or a capability to more frequently change prices to maximize their profits by attracting their customers. Kauffman and Wood (2004b) find, in their study of online bookselling industry, that the price of bestselling books may be dependent on booksellers’ business rules for selling books. For example, books that are selling very well may be discounted more frequently compared to other book categories. This is because bestsellers face markets with more unstable, changing demand due to the effects of announcements and the buzz in the media (e.g., New York Times bestsellers list, the many columns of leading book critics, etc.). With these ideas in mind, we present the next proposition:

Proposition 6 (The Product Demand Proposition): Internet-based sellers have an incentive to frequently change the prices of highly-demanded products; product popularity positively affects the likelihood of a price change.

Allen (1988) shows that prices are inflexible for products (e.g., automobiles) whose quality cannot be easily observed, while prices are flexible in industries (e.g., petroleum) where the quality is easier to gauge. Similar to traditional environments, as discussed in Relative Price Propositions (P1 and P2), information asymmetries also prevail on the Internet. It is rare for buyers to be able to inspect product quality before they purchase because buyers and sellers are geographically separated and cannot interact face-to-face as they transact. Also, it is doubtful that Internet retailers with low online prices will be the most reliable (Kauffman and Lee, 2004a). So, digital intermediaries, such as trusted third parties or an online reputation mechanism, will play a significant role in building trust between buyers and sellers to “perfect” business processes associated with Internet-based transaction-making. In some online products (e.g., books, CDs) where quality is homogenous and rarely in doubt, it seems unreasonable to view quality signaling as a cause of price rigidity. However, consumers on the Internet also have difficulties in detecting the quality of heterogeneous products (e.g., computers, electronics) even if buyer search costs are negligible. So, we suggest the following related proposition:

Proposition 7 (The Information Quality Proposition): If consumers have more information on the quality of a product sold on the Internet, then the price of the product will be changed less frequently by Internet-based sellers.
As discussed in the Relative Product Price Proposition (P1) and the Information Quality Proposition (P7), higher-quality products and higher-priced products, and products with higher information quality are more likely to be rigid in terms of price changes. We believe that it will be even more interesting if an additional test is conducted for the interaction effect between relative price and information quality on the likelihood of price changes. We expect that for products with better information quality, whose prices are higher to begin with, the prices will be even less likely to be observed to change. So, we propose the following assertion to provide further insights into the price-changing behavior of Internet-based retailers.

**Proposition 8 (The Price-Quality Interaction Proposition):** If it is easier for consumers to detect the quality of a product (i.e., higher information quality), Internet-based firms change prices less frequently for higher quality products (i.e., higher relative prices).

Figure 3 illustrates a conceptual model for the product/consumer-level analysis of Internet-based retailers’ price changes.

**Figure 3. A Conceptual Model for Price Changes at the Product/Consumer-Level**

**FIRM-LEVEL ANALYSIS**

Higher search costs tend to induce buyers to remain with their sellers, which may increase the seller’s market power and result in significant price rigidity (Stiglitz, 1987 and 1999). On the Internet, however, buyer search costs are negligible. So buyers can locate lower price products or services easily with the use of search engines or price comparison agents (Bakos, 1998; Brynjolfsson and Smith, 2000). The reduced information asymmetry gives firms more incentive to cut prices though, according to Daripa and Kapur (2001). The Internet also
enables firms to reach any individuals that have access to the Internet and to expand their customer base across regions and national borders. Lower search costs can make the demand curve more elastic and enable firms to achieve higher volumes of sales by cutting prices. Compared to traditional non-Internet markets, where significant costs associated with price adjustment are incurred, the Internet provides a new environment where physical price adjustment costs are almost absent (Bailey, 1998; Brynjolfsson and Smith, 2000). Changes in underlying technologies that support the production of price changes at the level of the firm lead to changes in costs of adjustment. So, we expect that Internet-based retailers have the capabilities to be more fluid and efficient in the application of pricing strategy, with price changes more spread out over time to match market demand. This suggests applying pricing models that are financial-market-like—the strategic equivalent of Clemons et al.’s (1999) “market technostructure”—all pure supply and demand plays (Bergen et al., 2005).

**Price Adjustment Costs in E-Commerce**

Bailey (1998) finds that Internet retailers make significantly more frequent changes than traditional retailers for homogeneous products, such as books and CDs. Brynjolfsson and Smith (2000) also observe that online retailers make price changes that are up to 100 times smaller than those made by bricks-and-mortars sellers.

But what about bricks-and-clicks firms? The Internet does not necessarily reduce the managerial costs for price changes due to the integration efforts of a firm’s Internet channel with traditional channels by ensuring product, price and promotion consistency (Bergen et al., 2003). Zbaracki et al. (2004) uncovered evidence from industrial markets that shows the managerial costs are significantly greater (i.e., more than six times) than the menu costs associated with price changes. So, Internet retailers may have more price rigidities that stem from managerial costs (Bergen et al., 2003). Table 3 compares the costs of price adjustment in terms of menu costs and managerial costs between the different channels.

**Table 3. A Comparison of the Price Adjustment Costs by Channel**

<table>
<thead>
<tr>
<th>COST TYPE</th>
<th>BRICKS-AND-MORTARS</th>
<th>BRICKS-AND-CLICKS</th>
<th>PURE INTERNET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menu Costs</td>
<td>High due to physical lump-sum costs</td>
<td>High due to costs incurred by traditional channel</td>
<td>Low, almost absent</td>
</tr>
<tr>
<td>Managerial Costs</td>
<td>High due to hierarchies for decision-making</td>
<td>High due to the integration efforts</td>
<td>Low due to intensive use of IT</td>
</tr>
</tbody>
</table>
Analyzing the pricing behavior of two leading online bookstores (i.e., Amazon.com (Amazon) and BarnesandNoble.com (BN)), Chakrabarti and Scholnick (2001) find that online retailers exhibit within-store synchronization in price changes, and argue that price rigidities also exist in online environments. Tang and Xing (2001), comparing pricing for DVDs between bricks-and-clicks and pure Internet retailers, find that both types of retailers do not change prices frequently, in spite of the small menu costs in the online environment. They argue that online prices may be prone to error, even though they may be easier to change. Bergen, et al. (2005) explore daily patterns of Internet pricing, and find that Amazon, with a 222-day price change interval for the study period, appears to change prices less frequently than the BN, with a 56-day interval. This finding is hard to explain with the reduced physical costs of price adjustment that have been the primary focus in the literature. However, this might be explained by strategic pricing and managerial capabilities, and different underlying costs. The logic might go something like this: BN, as a later entrant to Internet-based selling, may have more strategic pricing expertise from its traditional store operations—allowing them to pursue a strategy of changing prices more frequently. An alternative explanation may lie in the negative media reports that resulted from Amazon’s brief foray into computer-based price discrimination for its existing customers. The firestorm that erupted around that incident may have caused management to temper its approach to strategic pricing, to ensure that frequent price changes would not create additional impressions that the firm was shifting prices for its own advantage.

Although there may be contradictory evidence on price adjustment costs, we believe that price rigidity continues to exist in e-commerce due to managerial costs for a firm’s channel integration efforts. Managerial costs are likely, as well, to lead to across-store staggering of prices. With these observations and ideas in minds, we suggest the following three propositions related to price adjustment costs:

**Proposition 9 (The Flexible Price Adjustment Proposition):** Due to very low menu costs, Internet-based sellers have the capability to change prices flexibly by any amount (e.g., 1¢) at any time (e.g., twice a day).

**Proposition 10 (The Within-Store Price Synchronization Proposition):** Internet-based multiproduct sellers will not necessarily be observed to synchronize price changes for individual products due to reduced menu costs.

**Proposition 11 (The Across-Store Price Staggering Proposition):** Internet-based sellers stagger price changes of the same product across firms due to managerial costs and the interdependence on the actions of their competitors.
Holiday Pricing in E-Commerce

During the 2004 winter holiday season, online shoppers in the United States spent $23.2 billion excluding travel, which accounts for more than 10% of the total for holiday retail sales and a 25% increase from the same time frame in 2003 (Seybold, 2005). In addition, comScore Networks (2005) also reported that in 2004 online retail spending including travel grew by 26% compared to the previous year to a record $117 billion in sales. Such rapid growth of online sales during the holiday period provides Internet-based sellers with huge opportunities and great incentives to attract potential consumers to their stores by applying the appropriate strategic pricing models. So, new technologies will offer the possibility to be more flexible and efficient in the application of pricing strategy, letting Internet-based sellers make immediate and frequent adjustments (Baker et al., 2001). They can further profit from small ticks in market demand and supply, by applying pricing models that are financial market-like. They will provide functionality that is analogous to what dealers and middlemen can utilize in settings involve dynamic trading. The use of new technology supports the production of prices—just like in the stock market—in terms of ability to rapidly make adjustments (Bergen et. al, 2005).

One might also expect to see more differences in price adjustment patterns between holiday periods and non-holiday periods. Why? We think it may be because Internet-based sellers use more data and can react without menu costs during the holiday periods. Another alternative explanation is possible though too: one might expect fewer differences because online consumers may be able to see the changes more easily due to their extensive use of search engines and price comparison agents (Bakos, 1997; Warner and Barsky, 1995). In addition, Seybold (2005) reports that the biggest concern that consumers have during the holiday season typically is shipping delays. Indeed, many Internet-based firms have experienced their customers’ anger due to delayed shipments and orders during the holiday season, and had to endure the publication of scathing articles in national newspapers and magazines and Internet blogs decrying their fulfillment capabilities.

So we wonder: in the presence of the new technologies that support the production of prices for Internet-based sellers, will the holiday period be different due to the potential problems associated with the delivery of purchased goods? We expect that, instead of lowering prices, Internet-based sellers may offer free shipping with possible delivery lags in holiday seasons, as
suggested by Carlton (1983) for traditional sellers. With these ideas in mind, we suggest the following propositions related to holiday pricing and shipping delays:

**Proposition 12 (The Holiday Season Price Flexibility Proposition):** Because Internet-based sellers have the capability to change prices flexibly due to their low menu costs, they can be expected to change prices more frequently in periods of high market demand (e.g., the Christmas holiday season).

**Proposition 13 (The Holiday Season Delivery Lag Proposition):** During the holiday season, Internet-based sellers will offer free shipping more often to avoid antagonizing their customers due to delivery lags.

**MARKET-LEVEL ANALYSIS**

The new technologies of the Internet have also provided traditional “bricks-and-mortar” retailers with new opportunities to adopt “bricks-and-clicks” retail capabilities, to complement their traditional stores, as well as take advantage of the Internet channel. Many national retailers, including such well-known names as Best Buy and Barnes and Noble, have rushed to retrieve customers who switched to pure Internet retailers (e.g., Buy.com and Amazon.com). They did this by establishing online presences or strategic partnerships with Internet-only retailers. In March 2000, for example, Best Buy launched a partnership with Micronpc.com in which Best Buy would establish kiosks in its stores, allowing customers to buy computers directly from the manufacturer, Micron Electronics (Mainelli, 2000). Circuit City and Amazon.com also joined in a bricks-and-clicks partnership to sell electronics online, and the revenue sharing appeared beneficial for both companies (Junnarkar, 2001). As a result, many of the electronics that are sold by Amazon are available for pickup at Circuit City locations. Hence, bricks-and-clicks retailers can provide their customers with a “buy online, and pick-up and in-store return” capability by leveraging logistical and operational expertise with traditional distribution channels. They also take advantage of highly-developed technology infrastructures that are matched to the Internet channel. In addition, their turnover rates have increased due to a real-time inventory system, involving Internet-based electronic shelf pricing systems (ESPs) that coordinate with the physical stores. As a result, it is becoming more and more important to conduct seamless integration of a firm’s Internet channel with traditional distribution channels by ensuring product, price and promotion consistency (Gulati and Carino, 2000).
Industry Concentration in E-Commerce

Various observers say that the Internet environment offers less concentrated markets but nevertheless creates more competition by lowering technological barriers to entry due to lower set-up costs, as well as lowering the marginal costs of production and distribution (Daripa and Kapur, 2001; Latcovich and Smith, 2001). However, to survive in such competitive environments, e-commerce firms require a significant level of investment in advertising and IT infrastructure. But the necessary economies of scale for these kinds of investments raise barriers to entry and may induce greater industry concentration in markets (Daripa and Kapur, 2001; Shaked and Sutton, 1987). Amazon.com’s recent takeover of the online operations of Toys”R”Us and Borders offers a case in point.

Latcovich and Smith (2001) also report that the online book market has become more concentrated than the traditional book retailing industry in the United States. They calculated the top four-firm aggregate market share for online booksellers at 93%, while the same metric for the traditional book retailing industry was only 45%. Other research reported that the four largest Internet retailers accounted for 99.8% of the total number of Internet hits for book retailers in 2000 (Brynjolfsson and Smith, 2000). Highly-concentrated online markets may allow firms to exploit market power by reducing the costs of driving traffic to their Web sites. Although the true relationship between industry concentration and price rigidity is not clearly defined in prior research as we discussed in the previous section, we still expect that highly concentrated industries on the Internet (e.g., books, CDs) will behave as oligopolies with the corresponding price coordination problems. So, we propose the following assertion:

Proposition 14 (The Internet Market Concentration Proposition): On the Internet, high industry concentration leads to greater price rigidity; the more highly concentrated an industry, the less rapidly will firms adjust prices in response to changes in market conditions.

Coordination Failure in E-Commerce

No doubt, the Internet makes it easier for sellers and buyers to compare products and prices by using online price comparison sites or shopbots (Bakos, 1997; Brynjolfsson and Smith, 2000; Varian, 2000). Their diffusion increases the transparency of the cost and pricing strategies of the market participants (Daripa and Kapur, 2001; Granados, et al., 2005). In traditional channels, firms do not respond instantly to their competitors’ price reductions. It takes time to
learn about price changes and there may be menu costs for making the changes. But the Internet enables sellers to quickly monitor and react to their competitors’ price movements, and often creates an environment for firms to engage in tacit collusion (as the Department of Justice argued about the online travel agent, Orbitz, in 1999).

Knowing that competitors rapidly learn about price cuts, Internet-based sellers have become cautious about changing prices, and increasingly adopt price structures that create signals for their competitors, a form of tacit collusion (Daripa and Kapur, 2001). Kauffman and Wood (2004) suggest the possibility of follow-the-leader strategic pricing dynamics, where one of the players adopts a deliberately aggressive price change leader style, and others mimic the changes. Still others may ignore the price changes of their competitors, as has been reported for BestBuy in consumer electronics in their bricks-and-mortar stores and on the Internet. We expect that online prices also may be rigid due to incentives to sustain higher prices through implicit agreements. This seems especially true in industries where online transactions primarily deal with homogenous products (e.g., books, CDs, DVDs), when quality is rarely in doubt. So, we suggest the following proposition:

**Proposition 15 (The Tacit Collusion Proposition):** To avoid intense price competition, Internet-based sellers with homogenous products implicitly collude with each other, leading to rigid prices on the Internet.

Table 4 summarizes the possible causes and expected results that the different interdisciplinary theories suggest for price rigidity in e-commerce. We also identify the propositions from among the fifteen that we presented that relate to each of the theories. (See Table 4.)
<table>
<thead>
<tr>
<th>THEORIES</th>
<th>POSSIBLE CAUSES AND EXPECTED RESULTS</th>
<th>RELATED PROPOSITIONS</th>
</tr>
</thead>
</table>
| Price Adjustment Costs   | Price adjustment costs are rapidly diminishing within firms.  
  □ Simple database updates are possible, easily programmed  
  □ Real-time inventory systems, e.g., Internet-connected ESP systems, up-to-now managerial information.                                                                       | P9, P12               |
|                          | However, prices may still remain unchanged for other reasons.  
  □ Within-store synchronization may not exist due to reduced menu costs  
  □ Across-store staggering still exists due to managerial costs.                                                                                                                  | P10, P11              |
| Market Structure         | High industry concentration leads to greater price rigidity.  
  □ Likely to occur especially in online bookselling industry  
  □ Economies of scale and limit pricing support this outcome.                                                                                                                     | P14                   |
|                          | But coordination failures are also likely.  
  □ Stackelberg pricing and follow-the-leader is possible, but may lead to problems with profitability  
  □ So tacit collusion may be used to avoid intense price competition.                                                                                                           | P15                   |
| Asymmetric Information   | Too much price adjustment may signal lower quality products.  
  □ Mostly homogeneous products (e.g., books, CDs) should have more flexible prices, as a result                                                                                                                                   | P1, P2, P7, P8        |
|                          | But if lower prices signal lower quality, the demand curve will kink, making it more difficult for firms to maximize profit through price adjustments.  
  □ IT makes rapid price adjustments possible, but still they may not desirable in terms of overall firm value  
  □ However, search costs on the Internet are almost negligible, and this will make it possible for consumers to take advantage of sudden price adjustments | N/A                   |
| Demand-Based Effects     | Point to greater likelihood of changes in prices than inventories.  
  □ Real-time inventory systems and virtually no physical inventory.                                                                                                              | P6, P12, P13          |
|                          | Uncertain psychological pricing points may diminish the effects of rapid price adjustments.  
  □ Reduced information processing costs occur due to new technologies, but people still may be rationally inattentive to prices.                                                                                                            | P4                    |
|                          | May call for strategic use of non-price elements in competition.  
  □ Seller reputation, free shipping, etc., can be leveraged for gains.                                                                                                             | P5, P13               |
| Contract-Based Effects   | Explicit contracting is not sufficient to produce rigid prices.  
  □ High prices and cost transparency may motivate supply chain buyers to renegotiate contracts.                                                                                                                                   | N/A                   |
|                          | But implicit contracts may have the opposite effect.  
  □ Customer antagonization and undesirable switching costs create inertia for price adjustment  
  □ Lower search costs may not overcome the implicit contract costs.                                                                                                               | P1, P2, P3, P7, P8, P13 |

Note: Propositions ➔ P1 (Relative Product Price); P2 (Relative Firm Price); P3 (Price Discount); P4 (Price Points); P5 (Non-Price Promotions); P6 (Product Demand); P7 (Information Quality); P8 (Price-Quality Interaction); P9 (Flexible Price Adjustment); P10 (Within-Store Synchronization); P11 (Across-Store Staggering); P12 (Holiday Pricing); P13 (Holiday Delivery Lags); P14 (Market Concentration); P15 (Tacit Collusion)
IV. CONCLUSION

“Whether or not price rigidity is efficient, one common conclusion emerging from models with price rigidity is that markets with rigid prices behave very differently than markets with flexible prices. Therefore, an important unanswered question is: Just how rigid are prices? Despite the great interest in this question, there have been virtually no attempts to answer it with data on individual transaction prices.” (Carlton, 1986, p. 637)

Despite the growing number of theoretical and empirical studies on price-setting and dispersion in e-commerce, there are only a few studies on price changes and price rigidity. Compared to non-Internet markets, the Internet environment makes it possible to more accurately monitor and control inventory and costs, and gauge demand nearly in real-time. This, we believe, is likely to have a profound impact on pricing behavior and the nature of competition in retail markets. More observers tend to portray the e-commerce sector as one in which price adjustment costs are almost absent. The limited empirical evidence suggests that Internet-based firms make more frequent price changes than traditional firms. This permits us to tell a story that involves the role of IT for diminished menu costs. As suggested in several previous studies (e.g., Bailey, 1998; Bergen et al., 2003; Brynjolfsson and Smith, 2000), firms today are able to flexibly manage and optimize prices by reducing the managerial costs and menu costs through the intensive use of information technologies. By combining supply chain management systems with revenue yield management, for example, firms now possess the capability to achieve refined pricing decisions that are in line with both current demand and current supply.

At the beginning of this article, however, we asked: should we expect less price rigidity in e-commerce? Our cautious and early answer is probably not. Price rigidity in e-commerce should be reconsidered in the appropriate theoretical and practical terms as suggested in the previous sections: in terms of psychological pricing points, customer antagonization, and non-price elements, as well as other competitive considerations. These include managerial capabilities, the sophistication of the competition, and a firm’s chosen price/quality/service profile in the market, among other considerations—all of which may
provide a basis for a variance theory of Internet-based price rigidity. (See Table 4 again.)

These ideas are representative of a range of theory-based explanations that support an argument against the likelihood of observing greater price flexibility in the digital economy.

As we have discussed so far, price rigidity is a topic of long-standing interest for marketing science researchers and economists, as well as for senior managers in firms in different industries, and for those who seek to understand the economy as a whole. Yet, due to the difficulty of measuring the extent of price rigidity directly, only a few studies have attempted to provide empirical evidence for explanatory theories from marketing and economics. Many authors such as Carlton (1986), Cecchetti (1986), Kashyap (1995), Warner and Barsky (1995), and Dutta, et al. (2002) echo the need for more micro-level studies of price adjustment using actual retail transaction prices of firms. Their calls for additional research on these topics applies equally well to the Internet context, only it will be necessary for people who have an intimate knowledge of information technology and the Internet.

Today, the Internet provides unprecedented opportunities to collect data on more subjects with lower costs, fewer restrict assumptions, and greater realism (Kauffman and Wood, 2003). The ability of researchers to access transaction price data using price information gathering agents now offers the ability to explore price adjustment patterns at a level of micro-economic detail previously unimaginable (Allen and Wu, 2002). With some of the theories in mind, we are currently conducting empirical analyses with data collected from price comparison sites that explore the efficacy of rational inattention theory, menu cost theory, psychological pricing points theory, and shipping costs as non-price competition elements. To do this research, we are employing a sophisticated software agent for data collection. The tool is able to systematically mine price-related information (e.g., list prices, selling prices, shipping costs, release or publication date), as well as some qualitative information (e.g., consumers’ ratings of the products and stores, the number of reviews, sales rank) for multiple product categories (i.e., books, CDs, DVDs, video games, notebooks, PDAs, software, digital cameras/camcorders, DVD players, monitors, and hard drives) and more than 1,200 products since the end of March 2003. As of the end of December 2004, we have collected more than 6 million data points to examine empirical regularities and variations of Internet-based retailers’ price setting behaviors and strategies. Indeed, massive quasi-
experimental data mining of the kind that we have implemented (see Figure 4), subject to the appropriate analysis, has the capacity to answer the questions that many researchers in marketing and economics never have thought to ask (Kauffman and Wood, 2003; Hahn and Kauffman, 2003). But data on related issues, such as sales volume, operating costs, wholesale prices, and so on do not become “magically” available using this method. Nor is direct information about customer perceptions and information processing. This suggests that data-collecting agents are best suited to test theories that lead to direct implications of pricing patterns across products, categories, stores or time. To go substantially beyond these questions, the data available from the Internet will need to be subsidized by additional data on firms (e.g., their costs, policies with respect to the use of technology for the production of prices, etc.) or a laboratory experiment (e.g., consumers with similar demographics and other factors presented with the same goods at different prices and price adjustments and to see what their reactions are), to be most effective in the future.

**Figure 4. Massive Quasi-Experimental Data Mining Methods**

In this research, we have attempted to draw upon theoretical perspectives from economics and marketing science to explain the price change behaviors of Internet-based sellers—players in the digital economy who are among the most effective users of new technologies. The theories that we have explored are largely new to the IS field, even though they are well known within marketing and economics. We believe that they offer rich opportunities for new theory-building and empirical research in settings that involve investments in IT and Internet technologies related to the marketing function. We believe that such interdisciplinary studies based on massive quasi-experimental data mining methods will provide a foundation for the development of new theories at the crossroads of the academic disciplines of marketing, economics and IS, and will encourage research that is able to probe
for a deeper understanding of new economic phenomena associated with the expansion of the digital economy.

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December 12-15.


