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Research Article

A Multi-Level Theory Approach to Understanding Price Rigidity in Internet Retailing*

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Abstract

Price rigidity involves prices that do not change with the regularity predicted by standard economic theory, and is of long-standing interest to firms and industries, and our understanding of the economy as a whole. The previous IS literature has failed to identify the central role of IT and Internet retailing-related technologies to explain the rigidity of prices on the Internet. Instead, it has offered only limited explanations, such as menu costs and tacit collusion. These ideas, and quite a few other key theoretical perspectives were formulated in disciplines other than ours. Thus, the issue of price rigidity and price adjustment in Internet retailing should be given more scrutiny than the literature has provided to date. We review and synthesize what we know about price rigidity in non-electronic retailing contexts using a multi-level theory approach that identifies three unique levels of analysis: the firm-specific level, the firm-to-consumer level, and the firm-to-market level. We evaluate to what extent this knowledge is applicable to explain price-setting and price adjustment on the Internet. We conclude that there should not be less price rigidity in Internet retailing than in traditional retailing – even though the Internet is involved. To this end, we recommend a multi-level variance theory of Internet-based price rigidity. This study provides a foundation for the development of new theoretical perspectives at the crossroads of the academic disciplines of marketing, economics and IS. It encourages research that is able to probe for a deeper understanding of new economic phenomena associated with the digital economy's growth.

Keywords: *Economic analysis, information systems, information technology, interfirm competition, Internet retailing, multi-level theory, price rigidity, pricing strategy, variance theory.*

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1. Introduction

Price rigidity, the inability of firms to adjust prices in the presence of forces that suggest they should change, occupies a central stage in the research agenda of new Keynesian macroeconomics (Ball and Mankiw, 1994; Rotemberg and Saloner, 1987) and industrial organization (Carlton, 1989; Stiglitz, 1984). This is in 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 (Anderson, 1994; Blinder et al., 1998).

Price rigidity is of particular interest in the context of Internet retailing, and the capabilities that firms now have to set and adjust prices flexibly (Brynjolfsson and Smith, 2000; Ghose and Gu, 2008; Oh and Lucas, 2006). For the purposes of this research on Internet retailing and price rigidity, it is important for us to establish the scope of our investigation. By *the Internet* and in *the Internet retailing* (or *electronic retailing*) *context*, we are referring to *the set of technological, organizational and managerial capabilities that permit a firm's prices to be made accessible to consumers and businesses via websites and other means to support the sales transactions for information, goods and services.* Such activities are *associated with electronic commerce*.[1] In contrast, *traditional retailing* does not involve the presentation of prices to consumers and businesses via the Internet. Instead, prices in traditional retailing are typically made available through in-store price tags, promotions, and advertisements in the print, television, and radio media, and by mail and phone, among other typically non-technological means.

Today, the Internet offers opportunities to inform our understanding of *price rigidity* and the nature of price adjustment in two fundamental ways. First, the Internet provides a unique technological context for the micro-level study of price-setting behavior and strategies. In the late 1990s, when the hype around electronic commerce crested, it was commonplace in discussions among academic researchers to hear observations about how information technology (IT) was changing industry practices in strategic pricing. In fact, some of the most influential papers of that time, including Bakos (1997) and Brynjolfsson and Smith (2000), adopted this general perspective that pricing is likely to be frictionless on the Internet. This suggested applying pricing models that were financial market-like – the strategic pricing equivalent of Clemons et al.'s (1999) market technostructure. The e-commerce marketplace now provides the functionality of the stock markets in terms of firms' ability to adjust prices and consumers' capacity to understand how they are changing. Sometime in 2001 and 2002 though, the weight of the discussion and debate seemed to shift to *pricing frictions* in e-commerce, in spite of the revolutionary, powerful and new capabilities of technology to support the firm in adjusting prices (Baye and Morgan, 2004; Carlton and Chevalier, 2001).

Second, the technologies that are associated with Internet retailing and price production operations have created forces to transform or reform markets, so they operate differently from how they once did (Kim and Mauborgne 2005). Technological change has created an innovative new production process for prices, which, in turn, has transformed the landscape of business price-setting (Dutta et al., 2003). An alternative perspective is to view the strategic pricing process as reformed relative to the way things have worked in the past. From this viewpoint, we can think of strategic pricing as being brought to real-time delivery in electronic environments, without simultaneously suggesting that the business processes that exist around strategic processes are entirely different from before (Smith et al., 2001). Changes in price rigidity and flexibility levels at firms – if indeed there are any changes – should occur, in part, as a result of differences that relate to business processes for price production and price setting between the traditional and electronic environments. Therefore, firms may adjust prices on the Internet differently from the way they do than in traditional commercial settings, and

[1] It is important for us to help the reader to recognize the breadth of our application of these terms, since they will be easily misunderstood or misinterpreted by the reader. We will refrain from using the term "the Web" since the developments that we are considering are more specific to selling and pricing. We include the technologies that make it possible for consumers to identify the products they wish to buy, including *search engines, shopbots*, *social networking systems* (such as Twitter and Facebook), *short message service* (SMS) *systems*, *recommender systems,* and other emerging technologies that support consumer search for products and prices. Many of these have become available for mobile hand-held devices.

being able to detect this kind of behavior may change our conventional wisdom about price rigidity (Bailey 1998; Brynjolfsson and Smith, 2000).

The issue of price rigidity in Internet retailing should be given more scrutiny than the literature has provided to date. The previous IS literature has failed to identify the central role of Internet technologies 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 (Campbell et al., 2005; Kauffman and Wood, 2007). Although this work has been commendable and innovative in its efforts to open up a meaningful dialogue across economics, marketing, and IS, it has been limited in its scope from a theoretical perspective. There may be factors that can explain the price-changing behavior that Internet retailers demonstrate other than menu costs and collusive behavior. For example, there still seems to be a role for *market forces* to play in price adjustment, even for Internet retailers (Bergen et al., 2005; Oh and Lucas, 2006). Firms may also make use of *non-price elements*, such as customer service, product information, reputation or fast delivery, instead of price adjustments (Clay et al., 2002a). In addition, certain *price points* maybe observed like 99¢ – even on the Internet – due to consumers' *rational inattention* to the last digit of the price, and sellers' interest in exploiting their decision-making behavior (Lee et al., 2009). Furthermore, there may be differences in price adjustment tactics that are observed for different firms relative to different products (Bergen et al., 2005; Ghose and Gu, 2008; Kauffman and Lee, 2004a). Similar explanations may also occur at the level of industries, as well as within or between sales channels.

With this concern in mind about the pervasive expectation of declining price rigidity in Internet retailing, IS researchers have an important opportunity to address research questions from the unique perspective of our academic field:

- Should we expect less price rigidity in Internet retailing, compared to traditional non-Internet channels? Are there any differences in price-changing behavior within and between firms, channels, and industries?
- What theories or theoretical knowledge would provide a basis for understanding what we observe?

To answer these questions, we will draw upon perspectives that are 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. The objective of this research is to deliver a critical survey of the research in the area we have selected – price rigidity and price adjustments – and to support further exploration on the basis of a set of carefully distilled theoretical truths. To make the case in this article, we primarily develop our arguments from the perspective of IS and economics research. We will return to a number of specific ideas that have guided and helped us sort out the many conflicting (menu costs and managerial costs, inventory, and demand) and complementary (search costs and price points, implicit contracts and customer antagonization) ideas that are available. We will also discuss ideas that have aided our clarification of the different perspectives on the relevant research levels (micro-macro, consumer-firm-market) and the relationships among them. Further, we will consider the ideas that facilitated our determination of the paramount theoretical explanations, informed our assessment of new theoretical knowledge, and enabled us to present a more convincing synthesis of current thinking in this area.

The aim of this article is to review and synthesize what we know about price rigidity in non-electronic contexts and to discover the extent to which this explains dynamism of price setting as observed in Internet retailing. We use this review to set up an agenda for future research that involves the presentation of a multi-level variance theory of price rigidity in Internet retailing. Section 2 presents our organizing framework for this research. Section 3 discusses the firm-specific level of analysis and what is known about price rigidity in traditional contexts and how the relevant knowledge is applicable to price setting on the Internet. Section 4 extends this view by assessing different theoretical perspectives that bring different issues into focus at the firm-to-consumer level of analysis. Section 5 explores knowledge about price rigidity and price adjustment at the firm-to-market level of analysis, where we see different impacts associated with the use of various technologies that have made

Internet retailing possible. Section 6 discusses the empirical evidence of price rigidity in Internet retailing from the point of view of our multi-level theory analysis. It also presents an evaluation and synthesis of the value and the benefits of the theory work in this research. Section 7 concludes with a discussion of a number of managerial implications for pricing managers, as well as the work's limitations and possible extensions for future research.

2. Research Framework

We next survey interdisciplinary perspectives that help to position this work with respect to strategic pricing, price rigidity, and price adjustment as an important new area for IS research. We will concentrate on theories from economics and marketing. Based on our examination of different theories on price rigidity and price adjustment, we propose a multi-level, multi-theoretical research framework that considers the impacts of Internet retailing-related technologies. The research framework provides a means to evaluate the observed empirical evidence for price-change behavior in Internet retailing in a manner that emphasizes theory.

2.1. 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 master the vast, theoretically complex, and methodologically mature literature on price rigidity and price adjustment in economics and marketing. Moreover, we need to come to grips with the complementary and contradictory aspects of the multi-theoretic predictions, and the range of ideas that are offered for when the different theories are likely to be most operative. We also need a means to locate the theoretical perspectives in the space of our analysis – in *multi-level theory terms* – as suggested by the organizational research work of Klein and Kozlowski (2000a, 2000b) and Kozlowski and Klein (2000). Though their work does not involve economic analysis, it nevertheless supports a key insight that proved to be very powerful to us in this research: that different theories most effectively treat unique levels of analysis of a business problem. As the reader will soon see, this enabled us to be more effective in our selection of price rigidity-related theories, since different theories offer useful managerial and economic knowledge at different levels of analysis. First though, we need to establish some basic definitions to ensure that the IS reader is familiar with the conceptual underpinnings of research in the price rigidity area.

Price rigidity is an essential component of new-Keynesian macroeconomic theory. Economists refer to this as the *economics of nominal rigidities* (Blinder et al., 1998; Carlton, 1989). 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 (Anderson, 1994). 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 efficiency (Carlton and Perloff, 2000).

An influential study of price rigidity was conducted by Means (1935), who found that some prices are *administered*, and consequently, are insensitive to fluctuations of supply and demand. Later, a wide range of theories, based on price adjustment costs, market interactions, asymmetric information, and demand and contract-based explanations, were proposed to explain why price changes might be sluggish (Andersen, 1994; Blinder et al., 1998). Table 1 lays out and briefly explains the multi-theoretical background of current knowledge on price rigidity.

A number of settings have been of special interest to researchers, who have revealed rich multi-theoretical knowledge about price adjustment. Some of the contexts that have been studied in terms of price rigidity include: product quality (Allen, 1988), inventory policies (Amihud and Mendelson, 1983), crude oil price changes and gasoline prices at the service station pump (Borenstein et al., 1997), wholesaler contracts (Carlton, 1979), banking and financial services (Hannan and Berger, 1991), and grocery stores (Powers and Powers, 2001). However, the weight of these studies suggests that there has been no single reason for either price adjustment or price rigidity, but rather a variety of useful theories to explain what has been observed.

Table 1: A Multi-Theoretical Overview of Price Rigidity

Theories	Explanations
Cost of Price Adjustment	*Changing prices is costly, so prices go unchanged even with changes in supply and demand.* • **Menu Cost**: Firms face a lump sum cost whenever they change their prices. • **Managerial Cost**: Time and attention required by managers for price decisions may slow down price changes. • **Synchronization and Staggering**: Stores change the prices of different products either together due to menu costs, or independently due to managerial costs.
Market Structure	*Monopoly power and coordination failure in markets are the primary sources of price rigidity.* • **Industry Concentration:** Sluggish price changes often indicate monopoly power in the mix. • **Coordination Failure:** Absence of an effective coordinating mechanism for market clearing leads to price rigidity.
Asymmetric Information	*Price rigidity may arise when one party to a transaction has more information than another.* • **Price as Signal of Quality:** Firms are reluctant to lower prices for fear that their customers may misinterpret price cuts as reductions in quality. • **Search and Kinked Demand Curve:** Customer search costs lead to firms facing a kinked demand curve. • **Psychological Price Points:** Prices tend to get stuck at certain ending prices, because firms know about the psychological responses to them on the part of the consumer.
Demand-Based	*Firms react to other changes (inventories, non-price elements) than price changes.* • **Procyclical Elasticity of Demand:** Demand curves become less elastic to price changes as they shift in. • **Inventories:** Inventories are used by firms to buffer demand shocks. • **Non-Price Competition:** Instead of making changes to their prices, firms use non-price elements such as delivery lags, service, reputation, or product quality to be competitive.
Contract-Based	*Prices remain unchanged in the presence of explicit or implicit contracts.* • **Explicit Contracts:** Prices become fixed for limited time periods under nominal contracts. • **Implicit Contracts:** Price changes may antagonize customers, so implicit agreements are established between firms and customers to stabilize prices and diminish friction.

2.2. A Framework for Price Rigidity in Internet Retailing

The unprecedented growth of Internet retailing-related technologies has resulted in enormous impacts and opportunities at the micro-level of consumers and firms, as well as at the macro-level of industries and markets. From the firm's perspective, such technologies enable firms to adjust prices differently, which may change our conventional wisdom about price rigidity. Many observers have commented that physical price adjustment costs that are affected by menu costs are almost entirely absent in Internet retailing because they primarily consist of simple database updates, which may be easily programmed (Bailey, 1998; Brynjolfsson and Smith, 2000). This suggests that Internet retailers have the capability to adjust prices more flexibly than traditional retailers, like financial markets for foreign exchange and equity trading, where there are pure supply and demand plays (Clemons et al., 1999). From the consumer's perspective, Internet retailing-related technologies greatly reduce search costs and switching costs between competitive sellers, enabling buyers to easily compare products and their prices by using search engines or shopbots (Daripa and Kapur, 2001; Varian, 2000). Not only do the new technologies far surpass the capabilities that have been available in traditional bricks-and-mortar stores to adjust prices and track competitors' prices, they provide the basis for

consumers to make to-the-penny price comparisons (Bakos, 1997; Bergen et al., 2005). Also from the market perspective, Internet technologies have profoundly impacted the scope and efficiency of markets. This has made prices and costs more transparent, lowering technological barriers to entry, and creating more competitive markets (Brynjolfsson and Kahin, 2000).

With these observations about the new economy in mind, we now turn to the application of the new theoretical perspectives for price rigidity in the context of Internet retailing. The theories are all related to existing price rigidity theories that have been developed and applied to traditional retailing contexts. (See Table 1.) A key basis for price rigidity theories is that prices are under the control of and administered by firms, and not subject to the laws of supply and demand (Carlton and Perloff, 2000; Means, 1935). The firm sets or changes its prices based on its own pricing capabilities, in terms of menu costs and managerial costs, as well as in response to consumer actions and behavior. The changes occur in the presence of different market structures and degrees of industry concentration (Andersen, 1994; Blinder et al., 1998). Price rigidity theories explain the observed behavior of consumers, firms and their pricing strategies, and markets in Internet retailing environments.

Based on interdisciplinary theories from marketing and economics, we propose a research framework to examine different theories on price rigidity that will be observed in Internet retailing environments at the different levels of analysis covering the firm, the consumer, and the market. More specifically, we examine possible causes of price rigidity in Internet retailing by considering that firms' pricing capabilities are mediated by IT and Internet technologies, as well as their interactions with consumers and the market. (See Figure 1.)

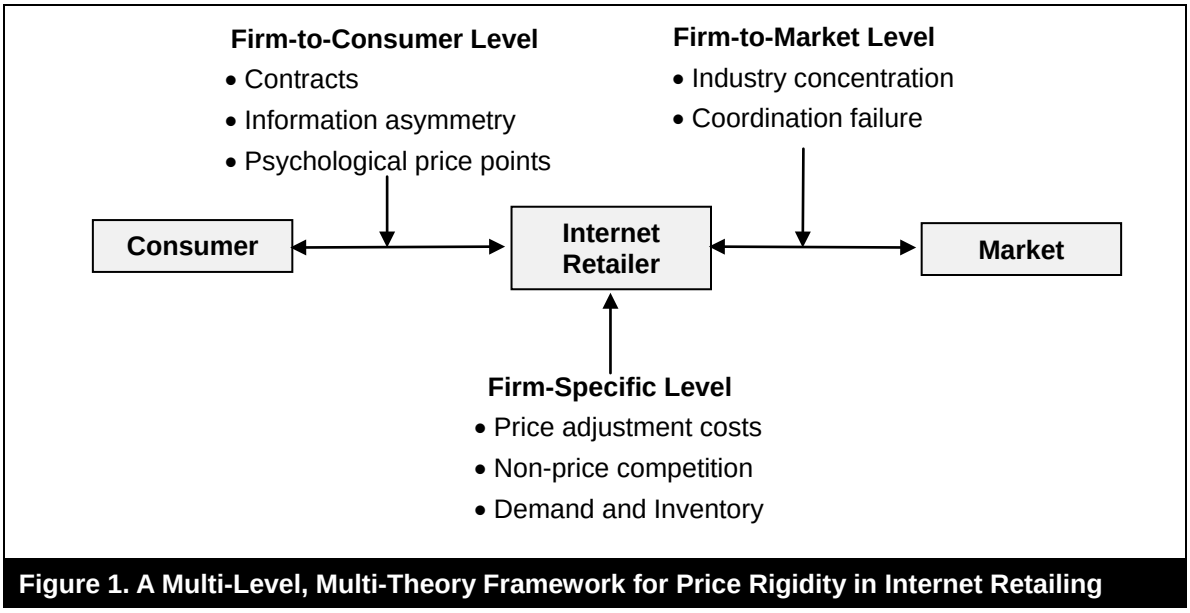

Figure 1. A Multi-Level, Multi-Theory Framework for Price Rigidity in Internet Retailing

Note: It is well recognized in the marketing and economics literature that different price rigidity theories treat different levels of analysis, and some may have overlaps.

At the *firm-specific level*, we emphasize Internet retailers' strategic pricing capabilities. This especially includes the firm's production process for prices. This production process is driven by intensive use of Internet retailing-related technologies to evaluate the effectiveness of changing prices relative to other traditional competing retailers. In particular, we consider Internet retailers' enhanced organizational capabilities (in terms of information available on demand, inventory, and non-price competition, as well as price adjustment costs) and their impacts on real price changes.

At the *firm-to-consumer level*, we focus on Internet retailers' price-changing behavior influenced by the psychology and behavior of consumers. New technological capabilities impact both the firm and the consumer, and help to explain why we observe price rigidities in Internet retailing. These include leveraging firm-level incentives to avoid customer anger incurred by violations of implicit contracts,

taking advantage of customers' psychological misinterpretation of price cuts as quality reduction, and responding to consumers' rational inattention to certain price endings and psychological price points.

Finally, we examine Internet retailers' pricing behavior at the *firm-to-market level*. Market structure, the level of competition, and possible collusive actions, including tacit collusion, also influence them. IT and Internet technologies also affect pricing behavior differently compared to traditional environments.

We will discuss these theories in the next several sections to evaluate price rigidity for the context of Internet retailing. We also develop our theoretical arguments in response to our research questions, specifically emphasizing the *mediating role of the Internet* to explain price rigidity. We have chosen different contexts that will help make this work more grounded and illustrative for the reader.[2] First, we chose the context of cross-channel pricing – represented by bricks-and-clicks retailers that operate as traditional retailers and as Internet retailers via their associated .com entities. Second, we selected pure Internet-only retailers, and explore how the price rigidity and price flexibility issues contrast in that setting. Where it seems to be appropriate, we also offer additional examples that illustrate aspects of the price rigidity and price flexibility issues that we are examining, in situations where the bricks-and-clicks and Internet-only national retailers examples do not quite fit.

3. The Firm-Specific Level of Analysis

In the 1990s and earlier, technology-driven pricing was largely in the domain of the airlines, as well as that of hotels and rental car companies that implemented revenue yield management practices. The technologies of that pre-Internet era combined powerful underlying data capture and online, real-time capabilities. They also took advantage of advanced knowledge in economic modeling and marginal value-based price discrimination approaches. This enabled companies like Marriott and American Airlines to effectively implement revenue yield pricing structures, as well as to make day-to-day adjustments in "demand bucket" prices in response to shifting demand patterns and shocks (Clemons et al., 2002; Hagel and Armstrong, 1997). Today, however, we have the same kinds of technologies available in many price-setting contexts that do not involve perishable products and services. As a result, now it is possible for bricks-and-clicks firms and traditional retailers to implement systems that permit significant adjustments to be made to prices in situations where menu costs previously made rapid price changes uneconomical (Brynjolfsson and Smith, 2000; Gulati and Garino, 2000).

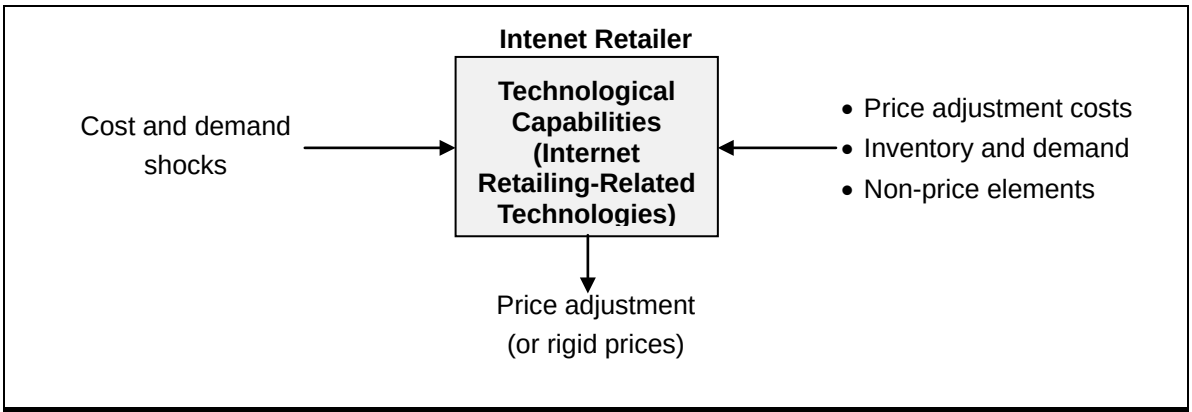

Figure 2. The Firm-Specific Level of Analysis for Price Rigidity in Internet Retailing

[2] In a critical survey of the literature, it is important to explain to the reader what constitutes a *valid illustration* of the application of the theoretical ideas that we will evaluate, extend and discuss. In our view, a valid illustration needs to have several desirable properties – and preferably, all of them. First, a valid illustration should be based on actual observations of the real world, whether through empirical studies that work with large-scale data or through small-scale data analysis or case study analysis. Second, a valid illustration should be drawn from a context that analysts would recognize as being representative of the setting in which the phenomenon under study arises. This suggests, for example, that pricing patterns in a time of economic shocks, such as sky-rocketing gasoline prices during a time of war, or used car prices after a large-scale recall occurs, should not be considered. Finally, a valid illustration should be one that is not subject to conflicting interpretations that diminish the force of the logic that it should support.

With new retailing activities enabled by the Internet, we expect to see changes that reflect the different technological underpinnings of the firm's *production process for prices* (Dutta et al., 2003). The reduction in search costs for attractive prices and bargains is accompanied by opportunities for firms to implement algorithmic price discrimination approaches that segment customers based on customer relationship management (CRM) systems information and new data mining techniques. It is natural, then, that Internet retailers will create new ways to set and adjust prices. We consider the mediating role of Internet retailing-related technologies in terms of the strategic pricing of Internet retailers. This permits us to think through the impacts of the new technology capabilities of firms to adjust prices in response to cost and demand shocks. (See Figure 2.)

3.1. Price Adjustment Costs

One explanation for price rigidity is based on *theories of price adjustment costs*: it is costly for firms to change prices (Barro, 1972; Mankiw, 1985). A profit-maximizing firm facing price adjustment costs will change its prices less often than an identical firm without such costs (Blinder et al., 1998). Price adjustment costs 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; and spending time to obtain managers' commitment to gather and process relevant information, and to make and implement decisions (Levy et al., 1997). So these theories explain the rigidity of prices for two important costs generated by firms: menu costs and managerial costs (Blinder et al., 1998; Zbaracki et al., 2004).

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 (Barro, 1972). Some of the states in the U.S. require item pricing by law, which is known to add about 20¢ to 25¢ per item, on average, and so changing item prices is not free for the seller (Bergen et al., 2008). Menu costs drive firms to make relatively large and infrequent price changes, and, thus, make prices less flexible by deterring recurrent price changes (Ball and Romer, 1990). 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. Interestingly, prior to the studies by Mankiw (1985) and Akerlof and Yellen (1985), menu costs were thought to be too small to result in any substantial effects related to price rigidity. 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 (Carlton, 1986). In many settings, the costs of collecting such data are prohibitive. As a result, empirical studies have used *indirect proxies* (frequency of price changes and time between changes) to provide evidence supporting this theory (Cecchetti, 1986; Kashyap, 1995; Levy et al., 2002). Using data on actual trans actions 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 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 12 selected retail items sold through catalogs over 35 years, heterogeneity existed in both the frequency and the amount of price changes. Based on survey data from New Zealand businesses, Buckle and Carlson (2000) assert that larger firms change prices more often than smaller firms due to menu costs, which fall systematically as firm size increases. On the other hand, Powers and Powers' (2001) analysis of price data from grocery stores shows a symmetric pattern in the frequency and size of price changes for price rises and declines.

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 price decision-making (Ball and Mankiw, 1994; Levy et al., 1997). The *theory of managerial costs* assumes that firms cannot change their prices promptly in response to changes in their economic situations if many individuals' decisions in a hierarchical organization are required to process a price change

(Bergen et al., 2003; Blinder et al., 1998; Hicks, 2007). Sheshinski and Weiss (1992) distinguish managerial costs from menu costs as the more critical component, arguing that these costs induce *price staggering* by firms. Mankiw and Reis (2002) incorporate managerial costs into a formal macroeconomic model, that they call a *sticky information model.* The model assumes that costs of information gathering and processing lead to slower information acquisition and price adjustment. Alvarez et al. (2010) make an even stronger argument: that firms optimize their price change decisions around menu costs and managerial costs of acquiring information.

With direct measurement of the size of the managerial and customer costs in a single large manufacturing firm, Zbaracki et al. (2004) empirically 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 more than six times greater than the menu costs associated with changing prices. Thus, both physical menu costs and managerial costs give ris e to price adjustment barriers within a firm (Bergen et al., 2003), although some consider managerial cost a special kind of menu cost (Blinder et al., 1998; Levy et al., 1997).

Price Synchronization and Staggering. New-Keynesian macroeconomists assume that firms change prices step-by-step over time in a process that is called *price staggering* (Ball and Romer, 1989; Blanchard, 1982). Not all firms change prices simultaneously. For example, some use *price synchronization*, the process of aligning strategic price changes in time, instead. Klenow and Malin (2010) argue that long-lasting price changes are surprisingly infrequent for many products, and may occur only once per year, once minor discounts and short-term inventory-based price adjustments are excluded. 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). Blanchard (1982) argues that staggered price-setting leads to inertia in the aggregate price level. Ball and Cecchetti (1988) propose price staggering and synchronization. They develop a model in which firms have imperfect information about 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 is advantageous in that it permits rapid adjustment to firm-specific shocks, but the disadvantages include unwanted fluctuations in relative prices. Sheshinski and Weiss (1992) study optimal pricing strategy for a multiproduct monopolist when the timing of price adjustments is endogenous. They argue for a further source for interdependence, namely, increasing returns in the costs of price adjustment. 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 pr oportional to the number of products.

There are relatively few empirical studies on price synchronization and staggering in traditional retail settings. The work on price rigidity has concentrated on single product firms for the most part. For example, 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*). Also, Fisher and and Konieczny (2000), in their empirical work on Canadian newspapers, present evidence of synchronization within same firm, as well as staggering of newspaper prices.

Price Adjustment Costs in Internet Retailing. 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 or menu costs are almost absent (Bailey, 1998; Brynjolfsson and Smith, 2000). Changes in underlying technologies to support the production of price changes at the level of the firm lead to changes in costs of adjustment. This flexibility also suggests that Internet retailers like Amazon.com and Buy.com have the capacity to be more fluid, with price changes that are more spread out over time to match market demand. So, we also expect that new

technologies will offer firms the possibility to be more flexible and efficient in the application of pricing strategy. This logic may also be applied to physical stores with bar code scanner systems, since it is easy for the stores to change prices due to reduced menu costs. However, even for modern retailers like Target and Best Buy, there still are physical menu costs, including tagging and printing changed prices for individual items to provide new price information to offline consumers, among others.[3]

But what about the hybrid bricks-and-clicks firm? The Internet does not necessarily reduce the managerial costs for price changes because a firm's Internet channel must be integrated with traditional channels to ensure, price and promotion consistency (Bergen et al., 2003; Gulati and Garino, 2000).[4] So, bricks-and-clicks retailers like Best Buy and Target may not change prices frequently due to higher managerial costs stemming from their integration efforts, compared to Internet-only retailers like Amazon.com and Buy.com (Bergen et al., 2003). Table 2 compares price adjustment costs by channel.

Table 2. A Comparison of the Price Adjustment Costs by Channel

Cost Type	Bricks-and-Mortar	Bricks-and-Clicks	Internet-Only
Menu Costs	High due to physical lump-sum costs	High due to costs incurred by traditional channel	Low, almost absent due to intensive use of IT
Managerial Costs	High due to hierarchies for decision-making	High due to the integration efforts across channels	Low due to less hierarchies for decision-making

There are several empirical studies that corroborate this argument in Internet retailing. Bailey (1998) finds that Internet retailers make significantly more frequent price changes than traditional retailers for homogeneous products, such as books and CDs. Brynjolfsson and Smith (2000) also observe that, due to low menu costs, online retailers make price changes that are up to 100 times smaller than those made by bricks-and-mortar sellers. In a recent study, Oh and Lucas (2006) find that online vendors in the computer commodity market synchronize the timing of price changes across stores due to low menu costs and increased supplier coordination. So, it appears that Internet retailers can adjust prices any day of the week throughout the year (Bergen et al., 2005). This is in contrast to grocery stores or traditional retailers, who adjust prices with sales fliers and print and radio advertise ments to take advantage of greater demand that occurs around the weekend (Dutta et al., 1999). Inte rnet retailers are capable of being more flexible than traditional bricks-and-mortar retailers due to their technology prowess.

On the other hand, there are several empirical studies that provide evidence for price inflexibility in Internet retailing. Analyzing the pricing behavior of two leading online bookstores, Amazon.com and BN.com, Chakrabarti and Scholnick (2005) 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 Internet retailers' price changes for DVDs, find that Internet retailers do not change prices frequently, in spite of the small menu costs in the online environment. Tang and Xing (2001), comparing Internet retailers' price changes for DVDs, find that Internet 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.

[3] Today, there still are a few bricks-and-mortar retailers that do not tag individual items for reading by barcode scanners. Most bricks-and-mortar retailers experience considerable menu costs for tagging and printing prices as well as printing new catalogs. So, our argument is valid in terms of the role of Internet retailing-related technologies for strategic pricing.

[4] For example, Best Buy advertises a store price guarantee on its website: "If you find a lower price on BestBuy.com or in a Best Buy Retail Store for the same brand and model during the exchange and return period, we will match that price. For purchases made on BestBuy.com, we will not match our competitors' store or website prices." See http://www.bestbuy.com/site/Help-Topics/Bestbuy.com-Price-Match-Guarantee/pcmcat204400050011.c?id=pcmcat204400050011, last accessed on June 21, 2010.

Although there may be contradictory evidence on price adjustment costs, price rigidity exists in Internet retailing due to managerial costs for channel integration. Further research will uncover the true relationship between price adjustment costs and price rigidity in Internet retailing.

3.2. Non-Price Competition

Prices are 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 it to match or beat its competitors. But 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, stressing customer service, conducting promotional efforts, expanding advertising expenditures, etc. (Carlton, 1983; Maccini, 1973). 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 elements work to clear markets (Blinder et al., 1998; Carlton, 1989). Because the theory involves unobserved elements, such as service quality and promotional efforts, there are few empirical studies that explain the causes of price rigidity in traditional settings.

Non-Price Competition in Internet Retailing. Online consumers also care about other non-price aspects, such as seller reputation, delivery locations and times, contract lengths, and so on. So, the Internet has impacted both price competition and non-price competition between firms (Clay et al., 2002a). For example, Internet retailers, as a result, may also offer high-quality services like customer support instead of lowering product prices, even if the underlying market conditions have changed. Such adjustments to non-price elements are likely to offer new ways to compete and will require firms to formulate new business rules, too (Kauffman and Wood, 2007). 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.

The use of non-price elements does not necessarily indicate that online retailers adjust prices less frequently. Instead, we expect that retailers use non-price competition in Internet retailing just as in traditional retail environments, though it causes price rigidity.

3.3. Inventories and Demand

Inventories. Firms operating with little inventory are not able to avoid the impacts of unexpected demand shocks (Blinder et al., 1998; Okun, 1981). Achieving the right level of inventory becomes 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 firms use to smooth fluctuations in demand and production (Blinder et al., 1982). *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 raise) prices (Blinder et al., 1998; Reagan, 1982). The price smoothing caused by inventories depends upon whether the demand shocks are perceived as short-run or long-run shocks (Irvine, 1980). Firms are likely to use inventory adjustments for temporary changes of demand. 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.

With permanent changes in demand, real price changes are inevitable. We have recently seen this with the downturn in demand and real prices for real estate (Christie 2009) and other services in the economy (Blackstone 2009), while the demand and real prices for used cars (Woodyard 2009) and gold (Scott 2010) have climbed dramatically. Since recent developments with respect to real prices are a result of economic failure in the U.S., and other foreign forces, and these are rather unusual developments, we hesitate to draw additional conclusions about the Internet economy and pricing

dynamics in Internet retailing. Most of the examples and illustrations that we might draw upon would not offer valid contexts because of the unexpected market changes that occurred from mid-2008 to early 2010.

Several empirical studies corroborate the relationship between inventory management practices and price rigidities in traditional environments. 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.

Demand. Firm-level price-changing behavior over the business cycle necessitates that consideration be given to the roles of demand and supply shocks that relate to business cycles (Stiglitz, 1984). 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 firms' ability to coordinate their prices, reducing price competition. In addition, firms will not reduce prices because the remaining customers may be insensitive to price changes (Bils, 1987; Toolsema and Jacobs, 2007). This trend is known as *procyclical elasticity of demand* (Warner and Barsky, 1995). 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 (Blinder et al., 1998).

There are some studies providing empirical evidence on procyclical elasticity of demand. Warner and Barsky (1995) find such empirical evidence 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 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 leads to 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 (Axarloglou, 2007).[5] In contrast to this perspective, though, Levy et al. (2010b) suggest that the opportunity cost of price adjustment increases dramatically for traditional retailers like grocery stores during high demand periods like Thanksgiving to Christmas. Since they do not experience the bulk of their annual demand then, they are more likely to exhibit a greater reluctance to change prices.

Inventories and Demand in Internet Retailing. What has been changed in today's environment, where new technologies impact the process of inventory logistics? There is no doubt that a foundational inventory level is necessary to serve and retain customers in Internet retailing. To increase sales, firms must be responsive to customers' special needs and requests for supply chain and logistics support. From an economic perspective, firms want to be able to adjust prices to react to changes in demand. Yet this is often difficult to do in a traditional bricks-and-mortar retail setting. The flow of data and the processes and costs associated with changing prices can limit a traditional bricks-and-mortar store's ability to react to these changes. Compared to traditional retailers like Best Buy and Target that require the highest inventories, Internet retailers are now able to more accurately control inventory and costs, and sample demand any time they need to. For example, Amazon.com has had much better inventory turnover than bricks-and-mortar bookstores. Amazon.com achieved 10.42 times turnover in 2009, compared to 2.75 times for Barnes and Noble and 2.34 times for Borders (*DailyFinance.com*, 2010a, 2010b, 2010c). Morgan Stanley also reported something similar to this in 1997 (Meeker and Pearson, 1997). Internet retailers also possess significant price-changing capabilities. The new technologies associated with the Internet provide traditional bricks-and-mortar

[5] Chevalier et al. (2003) provide contradicting evidence that prices do not fall during the Thanksgiving and Christmas holidays, however. Instead, they find significant procyclical pricing patterns and seasonal cycles due to retail margin changes. This is consistent with the loss-leader competitive strategies of retailers. Loss-leader advertising is a strategy in which retailers offer a big discount in order to attract customers for future profits.

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. And, with digital goods such as e-books or MP3 music, retail businesses can be designed with virtually no physical inventory.

Rapid growth of online sales during the holiday period also provides Internet retailers with opportunities and incentives to attract potential consumers to their stores by applying the appropriate strategic pricing models.[6] New technologies offer the possibility to be more flexible and efficient in the application of pricing strategy, letting Internet retailers make immediate and frequent adjustments (Ba ker et al., 2001). Price changes are more likely to be driven by demand considerations than by inventory levels in Internet retailing. As the demand for the product increases, firms have an incentive to more frequently lower prices to maximize their profits by attracting customers.

Other observations lend support to this argument. For example, in the online bookselling industry, Kauffman and Wood (2007) find that the price of bestselling books is dependent on booksellers' business rules for selling books. Books that are selling very well may be discounted more frequently compared to other book categories. This is because bestsellers face markets with less stable demand due to the effects of announcements and media buzz. These include the *New York Times* bestsellers list, leading book critics' columns and so forth. Analyzing more than over three million daily observations of prices for books, CDs, and DVDs, Kauffman and Lee (2007) find that product demand, in terms of sales ranks from Amazon.com and BN.com, positively affects the frequency of observed price changes. In addition, they find that the bestseller category shows the highest percentage of price changes compared to other categories. These include computer books, new books, and steady sellers. We conclude that price changes in Internet retailing are more likely to be driven by demand than inventories.

3.4. Discussion of the Firm-Specific Level of Analysis

Our multi-level theory evaluation perspective was helpful in our review of prior literature and theories on price rigidity at the firm-specific level. At this level of analysis, we considered the role of the firm's new technological capabilities and its impact on price changes in Internet retailing. Table 3 suggests theories for traditional retailing also relevant for Internet retailing.

The theories are all unique at the firm-specific level, where managers experience menu and managerial costs for price changes, and have the opportunity to make studied business policy choices about how they use inventories in reaction to changing demand. In addition, managers have some choices about how they synchronize or stagger a firm's price changes, even if they do not have total control as they might wish due to cost factors. Their choices also affect whether they use non-price elements. After considering the empirical evidence, at this level of analysis, the most relevant theories include the theory of managerial costs, price synchronization theory, non-price competition theory, and demand theory. These appear to explain the possible causes of price rigidity in Internet retailing based on the current empirical evidence. Other explanations that pertain to menu costs and inventories that a firm holds may not be as applicable to Internet retailing contexts as the others, again, based on the empirical evidence.

[6] During the 2009 winter holiday season, November 1 to December 31, online shoppers in the U.S. spent $29.1 billion excluding travel, a gain of 4% over the prior year's sales of $28.0 billion (comScore, 2010). Previously during the 2008 Christmas season, a number of leading retailers, including Amazon.com, Wal-Mart and Target, offered big discounts. Amazon.com had the best ever holiday, as a result, selling 73 items per second on the peak day (Helft, 2008; *Product Review News*, 2008).

Table 3. Summary of the Firm-Specific Level of Analysis

Theory	Traditional Setting		Internet Retailing		Match with Theory
	Prediction	Empirical Evidence	Prediction	Empirical Evidence	
Menu Costs	Menu costs deter price changes.	Carlton (1986), Levy et al. (1997)	Due to low menu costs, prices can be changed by any amount at any time.	Bailey (1998), Brynjolfsson and Smith (2000)	No
Managerial Costs	Managerial costs deter price changes.	Zbaracki et al. (2004)	Managerial costs still exist due to integration efforts.	Bergen et al. (2005), Tang and Xing (2001)	Yes
Price Synchronization and Staggering	Firms change prices together due to menu costs, or independently due to managerial costs.	Lach and Tsiddon (1996), Fisher and Konieczny (2000)	Due to low menu costs, across-store synchronization will exist.	Oh and Lucas (2006)	Yes
Non-Price Competition	Firms will use non-price elements instead of price changes.	N/A	Non-price elements can be used instead of price changes.	Clay et al. (2002a), Kauffman and Wood (2007)	Yes
Inventory	Firms use inventories to buffer demand shocks.	Borenstein et al. (1997), Irvine (1980)	With low inventory turnover, price changes will be more flexible.	N/A	No
Demand	In high demand periods, firms will change their prices frequently.	Axarloglou (2007), Warner and Barsky (1995)	Due to less dependency on inventory, prices will be changed frequently in high demand periods.	Kauffman and Wood (2007), Kauffman and Lee (2007)	Yes

4. The Firm-to-Consumer Level of Analysis

Internet retailing represents a transformed environment of mercantile exchange. More than other conclusions that observers have drawn about Internet retailing, the common wisdom is that Internet technologies have led to greater transparency, more widespread dissemination of information, and increasingly similar information about many elements of product, price, and market competition that are readily available to archrivals. This has been to the great benefit of consumers, who are now better informed about the opportunities they have to make value-maximizing purchases in the marketplace than ever before. In this context, it makes sense to undertake a careful assessment of the extent to which consumer-related forces are operative in determining the observed price rigidity and adjustment outcomes. Thus, our multi-level theory analysis now turns to firm-to-consumer level perspectives.

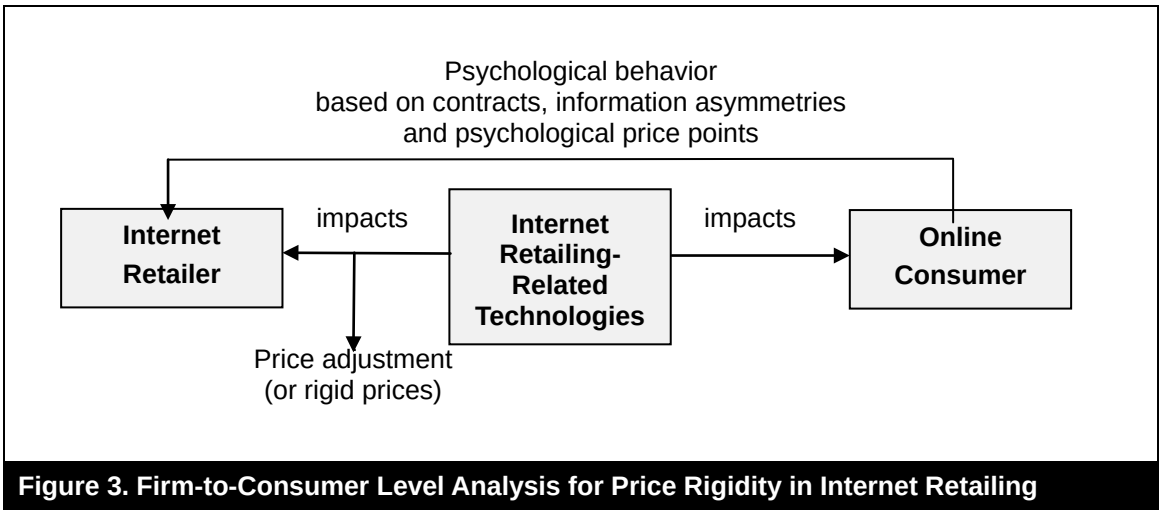

Figure 3. Firm-to-Consumer Level Analysis for Price Rigidity in Internet Retailing

We next look at Internet retailers' responses to consumer behavior and consumer psychology in determining price adjustments. We also consider how technology impacts firms and consumers to explain why price changes may be sluggish in Internet retailing. Due to our focus on the firm's response to consumer behavior at this level, it is appropriate for us to cover a broad range of theories from economics, marketing, and psychology to identify the necessary issues and derive the related basis for understanding. We will focus on contracts, information asymmetries, and psychological price points at this level of analysis. (See Figure 3.)

4.1. Contracts

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). So, the theories have been used as important tools to understand price-setting and adjustment strategies.

Explicit Contracts. Most firms that trade goods and services have nominal contracts that fix prices for finite periods of time to avoid uncertainties or transaction costs (Carlton, 1979). The *theory of explicit contracts* assumes that prices are not free to adjust to either demand or cost shocks underwritten contracts. Thus, from the perspective of this theory, firms may not be able to raise prices for existing customers without contract renegotiations, even with cost shocks or demand shocks (Hub bard and Weiner, 1992). Blinder et al. (1998, p. 302) report that "about 85% of all goods and services in the U.S. 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." The reader should think of the move-to-the-middle theory (Clemons et al., 1993) in procurement and the balance between achieving access to low cost inputs versus the risks of failed fulfillment that it implies. Explicit contracts explain rigid prices in the B2B context, such as supply chain-based procurement, where IT plays an important role as well. However, explicit contracts are not often made between firms and consumers in the Internet retailing context, so we exclude this theory in our discussion.

Implicit Contracts. If customers and sellers trade with one another for long periods of time, they develop some attachment to making transactions involving the product (Carlton, 1986; Okun, 1981). This is referred to as the *theory of implicit contracts*. Any price changes for the product, as a result, can irritate customers when they think the changes are unreasonable (Bergen et al., 2003; Zbaracki et al., 2004). This theory can also be combined with *customer antagonism theory,* which suggests that customers may be antagonized, and react negatively whenever a price change exceeds the expected range or violates established pricing patterns from past periods (Blinder et al., 1998; Stiglitz, 1999). 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. However, Carlton (1986) posits that prices tend to be more flexible the longer the buyer-seller association. 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.

There is empirical evidence that lends support to this argument. Blinder et al. (1998) shows that implicit contracts exist within two-thirds of the purchasing economy. Powers and Powers (2001), in their study of grocery stores, find that large firms lose more customers to their rivals when they change prices. Zbaracki et al. (2004) provide 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. Rotemberg (2009) further notes that the size of price changes that are made by a firm will lead to different levels of customer regret. And finally, Mitev (2004) reports empirical evidence that French Railways' move from fixed and predictable pricing to dynamic pricing by implementing revenue yield management caused a huge backlash from French public transportation users. Nevertheless, such system-based pricing practices later became widely accepted throughout Europe, the U.S., and Asia.

Customers may be less antagonized if price increases can be justified by increases in sellers' costs (Kahneman et al., 1986; Okun, 1981). 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, all of which are elements of implicit contracts.

Contracts in Internet Retailing. But what about Internet retailing? Are the same forces at work? Unexpected price changes in terms of implicit contracts may antagonize customers and diminish the firm's reputation, even in Internet retailing. A classic example occurred in 2000 when Amazon.com experimented with a price discrimination policy to sell the exact same DVD titles at different prices to different customers. The outraged responses were swift and clear in their message to Amazon: don't do this to your best customers! As a result, Amazon put its price experimentation policy on hold, apparently permanently, and also refunded money to consumers who paid the higher prices (Bergen et al., 2003; Rosencrance, 2000). With reduced consumer search and switching costs in Internet retailing, firms may lose more of their customers when they violate consumer expectations about pricing patterns. So, explanations of price rigidity in Internet retailing based on the theory of implicit contracts may apply to the Internet marketplace as well as traditional retail contexts. Still, there may be circumstances under which some contingencies come into play to override this conclusion.

4.2. Asymmetric Information

Asymmetric information theory assumes that one party to a transaction, a firm, is better informed than the other, a consumer. It gives new insights about why market failures occur (Blinder et al., 1998). Stiglitz (1979) argues that under asymmetric information, customers tend to transact with firms with relatively stable prices and avoid firms that make frequent 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 in these theoretical terms (Blinder et al., 1998).

In the context of Internet retailing, shopbots and search engines have diminished information asymmetries around product prices, descriptions, and quality. A countervailing force is also present, however, and this may give rise to a paradox with respect to the observed outcomes. *Market transparency*, the selling mechanism design capability of firms to make various dimensions of their products (especially product prices, descriptional completeness, quality level, and information accuracy) more visible or more opaque to consumers, will play a role here. Just as firms can strategically use new technologies to reveal information in Internet retailing, so can they also be used to strategically mask information and create *induced informational asymmetries*. Here again, empirical research will be necessary to sort out the conditions under which each explanation will be paramount in interpreting the outcomes.

Search Costs and Kinked Demand Curves. Since Stigler's (1961) inventive work on search theory, which is now critical to our understanding of the Internet retailing context, a number of studies have analyzed the impact of *search costs* and asymmetric information on price rigidity. The general argument is that search is costly to customers (Stiglitz, 1999), and a firm's price changes will be 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, it will sell more to current customers but will be unable to attract new customers due to the search costs involved: potential new customers will not be able to observe the lower price without a search (Stiglitz, 1987, 1999). Thus, this theory suggests that search costs will make the demand curve more inelastic for price decreases than for price increases: kinked demand curves will occur.

Search Costs in Internet Retailing. On the Internet, buyer search costs are almost negligible. Buyers can locate lower prices for products or services easily with the use of search engines or shopbots (Bakos, 1997; Varian, 2000). The reduced information asymmetry may increase the firm's incentive to cut prices (Daripa and Kapur, 2001). Compared to retailing via traditional channels, the Internet 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 lead to firms gaining more returns from price cuts than might otherwise be predicted. Therefore, the existing theory of search and kinked demand curves may not be able to explain price rigidities in Internet retailing.

As we discussed earlier, there are few empirical studies to corroborate this theory due to the unobservable characteristics of search costs. Ghose and Gu (2008), using data collected from Amazon.com and BN.com, find that search costs vary even across Internet retailers: consumers face lower search costs for price information from Amazon than from BN. This leads to a higher incentive for Amazon to engage in price competition with more price adjustments but less incentive for BN to engage in price competition.

Quality Signaling. With so many products available, it is also difficult for customers to observe quality in traditional retailing even at the time of purchase because they are imperfectly informed about the product characteristics (Stiglitz, 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. Inevitably, products will be traded at a price that 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).[7] But if cutting prices is interpreted as a quality reduction, then demand may actually decrease rather than increase (Stiglitz, 1984). 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. He shows that prices are inflexible for products whose quality cannot be easily observed, while prices are flexible in industries where quality is easier to gauge.

Quality Signaling in Internet Retailing. Just as in the traditional market, online consumers can have difficulties with examining the quality of products or the product and service delivery capabilities of firms. At the time of purchase from an Internet retailer, 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 online may be inaccurate. Also, it is doubtful that Internet retailers with low online prices will be the most reliable. So digital intermediaries, such as a trusted third party or an online reputation mechanism, will play a significant role in building trust between buyers and sellers to further refine and perfect business processes associated with Internet-based transaction-making. The Internet also 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 that customers can interact with Internet retailers. Higher quality firms tend to have higher product quality, service levels, product assortments and support. They may face higher costs or charge higher margins for their products. This leads to higher prices for higher-quality firms. Varian (2000) predicted two types of Internet sellers: those with low service levels and low prices, and those with high service levels and high prices. In addition, higher quality firms that signal the market with their higher prices are more sensitive to consumers' responses to unexpected price changes.

Some empirical research has been done to support this theoretical argument. Baylis and Perloff (2002) find evidence that the price ranking of Internet retailers selling consumer electronics products does not change frequently: high-price firms usually keep their prices high over long periods. Kauffman and Lee (2004b) also report, in their analysis of homogenous products such as books, CDs, and DVDs, that high-priced online stores change prices less frequently than low-priced online stores do.

Internet retailers, thus, should be wary of the signals associated with their pricing approaches, especially if they are competing on quality. The theory of quality signaling offers a possible

[7] Blinder et al. (1998) assert that this theory appears only to be relevant for the luxury product market, or perhaps certain niche markets for clothes or food. The signaling of quality, however, applies to every type of good. Indeed, the providers of luxury goods can afford promotion expenses to inform the consumers about quality and the consumers have strong incentives to invest in gathering information about quality. For standard goods, pricing is an efficient means for both sides of the market to provide and get information about quality at a low cost.

explanation of price rigidity in Internet retailing, just as it does for traditional retailing.

4.3. Psychological Price Points

One of the recent additions to the lexicon of theories to explain price rigidity is Kashyap's (1995) *psychological price point theory*, which builds on work in economics and marketing. This theoretical perspective appears to be useful in order to interpret the extent of price rigidity that has been observed to date (Blinder et al., 1998; Levy et al., 2010a). Kashyap argues that pricing managers attach great psychological importance to price point thresholds, such as $9 or 9¢, which consumers may misperceive or not round up, for different cognitive reasons.[8] He shows that catalog prices tend to have rigid price-endings.

Price rigidity may occur due to *rational inattention* on the part of consumers. *Rational inattention theory* posits that it may be rational for consumers to be inattentive to the rightmost digit or digits in a price because they are constrained by time, resources, and information processing capacity (Lee et al., 2009; 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). So, firms will tend to stick to prices with 9-endings even if they face cost shocks to change prices in small amounts, such as a 1¢ increase or decrease in cost.[9] The results of Levy et al. (2010a), who use about 100 million observations from grocery scanner data and the Internet, suggest that price points lead to price rigidity due to consumer inattention to the last digits of prices. An alternative perspective, put forward by Knotek (2010), is that some price points are set to speed transaction-making, especially when consumers buy items separately and have to wait in line to make a purchase.

Psychological Price Points in Internet Retailing. What about price points in Internet retailing? Consumers on the Internet can easily compare prices and trace product information, as we have noted. So, processing price information is much less costly on the Internet. With the use of the Internet as a new channel, and the existence of shopbots that allow consumers to see different prices side-by-side by price rank, consumers' search costs are tremendously reduced (Bakos, 1997; Lee et al., 2009; Varian, 2000). Shopbots and search engines provide a basis for consumers to be able to give greater attention to price. Consumers who shop on the Internet should have better opportunities to use all the digits of a price in making purchase decisions. Thus, Internet retailers may use psychological price points such as 9-ending prices less frequently, leading prices to be less rigid compared to traditional retailers. So psychological price point theory may not be as relevant in explaining price rigidities in Internet retailing as it does in traditional marketing.

There are few empirical studies that provide evidence for this in the Internet retailing context. Oh and Lucas (2006) report asymmetric and small price changes in online computer markets. They further note that small price increases occur more often than decreases due to the consumer's rational inattention to small price changes. Levy et al. (2010a) also find that the use of 9-ending prices seems to vary across Internet-based selling channels in a way that is consistent with differences in the *rational attentiveness* that these channels engender with the consumers who use them. Bricks-and-

[8] For example, consumers may perceive an actual price of $999.99 as $999 or $990, or possibly even $900 instead of $1,000. Blinder et al. (1998) also provide evidence on the importance of price points. They find that 88 percent of firms in the retail industry and 47 percent of firms in non-retail industries report some importance of psychological price points in their pricing decisions.

[9] This is because when the price-setter is facing a *price change* decision that would require, say, a price increase from $1.79 to $1.80, the increase may not be optimal if the customers ignore the last digit and perceive the change to be bigger than it actually is, for example, as a 10¢ increase. Such a misperception may decrease demand more than what is justified by the actual price increase of 1¢. Similarly, a price decrease from $1.79 to $1.78 may not have the desired effect on demand if consumers ignore the last digit. On the other hand, prices that do not end with a 9 may become more flexible compared to when consumers are rationally attentive. For example, an increase from $1.78 to $1.79 may not decrease demand at all if customers ignore the last digit. Similarly, a decrease from $1.80 to $1.79 may be perceived to be bigger (like a 10¢ decrease) than it actually is, and thus, may boost demand more than expected.

clicks firms use more 9-endings and change prices less frequently than Internet-only firms.

4.4. Discussion of the Firm-to-Consumer Level of Analysis

The firm-to-consumer level of analysis offers a second useful means to implement our multi-level theory analysis to yield unique insights. We reviewed the previous literature and five selected theories on price rigidity at this level of analysis, and evaluated the relationships that appear to be present between firm pricing and consumer behavior for Internet retailing. As we summarize in Table 4, some theories from traditional retailing seem readily applicable to Internet retailing. For example, implicit contracts and quality signaling explain some possible causes of price rigidity in Internet retailing with compelling empirical evidence. However, the explanations that we discussed related to search costs and psychological price points may not be as applicable to understanding what is happening with pricing in Internet retailing contexts.

Table 4. Summary of Firm-to-Consumer Level of Analysis

	Traditional Setting		Internet Retailing		Match with Theory
Theory	**Prediction**	**Empirical Evidence**	**Prediction**	**Empirical Evidence**	
Explicit Contracts	Prices are fixed for the contract.	Carlton (1979), Hubbard and Weiner (1992)	Explicit contracts are seldom made.	N/A	N/A
Implicit Contracts	Prices are rigid due to customer antagonization.	Mitev (2004), Powers and Powers (2001)	Customer antagonization prevails due to lower search costs.	Bergen et al. (2003), Rosencrane (2000)	Yes
Search Costs	Customer search costs lead to kinked demand curve.	N/A	Lower search costs online make prices flexible.	Ghose and Gu (2008)	No
Quality Signaling	Firms do not change prices not to signal quality reduction.	Allen (1988)	High quality, high-price firms do not change prices frequently.	Baylis and Perloff (2002), Kauffman and Lee (2004b)	Yes
Psychological Price Points	Prices are stuck at certain price endings.	Kashyap (1995), Levy et al. (2010a)	Prices are not stuck at certain price endings due to how consumers rationally focus their attention.	Levy et al. (2010a)	No

5. The Firm-to-Market Level of Analysis

In the economics of industrial organization, it is commonly noted that the sluggishness of prices in response to demand shifts 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 like 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).

What about Internet retailing markets though? Will the same dynamics obtain? The Internet enhances the performance of markets by reducing the 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. This offers them new ways to collect detailed data about consumers' purchasing behavior, 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). So, market forces in Internet retailing may also play quite different roles in firms' strategic pricing and price adjustment decisions compared to in traditional environments. Our multi-level theory analysis now turns to the macro-level of analysis of market structures – the firm-to-market level – including the degree of competition and coordination failures. (See Figure 4.)

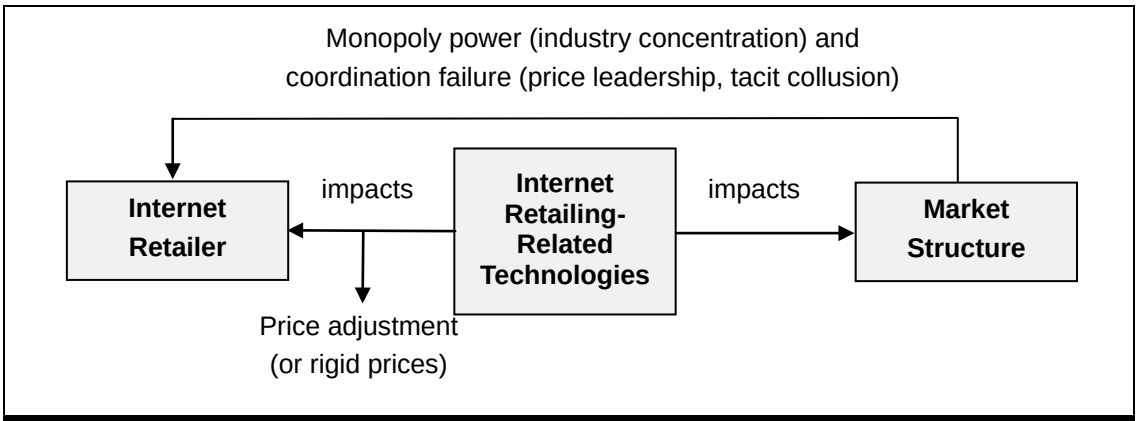

Figure 4. Firm-to-Market Level Analysis for Price Rigidity in Internet Retailing

5.1. 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; Qualls, 1979). Numerous studies have investigated the *theory of industry concentration.* They 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. 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 and market concentration. This has been measured by the Herfindahl-Hirschman index, which gauges 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.

The reason there might be a positive relationship is that highly-concentrated industries behave as oligopolies and have the attendant problems of pricing coordination. An oligopolistic firm expects its competitors to react differently to a price increase and decrease. Although a price decrease is likely to be followed, a price increase probably won't be (Sweezy, 1939). Another explanation for this relationship is limit pricing or pricing to prevent entry, where firms in concentrated industries are able to enjoy increasing returns to scale, and thus, they tend to keep their prices lower than they otherwise would in order to discourage or delay new firm entry (Carlton, 1986; 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.

Several empirical works corroborate this argument in traditional retail settings. 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 a 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 are fewer firms in an industry (Domberger, 1979). Thus, firms avoid the secret cutting of prices. Domberger (1979), in his study on 21 industries using the Herfindahl-Hirschman 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 (Dixon, 1983). Without a 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.

Industry Concentration in Internet Retailing. What are the impacts of the technologies on Internet retailing markets? Do they create more competitive markets compared to traditional channels? 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 the lower marginal costs of production and distribution (Daripa and Kapur, 2001; Lat covich and smith, 2001). To survive in such competitive environments, Internet retailers require a significant level of investment in advertising and IT infrastructure. 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 takeover of the online operations of Toys"R"Us and Borders offers a case in point. Latcovich and Smith (2001) also report th at 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 percent, while the same metric for the traditional book retailing industry was only 45 percent. Other research reported that the four largest Internet retailers accounted for 99.8 percent 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 websites. In such markets, consumers bear fewer costs to get information about the prices posted by each of the competitors. In addition, consumers can easily detect price changes through the use of search engines or shopbots if there are fewer sellers in a market. So, firms may be reluctant to change prices. Thus, the theory of industry concentration provides a possible explanation for price rigidities in Internet retailing.

There are few empirical studies that provide evidence for this related to Internet retailing. Kauffman and Lee (2007) examine homogenous online products, including books, CDs, and DVDs. They find that high concentration leads to high price rigidity. From this work, they also find that books, where the industry is the most concentrated, change prices the least frequently (more than two times less than CDs and 3.5 times less than DVDs). Although the true relationship between industry concentration and price rigidity is not clearly defined in prior research, highly-concentrated industries on the Internet, like books and CDs may behave as oligopolies with the corresponding price coordination problems, resulting in greater price rigidity.

5.2. Coordination Failure

Coordination failure theory states that the inability of firms to plan and implement pricing in coordination with one another is due to externalities or a lack of coordination mechanisms that may affect them in different ways. Coordination failures can be explained by many sources of heterogeneity among firms: differences in size, cost structure, product differentiation, and information (Tirole, 1988). Blinder et al. (1998) suggest two theories to explain such coordination problems: *price leadership* and *implicit collusion*. They find coordination failure theory to be the most revealing in their list of theories.

Several studies on coordination failure have characterized firms' pricing behavior in markets of imperfect competition as *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 leader-follower Stackelberg model. 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.[10]

Another explanation for the coordination failure is based on firms' *tacit collusion*. Chamberlin (1929) argues that oligopolistic firms can maintain the monopoly price by cooperating with their competitors even without a formal agreement to avoid intense price competition. Such collusion can be very difficult to sustain in the following situations: when large business fluctuations occur in the presence of minimal punishment for collusion, when large gains from cheating are possible, and when detection lags make it difficult to apprehend the transgressor (Tirole, 1988). Stiglitz (1984) argues that firms' collusive agreements are non-cooperative equilibria that lead to price rigidities. Rotemberg and Salon er (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. 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) argues that strategic complementarity between prices charged by different firms can increase price rigidity. According to collusion theory, thus, prices could be rigid because of incentives for firms to sustain higher prices through implicit agreements.

Coordination Failures in Internet Retailing. Is Internet retailing affected by some of these issues? No doubt, it is. Internet retailing technologies make it easier for sellers and buyers to compare products and prices by using search engines (Bakos, 1997; Varian, 2000). The diffusion of related technologies increases the cost transparency and pricing strategies of market participants (Daripa and Kapur, 2001). In traditional channels, firms do not respond instantly to competitors' price reductions. Instead, it takes time for them to learn about price changes, and there may be menu costs for making the changes. But the Internet has created a technological environment in which sellers are able to monitor and react to competitor price movements much more rapidly than ever before. This creates the impetus for firms to engage in tacit collusion. The U.S. Department of Justice argued for this conclusion about the online travel agent, Orbitz, in 1999, for example. By being more transparent, Internet retailing markets may become more competitive. This permits firms to beat competitor prices with competitive price change moves or to match competitor prices with tacitly collusive price change moves. Knowing that competitors rapidly learn about price cuts, however, Internet retailers have become more cautious about changing prices, and increasingly have adopted price structures that create signals for their competitors, a form of tacit collusion (Daripa and Kapur, 2001). Thus, online prices can be rigid due to incentives to sustain higher prices.

Internet retailing-relevant technologies appear to enable firms to tacitly collude to keep their prices higher. A number of researchers have studied this theory and provided interesting results to support this view. Bailey (1998) provides empirical evidence for convergence of book prices that prices between Amazon.com and BN.com were almost the same four months after BN entered into the Internet bookselling industry. Varian (2000) also demonstrates how collusion is occurring in the Internet bookselling industry by tracking a book price. There is some evidence from the bookselling and CD industries to suggest that Internet retailers tacitly collude via swift reactions to competitors' prices. Finally, Campbell et al. (2005) show that reduced consumer search costs to locate lower prices and firms' enhanced capability to detect cheating on collusive price arrangements facilitate the firms' incentives to sustain collusion and result in higher prices.

[10] The *kinked demand curve* (Hall and Hitch, 1939; Sweezy, 1939), the classic explanation for price rigidity in oligopolistic industries, depicts the firm's reluctance to cut prices. Competitors match price reductions and, consequently, the first firm to make a price change cannot gain market share by lowering its price. For 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 its market share (Blinder et al., 1998; Okun, 1981).

5.3. Discussion of the Firm-to-Market Level of Analysis

We reviewed the previous literature and theories on price rigidity at the firm-to-market level, and considered the firm's reaction to market structure, especially the extent of competition and coordination failures, in changing prices in Internet retailing. Table 5 gives an overview of the theories and empirical results for traditional market observations of price rigidity, as possible explanations of price rigidity in Internet retailing. Industry concentration theory and coordination failure theory are good examples of why multi-level theory is appropriate for understanding how Internet retailing-related technologies might affect market prices. This provides evidence for why the recent market observations and empirical findings dovetail with the predictions of theory that are able to uniquely characterize the firm-to-market level of analysis.

Table 5. Summary of the Firm-to-Market Level of Analysis

	Traditional Setting		Internet Retailing		Match with Theory
Theory	**Prediction**	**Empirical Evidence**	**Prediction**	**Empirical Evidence**	
Industry Concentration	High industry concentration leads to more price rigidity.	Carlton (1986), Hannan and Berger (1991)	High industry concentration reduces price competition.	Kauffman and Lee (2007)	Yes
Coordination Failures	Coordination failures lead to price rigidity.	N/A	To avoid intense competition, firms collude on price changes.	Bailey (1998), Varian (2000)	Yes

6. Discussion

Price rigidity is a topic of long-standing interest for marketing science researchers and economists, for senior managers in firms in different industries, and for those who seek to better understand the economy as a whole. We next provide a critical assessment of the value and benefits of the evaluation of different theories that we have undertaken, and whether it holds in the Internet retailing context. We consider how we might be able to use these theories in combination with one another to further advance our understanding of price rigidity in Internet retailing. We will also consider the diversity of findings across the different research streams we have explored, as a basis for offering a new and insightful synthesis of the theoretical perspectives that will drive our future research agenda. In this context, we ask: What are the next-stage issues that we should be focusing on and why? How has a multi-level theoretical perspective informed our exploration of them? What sorts of research will this prompt that we have not seen to date?

6.1. Taking Stock of the Evidence on Price Rigidity in Internet Retailing

At the beginning of this article, we asked a key question that we addressed using a multi-level theoretical research perspective: Should we expect less price rigidity in Internet retailing? Our cautious and counter-intuitive answer on the basis of this broad body of theoretical knowledge and the related empirical findings is: probably not. We examined evidence that is specific to the firm-level of analysis, as well as other findings that bridge the firm-to-consumer and firm-to-market levels of analysis. We have been able to piece together a richer understanding of how Internet retailing technology represents a process variable that mediates the observed outcomes of price rigidity and price adjustment.

We first summarize the main findings of the related literature, including empirical studies that focus on price rigidity and price adjustment in Internet retailing. These studies use different kinds of product categories (books, CDs, DVDs, computer products), the pricing practices of Internet retailers, time interval differences (daily, weekly, bi-weekly), and different time periods between 1997 and 2006 to measure the duration of price adjustments in the Internet retailing context. The literature suggests that the time between price adjustments is a pragmatic *indirect proxy* for price rigidity (Cecchetti,

1986; Levy et al. 2002). Table 6 summarizes the results of these studies.

The duration of price adjustments ranged from 23 days for computer products (Ray et al., 2008) to 161 days for books (Chakrabarti and Scholnick, 2005) in the studies we tracked. The average duration for price changes across the different studies appears to be approximately 70 days for Internet retailing. With the reduced physical costs of adjustment on the Internet, we expected to find less price rigidity for Internet retailers in comparison to traditional bricks-and-mortar stores. But this is not what we observe. For example, the findings of Dutta et al. (1999) related to price changes in supermarket chains suggest that prices change about twice as frequently as observed in the previous literature. In addition, Levy et al. (1998) report on the analysis of similar kinds of data from drug store chains. Our estimates for Internet retailers are more consistent with the findings for drug store chains, which changed prices about every 93 or 94 days in the 1990s. Thus, in spite of the new technologies that are available for the Internet, there may be other theoretical explanations that will help to explain how firms approach adjusting prices in Internet retailing.

Table 6. Empirical Research on Price Rigidity in Internet Retailing

Research	Period	Data Interval	Product Category	Number of Products	Number of E-tailers	Data Points	Duration of Price Change
Bailey (1998)	02/1997–03/1997	Weekly	Books, CDs and Software	337	48	23,789	44 days
Bergen et al. (2005)	03/2003–06/2004	Daily	Books	377	2	337,792	90 days
Brynjolfsson and Smith (2000)	02/1998–05/1999	Weekly	Books and CDs	80	16	4,485	61 days
Chakrabarti and Scholnick (2005)	03/2000–04/2001	Weekly	Books	3,124	2	343,640	161 days
Clay et al. (2002b)	08/1999–01/2000	Daily	Books	399	26	552,110	66 days
Ghose and Gu (2008)	09/2005–04/2006	Daily	Books	3,210	2	1,138,918	74 days
Kauffman and Lee (2004b)	03/2003–02/2004	Daily	Books	387	11	1,158,388	75 days
Kauffman and Wood (2007)	02/2000–03/2000	Daily	Books and CDs	169	53	92,496	55 days
Levy et al. (2010a)	03/2003–04/2005	Daily	CDs, DVDs and computer products	474	293	2,650,994	64 days
Oh and Lucas (2006)	03/1999–02/2000	Bi-weekly	Computer products	37	14	11,541	36 days
Ray et al. (2008)	01/2005–10/2005	Daily	Computer products	1,052	102	669,557	23 days
Tang and Xing (2001)	07/2000–08/2000	Weekly (5 days)	DVDs	51	12	4,284	95 days

A multi-level theory approach is especially useful in this analysis context, since it gives us greater capability to identify the theories whose knowledge is most actionable for the different levels of analysis. The firm-specific level of analysis is relatively traditional in economic terms, and is often used and relatively well understood in general terms. Its power lies in the understanding we are able to develop about the connections between the firm and its technology deployment decisions, and how they change impacts for consumers and markets.

Firm-specific level theories provide the first perspective to understand these results. We can see that most price-change observations from the different studies are less than we might expect, assuming that Internet retailing-related technology somehow has the potential to change everything. At the firm-specific level of analysis, as we know from the extensive evaluation of the literature in Section 3, the theory of managerial costs, price synchronization and staggering theory, non-price competition theory, and explanations about firm pricing choices during periods of high demand potentially have the greatest power to explain why we see different durations of time between the firms' and industries' price changes. The obvious conclusion that one can draw at this level of analysis is that Internet

retailing-related technologies are probably only able to partially explain price-change behavior, since other firm-level issues are likely to be important too. Even though menu costs have very likely declined, factors that are more closely associated with the other theories at the firm-specific level may offer greater explanatory power.

At the firm-to-consumer level of analysis, as we learned in our analysis work in Section 4, the key explanations for price rigidity in Internet retailing are the existence of implicit contracts between firms and their customers, and efforts to signal product quality through prices. Such explanations are helpful to interpret why we observe different durations of time between price changes. Even in the absence of the effects of explicit contracts and consumer search costs, there still is a need to explain the outcomes based on heterogeneities a level up from the firm-to-consumer level though.

The third level of analysis of our multi-level theory framework – the firm-to-market level – may offer additional power for interpretation. In Section 5, we reported that both of the firm-to-market level theories – monopoly power and industry concentration theory, and coordination failure theory – successfully explained price rigidity in empirical research. The theories may have specific relevance in explaining durations between price changes. To do this will require performing comparative meta-analysis of the empirical results across the studies that we noted in Table 6 to ascertain the role of the industries. We include books, music CDs, movie DVDs, and computer products. This is not too great a span of Internet retailing areas so as to preclude meaningful comparative analysis. Moreover, by controlling for industry, time period, number of retailers, number of products, the data collection interval, and so on, we are likely to be able to obtain a lot more information about why we see such different durations of time between price changes. Again, we expect that the multi-level, multi-theoretical perspective that we propose will be especially revealing for authors who conduct follow-on research in the price rigidity area for Internet retailing

6.2. Toward a Multi-Level Variance Theory of Price Rigidity in Internet Retailing

Price rigidity in Internet retailing should be reconsidered in the appropriate multi-level theoretical and practical terms: using psychological price points, customer antagonism, 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. These may all provide a basis for a *multi-level variance theory* of *Internet-based price rigidity and price adjustment*, consistent with some of the foundational work conducted by Van de Ven (2007) on variance theory-building, and the applied work of Sabherwal and Robey (1995) on variance and process theory development.

We view the opportunity for theorizing in this area as going somewhat beyond typical variance theory approaches. In this article, we have argued for the relevance of distinguishing how different theories can help to support our understanding of causality at distinctly different levels of analysis. We proposed three analytic levels at which different theories seem to provide different degrees of usefulness. They include the firm-specific level, the firm-to-consumer level, and the firm-to-market level.

These ideas represent a range of theory-based explanations that support an argument against the likelihood of observing greater price flexibility in the digital economy when technology play a pivotal role in the setting of a firm's prices. Table 7 summarizes the possible causes and expected results that different interdisciplinary theories suggest for price rigidity in Internet retailing, to provide synthesis of our ideas for the reader. The mediating role of Internet retailing-related technologies is an important basis for distinguishing the likely effects on price rigidity on the Internet relative to the non-Internet channel. It will be necessary to supplement this theoretical perspective with other aspects of theoretical knowledge at the different levels of analysis for which we have argued in this article.

The primary tension in the current literature involves how to provide theory-driven explanations to support the belief that prices in Internet retailing ought to be more flexible and more often adjusted. The counter-perspective is that there are underlying drivers of price rigidity that will persist. We now

consider the balance of the impact of these factors from the multi-level theory perspective that we have suggested.

At the firm-specific level, price adjustments are supported by the new technological capabilities of the Internet retailer beyond the traditional limits of menu costs. Changes in the underlying technologies that support the production of price changes at the level of the firm lead to changes in the costs of adjustment. The technology may not impact other factors that are central to pricing decisions by firms, although the Internet will change some of the observed patterns of price adjustment. At the firm-to-consumer level, Internet retailing-related technologies make it possible for the firm to operate in a dramatically different manner. It is able to obtain consumer-related information much more cheaply and rapidly than ever before. This creates the basis for more responsive and effective price-setting. At the firm-to-market level, current technologies also make it possible for the firm to engage in other forms of market-sensing activities that emphasize forces that go beyond consumer reactions. For example, new technologies that support procurement in electronic markets and vendor-managed inventory will assist retailers to smooth their costs and implement pricing strategies that are more effective over time.

Table 7. Causes of and Expected Outcomes for Price Rigidity in Internet Retailing: A Multi-Level Theory

Theories	Possible Causes and Expected Outcomes
The Firm-Specific Level	
Price Adjustment Costs	Menu costs are rapidly diminishing within firms due to the Internet. Simple database updates are possible and easily programmed, so price changes are cheap to implement in Internet retailing.
	Prices may still remain unchanged for other reasons in Internet retailing. There still are managerial costs due to integration efforts, for example.
Inventories and Demand	There is a greater probability that changes in prices in Internet retailing are affected by demand as opposed to inventories due to real-time inventory systems and no physical inventories at pure-Internet firms.
Non-Price Competition	Strategic uses of non-price elements are effective in competition in Internet retailing. Seller reputation, service quality, and other distinguishing characteristics can be leveraged for gains too.
The Firm-to-Consumer Level	
Contracts	Explicit contracting may produce rigid prices on the Internet, however, explicit contracts are seldom executed in Internet retailing.
	Implicit contracts may explain rigid prices in Internet retailing, where customer antagonization and undesirable switching costs create inertia for price adjustment. Lower search costs may not overcome the implicit contract costs, though.
Asymmetric Information	Too much price adjustment may signal lower quality products in Internet retailing. High-price, high-quality firms should have less flexible prices as a result.
	Search costs on the Internet are almost negligible, so the demand curve will not kink. Lower search costs make it possible for consumers to take advantage of sudden price adjustments too.
Psychological Price Points	Psychological price points may diminish the effects of rapid price adjustments in Internet retailing. Reduced information processing costs occur due to new ITs, so online consumers may be more rationally attentive to prices.
The Firm-to-Market Level	
Market Structure	High industry concentration leads to more price rigidity for sales via the Internet, as we have seen in online bookselling. Economies of scale and limit pricing support this outcome also.
	Coordination failures are also likely in Internet retailing. Stackelberg follow-the-leader pricing is possible, but may lead to problems with profitability. So firms may use tacit collusion to avoid intense price competition.

6.3. Other Research Directions to Leverage the Multi-Level Theory Perspective

We have identified four research directions related to price rigidity and flexibility in Internet retailing that seem likely to yield new theoretical and managerial knowledge, if the appropriate exploratory efforts are made. Each is based on a key observation about multi-level theory development. This process offers the analyst a chance to understand multiple facets of the same phenomenon, albeit with a different relational lens (the firm, the firm and its consumers, and the firm and its markets), and a relevant theoretical perspective.

Price Synchronization and Staggering in Hybrid Bricks-and-Clicks Firms. To be able to deal with the issues and develop explanations about price rigidity and flexibility, it will be necessary to theorize across different kinds of operations, including physical stores versus the websites of hybrid bricks-and clicks firms. Examples include Target and Best Buy, which are so well funded that it is possible for them to synchronize price changes well when it suits their strategies. On the other hand, we might expect staggered price changes, also based on technology capabilities that support strategic pricing for the organization. Best Buy appears to be so familiar with channel and location-based pricing that it is in a position practice strategic synchronization or staggering of price changes when its analysts determine that one or the other approach is value-maximizing.

Internet-Based Psychological Price Points. Establishing new psychological price points on the Internet can change consumer preferences in the presence of search engines. We are thinking about firms moving beyond 9-ending prices, since there is not much opportunity for a firm to distinguish itself with consumers if all the prices delivered by shopbots end in 99¢. So now we see prices ending in 76¢, 88¢, 43¢, and so on at Wal-Mart's online sites, among others, as well as to-the-dollar pricing (Lee et al., 2009). This seems to be a firm-specific technology capability-driven choice, since Wal-Mart is undoubtedly exploiting the advantages that search engines can give when the company implements non-9-ending prices. It is also an approach that may be related to consumer psychology, since pricing away from the usual psychological price points has arisen. So this also seems like an appropriate direction for exploring the impacts of Internet retailing-related technologies.

Product Life Cycle. A firm's pricing strategy will also change as its product, markets, and competitors change over time. *Product life* is the duration of the availability of a product or service in the marketplace. We encourage further study of price changes at the firm-specific level, as well as the firm-to-market level. When the life of a product or a service is perishable (airline tickets and hotel rooms) or limited (computer products and electronics), firms sell their products and services through distinct stages of their individual life cycles (Kotler, 2008). Each is likely to pose different strategic pricing challenges, opportunities, and problems for sellers, including pricing with launch discounts for new products, setting higher prices to capture full market value from consumers for maturing products, and adjusting prices downward when the product passes its prime. Recall Table 6, which showed that computer products exhibit a shorter duration for price changes – 36 days according to Oh and Lucas (2006) and 23 days according to Ray et al. (2008), compared to other non-perishable products, such as books, CDs and DVDs. This indicates that firms have incentives to change the prices of products with a more limited life frequently, such as for computer books and software products that are subject to versioning. We also know anecdotally and from data that we have worked with over the years that firm-level price change behavior is heterogeneous across different industries and markets related to product life cycle considerations. We advocate the exploration of how Internet retailing-related technologies affect price-change behavior among firms in different industries that sell diverse products, and especially those that differ in the amount of time that a product can be sold at a relatively full price. We expect that there will be interesting differences in how the Internet is used for pricing when a product is subject to frequent technological changes and rapid obsolescence.

Price Information Diffusion. The speed of price information diffusion for Internet retailing increasingly mimics the diffusion of financial market-based prices for financial instruments. As a result, we see another direction for research that involves all three of our multi-level theory-building and analysis levels: the firm-specific level for technology investments; the firm-to-market level for

theory about the multiple paths that price diffusion now takes; and the firm-to-consumer level as a means to characterize information-induced behavioral changes on the part of consumers. We call for research that characterizes Internet retailing more in terms of financial market-based information flows and the changed dynamics of consumer responses, so that we can begin to understand firm-specific choices about how to optimize the business process for setting prices and the new price-change behaviors of firms.

7. Conclusion

In this research, we presented a critical survey of the relevant theory to support our analysis of price rigidity in Internet retailing. In the process of developing this research, we have applied new thinking about the use of multi-level theory development ideas. We have sought to make the process plain and compelling to the reader and logically consistent with the range of existing findings. Moreover, in spite of the large body of knowledge that exists in the economics and marketing literature, the essence of our work here has been to produce IS research-relevant knowledge. We have been selectively inclusive of just those theories that represent focal theories for IS researchers related to the study of various price rigidity-related issues in Internet retailing. We next discuss the primary managerial contributions and limitations of this work.

7.1. Managerial Contributions

Who should care about trends in price rigidity in Internet retailing, and who will benefit from the new knowledge that we have developed? Who will be able to use the information that we present about price rigidity, and how will they use it? How does this research work help senior managers, IS and marketing professionals, and industry consultants and other observers to make better sense of the world of Internet retailing?

We have argued for the importance of Internet retailing-related technologies as a mediating influence in price rigidity and price flexibility across different sales channels within the same firm and across firms in the same channel. From a practitioner's point of view, this research enables senior managers, marketing analysts, and industry consultants to achieve a better understanding of price change dynamics in the context of Internet retailing. Such knowledge should empower their strategy formulation and decision-making. Our research also helps pricing managers more thoroughly understand the dynamics of pricing in online environments.

The analysis framework that we have presented spans the spectrum of pricing strategy contexts from the micro level of the consumer and the firm to the macro level of the market. Senior managers and marketing analysts will benefit from knowing that Internet retailers compete on the basis of the price levels they set and the capabilities that they possess to change prices. This research will provide them with a comprehensive overview of the literature, and the kinds of analyses that help uncover the hidden patterns of price rigidity and flexibility within their competitive environment. The knowledge that we offer applies to different kinds of products and retailers and to the different price levels of the goods and services they sell too. Knowing about the duration patterns of price changes in a competitive environment permits the formulation of proactive rather than reactive pricing strategy. Further, when marketing and IS professionals come to know more about the underlying structures of pricing strategy in their companies' markets, they will be able to be more innovative and effective in the creation of IT artifacts that can transform the power of their approaches to strategic pricing. These include business intelligence and data mining tools, for example. Clearly, IT and technological innovation represent an important engine for that transformation.

7.2. Limitations and Final Thoughts

Several words of caution are in order on the perspectives that we have offered in this article. First, technology is not the only force at work driving price change capabilities and what we have observed about Internet retailing. For example, we have not considered cultural and geographical factors, international linkages that may affect firms' business policies on a local level, or other external forces involving some industry-specific business practices and policies for price stability. Second, nor have we considered situations in which legal, regulatory and other non-business considerations are likely

to play a significant role. An example of this came with the recent and historic rise in gasoline prices in the U.S. in 2008 and 2009. Government lawyers and concerned citizens made public accusations about price gouging, antitrust actions, and exploitative profiteering in the wake of rising prices that had nothing to do with the Internet.

Third, we have not attempted to characterize what may happen over a longer period of time, as Internet retailing-related technologies, and the business processes that are affected by them, evolve. The process of arriving at an economic equilibrium with respect to pricing behavior in Internet retailing will involve firm-level considerations of how to optimize technology investments to drive pricing strategy, based on perceptions of the corresponding profitability and return on investment. It will also involve exogenous changes in the technologies themselves, which means management must come to an understanding of how to implement them to most effectively enhance pricing practices. Thus, we would expect there to be a time lag for other impacts and changes to arise, since it will take time for the market to figure out how best to employ emerging technologies. This might offer opportunities for IS researchers to develop process theories about how changing technology affects pricing strategy and price-changing behavior within organizations at a micro-level, and at a more macro level in different industries in the market (Sabherwal and Robey, 1995; Van de Ven, 2007).

In addition, it will take time for Internet retailing-related systems integration efforts to truly take hold in business practice. This will impede senior executives' efforts to understand the efficacy of technology use in support of pricing for Internet retailing. Finally, the technological evolution of organizational business processes for pricing is affected by changes and transformations in other business processes. We see this today, for example, with systems development outsourcing, IT services contracting, web services, and business process outsourcing, where pricing increasingly emulates price-setting approaches that are associated with financial markets. Another example involves suppliers that set future prices for corporate purchases of production resources and travel services, where risk management and hedging concerns arise. Future theorizing should extend our understanding of the role and impact of technology in these kinds of pricing settings.

We have drawn on different theoretical perspectives from economics and marketing to explain the price-changing behavior of Internet retailers. These are the players in the digital economy who are among the most effective users of new technologies. Even though they are well known within other disciplines, the theories we have evaluated related to price rigidity and adjustment are fairly novel to the IS field. They offer rich opportunities to support new theory-building and empirical research on investments in Internet retailing-related technologies and their effects. Such interdisciplinary studies will provide a foundation for the development of new theories at the crossroads of the academic disciplines of marketing, economics, and IS.

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