Should We Expect Less Price Rigidity in the Digital Economy?

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Abstract

Price rigidity in firms, industries and the economy as a whole is a topic of long-standing interest among scholars of many disciplines such as economics and marketing. Today, however, information technology is increasingly changing the process by which strategic pricing decisions in firms are made and implemented in business operations. This creates the impetus for developing a more substantial managerial understanding of firm pricing processes in the presence of information technology. In the 1990s, technology-driven pricing was largely the domain of the airlines, hotels and rental car companies – with the practice of revenue yield management. However, now it is possible for bricks-and-clicks firms, and even traditional retailers, to implement systems that permit significant adjustments to be made to prices in situations where menu costs previously made rapid price changes difficult to achieve in an economical way. The paper draws upon theoretical perspectives that are largely new to the field of Information Systems, but that offer rich opportunities for theory-building and empirical research in settings that will be of high interdisciplinary interest.

1. Introduction

From our daily lives to commercial transactions between businesses, Internet technologies have profoundly impacted and created new forms of socio-economic organizations. The Internet enhances firm performance by reducing many transaction costs necessary to produce and market goods and services, by increasing managerial efficiency, especially by enabling firms to connect their supply chains more with their suppliers and buyers and to collect detailed data about buyers' purchasing behaviors, and by making prices and costs more transparent, lowering technological barriers to entry, and creating more competitive markets [5, 39]. From the customer's perspective, the Internet reduces search costs and switching costs between competitive sellers, enabling buyers to compare products and their prices by using search engines or shopbots [6]. These function as price comparison agents, and are seen on the Internet at such popular Web sites as mySimon.com and BizRate.com. There are now many electronic marketplaces where consumers and businesses can benefit from immediate access to products and services and where suppliers can distribute their products more efficiently.

The digital economy has also provided traditional "bricks-and-mortar" retailers with new opportunities to adopt "bricks-and-clicks" retail capabilities, to both complement their traditional stores as well as take advantage of the Internet channel. Many national retailers, including such familiar names Best Buy and Barnes and Noble, have rushed to retrieve customers who switched to pure Internet retailers (e.g., Buy.com and Amazon.com). They did this by establishing online presences or strategic partnerships with Internet only retailers. For example, many of the electronics sold at Amazon are available for pickup at Circuit City locations. Hence, bricks-and-clicks retailers can provide their customers with a "buy-online, pick-up-and-return-in-store" capability by leveraging logistical and operational expertise with traditional distribution channels, as well as through technology infrastructures that connect with the Internet. Turnover has increased due to a real-time inventory system, involving Internet-based *electronic shelf pricing* systems (**ESPs**) that coordinate with the physical stores. As a result, it is becoming more and more important to conduct seamless integration of a firm's Internet channel with traditional distribution channels by ensuring product, price and promotion consistency [29].

1.1. Price-related phenomena in the digital economy

The new IT capabilities enable firms to better estimate product demand and to make flexible adjustments in the supply of products or services—thereby increasing market efficiency. Economists, especially those who work with the theoretical perspectives of microeconomics, have focused on price as the primary mechanism for efficient resource allocation. Thus, pricing and strategies of firms

are essential in most economic analysis of market performance. Research in IS has focused on price *dispersion* (e.g., [4], [14], [24]), *price levels* (e.g., [14], [22]), and *price-setting* (e.g., [6], [23]) to explain the firms' pricing strategies on the Internet. Most empirical evidence shows that the results are lower price levels and the failure of the "one price" *Bertrand price competition* would predict in e-markets.

Despite the theoretical and empirical studies on price dispersion, price levels and price-setting behavior, there are only a few studies on price-changing behaviors—*price rigidities*—in e-commerce. Compared to non-Internet markets in which significant costs associated with changing prices are incurred by retailers, the Internet technologies make it possible to more accurately control inventory and costs, to sample demand at any given moment, and to have significant capabilities with respect to price changes and the nature of competition in retail markets [14].

Most observers comment that price adjustment costs are almost entirely absent in the digital economy because they primarily consist of the costs of simple database updates, which may be easily programmed. Thus, the limited number of previous empirical studies suggests that Internet retailers will have the capability to make more frequent price changes than traditional retailers [4, 14].

However, we believe that the issue of price rigidity in the Digital Economy should be given more scrutiny than the literature has actually provided up until now. There may be factors that can explain price-changing behaviors that Digital Economy firms demonstrate besides menu costs. For example, firms may make use of *non-price elements*, such as customer service, delivery lags or free shipping instead of price adjustments. In addition, there may be differences in price-changing behaviors that are observed for different firms relative to the different products. Similar explanations may also occur at the level of industries, as well as within or between sales channels. So with this concern about the pervasive expectation of declining price rigidity on the Internet, we address the following research questions in this article:

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

To answer these questions, we draw upon theoretical perspectives that are largely new to the field of IS. They offer rich opportunities for theory-building and empirical research in settings that will be of high interdisciplinary interest. Such interdisciplinary studies, we believe, have the potential to provide a distinctive foundation for IS research and can also serve as a guide to research on other economic phenomena in e-commerce.

1.2. Price rigidity theories in marketing and economics

Price rigidity is an essential component of new-Keynesian economic and macroeconomic theory. Economists refer to this as the *economics of nominal rigidities* [12]. Some other terms are also seen: *price inertia*, *price stickiness*, and *price inflexibility*. Rigid prices occur when prices do not adequately change in response to underlying cost and demand shocks. Once set, prices often remain unchanged, in spite of changes in the underlying conditions of supply and demand. Price rigidity has the potential to prevent Walrasian market clearing that leads to equilibrium in supply and demand and market inefficiency [19].

An early influential study of price rigidity was conducted by Means [42], who found that some prices are "administered," and consequently, are insensitive to the fluctuations of supply and demand. Subsequently, a wide range of partial equilibrium theories, such as those based on price adjustment costs, market interactions, asymmetric information, and demand-based and contract-based explanations have been proposed to explain why prices might be sluggish. They provide a basis for the macroeconomic assumptions of rigid prices. (See Table 1.)

The remainder of this paper is organized as follows. We first develop our thinking by providing a broad-based review of the literature on the theories of price rigidity from the perspectives of economics and marketing Science. Then, we present new ways of understanding price rigidity in the digital economy based on the interdisciplinary theories. Finally we draw conclusions on our assessment of the theory, and discuss a number of implications of our study for future academic research and pricing strategy formulation in industry.

2. Theories of price adjustment cost

One explanation for price rigidity is based on *theories of price adjustment* cost: it is costly for firms to change prices [12]. A profit-maximizing firm facing price adjustment costs will change its prices less often than an identical firm without such costs. They include real costs associated with price changes: printing new catalogs, new price lists, new packaging, etc; informing sales people and customers; obtaining sales force cooperation; antagonizing customers resulting in lost future sales; and spending the time and obtaining the attention required of managers to gather and process the relevant information and to make and implement decisions [37]. The previous literature shows that price adjustment costs are, in general, modeled in one of two ways: in a *menu cost model* or using a *convex adjustment cost model* [15].

Table 1. An overview of the multiple theories of price rigidity

Theories	Description
Cost of price adjustment	As changing prices is costly, prices remain unchanged even with changes in supply and demand. ❑ **Menu cost:** Firms face a lump sum cost whenever they change their prices. ❑ **Convex adjustment cost:** The costs of changing prices rise at an increasing rate. ❑ **Managerial cost**: Time and attention required for price decision-making slow down price changes. ❑ **Synchronization and staggering:** Stores tend to change the price of different products either together or independently.
Market structure	Monopoly power as well as coordination failure in markets are the primary sources of price rigidity ❑ **Industry concentration:** The sluggishness of price changes is a demonstration of monopoly power. ❑ **Coordination failure:** Absence of an effective coordinating mechanism is the cause of the price rigidity.
Asymmetric information	The fact that one party to a transaction has more information than the other provides an explanation of price rigidity. ❑ **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.
Demand-based	Firms react to demand fluctuations other than price changes: inventories and non-price elements. ❑ **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 price competition, firms use non-price elements such as delivery lags, service, or product quality.
Contract-based	Prices remain unchanged by nominal or implicit contracts. ❑ **Explicit contracts:** Prices are fixed for limited time periods under nominal contracts. ❑ **Implicit contracts and customer antagonization:** As price changes may antagonize customers, implicit agreements between firms and customers are used to stabilize prices.

2.1. Menu cost theory

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. Interestingly, however, prior to the publication of articles by Mankiw [41] and Akerlof and Yellen [1], menu costs were thought to be too small to rationalize any substantial effects of price rigidity. Mankiw [41] states that in monopoly competition a firm's increased return from changing prices is smaller than the increased social welfare, and prices may not change even with inefficient allocations.

It has been hard to directly test menu cost theory due to the lack of cost-related data [12]. So empirical studies have used indirect proxies (e.g., frequency of price changes and time between changes) to provide evidence that supports this theory [38]. Using data on actual transactions prices, Carlton [18] finds that the fixed cost of price adjustment differs across buyers and sellers. Cecchetti [20] analyzes the frequency and size of newsstand magazine price changes and shows that higher inflation causes more frequent price changes. Kashyap [32] notes that, for 12 selected retail items sold through catalogs over 35 years, there is heterogeneity in frequency and price change amounts. To directly measure menu costs, Levy and his colleagues [27, 37] take into account components of menu costs: labor cost of changing grocery shelf prices; cost of printing and delivering new price tags; cost of mistakes made during the price change process; and cost of in-store supervision of price changes. They find non-trivial costs of price adjustments for large food and drugstore chains and point out that prices are less flexible in response to cost shocks that are smaller, less persistent, and on which market participants have less information.

2.2. Convex adjustment cost theory

Convex adjustment cost theory assumes that the cost of changing prices is convex and quadratic, increasing in the size of the change. Convex adjustment costs tend to discourage large price changes and lead to relatively small, frequent partial price adjustments that move toward a target price level [12, 15]. Rotemberg [46] combines microeconomic models of gradual price adjustment with a simple macroeconomic model in which the money supply drives aggregate demand. For monopoly firms, Rotemberg asserts that it is more expensive to make a large change than several smaller changes of the same total magnitude. Carlson [16] reports that a large percentage of firms leave their prices unchanged and make larger and more frequent price changes when inflation is higher. Zbaracki et al. [58] find that the

managerial and customer parts of the price adjustment costs are convex, while physical costs of price adjustment, such as the costs related to printing and distributing new catalog and new price lists, and notifying suppliers, are non-convex. Why? The decision and internal discussion costs, as well as customer negotiation costs, are higher for larger price changes.

2.3. Managerial cost theory

Managerial costs are defined as the managerial time and effort dedicated for relevant information gathering and price decision making [50]. The *theory of managerial cost* assumes that firms cannot change prices promptly in response to changes if many individuals' decisions in a hierarchical organization are required to process a price change [10]. Physical menu costs and managerial costs give rise to price adjustment barriers within a firm [58].

Sheshinski and Weiss [50] distinguish managerial costs from menu costs as the more critical component by arguing that these costs induce price staggering by firms. Mankiw and Reis [41] incorporate managerial costs into a formal macroeconomic model, called the *sticky information model,* assuming that the costs of information gathering and processing lead to slow information acquisition and price adjustment. Through the direct measurement of the size of the managerial and customer costs in a single large manufacturing firm, Zbaracki et al. [58] analyze several types of managerial and customer costs, including costs of information gathering, decision making, negotiation, and communication. They find that the managerial costs are over six times the size of menu costs associated with changing prices.

2.4. Price synchronization and price staggering

New-Keynesian macroeconomists assume that firms change prices step-by-step over time. Not all firms change them simultaneously though. In oligopolistic markets, for example, each firm takes into account the actions of its competitors, and thus pricing policies will be interdependent, preventing the firm from changing its prices [50]. Blanchard [11] argues that this *staggered price setting* leads to inertia in the aggregate price level. Staggering and synchronization are also proposed by Ball and Cecchetti [7], who develop a model in which firms have imperfect information of the current state of the economy and obtain information by observing the prices set by others. This gives each firm an incentive to set its price shortly after other firms set their prices.

Sheshinski and Weiss [50] study optimal pricing strategy for a multi-product monopolist when the timing of price adjustment is endogenous. They argue for a further source for interdependence, namely, increasing returns in the costs of price adjustment (i.e., economies of scope). They further state 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 cost of changing prices is independent of the number of products. There are few empirical studies because the work on price rigidity has been on single-product firms. Lach and Tsiddon [34] use multi-product data and find evidence of *across-stores staggering* and *within-store synchronization*. Fisher and Konieczny [28] present the evidence of price synchronization and staggering for Canadian newspaper firms.

3. Theories based on market structure

In industrial economics, it is commonly observed that the sluggishness of prices with respect to changing demand is a demonstration of market power [43]. For example, a duopoly with fixed costs of price adjustment is more flexible in price changes than a monopoly under certain conditions [47]. In many industries, pricing strategies are interdependent because firms take into account competitor actions.

3.1. Theory of industry concentration

Economists have emphasized monopoly power or a limited number of sellers in markets as the primary causes of price rigidity or inflexibility [45]. Because of the difficulty in measuring the competitive conditions in a given market, most of the studies have focused on proxies for market competitiveness, i.e., industry concentration (e.g., Herfindahl index), which iteratively measures what share of a market is held by the first "x number" of largest firms [55]. It provides a rudimentary indicator of the extent of monopoly power. Numerous studies investigate industry concentration and the relationship between degree of concentration and price rigidity.

The studies that suggest the existence of a positive relationship show that highly concentrated industries behave as oligopolies with price coordination problems. Carlton [18] reports an overall 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 [30] find evidence from the banking industry of a significant positive relationship between industry concentration and price rigidity, and a limited level of asymmetric behavior.

Justification for a negative relationship is easier for other competitors to identify secret price-cutting when there are fewer firms in an industry. Domberger [26], in

his study on 21 industries using the Herfindahl index of concentration, shows a negative relationship between price rigidity and industry concentration. Powers and Powers [44], analyzing grocery price data, find that higher industry concentration leads to more frequent and larger price changes.

Other research finds no relationship. Without perfect monopoly or explicit pricing collusion, firms behave as price competitors and the degree of industry concentration is inconsequential [45]. Worthington [57] demonstrates an uncertain relationship: higher industry concentration may result in an increase, decrease, or no change in price rigidity.

3.2. Theory of Coordination Failure

Coordination failure theory assumes that the inability of firms to plan and implement pricing is due to the externalities or a lack of coordination mechanism that may affect firms in different ways [12]. Potential coordination failures can be explained by many sources of heterogeneity among firms, such as differences in relative size, cost structure, product differentiation, and information [55].

Several studies on coordination failure characterize firm pricing behavior in markets of imperfect competition by *price leadership* [48]. 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. Tyagi [56] proposes the Stackelberg pricing model, which shows leader-follower pricing behavior in markets. The kinked demand curve, the classic explanation for price rigidity in oligopolistic industries, explains the firm's reluctance to cut prices because competitors match price reductions and consequently the first firm cannot gain market shares. In the case of cost increases affecting several rival firms, each individual firm may be unwilling to remain the price leader out of fear that its competitors will not follow and the firm will then lose its market share [12, 43]. Without a price leader to efficiently coordinate price changes, prices may remain unchanged.

Another explanation for the coordination failures is based on firms' *implicit collusion*. Oligopolistic firms maintain the monopoly price by cooperating with their competitors, even without a formal agreement, to avoid intense price competition. However, such collusion can be very difficult to sustain in the following situations: when there are large business fluctuations (e.g., booms), when punishment is ineffective, when greater gains from cheating are possible, and when detection lags [55]. Stiglitz [52] argues that firms' collusive agreements may result in non-cooperative equilibria, leading to price rigidity. Rotemberg and Saloner [47], offer a game-theoretic model of oligopoly during booms.

4. Asymmetric information theories

Asymmetric information theory assumes that one party to a transaction (e.g., firm) is better informed than another (e.g., customer). The theory offers insights into why market failures occur, such as price rigidity [12]. Since the theory involves unobserved information (e.g., product quality and search costs), there are few related empirical studies to explain price rigidity. We next consider several related theories.

4.1. Theory of quality signaling

With many products, it is difficult for customers to observe *quality* even at the time of purchase because customers are imperfectly informed about the product characteristics [52]. A pervasive belief is that higher priced products are of higher quality. Firms are reluctant to decrease prices in economic recessions for fear that customers may incorrectly interpret the price lowering as a signal that the product quality has been reduced [12]. Cutting price may be interpreted as a quality reduction, and demand may actually decrease rather than increase [52].

Allen [2] 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 in the products (e.g., automobiles) whose quality cannot be easily observed, while prices are flexible in the industries (e.g., petroleum) where the quality is more straightforward. In Blinder et al.'s [12] survey, this theory is the least significant because the quality differences on which this theory is based are unobservable.

4.2. Theory of search and kinked demand curve

Since Stigler's [51] inventive work on *search theory*, several studies have analyzed the impact of search costs and asymmetric information on price rigidity. They argue that search is costly to customers [53] and a firm's price change is observed by current customers but not by other customers due to the search costs [8]. If the firm raises its price by more than what customers expect, it may lose customers. Regular customers quickly learn about the price change and search for sellers with lower prices. But if the firm lowers price, it sells more to current customers but does not attract new customers due to search costs. Thus, this theory assumes that search costs make the demand curve more inelastic for price decreases than for price increases, and lead firms face *kinked demand curves*: the returns from price decreases may be clearly less than the sales loss from price increases [53].

5. Demand-based theories

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

5.1. Theory of procyclical elasticity of demand

Price changes over the business cycle suggest the importance of demand and supply shocks as a cause for business cycles [12]. When economic fortunes wane, and many firms fail, the remaining firms' ability to coordinate their prices and reduce price competition may rise. But they may not reduce prices. Why? The remaining customers may not be sensitive to price [12]. This *procyclical elasticity of demand* explains why prices response to demand changes may be dampened in a cyclical downturn.

Stiglitz [52] argues that prices may stay level in a business cycle although the marginal costs of production fall. This is because markups may increase, even if the elasticity of demand were to decrease. Rotemberg and Saloner [47] suggest that strategic interactions between firms are affected by business cycles.

5.2. Theory of inventories

Economists think of *inventories* as buffers that companies can use to manage fluctuations in demand and production [12]. Okun [43] states that inventories provide an inter-temporal link for prices and end-use quantities of a product. This theory assumes that firms use inventories rather than price changes to cushion demand shocks [12]. The degree of price smoothing caused by inventories depends on if demand shocks are perceived as short-run or long-run shocks. Firms are more likely to adjust inventory in temporal changes of demand. With permanent demand changes, firms change their prices, not their inventories.

Amihud and Mendelson [3] find that the degree of price flexibility and asymmetric price responses by firms to economic shocks primarily rely on the relationship between the cost of holding inventory or stocking out. Borenstein et al. [13] find that, due to the production and inventory adjustment lags, there is asymmetry in the adjustment of spot gasoline prices to spot crude oil prices.

5.3. Theory of non-price competition

Prices are generally considered a key means for market clearing and resource allocation. Price competition occurs when a seller emphasizes the lower price of a product and sets a price that matches or beats competitors' prices. However, firms hesitate to cut prices out of fear that customers will misinterpret a cut as a reduction in quality [12]. Carlton and Perloff [19] point out that markets may clear through other means. *Non-price competition* can be used effectively when a seller can make its product stand out from the competition by distinctive product quality, delivery lags, customer service, promotional efforts, packaging, advertising, etc.

Carlton [17] views delivery lags as another means for market clearing, determining demand in market. For example, in response to an increase in demand, price may remain relatively unchanged, but consumers may have to wait a little longer for delivery. Thus, he argues that many markets can be characterized by large fluctuations in delivery dates and small fluctuations in price. Blinder et al. [12] also state that firms are willing to decrease delivery lags or provide more customer service rather than cut prices when demand is low (and vice versa). Thus, delivery lags may play the same buffering role as inventories.

6. Contract based theories

Contract-based theories provide an explanation of rigid prices. Firms and customers may enter into explicit or implicit contracts fixing prices over a given period. Such contracts provide insurance against adverse market conditions by ensuring prices [12].

6.1. Explicit contracts

Most firms that trade goods and services have contracts that fix prices to avoid uncertainties or transaction costs [16]. *Explicit contracts* assume that prices are not free to adjust to either demand or cost shocks under written contracts. Thus, firms cannot raise prices for existing customers without any contract renegotiation even with cost shocks or demand shocks.

Carlton [16] examines the relationship between price changes and duration of contracts in industrial purchases and finds that prices move in the same direction but by different magnitudes in response to supply shocks. Hubbard and Weiner [31] also analyze the role of contracts in industrial product markets and argue that depending on the importance of demand and supply shocks, contracts have different effects on price flexibility.

6.2. Implicit contracts

Blinder et al. [12] explore *implicit contracts,* which exist in two-thirds of the economy. If a customer and a seller trade with one another over time, they develop a strong relationship. Okun [43] proposes an "invisible handshake" as a possible source of price rigidity in the market. Firms and customers in long-term relationships tend to have implicit agreements that stiffen prices

because the customers are antagonized when the price is raised, leading to a loss of sales as they switch to competitors. Carlton [18] posits that prices tend to be more flexible the longer-standing the buyer-seller association, and that customers involved in shorter relationships with suppliers are more likely to use fixed-price contracts because of the fear that companies may exploit them by price changes.

Price changes can be a nuisance to the customer, especially when they perceive them to be unfair [10]. Powers and Powers [44] find that large firms lose more customers this way: a larger proportion switch when large firms change prices. Zbaracki et al. [58] provide qualitative evidence of managers' fear of antagonizing customers. They show that price changes call attention to prices and may damage the firm's reputation. Customers may be antagonized when a price change exceeds an expected range or violates historical pricing patterns [53]. So a customer and a seller may not rely on prices but on trust, reciprocal fairness, and "fair play." Finally, Bergen et al. [10] argue that the excessive use of sales promotions creates customer norms in which sales promotions are expected.

7. Price rigidity in the e-commerce sector

We now turn to the application of these theoretical perspectives in the context of e-commerce sector issues.

7.1. Price adjustment costs in e-commerce

Compared to traditional markets where significant costs associated with price adjustment such as menu costs are incurred, most people think that the Internet provides a new environment where physical price adjustment costs are almost absent due to simple database updates [4, 14]. Others believe pure Internet retailers have more price rigidities that stem from managerial costs [10]. The economy lets firms make immediate and frequent adjustments, so they can profit from small ticks in demand and supply [5]. Bailey [4] finds that Internet retailers made significantly more frequent changes than traditional retailers for the homogeneous products, such as books and CDs. Brynjolfsson and Smith [14] also observe that e-tailers make price changes that were up to 100 times smaller than those made by bricks-and-mortar sellers.

But what about bricks-and-clicks firms? The Internet does not necessarily reduce managerial costs inherent in a price change due to the integration efforts of a firm's Internet channel with traditional channels by ensuring product, price and promotion consistency [10]. Analyzing pricing behavior of two leading e-bookstores, Chakrabarti and Scholnick [21] find that they exhibit *within-store synchronization* in price changes, and argue that price rigidities still exist in the online environment, which is largely free of menu costs. Tang and Xing [54] compare DVD prices between bricks-and-clicks and pure e-retailers find that both do not change prices frequently, despite the small menu costs for the online environment. They argue that online prices may be prone to error, even though they are easier to change.

Based on the evidence, we believe that price rigidities continue to exist in e-commerce due to *within-store synchronization of prices* caused by menu costs, as well as by *across-store staggering of prices* caused by managerial costs. (See Table 2.)

Table 2. Comparison of price adjustment costs

Cost Type	Bricks-and-Mortar	Bricks-and-Clicks	Pure Internet
Menu Costs	High due to physical lump-sum costs	High due to costs incurred by traditional channel	Low, almost absent
Mgrl Costs	High due to hierarchies for decisions	High due to the integration efforts	Low due to intensive use of IT

7.2. Market structure effects in e-commerce

Various observers say the digital economy offers less concentrated markets and creates more competition by lowering technological barriers to entry due to lower set-up costs, as well as lower marginal costs of production and distribution [25, 35]. However, to survive, e-commerce firms require a significant level of investment in advertising and IT infrastructure. But needed economies of scale raise barriers to entry and may induce industry concentration in markets [49]. Amazon.com's takeover of the online operations of Toys "R" Us and Borders offers a case in point. Latcovich and Smith [35] also find that the online book market, at 93% in the U.S., is more concentrated than traditional book retail industry, at only 45%. Brynjolfsson and Smith [14], based on information from Web21, also report that the four largest Internet retailers account for 99.8% of the total number of hits for book retailers. High concentration in online markets may allow firms to exploit market power by reducing the costs of driving traffic to their Web sites.

No doubt, the Internet makes it easier for firms and buyers to compare products and prices by using online price comparison sites or shopbots. Their diffusion increases *market transparency* [25]. In traditional channels, firms do not respond instantly to their competitors' price reductions because it takes time to learn about the price changes and there may be significant menu costs for changing prices. But the Internet enables firms to quickly monitor and react to competitors' price movements, and often creates an environment for firms to

engage in tacit collusion (as the Department of Justice argued about the online travel agent, Orbitz, in 1999). Knowing that competitors instantly learn about price cuts, firms have become cautious about changing prices, and increasingly adopt similar price structures [25]. So online prices may be higher than expected, possibly due to tacit collusion. Online prices also may be rigid due to incentives to sustain them at a higher level through implicit agreements.

7.3. Information asymmetry in e-commerce

According to Stiglitz [53], *information asymmetries* between buyers and sellers about product quality are one of the root causes of price rigidity. Buyers and sellers are geographically separated and do not interact face-to-face as they transact. Thus, it is difficult for buyers to inspect product quality. Further, it is doubtful that the firm with a low online price will be the most reliable if competition is based only on prices. So advertising, consumer search, and digital intermediaries (e.g., trusted third parties, online reputation mechanisms) will play a significant role in building trust between buyers and sellers. However, it seems unreasonable to view quality signaling as a cause of price rigidity. Why? Because most online transactions primarily deal with *homogeneous products* (e.g., books, CDs) where quality is rarely in doubt. Rather, online firms compete on price as well as on non-price elements, such as customer service, promotional activities, and advertising.

On the Internet, buyer search costs are negligible; buyers can locate lower price products or services easily with the use of search engines or price comparison agents. The reduced information asymmetry gives firms more incentive to cut prices [25]. Lower search costs can make the demand curve more elastic and lead to higher firm returns from price cuts. Kinked demand curves and search theory may not explain price rigidity in e-commerce.

7.4. Consumer demand in e-commerce

Blinder et al. [12] and Okun [43] point out that firms operating with little inventory are not able to avoid the impacts of unexpected demand shocks. In today's environment, a basic level of firm inventories is necessary to serve and retain customers. To increase sales with customers, firms must be responsive to their special needs and requests for supply chain and logistics support. Compared to traditional channels which require firms to keep the highest inventories, in e-commerce operations it is possible for firms to obtain more efficient supply chain benefits. Such benefits extend to both customers and manufacturers due to the increased use of computer technologies, such as the real-time inventory systems, so firms can accurately control inventory and send products to market faster. Further, with the growth of information goods (e.g., electronic books and downloadable music), new retail businesses can be designed with virtually no physical inventory. Therefore, we believe that, in the firm price changes are likely to be driven more by demand shocks than inventories in the e-commerce sector.

The Internet gives consumers access to more information about products than has ever been available to them before. Clay et al. [23] point out that it facilitates both price competition and non-price competition. Online consumers care about other non-price aspects like seller reputation, delivery locations and times, contract lengths, etc. Firm non-price strategies create a new focus on the consumer, not the transaction. Thus, we expect that strategic use of non-price elements will be a cause of price rigidity on the Internet.

7.5. Contracts in e-commerce

Blinder et al. [12] 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." Explicit contracts explain rigid prices in supply chain-based procurement, where market participants may benefit from price rigidities by facilitating risk sharing. However, transparency of price and cost on the Internet makes it difficult to sustain stable prices using long-term contracts. Why? Fluctuations in cost and price may have an effect on negotiated contract prices, leading to a shift from a stable contractual environment to greater price uncertainty. Overall though, we doubt explicit contracts can explain the observed price rigidity in Internet-based selling.

Unexpected changes in the terms of implicit contracts, in contrast, may antagonize customers and diminish the firm's reputation—even in the digital economy. For example, Amazon.com experimented with a price discrimination policy to sell the exact same DVD titles for different amounts to different customers in 2000. However, the outraged response from consumers was swift and clear in its message: the online retailer put its price experimentation policy on hold, and also refunded money to consumers who paid the higher prices [10]. With reduced search and switching costs for the consumer, firms may lose more of their customers when they violate consumer expectations about pricing patterns. So the implicit contract explanation should do well in interpreting price rigidity in Internet-based selling.

8. Conclusion

Despite the growing number of theoretical and empirical studies on price setting and dispersion in e-

commerce, there are only a few on price changes and price rigidity. Compared to non-Internet markets, the Internet environment makes it possible to more accurately monitor and control inventory and costs, and gauge demand nearly in real-time. This, we believe, is likely to have a profound impact on pricing behavior and the nature of competition in retail markets. More observers tend to portray the e-commerce sector as one in which price adjustment costs are almost absent. The limited empirical evidence suggests that e-retailers, indeed, make more frequent price changes than traditional retailers by putting their emphasis on the role of menu costs. As suggested in several previous studies [4, 10], firms can flexibly manage and optimize prices by reducing the managerial costs and menu costs through the intensive use of IT. By incorporating supply chain management systems with revenue yield management, for example, firms will further refine pricing decisions that are in line with both demand and supply. At the outset of this article, however, we asked: should we expect less price rigidity in e-commerce? Our cautious and early answer is: probably not. Price rigidity in e-commerce should be reconsidered in the appropriate theoretical and practical terms as suggested in the previous sections: (implicit) collusion, customer antagonization, non-price elements, market power, etc.

In this article, we have attempted to draw upon theoretical perspectives from economics and marketing science to explain the price change behaviors of Internet-based sellers. The suggested theories are largely new to the IS field, even though they are well known in marketing and economics, from which they are drawn. Taken together, they offer rich opportunities for new theory-building and empirical research in e-commerce settings that will be of high interdisciplinary interest.

Currently we are conducting empirical analyses with data collected from price comparison sites. We are utilizing a data collection software agent to mine price information for multiple product categories (i.e., books, CDs, DVDs, video games, notebooks, PDAs, software, digital cameras/camcorders, DVD players, monitors, and hard drives) and more than 1,200 products since the end of March 2003. Such interdisciplinary studies will provide a new foundation for the development of theory at the crossroads of the academic disciplines of marketing and IS, and will encourage research on new economic phenomena in the digital economy.

Acknowledgements. The authors wish to thank Mark Bergen and Daniel Levi for helpful comments on an earlier version of this article. In addition, we benefited from input received from two anonymous reviewers in the Electronic Marketing mini-track of the 2004 HICSS Conference.

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