

# **Beyond the Cost of Price Adjustment: Investments in Pricing Capital**

Mark Zbaracki, The Wharton School  
Mark Bergen, University of Minnesota  
Shantanu Dutta, University of Southern California  
Daniel Levy, Bar-Ilan University and Emory University  
Mark Ritson, London School of Business

Last Revision: June 19, 2002

JEL Codes: E31, D21, D4

For Presentation at the NBER's Summer Institute Workshop on  
Capital Markets in the Economy,  
July 22, 2002, Royal Sonesta Hotel, Cambridge, MA  
Discussant: Julio Rotemberg, Harvard University and NBER

The authors would like to thank the management of a large mid-western manufacturer, the management of electronic shelf label manufacturer, and other anonymous participants in our studies, without whom this study wouldn't have been possible. The authors would also like to thank Andy Caplin and Julio Rotemberg for inspiring comments and suggestions in their roles as discussants of our previous papers at the NBER and the American Economic Association meetings, and the seminar participants at the University of Minnesota (CSOM) and the University of Pennsylvania (Wharton) for comments. Finally, we thank Bob Barsky, Leif Danziger, Sandeep Mangaraj, Charles Martin, Om Narasimhan, Akshay Rao, Sourav Ray, K.K. Sinha, and Orv Walker, for their helpful comments and discussions on earlier drafts of the paper. All authors contributed equally: we rotate co-authorship. The usual disclaimer applies.

# **Beyond the Cost of Price Adjustment: Investments in Pricing Capital**

## ***Abstract***

The literature on costs of price adjustment has long argued that changing prices is a complex and costly process. In fact, some authors have suggested that we should think of firms' price-setting activities as "producing" prices, similar to the way firms use production processes to produce goods and services. In this paper we explore one natural extension of this view, that besides observing costs of price adjustment, we should also expect to see firm-level investments in capital expenditures into these "pricing" production processes. We coin the term "pricing capital" for these investments, and suggest that they can improve the efficiency of the "pricing production" activities by both reducing the costs of adjusting prices, and improving the effectiveness of price adjustments in future periods. Using two types of data sources, we find compelling evidence of the existence as well as the importance of pricing capital in firms. The existence of firm-level "pricing capital" has the potential of fundamentally altering the way we think about pricing and price adjustment in many areas of economics. It suggests looking toward the "pricing capital" to decipher the likely degree and causes of price rigidity and its variation across price setters, markets, and industries. Moreover, "pricing capital" introduces a new, higher-level, pricing decision made by individual firms. Decisions to invest in pricing capital compete with traditional capital investment decisions that have long been studied in economics, such as capital investments in plant, equipment, and R&D. Furthermore, since pricing capital is a choice variable, it implies that costs of price adjustment often used in models of price rigidity are endogenous. As such, pricing capital offers new insights into the micro-foundations of the costs of price adjustment. The most provocative implication of the new theory of pricing, however, is that the allocative efficiency of the price system itself may be determined endogenously by individual price setters who choose whether and how much to invest in pricing capital.

## 1. Introduction

There is a large and growing literature on costs of price adjustment and its role in market economies. See, for example, Andersen (1994), Ball and Mankiw (1994), Caplin and Spulber, 1987, Caplin and Leahy (1991, 1997), Danziger (1988, 1999), Mankiw (1985), Mankiw and Romer (1991), Rotemberg (1982, 1987), and Sheshinski and Weiss (1977), to mention just a few. These price adjustment costs can be a source of price rigidity as demonstrated theoretically by Mankiw (1985), Blanchard and Kiyotaki (1987), and Ball and Romer (1990), and empirically by Levy et al. (1997, 1998) and Dutta et al. (1999). Indeed, according to Blinder et al. (1998, p. 21), these costs have become “...one of the main strands of New Keynesian theorizing” as many predictions of the traditional Keynesian and more recent New Keynesian models crucially depend on the existence of some form of price rigidity.

Many scholars have emphasized the importance of going to the field to study business pricing-practices. For example, Caplin (1993, p. 21) calls for “more detailed empirical work and for increased understanding of the manner in which corporations actually arrive at pricing decisions.” Similarly, Blinder et al. (1998, p. \*\*\*) suggest “going to the source of price change activity—the managers who change the prices—to gain insights about pricing and price change processes and their implementation.” This motivation has led to a revival of studying business-pricing practices in economics. Consequently, scholars have been using a variety of field-based techniques and methods to study pricing processes and cost of price adjustment at firms in order to improve our understanding of how firms set and adjust prices. These methods include surveys (Blinder et al., 1998), interviews, historical case studies (Levy and Young, 2001), and field studies (Levy et al., 1997 and 1998; Dutta et al., 1999; and Zbaracki et al., 2001).

One of the key lessons from these studies is that price adjustment is a “...very difficult, costly and time-consuming process” (Caplin and Leahy, 1995) and that changing prices “is a complex process, requiring dozens of steps and a non-trivial amount of resources” (Levy et al., 1997, p. 792). Consistent with these findings, recent empirical studies of price adjustment processes by Levy et al. (1997, 1998), Slade (1998), and Dutta et al. (1999, 2002), conclude that the menu costs associated with these processes may be significant in many markets and industries. Blinder et al. (1998), in a remarkable

interview study report that the managers they interviewed considered these costs as important as well. Zbaracki et al. (2001) extend the category of the price adjustment costs they consider to include managerial and customer costs and find that these two components dwarf the magnitude of menu costs: they account for only 3 percent of the total price adjustment costs at the establishments they studied.

However, while the above studies focused on measuring the magnitude of price adjustment costs, what we really discovered in our field studies was that from the standpoint of the firms, the problem of price adjustment costs was secondary at most. Before their decisions about whether to change prices they faced a higher-level decision about how to allocate their limited resources among various uses and needs. We discovered that besides the traditional uses of the resources for investments in plant, equipment and production capacity, R & D, brand development, marketing, service, etc., these organizations needed investments in resources designed to help them improve their price-setting capabilities.

For example, the data used by Levy et al. (1997, 1998) and Dutta et al. (1999) was collected by a company producing electronic shelf label systems—small LCD panels displaying price and unit information which are designed to replace the standard paper price tags commonly used in supermarket, drugstore, and many types of other retail establishments. That data were collected by the company because supermarket chains were in the processes of assessing the feasibility of purchasing these systems, and they needed to know the cost of the existing price adjustment processes, in order to determine the benefits these systems could provide in terms of greater flexibility and more optimal pricing. Supermarket managers had to consider these kinds of investments because of the pricing task they face: they carry about 25,000 different products, and each week they change the prices of about 4,000–5,000 of them. How do you *optimally* adjust the prices of so many products week after week in a dynamic and competitive marketplace?

The industrial manufacturing company studied by Zbaracki, et al. (2001) was facing a similarly difficult task of optimal pricing: the company manufactures over 8,000 different products; it has about 1,300 customers, some of them purchasing as many as 3,000 different products; and on each product the company faces multiple competitors. How can the company's price managers adjust the prices of so many products *optimally* as market conditions—costs, competitors' prices, demand, etc.—change?

Based on numerous observations of this kind, we argue that there is more to price adjustment than the existing literature recognizes. Beyond the cost of price adjustment lie higher form decisions firms make about how much to invest in the infrastructure, computer systems, information systems, routines and processes, that they use to adjust prices.

These observations suggest that we could think of prices as being “produced.” I.e., we could think of pricing process as similar to other production processes in the firm, and describe it by means of a production function, the “pricing production function.” Such a perspective on price adjustment is consistent with a suggestion made by Julio Rotemberg (2000) in his comments as the discussant of Zbaracki et al.’s (2001) paper, that perhaps, we should think of firms pricing processes as “producing” prices and price lists, in the same way that firms use production processes to produce goods and services. Caplin and Spulber (1987, p. 105, footnote 10) make a similar remark in passing: “If these [menu costs] are indeed real costs, they should be explicitly included as part of output. Hence, a closed model of the economy should include a sector of variable size dedicated to the production of menus.”

Applying this line of thinking to the investments firms may undertake in their pricing infrastructure, we can think of the expenditures incurred by retail supermarket chains on electronic shelf labels, or by industrial manufacturers on computer hardware and software, information systems, and pricing managers’ training, etc., as investments in “pricing capital.” These investments in pricing capital enable the companies to improve the efficiency of the pricing production function because they enable the firms both to reduce the costs of changing prices, and also improve the effectiveness of price adjustments, in future periods.

We use two different sources of data to provide evidence supporting the existence of firm-level investments in pricing capital, and the impact of these investments (or the lack thereof) on pricing decisions made by firms. First, we use quantitative data collected using industrial engineering time-and-motion methods, on the costs and benefits of electronic shelf label systems in the US retail supermarket industry. The second data set consists of qualitative evidence from a cross-disciplinary ethnographic study of price adjustment processes by large US industrial firms. In addition, we provide some anecdotal evidence of business practices drawn from various industries, consistent with

our interpretation of the data. We find that, taken as a whole, these data offer compelling evidence of the existence and importance of firm-level pricing capital in market economies.

The existence of “pricing capital” introduces a new, higher level, pricing decision made by firms’ pricing managers. Decisions to invest in pricing capital compete for organizational resources with traditional capital investment decisions that have long been studied in economics, such as capital investments in plant and equipment, R & D, supply chains, brands, service, etc. As such, a pricing manager can be viewed as trading off investments in pricing capital for investments in such areas as new production lines, investment in R & D capital, etc, and vice-versa. For example, according to the manufacturer of the electronic shelf label systems, some supermarket chains have decided not to invest in electronic shelf label systems and instead they chose to invest in other investment initiatives, such as changing store layout, inventory systems, and database systems, opening new stores, etc.

Focusing on investments in pricing capital rather than just on prices themselves fundamentally changes the way we think about price adjustment in economics. It suggests looking toward the pricing infrastructure that has or has not been developed to decipher the likely degree and causes of price rigidity and its variation across price setters, markets, and industries. Furthermore, since pricing capital is a choice variable for firms, it implies that constraints such as costs of price adjustment, that are commonly used in models of price rigidity are endogenous. As such, pricing capital not only explains the existence of price adjustment costs, but also provides their microeconomic foundations. These micro-foundations have important implications for how we should think of price adjustments, and thus how we should model the price dynamics in many areas of economics.

The theory of pricing capital and pricing production function we offer in this paper should be viewed as a generalization of the standard neoclassical model. According to the standard model, price setters somehow know or discover the optimal price without devoting any resource to this knowledge acquisition and discovery process. Our theory, in contrast, is based on the idea that the optimal price discovery process is not a costless process. To the contrary, it requires substantial amount of real resources (not just “small menu costs”), which have alternative uses. This is especially true for a multi-product

manufacturer facing multiple competitors. Further, the theory implies that the more resources a price-setter is investing in pricing capability in the form of pricing capital, the more flexibility it attains in its ability to optimally set and adjust prices. Thus, the ability of a firm to set and adjust prices effectively, and therefore the efficiency of the price system itself, emerge as endogenous choice variables of price setters.

The paper is organized as follows. In section 2 we present the lessons from the field by discussing two different data sets to demonstrate how firms operating in various markets and industries are forced to invest in pricing capital. The data provide overwhelming evidence on the critical importance of pricing capital for reducing the cost of price adjustment. The data, we believe, also indicate the critical importance of the pricing capital for optimal price setting. In section 3 of the paper we discuss the implications of the pricing production function theory for various issues in the economics of pricing, price adjustment, and the price system. In section 4, we conclude by summarizing the key insights of the pricing production function theory and suggest future research questions.

## **2. Lessons from the Field**

In this section we present evidence of investments firms make in pricing capital, and the impact of these investments on the ability of firms to adjust prices effectively. We offer two separate sources of evidence. The first is from field studies conducted by a firm selling electronic shelf label systems in the U.S. supermarket industry. The second is from a two-year multi-disciplinary field study of pricing processes for a major industrial manufacturer and its major customers. In addition, we offer some anecdotal evidence (see the conclusions section) from the trade press documenting pricing capital investments made by firms operating in a wide variety of industries, ranging from pricing on the internet, to airlines, packaged goods, automobiles, business-to-business markets and services, etc.

For each piece of evidence we begin by describing the industry and the data source. We then describe the investments the pricing managers have made in pricing capital, and the economic implications of those investments for price adjustments made by the firms. The specific forms of pricing capital investments range from new

technologies in presenting prices and pricing structures, to new computer systems and software for intensive data analysis, and to training and development of human capital. The economic implications that follow from these investments range from reductions in future costs of price adjustment, to more effective adjustment of prices to changes in market conditions, and a greater price flexibility in terms of the ability to change more prices more quickly and more optimally.

## **2.1     *Electronic Shelf Labels***

We begin with a discussion of electronic shelf labels, which are small, radio-controlled LCD displays that are attached to the shelf instead of the standard paper price tags. These electronic shelf labels enable the retail supermarket and drugstore managers to change prices at both the shelf and the cash register (scanner database) with the touch of a button on their computer terminal. Given the speed and accuracy of the electronic shelf label systems in changing and managing the shelf prices, they can be used by the retail supermarket and drugstore chains to greatly reduce the complexity and the lead times currently associated with changing shelf prices using standard shelf paper price tags.

In order to sell the product, the company needed to validate what the existing processes of changing price tags and price signs were in the supermarket and drugstore chains in order to estimate the benefits of using the electronic shelf label systems. The company has received a permission from several supermarket and drugstore chains to go to representative stores and record the exact steps involved in the price change process and measure the resources (primarily labor) it consumes. The electronic shelf label company's researchers worked along with the people involved in the process of changing prices on the store floor where the shelf price tags are physically changed, and undertook detailed time and motion recordings measuring the frequency of various steps undertaken in the price change process along with the required labor time. These studies, which were conducted during the years 1991–1992, were also designed to help the electronic shelf label system manufacturer and its potential customers (retail supermarket and drug store chains) assess the overall efficiency improvements an electronic shelf label system would provide.



We were given access to the raw data and the analyses the electronic shelf label manufacturing company conducted in its effort to estimate the anticipated benefits this system offered to the retail supermarket and drugstore chains. These benefits range from hard measurable benefits in reducing the future costs of adjusting prices, to less quantifiable benefits in terms of new pricing and business practices that the company could undertake because of the new technology. See Levy et al. (1997) and (1998), and Dutta et al. (1999), for a more detailed discussion of the data, methods and findings in terms of the cost of price adjustment for the traditional paper shelf price tag environments.

The retail supermarket and drugstore managers in general seem to agree that electronic shelf label systems may help them make the price change process more efficient in comparison to the existing paper based price change system. However, purchasing an electronic shelf label system involves an assessment of both, the costs as well as the benefits of the system. According to the Electronic Shelf Label Company, the main items included in the costs' side of these cost-benefit considerations are the following.

First, the direct cost of an electronic shelf label system, in the range of \$100,000–\$170,000 in 1991–92 dollars (the exact price depends on the bells and whistles included in the system), is substantial. Second, there is the cost (in the range of \$7,000–\$9,000) of installing the system and training the supermarket employees to correctly use the system as well as to take advantage of all of its features. Third, the costs of converting to the ESL-based price display and price adjustment system also include time-loss incurred by the stores, employees and customers for down-time caused by readjusting the tags and store layout. Fourth, the ESL system comes with software and hardware, which require routine maintenance on an on-going basis, which is also costly. The transition from paper-based shelf price tags to electronic shelf label systems, therefore, entails a substantial capital investment on the part of retail supermarket and drugstore chains.

In addition to these direct costs of the ESL system, the retailers face capital constraints, as well as alternative investment strategies, such as opening new stores or expanding existing stores, which may yield higher net present value: a payback period of 2 years or less seems to be the minimum necessary in the retail supermarket and drugstore industry. There is also a concern over evolving technology standards and

technological obsolescence: retailers need to be confident that the system works and that the vendor will be in business at least for the next five years minimum. Finally, the electronic shelf label system only works with 60–75 percent of the products supermarket and drugstore chains carry. It does not work well with frozen products or variable weight products.

On the benefit side, the use of electronic shelf label system in the retail supermarket and drugstore industry promises to reduce the physical costs of price adjustment substantially. In Table 1 we report a range of estimates from the Electronic Shelf Label Company of the annual savings from adopting their system in comparison to the traditional paper shelf price tag environments. The anticipated savings come from reductions in four categories, printing and delivering shelf price tags, labor required to change shelf labels, and reduced mistakes in the process. In addition to these measurable “hard” benefits, the ESL systems offer numerous “soft” benefits such as the ability to adjust prices almost instantly to changes in costs or even to changes in demand by adjusting prices by times of day when the stores are more/less busy. In addition, the system makes the process of price change management less complex, less cumbersome, and more efficient. This is because the price changes are made in a computer with a click of a button, and it is automatically communicated to the ESL’s LCD displays on the shelves as well as to the scanner database, which feed the price information to the cash registers. The higher price and price change accuracy ensured by the integration of the scanner database with the ESL price display information on the shelves, promises to retain more customers and attract more new customers. The new system also eliminates the paper-based price label change cost as a barrier to implementing low-yield price changes.

Thus, these investments promise to reduce the costs of price adjustment in the future. These “menu costs” are known to be significant in this industry, as reported by Levy et al. (1997, 1998), and Dutta et al. (1999), in the range of \$91,416–\$114,188 for an average of \$105,887 a year (in 1991-92 prices), per store of the sampled supermarket chains. These systems promise to save a substantial portion of these costs as Table 1 indicates. According to the data obtained from the ESL Company reports, the company promises a payback of the ESL system cost (the direct cost of the system plus the maintenance cost) in 1.5–2.4 years. In order to get a sense of the saving the system might

provide if these payback periods do not materialize, we have calculated in Table 1 the saving the system may provide under different rates, from 50% savings of the menu cost to 95% of the menu cost.

Therefore, these firms have a choice of investing today in a capital investment and reducing their costs of price adjustment in the future. We were able to observe meetings between ESL vendors and two supermarket chains considering buying the systems. In fact, these customers did compare the investment in ESL's with other investments in new initiatives in their supply chain, inventory management, or store improvements. As discussed by Levy et al. (1998), many supermarket chains have since adopted these ESL systems, especially chains operating in states with item pricing laws such as in Connecticut, New Jersey, etc.

## **2.2. *Managing Pricing Processes in Industrial Markets***

*“Such a study [of pricing processes] should attempt to look at issues of price setting for one product as well as a line of related products and at various levels of the distribution channel; attention also has to be paid on the problems and procedures relating to the implementation of price policies.”*

(V. Rao, 1984)

Consider now the price adjustment processes used by a large Mid-western industrial manufacturer selling to value added resellers. The company is a market leader in its industries, and sells more than 8,000 products. We undertook a two-year, cross-disciplinary, ethnographic research study into the price adjustment processes at this firm. In addition to the company itself, we also studied the price adjustment processes at a variety of the firm's customers. We formed a unique research team made up of an organizational behavior ethnographer, a consumer behavior ethnographer, an economist, a pricing scholar and a distribution scholar. This gave us a unique ability to combine the ethnographic methodology with detailed knowledge of the business and economic issues underneath the processes we were studying. We conducted non-participant observations (Atkinson and Hammsersley, 1994) during a wide variety of pricing activities, as well as open ended, tape-recorded ethnographic interviews (Spradley, 1980) with the individuals who were involved at various stages in the price adjustment process. In total, our team spent more than 500 man-hours in the field and this period of immersion produced over

800 pages of observational notes and 2,000 pages of single spaced pages of interview transcripts. Additional documentary data such as organizational charts, pricing documents and e-mails were also collected. (See Zbaracki et al., 2001, for more details on these data and the methodology.)

Following Levy, et al. (1997, 1998) and Dutta, et al. (1999), this study sought to understand the costs of adjusting prices at the firm, except that rather than addressing the physical costs of changing prices, the study addressed the managerial and customer costs of changing prices. Consistent with that aim, our ethnographic work aimed at discovering how the firm changed prices and what changing prices cost the firm. We sought detailed descriptions of the various tasks and tools used in that process. Over the course of our two-year study, we found that the managerial and customer costs of changing prices were quite substantial; indeed these costs swamped the physical costs of changing prices. But we also found that managers also frequently described various investments made to improve its price adjustment processes.

In this section we highlight three examples of such investments, and discuss their implications for pricing decisions at these firms. Two of these investments are tools and systems to handle data and help managers do analysis. Many of the price-adjustment practices require that managers marshal immense amounts of data, so the managers must have systems that permit effective price adjustment. In contrast to the electronic shelf label systems discussed above, which are front room technologies used to present, display, and readily adjust prices, these are the back-room technologies used by firms to analyze and assess the effects of price adjustments. These technologies are like the physical capital used in production systems, except here there are no physical goods being produced; prices are produced. In comparison to traditional physical capital elements, here “plant,” rather than referring to manufacturing space, might include office space. Similarly, “equipment,” rather than production equipment, might mean computer hardware and software. The third of these investments is human capital, in such forms as academic training for pricing managing team members and hands-on practice in the latest pricing techniques, methods, and tools.

#### Example 1: Investment in Price Generation System

Consider first the decision by the firm in our study to invest millions of dollars in new computer hardware and software to create improved pricing systems at corporate headquarters. We saw investments in greater computer power, in software to connect information systems within the company and between the companies (the company and its customers), in software to analyze the pricing data at headquarters, in computers and software to help the field sales force analyze pricing and price change decisions, and in refinements to existing systems. For many of the managers and participants that we interviewed, the pricing system was one of the central components of the price-adjustment process at the firm. A pricing manager we interviewed, two years after he arrived, recalled it as the centerpiece of the price adjustment process, commenting, “ I started here two years ago. One of the first things I saw was my former boss design the (new pricing) system which was all about setting prices.”

That manager’s boss, a senior pricing manager, saw the investments in such a pricing system as essential to effectively adjust prices. He faced a constantly changing market for over 8,000 different products purchased by 1,500 different customers, with multiple competitors offering alternatives to each of those 8000 products. As he described it, he felt uncomfortable because he didn’t have sufficient competitor data to make good pricing decisions:

*The only data I have is cost. So you start to consider the [pricing] responsibility and you dig out of the cupboard the competitive price list and hear that people had different things on their price list and you were never sure what they actually meant. Were they discounting off this number or off this number? I never felt comfortable that I was making a rational decision because I felt like I had part of the data.*

In response, the senior pricing manager developed one central element of his pricing system, a more complete database, which also included various pricing history detail. That meant that the firm had more than cost information available. He also developed a competitor database. That allowed the pricing staff to know and understand competitor actions and therefore make more carefully considered pricing actions. Without such data, the manager simply couldn’t make effective pricing decisions. Of course, developing the new database necessitated large financial and time commitments by the manager and his group. He had to buy new software, hardware, and get the sales force to collect and send in competitive information. He also needed to check the quality of the data and bring in salespeople and engineers to make sure the prices made sense in light of technical and

market realities. Nevertheless, our interview data suggested that the system was one of the legacies this manager left behind. Indeed, two years later the pricing analysts continued to develop more sophisticated ways to analyze competitor data using the system he had developed.

A second major element of the new system was increased flexibility for adjusting prices. Sometimes the existing systems weren't sophisticated enough to manage the pricing information optimally. For example, the limitations of the existing pricing systems presented nagging problems by preventing the firm from responding to competitors' actions. The senior pricing managers described the difficulty:

*It was that the systems didn't have flexibility. People were discounting one level off of list price for everything on the price list. This happens today and it drives me insane. There are parts that are driving our business and you do not discount them. This was the fundamental problem. [One of our competitors] had a program and they were using it against us and it was frustrating. I had to match what they were doing. We cannot give discounts across the board; our pricing system did not allow us to do that. And that is why we created so many price lists. ... We can only sell to the reseller at one discount for everything they do.*

In contrast to its competitors, the only way the firm could match competitor actions was to offer discounts across the entire product line. When a competitor offered a discount off of one specific part in a package of products it sold to a distributor, the firm we studied could only match that price by offering a comparable discount for all the parts that it sold to that distributor. The lack of system flexibility was a clear shortcoming in the pricing system, and placed the firm at a pricing disadvantage in comparison to their competitors. The only alternative would be to price each product individually, but here the process of doing comparison across 8000 parts, 1500 customers, and multiple competitors would create for the firm a nearly impossible analytic task.

The investment costs of the system extended beyond the investment in the systems and software to estimate prices to other system requirements. The firm we studied discovered that updating its pricing systems required corresponding updating of its systems and of its customers' systems. For example, because of the complexity of the price adjustment processes, using the new pricing system placed extraordinary demands on the accounting systems, sometimes crashing those systems. As one pricing manager stated:

*In 1996 we were not able to [do analysis] basically because of communication issue or what the system could do. It can't handle 8,000 part numbers times 250 [major] customers effectively without dogging everything else in the company now. We weren't able to jive what we wanted to do with what the system could do and I think we made some less than optimal decision. We have addressed some of those this year quite well.*

In other cases, the new pricing systems at the company headquarter required that the customer firm managers enter the prices by hand, because their systems couldn't accommodate the structure of prices in the firm's new systems.

These instances pointed to further examples of investments in pricing systems. In the course of our study of the customers, we found that the firm we studied was not alone in developing a price generation system. We also found that the major customers had developed similar systems for adjusting their prices in response to changes at the firm that we studied. For instance, the firm that we studied began to offer rebates (further discounts off of the list price targeted towards specific customers and market opportunities). In response, one of the customers we interviewed designed a system to automatically take into account rebates to have data available immediately on updated prices:

*I saw this rebate thing get larger and larger so I decided this was a thing we could automate. So we put in a process that is hands on with a button that is pushed at the end of the month. Our system is updated enough that we closed out April last night and we had sales figures after the last guy walked out of the door. I want things done and at my fingertips. This precludes us from having to actually having to make photocopies of invoices. It takes two minutes to set up a customer when they come on board. I can do it any way I want on the screen and I can dissect it any way I want. This is a powerful program. I prefer to go out and negotiate with customers and tell them here is our deal, you get this break over this product line.*

The system offered two major advantages. First, the owner of the distributor could update his prices as soon as the rebates were agreed on. He could therefore quote prices to his customers almost immediately, whereas historically after meeting with customers he had to return to his office to calculate prices. Second, given the deals that he struck with his customers, he immediately could calculate sales and send rebate requests back to the firm's headquarters. Consequently, he could also respond to sales trends much more quickly. That customer was not alone in automating price-adjustments. Over the course of our studies, we saw other instances where major customers had invested capital to develop systems that could provide such improved responsiveness.

Similarly, at the firm that we studied, investments in the price generation system allowed the firm to integrate its pricing processes with other parts of the firm. For example, some of the systems were designed to allow information flow across multiple pricing systems within the company. Other components of the system provide the pricing staff at the company headquarters and the sales force in the field access to company databases from different divisions such as marketing, accounting, and finance. These elements of the system allowed the firm to integrate pricing processes more readily with, for example, improved production processes. And, as we discuss next, a more powerful example of such a system was developed to help integrate the sales force more directly.

### Example 2: Investment in Pricing Toolbox

The firm invested still more in computers and software to create pricing tools for their field sales force. As the former director of pricing described it, “We developed toolbox to give the reseller [the distributors to whom they sold products] the cross-reference information. In 1992 there wasn’t a central filing system where the stuff goes.” Over time, they added features to the program, and when we studied the firm, one of the pricing analysts described it as a program “that allows our field sales people out there in the field to cross their own part numbers on competitive bids ... When they do quotes they can see the competitor’s price also and they can see what type of a discount they need to apply part number by part number.” Similarly, such systems provide the pricing staff at company headquarters and the sales force access to databases from different areas such as marketing, accounting and finance.

The sales force quite clearly saw the benefits of this pricing tool. One of the members of the sales force described how it changed how they developed quotes for customers:

*When I first started we would make sales calls and we would want to quote that guy. So what I would have to do is I would have to go to the shelf and write all the part numbers down that he has manually and then I would have to go back home and I would have to write all those part numbers down again and then search for the competitor’s price sheet and put what their blue sheet was, then write manually what our blue sheet was, and then put down what the selling the guy told me or I guessed it was. Then I would have to try and figure out what discount that was on all these manually. Then when we had this tool box it was an automatic process with quotes.”*



We found clear evidence that these expenditures were directly related to the costs of price adjustment, because these fixed costs reduced the costs of changing prices in future periods. For example, when asked whether it saved time, the salesperson was clear about the benefits:

*Q. How much time did that save you?*

*A. Not hours - days. ... You wouldn't like to make five calls a day with the salesman and have to do all five of those manually - you wouldn't want to do that. It took up so much time. You would do maybe one call a day. A lot of the distributors didn't have computers so they would have to do it manually also and have to go in and quote manually. The computer and the toolbox helped save a lot of time.*

Toolbox was a simple idea: it allowed the sales force to call up a part number and get information about the various uses of that product, comparable competitor products, and engineering details. It also made pricing information available. But the consistent theme in discussing it as a pricing tool was that it changed the way that they offered quotes to customers—and changed the frequency of such quotes. Such investments also allowed firms to improve their pricing effectiveness. The new computer systems and software allowed the firm to do more sophisticated analysis of their data and better estimate the customer, competitive and financial aspects of their proposed price adjustments. They could look at more products in more detail, look at more customers, analyze price sensitivity more effectively, and try out the financial implications of more prices and greater forms of pricing.

### Example 3: Investment in Human Capital

We also found evidence of investments in human capital in the form of various skill acquisitions by pricing team members. The new pricing systems required skills ranging from analysis of consequences of price changes, to financial analyses of price changes that incorporated estimates of customer elasticity, to dynamic estimates of projected cost changes, and finally to calculations of anticipated growth and lifetime value of customers. For example, one senior pricing manager consequently found that he needed to work on developing “the financial skills sets and engineering skill sets that the pricing work increasingly required.” The firm that we studied and many of its customers

were therefore constantly investing in different means to improve the knowledge and skills of their pricing staff.

Such investments took two broad forms. Human capital investments were undertaken through formal education and through less formal training of the pricing group employees. Formal programs aimed at improving the knowledge of the state of the art in pricing. For example, the firm we studied had begun sending current pricing managers to academic pricing courses in order to increase their theoretical knowledge about pricing. At one customer firm, the employees we talked to had been to executive training courses on pricing at major U.S. universities. And, less directly, the firm invested in formal training by increasingly seeking employees with graduate training in business.

Less-formal training programs were aimed more at task-specific human capital. For example, one sales manager described a training package that he put together in order to help members of the sales force recognize whether they have negotiated a good deal:

*I put together part of this in this packet purely to help address the training part of it to understand: this represents our standard product, you see our profitability and net profit before taxes, fixed costs and over here is the freight that we talk about and the other variable costs.*

Numerous similar training programs introduced organizational members to new pricing tools or educated firm members about the pricing actions the managers intended to take in changing its list prices.

In contrast, a lack of pricing capital was often seen as a barrier to more effective pricing decisions. For example, at the firm we studied, one the senior pricing managers realized that he couldn't have his staff address new pricing issues because the firm did not have anyone with experience in pricing, commenting, "The problem that I knew we were encountering when we were doing this pricing was that you couldn't delegate this to anybody because nobody had been around ten years to know what was going on." Similarly, one senior pricing manager lamented how a lack of human capital prevented another group from applying effective pricing practices, even with training. He observed that "They put a bunch of people in there and said, 'We are going to train you to be different.' But they did not invest in a group who had the financial skills sets and engineering skill sets to be able to recognize business units." In this instance, the

managers could not implement a proposed set of strategies and price change decisions because the workforce lacked financial and engineering analysis skills.

Here we have only presented examples of human capital required. In the course of our studies, however, we found extensive evidence that the pricing managers at the firm were keenly aware of the need to build pricing skills and capabilities of their employees. Much of a pricing manager's time was spent on the development of these "pricing investments" in the firm. The most important actions the managers could undertake that would impact pricing at their firms in a significant way, were investments in the pricing capital of the firm—not any particular pricing decision they made. In fact, we discovered that the legacy of most pricing managers, in retrospect, were the improvements in the price adjustment processes they developed. Thus, pricing, as it was practiced at these firms, was being defined in terms of investments in people and processes.

### **3. Implications of the New Theory of Pricing**

The evidence we provide in section 2 above suggests a view of what pricing is all about in organizations, and what tasks the pricing managers really face in their firms, that differs from the commonly accepted view. Pricing, we believe, is more about investing in pricing capital, then about adjusting the prices themselves. This line of thought points towards a new level of pricing decision that lies behind the scenes of the prices and price changes we observe—managing investments in pricing capital. It turns out that this point of view leads to numerous important insights and implications. Below we briefly discuss some of them.

#### **(i) *Cost of Price Adjustment (Menu Cost)***

The existing literature on costs of price adjustment takes a very simplistic view of the price adjustment process: it says that the price setter must incur a small fixed cost each time it changes the price. The term "menu cost," which has been coined to describe the need to incur the cost of printing a new menu if the restaurant owner decides to change his prices, tries to capture this idea.

However, scholars had a great difficulty to identify and pin down these menu costs or assess its magnitude (Blinder et al., 1998). Further, several authors such as

Gordon (1990) and Ball and Mankiw (1994), among others, have expressed the view that menu costs, if interpreted literally, may not be high enough to cause substantial effects. It has been argued, therefore, that these costs should be viewed metaphorically, like a parable, to formalize the fact that prices are not adjusted continuously. For example, according to Ball and Mankiw (1994, p. 143), “Walras observed that prices move to equilibrate supply and demand, and he captured this tendency with the parable of an auctioneer. Similarly, macroeconomists have noted that many prices are sticky in the short run, and they capture this fact with the parable of menu costs. It is no more appropriate to insist on an exact identification of menu costs than it is to demand the social security number of the Walrasian auctioneer.” Slade (1998, p. 104), in contrast, argues that “... given the large number of theoretical papers that evaluate the implications of [price] adjustment costs, obtaining direct evidence that such costs are present seems crucial.” More fundamentally, she raises this point as a prerequisite for our understanding of why these menu costs might exist.

We believe that the new theory of pricing capital we are offering here addresses all these questions. First, the theory offers a language to identify the sources of the constraints firms and price-setters face in adjusting prices. Second, and more importantly, the theory offers an explanation for where these price adjustment costs come from. Firms need to devote real resources to pricing capital in order to optimize their pricing and price adjustment mechanisms, processes, and routines. The cost of price adjustment is therefore determined by the amount of the resources the firms invest in their pricing capital. If firms choose to not invest—or to invest very little—in pricing capital, then they will have only a limited ability to adjust prices. In that case, optimal price adjustment will require an expenditure of higher marginal cost for each price change. If on the other hand the firm is willing to devote substantial resources to its pricing capabilities, then the firm will gain the ability to adjust the prices of more products, more frequently, more optimally, and at a lower marginal cost.

For example, the whole purpose of electronic shelf labels was to reduce the future costs of adjusting prices in the store. In industrial markets new computer systems and software were developed for the explicit purpose of reducing the cost of the analysis of the proposed price changes in the firm we studied. Further, the software developed for the

field sales force was explicitly meant to lower their costs of preparing price communications and negotiations with customers.

The theory of pricing production function, thus, offers a new explanation for why firms face costs of price adjustment in the first place: it may not be profitable enough to invest in pricing capital for reducing the price adjustment costs because alternative investment projects may yield higher return. That is, the firm can choose to invest in reducing their costs of price adjustment by investing in various forms of pricing capital, or use those resources to finance other forms of investment such as improvements in production processes, expanding the variety of goods offered, improve service, R&D, etc.

**(ii) *Endogeneity of Price Adjustment Costs***

An important aspect of these expenditures on pricing capital then is that they are directly related to the future costs of price adjustment. But that means that the size of the costs of price adjustment is endogenous because managers can choose pricing processes that reduce these costs by judicious investments in their pricing capital. Thus, we can think of pricing production function with a given cost of price adjustment structure, which determine the marginal costs of price adjustment and each period firms can invest in lowering those costs in future periods through judicious expenditures on pricing capital.

Of course, once we allow for the reality that firms can choose the marginal costs of price adjustment, we need to consider the possibility that firms could be even more strategic and choose to “create them.” We saw this in the data of the industrial manufacturer in the reporting structure the firm created for rebates. For small rebates the sales person could simply mail them in to the home office and they would be approved. As the size of the rebate increased more people at corporate headquarters were involved in the approval process, more analysis was done, and more signatures were required on the supporting documents. Such costs, we argue, depend on two levels of choices. First, the costs depend on a choice to use rebates at all a decision that the firm acknowledged frequently in our discussions. Using rebates allowed the firm to create costs—both for themselves and for their competitors—by making the price less transparent. Second, the costs depend on the choice of *how* to use rebates, especially here on the process of approval.

**(iii) *Heuristic Pricing Rules and the Behavioral Theory of the Firm***

The theory of pricing production function can also explain heuristic pricing rules we observed at the company headquarters. The company, which is producing over 8,000 different products, faced the impossible task of optimally pricing all their products for all 1,500 customers, some of whom purchase as many as 3,000 different products, and for each product, the company faced multiple competitors. Before the firm invested in the price generation system (see Section 2.2), they faced a substantial cost of price adjustment year after year, during each pricing season. Because these costs were too high, the company tried to economize, by using more cost-efficient price production rules such as “competitor + 3,” “cost + 5,” “competitor – 2,” “last year + 3,” etc. Moreover, these and other similar rules were applied to thousands of products at a time.

Thus, the theory predicts the use of the kinds of heuristic price adjustment rules, shortcuts, and other simple, not fully “economically rational” pricing rules we observed in actual settings. At the strategic level, it may not be profitable to invest too much in pricing processes to make them fully “rational.” These are the best rules given the available pricing production functions, and given the allocation of investments between pricing capital and other productive capital. Given the complexity required to do pricing as it is taught in marketing and economics, and the value of other activities to the firm, it is likely that many firms would choose to adopt these kinds of simplifying rules and heuristics. Further, by focusing on the higher-level decision of investments in pricing capital, it moves pricing to a level of decision-making in the firm that Cyert and March (1963) suggest.

Our theory may also shed light on the “marginalists controversy” that raged in economics in the 1950’s. Once we look at pricing and price adjustment as requiring pricing capital investments, then a lack of these investments would cause a manager to choose simpler rules and heuristics because that’s all they can do under the circumstances. In this sense, the level of pricing investment defines the “marginality,” in terms of using the full range of economic tools and pricing techniques a pricing manager can establish and adopt. Thus, the firms that invest in pricing capital will act more “marginal,” and firms that have not invested in pricing will act less “marginal” in their processes.

**(iv) *Endogeneity of the Degree of Price Rigidity***

Our theory also explains why firms may be willing to use pricing routines and processes that lead to price rigidity: it must be more profitable for them to invest in other activities. Firms will not invest in pricing capital if there are other, more effective and more profitable uses to these resources. To that end, the theory offers an explanation for why firms will endogenously choose pricing environments in which prices do not fully adjust to changes in the marketplace, thereby allowing some rigidity in their prices. It may be too costly to create a perfectly efficient pricing and price adjustment systems, and resources may be better spent on other productive activities.

This may offer an explanation to the indexation puzzle (McCallum, 1986; Gordon, 1990): why firms in market economies don't index their nominal prices (except perhaps in high inflation economies)? It may be that for such indexation, they need pricing capital that are beyond what they are willing to invested. That is, indexation may require kinds of information systems, knowledge, and tools, and it may entail such complexities, that can't be efficiently or effectively implemented with current pricing processes. Furthermore, firms may believe that the risks and costs associated with inflation are small relative to other concerns. As such, they may choose to invest in other types of pricing capital, at the managerial level, or not even invest in pricing capabilities at all, at the strategic level.

**(v) *Heterogeneity in Price Rigidity***

An issue of interest in the economic literature on cost of price adjustment is the variation in price rigidity across firms, industries, and markets (Gordon, 1990; Caplin, 1993; Carlton and Perloff, 1994; Dutta et al. (2002), Levy et al. (2002), Müller et al. (2002)). Our theory of pricing capital offers an explanation to such a variation as well. For example, large firms like the one we study here, may have different pricing processes and routines for different set of product categories. A variation in pricing capital investments across these categories may lead to variation in price rigidity across the products within the firm. Similarly, firms in the same industry may choose different levels of investments in their pricing processes, which can lead to heterogeneity in price rigidity across firms in an industry. At a more macro level, since firms in different

industries and different economies may choose different levels of investments in their pricing processes, we will observe heterogeneity in price rigidity across industries and economies as well. Furthermore, the degree of heterogeneity in price rigidity is likely to change over time, as firms invest in improving their pricing processes.

**(vi) *A New Source of Price Rigidity—Pricing Process Rigidity***

If pricing processes require investments in “pricing capital” in order to make them more flexible, then it is likely that the required resources and time period to change the processes themselves will be substantial. That is, it is very likely that the costs of adjusting pricing processes may be greater than the costs of adjusting prices, because it requires changes in the pricing infrastructure and systems, not just in prices. This is a well-recognized principle in the marketing literature, where it is common knowledge that changes in systems such as new product development processes, organizational structures, or channels of distribution, are slow and difficult to make. As such, changes in pricing processes will move more slowly, and be much longer lasting, than prices themselves. This suggests that at least some of the price rigidity we observe in various markets and industries may be caused by the rigidity of the pricing processes themselves. A recent paper by Mankiw and Reis (2001) suggests a similar idea, which they term “decision rigidity.”

**(vii) *Growth and Development***

Viewing pricing in this way is a natural extension of the literature on the economics of adjustment. Caplin and Leahy (1995, p. \*\*\*) define the economics of adjustment as “... how the economy must adjust to changing circumstances. It must reallocate resources away from less desirable goods and less productive technologies, towards more desirable and more productive ones.”

Given the links between this view of pricing and the economics of adjustment, it is likely that our theory of pricing capital can offer some insight into how economies develop and grow. Caplin and Leahy (1995, p.78) argue that “the economics of transition, growth and development share much in common with the economics of adjustment.” If, in fact, resources can be used for either productive purposes or to improve pricing processes, then developing economies have to continually make a trade



off between the two investments. Different economies may choose different trade off. For example, it may be rational to develop productive resources first and develop pricing resources only later. This may lead to different paths of productivity, growth and distribution of income in developing economies. This is consistent with the situation—the complete lack of pricing resources and infrastructure—observed in many states of the former Soviet Union, where the free market price system was non-existent.

There is an interesting theoretical link—a complementarity—between productive and pricing capital, in that greater investments in pricing capital make a firm's investments in productive capital more profitable. Thus we may see investments in pricing capital go hand in hand with investments in productive capital. Investments in pricing capital, therefore, may be related to business cycles. For example, firms, once they start investing in some productive capital, they may accelerate their investments in their pricing capital as well.

#### ***(viii) Models of Competition***

Our theory of pricing offers a new and perhaps more effective way of understanding the dynamics of pricing and price competition in the marketplace. Our theory of pricing implies that firms are simultaneously competing on pricing with other firms at *all levels* of the organization, not just on the prices themselves. At the managerial level, therefore, CEO's are competing on how much to invest in pricing capital and capabilities. So when the CEO at Ford begins to invest in pricing capabilities of his company, the CEO of General Motors, Honda and others need to take note. The pricing playing field is being set. Pricing managers are competing on what to invest in. A narrow view of only one type of pricing capital may doom the company to inefficiency and undermine the strategic pricing direction of the firm. And price setters need to take into account the pricing capabilities of their company, customers, supply chain members and competitors.

Thus models of prices using both competition and imperfect competition should take the pricing capital structures into account when studying price behavior. It forces one to consider price competition between firms equipped with incomplete pricing processes, or different pricing processes in the market. This leads to many possible dimensions of price competition. For example, one could study how firms with similar

processes compete at different levels of investment in pricing capital. It would be interesting to see whether two firms with low levels of investment in their pricing processes compete differently than two firms with high levels of investments in their pricing processes. One could also study how firms with different processes compete with one another. For example, how does a firm with higher level of investment in pricing processes compete against a firm with lower levels of investments? How critical are the relative differences in pricing processes to the prices set by two competing firms?

A further outgrowth of this new organizational theory of pricing is that we should study models of investments in pricing processes, and how firms compete at the level of these investments. Competition is really being fought between firms with different portfolios of pricing capital, and the dynamics of pricing in the industry may well be better described by following the pricing capital investments of market participants than by the prices themselves. This raises a host of interesting questions: will firms converge to the same level of pricing capital in an industry? Does the most effective capital structure vary with the product life cycle? What determines the optimal level of pricing capital?

**(ix) *Economic Policy and Investment in Pricing Capital***

The new theory of pricing suggests a new dimension to government policy—that it can have long-lasting effects on the pricing processes of firms and the economy. Policies such as wage and price controls, government taxes, transfers and subsidies, or even macroeconomic policy need to consider these long-term effects in their decision-making.

Consider the affect of price controls on an economy. In the short term the price controls distort the price system as they limit the ability of prices to move. But now there is another, higher level, effect such a policy will likely have on firms. They can affect the kinds of pricing investments the firms choose to undertake. For example, firms may choose to invest more in pricing-related processes and infrastructure that are less affected by regulatory scrutiny.

For example, consider the reaction of firms to wage and price controls in the early 50's. This is when a series of benefits in health care and other insurance and retirement benefits came into existence. Managing these benefits required investments in skills,

processes, and infrastructure in order to understand and manage these kinds of services. Long after the controls are gone, these investments still exist in companies and can be used to set wages. So these wage and price controls can lead to firms developing perverse abilities that may undermine future policy initiatives and fundamentally alter the fabric of the economy. At the highest level, these wage and price controls affect whether the firm will invest in pricing processes or other processes. A clear implication is that the firms will find pricing capabilities less valuable, and other investments more valuable. This makes firms less effective in their pricing, making their future price adjustments more costly, less frequent, and less effective.

(x) ***Economic Theory and Pricing Investments: A Self-Referential Feedback Loop***

If, as we observed in the field on numerous occasions, investments in human capital in the form of new knowledge and skills are part of the investments firms undertake to improve their pricing processes, then advances in economic theory of pricing become an input into these pricing processes. Since these processes define the prices we observe, advances in pricing theory eventually impact prices themselves. Thus economics is a self-referential discipline, with advances in price theory affecting the prices it studies. Marketing and other business disciplines are even more vulnerable to this effect. Since marketers are closer to practice, and often have the stated goal of improving business practice they are even more likely to change the very systems they are studying.

For example, as economists develop better or more complete theories of competition in market economies, these theories will eventually permeate the pricing processes of firms as they invest in the pricing infrastructure, systems and processes that the theories support. To understand the full impact, new theories in marketing and economics must consider how firm's incorporating their insights may change behavior in the future. Similarly, older, outdated marketing and economic theories may still have some affect on pricing processes, and therefore the prices we observe in the marketplace. Basically price theory is part of a feedback loop, with a lag, into the very pricing processes that we study.

(xi) *Endogeneity of Market Efficiency*

Perhaps the most provocative implication of the new theory of pricing is that the firms themselves, by choosing whether to invest in pricing processes, determine the efficiency of the pricing mechanism of the markets, industries and economies they operate in. If firms choose not to invest in pricing processes, then they will be constrained in their ability to set and change prices effectively. As such, the pricing mechanism will not work as effectively to clear markets and allocate resources efficiently as the standard neoclassical economic theory predicts. At the same time, if firms do invest in pricing capabilities then one can expect that pricing theory as it is understood in marketing and economics can be at play, and prices and markets can attain their role as efficiency enhancing mechanisms.

Based on the ideas presented in this paper, we suggest that what may be missing from the traditional line of thinking is that the price system itself requires investments and resources to be able to serve its allocative function. Prices have long been viewed as the cornerstone of the market economy, serving at the center of the allocative mechanism of scarce resources among competing uses. The new theory of pricing turns this argument on its head: if what we have observed is true, the ability of prices to play this allocative role, crucially depends on the decision of individual firms as to how much to invest in their pricing capabilities. This makes the efficiency of price system an endogenous variable, directly determined by the pricing investment decision made by individual firms.

At a minimum, our theory of pricing implies that a free market economy requires investments in pricing resources for efficient functioning. The efficiency of the price system does not come for free. Firms that choose to adopt free market economic principles will have to invest in pricing infrastructure, systems and processes to make this system work. Governments and societies must create policies that support investments in pricing processes if they want the price mechanisms to function efficiently in their economies.

At the broad level, the new theory of pricing provides a new perspective on the choices between economic systems, suggesting that economies and societies can also take into account the costs associated with using prices as their resource allocation mechanism or using some other forms/means of transaction and exchange. If a society is more

focused on investing in other forms of capital, then it must recognize the consequence of that choice: the possible inefficiency of their price system.

#### **4. Conclusion**

In this paper we have asked the reader to go beyond the current view of pricing and the costs of price adjustment, to a view in which firms manage investments in pricing capital, which determine their ability to adjust prices. We have provided evidence supporting this new view from two different sources of data covering a variety of industries.

Our argument is that setting and adjusting prices as described in academic papers and textbooks requires considerable resources, infrastructure, and tools. To set and adjust prices effectively, firms need to gather and analyze data that may be in different parts of the organization. They need the ability to assess a wide variety of market factors, from costs to customer segments, to estimating market demand, to understanding customer psychology, to anticipating competitors' reactions, to name just a few. They also need organizational structures and processes supporting these activities. Add the complexities of firms selling multiple products (often hundreds, and even thousands, like the company we study) through multiple distribution channels, and to multiple customers, often internationally, and the required organizational processes, infrastructure, and tools, become clear.

Existing business practices can provide anecdotal evidence consistent with this argument. First, consider what was required for American Airlines and other airlines to undertake yield management pricing systems. They had to invest millions of dollars in computer hardware and software. American was the first to invest in Sabre, a system to collect and display airline prices for travel agents. This made it possible for all market participants in the industry to see the price activities, such as price changes, of each airline as soon as they were implemented. Within ten years most major airlines had adopted some form of yield management in their pricing.

These ideas of yield management have been spreading to other industries under the name of "smart" pricing. For example, Ford has begun following a version of smart

pricing. Since the 1990's these smart pricing systems have been adopted by other car-makers as well as by hotels and many internet companies, among others.

Second, consider activity-based pricing. SuperValu (the largest wholesaler operating in the grocery industry) and Owens & Minor (the largest wholesaler in health care industry) have recently both adopted activity-based pricing. To be able to use these methods and tools, both firms had to train their employees on activity-based cost accounting, change their information systems to measure these costs by activity, and match activities to each customer. They also needed to develop processes that would enable them to use the price information appropriately and effectively.

As another example, Rainbow Foods, a large US retail supermarket chain, has recently invested in electronic shelf label systems, in order to reduce the costs of price adjustment it incurs on a weekly basis. Roche has recently invested in computer pricing hardware and software systems to be able to do more effective analysis of prices as market conditions change. Similarly, companies such as GE and 3M have invested in human capital by developing academic and hands-on training courses and training camps for their employees on the most current pricing theories, tools and techniques.

Third, consider the conclusions in managerial textbooks, such as Dolan and Simon (1996), who mention—only in passing—the need to make investments to improve pricing processes. They state that becoming effective at pricing “is not without certain costs. Investments must be made in mechanisms to assemble the necessary fact base and to rethink what it means to manage price.” In addition, they discuss how the lack of investments can lead to ineffective pricing methods: “How well are managers equipped with the informational and organizational means to develop and implement ... pricing strategies? Usually not too well.”

We argue that what determines how well managers are equipped depends on how their firms have invested in pricing capital. We argue further that these pricing capital investments fundamentally alter the costs and effectiveness of price adjustment at those firms. Finally, we argue that such a view has important implications for how we think about price setting.

In many ways, the existence of pricing capital seems almost self-evident if we consider what economic theory requires of firms to effectively adjust prices, or even if we casually observe how prices are actually adjusted in firms. What is puzzling is why we, as

economists, have not acknowledged the existence of pricing capital in our development of price theory.

The primary contribution of this paper is to call the profession's attention to this heretofore ignored dimension of pricing. We argue that the theory of pricing capital offers a new, more organizational, view of pricing, which price theorist should explore. Firms, in this view, simultaneously adjust prices, and make investment decisions in pricing capital, thereby defining their ability to adjust prices in the future. Thus, our theory suggests that the literature on costs of price adjustment should take a broader view of these costs—that they are endogenous outcome of higher-level allocation decision made by the firm on its pricing infrastructure.

We discuss how firm decisions to invest in pricing capital, fundamentally alters the way we should think about pricing and price adjustment in many areas of economics. But it is clearly only a first step in this direction, and perhaps only the tip of a much larger iceberg as, much is yet to be discovered about the role pricing capital plays in firms' pricing decisions.

The idea that investments in pricing capital in terms offer return in terms of lower future costs of price adjustment and/or more effective adjustment offers an exciting direction for future empirical work. How firms allocate resources to pricing capital relative to other forms of capital is an interesting area for future study.

There are many promising theoretical directions as well ranging from competition to growth to the theory of the firm to macroeconomics. The relation between pricing investment and business cycles is less clear but obviously worth pursuing as well. Although we don't know what future research will find, we can say that based on our research we believe that answering these questions are critically important to as they are a large part of the realities managers face when setting prices. We can, however, make one prediction: our profession's investment in learning on pricing capital will likely lead to a better understanding of the role prices and price systems play in market economies.

## References

Akerlof, George A., and Janet L. Yellen (1985), "A Near-Rational Model of Business Cycle, with Wage and Price Inertia." *Quarterly Journal of Economics* 100, 823–838.

- Andersen, Torben M. (1994), *Price Rigidity: Causes and Macroeconomic Implications* (Oxford: Clarendon Press).
- Arnould, Eric and Melanie Wallendorf (1993) Market Oriented Ethnography, *Journal of Marketing Research*, XXXI (November), 484–504.
- Atkinson and Hammsersley (1994), \*\*\*.
- Ball, Laurence, and N. Gregory Mankiw (1994), “A Sticky-Price Manifesto.” *Carnegie-Rochester Conference Series on Public Policy*, 127–152.
- Ball, Laurence, and David Romer (1990), “Real Rigidities and Nonneutrality of Money,” *Review of Economic Studies*, LVII, 183–203.
- Barnett, Steven A. and Plutarchos Sakellaris (1998), “Nonlinear Response of Firm Investment to Q: Testing a Model of Convex and Non-convex Adjustment Costs,” *Journal of Monetary Economics*, Vol. 42, 261–288.
- Bewley, T. and W. Brainard (1993), “A Depressed Labor Market, As Explained by Participants,” Yale University, February, mimeo.
- Blanchard Olivier J. (1994), “On Sticky Prices: Academic Theories Meet the Real World: Comment, in *Monetary Policy, Studies in Business Cycles*, Vol. 29, Chicago and London: The University of Chicago Press, 150–54.
- Blanchard Olivier J., and Nobuhiro Kiyotaki (1987), “Monopolistic Competition and the Effects of Aggregate Demand.” *American Economic Review* 77, 647–666.
- Blinder, Alan S., Elie R. D. Canetti, David E. Lebow, and Jeremy B. Rudd (1998), *Asking About Prices: A New Approach to Understanding Price Stickiness*. New York, NY: Russell Sage Foundation.
- Caballero, R. and Engel (1991), “Dynamic S-s Economies,” *Econometrica* LXI, 1659–1686.
- Caplin, Andrew (1993), “Individual Inertia and Aggregate Dynamics,” in *Optimal Pricing, Inflation, and the Cost of Price Adjustment*, edited by E. Sheshinski and Y. Weiss, pp. 19-45. Cambridge, MA: The MIT Press.
- Caplin, Andrew S., and John Leahy (1991), “State Dependent Pricing and the Dynamics of Money and Output.” *Quarterly Journal of Economics* 106, 683–708.
- Caplin, Andrew S., and John Leahy (1995), “The Economics of Adjustment,” in *The Natural Rate of Unemployment*, edited by Rod Cross (New York: Cambridge University Press, 77–89.
- Caplin, Andrew S., and John Leahy (1997), “Aggregation and Optimization with State-Dependent Pricing.” *Econometrica* 65, 601–625.



- Caplin, Andrew S., and Daniel F. Spulber (1987), "Menu Costs and the Neutrality of Money," *Quarterly Journal of Economics* 102, 703–725.
- Carlton, Dennis W. (1986), "The Rigidity of Prices." *American Economic Review* 76, 637–58.
- Carlton, Dennis W. (1989), "The Theory and the Facts of How Markets Clear: Is Industrial Organization Valuable for Understanding Macroeconomics?" in *Handbook of Industrial Organization, Volume 1*, edited by Richard Schmalensee and Robert D. Willig, pp. 909–946. Amsterdam: North Holland.
- Carlton, Dennis W., and Jeffrey M. Perloff (1994), *Modern Industrial Organization*. New York, NY: Harper Collins.
- Cecchetti, Stephen G. (1986), "The Frequency of Price Adjustment: A study of the newsstand prices of magazines." *Journal of Econometrics*, Volume 31, 255–274.
- Cyert, Richard M. and James G. March. (1963), *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice Hall.
- Danziger, Leif, (1988), "Costs of Price Adjustment and the Welfare Economics of Inflation and Disinflation," *American Economic Review*, 78, 633–646.
- Danziger, Leif (1999), "A Dynamic Economy with Costly Price Adjustment," *American Economic Review*, Vol. 89, No. 4, 878–901.
- Dolan, R. J. and H. Simon (1996), *Power Pricing: How Managing Price Transforms the Bottom Line* (New York: The Free Press).
- Dutta, Shantanu, Mark Bergen, and Daniel Levy (2002), "Price Flexibility in Channels of Distribution: Evidence from Scanner Data," *Journal of Economic Dynamics and Control*, Vol. 26, No. 11 (June), 1845–1900.
- Dutta, Shantanu, Mark Bergen, Daniel Levy, and Robert Venable (1999), "Menu Costs, Posted Prices, and Multiproduct Retailers," *Journal of Money, Credit, and Banking*, Vol. 31, No. 4 (November), 683–703.
- Eisenhardt, Kathleen M., (1989) "Building theories from case study research," *Academy of Management Review*, 14, 532–550.
- Gordon, Robert J. (1990) "What is New-Keynesian Economics?" *Journal of Economic Literature* 28, 1115–1171.
- Greenwald, Bruce, and Joseph Stiglitz (1993), "New and Old Keynesians," *Journal of Economic Perspectives*, 7 (Winter), 23–44.

Haddock, David D. and Fred S. McChesney (1994), “Why Do Firms Contrive Shortages? The Economics of Intentional Mispricing,” *Economic Inquiry* 32, No. 4, October, 562–581.

Hall, Simon, Mark Walsh, and Anthony Yates (1997), “How Do UK Companies Set Prices?” Bank of England Working Paper No. 67, July.

Heide, Jan B. and George John (1988), “The Role of Dependence Balancing in Safeguarding Transaction-Specific Assets in Conventional Channels,” *Journal of Marketing*, 52(1), 20-35.

Kashyap, Anil K. (1995), “Sticky Prices: New Evidence from Retail Catalogues,” *Quarterly Journal of Economics* 110, 245–274.

Krusell, Per and Anthony A. Smith, Jr. (1996), “Rules of Thumb in Macroeconomic Equilibrium: A Quantitative Analysis,” *Journal of Economic Dynamics and Control*, Vol. 20, 527–558.

Lach, Saul, and Daniel Tsiddon (1996), “Staggering and Synchronization in Price-Setting: Evidence from Multiproduct Firms.” *American Economic Review* 86, 1175–1196.

Levy, Daniel, Mark Bergen, Shantanu Dutta, and Robert Venable (1997). “The Magnitude of Menu Costs: Direct Evidence from Large U.S. Supermarket Chains.” *Quarterly Journal of Economics* 112 (August), 791–825.

Levy, Daniel, Shantanu Dutta, Mark Bergen, and Robert Venable (1998) “Price Adjustment at Multiproduct Retailers,” *Managerial and Decision Economics* 19 (February), 81–120.

Levy, Daniel and Andrew Young (2001), “The Real Thing: Nominal Price Rigidity of the Nickel Coke, 1886–1959,” manuscript, presented at the American Economic Association Meeting.

Lincoln, Yvonna and Egon Guba (1985) *Naturalistic Inquiry*, Beverly Hills: Sage.

Lindbeck, Assar (1987), in Discussion of Julio Rotemberg’s The New Keynesian Microfoundations, in *NBER Macroeconomics Annual*, p. 115.

Mankiw, N. Gregory (1985), “Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly,” *Quarterly Journal of Economics* 100, 529–539.

Mankiw, N. Gregory and David Romer (1991), *New Keynesian Economics* (Cambridge, MA: MIT Press).

Mankiw, N. Gregory and Ricardo Reis (2001), “Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve,” NBER Working Paper No. 8290, May.

- McCallum, Bennett T. (1986), On Real and Sticky-Price Theories of the Business Cycle, *Journal of Money, Credit, and Banking*, Vol. 18, No.4, November, 397–414.
- Meltzer, Allan H. (1995), “Information, Sticky Prices, and Macroeconomic Foundations.” *Federal Reserve Bank of St. Louis Review* 77, 101–118.
- Miles, Matthew B. and A. Michael Huberman, (1984), *Qualitative Data Analysis*. Beverly Hills, CA: Sage.
- Müller, Georg, Daniel Levy, Shantanu Dutta, and Mark Bergen (2002), “Holiday Price Rigidity and Cost of Price Adjustment,” Working Paper No. 3-2002 (March), manuscript presented at the July 2001 NBER-CRIW Conference, Cambridge, MA.
- Okun, Arthur M. (1981), *Prices and Quantities: A Macroeconomic Analysis*. Washington, DC: The Brookings Institution.
- Parkin, Michael. (1986), “The Output-Inflation Trade-off When Prices Are Costly to Change,” *Journal of Political Economy* 94, 200–224.
- Rao, V. (1984), “Pricing Research in Marketing: the State of the Art,” *Journal of Business* 57 (1), S39–S60.
- Rotemberg, Julio J. (1982), “Sticky Prices in the United States.” *Journal of Political Economy* 90, 1187–1211.
- Rotemberg, Julio J. (1987), “The New Keynesian Microfoundations.” *NBER Macroeconomics Annual*, 69–104.
- Rotemberg, Julio J. (2000), Discussant’s Comments on Zbaracki, Ritson, Levy, Dutta, and Bergen, at the NBER Monetary Economics Program Meeting in April 28, 2000, Cambridge, MA.
- Rubin, Paul (1990), *Managing Business Transactions*. New York, NY: The Free Press.
- Sherry, John (1995) *Contemporary Marketing and Consumer Behavior*, London: Sage.
- Sheshinski, Eytan and Yoram Weiss (1977). Inflation and Costs of Price Adjustment, *Review of Economic Studies*, 44, 287–303.
- Sheshinski, Eytan and Yoram Weiss (1992). Staggered and Synchronized Price Policies Under Inflation: The Multi-product Monopoly Case. *Review of Economic Studies*, 59, 331–359.
- Slade, Margaret E. (1998), “Optimal Pricing with Costly Adjustment: Evidence from Retail-Grocery Prices.” *Review of Economic Studies* 65, 87–107.
- Spradley, James (1980) *Participant Observation*, London: Holt: Rinehart.

Thompson, Craig, William B. Locander and Howard R. Pollio (1994) “The spoken and the unspoken: A Hermenutic Approach to Understanding the cultural viewpoints that underlie consumers expressed meanings”, *Journal of Consumer Research* 21, (December), 432–452

Wells, William D. (1993), *Discovery Oriented Consumer Research*, 19, March, 489–504.

Willis, Jonathan L. (1999) “Estimation of Adjustment Costs in a Model of State-Dependent Pricing.” Ph.D. Dissertation: Boston University.

Zbaracki, Mark and M. Bergen (2000), “The Social (Re)construction of Price and Pricing: Organizational Perspectives,” Working Paper, Wharton.

Zbaracki, Mark, Mark Ritson, Daniel Levy, Shantanu Dutta, and Mark Bergen (2001), “Managerial and Customer Costs of Price Adjustment: Direct Evidence from Industrial Markets,” manuscript under revision.

**Table 1: ESL Capital Expenditure and Savings (in 1991-92 dollars)**

Supermarket Chain	Estimated Annual Menu Cost per Store <sup>1</sup>	Cost of the ESL System <sup>2</sup>	Annual Savings @ 50%	Annual Savings @ 75%	Annual Savings @ 95%
A	\$ 105,311.00	\$157,230.00	\$52,655.50	\$78,983.25	\$100,045.45
B	\$ 112,635.00	\$139,104.00	\$56,317.50	\$84,476.25	\$107,003.25
C	\$ 91,416.00	\$110,173.00	\$45,708.00	\$68,562.00	\$86,845.20
D	\$ 114,188.00	\$141,898.00	\$57,094.00	\$85,641.00	\$108,478.60
Average of Chains A–D	\$ 105,887.00	\$137,101.25	\$52,943.50	\$79,415.25	\$100,592.65

1. Source: Levy et al. (1997), Table III, p. 805.

2. Includes the ESL system cost and its maintenance cost. Source: the ESL Company.

**Bar-Ilan University**  
**Department of Economics**  
**WORKING PAPERS**

---

- 1-01 **The Optimal Size for a Minority**  
Hillel Rapoport and Avi Weiss, January 2001.
- 2-01 **An Application of a Switching Regimes Regression to the Study of Urban Structure**  
Gershon Alperovich and Joseph Deutsch, January 2001.
- 3-01 **The Kuznets Curve and the Impact of Various Income Sources on the Link Between Inequality and Development**  
Joseph Deutsch and Jacques Silber, February 2001.
- 4-01 **International Asset Allocation: A New Perspective**  
Abraham Lioui and Patrice Ponce, February 2001.
- 5-01 **מודל המועדון והקהילה החרדית**  
יעקב רוזנברג, פברואר 2001.
- 6-01 **Multi-Generation Model of Immigrant Earnings: Theory and Application**  
Gil S. Epstein and Tikva Lecker, February 2001.
- 7-01 **Shattered Rails, Ruined Credit: Financial Fragility and Railroad Operations in the Great Depression**  
Daniel A. Schiffman, February 2001.
- 8-01 **Cooperation and Competition in a Duopoly R&D Market**  
Damiano Bruno Silipo and Avi Weiss, March 2001.
- 9-01 **A Theory of Immigration Amnesties**  
Gil S. Epstein and Avi Weiss, April 2001.
- 10-01 **Dynamic Asset Pricing With Non-Redundant Forwards**  
Abraham Lioui and Patrice Ponce, May 2001.

Electronic versions of the papers are available at  
[http://www.biu.ac.il/soc/ec/wp/working\\_papers.html](http://www.biu.ac.il/soc/ec/wp/working_papers.html)

- 11-01 **Macroeconomic and Labor Market Impact of Russian Immigration in Israel**  
Sarit Cohen and Chang-Tai Hsieh, May 2001.
- 12-01 **Network Topology and the Efficiency of Equilibrium**  
Igal Milchtaich, June 2001.
- 13-01 **General Equilibrium Pricing of Trading Strategy Risk**  
Abraham Lioui and Patrice Poncet, July 2001.
- 14-01 **Social Conformity and Child Labor**  
Shirit Katav-Herz, July 2001.
- 15-01 **Determinants of Railroad Capital Structure, 1830–1885**  
Daniel A. Schiffman, July 2001.
- 16-01 **Political-Legal Institutions and the Railroad Financing Mix, 1885–1929**  
Daniel A. Schiffman, September 2001.
- 17-01 **Macroeconomic Instability, Migration, and the Option Value of Education**  
Eliakim Katz and Hillel Rapoport, October 2001.
- 18-01 **Property Rights, Theft, and Efficiency: The Biblical Waiver of Fines in the Case of Confessed Theft**  
Eliakim Katz and Jacob Rosenberg, November 2001.
- 19-01 **Ethnic Discrimination and the Migration of Skilled Labor**  
Frédéric Docquier and Hillel Rapoport, December 2001.
- 1-02 **Can Vocational Education Improve the Wages of Minorities and Disadvantaged Groups? The Case of Israel**  
Shoshana Neuman and Adrian Ziderman, February 2002.
- 2-02 **What Can the Price Gap between Branded and Private Label Products Tell Us about Markups?**  
Robert Barsky, Mark Bergen, Shantanu Dutta, and Daniel Levy, March 2002.
- 3-02 **Holiday Price Rigidity and Cost of Price Adjustment**  
Daniel Levy, Georg Müller, Shantanu Dutta, and Mark Bergen, March 2002.
- 4-02 **Computation of Completely Mixed Equilibrium Payoffs**  
Igal Milchtaich, March 2002.

- 5-02 **Coordination and Critical Mass in a Network Market – An Experimental Evaluation**  
Amir Etziony and Avi Weiss, March 2002.
- 6-02 **Inviting Competition to Achieve Critical Mass**  
Amir Etziony and Avi Weiss, April 2002.
- 7-02 **Credibility, Pre-Production and Inviting Competition in a Network Market**  
Amir Etziony and Avi Weiss, April 2002.
- 8-02 **Brain Drain and LDCs' Growth: Winners and Losers**  
Michel Beine, Frédéric Docquier, and Hillel Rapoport, April 2002.
- 9-02 **Heterogeneity in Price Rigidity: Evidence from a Case Study Using Micro-Level Data**  
Daniel Levy, Shantanu Dutta, and Mark Bergen, April 2002.
- 10-02 **Price Flexibility in Channels of Distribution: Evidence from Scanner Data**  
Shantanu Dutta, Mark Bergen, and Daniel Levy, April 2002.
- 11-02 **Acquired Cooperation in Finite-Horizon Dynamic Games**  
Igal Milchtaich and Avi Weiss, April 2002.
- 12-02 **Cointegration in Frequency Domain**  
Daniel Levy, May 2002.
- 13-02 **Which Voting Rules Elicit Informative Voting?**  
Ruth Ben-Yashar and Igal Milchtaich, May 2002.
- 14-02 **Fertility, Non-Altruism and Economic Growth: Industrialization in the Nineteenth Century**  
Elise S. Brezis, October 2002.
- 15-02 **Changes in the Recruitment and Education of the Power Elites in Twentieth Century Western Democracies**  
Elise S. Brezis and François Crouzet, November 2002.
- 16-02 **On the Typical Spectral Shape of an Economic Variable**  
Daniel Levy and Hashem Dezhbakhsh, December 2002.
- 17-02 **International Evidence on Output Fluctuation and Shock Persistence**  
Daniel Levy and Hashem Dezhbakhsh, December 2002.



- 1-03 **Topological Conditions for Uniqueness of Equilibrium in Networks**  
Igal Milchtaich, March 2003.
- 2-03 **Is the Feldstein-Horioka Puzzle Really a Puzzle?**  
Daniel Levy, June 2003.
- 3-03 **Growth and Convergence across the US: Evidence from County-Level Data**  
Matthew Higgins, Daniel Levy, and Andrew Young, June 2003.
- 4-03 **Economic Growth and Endogenous Intergenerational Altruism**  
Hillel Rapoport and Jean-Pierre Vidal, June 2003.
- 5-03 **Remittances and Inequality: A Dynamic Migration Model**  
Frédéric Docquier and Hillel Rapoport, June 2003.
- 6-03 **Sigma Convergence Versus Beta Convergence: Evidence from U.S. County-Level Data**  
Andrew T. Young, Matthew J. Higgins, and Daniel Levy, September 2003.
- 7-03 **Managerial and Customer Costs of Price Adjustment: Direct Evidence from Industrial Markets**  
Mark J. Zbaracki, Mark Ritson, Daniel Levy, Shantanu Dutta, and Mark Bergen, September 2003.
- 8-03 **First and Second Best Voting Rules in Committees**  
Ruth Ben-Yashar and Igal Milchtaich, October 2003.
- 9-03 **Shattering the Myth of Costless Price Changes: Emerging Perspectives on Dynamic Pricing**  
Mark Bergen, Shantanu Dutta, Daniel Levy, Mark Ritson, and Mark J. Zbaracki, November 2003.
- 1-04 **Heterogeneity in Convergence Rates and Income Determination across U.S. States: Evidence from County-Level Data**  
Andrew T. Young, Matthew J. Higgins, and Daniel Levy, January 2004.
- 2-04 **"The Real Thing:" Nominal Price Rigidity of the Nickel Coke, 1886-1959**  
Daniel Levy and Andrew T. Young, February 2004.
- 3-04 **Network Effects and the Dynamics of Migration and Inequality: Theory and Evidence from Mexico**  
David Mckenzie and Hillel Rapoport, March 2004.

- 4-04 **Migration Selectivity and the Evolution of Spatial Inequality**  
Ravi Kanbur and Hillel Rapoport, March 2004.
- 5-04 **Many Types of Human Capital and Many Roles in U.S. Growth: Evidence from County-Level Educational Attainment Data**  
Andrew T. Young, Daniel Levy and Matthew J. Higgins, March 2004.
- 6-04 **When Little Things Mean a Lot: On the Inefficiency of Item Pricing Laws**  
Mark Bergen, Daniel Levy, Sourav Ray, Paul H. Rubin and Benjamin Zelig, May 2004.
- 7-04 **Comparative Statics of Altruism and Spite**  
Igal Milchtaich, June 2004.
- 8-04 **Asymmetric Price Adjustment in the Small: An Implication of Rational Inattention**  
Daniel Levy, Haipeng (Allan) Chen, Sourav Ray and Mark Bergen, July 2004.
- 1-05 **Private Label Price Rigidity during Holiday Periods**  
Georg Müller, Mark Bergen, Shantanu Dutta and Daniel Levy, March 2005.
- 2-05 **Asymmetric Wholesale Pricing: Theory and Evidence**  
Sourav Ray, Haipeng (Allan) Chen, Mark Bergen and Daniel Levy, March 2005.
- 3-05 **Beyond the Cost of Price Adjustment: Investments in Pricing Capital**  
Mark Zbaracki, Mark Bergen, Shantanu Dutta, Daniel Levy and Mark Ritson, May 2005.