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Price Rigidity and Flexibility: New Empirical Evidence

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The marketplace, along with its price system, is the single most important institution in a western-style free enterprise economy. The ability of prices to adjust to changes in supply and demand conditions enables the market to function efficiently, and that ability lies behind the magical invisible hand mechanism. The behaviour of prices and in particular the ability of prices to adjust to changes in market conditions, therefore, have fundamental implications for many key issues in many areas of both microeconomics as well as macroeconomics. It is, therefore, critical to study and understand whether there are barriers to price adjustments, what are the nature of these barriers, how the barriers lead to price rigidity, what are the possible implications of these rigidities, etc. This introductory essay briefly summarizes the 14 empirical studies of price rigidity that are included in this special issue. Copyright © 2007 John Wiley & Sons, Ltd.

INTRODUCTION

The marketplace, along with its price system, is the single most important institution in a western-style free enterprise economy. It is the ability of prices to adjust to changes in supply and demand conditions that enables the market to function efficiently. It is the ability of prices to adjust to changes in market conditions that lies behind the magical invisible hand mechanism. The behaviour of prices, therefore, has fundamental implications for many key issues in many areas of both microeconomics as well as macroeconomics.

One of the key questions of interest in this context is to what extent do prices indeed adjust to changes in market conditions. In other words, how rigid or how flexible are the prices? In microeconomics and industrial organization, this question is important as the extent of price rigidity and flexibility may serve as an indicator of the efficiency of the price system and market outcomes. In macroeconomics and in monetary economics this question is important because of the role rigid prices play in explaining short-run monetary non-neutrality and therefore in the study and conduct of macroeconomic and monetary policy. It is, therefore, critical to study and understand whether prices are rigid or not, that is, whether there are barriers to price adjustments, what are the nature of these barriers, how the barriers lead to price rigidity, what is the extent of the price rigidity, what are the microeconomic and macroeconomic consequences of the price rigidity, how widespread price rigidities really are, etc.

Certainly, these and many similar questions about price rigidity are not new. The rigidity of prices and wages is one of the key ingredients of the traditional Keynesian economics. Until about early 1990s, however, there were only a handful of empirical studies that studied price rigidity using micro-level (i.e., store level and product level) data on actual transaction prices.

During the last 15–20 years, the literature has witnessed a remarkable revival in the popularity of New Keynesian models, that is, models that incorporate various forms of price rigidities as

the main source of friction that generates monetary non-neutrality. See, for example, Mankiw and Romer (1991a, b) and Sheshinski and Weiss (1993), which contain references to other related studies.

The revival of the theoretical New Keynesian research program has rekindled the economists' interest in the empirical aspects of price rigidity. The literature, therefore, began producing empirical studies of price rigidity using various types of micro-level data from the US as well as from the European Union member countries.

A previous special issue of *Managerial and Decision Economics* (Levy, 2007) was devoted to reporting some of the recent theoretical developments in this line of research. The goal of the current special issue of *Managerial and Decision Economics* is to report the findings of some of the most recent empirical studies of price rigidity. A forthcoming special issue of *Managerial and Decision Economics* (Levy and Smets, 2008) will report the results of some recent additional empirical studies that use micro-level retail and wholesale transaction price data as well as survey data from several European Union member countries.

IN THIS ISSUE

This special issue of *Managerial and Decision Economics* contains 14 empirical contributions. These papers address empirically various aspects of price rigidity and flexibility from different angles using different types of data from different sources. Of the 14 papers, eight of them use data from the US, three studies use data from Germany, one study uses data from Hungary, one from the Netherlands, and one from Israel. The types of data range from internet prices, to scanner data, to store-level hand-collected price data, to mail-order catalogue price data, and to individual product-level price data that are collected by national statistical agencies. The nature of the products and goods covered also varies, from books and CD's, to various food items, computer hardware, mortgages, consumer products, gasoline, etc.

The analysis of price data from the internet is particularly beneficial because on the internet the information gathering and search cost is substantially lower in comparison to more traditional settings. For example, consumers can conduct easy and quick price comparisons by going to various price comparison sites. Individual sellers can track the prices of their competitors continuously at almost no cost by having special data gathering software monitor, access, and download the relevant price information. This, presumably, allows the sellers react to competitors' prices, or study the competitors' reactions to their pricing and price adjustment decisions. The resulting reduction in the extent of the information asymmetry and in search cost, it has been suggested, should reduce the price dispersion and could potentially lead the markets to converge to a single price. Further, the internet setting is relatively free of menu cost-type price adjustment costs, making the internet price data particularly useful for conducting controlled experiments for assessing the relevance of various types of menu cost models by confronting the menu cost models' predictions against the data behaviour found on the internet.

Two papers in the special issue study the relevance of menu cost-type price adjustment costs directly, although as discussed below, several other papers address the question as well, but not necessarily directly.

In the paper 'Small Price Changes and Menu Costs,' Saul Lach and Daniel Tsiddon use monthly store-level transaction price data for wine and meat products, sampled at Israeli wine and grocery stores, respectively. These are the same data used by the Israeli Central Bureau of Statistics for constructing the monthly consumer price index. Lach and Tsiddon use these data to address one of the central questions of the literature on menu costs: if the cost of price change is a 'small fixed' amount as the menu cost literature usually envisions, then we should not see small price changes. However, many data sets, it turns out, contain small price changes. In addition to current study of Lach and Tsiddon, which they have also used in their earlier studies (Lach and Tsiddon, 1992, 1996), small price changes have been documented, for example, by Carlton (1986) for intermediate good price data, by Kashyap (1995) for mail-order catalogue price data, and more recently by Levy *et al.* (2006) for retail prices of food products and by Ray *et al.* (2006) for wholesale prices of food products.

Lach and Tsiddon argue that there is no contradiction between the presence of small price

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changes on the one hand, and menu costs on the other, as long as many different products are sold by the same firm and the firm is subject to price adjustment costs that have a firm-specific component. Lach and Tsiddon argue that in such an environment, the optimal change in the price of a single product may indeed be small as long as the average price change of different products by the same firm is large. The findings Lach and Tsiddon report are consistent with this explanation. For example, Lach and Tsiddon find that the smaller a price change of a given product, the larger the average price change of the remaining products sold by the firm.

Rajesh Chakrabarti and Barry Scholnick argue in the paper 'The Mechanics of Price Adjustment: New Evidence on the (Un)importance of Menu Costs' that if menu cost is the main cause of nominal price rigidity, then no nominal rigidities should exist in the internet prices because in the internet setting price changes can be made with a click of a keystroke at virtually zero cost. In other words, Chakrabarti and Scholnick argue, the internet is free of menu costs.

In their paper, Chakrabarti and Scholnick examine the price change behaviour of two well-known online booksellers, Amazon.com and BarnesandNoble.com, and find strong evidence that nominal price rigidities indeed persist on the internet. Given the virtual absence of menu costs in the internet setting, they conclude that other types of costs besides menu costs, for example managerial thinking costs (Bergen *et al*., 2003; Zbaracki *et al*., 2004, 2006), must be causing these rigidities.

In the paper 'Thick Markets, Market Competition and Pricing Dynamics: Evidence from Retailers,' Kostas Axarloglou uses store-level transaction price data for books collected in Ann Arbor, Michigan, and for music CDs collected in Natick, Massachusetts, to study the implications of thick markets and of the intensity of market competition on price markups and the synchronization in price adjustments.

Axarloglou finds that price markups decline in the presence of thick market effect due to extensive market competition among retailers. Furthermore, he finds evidence that the likelihood of price adjustments as well as the cross-store price adjustment synchronization is closely related to the intensity of market competition among price setters over fairly standardized products with relatively short product life cycle.

In the paper 'Follow the Leader: Price Change Timing in Internet-Based Selling,' Robert Kauffman and Charles Wood examine pricing strategies and competitive interactions for internet sellers in books and music CD markets. Using customized internet data collection agent which run daily and gathered price data from various internet sellers and price comparison sites, Kauffman and Wood examine the pricing strategies that are observed among internet sellers, and attempt to identify the theories that best explain these observations. They use the VAR methodology to study the competitive strategies employed by internet sellers for pricing identical goods in the books' and music CDs' markets and explore the variation in these strategies across the sampled firms.

Kauffman and Wood find that the theory of Bertrand competition seems to be insufficient for explaining the competitive pricing interactions that are occurring among internet-based sellers in terms of the timing of the competitive price changes. Instead, their results show that the firms operating in the electronic marketplace appear to pursue different market segments. Moreover, they argue that within each segment different types of competitive interactions are feasible. Kauffman and Wood also find that rather than pricing at or near marginal costs, as predicted by Bertrand competition, internet sellers try to anticipate the price changes of their rivals and accordingly time their own price changes. They do this by either using similar business rules that cause their price adjustments to react to the same external events as the other sellers do, or by monitoring price changes directly and responding accordingly.

Three papers in the special issue address the question of asymmetric price adjustment directly or indirectly. The possibility that prices might adjust asymmetrically to cost increases and decreases (or to demand increases and decreases), has received considerable attention in the empirical price rigidity literature. The three studies of asymmetric price adjustment that are included in this special issue continue that line of research.

In the paper 'Why Do Prices Rise Faster than They Fall? With an Application to Mortgage Rates,' Linda Toolsema and Jan Jacobs study asymmetric price adjustment of mortgage rates in the Netherlands. They use two main interest rate series for their study. The first is the average interest rate the Dutch banks charge for a mortgage with fixed interest term of five years.

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The second is the long-term (10 years) interest rate. This long-term interest rate is interpreted and treated as the capital market rate. Thus, the former series is interpreted as the price, while the latter series is interpreted as the cost. Using these two series, Toolsema and Jacobs estimate an error correction model of a cointegration relationship in the framework of a bivariate VAR, where the change in the mortgage rate is explained by the deviation from the long-run equilibrium in the previous month and by the current and lagged *increases* as well as *decreases* in the capital market rate.

Toolsema and Jacobs find that the Dutch mortgage rates adjust asymmetrically to changes in their costs. Specifically, they find that the response of the mortgage rate is stronger if the cost, that is the capital market rate, increases in comparison to the situation where the cost decreases. Given the reduced form framework of the econometric estimation strategy they employ in their estimations, and given the absence of important exogenous determinants of the mortgage rates, they are unable to offer a clear-cut explanation to the findings they report. Instead, they suggest that the asymmetric interest rate adjustment may be due to (i) tacit collusion, (ii) consumer search or switching costs (where the search cost is primarily caused by the lack of transparency in mortgage markets), and (iii) prepayment risk.

In the paper, 'The Dynamics of Daily Retail Gasoline Prices,' Michael Davis studies the behaviour and the dynamics of daily gasoline prices in the US. Using two years of daily retail gasoline price data from four gas stations (two Mobil and two Citgo) located in Newburgh, New York, Davis studies asymmetric price adjustment of the gas prices and assesses the relevance of the existing menu cost models by estimating a structural dynamic model of firms' price adjustment behaviour that incorporate menu costs, and finds that although the menu cost can explain the behaviour of gas prices, menu fully.

Davis explores the asymmetry in gas price adjustment using a version of the autoregressive conditional hazard rate model as well as the more standard logit model. Both models enable him to assess probabilistically the likelihood of price adjustments. He finds that in his sample, a price adjustment is more likely to occur upward than downward. Moreover, Davis explores the validity of a version of partial adjustment model and lagged information model and concludes that neither of them are consistent with the gas price behaviour that he documents. He also concludes that a likely explanation for his finding is related to the consumers search behaviour.

In the paper 'Asymmetric Price Adjustment: Evidence from Weekly Product-Level Scanner Price Data,' Georg Müller and Sourav Ray use Dominick's supermarket chain's scanner price data for both the retail as well the wholesale price for 30 commonly used food products in six categories in order to explore asymmetric price adjustment.

Dominick's is a large Midwestern supermarket chain, operating about 95 large supermarket stores in and around Chicago metro area. The chain controls about 25% of the market share in Chicago and its vicinity, making it an economically significant representative of a large retail supermarket industry.

The paper is a follow-up of Peltzman's (2000) study in which he uses the same basic data set (along with several other data sets) to explore the asymmetry. The difference between the two studies is that while Peltzman uses the data at a monthly frequency, Müller and Ray use the data at a weekly frequency, which the frequency at which the original scanner data is actually recorded. Their findings indicate that there is some limited asymmetry in the price behaviour of some individual products, but they do not find any evidence of pervasive chain-wide asymmetric pricing strategy. Müller and Ray discuss the issues of operational efficiencies, competition, and consumer perceptions as possible explanations for their findings, but in the end they rule them out. Instead, they conclude that models based on a version of costs of price adjustment offer most plausible explanation for the findings.

In the paper, 'Price Rigidity and Market Power in German Retailing,' Sascha Weber and Sven Anders study the scope of market power in the German retail market. They also try to assess the magnitude of the effect of the market power on the extent of price rigidity and flexibility in the retail markets for beef and pork in Germany. Weber and Anders use a panel of weekly retail scanner price data for the two-year period from January 2000 to December 2001 from 207 different retail outlets for 24 product categories. Amongst the sampled stores

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are small corner grocery stores as well as large self-service warehouses and discount chain stores. They also compare their findings to the findings reported for the US (see, for example, Barsky *et al*., 2003).

Weber and Anders conduct two types of analysis with this rich data set: extensive mean analysis and structural conjectural variation analysis. The extensive mean price analysis of the data shows that the hypothesis of competitive behaviour in the German retail food market can be rejected, because in their data items are sold at varying and temporarily rigid prices across different types of retail store. Weber and Anders find significant differences in the pricing behaviour across store types with discount stores featuring the highest degrees of price rigidity for beef and pork products. When Weber and Anders employ a structural conjectural variation approach to parameterize the retail industry-level equilibria, they again find significant deviations from perfectly competitive behaviour. Thus, both approaches seem to suggest that the hypotheses of perfect competition in German retailing can be rejected, indicating that German retailers have some market power.

The link between individual price dynamics and the aggregate inflation unfortunately is not well-understood and is not often studied. The next four papers try to fill this gap in the literature by studying individual product-level price behaviour under various inflationary and monetary regimes using various types of data from three different countries.

In the paper 'The Frequency and Size of Price Adjustment: Microeconomic Evidence,' Attila Rátfai documents some basic facts about price adjustment patterns at the level of individual price setter using high-frequency panel data set of retail prices of 14 processed meat products collected in nine distinct stores in Hungary during the 1993–1996, when Hungary was experiencing moderate and stable inflation rates.

As Rátfai notes, the findings from a moderate inflation regime are particularly interesting because other related studies have typically focused on data from either low- or high-inflation countries. Studies of low-inflation period might suppress the role trend inflation may play in microeconomic pricing decisions, while the studies of high-inflation periods might end up reporting biased result because at high inflation the price adjustment frequency may exceed its 'true' frequency.

Rátfai finds that stores typically change their prices in large, discrete and infrequent jumps. He also finds that the prices are set for about three months on average and when they are changed, the average change is 9%. Rátfai finds heterogeneity across both, stores and products, but the heterogeneity seems to be more prevalent in the frequency of price changes. The fraction of stores making large adjustments varies considerably over time and is strongly correlated with the inflation. Overall, Rátfai concludes that none of the popular pricing models is fully able to account for microeconomic realities found in the price settings that exist in the stores that are contained in his sample. Nevertheless, the pricing patterns Rátfai finds appear to be most consistent with two-sided *S-s* price adjustment models.

In the paper, 'Retail Prices during a Change in Monetary Regimes: Evidence from Sears, Roebuck Catalogs, 1938–1951,' Andrew Young and Alexander Blue study micro-level price dynamics immediately before and immediately after the establishment of the Bretton Woods monetary regime. For this they use price data from Sears, Roebuck and Company catalogues for 49 different consumer goods, representing fairly wide range of products both nationally branded as well as private label products.

Young and Blue find that over the entire sample period the average length between nominal price changes was over two years. That average was longer in the pre-Bretton Woods period in comparison to the later period, but only by less than half a month. Additionally, they find that prices of nationally branded products were considerably more rigid than private labels (consistent with the findings reported by Barsky *et al*., 2003). Moreover, they identify three goods that did not experience a single price change. In terms of the size of the price changes, the price changes of both nationally branded products and private label products were larger by 0.60–1.83% on average during the period from 1945 to 1951 than during the pre-Bretton Woods period. Young and Blue do not find evidence of decreased price inertia in the higher-inflation time period. Instead, they find that the price changes in their sample display a higher correlation with inflation from 1938 through 1944. Thus, Young and Blue conclude, the evidence favours a time-dependent pricing model that did not change significantly in response to the establishment of the Bretton Woods regime.

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In the paper 'Are They Always Offering the Lowest Price? An Empirical Analysis of the Persistence of Price Dispersion in a Low Inflation Environment,' Sebnem Bahadir-Lust, Jens-Peter Loy, and Christoph Weiss study the nature of price distributions and the intra-distribution dynamics for 10 food products across 131 retail stores in Germany in 2000, when the ongoing aggregate inflation rate was relatively low. Using Varian's (1980) model of sales and weekly transaction price data, they investigate whether the position of stores within the cross-sectional price distribution is persistent or perhaps it changes over time.

Bahadir-Lust, Loy, and Weiss report that posted prices vary considerably across stores. Store heterogeneity, it turns out, accounts for roughly 30% of this price dispersion and significant amount of dispersion remains even after controlling for unobserved store heterogeneity. Bahadir-Lust *et al*. also document some changes in the position within the cross-sectional price distribution over time, but still they find more persistence in ranks than reported in previous studies. Finally, their regression analysis suggests that the degree of rank persistence varies across products, regions, as well as the type of stores.

In the paper 'Price Variability and Price Dispersion in a Stable Monetary Environment: Evidence from German Retail Markets,' Matthias Fengler and Joachim Winter study the relationship between inflation and price variation using weekly price data for consumption goods, collected by a German consumption analysis agency in 1995. The data include prices for 23 product categories and cover a total of 560 individual products, each identified by the manufacturer, the products' size, the products' brand, etc.

Using these data, Fengler and Winter construct three measures of price dispersion and find significant positive correlation between the rates of price change and price dispersion, both at the level of individual products and product groups. They, however, find no correlation between the rates of price changes and price variability. After comparing their findings with those reported by other studies in this literature, they conclude that when aggregate nominal shocks are small—that is, during low-inflation periods, only price dispersion is correlated with price changes. As the rate of inflation rises, both the variability as well as the dispersion become affected. Particularly during high-inflations periods such as during hyperinflationary periods, the systematic movements in the price dispersion seem to disappear. The price dispersion, Fengler and Winter conclude, is best explained by microeconomic frictions in price adjustment, whereas price variability appears to be related to costly price search and informational problems.

The only evidence the existing literature offers on the relevance of hierarchical delays for price rigidity is the survey evidence of Blinder *et al.* (1998) and several other replication survey studies that were conducted more recently by several EU central banks, some of which are included in the forthcoming special issue of *MDE* (Levy and Smets, 2008). This is unfortunate because Blinder *et al.* (1998) include the theory of hierarchical delays amongst the 12 leading theories of price rigidity.

In the paper, 'Hierarchical Delays as a Source of Nominal Price Rigidities: Evidence from the Microcomputer Industry,' Michael Hicks investigates the market for microcomputers in the United States from 1993 to 1995 and offers evidence of nominal price rigidities that are attributable to hierarchical delays. Hicks explores alternative explanations for these rigidities and is able to rule them out.

Hicks' data include price listings of the manufacturer's suggested retail prices for 80486SX computers and components in the 25–50 MHz range, including central processing units, partially and fully assembled systems and memory add-ons for the period from January 1993 through December 1995. Hicks argues that the prices in his data are sticky in a monopolistically or workably competitive industry, which he argues is consistent with the new Keynesian interpretation of his findings.

The last paper of the special issue focuses on a non-price adjustment mechanism. The entire existing literature on market behaviour in both microeconomic theory and industrial organization focuses almost exclusively on situations in which markets clear through price adjustment. The Walrasian model is exclusively devoted to the study of such markets.

Unfortunately, very few studies consider settings in which markets clear through some other mechanism (Carlton, 1983, 1985; Blinder *et al.*, 1998; Levy and Young, 2004; Young and Levy, 2006). However, we know that the equilibrium quantity depends on not only the product's price

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but also on its quality, on the delivery time, on the delivery place, etc. Therefore, markets in principle could clear through the adjustment of one of these non-price factors. It is, therefore, both interesting as well as important to understand how firms undertake such non-price adjustment activities, especially in situations where prices may be rigid despite changes in demand and supply conditions. For example, it might be that the observed nominal prices are rigid only because the market adjusts through quality changes, or through changes in the delivery time (e.g., waiting in queues or in lines), or perhaps through changes in the delivery place, etc. In that case, the nominal price rigidity is not necessarily an indicator of market failure or of market inefficiency.

In the paper 'Non-Price Rigidity and Cost of Adjustment,' Georg Müller, Mark Bergen, Shantanu Dutta, and Daniel Levy use scanner price data from a large supermarket chain to study one component of retailers' non-price retail activity, product additions and deletions. The data, which are used also by Müller and Ray (2007), come from the scanner data set of Dominick's, a large US supermarket chain in the Chicago metropolitan area, operating 94 stores with a market share of about 25%. According to Levy *et al*. (1997, 1998) and Dutta *et al*. (1999, 2002), the sales of large multi-store US supermarket chains of this type comprised 86.3% of the total US retail grocery sales. Thus, the market they are studying has a quantitative economic significance, as well.

The database Müller, Bergen, Dutta, and Levy use represents approximately 30% of Dominick's revenues. The data come from the chain's scanner database, which contains the actual retail transaction prices of the products by each SKU code. This enables them determine when a new product is introduced or when an old product is discontinued. The retail prices are the actual transaction prices: the price customers paid at the cash register each week. The subset of the data Müller, Bergen, Dutta, and Levy use consists of 4532 products in 18 product categories covering a four-year period, from the week of 14–20 September 1989 to the week of 16–22 September 1993, a total of 210 weeks. The specific time series they use for the analysis comes from six stores of the chain that face similar competitive environments. In total, they use 27 192 price time series. The same data set has been used by Chevalier *et al*. (2003), Levy *et al*. (2002), Levy *et al*. (2005, 2006), Müller *et al*. (2006), and Ray *et al*. (2006).

Using these data, Müller, Bergen, Dutta, and Levy document periods of rigidity in the activities related to new products' introduction and old products' deletion. Specifically, they find that new products are less likely to be introduced, and existing products are less likely to be discontinued during major US holiday periods than throughout the rest of the year. Müller, Bergen, Dutta, and Levy argue that this is likely due to higher costs of undertaking these kinds of product assortment activities during holiday periods. They discuss how this conclusion relates to the existing literature on price adjustment costs, non-price adjustment, price adjustment during holiday periods, and price rigidity.

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