Price Rigidity and Flexibility: Recent Theoretical Developments

Introduction to the Special Issue

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Abstract: The price system, the adjustment of prices to changes in market conditions, is the primary mechanism by which markets function and by which the three most basic questions get answered: what to produce, how much to produce and for whom to produce. To the behaviour of price and price system, therefore, have fundamental implications for many key issues in microeconomics and industrial organization, as well as in macroeconomics and monetary economics. In microeconomics, managerial economics, and industrial organization, economists focus on the price system efficiency. In macroeconomics and monetary economics, economists focus on the extent to which nominal prices fail to adjust to changes in market conditions. Nominal price rigidities play particularly important role in modern monetary economics and in the conduct of monetary policy because of their ability to explain short-run monetary non-neutrality. The behaviour of prices, and in particular the extent of their rigidity and flexibility, therefore, is of central importance in economics.

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INTRODUCTION

The price system, the adjustment of prices to changes in market conditions, is perhaps the single most important mechanism in a market-based economy. It is the price system that ensures that markets produce and offer the goods and the services that people want. It is the price system that ensures that the quantities produced are indeed the quantities that people and consumers would like to purchase. It is the price system that ensures that the products and services produced will end up in the hands of those that value them most. In short, the price system is the primary mechanism by which market-based economies function and by which the three most basic questions get answered: what to produce, how much to produce and for whom to produce.

To the behaviour of price and price system, therefore, have fundamental implications for many key issues in microeconomics and industrial organization, as well as in macroeconomics and monetary economics. In microeconomics, managerial economics, and industrial organization, historically the economists' interest has been in the efficiency of the price system and in the resulting market outcomes. That is, the process by which price adjustments to changes in market conditions lead to efficiency of the market system and the resulting equilibrium allocations. In macroeconomics and monetary economics, the primary focus of the economists has been on the extent to which nominal prices fail to adjust to changes in market conditions. This type of nominal price rigidities play central role in modern monetary economics because of their ability to explain short-run monetary non-neutrality.

The behaviour of prices, therefore, is of central importance in economics. At the theoretical level, it is important to study models with various types of rigidities. For example, all models with Keynesian or New Keynesian flavour rely on some form of price (or wage) rigidity in order to generate predictions that fit the behaviour of the aggregate data. Therefore, it is critical to study and understand what is the nature of the barriers to price adjustments, how these barriers lead to sluggishness in price adjustment, and what do these mechanisms imply for various issues and questions at the level of both microeconomics as well as macroeconomics.

During the last 15–20 years, we have 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. Some of these studies have been published in the edited volumes by Mankiw and Romer (1991a, 1991b) and Sheshinski and Weiss (1993), which also contain references to other related studies. Since the publication of these volumes, however, there have been numerous developments in the theoretical literature. The goal of this special issue is to report some of these developments.

At the empirical level, it is important to assess the extent of price rigidity and flexibility. In particular, studying whether or not prices adjust to changes in market conditions as the standard New Classical model predicts seems to be of particular importance. In response to recent theoretical developments, the literature has also begun producing during the last 10–15 years empirical studies of price rigidity using various types of micro-level data from the US as well as from the European Union member countries. Two forthcoming special issues of the *Managerial and Decision Economics* (Levy, 2006 and 2007) will include some of these empirical studies.

IN THIS ISSUE

This special issue of the *Managerial and Decision Economics* contains eight theoretical contributions. These papers address the topics of price rigidity and flexibility from various angles. Of the eight studies, the first is a broad and updated survey paper. The second paper provides a sociological perspective on price rigidity and offers a new methodological contribution. The third paper offers a marketing perspective on price rigidity linking it to the issue of reference price. The latter plays a central role in marketing, both in theory as well as in practice. The fourth paper focuses on non-price adjustment mechanisms by suggesting that prices may be rigid, if waiting time, i.e., the delivery lag, can respond endogenously to changes in market conditions.

The remaining four papers focus on macroeconomic implications of rigid prices and costs of price adjustment. One of the four papers studies the optimality of price stability, which is a topic of particular interest to monetary policy makers and to students of monetary policy. The second paper studies a model which can yield a hump-shaped inflation response to monetary policy shocks of the type frequently documented by empirical studies using variety of US as well as other countries' aggregate data. The third

paper analyses an equilibrium optimization model to explore the interaction between price rigidities and inventories and its role in the propagation of business cycles. Finally, the fourth paper compares the real effects of trend inflation and monetary shocks in discrete and continuous time versions of a simple New Keynesian model.

The paper by Alex Wolman, "The Frequency and Costs of Individual Price Adjustment," is a remarkably thorough survey of over 100 theoretical and empirical studies, all focusing on price rigidity, one way or another. The theoretical studies Wolman surveys, all use rigid prices as one of the key ingredients of their modelling strategy. The empirical studies—and Wolman surveys no less 50 of them, all try to assess the extent of price rigidity directly or indirectly, or study various issues relevant for price rigidity and flexibility, such as measurement of price adjustment costs such as menu costs or managerial and customer costs, and assessing the relevance of these costs for price rigidities that have been documented by empirical studies.

Besides its broad coverage, Wolman's study is unique because of the attention it gives to earlier studies of Mills (1927) and Means (1935a, 1935b, 1936), which have not been reviewed thoroughly in the post 1980s literature. The studies by Mills and Means have been extremely influential, although as Wolman notes, they are not without shortcomings.

In addition, Wolman provides a fascinating discussion of the early literature, including Keynes (1928), Hicks (1935) and Scitovsky (1941), as well as less known correspondence between Means and Galbraith (1936). It turns out that these studies and the exchange between Means and Galbraith, discusses and suggest the idea of price adjustment cost and its various facet, perhaps anticipating the ideas of Akerlof and Yellen (1985a, 1985b) and Mankiw (1985).

In the paper titled "A Sociological View of Costs of Price Adjustment: Contributions from Grounded Theory Methods," Mark Zbaracki offers a sociologist's and organizational behaviour scientist's perspective on the empirical approach that is based on hypothesis testing, which dominates the economics discipline. Zbaracki argues that the economic theory and data often pose problems that cannot be addressed with the existing econometric methods that are designed to test hypotheses. For example, theories of price adjustment costs rely on variables that cannot be observed. Although in principle such

costs could be measured, in practice there is little hope to expect such measurements with the existing statistical data-gathering and econometric methods.

Zbaracki argues that the grounded theory methods developed by sociologists can be used to demonstrate the importance of price adjustment costs and to address deeper questions about how firms adjust prices. Properly matched to economic problems, Zbaracki suggests, grounded theory may help economists in developing better theories and in improving the testing of the existing theories.

Grounded theory methods are discovery oriented and thus they are especially useful for generating new theories based on data and observations. In this respect, grounded theory methods differ from the more common approach used in economics and other social sciences. Rather than beginning with *a priori* theory and using data for hypothesis testing and falsification of the existing theory, grounded theory methods enable the social scientist to use data for generating new theories.

Zbaracki uses price adjustment and cost of price adjustment as an example to demonstrate the advantages of grounded theory approach in economics. He argues that discovery-oriented methods can be used not only for examining the validity of existing theories, but also, and perhaps more importantly, it allows us to ask deeper questions about how firms adjust prices.

Zbaracki argues that grounded theory can provide three kinds of evidence: (i) observation relevant to existing theory, (ii) discovery of behaviours that alter existing theory, and (iii) process these observations and data for developing new theories and models. Zbaracki addresses the three approaches to the use of evidence that emerges from the use of grounded theory methods. In the context of the cost of price adjustment, he interprets the first approach, observation, as a tool for measuring the managerial and customer costs of price adjustment (Zbaracki, et al., 2004). Zbaracki argues, however, that focusing only on these costs would mean ignoring most of the relevant data from such observations. According to Zbaracki, the second approach, discovery, results from careful analysis of what pricing managers and their teams must do to adjust prices. Such evidence can help us discover new theory relevant to costs of adjustment. The third approach, process theory, can be used to develop more comprehensive models of adjustment.

From this evidence, Zbaracki discuss existing methods, distinguishing the methods of grounded theory from other interview methods (see, for example, Blinder, et al. 1998) that might be more familiar to economists. Zbaracki concludes by arguing that grounded theory and firm-level data could be useful to economists who seek to overcome certain theoretical and empirical barriers. While these methods cannot resolve all unanswered questions, Zbaracki argues, they may help economists develop better theories and better empirical tests of existing theories when they are properly matched to certain problems and methods.

Gadi Fibich, Arieh Gavious, and Oded Lowengart offer a marketing perspective on price rigidity. In their paper "Optimal Price Promotion in the Presence of Asymmetric Reference-Price Effects," Fibich, et al. study the role of asymmetric reference-price effects in promotional pricing decisions, and demonstrate that reference pricing can be a possible source of price rigidity. An additional contribution of their study is exploring the role of reference price in price promotions.

As Fibich, et al. note, price promotion is a common managerial practice employed for a variety of reasons such as luring customers into stores to buy other products at regular price (i.e., loss leader), increasing repeat buying, increasing market share among brand switchers, and targeting deal-prone consumers. Although there is a large body of literature on the effects of price promotions on demand and profitability of firms, Fibich, et al. argue, relatively little has been done to explore the effect of promotional activities on the reference price of a specific brand. Specifically, the concept that both deal frequency and depth of price cut can affect reference price has gained virtually no attention by researchers.

In "Production, Inventory and Waiting Costs," Gil Epstein models an environment with a non-price adjustment mechanism. That is, Epstein argues that often prices are rigid because adjustment occurs through waiting time. This idea has been proposed by Carlton (1983, 1985) who described it as a situation where "markets clear through delivery lags." Epstein assumes that demand is a negative function of the waiting time. In many settings sellers with fixed capacities serve randomly arriving customers. From time to time queues form and customers end up paying two prices, an explicit price to the seller and, in addition, an implicit price in the time spent waiting.

Some studies cited by Epstein find that indeed, the retail demand is sensitive to service time: customers are willing to pay about one percent more for a six percent reduction in congestion, on average. Consistent with these observations, Blinder, et al. (1998) report in their interview study that firms often prefer to respond to variations in demand by changing delivery time and improve other auxiliary services rather than change prices.

Epstein derives conditions under which an inventory policy, with regard to changes in waiting times and prices, will be optimal, i.e., preferred to a policy where sales are from current production. Epstein shows that a possible reason for the necessity of holding inventory is that it gives the firm the ability to sell its products with different waiting times. At any given price level, as the waiting time for receiving a product increases, the cost facing the buyer increases and thus demand decreases. The producers can use this fact in order to increase sales and profits.

Thus, Epstein's paper offers a possible explanation for price rigidity: the demand is more sensitive to the consumer's waiting costs than to the price of the product and thus, firms may whish to change the waiting time for a product to be supplied rather than to change the product's price.

The last four papers of the special issue focus on macroeconomic implications of price rigidity and cost of price adjustment. In "Costly Price Adjustment and the Optimal Rate of Inflation," Jerzy Konieczny studies the optimality of price stability. As Konieczny argues, stable price level, that is zero inflation, has become a reference point for many students of monetary economics and for central bankers. Konieczny develops a model in which price stability is optimal. Konieczny's economy consists of monopolistically competitive firms that face costs of nominal price adjustment. Konieczny considers the effects of different, constant rates of inflation on welfare by assuming that money pays interest. In his model, money is indexed while prices are not. The main friction in Konieczny's the model is the presence of the costs of adjusting nominal price and so the effects of inflation stem from the accounting role of money.

In Konieczny's model, inflation has there types of effects on welfare. First, the firm in his model has to bear the price adjustment costs as inflation affects its desired nominal price. Second, inflation affects the average desired real price over the pricing cycle.

Third, inflation affects the average productivity of the monopolistic firms. Focusing on the two latter effects, Konieczny argues that they arise because firms change nominal prices infrequently and, in the presence of inflation, real prices vary over time. The effect of desired real prices on welfare is due to the fact that the economy is monopolized and real wages and output are too low. Inflation may strengthen the monopolistic distortion by increasing the average desired real price over the pricing cycle.

This *productivity distortion* arises from the effect of inflation-induced real price variability on the average productivity. As the pricing period is typically short relative to the lifetime of fixed factors such as capital, firms satisfy demand by changing the variable factor input and so they face increasing marginal costs. Inflation increases the variability of real prices over the pricing cycle. Since more output is sold by firms whose price is relatively low and marginal costs high, inflation reduces the average productivity of the variable factor and shrinks the economy's production-possibilities set. The productivity distortion is symmetric around zero and both inflation and deflation are detrimental.

Konieczny finds that the net effect of inflation on welfare depends on the balance of the two distortions. The monopolistic distortion depends on the properties of the demand function while the productivity distortion depends on the convexity of the cost function. The more convex is the cost function, the more likely is the productivity distortion to dominate and welfare to fall, regardless of the monopolistic distortion, as inflation departs from zero. If the cost function is close to linear, inflation may increase welfare if it induces monopolistic firms to reduce their desired real prices. A superior policy, however, is to maintain a constant price level and subsidize labor services. Such policy lowers the desired real price in terms of wages and increases output but does not generate the productivity distortion.

In “Explaining Hump-Shaped Inflation Responses to Monetary Policy Shocks,” James Yetman notes that according to conventional wisdom, the output effects of a monetary policy shock commence within months of the shock, while most inflationary effects lag significantly. This conventional wisdom is based both on specific historical events, as well as empirical estimates. For example, Mankiw (2001) argues that while the monetary policy tightening of the Volcker disinflation commenced in October 1979, large

declines in inflation only started in 1981, while output growth rates declined coincident with the monetary policy tightening.

This phenomenon has been documented using data from other countries as well. Studies that use the popular VAR methodology have reported similar findings. For example, Bernanke and Gertler (1995) find that the largest declines in real output occur between eight and twenty-four months after a tightening of monetary policy. In contrast, prices are essentially stable for the first 12 months, before declining steadily.

As Yetman notes, many existing theoretical models have problems explaining these findings. Standard sticky price models, for example, are unable to generate a hump-shaped inflationary response that lags the output response to any significant degree. In a recent contribution, Mankiw and Reis (2002) introduce a model of sticky information and argue that the model can explain the above phenomenon. Within their model, firms do not set a single price for their good, but instead a pricing plan that may entail a new price in each future period. They combine their assumption of sticky information with Calvo's (1983) timing of price adjustment, in which the probability that firms update their pricing plan is assumed to be constant and independent of the length of time since the pricing plan was last adjusted.

Yetman examines the robustness of Mankiw and Reis' (2002) finding by exploring whether the assumption of optimal updating of pricing plans on the part of price setters influences the results reported by Mankiw and Reis, by incorporating state-contingent (rather than time-contingent) price setting. Firms are assumed to optimally choose whether to reset their pricing plan each period, after observing the state of the economy. Thus firms' price setting decisions are fully consistent with profit maximization, given the existence of costs of changing pricing plans.

Yetman finds that for the specific experiment Mankiw and Reis examine—a ten percent reduction in aggregate demand, state-contingent price adjustment implies an almost uniform inflation response over the first several periods following a monetary policy shock, and for the more realistic case of a smaller shock—a one percent reduction in aggregate demand, the inflation response is greatest either in the period of the shock, or the following period. Thus the hump-shaped response reported by Mankiw and Reis (2002) is not robust to optimal price path adjustment by firms.

Yetman proposes a solution that remains consistent with profit maximizing price setting decisions by firms that can recover a hump-shaped response of inflation for small nominal shocks, and is consistent with empirical evidence on sources of nominal rigidity. As Yetman notes, there is clear empirical evidence that points to the importance of both, menu costs (Levy, et al. 1997, 1998, 2002; Dutta, et al.1999, 2002; Levy and Young 2004; Young and Levy 2006; Zbaracki, et al. 2004), as well as contractual obligations as sources of price rigidity. Yetman, therefore, models firms as choosing both the price and the average contract length optimally, conditional on their information at the time of price setting. In particular, he assumes that there is a prohibitive cost of renegotiating contracts currently in effect in response to a shock.

Yetman demonstrates that with fixed average lengths contracts, and combined with menu costs, his model can retrieve the hump-shaped inflation response for realistically sized shocks. He also argues that sticky contracts remedy another limitation of the sticky information model. Sticky contracts imply that the level of trend inflation affects the inflation dynamics of the economy, which is consistent with existing empirical evidence, whereas sticky information combined with time-contingent price-path adjustment implies that stable trend inflation has no effect on inflation dynamics.

In “Price Rigidities, Inventories and Business Cycles,”Chris Tsoukis and Naveed Naqvi set up an equilibrium optimization model to study the interaction between price rigidities and inventories and its role in the emergence and propagation of business cycles. According to Tsoukis and Naqvi, this interaction may be important at both the micro and macro levels. When firms fix prices, they meet demand by varying supply, but when supply cannot be varied instantaneously then they adjust the inventories. Thus, price fixity and inventory fluctuations are closely linked. At the macro level, the (temporary) decoupling of demand and supply allowed by the existence of inventories could provide important insights into business cycles.

Tsoukis and Naqvi note that despite the attention received in the existing literature by price rigidities and inventories in isolation, the interactions between the two has been largely ignored. With the goal of filling this gap in the literature, Tsoukis and Naqvi investigate the effects of greater price flexibility and storability of the inventory goods on business cycle dynamics. They also show how inflation persistence can arise in an

optimization framework. They link the inflation persistence to price flexibility and the storability of goods.

The strategy adopted by Tsoukis and Naqvi is to pursue a general equilibrium analysis in terms of growth rates rather than the more popular HP-filtered levels. That is because the public and policy-making discourse is cast in terms of growth rates, and also because the time-series properties of growth rates (log differences) are easier to interpret than those of HP residuals.

The model of Tsoukis and Naqvi assumes profit maximizing firms with an AK technology and proportional capital adjustment costs. The firm maintains a stock of inventories as a buffer between supply and demand, which allows it to meet fluctuations in demand. The firm is a monopolistic competitor with the ability to set its own price. Price adjustment, however, is sluggish because of the menu costs and follows the well-known Calvo pattern, which gives rise to a forward-looking inflation equation.

Tsoukis and Naqvi derive analytically a number of results about the effect of greater price flexibility and inventory good storability on the persistence and volatility of the macro system. They find that greater price flexibility reduces the persistence of growth fluctuations but does not necessarily reduce the overall volatility of the macro system. Tsoukis and Naqvi also find that inflation is negatively related to growth and the inventory ratio regardless of the origin of the shock. Finally, they show how persistence of inflation can arise in a general equilibrium system. Overall, Tsoukis and Naqvi note, their analysis points to rather complex interactions between price rigidities and storability of inventory goods.

In the last paper of the special issue, “The Real Effects of Inflation in Continuous versus Discrete Time Sticky Price Models,” Wai-Yip Alex Ho and James Yetman compare the real effects of trend inflation and monetary shocks in discrete and continuous time versions of a simple model of a New Keynesian style economy. As Ho and Yetman note, many New Keynesian models incorporate time-dependent sticky prices. These models often use a discrete time framework, which effectively imposes an arbitrary minimum length of time over which prices must be fixed. With many authors defining a period as corresponding to one quarter, this implies that a complete price flexibility corresponds to a situation where prices are updated once a quarter. If one removes this

restriction, then continuous time modes are obtained. Ho and Yetman assume that nominal prices are sticky because of menu costs, but that firms optimally choose their average contract length.

Based on the analysis of this model, Ho and Yetman conclude that for given menu costs, continuous time setting implies a shorter average contract length, and larger real effects of both trend inflation and monetary shocks, than discrete time unless inflation is very low. Further, Ho and Yetman find that while discrete time models result in complete price flexibility above some finite level of trend inflation, price flexibility arises only asymptotically in continuous time models. Finally, consistent with common wisdom, Ho and Yetman find that if changing prices requires labor input (see, for example, Levy, et al. 1997, 1998; Dutta, et al. 1999; Zbaracki, et al. 2004), then continuous time models lead to large welfare costs of high rates of inflation, while discrete time models do not.

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