Price-Matching Guarantees with Endogenous Search: A Market Experiment Approach

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Abstract

Price-matching guarantees are commonly used by sellers as promises to match the lowest price for an item that a customer can find elsewhere. In this paper, we use a market experiment approach to examine buyer search as well as sellers’ pricing decisions in the presence versus absence of Price-Matching Guarantees. We use student subjects as well as real consumers in an interactive laboratory setting to trade with each other, acting as buyers and sellers. Our findings from two experiments indicate that when searchers’ demand is more elastic than non-searchers, PMGs can result in more intense price competition, even when sellers are symmetric. Price-Matching sellers benefit from converting more consumers into searchers who buy a larger quantity at a lower price. The lower (average) market prices also benefit buyers. These implications should be of great interest to researchers, practitioners, and public policymakers.

Keywords: Price-matching guarantees; Market experiment; Price dispersion; Search

Introduction

Customers today are always looking for a good deal in whatever they purchase. Retailers have responded to customers’ needs with various pricing strategies as a means of creating a differential advantage. In this paper, we study a pricing strategy commonly used in many industrial and consumer markets, namely price-matching guarantees (PMGs). Specifically, we are interested in how this policy decision affects buyers’ search behavior and sellers’ pricing behavior in a market.

In industrial markets, PMGs are implemented through the “meet-or-release” clause. Under this clause, if a buyer is offered a lower price by another seller, (s)he can request the first seller to match the price offer. If the initial seller refuses to match it, the buyer is released from the obligation to buy. These meet-or-release clauses, which are very similar to PMGs, have reportedly been used in wholesale markets for salt, chlor-alkali, and lead fuel additives.

In consumer markets, PMGs are prevalent in a variety of retail markets, including books, toys, groceries, furniture, and consumer electronics. For example, Office Depot claims on their website\textsuperscript{2} that “As always, if you find a lower price on a new, identical product advertised for less at any other office product or consumer electronic supplier within 14 days after your Office Depot purchase, please call us at 800-GO-DEPOT (1-800-463-3768) and we will match the price, instantly.” Other examples include a catalog carried by United Airlines which offered such a guarantee on in-flight sales.\textsuperscript{3} Bank of the West even advertised an interest rate matching policy on San Francisco Bay area radio stations (Edlin and Emch 1999).

In this paper, we use a market experiment approach to examine buyer search as well as sellers’ pricing decisions in the presence versus absence of PMGs. We simulate interactive markets where boundedly rational buyers and boundedly rational sellers trade with each other. Other experimental studies in marketing and economics have also focused on PMGs. How-
ever, none of them are conducted in interactive market settings. In marketing, experimental research focuses on the impact of PMGs on consumer perceptions, beliefs, and intentions given seller’s strategies (e.g., Srivastava and Lurie 2001). In economics, experimental papers have examined seller’s decisions using computer simulated buyers programmed to behave (search and purchase) in pre-determined ways (e.g., Fatás and Mañez 2007). As opposed to these experiments, we investigate the strategic behavior of both buyers and sellers when they interact in a simulated market environment.

We propose and find that in markets where search leads to more elastic demand, price-matching sellers may benefit from encouraging more consumers to search by charging lower and widely dispersed prices. In other words, PMGs can result in more intense price competition even with symmetric sellers. More specifically, we find that when given a choice, sellers tend to use PMGs, randomize prices and price lower in the presence versus absence of PMGs. There is also greater price dispersion with PMGs and buyers search more (for lower prices) in the presence versus absence of PMGs. This means that PMGs do not necessarily lead to higher prices and reduced price competition even with symmetric sellers. Price-Matching sellers benefit from converting more consumers into informed buyers who buy a larger quantity at a lower price. The lower (average) market prices also benefit buyers. This is the opposite of what prior literature predicts.

From a theoretical perspective, in order to examine strategic behavior from both sides of the markets, one should develop market equilibrium models with endogenous buyer search and endogenous seller price distribution. However, to the best of our knowledge there are no existing market equilibrium models in the PMG literature most likely because these models turn out to be analytically intractable. Another challenge for the modelers in this area is the existence of multiple equilibria. Then the question is which type of equilibrium is more likely to prevail in real markets. The market experiment approach helps us to understand how consumer and markets operate when there is no existing good theoretical representation of the process that occur (Fisher, Wheeler, and Zwick 1993). It also allows us to test the predictive power of alternative theories. To accomplish both goals, we first conduct a set of market experiments with student subjects then invite real consumers into our lab to assess the external validity of our results. The experimental results and implications should be of great interest to both practitioners and researchers.

The rest of the paper is organized as follows: We first summarize the existing literature on PMGs and provide the theoretical background for our experiments. We then lay out the design of two market experiments and discuss experimental results. We conclude with managerial implications and suggestions for future research.

Prior literature

In this section, we first review the analytical models developed by researchers in marketing and economics explaining the competitive effects of PMGs. We then discuss the empirical literature on PMGs focusing on either the buyers’ or the sellers’ side of the market.

Theoretical literature

The predominant view in the theoretical economics literature holds that the existence of PMGs results in collusion and hence higher prices. This is known as the Implicit Collusion Theory. The earlier work by Salop (1986) points out that PMGs can lead to price collusion by removing rivals’ incentives to initiate price cuts. As a result, PMGs can lead to non-cooperative sellers achieving collusive outcomes. Salop’s argument was later formally illustrated by Doyle (1988) in an oligopoly market. Since then, a number of studies have re-affirmed Implicit Collusion Theory in markets with symmetric sellers and informed buyers (e.g., Zhang 1995). The essence of Implicit Collusion Theory is that PMGs are not only guarantees for buyers but also guarantees for other sellers. Particularly, PMGs ensure a seller’s rivals that any price-cutting they do in an attempt to steal share is automatically and instantaneously matched. When all buyers are informed, competitive price-cutting is futile, as it fails to steal share from the matching seller and simply lowers both one’s own and one’s rivals’ prices. It is a weakly dominant strategy, therefore, for sellers to adopt PMGs which then lead to collusive prices and profits.

One of the major assumptions of Implicit Collusion Theory is that consumers are all informed of the prices and price changes. Another theory which also offers an explanation for reduced price competition between price matching sellers but focuses on consumer segments with different search costs is Price Discrimination Theory. It argues that sellers can use PMGs to price discriminate between buyers who are either informed or uninformed of the prices. Since the informed buyers can take advantage of the PMGs, the firms have every incentive to raise prices to the uninformed buyers. For example, Png and Hirshleifer (1987) argue that the presence of competition allows each firm an additional method of discrimination, namely, the offer to match price. It is shown that, in symmetric equilibrium, sellers will attempt to discriminate by randomization of their list prices and by offering to match the prices of their competitors. This causes each firm to try to extract more from its uninformed consumers by raising its list price. As a result, under discriminating duopoly, the expected combined sales will be less than under non-discriminating monopoly.

Some economics researchers have questioned the predominant view that PMGs reduce price competition. Logan and Lutter (1989), for example, show that with sufficient differentiation in sellers’ costs, only the low marginal cost seller chooses to offer PMG and the differentiated Bertrand prices prevail. Chen, Narasimhan, and Zhang (2001) show that in markets where some buyers strategically search price information upon observing PMGs, price competition can become more intense when there is a large proportion of switchers who have very low search costs.

More recently, marketing researchers have adopted Signaling Theory (Spence 1973) and argued that in contrast to Implicit Collusion Theory which focuses on PMGs as signals among sellers (for tacit collusion), PMGs can serve as signals that sellers
use to indicate lower prices to buyers. Similar to the signaling effects of price (e.g., Wolinsky 1983), advertising (e.g., Nelson 1974), and warranties (e.g., Spence 1977) on unobservable quality, PMGs can be used as signals of unobservable prices (Jain and Srivastava 2000), quality (Moorthy and Srinivasan 1995), or service (Moorthy and Zhang 2006) and therefore lead to a separating equilibrium in which only the low price sellers adopt PMGs. For PMGs to be credible signals of low prices (Ippolito 1990), sellers have to be sufficiently differentiated (on factors such as cost structure and consumer demand) and there have to be enough informed buyers to discipline the market (i.e., to demand the lowest price in the market from the high cost sellers who cannot afford to offer it).

Although specific model structures vary, the theoretical literature basically indicates that symmetry in sellers leads to increased market price and decreased price competition whereas sufficient differentiation in sellers leads to decreased market price and more intense price competition.

**Empirical literature**

Despite the large volume of theoretical research on the topic, empirical research on the competitive effects of PMGs using secondary data is sparse and inconclusive. Hess and Gerstner (1991) conduct time-series analysis of supermarket pricing following the adoption of PMGs. They show that prices increase slightly after the adoption of the policy. Arbatkayka, Hviid, and Shaffer (2006) also find evidence of higher prices in the presence of price-matching guarantees. Mañez (2006), however, finds some evidence for the opposite effect. In his study, supermarket prices decrease after one firm adopts PMGs. Arbatkayka, Hviid, and Shaffer (1999) find that a tire retailer’s advertised PMGs have no significant effects on the retailer’s own advertised tire prices.

In addition to secondary data research, experimental research has also been conducted using laboratory experiments to examine consumers’ and sellers’ strategic behavior. In marketing, the experimental literature on PMGs has focused primarily on consumer search behavior. Jain and Srivastava (2000) conduct laboratory experiments to examine buyer perception of PMGs as signals for lower store prices. They find that price expectations are lower, confidence of finding low prices is higher, and purchase intentions are higher when PMGs are present versus when they are absent. Srivastava and Lurie (2001) examine actual buyer search behavior in the context of PMGs. Similar to Jain and Srivastava (2000), in Study 1 they find that buyer perceptions of store prices are lower and “intention” to discontinue searching is higher when a store offers PMG. In their second and third studies where “actual” buyer search behavior is observed, they find, inconsistent with their prediction, that although high search cost buyers search less, when search costs of all buyers are manipulated at a low level, buyers search more in the presence versus absence of PMGs. Lurie and Srivastava (2005) show that PMGs raise consumers’ estimates of the lowest and average prices in the market, and lead to a perception of lower price in PMG stores. Srivastava and Lurie (2004) argue and demonstrate that the effectiveness of price-matching guarantees depends on consumer believing that disciplinary mechanisms in the market-place are strong. Other important PMG characteristics that have been examined in experimental studies include refund depth, length, and scope of eligible competitors (Kukar-Kinney and Walters 2003; Kukar-Kinney, Walters, and MacKenzie 2007; Kukar-Kinney, Xia, and Monroe 2007).

Experimental economists have always been interested in PMGs from the sellers’ perspective. Fatás and Mañe (2007), experimentally test the ability of PMGs to raise prices above the competitive level. In their experiment, symmetric sellers decide on prices and (PMG) policies whereas demand from buyers is calculated from a given demand function (i.e., there are no real buyers). They find that markets quickly converge to the collusive outcome and that almost all sellers choose to adopt PMGs. Charness and Chen (2002) examine the effect of various penalties that a manufacturer can enforce on retailers for violating Minimum Advertised Prices, that is, prices below which one cannot advertise. Similar to Fatás and Mañe (2007), buyer demand in Charness and Chen’s study is also simulated by computers.

**Theoretical framework for the market experiments**

Our research focuses on symmetric sellers and addresses several important issues in the literature. First, as pointed out by Edlin (1997), one of the major limitations of the theoretical PMG models is that buyer search behavior is exogenous to the models. Sellers’ pricing and policy decisions do not have any effect on buyers’ search behavior since they are assumed to be either informed or uninformed. In reality, buyers may incur some costs to become informed by reading newspaper advertisements or subscribing to pricing services. They are more apt to do so when they believe that price dispersion is wider. This means that sellers’ pricing strategies may not only allow them to screen consumers on the basis of their cost of information (as explained by Price Discrimination Theory) but also influence the search intensity in the market. The effect of prices and pricing policies on consumer search intensity has not been examined in models presented in prior literature where consumers are pre-determined to be informed or uninformed. Extending the model to address those issues theoretically may not be possible because of the difficulty in solving analytical solutions for market equilibrium models. This is why we choose the market experiment approach to gain more insights about the effects of endogenized search.

Second, Implicit Collusion Theory predicts a pure strategy equilibrium while Price Discrimination Theory is based on a mixed strategy equilibrium although both theories focus on symmetric sellers and have similar predictions regarding the competitive effects of PMGs. Experimental economists have shown some support for the Implicit Collusion Theory. However, their experiments only focus on the seller side of the market. We simulate markets where real buyers and sellers trade with each other and observe strategic behaviors from both sides of the market. Our experiments will help us identify the type of (pure or mixed) equilibrium that is more likely to prevail in reality.

In the following sections, we provide a theoretical framework capturing a market with endogenous decisions from both sides of the market. We first describe the characteristics of buyers’
Buyers’ search and demand

It has been well established in the literature that search can effectively eliminate price uncertainty. This uncertainty can be caused by a number of factors, including price variability in the market place (Mazumdar and Jun 1993; Winer 1989). Regardless of its origin, when consumers are less (more) certain about the range and/or variability of prices in the market place for a given product, they perceive higher (lower) financial risk in purchasing from sellers (Biswas, Dutta, and Pullig 2006; Grewal, Gotlieb, and Marmorstein 1994). To effectively eliminate price uncertainty, consumers must incur mental, physical or financial resources to search for information. They will search as long as perceived benefits outweigh costs.

Because searching reduces uncertainty involved in the purchase decision (Srivastava and Lurie 2001) and equips consumers with more market information, it may influence consumers’ demand. There are two streams of literature in economics focusing on the relationship between buyer search and demand elasticity. The search literature argues that easy search makes demand more price sensitive (e.g., Ellison and Ellison 2009). The market transparency literature has also shown that sellers can use their pricing strategies to affect market transparency (Bester and Petrakis 1995) and improved transparency on the consumer side increases the effective demand elasticity (Schultz 2005). It is true not only for products but also for services. Pauly and Satterthwaite (1981) for example have shown empirically that when consumers have a more difficult time searching for physician information, they become less price sensitive.

This difference in demand elasticity between searchers (who eventually become informed) and non-searchers (who remain uninformed) is representative of many market conditions. For example, Png and Hirshleifer (1987) refer to informed consumers as locals and uninformed as tourists. A Tourist usually has little information about the sellers and relatively inelastic demand. She randomly chooses a seller and buys at any price at or below her reservation price. Locals who have more information about the market also have more elastic demands.

Another example where consumers’ demands are correlated with their search costs is a market of beginners and advanced members such as a hobby market for gardeners, model plane builders and cheesemakers. The beginners are still learning the hobby and have high search costs for buying, for instance, for bulbs, balsa wood, and rennet, respectively for the three hobbies. The advanced members who know the hobby have low search costs for these items. In addition, the beginners have a low base-level demand which is fairly inelastic to price (we simplify this to one unit e.g., a beginner gardener buys one dozen tulip bulbs), whereas the advanced members’ demand is price elastic (an avid gardener searches for a good price and buys many dozen tulip bulbs if she finds a low price). As such, search costs and demand are related. The beginners have high search costs and low-inelastic demand, whereas the advanced have low search costs and elastic demand. Therefore, if a consumer decides to become informed, it is likely that her search costs are low and her demand is high (that she is an advanced member). If she decides not to search, it is likely that her demand is low and search cost is high (that she is a beginner). A beginner could also decide to search but her search costs would be very high and once spent, she also may want to buy more if she gets a good price. Similarly, an advanced member may decide not to search because she has low inelastic demand in that period for some reason (no time to plant bulbs). This also implies that members benefit from search both by obtaining a lower price and by a higher demand if they obtain a low price.

In this paper, we argue that it is important to examine the situation where searchers have more elastic demand than non-searchers not only because it is commonly observed in the marketplace and consistent with prior literature in marketing and economics. More importantly, we show that this may lead to completely different conclusions regarding the competitive impact of PMGs. In the section below, we will provide a detailed discussion on the effect of endogenized search behavior on sellers’ pricing and policy decisions.

Sellers’ pricing and policy strategies

Consider a market of two symmetric sellers operating in the same industry under conditions of zero cost. The products sold by the two sellers are known by buyers to be identical. Buyers in the market have the same reservation price but do not have perfect information about the sellers in the market; this information must be gathered at a cost. There are differences in buyers’ information-gathering costs due to differences in analytic ability, the cost of time and preference for reading and processing information (Salop and Stiglitz 1977). For simplicity and similar to Salop and Stiglitz (1977), we assume that only complete information may be gathered by buyers. Consistent with past research on search (e.g., Salop and Stiglitz 1977), the search cost distribution is common knowledge but the realizations of search costs are only revealed to individual buyers.

We will start the discussion with the situations where sellers charge fixed prices both in the presence and in the absence of PMGs. In the market where sellers do not offer PMGs, non-searchers will randomly buy from one of the sellers whereas searchers will only purchase from the lower price seller. It is not hard to see that one optimal strategy in this type of market would be for both sellers to price at the buyers’ reservation price and all buyers choose not to search. Intuitively, given buyers are all uninformed and will be randomly selecting sellers to purchase from, sellers do not gain anything by lowering their prices. On the other hand, given that there is no difference in prices between the sellers, buyers do not have any incentives to search. Of course, if the search cost distribution degenerates to zero so that every buyer can become informed with no cost,
then both sellers should price at cost – zero in this setting and all buyers should search.

What if both sellers in the market offer PMGs? Similar to Logan and Lutter (1989), we assume that unlike sellers’ pricing decisions, sellers’ policy decisions are assumed known to all buyers. This is justified on the grounds that PMGs are usually long term policy decisions whereas sellers change prices frequently. Non-searchers cannot take advantage of PMG offers even though they are aware of sellers’ policy decisions since they decide not to find out about prices in the market. Similar to Png and Hirshleifer (1987), we assume that when both sellers offer PMGs half of the searchers buy from one seller and half of them buy from the other, so that when sellers charge the same price through the list price or through matching, the number of searchers is equally divided between the two sellers.²

In this type of market, a similar optimal strategy should exist where both price matching sellers charge buyers’ reservation price and none of the buyers search. It is important to note that this is different from the situation described by Implicit Collusion Theory where all buyers are assumed to be informed. When we endogenize the buyer search decision, buyers will not conduct costly search if sellers collude. Therefore, Implicit Collusion Theory is a special case where the search cost distribution degenerates to zero.

In addition to charging a fixed price, sellers may also randomize their prices between a lower bound and a higher bound to sell to both searchers and non-searchers. This type of pricing strategy may exist in the presence (as discussed in Png and Hirshleifer 1987) and absence (similar to Varian 1980) of PMGs although the actual price distribution should be different. Then the question is how market price and buyers’ search behavior differ when sellers randomize their prices. We compare them and discuss the intuition below.

In the absence of PMGs, each seller gets half of the non-searchers and the lower price seller sells to all the searchers by charging a slightly lower price than the rival. With a more elastic demand from searchers, the lower price seller also benefit if there are more searchers in the market. However, the price does not unravel down to variable cost (zero in this case) because of the presence of non-searchers in the market.

In the market where both sellers offer PMGs, there are two price randomization mechanisms taking place simultaneously. The first mechanism is the temporal price dispersion (Varian 1980) in the sense that each store varies its own price over time. Similar to the No-PMG markets, sellers randomize prices to capture the demand from searchers and non-searchers. However, in PMG markets each seller gets half of the searchers because a searcher can take advantage of a PMG offer and buy from either seller at a price matched to the lowest price in the market. When the demand from the searchers is more elastic, it is thus in both sellers’ best interest to charge a lower (average) price that encourages buyers search and maximize profit. Each seller then gets half of the maximum profit they can earn from the searchers. Because both sellers have incentives to lower prices (as opposed to only the lower price seller in No-PMG markets), there should be wider temporal price dispersion in the presence versus absence of PMGs.

In addition to sellers’ efforts to price discriminate by randomizing their list prices, PMGs allow sellers to discriminate by offering to match the prices their competitors offer. As pointed out by Png and Hirshleifer (1987), this type of price discrimination (across sellers) only exists in PMG markets and cannot be implemented by a single firm as one seller can only be successful in price discrimination if the list price elsewhere is lower.

Therefore, when searchers’ demands are more elastic than non-searchers, the two price randomization mechanisms together may cause price dispersion to be greater resulting in greater advantage for consumers to search in the presence versus absence of PMGs. Since sellers’ prices are lower and price dispersion in the market is wider when they offer PMGs, profit maximizing buyers should search more. When PMG policies are present, all sellers (not just the lowest price seller) make sales through matching even with the wider price dispersion. With more searchers in the market, and a wider price dispersion, the sellers price lower on average (than without PMGs) to get a higher sales quantity and higher revenue and profit. Since sellers’ expected profits are higher in the presence versus absence of PMGs, they should couple their pricing strategy with offers to match the lower price in the market. Although prices are lower when sellers price match, the lower prices are offset by higher demands from searchers which leads to higher profits for both sellers.

**Market experiments**

We now describe in detail the two sets of market experiments we conducted to examine buyer search and sellers’ pricing behavior. In these experiments, some markets allow PMG as a policy decision for sellers and some do not. Subjects are randomly assigned to networked computers as buyers or sellers trading in experimental dollars (EDs). Buyers’ reservation price for a physically identical product and sellers’ costs are induced in the following manner – buyers earn real money by purchasing from sellers and reselling to the experimenter. Sellers make money by buying from the experimenter and selling to the buyers. The higher (lower) their selling (buying) prices, the higher the sellers’ (buyers’) earnings are. Buyers can pay for search costs and become completely informed of the prices in the market or remain uninformed. With these induced values, buyers and sellers maximize their earnings acting as if they are in the real world. In a repeated setting, we observe how buyers and sellers trade and what equilibrium conditions are reached. Particularly, we are interested in whether buyers choose to search more when PMGs are offered, whether sellers choose to adopt PMGs, and the price level and dispersion in the market.

**Experiment 1**

In Experiment 1, buyers all have the same reservation price, \( r \). To characterize the difference in demand elasticity for searchers

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² Here we do not take into account the “hassle costs” incurred in redeeming PMGs. For a detailed discussion on “hassle costs”, see Hviid and Shaffer (1999).
and non-searchers, we induce unit demand from non-searchers and a simple linear demand \( D_l = a - P \) from searchers, where \( a \geq r > 0 \) is the choke quantity\(^6\) (the quantity for which the market-clearing price is zero) and \( P^e \) is the lower (effective) price in the market. The condition \( a \geq r > 0 \) ensures that demand from any informed buyer is positive when sellers price at the reservation price. The search cost for buyers in the market is simulated to be uniformly distributed between \([0, \bar{c}]\) with \( \bar{c} \) being the highest search cost in the market (where \( \bar{c} < r \)).

We used a 3(markets with distinct \( a, r, \bar{c} \) — between subject) \( \times 2 \) (PMG versus No-PMG — between subject) design for a total of six markets. In the three PMG markets (Markets 1, 3 and 5) sellers made pricing and policy decisions (i.e., whether or not to offer PMGs) while in the other three markets (Markets 2, 4, and 6) sellers only made pricing decisions. The three pairs of PMG and No-PMG markets (Markets 1 and 2, Markets 3 and 4, Markets 5 and 6) had exactly the same parameters. Each of these six markets was run for 48 consecutive periods. Twenty undergraduate students were recruited as subjects for each of the six markets for a total of 120 subjects.

Although we used multiple periods to allow learning from the subjects, each period in the experiment should be independent. However, with 48 consecutive periods, there can be a possibility that reputation effects carry over periods. Therefore, while we had six distinct markets in our design, we used a random matching protocol (Amaldoss and Rapoport 2005; Ho, Camerer, and Chong 2007) to prevent any seller reputation effects from affecting buyer behavior over time. In order to do this, we actually had two mini-markets within each of the six markets, each with two sellers and eight buyers. These two mini-markets were identical in all respects. The twenty subjects within a certain market were then randomly assigned as buyers or sellers — four as sellers and sixteen as buyers in each of the 48 periods. This resulted in subjects playing with a different set of people in each period and subjects were made aware of this fact (see specific instructions given to subjects in Appendix A). As such, we minimized the reputation effect being carried from period to period.

The parameters (\( a, r, \bar{c} \)) were held constant over the 48 successive trading periods within a market. See Table 1 for parameter values. These parameters were selected so that buyer search cost was not too high (to satisfy buyers’ participation constraint) and when sellers price at reservation value, \( r \), searchers’ demand was one which would be the same as non-searchers. We simulated a uniform distribution of search cost by generating eight evenly spaced values between 0 and the maximum search cost \( \bar{c} \). If the maximum search cost was 1ED, the search cost values we chose were \((0.125, 0.25, 0.375, 0.5, 0.625, 0.75, 0.875, 1)\); and if the maximum search cost was 2EDs, we used \((0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2)\). Then, in each period, these eight different values were assigned randomly (and without replacement) to each buyer in a mini-market so that each got a different search cost. Both sellers and buyers knew the search cost distribution ex ante and each buyer learned about actual search cost before making search decision in each period. We believe that this procedure gave us a good approximation of the uniform distribution at the aggregate level.

At the beginning of each market, the twenty students were randomly assigned to twenty computers, which determined whether they were buyers or sellers. We used a practice period to familiarize subjects with the experimental procedure. During the practice period, the experimenter explained information on each screen and answered questions as the experiment progressed. This market of buyers and sellers then traded in experimental dollars.

There were essentially three stages in each market period. In the first stage of each period, sellers decided on their list prices (sellers in PMG markets also decided whether or not to offer PMGs). Then buyers chose whether or not they wanted to search. If a buyer decided to search and become informed, (s)he was matched with the lower price seller and the transaction was completed in the third stage. For buyers who decided to remain uninformed, we randomly matched half of them with each seller. In the markets where sellers were allowed to adopt PMGs, informed buyers were randomly matched with one seller and the buyers paid the lower price in the market. This happened when only the high price seller offered PMG or when both sellers offered PMGs; when only the low price seller offered PMG, all informed buyers purchased from the low price seller. The procedures for the markets where sellers did not offer PMGs were very similar, the only difference was that in the first stage, sellers only made pricing decisions. Fig. 1 illustrates the procedures for markets where sellers were allowed to offer PMGs. These PMG policy decisions were shown to all buyers at the beginning of the buyer search stage. At the end of each period, subjects’

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\(^6\) Deneckere, Marvel, and Peck (1997).
earnings were calculated in experimental dollars. Although all the buyers could learn about their own profits, only the searchers could see the prices from both sellers. For a buyer who decided not to search, profit was simply the buyer’s reservation minus her transaction price. Profit for a searcher equaled “(buyer reservation price – transaction price) × (number of units purchased) × search cost”. A seller’s profit in the No-PMG markets was calculated as “list price × number of units sold”; in PMG markets, a seller’s profit was calculated as the sum of profits from each individual buyer since the effective price from each buyer could be different. Sellers were also shown the sales and profits for themselves as well as the prices and PMG policies of the rivals. Profits for each participant was then accumulated over the 48 periods and translated into real dollars at the end of the experiment. The subjects were paid a show-up fee of $5 and an additional $5–$10 based on how much they earned in EDs and pre-calculated conversion rates.

**Experiment 1 results**

We first examine buyer search behavior in all six markets. Buyer search is computed as follows – each of the 16 buyers in each market has a choice of searching (1) or not (0) in each of the 48 periods. We add up the total amount of search for all 16 buyers in all 48 periods, and compute the proportion of instances in which buyers search. The first column of Table 2 shows the magnitude of buyer search. First of all, recall that when we endogenize buyer search, the collusive pure strategy equilibria in PMG and No-PMG markets both predict no buyer search. However, as one can see from Table 2, the amount of buyer search in both types of markets is significantly different from zero which is more consistent with the prediction from the mixed strategy equilibria.

Furthermore, when comparing across the two types of markets, we found that buyers on average searched 65 percent of the time in Market 1 (i.e., across all buyers and time periods = 16 × 48 = 768 instances, search was done in 499 = 65 percent of the instances), 38 percent of the time in Market 3, and 43 percent of the time in Market 5. In the No-PMG markets, they searched 46 percent, 27 percent, and 24 percent of the times in Markets 2, 4, and 6, respectively. Thus, consistent with what we expected, buyers search significantly more in Market 1 versus Market 2 ($\chi^2(1) = 54.67$, $p < .001$), in Market 3 versus Market 4 ($\chi^2(1) = 20.63$, $p < .001$), and in Market 5 versus Market 6 ($\chi^2(1) = 60.61$, $p < .001$).

From the sellers’ side, we are interested in sellers’ pricing policy decisions, their prices, and the price dispersion in the market. To examine the PMG policy (whether or not to offer PMGs) decisions of the sellers, we average across four sellers in each of the PMG markets. We find that sellers offer PMGs 94 percent of the time in Market 1, 80 percent in Market 3, and 97 percent in Market 5. We also conduct pairwise comparisons between the PMG and No-PMG markets and find that seller profits are significantly higher ($p < .01$) in all PMG markets (Markets 1, 3, and 5) compared to their corresponding No-PMG markets (Markets 2, 4, and 6). This is consistent with our finding that sellers offered PMGs most of the time when allowed to do so.

Our results regarding sellers’ prices are also presented in Table 2. We first conduct pairwise comparisons between the PMG and No-PMG markets and find that average prices are significantly lower ($p < .01$) in all PMG markets (Markets 1, 3, and 5) compared to their corresponding No-PMG markets (Markets 2, 4, and 6).

In order to examine the two price randomization strategies sellers may adopt, we calculate the price variance in two different ways. Price dispersion across sellers (second last column of Table 2) is measured by taking the variance across the four sellers in each period and then average across all 48 periods. Using F-tests, we find that price dispersion is significantly wider in Market 1 compared to Market 2 ($p = .03$), in Market 3 compared to Market 4 ($p = .02$), and in Market 5 compared to Market 6 ($p = .02$). Temporal price dispersion within a seller (last column of Table 2) is measured by taking the price variance of each seller across all periods and then average across the four sellers. By comparing the PMG markets versus No-PMG markets, we find that sellers vary prices significantly more in Market 1 compared to Market 2 ($p = .02$), in Market 3 compared to Market 4 ($p = .02$), and in Market 5 compared to Market 6 ($p = .02$). It is also important to note that all of the price variances are significantly different from zero whether they were calculated across sellers or for each seller across time periods. Same as the buyer search behavior we observe in the experiment, sellers’ pricing behavior are also seemed to be more consistent with the mixed strategy equilibria than with the pure strategy equilibria.

Based on our experimental results, we conclude that our findings in market experiments with boundedly rational buyers and sellers are consistent with our expectations. More specifically, buyers in PMG markets on average search more compared to No-PMG markets. Symmetric sellers choose to offer PMGs and randomize their prices. In markets where searchers’ demand is more elastic than non-searchers, sellers have the incentive to charge a lower (average) price to encourage buyer search. Prices are also more widely dispersed across sellers and each seller seems to vary the price more in the presence versus absence of PMGs.

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8 By showing the prices and policies of the rivals in the previous periods, we allow the sellers to learn as the experiment progresses so that the market outcome has an opportunity to converge to an equilibrium.
Experiment 2

Experiment 2 was designed to test robustness and further validate the results from Experiment 1. Therefore, it was different from the first set of experiments in several aspects. First, recall that in the first experiment, transactions were completed by computers after the search decisions were made in the third stage. To make the purchase environment more realistic, in Experiment 2, we allowed buyers to make their own purchase decisions after the search decisions were made. Second, instead of using numerical approximation we used random number generators to simulate the Uniform search cost distribution. Third, we invited real consumers to our lab instead of using student subjects. Finally, in order to understand how pricing, search, and purchase decisions were made, we also conducted a short survey at the end of the experiment.

In Experiment 2, we used a 2(PMG versus No-PMG) × 2(replications) between-subjects design for a total of four markets. Each market was played for eight periods. In the two PMG markets (Markets 3 and 4) sellers made pricing and policy decisions (i.e., whether or not to offer PMGs), and in the other two markets (Markets 1 and 2) sellers only made pricing decisions. The experimental parameters we used were the same as Markets 5 and 6 in Experiment 1: demand factor $a = 5$, buyer reservation price $r = 4$, and the maximum search cost $\bar{c} = 2$. These parameters ($a$, $r$, and $\bar{c}$) were also held constant over the eight successive trading periods within a market, and also across the four markets. However, in every period, individual buyer’s search cost was randomly generated from the Uniform distribution with support $[0, \bar{c}]$. To facilitate comparison between the four markets, we did not vary these individual buyer search costs across the four markets. Other than the design aspects that we mentioned above, Experiment 2 is the same as Experiment 1 in terms of experimental design and procedures.

Subjects were recruited online using a paid subject pool at a large mid-western university. Any adult of age 18 and older could sign up for these experiments. The subjects included university (undergraduate, graduate, doctoral, and post-doctoral) students and non-students aged between 18 and 46. Ten subjects were used for each market. At the beginning of each market, subjects were randomly assigned to computers, two as sellers and eight as buyers. Instructions were read and questions were answered publicly. Since we had such a diverse group of subjects, we used four practice periods to familiarize subjects with the experimental procedure. After the practice periods, subjects’ earnings in Experimental Dollars (EDs) are accumulated and they were paid privately after the experimental session. On average, the participants earned $20 with a maximum of $30 and a minimum of $10.

In terms of sellers’ policy decisions, in both markets where sellers are allowed to offer PMGs (Markets 3 and 4), both sellers offer PMGs in all periods. To examine the average market prices in these two types of markets, we take the average price (of the two sellers) for each period in each market and then pool the data across markets where PMGs are not offered (Markets 1 and 2) and across markets where PMGs are allowed (Markets 3 and 4). The line with square (diamond) shape markers in Fig. 2 shows the average prices in markets with (without) PMGs. We also use a line with triangle markers to denote the price differences between the two markets. As one can see, the average price in the market where sellers offer PMGs is significantly lower ($p < .05$) with the difference being $−0.58(−16\%$).

In order to investigate the effects of PMGs on price dispersion in the market, we again calculate the variance for each seller within the eight-period market and across sellers. A Wilcoxon test finds support for our theoretical argument that the price variance (for a specific seller) is significantly larger in the markets where sellers offer PMGs compared to the markets where they do not ($p < .05$). Price dispersion across sellers are also wider ($p < .01$) in the presence versus absence of PMGs.

In terms of buyer search, we find that on average buyers search significantly more ($p < .05$) in the presence versus absence of PMGs, with buyers searching 40 percent of the time in markets without PMGs compared to 67 percent of the time in markets with PMGs. This is also consistent with what we find in Experiment 1 with student subjects.

In order for us to understand the reasoning behind the decisions, we asked the subjects to fill out a survey right after they have completed the experiment. The questions in the survey include the type of strategies they used in the trading periods and some classification information. Sellers were asked about their pricing strategies whereas buyers answered questions related to their search and purchase decisions. The majority of the sellers mentioned “vary”, “change”, or “adjust” prices and this type of response was even more dominant from sellers in PMG markets. This explains why we observe price randomization rather than fixed prices although pure strategy and mixed strategy equilibrium are both predicted. We also asked the sellers and buyers to rank a list of all the experimental parameters (the buyer reservation $r$, the buyer maximum search cost $\bar{c}$, and the buyer demand factor $a$) as to how important they were (1 being the most important) for making pricing and search decisions. We find that the average ranking for the demand factor is 1.44 from the sellers and 1.16 for the buyers. These ranks indicate that both sellers and buyers took into account the difference in demand elasticity between the searchers and non-searchers when making decisions.

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9 We did not have as many periods in Experiment 2 as we had in Experiment 1 because we tried to keep the entire study (experiment and survey) within an hour time frame.
Conclusions

In this paper, we focus on PMG policy and its effect on buyers’ search behavior and sellers’ pricing behavior. We examine strategic behavior from both sides of the market using a series of market experiments with boundedly rational buyers and sellers. Experimental economics has gain acclaim recently as academics have accepted that (1) long held theories need to be tested, (2) certain policy questions cannot be answered by theory – for example, there may be no theory regarding the questions or different theories may offer conflicting answers, and (3) a description of human behavior require study of this behavior. The first and second aspects often require test of “market” behavior, whereas the third aspect always entails “individual choice experiments” (i.e., study of individuals). Marketing, which is made up equally of quantitatively and behaviorally oriented researchers has always been focusing on individual behavior. Very little attention has been given to the first two aspects so far. This paper is the first to use interactive market experiments with both sides of the market designed to test the implications of PMG policies. As such, it should yield many insightful results for both marketing managers and researchers.

We also contribute to the PMG literature by explicitly examining how endogenized buyer search influences the competitive effects of PMGs. We first describe the theoretical aspects of endogenous buyer search and endogenous seller prices and policies and discuss the type of market behavior we expect both in the presence and in the absence of PMGs. Building on prior marketing and economics literature, we discuss a very important aspect of consumer search, which has not been examined in the PMG literature. We argue that consumer search may influence demand such that searchers are more price sensitive than non-searchers. We then provide intuitions about why in this type of market, sellers may have incentives to induce buyers search by charging lower and more widely dispersed prices in the presence (vs. absence) of PMGs when sellers randomize their prices. This is because PMGs benefit sellers by converting more consumers into searchers who buy a larger quantity at a lower price. The lower (average) market prices encourage buyers to search more and also improve consumer welfare.

Consistent with our rationale, we find in our two market experiments that sellers tend to use PMGs when given a choice, prices are lower and price dispersion greater in the presence versus absence of PMGs. Even though it is possible for sellers to charge a fixed price, we conclude from our experiments that price matching symmetric sellers are more likely to use PMGs as devices to price discriminate than to collude, that is, they will randomize their prices rather than collude at a high price level.

These experimental results may have very important public policy implications. Antitrust scholars have always claimed that price matching has the potential to produce anti-competition results in a wide variety of market because sellers do not need to sustain an agreement and high prices can be sustained even when many firms enter the industry. Although it may seem odd for them to focus on a buyer–seller agreement as the source of reduction of competition among sellers, this type of agreement have in fact become suspect under section I of the Sherman Act. Anti-trust cases have used these arguments to justify calls for actions against stores adopting PMGs (Edlin 1997). Policymakers also believe that banning matching sales under the Sherman Act would give sellers the incentive to quote low prices in the first place to avoid being undercut. However, it is important to note that all of these conclusions are based on the theoretical models where sellers’ prices have no effects on buyers’ search behavior. Making policy decisions based on these assumptions can be risky because in reality market prices do influence how buyers search. We argue and show that in markets where buyers’ search have strong demand effects, price matching sellers may have the incentive to induce more buyers to search (through price randomization) and then benefit from higher market demands (by charging lower prices).

Although our paper contains interesting insights on PMG policies, the results must be interpreted within the context of certain limitations. First, our results may only apply to markets where sellers are very similar. While this may be representative of certain product categories such as groceries, books, toys and office supplies, it may not be of all product categories. Second, although for simplicity we focus on markets with two sellers in our market experiments, our results can be applied to markets with $n$ symmetric sellers. However, the larger the number of sellers, the higher the market price would be when PMGs are offered. This is because all price matching sellers can effectively price discriminate as long as there exists a lower price in the market. As the number of sellers increases, the pressure on any one seller to offer low price is smaller. Therefore, the average market prices will be higher. On the other hand, temporal price dispersion is less likely to be influenced by the number of sellers because this type of price discrimination does not depend on other sellers’ prices. Therefore, considering both price discrimination mechanisms, we would predict the market price to be higher for PMG markets as the number of sellers increases but not for No-PMG markets.

From the buyers’ side, it is important to note that our experimental results are more applicable to markets where consumers conduct non-sequential search by submitting their search requests once and get all the information. Good examples would be purchasing a newspaper, a pricing service, or conducting an on-line price search through comparison shopping websites. However, there are scenarios where buyers engage in sequential search and make decisions on when to stop searching after each search. A useful avenue for future research would be to see how our results change in a sequential search market. Finally, since we did not manipulate buyers’ risk perceptions, buyers in our experiments were most likely risk-neutral. As a result, we may not be able apply our results in situations where buyers take risks that are inconsistent with a risk-neutral buyer’s expected value of search. For example, risk-seeking buyers may choose not to search even with low search costs. Future research should extend our model to consider risk-averse and risk-seeking buyers.

These limitations notwithstanding, we believe our study is a first step to investigate PMGs in a market equilibrium context and to examine PMGs in market experiments with interactive buyers and sellers. The implications should be of great interest to researchers, practitioners, and public policy makers.
Appendix A. Instructions for Experiment 1

General instructions

This is an experiment in the economics of market decision making. Various research institutions have provided funds for this research. In this experiment, 4 of you will be randomly assigned as sellers and 16 as buyers in a sequence of 48 market trading periods. You remain in the same role throughout the experiment. In each period, we are going to simulate two markets by randomly selecting two sellers and eight buyers to form each market. The rules are simple and you will be privately paid at the end of the experiment. You can raise your hands if you have any questions regarding this instruction. Do not talk to others during the experiment.

The type of currency in this market is Experimental Dollars (ED). All transactions will be in terms of EDs. At the end, your earnings in EDs will be converted to dollars and you will be paid in dollars. The more EDs you earn, the more dollars you earn.

The applicable information is the following.

The sellers sell the same products. They incur NO cost for selling any unit and they are free to sell as many units as they want. Sellers make profits by selling to the buyers. The higher their selling prices, the higher the sellers’ earnings are.

Buyers earn profits by purchasing from sellers and reselling to the experimenters. The resale values are the same for all buyers. Buyers do not know the prices from sellers. However, buyers can pay a cost (e.g., purchase a newspaper or pricing service) to find out both sellers’ prices. The search cost lies between 0 and a maximum value. It varies among different buyers and may change from period to period for each buyer.

If a buyer decides not to search, (s)he will demand 1 unit of the product. A buyer can also choose to pay a search cost to find out prices from both sellers and buy from the seller who offers the lower price. If a buyer decides to search, her/his demand will be determined by a simple formula: A–P. “A” is a demand factor which is the same for all searchers and P is the price per unit.

For each period, the sequence of the experiment is the following.

Specific instructions: No-PMG markets

In the first stage, each seller makes her/his own decision on per unit list price and whether or not to offer a Price-Matching Guarantee policy. A seller who offers a PMG policy has to match the lower price if a buyer search for price information and finds a lower price elsewhere. Although the price information is costly to the buyers, the PMG policy decisions will be publicly announced.

In the second stage, buyers decide whether they want to search given their search costs.

After all the buyers finish searching, transactions will take place in the third stage according to the following rules:

If you decide not to search, you will be randomly matched with a seller to complete the transaction and pay the listed price. Remember, when PMGs are offered, the buyers who decide not to search cannot take advantage of the offer. Even if a higher price seller offers to price match, the buyers who choose not to search will pay the higher listed price.

If you decide to search, you will pay the lower price in the market. However, from which seller you purchase the items depends on the market situation. When only the high price seller offers PMG or when both sellers offer PMGs, since the price after matching is the same for both sellers, you will be randomly matched with one seller and pay the lower price in the market.

For each period, profit is calculated by:

\[ \text{Seller profit} = \text{Total units} \times \text{price}. \]

Specific instructions: PMG markets

In the first stage, each seller makes her/his own decision on per unit list price and whether or not to offer a Price-Matching Guarantee policy. A seller who offers a PMG policy has to match the lower price if a buyer search for price information and finds a lower price elsewhere. Although the price information is costly to the buyers, the PMG policy decisions will be publicly announced.

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Specific instructions: PMG markets

In the first stage, each seller makes her/his own decision on per unit list price and whether or not to offer a Price-Matching Guarantee policy. A seller who offers a PMG policy has to match the lower price if a buyer search for price information and finds a lower price elsewhere. Although the price information is costly to the buyers, the PMG policy decisions will be publicly announced.

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If you decide to search, you will pay the lower price in the market. However, from which seller you purchase the items depends on the market situation. When only the high price seller offers PMG or when both sellers offer PMGs, since the price after matching is the same for both sellers, you will be randomly matched with one seller and pay the lower price in the market.

For each period, profit is calculated by:

\[ \text{Seller profit} = \text{Total units} \times \text{price}. \]

Specific instructions: PMG markets

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If you decide to search, you will pay the lower price in the market. However, from which seller you purchase the items depends on the market situation. When only the high price seller offers PMG or when both sellers offer PMGs, since the price after matching is the same for both sellers, you will be randomly matched with one seller and pay the lower price in the market.

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If you decide not to search, you will be randomly matched with a seller to complete the transaction and pay the listed price. Remember, when PMGs are offered, the buyers who decide not to search cannot take advantage of the offer. Even if a higher price seller offers to price match, the buyers who choose not to search will pay the higher listed price.

If you decide to search, you will pay the lower price in the market. However, from which seller you purchase the items depends on the market situation. When only the high price seller offers PMG or when both sellers offer PMGs, since the price after matching is the same for both sellers, you will be randomly matched with one seller and pay the lower price in the market.

For each period, profit is calculated by:

\[ \text{Seller profit} = \text{Total units} \times \text{price}. \]
If a buyer decides not to search, (s)he will be randomly matched with one seller and demand only 1 unit. A non-searcher’s profit can be calculated by:

**Non-searcher profit**

\[
\text{Buyer resale value} - \text{transaction price}.
\]

For each seller, profit is calculated by adding up profits from each buyer who buys from this seller:

**Seller profit** = Sum(units × price).

Note that when a seller offers a PMG policy, her/his price to each buyer is different depending on whether or not the buyer has conducted a search. A searcher will pay the lower price in the market whereas a non-searcher will pay the listed price.

Suppose in period 1, you charge 4ED and offer PMG and the other seller charges 3ED. Two buyers are buying from you. One of them searched for price information and the other did not. In this case, your transaction price for the searcher is 3ED and for the non-searcher is 4ED. If in this period, the searcher demand factor is \( A = 6 \), the searcher will demand 2 units from you and you earn \( 2 \times 3 = 6ED \). Your profit from the non-searcher is 4ED. Therefore, you total profit in this period is \( 6 + 4 = 10ED \).

You will find out your profits for the current period before you move on to the next period.

Your goal in this setting is to maximize your profits across all periods. At the end of the experiment, total profits will be calculated and you will get monetary rewards for your earnings. You will be paid $5–$10 (translated from ED to dollars) depending on your performance.

### References


