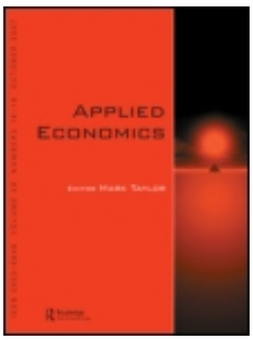

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Firm strategy and biased decision making: the price dispersion puzzle

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This article confronts the empirical evidence and theoretical predictions about the correlation between price dispersion and price. Theoretically, search and location differentiation models suggest that price dispersion is a function of search and transportation costs, but is independent of the good's price. Empirical evidence, however, suggests otherwise: price dispersion and price are strongly correlated. This article points out the discrepancy between theory and evidence, which it denotes as 'the price dispersion puzzle'. It then explains why the documented behaviour of relative thinking (people behave as if their search or transportation costs are increasing in the good's price) can solve the puzzle.

Keywords: consumer behaviour; relative thinking; price dispersion; behavioural economics; pricing

JEL Classification: D11; D12; L13; L81; M31

I. Introduction

Studies of price dispersion find that absolute price dispersion is increasing in the good's price.[1] Examples involve various markets: Xing (2010) uses panel data collected for over 2 years in the DVD market, for both Multi-Channel Retailers (MCRs) and online-only retailers. Pratt, Wise and Zeckhauser (PWZ, 1979) sampled 39 categories randomly from yellow pages and chose one good in each category, for which they obtained prices from different sellers Pan, Ratchford and Shankar (PRS, 2001) collected price quotes for 581 identical products in eight categories (Books, CDs, DVDs, desktop computers, laptop computers, PDAs, software and consumer electronics) from 105 e-tailers. Sorensen (2000) studies the price dispersion of prescription drugs. Aalto-Setälä (2003) studies price dispersion of grocery products in Finland, using a large dataset that includes data about prices of 120 items in 157 stores at two periods. Xing (2010) analyses the price dispersion in the online DVD market. I present data about airline prices. In all these different markets, there is a very strong positive correlation between price dispersion and the good's price.

[1] Absolute price dispersion is price dispersion that is not divided by the good's price. Two common measures of absolute price dispersion are the SD of prices, and the range of prices (maximum minus minimum price of a certain good). For the sake of brevity, in what follows I use 'price dispersion' to mean 'absolute price dispersion', and also I use 'the good's price' to mean 'the average price of the good'.

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One of the early analyses of price dispersion is offered by Fershtman (1982), who analyses how the assumption that consumers do not respond to small price differences affects oligopoly price dispersion. Cohen (1998) studies the relationship between product differentiation and price dispersion. Dana (1999) analyses price dispersion with demand uncertainty and costly capacity. Baye and Morgan (2001) examine the equilibrium interaction between a market for price information that is controlled by a gatekeeper and the homogenous product market it serves. The gatekeeper charges fees from both firms that advertise prices on its website and consumers who access the advertised prices list. Belton *et al.* (2002) consider the relationship between money and price dispersion. Cason and Friedman (2003) examine the relationship between buyer search and price dispersion using a lab experiment, where they vary the number of buyers, the search cost and the number of prices observed, and report how these variables affect the outcomes. Baye *et al.* (2004) examine price dispersion on an internet price comparison site using over 4 million price observations for more than 1000 consumer electronic products. They find that observed levels of price dispersion vary systematically with the number of sellers, with more sellers resulting in a lower price dispersion between the two lowest prices. Baye and Morgan (2004) show that a little bounded rationality among sellers can result in price dispersion, and that data from lab experiments and from an online price comparison site are consistent with theories of price dispersion that are based on bounded rationality. Connor (2005) discusses the impact of collusion on price dispersion. Morgan *et al.* (2006) examine a simple clearinghouse price dispersion model using an experiment. In the model, price dispersion arises because of consumer heterogeneity between informed and captive consumers. The experiment documents substantial and persistent price dispersion. Gil-Pareja and Sosvilla-Rivero (2008) examine the price dispersion in the EU car market, and Fava (2010) suggests that price dispersion should be taken into account when computing price indexes.

Price dispersion is an important research area, because its existence seems to contradict the common assumption that due to rationality and budget constraints, consumers should buy from the lowest price seller (assuming all sellers offer an identical good). Consequently, price dispersion also appears to violate one of the basic laws in economics – the law of one price. This law, however, assumes that the good is homogenous and that consumers have perfect information about prices. Accordingly, two common explanations for the existence of price dispersion are that the good in question is differentiated rather than homogenous, and that obtaining information about prices is costly. Another branch of the literature explains price dispersion using clearinghouse models (e.g. Baye and Morgan, 2001; Baye *et al.*, 2004). These models generally have some consumers who subscribe to a clearinghouse in which some firms advertise their prices, while other consumers and firms do not use the clearinghouse. This article focuses on the case of price dispersion that comes from location differentiation and from costly information search.

While the goods in the studies cited above are generally homogeneous, sellers might differ in their location (in the datasets of PWZ, Sorensen and Aalto-Setälä), creating product differentiation due to the geographical location in which transactions have to take place. This can lead to price dispersion, because the more conveniently located sellers can charge a higher price than others. What prevent consumers from buying only from the lowest-price sellers are the transportation costs they have to incur to go to a remote seller. Transportation costs, however, are determined by how far the store is, the value of the consumer's time, gasoline prices, etc. and are not a function of the price of the good the consumer wants to purchase. Consequently, price dispersion should be independent of the good's price. I demonstrate this point with a simple theoretical model of spatial competition.

Another reason for price dispersion when goods are homogeneous is search costs. In search models, the assumption of perfect information about prices is relaxed, and instead we assume that it is costly to obtain prices of various sellers. The cost of obtaining information about prices (a major part of which is the time cost) is referred to as search costs. The reason for price dispersion according to search models is that even if consumers know the price distribution, they might prefer buying in a store that does not offer the lowest price to spending time and money obtaining information about prices in other stores in order to find a lower price. Because price dispersion is the result of search costs, price dispersion is higher when search costs are higher. Price dispersion is not a function of the good's price, however, because consumers should make the same search effort to save \$5 on a \$20 item as on a \$300 item; the extra utility they can derive from additional consumption is a function of the amount saved (\$5) regardless of the price of the good on which the \$5 were saved. If search behaviour is independent of price, the premium that high-price sellers can charge over lower price sellers is independent of price,

leading to price dispersion that is uncorrelated with the good's price.[2]

While both location differentiation and search models predict that price dispersion should be independent of the price level, the empirical evidence mentioned at the beginning shows that price dispersion is significantly increasing in the price level. Pointing out the inconsistency between the theoretical predictions and the empirical evidence on price dispersion (which I denote 'the price dispersion puzzle') is the first goal of this article. This significant inconsistency is an important issue that should be brought to the attention of scholars interested in price dispersion, so that they can think about possible explanations for the inconsistency, and may offer new theoretical models that fit better the empirical evidence.

The second goal of this article is to discuss several such explanations, one of which seems to be the major reason for the 'price dispersion puzzle': this explanation is a consumer behaviour that was denoted as 'relative thinking' (e.g. Azar, 2004, 2011a). The concept of relative thinking was formulated following the results of experiments that showed that when people have to decide how much in monetary compensation they require in order to make a certain effort when shopping for a good (e.g. to drive 20 minutes to a cheaper store), the amount required is increasing in the good's price. This means that people behave as if their transportation costs, or search costs, are increasing in the good's price. This, in turn, can solve the price dispersion puzzle: since price dispersion is increasing in transportation costs (or search costs), if people behave as if their transportation and search costs are increasing in the good's price, this will lead to a positive correlation between price dispersion and the good's price.[3] Thus, this article contributes to the growing literature on behavioural industrial organization, a literature that examines how insights from psychology and deviations of economic agents from full rationality and selfishness affect firms and markets (see, e.g. the model of contract design by DellaVigna and Malmendier (2004); the model of add-ons' pricing by Gabaix and Laibson (2006); and the review on bounded rationality in industrial organization by Ellison (2006)).

The rest of this article is organized as follows: Section II presents empirical evidence from various markets on the correlation between price dispersion and price. Section III introduces a model of spatial competition and analyses the implications of this model. Section IV explains the price dispersion puzzle and suggests that relative thinking may explain it. Section V discusses another potential explanation for the price dispersion puzzle and explains why relative thinking seems the most plausible explanation, and the last section concludes.

II. Empirical Evidence on the Correlation Between Price Dispersion and Price

What do we know about the correlation between price dispersion and price? A few studies on price dispersion, while generally not focusing on this correlation, offer relevant information. PWZ (1979) found in a sample of 39 different products that the SD of prices is an increasing (and in fact almost linear) function of the mean price. They called on average 12 sellers of each good and asked for the price. In a regression of the log of the SD of prices on the log of the mean price (μ), the result was (SE is given within parentheses):

$$\ln \mathrm{SD} = -1.517 + 0.892(0.059)\ln \mu, \quad R^2 = 0.870$$

While PWZ realized that the strong positive relationship between average price and price dispersion is puzzling, they concluded that 'The explanation may lie with the infrequent purchase of expensive products, which reduces the incentive of a buyer to search. Less searching, in turn, allows greater variability among prices'. In a footnote, they mention that Sam Peltzman selected the products that were unambiguously consumer goods (32 out of the 39 goods) and distinguished frequently

[2] Noneconomists might find it surprising that economic theory predicts no correlation between the good's price and price dispersion, because in noneconomic contexts a positive correlation between average and dispersion is often natural. However, prices are not noisy variables chosen in random but rather are the result of optimization by firms. Consequently, their dispersion is affected by market characteristics, and higher prices do not imply (from a theoretical point of view) higher price dispersion. The crucial impact of market characteristics on price dispersion can be seen if we compare for example \$50 earrings to a \$1000 ounce of gold. The earrings can be sold at different stores for remarkably different prices, while an ounce of gold has a constant price worldwide at any given time. That is, the gold has no dispersion and the earrings may have significant dispersion due to the relevant market characteristics, even though the gold's price is much higher than the earrings' price.

[3] Azar (2008a) shows that this can also lead the firms to charge higher prices, in order to encourage the consumers to behave as if their transportation costs are higher, which is beneficial to the firms because it mitigates competition.

purchased goods from the others. Using a dummy variable D to represent frequently purchased goods, he obtained the following result (SEs are given within parentheses):

$$\ln \mathrm{SD} = -1.161 + 0.836(0.084)\ln \mu - 1.015(0.369)D$$

PWZ infer that this result shows that frequently purchased goods have much lower price dispersion. While this is correct, notice that even when controlling for frequency of purchase, the coefficient of $\ln \mu$ is still large (in fact, it is almost unchanged) and statistically significant, suggesting that the positive relationship between price dispersion and mean price is not only a result of more expensive goods being purchased less frequently.

Based on the data of PWZ, I also estimated a regression that replaces the SD of prices with the price range (maximum minus minimum price of the good) as the measure of price dispersion.[4] The change of the price dispersion measure did not change the striking positive correlation between price dispersion and mean price; the regression is presented below (SEs are given within parentheses)

$$\ln \text{Price-Range} = -0.419(0.232) + 0.917(0.069)\ln \mu, \quad R^2 = 0.828$$

More than 20 years later, PRS (2001) obtained similar results in a different environment, of online retailers. They collected 6739 price quotes for 581 identical products from 105 e-tailers during November 2000. In a Generalized Method of Moments (GMM) regression that aims to explain the drivers of price dispersion and includes many explanatory variables, including various e-tailer characteristics, the log–log regression yields a coefficient of 0.91 for the average price both when the dependent variable is the log of the price range and when it is the log of the SD of prices (both results with $p<0.01$). Moreover, the products in the study belong to only eight categories (Books, CDs, DVDs, desktop computers, laptop computers, PDAs, software and consumer electronics), and the regression includes dummies for different categories. This implies that purchase frequency is controlled for by these dummies; so the strong positive relationship between price dispersion and average price is not a result of low-priced items being purchased more often.

Sorensen (2000) studies price dispersion of prescription drugs and finds that the wholesale cost of the drug affects price dispersion significantly, where purchase frequency is one of the explanatory variables (in fact, it is the focus of his paper) and is therefore controlled for.[5] Sorensen examines several dispersion measures, and in all of them the effect of the wholesale cost is statistically significant. For example, the coefficient of the wholesale cost in Generalized Least Square (GLS) regressions when the dependent variable is the price range and the SDs of prices are 0.28 (SE: 0.033) and 0.18 (SE: 0.02), respectively.

Aalto-Setälä (2003) studies price dispersion of grocery products in Finland, using a large dataset that include data about prices of 120 items in 157 stores at two periods (February 1995 and February 1997). The items are well-defined: fixed packet size of branded products (e.g. 1 L of Coca Cola), to ensure that the goods are homogeneous. Aalto-Setälä runs both Ordinary Least Square (OLS) and GLS regressions where the dependent variable is the SD of prices. One of the explanatory variables is the average price, computed in all other market areas except the area for which the price dispersion is computed. The coefficient of average price in the OLS and GLS regressions is 0.081 (SE: 0.002) and 0.081 (SE: 0.001), respectively. Aalto-Setälä includes category and product characteristics dummies (such as whether the product has to be consumed fresh) that control for purchase frequency.

Xing (2010) collected data on the online DVD market, for both online-only retailers and MCRs, for a period of 2 years, collecting in total 22 950 price observations. Three regressions are reported, one for all titles, one for the most popular titles and one for titles chosen in random. In all three regressions, price dispersion of a DVD title (measured as the log of the SD of prices) is regressed on various variables, including the log of the Maximum List Price (MLP). The coefficient of log(MLP) ranges between 1.05 and 1.10 in the three regressions, with t-statistics that range between 14.34 and 23.54, again showing a positive correlation between price dispersion and price. Popular titles do not have lower prices than titles chosen in random; so there is no significant correlation between price and purchase frequency, and therefore purchase frequency cannot explain the correlation between price dispersion and price.

[4] The entire dataset, consisting of 479 prices, is included in the earlier working paper version of the article (PWZ, 1975).
[5] A drug's wholesale cost obviously has a strong positive correlation with the drug's retail price, and therefore I use the cost as a proxy for the price, in the absence of data on the drugs' retail prices.

Table 1. Price dispersion in airlines

	Dependent variable			
Independent variable	ln(1+PDISP)	ln(1+PDISP)	ln(1+WSTD)	ln (1+WSTD)
ln(CATP)	0.55 (0.082)		0.46 (0.070)	
ln(P)		0.53 (0.054)		0.44 (0.046)
R^2	0.035	0.065	0.033	0.059

Note: Robust SE values are given within parentheses.

To further examine the robustness of the correlation between price dispersion and price by looking at an additional industry, I examined a dataset of airline pricing. The data are taken from the US Department of Transportation's Databank 1A, a 10% sample of all tickets collected by US air carriers, for the years 1994 to 1995. The data used include 1335 observations of duopoly routes, defined as routes on which two carriers have more than 80% of the market and each of these two carriers has a market share of at least 10%.[6] Each observation includes the market shares and average prices of the two airlines and a variable denoted as category price (CATP), which is the average price on US routes of similar distance. CATP can serve as a proxy for the route's cost, or as a proxy for the route's price that does not depend on the specific pricing decisions made on this route. I computed weighted average price (P), price dispersion (PDISP) and weighted standard deviation (WSTD) of price for each route.[7] The results of four log–log regressions that regress one of the two measures of price dispersion (PDISP or WSTD) on one of the two measures of the route's price (CATP or P) are presented in Table 1.

It is easy to see that in all the specifications, the effect of the price on price dispersion is statistically significant, as well as economically significant: an increase of 1% in price raises the price dispersion by about 0.5%. Alternative specifications (e.g. with the log of nonweighted average price as the independent variable) yield similar results. Notice that CATP is exogenous to the route in question; therefore, having CATP as the independent variable provides a useful robustness check, for reasons that are discussed later.

III. Theoretical Predictions About the Correlation Between Price Dispersion and Price

If the market is served by two or more price-competing firms who produce a homogeneous good, the famous Bertrand paradox suggests that any firm that sells a positive quantity in equilibrium charges the same price. In that case, no price dispersion should be observed at all. The empirical evidence discussed above, however, suggests that in many markets, price dispersion exists. In what follows, I describe two common explanations for price dispersion and analyse the predicted correlation between price dispersion and price according to these explanations.

Geographical differentiation of sellers

One common explanation for price dispersion when goods are seemingly homogeneous is heterogeneity in the sellers' locations, leading to product differentiation and price dispersion. The analysis of such geographical differentiation of sellers often uses the framework of the linear city (Hotelling, 1929). Unfortunately, these models usually assume symmetry between the firms and therefore do not yield price dispersion in equilibrium. One exception is Tirole (1988, p. 281). Assume that the two firms have a marginal cost of c per unit and consumers are distributed uniformly in a linear city whose length is normalized to one and have quadratic transportation costs[8] with the transportation cost parameter being t.

[6] The data used are also limited to routes with both endpoints in the United States on which at least 3650 passengers travelled during the observed year and on which all service was by jet aircraft.

[7] Denote the prices by p_1 and p_2 and the market shares by x_1 and x_2. The market shares sum up to a number between 0.8 and 1. The normalized market shares that sum up to 1 are defined as $s_i = x_i/(x_1 + x_2)$ for $i = 1, 2$. The weighted average price is $P = s_1p_1 + s_2p_2$, the weighted SD, WSTD $= [s_1p_1^2 + s_2p_2^2 - P^2]^{0.5}$ and price dispersion, PDISP = absolute value of $(p_1 - p_2)$.

[8] That is, the total cost a consumer bears when buying from a firm is equal to the firm's price plus the parameter t multiplied by the squared distance between the consumer and the firm.

Denoting firm 1's location by a and firm 2's location by $(1-b)$, equilibrium prices are

$$P_1 = c + t(1-a-b)[1+(a-b)/3] \quad \text{and}$$
$$P_2 = c + t(1-a-b)[1+(b-a)/3]$$

It is then easy to see that the price dispersion (denoted by Δ) is given by

$$\Delta \equiv P_2 - P_1 = 2t(a^2 - b^2 - a + b)/3$$

Notice that assuming that asymmetry exists ($a \neq b$), the price dispersion is an increasing function of t, but does not depend on the good's cost, c. Is this result robust to other model specifications? To obtain price dispersion, we need to introduce some asymmetry in the model. Here, the asymmetry comes from the firms' locations. Azar (2008b) similarly finds that price dispersion is an increasing function of t and does not depend on the good's cost in a model where the two firms are located at the two endpoints of a linear city and the consumer distribution over the city is asymmetric.[9]

The intuition why price dispersion should be an increasing function of t is that the transportation costs are the reason price dispersion is possible in equilibrium, and therefore it makes sense that higher transportation costs allow greater price dispersion. To state this more formally, when $t=0$ every consumer who buys goes to the cheapest firm, prices are equal to marginal cost, and we have no price dispersion. We get price dispersion (assuming that the consumers' distribution in relation to the firms' locations is asymmetric) only when we increase t so that it becomes strictly positive. If price dispersion is continuous in t, it therefore must be increasing in t (at least when t is sufficiently close to zero).

The intuition why price dispersion is not a function of the good's cost is as follows: the reason for the seller heterogeneity that creates the price dispersion is that consumers have to incur transportation costs, which differ between the sellers. Since the transportation costs are unrelated to the good's cost (the time cost of driving to a remote seller is independent of the price of the good we want to purchase, for example), price dispersion is also independent of the good's cost.

Search

Another common explanation for price dispersion is search costs: obtaining information about prices is costly; so consumers are not fully informed about all the prices and this allows price dispersion. The two main points that were discussed above regarding location differentiation models have similar counterparts in search models.[10]

First, price dispersion is generally increasing in search costs. The intuition is as follows: without any search costs, price competition implies that any firm that sells a positive quantity in equilibrium must charge the same price; so, there is no price dispersion. What allows price dispersion is the introduction of positive search costs. It is therefore natural to expect that higher search costs will lead to higher price dispersion. Another intuition for this result is to think about a firm that charges a relatively high price. Such a firm sells to consumers who did not obtain a lower price quote, and who find the search cost too high compared to the expected gains from further search. When search costs are low, the difference between the price of this firm and of other firms must also be low; otherwise, consumers continue searching for a lower price and no one buys from the high-price firm. When search costs are higher, it is more costly for consumers to continue searching; so the firm can increase the difference between its price and prices of other firms without causing its consumers to buy elsewhere. This leads to price dispersion that is increasing in search costs.[11]

Second, price dispersion in search models is generally not affected by the price level. This is because price dispersion is the result of search costs, which are independent of the good's price: the cost of driving to another store, for example, is the same regardless of

[9] Assuming asymmetry due to different costs of the firms is not useful here because we want to analyse how price dispersion is affected by the price (for which the cost serves as a proxy), we will have to assume how the asymmetric costs change with the price level (e.g. is the difference in costs a constant dollar amount or a constant ratio?), and this assumption crucially affects how the price dispersion changes with the price level. When the price dispersion comes from asymmetric location of firms or asymmetric distribution of consumers on the line, however, we get price dispersion for any price level without additional assumptions.

[10] Various search models yield a large range of possible equilibria and it is probably possible to locate or create search models that do not fit the discussion below. Nevertheless, the intuition discussed below is quite general and does not depend on unreasonable assumptions and therefore it applies to a broad range of search models.

[11] Empirical studies support a closely related phenomenon: price dispersion is smaller when purchase frequency is higher (PWZ, 1979; Sorensen, 2000). Higher purchase frequency leads to greater benefits from finding a low price and thus encourages more search; lower search costs are somewhat equivalent to higher purchase frequency, because they also encourage more search. The empirical evidence that price dispersion is decreasing in purchase frequency therefore supports the theoretical prediction that price dispersion is increasing in search costs.

which good we buy. This means that the correlation between price dispersion and price should be close to zero.

IV. The Price Dispersion Puzzle and Relative Thinking

Section II presented empirical evidence from various markets suggesting that price dispersion and price are strongly correlated. Section III shows that from a theoretical perspective, price dispersion should be independent of price both when it comes from location differentiation and when it comes from search costs. Why is the empirical evidence on price dispersion so different from the theoretical predictions? This is what I denote 'the price dispersion puzzle'. Price dispersion is an important phenomenon, as it violates one of the fundamental laws in economics, the law of one price; indeed, the large theoretical, empirical and experimental literature on price dispersion reflects the topic's importance. We should therefore be worried about the discrepancy between the theoretical predictions and the empirical evidence on price dispersion, and try to explain it.

What is the explanation for the price dispersion puzzle? I suggest that a phenomenon that was previously denoted 'relative thinking' can solve the puzzle. Relative thinking means that people often consider relative price differences in addition to absolute price differences, even when a rational consumer should only consider the absolute differences. For example, Azar (2011b) conducted an experiment in which subjects were asked to imagine that they can buy a certain good at a store they are currently visiting, or spend 20 more minutes to obtain the exact same good at a cheaper store. He then asked the subjects what is the maximal price for which they will be willing to go to the other store. The difference between the good's price in the first store and the subject's answer reflects the subject's valuation of 20 minutes of his time in the context of shopping for the good. Azar shows that the valuation of one's time as reflected in the answers was affected very significantly by the price of the good subjects were told to imagine buying. For example, when the good was a \$3 pen, the average compensation subjects required for 20 minutes was \$1.88, but when it was a \$3000 computer, they required \$62.89 on average.[12]

While Azar's study is the easiest to interpret because he obtains the subjects' valuation of their time, earlier studies obtained qualitatively similar results, which also support the idea of relative thinking. Tversky and Kahneman (1981) asked people whether they would drive 20 minutes to save \$5 on a calculator when they are about to buy a calculator and a jacket. When the calculator's price was \$15 and the jacket's price \$125, 68% of the subjects were willing to drive, but when the calculator's price was \$125 and the jacket's price \$15, only 29% wanted to drive 20 minutes to save \$5. Tversky and Kahneman's result was later replicated in several other studies. Mowen and Mowen (1986), for example, show that the effect holds similarly for student subjects and for business managers' subjects. Ranyard and Abdel-Nabi (1993) vary the price of the second item (the jacket) and obtain similar results, and Frisch (1993) shows that the effect holds also when only a calculator is being purchased.

Furthermore, while the behaviour of relative thinking has virtually been ignored by economists so far, texts in marketing and consumer behaviour recognize that consumers care about percentage price differences. For example, Kindra *et al*. (1989, p. 80) write, 'Markups and markdowns, therefore, can be analyzed meaningfully only in terms of their percentage of the original price. Retailers have long recognized that markdowns of less than 20 percent generally go unnoticed'. Similarly, Schiffman and Lazar Kanuk (1983, p. 138) argue, '... retailers have long made use of a general rule of thumb that markdowns of merchandise must amount to at least 20 percent of the old price, since a smaller amount often goes unnoticed by consumers. They recognize that the *just noticeable difference* is not an absolute amount, but rather a relative amount contingent upon the level of the initial price'.[13]

Why does relative thinking solve the price dispersion puzzle? The basis for the price dispersion puzzle is the observation that search or transportation costs are identical regardless of the good's price, and therefore price dispersion, which depends on the level of search or transportation costs, should be independent of the good's price (as was analysed and discussed in the previous section). Relative thinking, however, suggests that people behave as if the value of their time is higher when they buy a more expensive good. This means that while from a normative perspective search and transportation

[12] See also Azar (2011b).

[13] A similar claim appears in Hanna and Wozniak (2001, p. 114), who write, 'Clothing retailers, for example, find that markdowns of less than 20 percent from the original price of a garment have little effect on enhancing sales. For consumers to believe they are getting a bargain, the markdown must be 20 percent or more'.

costs are independent of the good's price, people in fact behave as if their search and transportation costs are increasing in the price of the good they are about to purchase. Once we account for this behaviour, search and location differentiation models predict higher price dispersion for more expensive goods because of the higher search and transportation costs. Thus, relative thinking leads the standard models of search and location differentiation to predict exactly what we see in the empirical evidence – a positive correlation between price dispersion and price – and so it solves the price dispersion puzzle.

In terms of the preceding section, because Δ is not affected by c, and because t is independent of the good to be purchased for consumers without relative thinking, Δ is independent of c: the absolute price dispersion of expensive goods and cheap goods should be the same. This is because the extent of price dispersion is determined by the magnitude of transportation or search costs, and those are unaffected by the good's price (or cost) in standard economic theory. Relative thinking of consumers, however, means that they behave as if t is increasing in the price of the good they want to purchase. Consequently, because Δ is increasing in t and t is increasing in the good's price, relative thinking implies that Δ should be positively correlated with price: absolute price dispersion should be higher for more expensive goods.

To understand the intuition for how relative thinking affects price dispersion, a couple of simple examples might be helpful. For the location differentiation case, suppose that there is a competitive fringe of electronic equipment stores in the outskirts of a certain city, and a more conveniently located store at the city centre. The competitive fringe sells every good for its marginal cost because there is no location differentiation between the stores in this fringe – all are located at the same distance from the consumers. The city-centre store knows that it can charge higher prices and still induce sales, because it is closer to the consumers and therefore it saves them travel time. The store realizes that consumers exhibit relative thinking, and that consequently they will make more effort to save a constant dollar amount when the good's price is lower. Suppose that for a telephone that sells for \$20 in the competitive fringe, the city-centre store figures out that its optimal price is \$23. Now, consider a printer that sells for \$200 in the competitive fringe. The city-centre store realizes that because of relative thinking, consumers are less willing to go to the remote stores for a given dollar savings in this case (because relative to the good's price, the savings seem lower); in other words, it realizes that consumers behave as if their transportation costs are higher when they purchase the printer than when they purchase the telephone. Therefore, the store finds it optimal to charge a premium higher than \$3 in this case, say a premium of \$20 (i.e. it prices the printer at \$220). Consequently, price dispersion and price are positively correlated.

In search models, the intuition is similar. Here, consumers do not know in advance which store is the cheapest and they have to trade-off the effort of additional search (going to more stores) to its benefit (possibly finding a lower price). Due to relative thinking, they make more effort to save a certain amount when the good's price is lower (because the relative savings are then higher). Consequently, a store that charges above-average prices will realize that it can charge a higher premium on the printer (over the prices of other stores) without losing all its customers, compared to the premium that it can charge on the telephone. Once again, relative thinking of consumers and optimal pricing by firms lead to price dispersion and price that are positively correlated.

V. Alternative Explanations for the Empirical Evidence

The empirical evidence presented in Section II shows unambiguously a strong positive correlation between price dispersion and price (or cost) in various markets. The positive correlation is very significant, both statistically and economically, and is robust to various specifications of price dispersion (price range or SD of prices) and price (average price or cost as a proxy). Theoretical search and location differentiation models, however, predict that price dispersion should be independent of price. The last section proposed relative thinking as the explanation for this inconsistency, which was denoted as 'the price dispersion puzzle'. We might wonder, however, whether there are other potential explanations for the price dispersion puzzle. One potential explanation was discussed in Section II – the idea that people purchase more expensive goods less often – and as the discussion in that section showed, this explanation cannot account by itself for the strong correlation between price dispersion and price.

Another potential explanation is that people who buy high-price goods have higher search costs. The relative thinking argument claims that price dispersion for high-price goods is higher because people behave as if their search costs (or transportation costs) are increasing in price. One could make the

argument that search costs are increasing in price for another reason: people who buy high-price goods are wealthier, therefore their time is more valuable and consequently their search costs are higher. There might be some truth in this argument, but it is not likely to be the major explanation for the results for several reasons.

First, this argument depends on several correlations, each of which is not necessarily strong, and the combination of all of them is naturally even weaker. The correlation between wealth and prices of goods purchased may be weak or even eliminated because luxurious goods often come in package of smaller size than basic goods. For example, high-income people may tend to buy more ready-to-eat meals, but a ready meal might cost less than the packet of meat purchased by the less-wealthy consumer, simply because the former is smaller in size. In addition, the correlation between one's wealth and the effort he makes to save money (this effort reflects his search costs – higher effort means lower search costs) is not necessarily strong. Personality, for example, also plays an important role in determining search behaviour.

Second, the same results were obtained where this issue is irrelevant or controlled for. In the market for prescription drugs, for example (Sorensen, 2000), people do not choose to buy more expensive drugs if they are wealthier; they buy drugs according to their medical condition. In the airlines dataset, it also does not seem likely that there is a strong relationship between the route's price and the buyer's income. People who fly for business or to meet with family or friends obviously fly to their required destination rather than adjust their destination to their income level. For people who fly to vacations, the flight ticket is usually a fraction of the total expense (hotels, car rental, restaurants, entrance, fees . . .); so the decision where to fly is more a matter of where one wants to spend his vacation than a matter of how much the flight ticket costs there.

In the context of e-tailers (PRS, 2001) and the online DVD market (Xing, 2010), higher income might even be associated with lower search costs. Income is positively correlated with education and educated people are more familiar with the Internet and therefore can search more efficiently (for example, they may be more aware of price engines and how to use them well), reducing their search costs. The conclusion from all the above is that the explanation that the good's price and search costs are correlated through the buyer's income is a minor reason, at most, for the positive relationship between the good's price and price dispersion.

VI. Conclusions

This article confronts the empirical and theoretical literature on price dispersion, focusing on the correlation between price dispersion and price. Theoretically, search models and location differentiation models imply that price dispersion is a function of search and transportation costs, but not a function of the good's price. Empirical evidence, however, suggests otherwise: price dispersion and price are strongly and positively correlated. The article points out this discrepancy, and calls it 'the price dispersion puzzle'.

After explaining the puzzle, the article proposes an explanation for it. While for a rational consumer search or transportation costs should be independent of the good's price, experimental evidence suggests that people behave as if their search or transportation costs are increasing in the good's price (a behaviour that was denoted 'relative thinking'). Incorporating this observation into search or location differentiation models then provides the result that price dispersion is increasing in the good's price, in accordance with the empirical evidence on price dispersion. One limit of this article is that it focuses on price dispersion, which results from location differentiation or from costly information search. However, there are also additional models that yield price dispersion, such as clearinghouse models (e.g. Baye and Morgan, 2001; Baye *et al*., 2004). Exploring these other models in light of the correlation between price dispersion and price is left for future research.

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References

Aalto-Setälä, V. (2003) Price dispersion and search costs in grocery retailing, Working Paper, National Consumer Research Centre, Helsinki.

Azar, O. H. (2004) Psychological motivations and biases in economic behavior and their effects on markets and firm strategy, PhD dissertation, Northwestern University, Evanston, IL.

Azar, O. H. (2008a) The effect of relative thinking on firm strategy and market outcomes: a location differentiation model with endogenous transportation costs, *Journal of Economic Psychology*, **29**, 684–97.

Azar, O. H. (2008b) A model of spatial competition with asymmetric consumer distribution, Working Paper, Ben-Gurion University of the Negev, Israel.

Azar, O. H. (2011a) Relative thinking in consumer choice between differentiated goods and services and its implications for business strategy, *Judgment and Decision Making*, **6**, 176–85.

Azar, O. H. (2011b) Do consumers make too much effort to save on cheap items and too little to save on expensive items? Experimental results and implications for business strategy, *American Behavioral Scientist*, **55**, 1077–98.

Baye, M. R. and Morgan, J. (2001) Information gatekeepers on the internet and the competitiveness of homogeneous product markets, *American Economic Review*, **91**, 454–74.

Baye, M. R. and Morgan, J. (2004) Price dispersion in the lab and on the Internet: theory and evidence, *RAND Journal of Economics*, **35**, 449–66.

Baye, M. R., Morgan, J. and Scholten, P. (2004) Price dispersion in the small and in the large: evidence from an internet price comparison site, *Journal of Industrial Economics*, **52**, 463–96.

Belton Jr, W. J., Cebula, R. J. and Nair-Reichert, U. (2002) Money and the dispersion of relative prices revisited, *Applied Economics*, **34**, 1765–73.

Cason, T. N. and Friedman, D. (2003) Buyer search and price dispersion: a laboratory study, *Journal of Economic Theory*, **112**, 232–60.

Cohen, M. (1998) Linking price dispersion to product differentiation – incorporating aspects of customer involvement, *Applied Economics*, **30**, 829–35.

Connor, J. M. (2005) Collusion and price dispersion, *Applied Economics Letters*, **12**: 6, 335–8.

Dana, J. D. (1999) Equilibrium price dispersion under demand uncertainty, *RAND Journal of Economics*, **30**, 632–60.

DellaVigna, S. and Malmendier, U. (2004) Contract design and self-control: theory and evidence, *Quarterly Journal of Economics*, **119**, 353–402.

Ellison, G. (2006) Bounded rationality in industrial organization, in *Advances in Economics and Econometrics: Theory and Applications, Ninth World Congress (Econometric Society Monographs)* (Eds) R. Blundell, W. Newey and T. Persson, Cambridge University Press, Cambridge, UK, pp. 142–74.

Fava, V. L. (2010) Price dispersion and price indexes, *Applied Economics*, **42**, 23–36.

Fershtman, C. (1982) Price dispersion in oligopoly, *Journal of Economics, Behavior, and Organization*, **3**, 389–401.

Frisch, D. (1993) Reasons for framing effects, *Organizational Behavior and Human Decision Processes*, **54**, 399–429.

Gabaix, X. and Laibson, D. (2006) Shrouded attributes, consumer myopia, and information suppression in competitive markets, *Quarterly Journal of Economics*, **121**, 505–40.

Gil-Pareja, S. and Sosvilla-Rivero, S. (2008) Price convergence in the European car market, *Applied Economics*, **40**, 241–50.

Hanna, N. and Wozniak, R. (2001) *Consumer Behavior: An Applied Approach*, Prentice-Hall, Upper Saddle River, NJ.

Hotelling, H. (1929) Stability in competition, *The Economic Journal*, **39**, 41–57.

Kindra, G. S., Laroche, M. and Muller, T. E. (1989) *Consumer Behaviour in Canada: Concepts and Management Action*, Scarborough, Ontario, Nelson Canada.

Morgan, J., Orzen, H. and Sefton, M. (2006) An experimental study of price dispersion, *Games and Economic Behavior*, **54**, 134–58.

Mowen, M. M. and Mowen, J. C. (1986) An empirical examination of the biasing effects of framing on business decisions, *Decision Sciences*, **17**, 596–602.

Pan, X., Ratchford, B. T. and Shankar, V. (PRS) (2001) Why aren't the prices of the same item the same at me.com and you.com?: Drivers of price dispersion among e-tailers, Working Paper Sloan School of Management, MIT.

Pratt, J. W., Wise, D. A. and Zeckhauser, R. (PWZ) (1975) Price variations in almost competitive markets, Discussion Paper No. 37D, Kennedy School of Government, Cambridge, MA.

Pratt, J. W., Wise, D. A. and Zeckhauser, R. (PWZ) (1979) Price differences in almost competitive markets, *Quarterly Journal of Economics*, **93**, 189–211.

Ranyard, R. and Abdel-Nabi, D. (1993) Mental accounting and the process of multiattribute choice, *Acta Psychologica*, **84**, 161–77.

Schiffman, L. G. and Lazar Kanuk, L. (1983) *Consumer Behavior*, 2nd edn, Prentice-Hall, Englewood Cliffs, NJ.

Sorensen, A. T. (2000) Equilibrium price dispersion in retail markets for prescription drugs, *Journal of Political Economy*, **108**, 833–50.

Tirole, J. (1988) *The Theory of Industrial Organization*, MIT Press, Cambridge, MA.

Tversky, A. and Kahneman, D. (1981) The framing of decisions and the psychology of choice, *Science*, **211**, 453–8.

Xing, X. (2010) Can price dispersion be persistent in the Internet markets?, *Applied Economics*, **42**, 1927–40.