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Inflation, price dispersion, and market structure

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Abstract

In this paper, we use a novel data set containing prices from bazaars, convenience stores, and supermarkets in Istanbul to re-examine the relationship between price dispersion and inflation. Although existing evidence is mixed, we find positive and significant relationships between dispersion, on the one hand, and lagged dispersion and unexpected product-specific inflation on the other. We also find evidence that dispersion is initially decreasing in anticipated aggregate inflation but is eventually increasing. Finally, average price duration and dispersion are lowest in the bazaar. This is intuitive, since menu and search costs should be minimal in that market structure.

JEL classification: L1; C23; D40; D83; E31

Keywords: Inflation; Market structure; Menu cost models; Micro panel data; Price dispersion; Search; Sticky prices

> Information search, thus, is the really advanced art in the bazaar, a matter upon which everything else turns.
>
> Geertz (1978, p. 30), quoted in McMillan (2002, p. 41)

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1. Introduction

In this paper, we use a unique data set containing monthly price observations from individual sellers in Istanbul to explore several major issues in the literatures on search, sticky prices, and the relationship between inflation and price dispersion. A novel feature of the data is that it includes prices from three distinct market structures: *Bakkals* (small convenience stores), *pazars* (bazaars), and Western-style supermarkets, which should exhibit significant differences in terms of menu costs, search costs, and other important parameters identified by the relevant theoretical literatures.

We first investigate the frequency of price changes in the three different market structures, which we calculate according to the methodology in Bils and Klenow (2004). Since pazars contain a relatively large number of small sellers in a small geographical area, search and menu costs should be lower than in the other two market structures. According to the menu cost literature, including Sheshinski and Weiss (1977) and Bénabou (1988, 1992), prices should therefore turn over more quickly in the pazar, which is indeed what we find. Interestingly, we find that prices change more rapidly in supermarkets than in bakkals, and almost as fast as in pazars. A potential explanation, drawing on the recent literature on rational inattention, including Sims (2003) and Maćkowiak and Wiederholt (2005), is that supermarkets are relatively more sophisticated than the other two store types and hence may be able to track and react more quickly to changes in the economic environment. Our findings therefore suggest a role for both menu cost and rational inattention models in explaining observed price durations across distinct market structures.

We then turn to the empirical literature on the relationship between inflation and price dispersion, which includes Domberger (1987), Van Hoomissen (1988), Lach and Tsiddon (1992), Tommasi (1993), Reinsdorf (1994), Parsley (1996), Eden (2001), Baharad and Eden (2004), and Ahlin and Shintani (2007).[1] Overall, the existing evidence is mixed. Although several papers find a positive and significant relationship between inflation and dispersion, Reinsdorf (1994) finds a negative relationship driven by unanticipated inflation, while Eden (2001) and Baharad and Eden (2004) can discern no clear link.

The theoretical literature on search, inflation, and price dispersion consists of menu cost models—Bénabou (1988, 1992); signal extraction models—Bénabou and Gertner (1993) and Dana (1994); monetary search models—Peterson and Shi (2004) and Head and Kumar (2005); and the information investment model sketched in Van Hoomissen (1988). As our brief survey of this literature indicates (see Section 2), inflation plays very different roles across the different classes of models. Specifically, in menu cost and monetary search models inflation is assumed to be *fully anticipated* and its initial impact is to depreciate the real purchasing power of firms' revenues or buyers' fiat money, respectively. In contrast, signal extraction models focus on *unanticipated* inflation, whose effects are primarily informational. In practice, empirical researchers usually have access to more than one inflation rate[2] and the theory offers little guidance as to which one(s) are appropriate for

[1] In this paper, we focus exclusively on *intra-market* relative price variability, but there is also a substantial literature on *inter-market* relative price variability, including Vining and Elwertowski (1976), Parks (1978), Neumann and von Hagen (1991), Debelle and Lamont (1997) and Belton et al. (2002).

[2] E.g., in our case we had access to at least four distinct (albeit correlated) inflation rates: Inflation for individual products in our sample, average inflation across all the products in our sample, inflation relative to a broad cost-of-living index specific to the city of Istanbul, and CPI inflation for Turkey as a whole.

hypothesis testing. Indeed, it may well be that the distinct roles played by inflation in the different classes of theoretical models are distributed across different observed inflation measures, so that price dispersion has different empirical relationships with different inflation measures.

In this paper, we estimate an empirical specification of the relationship between inflation and dispersion that includes both product-specific (PS) inflation (inflation at the product level), as well as a measure of aggregate inflation based on a broad cost-of-living (COL) index specific to Istanbul. Since menu cost and monetary search models assume fully anticipated inflation, whereas signal extraction models focus on unanticipated inflation, we decompose these two inflation rates into their expected and unexpected components. We also include lagged dispersion since the information investment model in Van Hoomissen (1988) suggests that current dispersion should be positively related to the former, since it reflects consumers' pre-search stock of information. Finally, we control for product, store-type, and temporal fixed effects.

The store-type fixed effects are of particular interest, since they indicate the average level of dispersion in each market structure after controlling for the product, inflation, and temporal factors. These estimates therefore correspond to dispersion in static equilibrium search models such as Reinganum (1979), Burdett and Judd (1983), Carlson and McAfee (1983), Rob (1985), Bénabou (1993), and Rauh (2007), where dispersion can exist for homogeneous goods in the absence of inflation. For a survey of this literature, see Baye et al. (2006). Our estimates imply that on average dispersion is lowest in pazars, followed by bakkals, and then supermarkets. The finding that dispersion is lowest in the pazar is quite natural, since search costs should be minimal in that market structure.

With respect to the other estimates, the coefficient on lagged dispersion is positive and significant, so dispersion is decreasing in consumers' pre-search stock of information. Although unexpected COL inflation is insignificant, the coefficient for unexpected PS inflation is positive and significant. These findings support the basic prediction of signal extraction models, provided that the latter are interpreted in terms of narrow PS inflation. Finally, expected PS inflation is insignificant but we find evidence that dispersion initially decreases with expected COL inflation but eventually rises, as predicted by the monetary search model in Head and Kumar (2005). At a broader level, our findings suggest that dispersion can indeed have different relationships with different inflation measures.

The rest of the paper is organized as follows. In Section 2, we briefly survey the theoretical literature on inflation and dispersion. In Section 3, we describe the data, define the relevant dependent and independent variables, and present our findings on the frequency of price changes in the three distinct market structures. In Section 4, we estimate our specification of the relationship between inflation and price dispersion. Section 5 concludes.

2. Theoretical literature on search, inflation, and dispersion

2.1. Menu cost models

In their seminal contribution, Sheshinski and Weiss (1977) considered the problem of a monopolist in an environment where inflation is constant and fully anticipated and there are non-zero menu costs of adjusting nominal prices. In that case, they characterized the optimal pricing rule as an (S, s) strategy where the firm's real price begins at S and then falls to s over time because of inflation. At that point, the firm raises its nominal price so that its real price once again equals S, and the process repeats itself indefinitely.

This fundamental insight was extended by Bénabou (1988, 1992) to the case of monopolistically competitive markets where consumers search sequentially for the lowest price. In that context, an increase in expected inflation induces firms to widen their (S, s) band to conserve on menu costs. As a result, dispersion increases and the frequency of price changes is reduced. During deflationary periods, the model works in reverse, so dispersion is increasing in the absolute value of expected inflation (i.e., the relationship is V-shaped). Furthermore, an increase in firms' menu cost or consumers' search cost also widens firms' (S, s) band, increases dispersion, and lowers the frequency of price changes.

2.2. Signal extraction models

The literature on search and unanticipated inflation includes Bénabou and Gertner (1993) and Dana (1994). For concreteness, we focus on the former where consumers search sequentially and inflation is unexpected and cost-push—firms' marginal costs are subject to inflationary shocks via input prices. The "signal extraction" aspect of the model is that a consumer who observes a high price at a particular seller must infer to what extent that high price reflects a market-wide shock (e.g., inflation) as opposed to a firm-specific shock, in which case search is more valuable. A period of unanticipated inflation and inflation uncertainty is modeled as an increase in the variance of the market-wide shock, making firms' costs and therefore prices more correlated. As a result, a consumer who observes a high price at one seller may infer that prices are high across all sellers, leading to a reduction in search and an increase in dispersion.[3] Since what matters is inflation *uncertainty*, unanticipated *deflation* will have a similar impact and the relationship between dispersion and unexpected inflation is again V-shaped. Furthermore, dispersion is increasing in consumers' search cost as in previous models.

2.3. Information investment model

In the above models, consumers only purchase the good once. In contrast, Van Hoomissen (1988) sketches the repeat-purchase decision problem where at each date the consumer optimally chooses her search intensity given that search not only reduces the current purchase price but is also an investment that adds to her stock of information. The latter depreciates with the frequency of price changes, which the consumer proxies at any given date with the absolute value of anticipated inflation. It follows that an increase in expected inflation would induce consumers to hold smaller information stocks, which

[3] In the Bénabou and Gertner (1993) model, an increase in unanticipated inflation can lead to an increase in search and welfare when consumers' search cost is sufficiently low. It is therefore quite reasonable to speculate that dispersion could be decreasing in unexpected inflation over some range as found, for example, by Reinsdorf (1994). There are, however, no results or claims to that effect in the Bénabou and Gertner (1993) paper and our analysis of their Tables 1–3 on pp. 85–86 reveals that dispersion increases in all cases, even when search costs are low. (However, we did not consider the mixed-strategy type 4 equilibria in the intermediate search cost case.) We have benefitted from correspondence with Roland Bénabou on this point.

would presumably increase dispersion now and in the future. The model also predicts that current dispersion should be positively related to lagged dispersion, which reflects consumers' pre-search stock of information. Finally, unanticipated inflation (or deflation) represents a one-time reduction in information stocks, which should also increase dispersion.

2.4. Monetary search models

This literature includes Peterson and Shi (2004) and Head and Kumar (2005).[4] For concreteness, we focus on the latter paper where there are $H \geqslant 3$ different types of households, with a continuum of identical buyers and sellers in each household and a continuum of identical households in each type. A household of type h can only consume output from households of type $h+1$ (modulo H), which creates a potential role for fiat money. Assuming non-sequential search and restricting the analysis to stationary equilibria, the model is similar to that in Burdett and Judd (1983) except that buyers' reservation levels are endogenous and depend on the value of fiat money. In their model, an increase in fully anticipated inflation increases dispersion by lowering the value of fiat money and raising consumers' reservation levels, which increases sellers' market power. Since an increase in dispersion also increases search, the combined effect on dispersion is ambiguous. At low levels of inflation, the latter effect can dominate, leading to a reduction in dispersion and an improvement in welfare. In contrast, at high levels of inflation the former effect dominates, so dispersion can be U or V-shaped in anticipated inflation (Head and Kumar, 2005, p. 558). Note that menu cost models predict a V-shaped relationship between dispersion and anticipated inflation where the vertex of the V is at the origin, whereas in this model the vertex can occur at a positive level of anticipated inflation. We also note that the source of anticipated inflation in the Head and Kumar model is the deterministic growth of the stock of fiat money, so inflation is unambiguously *aggregate* inflation.

2.5. Summary

As the above discussion makes clear, inflation plays very different roles across the different classes of models. E.g., in menu cost models inflation depreciates the real purchasing power of firms' revenues, whereas in signal extraction models its effects are primarily informational. In practice, empirical researchers often have access to more than one inflation rate, which raises the distinct possibility that different inflation rates might capture different aspects of the overall impact of "inflation." Indeed, a major conclusion of the present paper will be that price dispersion can have different relationships with different inflation variables. Another important difference is that menu cost and monetary search models consider fully anticipated inflation, while signal extraction models focus on unanticipated inflation. Finally, the information investment model suggests that current dispersion may be positively related to lagged dispersion, since the latter reflects consumers' pre-search stock of information.

[4]We thank the Associate Editor for drawing our attention to this literature.

3. Data, definitions, and average price durations

3.1. Data

The data consist of monthly price observations for individual products sold by individual sellers in Istanbul during the period 1992:10–2000:06, when the average inflation rate was high but relatively stable at about 60% per annum.[5] The data was collected by the Istanbul Chamber of Commerce in order to construct a broad-based COL index for wage earners in the city, which we also use in this paper.[6] Each price observation p_{ijkt} is indexed by the product i (58 distinct products in all), the neighborhood (borough) j in Istanbul where it was collected (15 total), the store type k (bakkal, pazar, or supermarket), and the month t.[7] In Appendix A we list all 58 products, along with summary statistics, the correlation between each product's PS inflation rate [see Eq. (5)] and the aggregate COL inflation rate, and the number of store types represented for each product.[8] Whenever possible, the data collectors visited the same seller to record prices for the same product (same brand, quantity/weight, and other characteristics).

We now describe the main characteristics of each of the three market structures represented in the data. *Pazars* are bazaars in the classic sense. There is one main pazar in each neighborhood, open one day a week. These markets approach the perfectly competitive ideal, since individual sellers are quite small, selling 1–4 fresh produce or small consumer items each, and each product generally has several sellers within a small geographical area (a large pazar covers about 2–3 acres). Given their high spatial density, competition should be relatively intense and search costs—the cost of obtaining another price quote in terms of time, money, and effort—are minimal compared with the other two store types. Furthermore, menu costs—the cost of adjusting nominal prices—should also be negligible. Despite these characteristics, price dispersion is a persistent phenomenon in the pazar.

Bakkals are small convenience stores, almost always family-owned and operated and located in residential areas. They are also important social institutions, where one typically buys one or two items and exchanges news and gossip with the owner and his family. The nearest competitor is usually another bakkal a few blocks away, so search costs are small but significant. Bakkals tend to have a very loyal customer base, so this market structure is reminiscent of monopolistic competition based on spatial and "product" differentiation in the social dimension. Given their size, menu costs should be small.

Like their Western counterparts, Istanbul supermarkets are large, corporate-owned, and prefer to locate away from potential competitors.[9] Given their relative isolation from other

[5]The importance of stability is demonstrated by Caglayan and Filiztekin (2003), who show that the relationship between inflation and dispersion can break down in the presence of large structural changes.

[6]As a pre-condition for its use, the second author signed a confidentiality agreement with the Chamber that restricts the dissemination of the data. Although we can provide aggregated data for verification purposes (available upon request), we are prohibited from distributing the data in its entirety.

[7]All three market structures are important, so our results are not biased due to a lack of customers for some store type.

[8]These 58 products comprise about 25% of the entire COL index, which includes the following categories: Food; dwelling expenses; household expenses; clothing, health, and personal care; transportation and communication; culture, education, and entertainment; and other.

[9]The equilibrium search model in Fischer and Harrington (1996) predicts that firms with sufficiently heterogeneous products will cluster to conserve on consumers' search costs, whereas those with homogeneous

sellers, obtaining another price quote generally entails a trip by car or public transportation. As Bénabou (1992, p. 303) has emphasized, menu costs include all costs of changing nominal prices, including decision costs. Since supermarkets stock a much broader variety of products and brands than bakkals or individual sellers in the pazar, these may be substantial. Another important difference is that supermarkets routinely advertise, hold frequent sales, and engage in marketing tactics such as loss leadership.

3.2. Average price durations

Given our characterization of pazars as markets where search and menu costs are minimal, it may be of interest to compare average price durations across the three market structures using the method of Bils and Klenow (2004), which can be briefly described as follows.[10] Let λ denote the fraction of prices that changed over the previous month for the same product at the same outlet, averaged over the entire data set. Assuming $-\ln(1-\lambda)$ is the instantaneous probability of a price change, the average period between price changes (average price duration) is $-1/\ln(1-\lambda)$. In Table 1, we report λ, the standard deviation of λ, and the latter for each product sold within each market structure.

E.g., we observe that λ for rice in bakkals is 71.2% with a standard deviation of 23.2%. Given the above assumptions, this implies that the price of rice changes every 0.803 months in that market structure.

At the bottom of Table 1, we observe that the expected length of time between price changes, averaged over all products sold within a given store type, is 0.986 months for bakkals, 0.878 for supermarkets, and 0.674 for pazars. Since search and menu costs should be minimal for the latter market structure, the finding that average price duration is lowest in pazars is consistent with the predictions of menu cost models. What appears inconsistent, however, is the finding that supermarket prices change more frequently than bakkal prices, since it seems implausible that bakkals would have higher menu or search costs than supermarkets. Indeed, by some measures supermarket prices change as fast as pazar prices. In a direct comparison between the two, average price duration is lower in supermarkets for 7 out of the 14 products sold by both supermarkets and pazars.[11]

One potential explanation for these somewhat puzzling findings is provided by the theory of rational inattention developed by Sims (2003) and applied to the literature on sticky prices by Maćkowiak and Wiederholt (2005).[12] The basic idea of this literature is that people have limited information-processing capacities and can only react to shocks to the extent that these have been observed and processed. In particular, in the latter paper it is shown that if idiosyncratic shocks are more important or more variable than aggregate

(*footnote continued*)
products will disperse to capitalize on local market power. As evidence, they document the low spatial density of supermarkets in the Baltimore metropolitan area.

[10]We are grateful to an anonymous referee for suggesting this line of inquiry. In a related paper, Baharad and Eden (2004) compare four different methods of calculating average price duration and show that significant differences can arise because of Jensen's inequality. Since it is based on medians, the method in Bils and Klenow may suffer less from these problems. In any event, in this paper we are more interested in relative rankings as opposed to absolute magnitudes.

[11]I.e., rice, pasta, flour, veal, margarine, cooking oil, eggs, kasari cheese, lentils, dried beans, sunflower seeds, olives, honey, and tomato paste. Similarly, average price duration is lower in pazars for all 25 products sold by bakkals and pazars and lower in supermarkets for 28 out of the 34 products sold by bakkals and supermarkets.

[12]We thank the Editor, Jürgen von Hagen, for drawing our attention to this literature.

Table 1
The frequency of price changes and duration of prices

Product	Bakkal			Supermarket			Pazar		
	λ	σ	Duration	λ	σ	Duration	λ	σ	Duration
Rice	71.2	23.2	0.803	72.7	19.2	0.771	73.0	22.3	0.764
Pasta	49.1	31.1	1.479	69.5	21.9	0.842	57.3	25.8	1.176
Flour	58.0	28.0	1.151	68.1	22.2	0.875	62.9	26.7	1.009
Baklava	65.5	21.5	0.939	–	–	–	–	–	–
Cookies	65.2	21.2	0.947	–	–	–	–	–	–
Flodough	54.0	25.3	1.288	57.0	21.2	1.184	–	–	–
Cracked wheat	58.6	23.1	1.135	67.1	21.4	0.899	66.8	23.7	0.907
Veal	82.3	19.9	0.577	83.5	17.9	0.555	–	–	–
Chicken	82.5	20.1	0.574	87.5	15.2	0.482	–	–	–
Mutton	83.6	17.5	0.553	82.8	18.0	0.569	–	–	–
Fish	90.7	13.4	0.422	–	–	–	93.2	11.2	0.371
Sucuk	76.4	23.9	0.692	73.7	23.0	0.749	–	–	–
Offal	66.1	29.6	0.925	–	–	–	–	–	–
Salami	72.6	22.1	0.772	71.2	22.2	0.803	–	–	–
Sausage	70.8	19.6	0.812	67.9	19.0	0.880	–	–	–
Feta cheese	72.1	21.6	0.783	75.2	18.9	0.717	79.0	18.5	0.640
Margarine	75.4	19.7	0.712	83.0	16.0	0.565	–	–	–
Cooking oil	68.8	23.7	0.859	77.5	17.4	0.671	74.7	21.0	0.727
Eggs	83.8	19.6	0.550	89.8	13.2	0.438	91.4	13.4	0.408
Olive oil	66.5	25.0	0.914	70.7	18.1	0.816	71.7	23.0	0.791
Kasari cheese	66.7	24.8	0.908	67.2	23.2	0.898	–	–	–
Potato	60.7	26.5	1.070	–	–	–	76.4	20.7	0.692
Onion	69.1	27.7	0.851	–	–	–	82.7	19.9	0.570
Lentils	60.0	28.0	1.091	66.6	22.5	0.912	66.8	25.8	0.907
Chick peas	58.5	27.1	1.138	65.9	22.7	0.930	65.6	23.6	0.936
Dried beans	59.6	29.2	1.104	67.1	23.0	0.899	64.1	27.7	0.975
Sunflower seeds	44.7	27.1	1.688	–	–	–	–	–	–
Peanuts	52.2	28.6	1.353	–	–	–	–	–	–
Hazelnuts	59.3	31.2	1.113	–	–	–	–	–	–
Roasted chick peas	52.7	28.4	1.336	–	–	–	–	–	–
Walnuts	51.4	30.3	1.384	–	–	–	–	–	–
Raisins	48.8	27.1	1.492	–	–	–	–	–	–
Apple	81.4	18.5	0.594	–	–	–	86.9	14.4	0.492
Lemon	74.4	20.3	0.733	–	–	–	84.7	15.0	0.533
Tomato	94.1	9.8	0.353	–	–	–	97.1	5.2	0.283
Green peppers	96.2	7.8	0.305	–	–	–	96.8	5.9	0.290
Cucumbers	93.7	8.8	0.362	–	–	–	95.1	7.9	0.332
Lettuce	71.8	23.6	0.790	–	–	–	75.3	22.7	0.716
Zucchini	91.3	10.9	0.409	–	–	–	93.8	8.9	0.359
Scallion	84.2	17.0	0.542	–	–	–	89.6	12.5	0.441
Olives	74.6	19.1	0.729	75.8	16.1	0.705	80.9	14.8	0.605
Honey	68.2	21.8	0.873	66.3	22.2	0.919	73.8	21.0	0.746
Tomato paste	51.2	31.2	1.393	60.3	25.8	1.083	57.5	31.9	1.168
Halvah	60.4	24.9	1.081	59.1	24.1	1.118	–	–	–
Jam	62.1	21.9	1.031	63.4	20.0	0.995	–	–	–
Ready soup	46.9	21.8	1.581	55.7	22.8	1.230	–	–	–
Broom	47.2	24.4	1.567	49.0	26.5	1.486	–	–	–
Cleaning powder	67.1	23.0	0.899	70.7	18.4	0.814	–	–	–
Soap	68.6	22.9	0.863	71.1	19.7	0.806	–	–	–

Table 1 (*continued*)

Product	Bakkal			Supermarket			Pazar		
	λ	σ	Duration	λ	σ	Duration	λ	σ	Duration
Detergent	74.3	22.2	0.735	80.2	17.7	0.617	–	–	–
Bleach	63.8	22.4	0.985	68.6	17.5	0.863	–	–	–
Paper tissue	63.6	21.7	0.991	69.4	19.2	0.844	–	–	–
Light bulbs	37.6	25.2	2.120	46.7	22.8	1.591		–	–
Plastic kitchenware	52.5	24.4	1.345	53.1	26.5	1.320	–	–	–
Toothpaste	56.6	25.9	1.198	–	–	–	–	–	–
Toilet soap	48.3	21.3	1.514	–	–	–	–	–	–
Shampoo	54.6	26.0	1.265	–	–	–	–	–	–
Razor	48.8	31.3	1.495	–	–	–	–	–	–
Average	66.0	27.2	0.986	69.2	22.9	0.878	78.3	23.2	0.674

λ, average monthly frequency of price changes; σ, the standard deviation of λ; Duration, the monthly mean duration implied by λ; Average, the average over all products sold within the store type.

shocks such as changes in the money supply, then firms' prices may react quickly to changes in the former and sluggishly with respect to the latter, even with zero menu costs.

In our context, it may be that supermarkets—which are large, relatively sophisticated, and corporate-run—have more information-processing capacity than bakkals—which are small, family-owned and operated firms. If so, then this may explain why supermarket prices change more rapidly than bakkal prices, even if supermarkets have higher search and menu costs. Moreover, bakkals may be reluctant to raise prices because of their social bond with customers. As Bénabou (1992, p. 303) notes, this can be considered an important component of menu costs, in addition to the physical and decision costs of changing nominal prices. Our data therefore suggest a role for both traditional menu cost models and the emerging literature on rational inattention for explaining differences in price stickiness in different market structures.

3.3. Actual versus posted prices

A potential problem with the pazar data is that we only observe *posted* prices (sellers in the pazar are legally required to post such prices), whereas the actual purchase price may be determined by haggling. Nevertheless, we believe the pazar data are useful because the basic issues involved in setting posted prices are similar to those analyzed in menu cost and signal extraction models. In particular, changes in posted prices will entail menu costs, as usual, and consumers may make signal extraction-type inferences based on them. Moreover, the posted price will have to be set competitively. If it is too high, the seller will attract little consumer interest, and it cannot be set too low, because it will be extremely difficult for the seller to negotiate a price above the posted one.

In fact, actual purchase prices are usually fairly close to the posted ones. As Geertz (1978, p. 32) notes, "most bazaar 'price negotiation' takes place to the right of the decimal point." Our own casual observation suggests that in the morning, when the Chamber inspectors reputedly collect the data, the bulk of transactions occur at the posted price. Bargaining is more important in the afternoon, when sellers are eager to get rid of their stocks. For the skeptical reader, in Appendix B we report findings following the same empirical procedures as in the text, except that only the bakkal and supermarket data are used (haggling is not a feature of these markets). *The results are essentially the same.*

3.4. Definitions

We define the *relative price* of product i in neighborhood j sold by store type k in month t to be

$$R_{ijkt} = \ln(p_{ijkt}/p_{it}), \tag{1}$$

where

$$p_{it} = \frac{1}{J}\frac{1}{K}\sum_{j}\sum_{k} p_{ijkt} \tag{2}$$

is the average price of the product at date t, $J = 15$ the number of neighborhoods, and $K = 3$ the number of distinct store types. *Price dispersion* is defined by

$$V_{ikt} = \left[\frac{1}{J-1}\sum_{j}(R_{ijkt} - R_{ikt})^2\right]^{1/2}, \tag{3}$$

where

$$R_{ikt} = \frac{1}{J}\sum_{j} R_{ijkt}. \tag{4}$$

As Reinsdorf (1994, p. 728) emphasizes, the theoretical literature refers specifically to relative price *level* variability as defined in (3), although some empirical studies use relative price *change* variability. Indeed, these two dispersion measures are not equivalent and can have different relationships with inflation, so in this paper we only use (3). The *PS inflation rate* for product i is defined as the average[13]

$$\mathrm{PS}_{it} = \frac{1}{J}\frac{1}{K}\sum_{j}\sum_{k} \pi_{ijkt}, \tag{5}$$

where

$$\pi_{ijkt} = \ln[p_{ijkt}/p_{ijk(t-1)}]. \tag{6}$$

3.5. Expected and unexpected inflation

We follow the same procedure as Lach and Tsiddon (1992) and Reinsdorf (1994) to decompose COL and PS inflation into their expected and unexpected components. Accordingly, we regress PS_t against $\mathrm{PS}_{t-1}, \mathrm{PS}_{t-2}, \ldots$ up to six lags, past values of COL inflation up to three lags, and deterministic components including a constant, linear trend,

[13]Although one could use separate PS inflation rates for each market structure, there seems to be no theoretical basis for such narrow inflation measures. E.g., from the perspective of signal extraction models this would imply that a consumer who observes a high price of eggs in the pazar would not use this information to make inferences about the price of eggs in bakkals or supermarkets.

and time dummies. For each product i, the appropriate lag length and the choice of which deterministic components to include is determined by the Schwarz Information Criterion. For each estimation, the residuals are tested for serial correlation and autoregressive conditional heteroskedasticity up to six lags. If the residuals are clean with respect to these anomalies at conventional significance levels, the fitted values are used as the expected inflation series EPS_{it} and the residuals are taken to be unexpected inflation UPS_{it}. If the serial correlation or ARCH tests failed, we used the second-best specification according to the Schwarz Information Criterion, and so on. The same procedure was used to decompose COL inflation into its expected ECOL_t and unexpected UCOL_t components except that only past values of COL inflation were used, along with deterministic components including a constant, linear trend, and time dummies.[14]

4. Empirical results

We now investigate the relationship between inflation and price dispersion using an empirical specification motivated by our survey of the theoretical literature in Section 2.

$$\begin{aligned} V_{ikt} = \alpha &+ \beta_0 V_{ik(t-1)} + \beta_1 |\mathrm{EPS}_{it}| + \beta_2 |\mathrm{UPS}_{it}| + \beta_3 |\mathrm{ECOL}_t| + \beta_4 |\mathrm{UCOL}_t| \\ &+ \gamma_1 D|\mathrm{EPS}_{it}| + \gamma_2 D|\mathrm{UPS}_{it}| + \gamma_3 D|\mathrm{ECOL}_t| + \gamma_4 D|\mathrm{UCOL}_t| + u_{ikt}. \end{aligned} \tag{7}$$

In this specification, the dependent variable V_{ikt} is price dispersion for product i within market structure k in month t as defined in (3). For illustrative purposes, in Fig. 1 we depict average dispersion for each market structure over time, averaged over all products sold within that market structure.[15]

According to the information investment model, current and lagged dispersion should be positively related. Indeed, visual inspection of Fig. 1 suggests that dispersion shows some persistence, so we include lagged dispersion $V_{ik(t-1)}$ in (7) to avoid biased and inconsistent estimates.

As discussed in Section 2, the effects of inflation on dispersion operate through multiple distinct theoretical channels. It follows that if different inflation measures capture separate aspects of the overall impact of inflation, then dispersion could have different relationships with different inflation rates. Furthermore, menu cost and monetary search models assume fully anticipated inflation, whereas signal extraction models focus on unanticipated inflation. We therefore include both narrow PS and aggregate COL inflation in our specification, decomposed into their expected and unexpected components.[16] Finally, menu cost and signal extraction models predict a V-shaped relationship between dispersion and expected or unexpected inflation, respectively, so we take absolute values of all the inflation variables in (7).

As Jaramillo (1999) demonstrates, conclusions about the empirical relationship between inflation and dispersion can depend on the proper treatment of outliers, especially those corresponding to deflationary periods. To properly account for these, we introduce a dummy variable D in (7) which equals one when the relevant inflation variable is negative

[14] The details of the decomposition procedure are available from the authors upon request.

[15] Note that Fig. 1 uses 12 month averages for illustrative purposes, while our empirical analysis always uses the raw data.

[16] Using national CPI inflation produced qualitatively similar results. Note that the correlation between COL inflation in Istanbul and CPI inflation is about 0.7943.

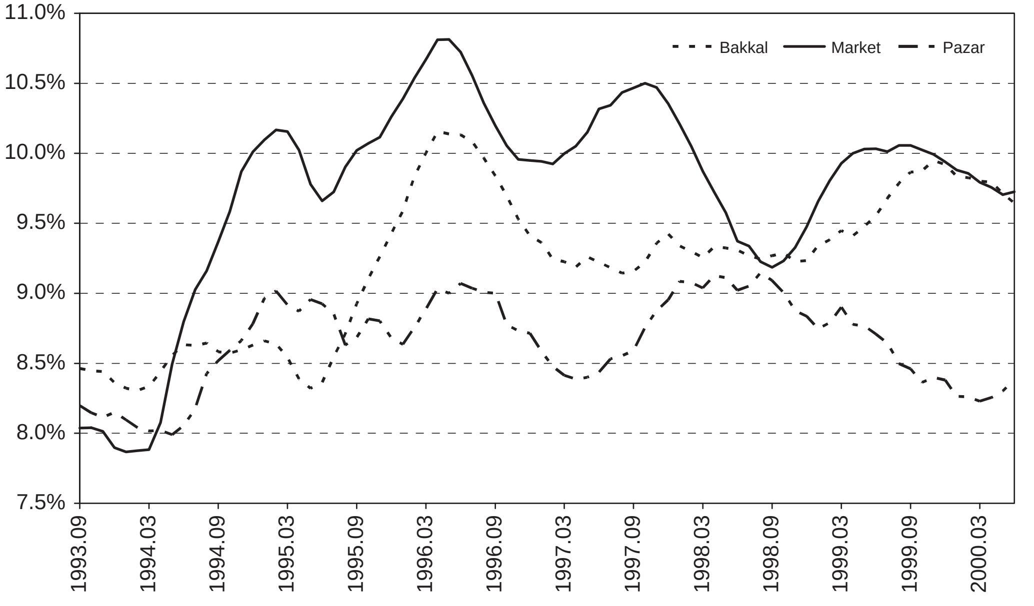

Fig. 1. The temporal behavior of average price dispersion within each market structure. Note: Dispersion for each market type is smoothed out by annualizing the monthly data.

(deflation) and zero otherwise. E.g., D in $D|\mathrm{ECOL}_t|$ is one when $\mathrm{ECOL}_t < 0$ and zero otherwise, and a similar statement holds for the other inflation variables. In effect, we allow for an asymmetric V-shaped relationship between dispersion and inflation, with different slopes on the positive and negative sides.[17]

To complete our specification, we add a constant α, product fixed effects to control for product heterogeneity, store-type fixed effects to control for differences in menu and search costs and other important parameters across the three market structures, month and year fixed effects, and an error term u_{ikt}.[18]

In Table 2, we report estimates for (7) using the one-step generalized method of moments (GMM) estimation procedure for dynamic panels analyzed in Arellano and Bond (1991).[19]

[17]Indeed, when we estimate (7) without taking absolute values of the inflation variables and without the deflation dummy variable, we find that all the coefficients on the inflation variables are insignificant.

[18]Our estimates are robust to the inclusion or exclusion of the month and year fixed effects, excluding one or both. Throughout the paper, we report estimates including both.

[19]Arellano and Bond (1991) report that the Sargan test has asymptotic chi-square distribution only if the error terms are homoskedastic, and that it over-rejects the null hypothesis of valid instruments in the presence of heteroskedasticity, which seems likely for our sample. Furthermore, they recommend using one-step results for inference on coefficients, as the estimated standard errors from the two-step method would be downward biased. We adopt this suggestion, and present one-step estimation results while implementing the Huber–White robust standard error estimation procedure to control for heteroskedasticity. All computations were performed by STATA, where lagged values of the inflation variables and the lagged dependant variable were used as instruments.

Table 2
Panel data dynamic GMM estimation results

Dependent variable: the dispersion measure, V	
Lagged V	0.5781 [0.0306]***
|EPS|	0.0102 [0.0132]
$D*$|EPS|	0.0136 [0.0243]
|ECOL|	0.1025 [0.0319]***
$D*$|ECOL|	1.1947 [0.342]***
|UPS|	0.0519 [0.0122]***
$D*$|UPS|	0.0036 [0.0217]
|UCOL|	−0.0240 [0.0167]
$D*$|UCOL|	−0.0044 [0.0279]
dmrk	0.0062 [0.0006]***
dpaz	−0.0061 [0.0007]***
Constant	−0.000 [0.000]
Observations	10,022
H_0: $\|UCOL\| = D*\|UCOL\| = 0$	
χ^2	2.28
p-val	0.319
H_0: $\|EPS\| = D*\|EPS\| = 0$	
χ^2	0.64
p-val	0.7244

V, price dispersion defined in (3); dmrk, 1 for supermarkets and 0 otherwise; dpaz, 1 for pazars and 0 otherwise; EPS, expected product-specific inflation; UPS, unexpected product-specific inflation; D, 1 if $x<0$ in $D|x|$; ECOL, expected aggregate inflation; UCOL, unexpected aggregate inflation; The numbers in parentheses are robust standard errors from Arellano–Bond one-step GMM estimation.
Standard errors in brackets.
*Significant at 10%.
**Significant at 5%.
***Significant at 1%.

4.1. Lagged dispersion

We observe that the estimate for $V_{ik(t-1)}$ is positive and statistically significant at the 1% level, so current and lagged dispersion are indeed positively related as predicted by the information investment model. In our view, this is an important finding since few, if any, existing empirical studies in this literature incorporate lagged dispersion, which may have significant implications for the results.

4.2. Anticipated inflation

With respect to anticipated inflation, the estimates for $|EPS_{it}|$ and $D|EPS_{it}|$ are insignificant at conventional significance levels. Furthermore, a chi-square test for joint significance could not reject the null hypothesis that both coefficients are zero. In contrast, the estimate for $|ECOL_t|$ is positive and significant at the 1% level, indicating a V-shaped relationship between dispersion and expected COL inflation. This result is consistent with the basic prediction of menu cost models, provided that we interpret those models in terms of anticipated *aggregate* inflation, rather than anticipated PS inflation. These findings also illustrate our hypothesis that dispersion can have different relationships with different inflation measures.

Since there is only one instance of expected COL *deflation* in our data set, including $D|\mathrm{ECOL}_t|$ in (7) is equivalent, as Jaramillo (1999) points out, to testing whether that lone observation is an influential outlier. Indeed, the relevant estimate is positive and significant at the 1% level. Note that Jaramillo, who had more deflationary episodes to work with, found a similar asymmetric relationship with a steeper slope for aggregate deflation.

4.3. Unanticipated inflation

Turning now to unanticipated inflation, the estimates for $|\mathrm{UCOL}_t|$ and $D|\mathrm{UCOL}_t|$ are individually as well as jointly insignificant, so there is no discernible relationship between dispersion and unexpected aggregate inflation. In contrast, the estimate for $|\mathrm{UPS}_{it}|$ is positive and significant at the 1% level, while $D|\mathrm{UPS}_{it}|$ is insignificant, indicating a symmetric V-shaped relationship between dispersion and unexpected PS inflation.[20] These findings are consistent with the basic prediction of signal extraction models provided we interpret those models in terms of unanticipated narrow PS inflation. Again, we note that dispersion can have different relationships with different inflation measures.

4.4. Market structure and price dispersion

In Table 2, dmrk is a dummy variable that equals 1 for supermarkets and zero otherwise. Likewise, dpaz is the dummy variable for pazars. These store-type fixed effects are important because they indicate the level of dispersion within each market structure after controlling for product heterogeneity and inflation. As such, these estimates correspond to dispersion in static equilibrium search models where firms' products are assumed to be homogeneous and inflation is zero. In Table 2, the estimates for dmrk and dpaz are positive and negative, respectively, and both are significant at the 1% level.[21] This implies that dispersion is on average highest for supermarkets, followed by bakkals, and then pazars, which confirms the visual evidence in Fig. 1.

Although these findings are consistent with the reasonable assumption that the same ordering applies to these market structures with respect to their search costs, it seems inconsistent with the predictions of menu cost models. In those models, the level of dispersion and the frequency of price changes are both determined by the width of the (S,s) band, so we should not observe both higher dispersion and lower average price duration in supermarkets relative to bakkals.

4.5. Economic significance

To appreciate the economic (as opposed to statistical) significance of our findings, consider the estimate 0.0062 for the supermarket fixed effect. Given some initial condition V_{ik0} for dispersion, this will be incorporated into V_{ik1} and then V_{ik2} via the lagged term,

[20] A re-estimation of (7) after eliminating all the statistically insignificant inflation variables produced essentially the same estimates.

[21] Since the GMM estimation procedure first differences all variables to remove fixed effects, to recover the latter we carried out a second stage fixed effects regression on the residuals from the first stage.

Table 3
Panel data dynamic GMM estimation results for each market

Dependent variable: The dispersion measure, V			
Market type	Bakkal	Supermarket	Pazar
Lagged V	0.5841 [0.0390]***	0.7266 [0.0228]***	0.3698 [0.0489]***
$\lvert EPS \rvert$	−0.0017 [0.0163]	0.0212 [0.0357]	0.0235 [0.0235]
$D * \lvert EPS \rvert$	0.0349 [0.0338]	−0.0608 [0.0650]	−0.0035 [0.0312]
$\lvert ECOL \rvert$	0.1026 [0.0417]**	0.231 [0.0643]***	0.0021 [0.0664]
$D * \lvert ECOL \rvert$	1.6079 [0.3468]***	−0.6016 [0.5215]	2.5749 [1.0393]**
$\lvert UPS \rvert$	0.0464 [0.0197]**	0.1122 [0.0324]***	0.0446 [0.0137]***
$D * \lvert UPS \rvert$	0.0253 [0.0311]	−0.0808 [0.0413]*	−0.0096 [0.0280]
$\lvert UCOL \rvert$	0.0049 [0.0206]	−0.0191 [0.0286]	−0.0652 [0.0441]
$D * \lvert UCOL \rvert$	−0.0136 [0.0318]	−0.0696 [0.0511]	0.0671 [0.0797]
Constant	−0.0001 [0.0000]*	−0.0001 [0.0000]**	0 [0.0001]
Observations	5009	2951	2062
H_0: $\lvert UCOL \rvert = D * \lvert UCOL \rvert = 0$			
χ^2	0.19	3.07	2.87
p-val	0.9081	0.216	0.238
H_0: $\lvert EPS \rvert = D * \lvert EPS \rvert = 0$			
χ^2	2.69	5.05	1.01
p-val	0.2611	0.0801	0.6024

See footnotes to Table 2.

and so on. Since the estimated coefficient on lagged dispersion is 0.5781, the cumulative impact of the supermarket fixed effect on steady-state dispersion is $1/(1-0.5781)\times 0.0062 \approx 0.015$. In Fig. 1, dispersion varies between 0.08 and 0.11 so this is a substantial effect. A similar calculation using the estimated coefficient 0.1025 on $\lvert ECOL_t \rvert$ reveals that a doubling of expected COL inflation from 60% to 120% (which did occur in Turkey during the early 1990s) would cause a short-run increase in dispersion of 0.0615 and a long-run increase of 0.146. Again, these are substantial effects.

4.6. Separate regressions

As a robustness check, we also estimated (7) for each market structure separately.[22] The advantage of this approach is that we can allow the coefficients on lagged dispersion and the different inflation variables to vary across market structures, whereas previously they were restricted to be identical. Table 3 reports the estimates for the separate regressions using the same one-step GMM estimation procedure that was used for Table 2.

For the most part, the estimates in Table 3 are consistent with our previous results in Table 2. In particular, the coefficient on lagged dispersion is positive and significant at the 1% level for all three market structures, and the estimates for $\lvert UPS_{it} \rvert$ are all positive and significant at the 5% level or better. If we disregard the estimate for $D\lvert UPS_{it} \rvert$ for supermarkets, which is negative and only significant at the 10% level, then $\lvert EPS_{it} \rvert$,

[22]We thank an anonymous referee for suggesting this. Note that in the separate regressions we continue to use PS inflation as defined in (5), which may use prices from all three market structures.

$D|\mathrm{EPS}_{it}|$, $D|\mathrm{UPS}_{it}|$, $|\mathrm{UCOL}_t|$, and $D|\mathrm{UCOL}_t|$ are all insignificant as before. Furthermore, a chi-square test could not reject the null hypothesis that $|\mathrm{UCOL}_t| = D|\mathrm{UCOL}_t| = 0$ for all three market structures.

We also note some interesting differences in the estimates across the three market structures. Overall, the significant estimates are larger for supermarkets with the exception of $D|\mathrm{ECOL}_t|$, which is positive and significant at the 5% level or better for bakkals and pazars, but insignificant for supermarkets. Furthermore, the coefficient on $|\mathrm{ECOL}_t|$ is positive and significant at the 5% level or better for bakkals and supermarkets, but insignificant for pazars. A potential explanation for the latter finding is that menu costs are too small in that market structure to discern any positive relationship between pazar dispersion and expected aggregate inflation. Note that this is consistent with our previous results that average price duration and price dispersion are lowest in the pazar because menu and search costs are minimal in that market structure.

4.7. Monetary search models

In our previous specification (7), we included the absolute value of ECOL_t to allow for a V-shaped relationship between dispersion and expected COL inflation. As in menu cost models, the vertex of the V was at the origin. We also included $D|\mathrm{ECOL}_t|$, where D is a dummy variable for negative ECOL_t, to control for our lone observation of expected COL deflation and to test whether the latter was an influential outlier.

In contrast, Head and Kumar (2005) show that in their monetary search model the relationship between dispersion and anticipated inflation can be V-shaped with a vertex at some positive value of anticipated inflation. In that case, dispersion is initially decreasing but eventually increasing in anticipated inflation. To investigate this possibility, we alter our previous specification (7) as follows:[23]

$$\begin{aligned} V_{ikt} &= \alpha + \beta_0 V_{ik(t-1)} + \beta_1|\mathrm{EPS}_{it}| + \beta_2|\mathrm{UPS}_{it}| + \beta_3|\mathrm{ECOL}_t - a| + \beta_4|\mathrm{UCOL}_t| \\ &\quad + \gamma_1 D|\mathrm{EPS}_{it}| + \gamma_2 D|\mathrm{UPS}_{it}| + \gamma_3 \tilde{D}|\mathrm{ECOL}_t - a| + \gamma_4 D|\mathrm{UCOL}_t| + u_{ikt}, \end{aligned} \tag{8}$$

where $\tilde{D}$ is one when $\mathrm{ECOL}_t < a$ and zero otherwise. In comparison with (7), we have replaced $|\mathrm{ECOL}_t|$ with $|\mathrm{ECOL}_t - a|$ and $D|\mathrm{ECOL}_t|$ with $\tilde{D}|\mathrm{ECOL}_t - a|$, where $a \geqslant 0$. In other words, we allow for a V-shaped relationship between dispersion and expected COL inflation where the vertex can occur at positive values. Recall that anticipated inflation in the Head and Kumar model stems from growth in the stock of fiat money, so it seems clear that our analysis should focus on expected COL inflation rather than expected PS inflation.

We then performed a grid search starting from $a = 0$, increasing in increments of 0.005 up to $a = 0.05$. Our choice of the endpoint $a = 0.05$ was guided by the fact that expected COL inflation averaged about 5% over the sample period (60% in annual terms). For each value of a in the interval $0 \leqslant a \leqslant 0.05$, we estimated (8) using the same one-step GMM procedure as before. In Table 4, we report the residual sum of squares σ^2 (our goodness-of-fit measure) for each of these regressions.

As can be seen from the table, the value $a = 0.035$ provides the best fit to the data. Although the improvement in σ^2 from 10.978 at $a = 0$ to 10.962 at $a = 0.035$ is relatively

[23]We thank the Editor, Jürgen von Hagen, for suggesting this line of inquiry.

Table 4
Panel data dynamic GMM estimation: Grid search results

a	0	0.005	0.010	0.015	0.020	
σ^2	10.978	10.978	10.978	10.978	10.978	
a	0.025	0.030	0.035	0.040	0.045	0.050
σ^2	10.972	10.967	10.962	10.969	10.981	10.986

σ^2 (the sum squared residuals) is computed for Eq. (7) allowing $a \in \{0, 0.005, 0.010, \ldots, 0.050\}$.

Table 5
Panel data dynamic GMM estimation results for $a = 0.035$

Dependent variable: The dispersion measure, V	
Lagged V	0.5756 (0.0305)***
$\lvert\mathrm{EPS}\rvert$	0.0099 (0.0131)
$D * \lvert\mathrm{EPS}\rvert$	0.0135 (0.0243)
$\lvert\mathrm{ECOL} - a\rvert$	0.1206 (0.0367)***
$\tilde{D} * \lvert\mathrm{ECOL} - a\rvert$	0.0691 (0.0759)
$\lvert\mathrm{UPS}\rvert$	0.0522 (0.0122)***
$D * \lvert\mathrm{UPS}\rvert$	0.0025 (0.0218)
$\lvert\mathrm{UCOL}\rvert$	−0.0243 (0.0168)
$D * \lvert\mathrm{UCOL}\rvert$	−0.0179 (0.0287)
Constant	−0.0000 (0.0000)
σ^2	10.962
Observations	10022

See footnotes to Table 2. $\tilde{D} = 1$ if $\mathrm{ECOL} < a$ and 0 otherwise.

small, a chi-square test with 1 degree of freedom rejects the null hypothesis that $a = 0$ at the 5% significance level. Table 5 provides the estimates for the specification in (8) when $a = 0.035$.

The new estimates in Table 5 are similar to our previous ones in Table 2, except that $\tilde{D}\lvert\mathrm{ECOL}_t - a\rvert$ is now insignificant. Recall that $D\lvert\mathrm{ECOL}_t\rvert$ was included in our previous specification (7) to control for the lone observation of expected COL deflation, which was found to be an influential outlier. In the current context, however, the interpretation is quite different because the estimate for $\tilde{D}\lvert\mathrm{ECOL}_t - a\rvert$ is based on 18 observations of $\mathrm{ECOL}_t < 0.035$ (about 20% of the total). Since $\tilde{D}\lvert\mathrm{ECOL}_t - a\rvert$ is insignificant, we find a *symmetric* V-shaped relationship between dispersion and expected COL inflation whose vertex occurs at $a = 0.035$.

We conclude that the Head–Kumar monetary search model provides a better fit to our data than traditional menu cost models. In particular, our findings suggest that dispersion is decreasing in anticipated inflation up to the 3.5% monthly or 42% annual level and is increasing thereafter. Although the improvement in goodness-of-fit as measured by σ^2 is slight, the difference is statistically significant. From an economic (as opposed to statistical) point of view, this difference is important, as Head and Kumar (2005) show that inflation is welfare-improving over the range where dispersion is decreasing in anticipated inflation.

5. Conclusion

In this paper, we explored a novel data set containing prices from individual sellers in pazars, bakkals, and supermarkets, which should exhibit significant variation in terms of menu costs, search costs, and other important parameters emphasized in the theoretical literature. Following the methodology in Bils and Klenow (2004), we found that average price duration is lowest in pazars, followed by supermarkets, then bakkals. The finding that prices turn over more rapidly in pazars is consistent with the basic predictions of menu cost models, since search and menu costs should be minimal in that market structure. We also found that prices change more frequently in supermarkets than in bakkals, and almost as quickly as in pazars. A potential explanation is that supermarkets have superior information-processing capabilities than bakkals, as emphasized by the literature on rational inattention. We conclude that both menu cost and rational inattention models are useful for understanding differences in average price duration across distinct market structures in our data.

We then used our data to re-examine the relationship between inflation and dispersion, where recent evidence has been mixed. Unlike the existing literature, we included lagged dispersion in our specification to reflect consumers' pre-search stock of information as in the information investment model in Van Hoomissen (1988). Another important difference with the existing literature was our inclusion of two different inflation measures, narrow PS inflation and aggregate COL inflation, decomposed into their expected and unexpected components. This was motivated by our observation that inflation plays highly distinct roles in the different classes of theoretical models, which suggests that different inflation measures might capture separate theoretical effects of inflation. In that case, dispersion could have different empirical relationships with different inflation measures. Finally, we controlled for product, store-type, and temporal fixed effects.

The store-type fixed effects reveal the average degree of dispersion in each market structure after controlling for product heterogeneity, inflation, and other factors. These effects therefore correspond to dispersion in static equilibrium search models, which assume homogeneous products and zero inflation. According to our estimates, dispersion is on average highest for supermarkets, followed by bakkals, then pazars. The finding that dispersion is lowest in the pazar is consistent with the basic predictions of static equilibrium search models, since search costs should be minimal in that market structure. We also found a positive and significant relationship between dispersion and lagged dispersion, so the former is decreasing in consumers' pre-search stock of information. In accordance with the basic prediction of signal extraction models, we found a symmetric V-shaped relationship between dispersion and unexpected PS inflation. Furthermore, there is some evidence that the relationship between dispersion and expected COL inflation is V-shaped, where the vertex occurs at a positive level of anticipated aggregate inflation, as predicted by the monetary search model in Head and Kumar (2005). Finally, expected PS and unexpected COL inflation were both insignificant.

From an empirical standpoint, a major conclusion of the paper is that price dispersion can indeed have different relationships with different inflation measures. Furthermore, our findings suggest that the Head–Kumar monetary search model will play an important role in future empirical work. At the theoretical level, we found that the information investment model, monetary search models, and signal extraction models all contribute to our understanding of the relationship between inflation and dispersion in our data. Our results therefore highlight the need for an integrated theory of that relationship to unify these separate insights within a single theoretical framework.

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Appendix A

Monthly product summary statistics

Product	N	π_i	σ_{π_i}	$Cor(\text{COL}, \pi_i)$
Rice	3	0.0486	0.0485	0.3668
Pasta	3	0.0457	0.0544	0.5464
Flour	3	0.0452	0.0361	0.4138
Baklava	1	0.0508	0.0317	0.4166
Cookies	1	0.0508	0.0317	0.4523
Flodough[a]	2	0.0472	0.0347	0.309
Cracked wheat	3	0.0487	0.0304	0.4415
Veal	2	0.0472	0.0386	0.218
Chicken	2	0.0446	0.0818	0.0404
Mutton	2	0.0472	0.0411	0.2364
Fish	2	0.0545	0.1898	−0.1583
Sucuk[b]	2	0.0489	0.0343	0.491
Offal[c]	1	0.0476	0.0448	0.2778
Salami	2	0.0479	0.0319	0.4757
Sausage	2	0.0453	0.0283	0.5685
Feta cheese	3	0.0464	0.0388	0.4623
Margarine	2	0.0501	0.0519	0.6299
Cooking oil	3	0.0485	0.0572	0.6325
Eggs	3	0.04	0.1307	0.3439
Olive oil	3	0.0504	0.0579	0.4845
Kasari cheese	2	0.0481	0.0555	0.2713
Potato	2	0.0474	0.1125	0.0798
Onion	2	0.053	0.1695	0.3485
Lentils	3	0.0489	0.0527	0.5238
Chick peas	3	0.0541	0.0569	0.5116
Dried beans	3	0.0525	0.061	0.2571
Sunflower seeds	1	0.046	0.042	0.2229
Peanuts	1	0.0493	0.047	0.2328
Hazelnuts	1	0.0599	0.1127	0.4076
Roasted chick peas	1	0.0523	0.0496	0.2963

Walnuts	1	0.0564	0.093	0.2299
Raisins	1	0.0473	0.0451	0.3965
Apple	2	0.0509	0.1394	−0.0849
Lemon	2	0.0453	0.1304	0.1387
Tomato	2	0.0497	0.2703	0.2903
Green peppers	2	0.0396	0.3354	0.1096
Cucumbers	2	0.0409	0.2619	−0.0492
Lettuce	2	0.042	0.1472	0.1773
Zucchini	2	0.0395	0.2209	0.1566
Scallion	2	0.0456	0.1722	0.2033
Olives	3	0.0488	0.0232	0.3374
Honey	3	0.0496	0.0344	0.437
Tomato paste	3	0.0464	0.061	0.3878
Halvah	2	0.0472	0.0482	0.6787
Jam	2	0.0469	0.036	0.3992
Ready soup	2	0.0462	0.03	0.1619
Broom	2	0.0505	0.0503	0.2182
Clean. powder	2	0.0496	0.0344	0.261
Soap	2	0.0477	0.0477	0.4982
Detergent	2	0.0451	0.0367	0.4843
Bleach	2	0.0497	0.0316	0.2321
Paper tissue	2	0.0501	0.0431	0.4172
Lightbulbs	2	0.039	0.0417	0.2704
Plastic Kitchenware	2	0.0495	0.0388	0.5665
Toothpaste	1	0.0489	0.0404	0.2653
Toilet soap	1	0.047	0.0468	0.5153
Shampoo	1	0.0436	0.0532	0.3524
Razor	1	0.0523	0.0579	0.2016

N, number of store types selling the product.
π_i, mean inflation of the product.
$\sigma_{\pi i}$, the standard deviation of π_i.
$Cor(\mathrm{COL}, \pi_i)$, the correlation between the cost-of-living index and π_i.
[a] A very thin sheet of dough.
[b] A type of sausage.
[c] Sheep viscera.

Appendix B

Panel data dynamic GMM estimation results excluding Pazar data

Dependent variable: The dispersion measure, V	
Lagged V	0.6448 [0.0300]***
|EPS|	0.0012 [0.0155]
$D*$|EPS|	0.0195 [0.0342]
|ECOL|	0.1478 [0.0354]***

$D*\|\text{ECOL}\|$	0.8812 [0.3305]***
$\|\text{UPS}\|$	0.0557 [0.0185]***
$D*\|\text{UPS}\|$	0.0147 [0.0310]
$\|\text{UCOL}\|$	0.001 [0.0171]
$D*\|\text{UCOL}\|$	−0.0381 [0.0258]
dmrk	0.0056 [0.0006]***
Constant	−0.0001 [0.0000]***
Observations	7960

V, price dispersion defined in (3); dmrk, 1 for supermarkets and 0 otherwise; EPS, expected product-specific inflation; UPS, unexpected product-specific inflation; D, 1 if $x<0$ in $D|x|$; ECOL, expected aggregate inflation; UCOL, unexpected aggregate inflation; The numbers in parentheses are robust standard errors from Arellano–Bond one-step GMM estimation; Standard errors in brackets.

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

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