Review of Economic Dynamics ••• (••••) •••–•••

Contents lists available at ScienceDirect

Review of Economic Dynamics

www.elsevier.com/locate/red

Equilibrium price dispersion across and within stores ☆

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ARTICLE INFO

Article history:
Received 9 August 2015
Received in revised form 14 August 2017
Available online xxxx

JEL classification:
D43

Keywords:
Search
Multidimensional price dispersion
Price discrimination
Bargain hunting

ABSTRACT

We develop a search-theoretic model of the product market that generates price dispersion across and within stores. Buyers differ with respect to their ability to shop around, both at different stores and at different times. The fact that some buyers can shop from only one seller while others can shop from multiple sellers causes price dispersion across stores. The fact that the buyers who can shop from multiple sellers are more likely to be able to shop at multiple times causes price dispersion within stores. Specifically, it causes sellers to post different prices for the same good at different times in order to discriminate between different types of buyers.

1. Introduction

This paper is a contribution to the theory of equilibrium price dispersion and it is motivated by three facts. First, it is well-known that the same product is sold at very different prices, even when one restricts attention to the same geographical area and the same period of time. In his pioneering article on price dispersion, Stigler (1961) finds that the same car was sold at very different prices by different dealerships in Chicago. Sorensen (2000) finds that the average standard deviation of the price posted by different pharmacies for the same drug in the same town in upstate New York is 22%. In a systematic study of price dispersion that covers 1.4 million goods in 54 geographical markets within the US, Kaplan and Menzio (2015) find that the average standard deviation of the price at which the same product is sold within the same geographical area and during the same quarter is 19%. Second, it is well-known that price dispersion is caused both by differences in prices across different stores and by differences in prices within each store. For instance, Kaplan and Menzio (2015) find that approximately half of the variance of prices for the same good in the same area and in the same quarter is due to the fact that different stores sell the good at a different price on average, while the remaining half is due to the fact that the same store sells the same good at different prices during the same quarter.[1] Third, as documented by Nakamura and Steinsson (2008)

☆ We are grateful to an Associate Editor and two anonymous referees for their fruitful suggestions. We also wish to thank Ken Burdett, Greg Kaplan, Agata Menzio, Leena Rudanko and Ali Shourideh for their comments. The views expressed in this paper are those of the authors and do not necessarily represent the views of the Federal Reserve Bank of Richmond or the Federal Reserve System.

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[1] These decompositions follow immediately from Table 3 in Kaplan and Menzio (2015). For a particular good, the fraction of the price variance coming from across-store variation is given by the sum of the variance of the store component and the store-good component. The fraction of the price variance coming from within store variation is the variance of the transaction component.

http://dx.doi.org/10.1016/j.red.2017.08.004
1094-2025/

Please cite this article in press as: Menzio, G., Trachter, N. Equilibrium price dispersion across and within stores. Review of Economic Dynamics (2017), http://dx.doi.org/10.1016/j.red.2017.08.004

and Klenow and Kryvtsov (2008), a large fraction of all the changes in the price of a particular good at a particular store are due to temporary sales, defined as temporary price reductions.[2]

Motivated by the above observations, we develop a theory of price dispersion across and within stores by building a model that combines the search theory of price dispersion across sellers (see, e.g., Burdett and Judd, 1983) with the intertemporal price discrimination theory of temporary sales (see, e.g., Conlisk et al., 1984). To this aim, we build a model of the market for an indivisible good. On the demand side, there are buyers who differ with respect to their ability to shop at different stores, as well as with respect to their ability to shop at different times: Some buyers can shop from only one seller while others can shop from multiple sellers, and some buyers can shop only during the day while others can shop both during the day and during the night. On the supply side, there are identical sellers and each seller posts a (potentially different) price for the good during the day and during the night.

We prove the existence and uniqueness of equilibrium. We find that the equilibrium features dispersion in the average price posted by different sellers (i.e., price dispersion across stores). Moreover, if the type of buyers who are more likely to be able to shop from multiple sellers are also more likely to be able to shop at different times, the equilibrium also features dispersion in the price posted by the same seller during the day and during the night (i.e., price dispersion within stores). In contrast, if the type of buyers who are more likely to be able to shop from multiple sellers are less likely to be able to shop at different times, the equilibrium does not feature any variation in the price posted by the same seller during the day and during the night (i.e., the equilibrium displays no price dispersion within stores).

The properties of equilibrium are intuitive. Price dispersion across sellers arises for essentially the same reason as in Burdett and Judd (1983). That is, whenever sellers face a population of potential customers that includes both captive buyers (i.e. buyers who cannot shop from any other seller) and non-captive buyers (i.e., buyers who can shop elsewhere), the equilibrium must feature price dispersion. Price dispersion within sellers arises if and only if the buyers who are more likely to be non-captive are also more likely to be able to shop at any time. In fact, a seller would like to charge higher prices to captive buyers than to non-captive buyers, because—given price dispersion across stores—captive buyers have on average a higher reservation price. If the non-captive buyers are more likely to be able to shop at any time while captive buyers are more likely to be able to only shop during the day, a seller can successfully price discriminate by posting a higher price during the day and a lower price during the night. If, on the other hand, non-captive buyers are less likely to be able to shop at any time, a seller cannot successfully price discriminate. Indeed, if the seller posted a lower price at night, he would end up offering a better deal to the captive buyers. And if the seller posted a lower price during the day, he would end up offering a better deal to both the non-captive and the captive buyers.

Our theory of price dispersion across and within sellers requires the same assumptions as the search theory of price dispersion and the intertemporal price discrimination theory of sales. As in the search theory of price dispersion (see, e.g., Butters, 1977; Varian, 1980; Burdett and Judd, 1983), we assume that some buyers can shop from multiple sellers while others can shop from only one seller. The assumption can be seen as a by-product of heterogeneity in the buyers' opportunity cost of shopping at different locations. As in the intertemporal price discrimination theory of sales (see, e.g., Conlisk et al., 1984; Sobel, 1984; Albrecht et al., 2013), we assume that some buyers need to shop at a particular time while others can shop at any time. The assumption can be seen as a by-product of heterogeneity in the buyers' opportunity cost of shopping at different times. Additionally, the theory of intertemporal price discrimination assumes that the buyers who must shop at a particular time have a higher willingness to pay for the good. In this paper, we make the closely related assumption that buyers who must shop at a particular time are less likely to be able to shop from multiple sellers which, in the presence of price dispersion, implies that these buyers have a higher reservation price. Basically, we endogenize the difference in the willingness to pay between buyers who are flexible and those who are not flexible with respect to the shopping schedule, and we do so in a natural way, as buyers who have a low opportunity cost of shopping at different locations presumably also have a low opportunity cost of shopping at different points in time. Even though there is not much direct evidence on the assumptions underlying the search theory of price dispersion and the intertemporal price discrimination theory of sales,[3] these theories are commonly viewed as the leading explanations for, respectively, dispersion in the price of a particular good across different stores and temporary sales.

The assumptions and properties of our model are a simple combination of the properties of models of price dispersion and intertemporal price discrimination. Yet, the characterization of the equilibrium of our model presents novel challenges and calls for a novel solution strategy. As this is the main technical contribution of the paper, let us expand on this point. In Burdett and Judd (1983), each seller posts one price. In equilibrium, each seller must attain the same profit by posting any

[2] Temporary sales account for approximately half of all the changes in the price of a particular good at a particular store. They account for a larger fraction of the within-seller price variance because, on average, price changes due to temporary sales are three times larger than regular price changes (see Nakamura and Steinsson, 2008).

[3] Evidence on the assumptions of the model is hard to come by because the assumptions involve heterogeneity across buyers in the number of their shopping option, not in the number of their choices. If one is willing to extrapolate the assumptions outside of the model, one can find some evidence that there is heterogeneity across buyers in their willingness to shop at different location, in their willingness of shopping at different times, and that the two traits are positively correlated. For instance, Aguiar and Hurst (2007) find that retirement-age people spend more time on each shopping trip (perhaps to reach less convenient locations and, if so, revealing a greater willingness to shop around), take more shopping trips (perhaps to take advantage of asynchronized sales and, if so, revealing a greater willingness to shop at different times), and end up paying lower prices than younger people. Similarly, Kaplan and Menzio (2015, 2016) show that non-employed, working-age people spend more time shopping, take more shopping trips and pay lower prices than employed people.

Please cite this article in press as: Menzio, G., Trachter, N. Equilibrium price dispersion across and within stores. Review of Economic Dynamics (2017), http://dx.doi.org/10.1016/j.red.2017.08.004