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Unobserved heterogeneity in price-setting behavior: A duration analysis approach

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ABSTRACT

There is strong empirical evidence that the degree of price stickiness differs across commodity items, and that the nonparametric hazard function of price changes is downward-sloping with some spikes. We introduce item-specific heterogeneity into the standard single-sector model of Calvo [Calvo, G., 1983. Staggered prices in a utility-maximizing framework. Journal of Monetary Economics 12 (3), 383–398]. By allowing the hazard rate of price changes to vary across items, we show that the decreasing nonparametric hazard function is well described except for the characteristic peaks at 1, 12, 24, and 36 months. We reject the hypothesis that the degree of price stickiness is the same across the items at 1 percent of significance. In the presence of item-specific heterogeneity, the probability that prices remain unchanged for long periods is higher than the single-sector model predicts.

1. Introduction

In recent years, empirical studies measuring price stickiness have begun to employ microprice data, which underlies the computation of consumer price index (CPI). (See, for example, Bils and Klenow, 2004; Nakamura and Steinsson, 2008, for the United States;Dhyne et al., 2005, for the European Union;Saita et al., 2006, for Japan.) Since then, studies on this issue have substantially achieved the same results.

First, the degree of price stickiness differs across commodity items. As Bils and Klenow (2004); Nakamura and Steinsson (2008) point out, the frequency of price changes varies widely: the CPI basket in the United States consists of several sticky as well as flexible items. Higo and Saita (2007) confirmed that the same holds true for the Japanese CPI. As illustrated in Fig. 1, there is a strong heterogeneity across items: the item average frequency of price changes is distributed throughout the range zero (no price change) to one (the price changes every month). Table 1 presents the sectoral frequency of price changes. Item groups with high frequency of price changes consist of agricultural and aquatic products and petroleum products, followed by the middle-frequency groups, which contain industrial products such as furniture, household utensils, and textiles. The groups with sticky price changes consist chiefly of services such as education, medical care, and eating out.

Second, the nonparametric hazard function of price changes is downward sloping with some spikes. According to Álvarez et al.

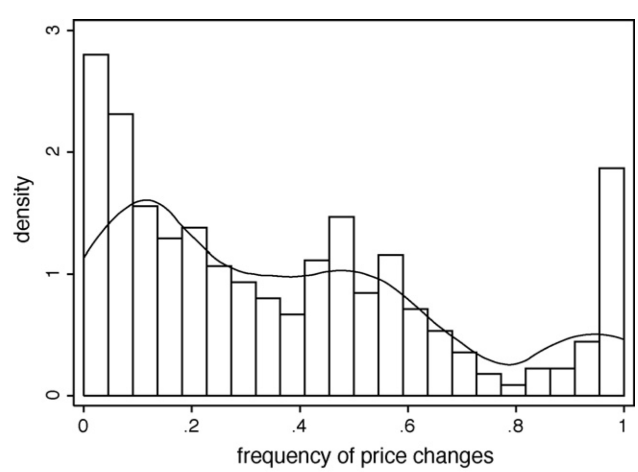

Fig. 1. The distribution of the frequency of price changes: Retail price data in Japan from 2000–2005; 495 items. The smooth line is the kernel density estimates (Epanechnikov kernel function; kernel bandwidth = 0.078).

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Table 1
Frequency of price changes by item groups. Frequency of price changes is $\bar{\eta} = \sum_i w_i \eta_i$, where w_i is the CPI weight for the ith item.

Group	Frequency of price changes	Average price duration	Number of items	Weight
General	0.291	7.1	495	1.000
Classification by the ten largest expenditure items:				
Food	0.455	3.8	208	0.384
Housing	0.042	21.2	15	0.031
Fuel, light and water charges	0.095	8.2	5	0.100
Furniture and household utensils	0.343	3.4	54	0.055
Cloths and footwear	0.428	3.7	74	0.083
Medical care	0.091	6.5	25	0.058
Transportation and communication	0.148	7.1	25	0.127
Education	0.056	18.0	3	0.019
Reading and recreation	0.204	16.8	55	0.089
Miscellaneous	0.138	10.7	34	0.052
Classification by type of items:				
Goods	0.406	4.1	406	0.683
Agricultural and aquatic products	0.798	0.7	73	0.115
Fresh products	0.841	0.6	68	0.100
Other products	0.515	1.4	5	0.015
Industrial products	0.372	4.0	330	0.480
Food products	0.398	2.8	121	0.207
Textiles	0.426	3.6	73	0.087
Petroleum products	0.574	1.2	3	0.033
Other industrial products	0.263	6.5	133	0.153
Electricity, gas and water charges	0.077	9.3	3	0.087
Services	0.042	13.6	89	0.317
Public services	0.006	–	27	0.126
General services	0.066	21.4	62	0.191
Eating out	0.087	11.9	17	0.068
Other services	0.054	26.7	45	0.123
Classification by durability of goods:				
Durable goods	0.351	6.1	40	0.045
Semi-durable goods	0.348	4.5	115	0.130
Non-durable goods	0.426	3.9	251	0.507
Industrial products manufactured by:				
Large enterprises	0.369	4.3	160	0.232
Small and medium enterprises	0.375	3.7	170	0.249

Average duration, reported in month, is the weighted average of price spell duration, i.e., $\bar{d} = \sum_i w_i d_i$, where d_i is the duration of price spells for the ith item, defined as $d_i = -1/\ln(1-\eta_i)$. Retail price data used for calculation of the Japanese CPI (January 2000–December 2005).

(2005), this result is "[a] common finding in empirical studies using microdata on consumer and producer prices" and "at odds with standard theoretical models of price setting." This is because the standard time-dependent pricing model as in Calvo (1983), in which one single parameter represents price stickiness in the economy, cannot deduce the fact that the aggregated hazard function of price changes is decreasing.

Intuition suggests that each commodity item has specific factors related to its survival experience.[1] These specific factors change the shape of the individual hazard function and may cause the aggregated hazard function to decrease over time. In the context of duration analysis, this phenomenon is known as "a selection effect" (Proschan, 1963; Lancaster, 1990).[2] In the presence of heterogeneity in the population, we must carefully interpret the shape of the aggregated hazard function. This is because, unless we somehow model unobserved heterogeneity, we cannot know whether the downward hazard function exhibits true duration dependence of price spells or the mere selection effect. As Meyer (1990) suggests, the nonparametric hazard function assumes that there is no heterogeneity which depends on either observable or unobservable factors. This means that previous studies using the nonparametric estimation of hazard rate cannot distinguish the selection effect from the aggregated hazard function. In order to control the variability in the individual hazard function, it is common to incorporate the related covariates in duration analysis. If it is not fully captured by the covariates, it is necessary to model unobserved heterogeneity.

However, few attempts have been made to analyze the heterogeneity in price-setting behavior. Leading examples are the finite mixture models developed by Álvarez et al. (2005). They specify the hazard function for each subpopulation and theoretically demonstrate that the mixture of the hazard functions is not constant and varies depending on the specification and number of subpopulations contained in the model. They document that it is optimal in terms of information criteria to estimate a model composed of three groups with a different but constant hazard rate, plus one group with a positive hazard rate at every 12 months. The other is the semiparametric hazard model with gamma heterogeneity model, which appears in Nakamura and Steinsson (2008). In order to account for heterogeneity, they specify the unobserved heterogeneity as being common to all observations

[1] The existing literature individually reveals the determinants of the item-level variation in the frequency of price changes. Two major determinants are the cost structure and the degree of market competition. See Álvarez (2007) for details. As for the former, a substantial part of the literature reports the inverse relation between the share of labor cost and the frequency of price changes (Álvarez et al., 2005; Higo and Saita, 2007). As for the latter, the results are mixed. According to Álvarez et al. (2005), the survey evidence from Spanish firms reveals that higher competition leads to more frequent price changes. However, Bils and Klenow (2004) conclude that, for 231 items in the U.S. CPI, the degree of concentration is not a robust predictor because the effect on the frequency of price changes is no longer significant if controlled for item-group dummies.

[2] In a heterogeneous population, subjects with a high risk of experiencing the event of interest will exit from the population first, leading to the group of survivors becoming more and more composed of subjects with low risk. The fact that this selection of the heterogeneous population may cause a decreasing aggregated hazard function has been known since Proschan (1963).