Nominal rigidities without literal menu costs: evidence from E-commerce

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Abstract

Using price data from online book retailers, Amazon.com and Barnes and Noble.com, we show that nominal rigidities persist in an environment that is free from literal menu costs. Menu costs, therefore, are not the prime reason for nominal rigidities.

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\textit{JEL classification:} E30

1. Introduction

Keynesian theorists have argued that menu costs induce nominal price rigidities that can cause business cycle dynamics (see Gordon 1990 for a review). Taken literally, ‘menu costs’ refer to the cost of implementing price changes. Levy et al. (1997) and Dutta et al., 1999 have sought to measure such literal menu costs using store and product level data and found them to be considerable. Others, like Gordon, (1990), Ball and Mankiw (1994) and Mankiw and Reis (2002), have argued that “menu costs” should be interpreted more broadly and should include decision-making costs as well.
Because different reasons for nominal price rigidities (e.g. menu costs or managerial or customer costs) can result in very different macroeconomic dynamics (Mankiw and Reis, 2002), it is important to differentiate between them. Empirically, however, it is difficult to distinguish between the literal menu costs and managerial and customer costs in their effect on nominal rigidities as they generally occur together.

The Internet, however, provides an environment where literal “menu costs” are almost wholly absent with price changes being implemented with a few keystrokes. For instance, the largest element of menu costs, according to Levy et al. (1997), consists of “labor cost of price changes” followed by “labor cost of sign changes”. These are precisely the kinds of costs that are altogether absent in the online environment. Here, we examine the price change behavior of two leading e-retailers—Amazon.com and Barnes and Noble.com—to study if the absence of such costs removes all nominal rigidities. We find strong evidence that nominal price rigidities—revealed by synchronization of price changes—persist even in the absence of literal menu costs. Blinder (1991) and Blinder et al. (1998) list many other reasons why prices are sticky. Several of them, like varying delivery lags (service rather than price) and coordination failure, carry over to the internet and cannot be ruled out by our study. We only establish that nominal rigidities persist in the absence of literal menu costs, so the latter cannot be their prime cause.

2. Data

Our data comprises weekly price observations for 3124 books from Amazon and Barnes and Noble for a period of 57 weeks—March 20, 2000 to April 22, 2001—obtained entirely from the respective web sites. We extract price information for a sample of 3124 books for which a price is available at each store for all 57 weeks by constructing a set of International Standard Book Number (ISBN)1 obtained from an online book-selling site “even better.com” and using a ‘bot’—a web-based program. The prices recorded do not include any frequent buyer or other discounts.

Following the extant literature on measuring nominal rigidity (see Lach and Tsiddon, 1996; Fisher and Konieczny, 2000), we create a panel of zeros (no price change over a week) and ones (some price change over a week) for each book, for each store for 56 weeks. Table 1 presents the descriptive statistics of the data.

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Table 1
Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Amazon</th>
<th>Barnes and Noble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of books</td>
<td>3124</td>
<td>3124</td>
</tr>
<tr>
<td>Number of weeks</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>Total number of changes</td>
<td>7759</td>
<td>7160</td>
</tr>
<tr>
<td>Average proportion of books changing prices per week</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Avg. number of changes per book</td>
<td>2.48</td>
<td>2.29</td>
</tr>
<tr>
<td>Standard deviation of number of changes</td>
<td>0.21</td>
<td>0.20</td>
</tr>
<tr>
<td>Maximum number of changes (in a particular book price in 56 weeks)</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Minimum number of changes</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

1 From a site originally called www.evenbetter.com. During our study, it was acquired by a more general comparison shopping site, DealTime.com (www.dealt ime.com).
3. Analysis

We largely follow the methodology used in Lach and Tsiddon (1996) and Fisher and Konieczny (2000). These authors develop tests for the extent to which synchronization occurs when multi-product stores change the price of their products. If there were no nominal rigidities, then price changes across products would be distributed across time—i.e. no synchronization. Alternatively, if all prices were changed at the same time (i.e. synchronization), this would imply significant nominal rigidities.

The results of the various tests used here not only corroborate one another but also indicate the robustness of our findings. In 43 of the 56 weeks, Amazon changes less than 3% of its book prices while in the three weeks with maximum price changes it changes the prices of over 37% books. For Barnes and Noble, less than 5% of books experience price changes in 49 of the 56 weeks, while in the top 2 weeks prices change for well over 20% of the books.

3.1. Tests of synchronization

Our first test is based on Fisher and Konieczny (2000). Since on average there are 2.48 price changes per book at Amazon and 2.29 price changes at Barnes and Noble, a case of perfect synchronization would imply a series of three ones and 53 zeros for either store with the associated standard deviation of 0.225 reflecting perfect synchronization. Perfect staggering will imply a constant series. Thus, the ratio \( r = \frac{S.D.\text{observed}}{S.D.\text{perfect synchronization}} \), \( 0 \leq r \leq 1 \), provides a measure of the degree of synchronization in price changes. For Amazon (S.D.=0.076) \( r=0.34 \), while that for Barnes and Noble (S.D.=0.045) it is 0.2. Thus, the degree of price synchronization observed here is at least as high if not higher than that found for Canadian newspapers by Fisher and Konieczny (2000), \( r=0.21 \). \( \chi^2 \) tests for both Amazon and Barnes and Noble indicate that the variances are significantly positive at 1% level providing formal evidence of the presence of synchronization.

If the price changes were indeed staggered evenly over time, then, during any particular week, the proportion of books changing prices would follow the binomial distribution (with \( n=3124 \) and \( p=4\% \) for both stores). Table 2 shows the distribution of binomial \( p \)-values for each store (two-way test, null hypothesis of no synchronization). In the case of Barnes and Noble, 43 out of 56 observations lie in the two 5% level of confidence critical regions. For Amazon the results are even more unequivocal—all values fall in the 5% tails, in fact all of them fall in the 1% tails. Once again, this indicates considerable level of synchronization in price changes over weeks in the two online stores.

Finally, we consider pair-wise correlation in the timing of price changes as outlined in Lach and Tsiddon (1996). Here, the null hypothesis is that, for any pair of books, the likelihood of price change for one book over the 56 weeks under study is independent from that for the other book. A sufficiently high level of correlation for several pairs would therefore lead to a rejection of the null hypothesis. However,

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Distribution of binomial ( p )-values</th>
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<tbody>
<tr>
<td>No. of obs.</td>
<td>( p )-values from binomial distribution</td>
</tr>
<tr>
<td></td>
<td>Below 5%</td>
</tr>
<tr>
<td>Amazon</td>
<td>56</td>
</tr>
<tr>
<td>Barnes and Noble</td>
<td>56</td>
</tr>
</tbody>
</table>
since the distribution of the relevant statistic in this case is a non-standard one, we employ Monte-Carlo simulations to generate the distribution and compare our observed values against this distribution. The 99% critical value of the distribution of the test statistic for Amazon and Barnes and Noble are 0.443 and 0.453, respectively, while the observed values are 0.85 and 0.88, respectively. Clearly then, this test, like all others, convincingly rejects the hypothesis of “no synchronization” for both stores.\footnote{Details of the Monte-Carlo estimation are available upon request.}

3.2. Robustness check

Next, we check whether our strong within-store price change synchronization results are driven by the weeks with relatively large amounts of price changes. We replicate our different tests dropping the weeks with changes over 15% of books.

The percentage difference from staggering (the ratio $r$) declines to 0.16 for Amazon (S.D.=0.031) and 0.08 for Barnes and Noble (S.D.=0.016)—comparable to those in Fisher and Konieczny (2000) who establish synchronization with figures ranging from 0.04 to 0.20. The $\chi^2$ tests continue to reject the “perfect staggering” null hypothesis of no variation. As for the binomial tests, the hypothesis of staggering is rejected in 41 weeks out 52 (over 75%) for Amazon and 35 weeks out of 54 (about 65%) for Barnes and Noble—again comparable to the relevant figures in Lach and Tsiddon (1996) that range from around 65% to 95%. As for the pair-wise correlations test, the hypothesis of no correlation is still comfortably rejected at the 1% level for both stores. This confirms that the evidence of synchronicity found in the test is not driven by a few episodes of large changes but is inherent throughout the data.

4. Conclusions

Our results indicate that literally construed “menu costs” are not solely responsible for nominal rigidities. Managerial costs and customer costs therefore appear to contribute heavily to nominal rigidity. Our results corroborate the findings of Zbaracki et al. (2004) who conclude in a very different context that such costs are likely to be several times the physical costs of price changes and may cause price rigidities. To the extent that alternative price adjustment dynamics lead to important differences in our understanding of the macroeconomy, further research should investigate the different causes of nominal price rigidities and the specific price dynamics they cause. Our result, that price rigidities persist in an environment with little or no menu costs, is a step in that direction.

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