

Singapore Management University

Institutional Knowledge at Singapore Management University

Research Collection School Of Economics

School of Economics

1-2003

Competitiveness and Price Convergence on the Internet: Evidence from the Online DVD Market

Xiaolin XING

National University of Singapore

Fang Fang TANG

Chinese University of Hong Kong

Zhenlin YANG

Singapore Management University, zlyang@smu.edu.sg

Follow this and additional works at: https://ink.library.smu.edu.sg/soe_research



Part of the [E-Commerce Commons](#), [Econometrics Commons](#), and the [Industrial Organization Commons](#)

Citation

XING, Xiaolin; TANG, Fang Fang; and YANG, Zhenlin. Competitiveness and Price Convergence on the Internet: Evidence from the Online DVD Market. (2003). 10-2003, 1-27.

Available at: https://ink.library.smu.edu.sg/soe_research/1185

This Working Paper is brought to you for free and open access by the School of Economics at Institutional Knowledge at Singapore Management University. It has been accepted for inclusion in Research Collection School Of Economics by an authorized administrator of Institutional Knowledge at Singapore Management University. For more information, please email cherylds@smu.edu.sg.

Competitiveness and Price Convergence on the Internet: Evidence from the Online DVD Market

**Xiaolin Xing
Fang-Fang Tang
Yang Zhenlin**

January 2003

Paper No. 10-2003

Competitiveness and Price Convergence on the Internet: Evidence from the Online DVD Market

Xiaolin Xing • Fang-Fang Tang • Zhenlin Yang

*Department of Economics, National University of Singapore, Singapore 119260
ecsxxl@nus.edu.sg*

*Department of Marketing, Chinese University of Hong Kong, Shatin, Hong Kong, China
fftang@baf.msmail.cuhk.edu.hk*

*School of Economics and Social Sciences, Singapore Management University, Singapore 259756
zlyang@smu.edu.sg*

January 21, 2003

ABSTRACT

We compare the pricing behavior between online branches of traditional retailers (MCR) and pure Internet retailers (Dotcom) in the DVD market. Based on a set of panel data from July 5, 2000 to June 11, 2001, we find that the average price of the MCRs is about 11.2% higher than that of the Dotcoms. Further statistical analyses on the market dynamics of price trends show that the prices of the Dotcoms went up with time much faster than the prices of the MCRs, which points to a possibility that eventually both types of retailers may charge similar prices on average. We also find that the price dispersion among the MCRs is about 74% higher than that among the Dotcoms, and that the price dispersion went down with time for the MCRs and up with time for the Dotcoms. This suggests that the two types of retailers not only will charge similar average prices in the long run, but also will have similar price dispersions.

Our methodology of market price evaluation to the online retailer formats directly addresses a fundamental question whether the online markets would evolve toward a perfectly competitive market. The online DVD market seems indeed moving towards such a direction, although significant pricing differentials still exist.

(Online Market; Dotcom; Multi-Channel Retailer; Pricing; Price Convergence; Competitive Market)

Acknowledgment:

The work described in this paper was supported in part by a grant (No. R-122-000-050-112) from the National University of Singapore, and in part by a grant (No. CUHK4310/02H) from the Research Grants Council of the Hong Kong Special Administrative Region, China.

1. Introduction

Despite of the bubble burst in Nasdaq, online retailing has been in fact growing very fast. According to a recent study commissioned by Shop.org, a division of National Retail Federation in the U.S., shoppers spent \$51.3 billion online in 2001, up 21 percent from the year before (see “The State of Retailing Online 5.0”, Boston Consulting Group with market-sizing data supplied by Forrester Research, June 12, 2002). It is particularly remarkable, because that year experienced a weakened economy in the U.S. and most other regions. This annual study also expected that consumer spending would increase 41 percent to \$72.1 billion in 2002. Consumer adoption of the online channel seems reaching critical mass, and retailers seem to manage turning this trend into profits, evidenced by the 56 percent of retailers reported profitable online operations in 2001, up from 43 percent in 2000. In particular, multi-channel retailers are reported to drive much of this profitability. On the consumer side, according to the study conducted by J.C. Williams Group and BizRate.com (“The Multi-Channel Retail Report” 2002), store shoppers who also bought online spend an average of \$600 more than single-channel shoppers. Online shoppers were found to be the most active, and the implication clearly points to the risk retailers would face if they do not support their online channel.

A natural question then is how these multi-channel retailers compete with online-only retailers on the Web. With low search costs and easy access to market information, Internet markets can match buyers and sellers more efficiently, and the price dispersion for homogenous products is expected to be smaller than in physical markets. As multi-channel retailers will presumably be exposed to the same set of online shopping pressures as online-only retailers, one may anticipate that they will have similar pricing behavior on the Internet. However, since multi-channel retailers’ pricing behavior would inevitably have influence upon demand in their conventional stores, the price differentials between the two internal

channels will create internal competition and conflict. Therefore, multi-channel retailers may not compete closely on prices with online-only retailers.

Empirical studies have found that online retailers tend to charge lower prices than traditional retailers.¹ Since multi-channel retailers may wish to coordinate prices across their different channels to prevent destructive competition among them, they may charge higher prices on the Web than their online-only competitors, although it is not necessary for a multi-channel retailer to charge the same prices online and offline. If multi-channel retailers can successfully translate their market power and brand to online markets, one may expect that conventional retailers will charge higher prices in the Internet markets than online-only retailers even in the intermediate or long term. Tang and Xing (2001) compared the pricing behavior between online branches of multi-channel retailers and pure Internet retailers in the online DVD market, based on data collected during eight weeks in mid-2000. They found that online prices and price dispersions by pure Internet retailers were significantly lower than online branches of multi-channel retailers.

However, prices and price dispersion may change over time. Economic theory predicts that in a competitive market for a homogenous good, price will converge to the marginal cost level. Since online retailing seems close to a competitive market, it is of a great interest to explore online market dynamics of prices and to test if prices converge over time on the Internet. In this study, we use a unique set of panel data, collected in the online DVD market over a nearly one-year span from mid-2000 to mid-2001, to examine the different pricing behavior between online-only retailers (hereafter, Dotcoms) and the online branches of multi-channel retailers (hereafter, MCRs). We use panel data analysis technique to address

¹ For example, Clay, Krishnan, and Wolff (2001) examined prices of books sold by thirty-two online bookstores and found that competition led to low prices and price dispersion. Brynjolfsson and Smith (2000) compared prices of books and CDs sold through Internet and conventional channels in 1998 and 1999 and found that online prices were 9-16 percent lower than those in conventional stores. Morton, Zettelmeyer, and Silva-Risso (2001) compared prices of cars sold in both online and conventional channels, and found that, on average, online consumers paid two percent less than offline consumers.

the important issues such as controlling factors and market pricing dynamics. This technique allows for different specifications of the error structure in time and in cross-section.

Based on our dataset, we find that Dotcoms offer prices lower than MCRs that sell mainly through traditional channels even in the intermediate term. Interestingly, we find that the prices for both Dotcoms and MCRs go up, but the prices for Dotcoms increase faster, implying price convergence in the long run. We also find that there exists remarkable price dispersion among each type of retailers and among both types of retailers, and the price dispersion is much higher for MCRs than for Dotcoms. But the price dispersion goes down with time, indicating again that the prices may converge over time, which suggests that the two types of retailers not only will charge similar average prices in the long run, but also will have similar price dispersions.

Our methodology of market price evaluation to the online retailer formats directly addresses a fundamental question whether the online markets would evolve toward a perfectly competitive market. The online DVD market seems indeed moving towards such a direction, although significant pricing differentials still exist. To the best of our knowledge, this is the first study from this angle on the relatively long-period market dynamics of this market.

Section 2 discusses some theoretical studies on search theory and empirical findings on pricing behavior in the Internet markets. Section 3 describes our data collection methodology and Section 4 reports some basic statistical results. In Section 5, we estimate a few parametric models on market dynamics in pricing and discuss the panel results. Section 6 concludes.

2. Search Costs, Brand Loyalty and Price Dispersion

According to search theory, the low search cost online would result in low price dispersion (see, for example, Stigler, 1961; Nelson, 1970; Pratt, Wise and Zeckhauser, 1979; Bakos, 1997). Although the law of one price may never be precisely valid in any retail markets, low search cost may result in a relatively small spread between the highest and the lowest prices. In a Bertrand model with homogeneous goods, price competition drives all retailing prices down to the marginal cost. However, asymmetric information and search costs may prevent market systems from achieving such pricing efficiency.

Stigler (1961) analyzed price dispersion across firms for a homogenous good. Because search is costly, an imperfectly informed consumer would only select a limited number of sellers for comparing prices. Higher search cost in a market with imperfectly informed customers would result in a greater dispersion of prices, and greater price dispersion would result in more searches. Following Stigler's seminal paper, both theoretical and empirical studies in the literature have attempted to explain the existence of price dispersion. Nelson (1970) extended Stigler's model by assuming that consumer behavior was affected by both price and quality. Pratt, Wise and Zeckhauser (1979) theoretically showed several cases where even small search costs also led to substantial price dispersion, but the general case is too complicated mathematically to obtain any generic results. Bakos (1997) used Salop (1979)'s circular city model to examine the effects of lower search cost on equilibrium prices in electronic markets and showed that lower search cost would drive Internet prices for homogeneous goods toward the Bertrand marginal cost pricing pattern. Clearly, the theoretical side is neither fully understood nor consistent for new type of markets like the Internet one. Empirical investigation is critically demanded.

Several recent studies have empirically showed considerable price dispersion in online markets as well. Clemons, Hann, and Hitt (2002) investigated online markets for

airline tickets and found differences in prices across online travel agents as large as 20 percent, even after controlling for observable product heterogeneity. Clay, Krishnan, and Wolff (2001) found that although online search cost was low, many consumers might not be engaging in search. In traditional markets, Sorensen (2000) found empirical evidence that price dispersion could be substantial even in a small local retail market for prescription drugs.

Although price dispersion exists in online markets, empirical studies found that such price dispersion was lower across online retailers as compared to conventional retailers or MCRs. Tang and Xing (2001) found that in online DVD market, the price dispersion is significantly lower among online-only retailers than that among multi-channel retailers. Clay, Krishnan, and Wolff (2001) investigated price dispersion in the online book market. They observed that although some multi-channel retailers set online prices very similar to their Dotcom rivals, others simply charge the same prices as their land-based stores. Thus, there may be a great price difference among multi-channel retailers. They partially attributed the price dispersion to the fact that stores had succeeded in differentiating themselves although they were selling a commodity product.

Brand loyalty may also contribute to the higher prices charged by multi-channel retailers and considerable price dispersion online. Shopping online is conducted at a distance and uncertainties are magnified. Reichheld and Schefter (2000) found that online shoppers are most likely to shop on a Web site that they know and trust. Ward and Lee (2000) examined whether consumers used brands as sources of information when shopping online. They found that recent adopters of the Internet would be less proficient at searching and would rely more on brands. Thus, online shoppers are more likely to buy goods from the online branches of the well-established traditional retailers, even if they charge higher prices. Smith and Brynjolfsson (2001) empirically analyzed online consumer behavior, and found that in the Internet bookselling market, heavily branded retailers hold a significant price

advantage over generic retailers. So far, relevant academic studies on the Internet markets are still few with mixed findings.

3. Data

Our analysis uses panel data collected in the online DVD market. The online DVD market is one of the most successful markets that have migrated online and enjoy considerable growth and sales. The fact that branded DVDs are physically homogeneous makes data collection tractable and price comparison meaningful. Following the store ratings by BizRate.com and DVD Talk Online store listing (www.dvdtalk.com), six top Dotcoms selling a general selection of titles were selected (see Table 3-1). Five top MCRs were selected according to the ratings by BizRate.com and the authoritative ranking in Darnay and Piwowarski (1999) on the conventional stores in the category of record and prerecorded tapes. Together, the market share of these retailers is substantial, insuring that their pricing behavior represents the online DVD market.

Table 3-1. Retailers and Item Shipping Costs (standard shipping within the USA)

	Shipping Rate		Number of Items Per Order							
	Per shipment	Per item	1	2	3	4	5	6	7	8
MCRs										
Borders	3.00	0.95	3.95	2.45	1.95	1.70	1.55	1.45	1.38	1.33
Musicland	1.99	1.00	2.99	2.00	1.67	1.50	1.40	1.33	1.28	1.25
Trans World	2.99	1.00	3.99	2.50	2.00	1.75	1.60	1.50	1.43	1.37
Tower	~	~	2.95	1.98	1.32	1.24	0.99	0.83	0.71	0.62
Djangos	1.00	0.99	1.99	1.49	1.32	1.24	1.19	1.16	1.13	1.12
Dotcoms										
Amazon	1.99	0.99	2.98	1.99	1.65	1.49	1.39	1.32	1.27	1.24
Bigstar	2.09	0.99	3.08	2.04	1.69	1.51	1.41	1.34	1.29	1.25
Buy.com	~	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
DVDempire	0.95	0.35	1.30	0.83	0.67	0.59	0.54	0.51	0.49	0.47
DVDplanet	~	~	2.50	1.50	1.33	1.13	1.00	0.92	0.86	0.81
Express	1.99	0.95	2.94	1.95	1.61	1.45	1.35	1.28	1.23	1.20

Next, a selection of titles for comparison was made. A total of 51 titles were examined.² Half of them (26 titles) were selected as an even mix of the top sellers from Borders and Amazon when the study was initiated while the rest were chosen randomly. The reason for such a combination is that if all the titles were selected from a specific bestseller list such as the Amazon's DVD Top Sellers, the results may be biased as these titles are likely to be loss leaders selected by the respective retailer. However, if all titles were selected randomly, one major trend of pricing behavior might be overlooked because the bestsellers occupy a substantial market share in the DVD market and competition in the bestsellers' segment is crucial for any market structural analysis. The random titles were compiled by randomly selecting pages from an English dictionary and finding a title starting with the words on the page. We refer to the first category of titles as "popular" and the second as "random." Further, during data collection process, we took care to make sure that the version and other features were exactly the same for a given title.

We commenced our data collection on July 5, 2000 and stopped on June 11, 2001. We collected data almost twice a month during the one year period. After removing a few titles that had become unavailable in some stores during the period of the data collection, we obtained 15,708 price observations in total. To ensure the independence of the samples collected, the general price was selected instead of membership price.

Table 3-1 reviews the standard shipping costs by each retailer within the United States. Since the shipping cost structure varies by retailers, we calculated the per item shipping cost based on their shipping cost tariff table for various baskets of typical purchases. Table 3-2 summarizes the mean and median per item shipping costs by the two types of retailer, with the Dotcoms being lower in both measures. But T-test shows that the difference

² Our original goal was 50 titles in total. In order to ensure that all retailers in the test carried each title for each data collection point, we selected 64 titles at the beginning (32 bestsellers and 32 random titles). Our complete data set comprises 51 titles. All data and details of reported statistic test results are available from the authors upon request.

in per item shipping costs by either type of retailer is not significant in any conventional sense. That is, any consumer who shops randomly among these retailers with a random basket of purchase would discover that the difference in per item shipping costs she would pay is insignificant, if not lower, through the Dotcoms. Since one of our basic findings is that the average price is lower by Dotcoms than by MCRs, we may focus our analysis on the posted prices, omitting further consideration of shipping costs.

Table 3-2. Analysis of Per Item Shipping Costs

Per item shipping cost	Mean	Median
Dotcom	1.50	1.39
MCR	1.67	1.44
<i>t</i> -value	0.101	

4. Basic Statistics

4.1. Price Levels

Table 4-1 summarizes the mean prices of our data sample at the most aggregate level. These show that posted prices are lower for Dotcoms than for MCRs by an average of \$1.74 or 7.8 percent. We also calculated the percentage of the posted prices by each retailer for each title at each date relative to the list price of each title. The percentage price is more comparable across titles because it avoids any weighting caused by some DVDs being higher priced than others. Here we see that Dotcoms sampled in our survey offered an average about 25 percent discount, compared to 18.6 percent by the MCRs. This again indicates a lower average price level by Dotcoms. In the rest of this paper, we will use *dollar-price* to reference the posted prices, and *percentage-price* for the percentage of the posted prices relative to the list prices for each title.

Table 4-1. Mean Prices

	MCR	Dotcom
Dollar-Price	\$22.28	\$20.54
Percentage-Price	81.39 %	75.05%
Observations	7140	8568

We also tested whether price discounts differed across the two types of retailers (MCR versus DotCom), given the type of titles (popular versus random), and vice versa. Table 4-2 summarizes the results in percentage prices, which can easily be converted to the results in terms of price discounts. The results show that all the differences are highly significant. Both types of retailers offer higher discounts for the popular titles than the random titles, with the discount difference between popular titles and random titles being higher for MCRs (3.03 percent) than for Dotcoms (1.88 percent). Wilcoxon tests lead to the same conclusions. Both types of titles receive lower discounts from MCRs than from Dotcoms, with the discount difference between the two types of retailers being lower for the popular titles (5.78 percent) than the random titles (6.93 percent). It likely reflects a policy for MCR retailers to approach Dotcom prices more closely for items that are more frequently purchased.

Table 4-2. Mean Percentage Prices

	MCR	Dotcom	<i>t</i> -value
Popular Titles	79.91% (3640)	74.13% (4368)	32.95
Random Titles	82.94% (3500)	76.01% (4200)	39.77
<i>t</i> -value	-15.17	-13.01	

Numbers in parenthesis are the number of observations. The *t*-value is the test statistic for comparing the two categories at the same column or the same row.

For the individual retailers, their mean prices across the period of our study are calculated and summarized in Table 4-3. Wilcoxon test clearly rejects the null hypothesis (at *p*-value of 0.026), in favor of the alternative hypothesis that the individual Dotcom's mean

prices are lower than the MCR ones. All MCRs priced on average more than \$20, while only half of the Dotcoms did so.

Table 4-3. Mean Prices of Individual Retailers

Borders 22.95 (11)	Musicland 21.01 (4)	TransWorld 22.04 (8)	Tower 21.15 (6)	Djangos 24.27 (12)	
Amazon 21.51 (7)	BigStar 22.12 (9)	Buy.com 19.22 (1)	DVDempire 19.90 (3)	DVDplanet 19.50 (2)	Express 20.99 (5)

There are 1428 observations for each retailer. Numbers in parenthesis indicate the rankings in ascending order.

4.2. Price Dispersion

For a given type of retailer at a time point and a fixed title, we can calculate the range and the standard deviation of the prices. We use the average of the price ranges and the average of the price standard deviations to measure the price dispersion. Table 4-4 summarizes the results.

Table 4-4. Price Dispersion

	Dollar Price		Percentage Price	
	MCR	Dotcom	MCR	Dotcom
Average Price Range	5.03	3.95	18.7%	14.5%
Average Price SD	2.05	1.58	7.6%	5.8%

While the dispersion statistics for our data show a substantial variation of prices for both Dotcoms and MCRs across the retailers, the MCR case is much larger. The ranges of dollar-prices across the Dotcoms average about four dollars, compared with five dollars for the MCRs. This corresponds to an average range in percentage price of 14.5 percent for the Dotcoms, compared with 18.7 percent across the MCRs. These results closely resemble the aggregate findings in Tang and Xing (2001). However, such aggregation may conceal crucial features of the market dynamics. It is important to examine the evolution of the Internet

market over time, whether the market would show further pricing convergence or divergence trend among the major online retailers.

4.3. Price Trends

We present a few plots to give a pictorial view on the price and price dispersion movements with time and their behavioral difference with respect to the type of retailers. The prices and standard deviations plotted are the averages and standard deviations of prices of a given retailer type for a given title and time period. Thus, each vertical strip contains 51 dots (51 titles) for the first two plots in Figures 1 and 2, and 102 dots (51 for MCR and 51 for Dotcom) in the last plot in Figures 1 and 2.

From Figure 4.1, we see a clear upward moving trend for the Dotcom prices. It is possible that Dotcoms faced more pressure for profit-making rather than cash-burning after the Nasdaq crash, thus their pricing strategies appeared more rational during this period. Prices of MCRs seem remaining stable. The combined plot for all retailers does not seem to exhibit a clear trend. This also reflects the importance of controlling certain factors while doing price comparisons.

From Figure 4.2, we see price dispersion moving slightly downward with time for the combined data. However, this trend seems resulting from the clear downward movement of price dispersion for the MCRs while the movement for the Dotcoms is in fact upward. This is a very interesting pattern. It seems to indicate the stabilizing sign of pricing strategies among the MCRs, either due to collusive effort or leader-follower signals, while the Dotcoms actually discriminate among themselves even further, contrary to the anticipation of higher competitive pressure among the Dotcoms leading to lower price dispersion. It will be fascinating to track whether such patterns could remain in the future.

(Figure 4.1 here)

(Figure 4.2 here)

5. Prices, Price Trends and Price Dispersion

5.1. The Model

The basic model for a rather comprehensive analysis of our panel data has the following form:

$$y_{it} = \sum_{k=1}^K X_{ik} \beta_k + u_{it}, \quad i = 1, \dots, N; \quad t = 1, \dots, T,$$

where N is the number of cross sections, T is the length of the time series for each cross section, and K is the number of exogenous or independent variables. The specification for the error structure can be quite flexible. It could be one and two-way fixed or random effects models, first-order autoregressive model with contemporaneous correlation in time, or mixed variance-component moving average error process. When the errors are independent and identically distributed normal random variables, the model is just an ordinary regression and hence the ordinary least square (OLS) method is used for estimating the parameters. For other specification of error structures, the generalized least squares (GLS) method is usually used.

For our data set, we have $N=51$ (number of titles) \times 11 (number of stores) = 561 cross sections and $T=28$ time periods. One primary concern in this analysis is whether the MCRs and Dotcoms charge different prices. To serve this purpose, we design a dummy variable, 'Store Type', to represent the retailer type. A regression of the price on 'Store Type' variable along shows that this variable is highly significant ($t = 26.86$), meaning that MCRs do charge higher prices than Dotcoms. This is consistent with the conclusion reached from the results in the previous section. However, one must realize that there can be other factors that affect the prices and if those factors are not controlled, the conclusion above could be misleading.

Obvious factors include the individual store effect, whether a title is one of the top sellers, and the individual title effect. Like the store type, the factors related to the individual stores and top sellers can also be modeled using properly designed dummy variables (See Appendix for the detailed definitions). The individual store effects can be related to the important issue of brand effect. The most important and also most tricky factor is the individual title effect. As there are intrinsic price differences among different DVDs, it is important to control the effect of this factor so that the analysis corresponding to the store type effect could be meaningful. It is ineffective to use dummy variables to quantify this effect as there are so many different DVDs considered. However, each DVD corresponds to a maximum list price (MLP)³ that does not change with stores. Hence the effect of DVD titles is modeled using the MLP variable.

Another important issue related to the analysis of the DVD prices is the price change over time. While the prices for two types of stores are different, are they going to remain different over time? To answer this question, we design two time trend variables: t_M , time trend for the MCRs, and t_D , the time trend for Dotcoms. Since the MCR price is higher than the Dotcom price, the two prices may converge over time if the regression coefficient for t_D is significantly larger than that of t_M .

The last issue is whether we should use the dollar price or the percentage price as the response variable. Percentage price equals the dollar price divided by MLP. A common perception is that one should use percentage prices for comparison to wash out the effect of the base price. However, with the variable MLP entering the model as a controlling variable, it is not critical which should be used as the response variable. In fact, our analysis shows that it is advantageous to use the dollar price from the model fit perspective (higher R^2) when

³ Occasionally, for the same DVD title, several stores exhibit slightly different list prices although list prices are supposed to be the same. For the convenience of our analysis, we take the maximum value. This treatment does not affect our analysis in the following.

the maximum list prices are taken into consideration. Further, if the log price is used as the response variable (as we will do next), the estimated regression coefficients for the store type and individual store dummies remain the same for dollar price or percentage price as the MLP does not vary with stores. Another advantage of using the log price as response is that the regression coefficients can be interpreted as percentage changes (after multiplying 100) with respect to the explanatory variables.

5.2. Estimates of Price Levels

5.2.1. Price Difference between MCR and Dotcom

We are now prepared to address the following question: conditional on the controlling variables, do the prices charged by the MCRs still significantly higher than those of the Dotcoms? Tables 5-1 summarizes the analyses of the log-dollar-prices, based on the OLS procedure. From the results, we see that the 'Store Type' variable is highly significant in all the three models, with *t* statistic values much larger than that of a simple linear regression when 'Store Type' is the sole explanatory variable. This shows that further analysis accounting for the other explanatory variables actually strengthens the results of statistical significance of the 'Store Type' variable. It can be concluded that the average price of the MCRs is indeed significantly higher than that of the Dotcoms. This conclusion does not change whether we use the combined data or separate data of popular-versus-random titles. The combined analysis shows that the average price of MCRs is about 11.2% higher than that of Doccoms. Analysis with popular titles shows that MCRs charge about 7.8% more than Dotcoms on average, whereas analysis with random titles shows that MCRs charge about 14.1% more than Dotcoms on average. Note that the analysis given in Table 4-1 at the most aggregate level shows that MCRs charge only about 7.8 percent higher than Dotcoms. A

large part of the price differentials was "hidden" in the other factors that were not considered. Clearly, it is important to introduce the control variables into the model. The explanation power of the models is quite high, with more than 80% of the price variation explained by only 13 or 14 variables. This shows an adequate model specification.

We have also performed regressions using the log percentage price as the response. As we mentioned earlier, the estimated regression coefficients for dummies remain the same, but the R^2 value drops to 0.4562, 0.4235, 0.5042, respectively for the three analyses.

Table 5-1. Analysis of Log Dollar Prices

Variable	Combined	Parameter Estimate Popular Titles	Random
Titles			
Store Type	0.1767 (44.53)	0.1876 (32.73)	0.1658 (31.97)
Store 1	-0.0603 (-19.18)	-0.0820 (-18.05)	-0.0378 (-9.19)
Store 2	-0.1458 (-46.34)	-0.1727 (-37.99)	-0.1179 (-28.66)
Store 3	-0.0926 (-29.43)	-0.1180 (-25.95)	-0.0662 (-16.11)
Store 4	-0.1424 (-45.26)	-0.1689 (-37.17)	-0.1154 (-28.08)
Store 6	0.0234 (7.44)	0.0263 (5.79)	0.0204 (4.97)
Store 7	0.0537 (17.07)	0.0747 (16.45)	0.0318 (7.74)
Store 8	-0.0883 (-28.06)	-0.0604 (-13.28)	-0.1173 (-28.54)
Store 9	-0.0545 (-17.33)	-0.0241 (-5.30)	-0.0862 (-20.96)
Store 10	-0.0727 (-23.10)	-0.0411 (-9.03)	-0.1056 (-25.67)
t_M	0.0015 (12.25)	0.0023 (12.84)	0.0007 (4.20)
t_D	0.0037 (33.13)	0.0030 (18.71)	0.0044 (30.20)
MLP	0.0391 (259.78)	0.0364 (166.45)	0.0420 (214.03)
PTitle	-0.0297 (-22.13)	--	--
R^2	0.8323	0.8022	0.8726
Obs.	15708	8008	7700

Note: The dependent variable is log dollar price. All variables are defined in Appendix. Values in parentheses are t -values.

5.2.2. Effect of Individual Stores

The store dummies represent to a certain degree of brand effect. The results in Tables 5-1 show that all the store dummies are highly significant. The coefficients of Store 1 to Store 4 dummies are all negative, showing that prices charged by Borders, Musicland, TransWorld and Tower are all significantly lower than that of Djangos, with Borders being about 6.0% lower, Musicland 14.6%, Transworld 9.3% and Tower 14.2%. The coefficients

for the five Dotcoms (Store 6 to Store 10) show that, compared with Express, Amazon charges about 2.3% higher, Bigstar 5.4% higher, Buy.com 8.8% lower, DVDempire 5.5% lower, and DVDplanet 7.3% lower. Amazon seems comfortably enjoying its brand name, consistent with the findings by Goolsbee and Chevalier (2002), while Buy.com clearly took a low-price strategy.

Further analysis can be carried out regarding the price difference between other pairs of stores of the same type. For example, taking the difference between the coefficients of Store 1 and Store 2 dummies, we have $-0.0603 - (-0.1458) = 0.0855$, indicating that Borders charges about 8.6% higher than Musicland (the lowest-pricing MCR). A *t*-test can be easily constructed (from the two individual *t*-tests) for testing the significance of this difference and the result shows that it is highly significant.

The results of Table 5-1 also allow price comparisons between an MCR and a Dotcom, fixing the title and time period. For example, based on the combined analysis, the log price difference between Musicland and Bigstar is $(0.1767 - 0.1458 - 0.0537) = -0.0228$. In other words, Musicland charges about 2.3% lower than Bigstar. Thus, an individual MCR could charge a lower price than an individual Dotcom, though the MCRs charge higher prices than Dotcoms in general. Analysis by separate categories of titles tells the reason why this happens. The same price difference becomes $(0.1876 - 0.1727 - 0.0747) = -0.0598$ from the analysis of popular titles, and $(0.1658 - 0.1179 - 0.0318) = 0.0161$ from the analysis of random titles. That is, Bigstar charges much higher prices for the popular titles (about 6% more) than Musicland, while it charges only about 1.6% less than Musicland for the random titles. In fact, Bigstar charges the highest price among the Dotcoms for the popular titles, with Amazon being the second highest in this score. Bigstar charges popular titles significantly higher than Tower as well (about 5.6% higher), similar to Borders and TransWorld, but significantly lower than Djangos (about 11.3% lower). For the Amazon case in this aspect, it

is about 1% higher than Musicland, about 0.8% higher than Tower but lower than the other MCRs. All the other four Dotcoms charge lower price on popular titles than the MCRs do. Finally, for the random title case, it is clear that all the MCRs charge higher prices than any of the Dotcoms.

5.3. *Estimates of Price Dispersion*

The simplest analysis of price dispersions is to regress price standard deviation on the average price (for the same type retailers at a time point). The results show that the explanatory variable 'Average Price' is highly significant with a t -value of 14.6 and a p -value less than 0.0001. Hence, price dispersion goes up with the price level, which leads to an observation that price dispersion for MCRs is higher than the price dispersion for Dotcoms since the former has a higher price level. This is the simplest conclusion at an aggregated level of analysis. Details of price and price dispersion dynamics may be more complicated as suggested by the plots in Figures 1 and 2: price goes up (or stays the same) with time for both MCRs and Dotcoms, whereas the price dispersion clearly goes down with time for MCRs but up for Dotcomes

Formal analysis of price dispersion has to take into account of other control variables, that is, the variables that also significantly affect the price dispersion. The 'Store Type' variable is used here again to test whether the price dispersion is higher for the MCRs than for the Dotcoms. The other variables include the two time trends t_M and t_D , and the maximum list price MLP. However, the variables 'Average Price' and MPL are very similar (highly correlated), hence only one should appear in the model (a consequence of putting both in the model is that the coefficient of Average Price would have a wrong sign). We have decided to put the MLP in the model. Once again, it is more convenient to carry out the analysis of price dispersion in log scale so that the estimated regression coefficients can be interpreted as

percentage changes or percentage difference. Also, log scale leads to the same estimates of regression coefficients of dummy variables, no matter whether price or percentage price is considered. Results are summarized in Table 5-2.

Table 5-2. Analysis of Log Dollar Price Standard Deviation

Variable	Parameter Estimate		
	Combined	Popular Titles	Random
Store Type	0.7355 (33.67)	0.8397 (30.35)	0.6271 (19.29)
t_M	-0.0255 (-27.41)	-0.0267 (-22.63)	-0.0243 (-17.55)
t_D	0.0085 (9.09)	0.0060 (5.08)	0.0110 (7.97)
MLP	0.0216 (18.12)	0.0217 (14.30)	0.0216 (12.18)
PTitle	-0.0081 (-0.76)	--	--
R^2	0.3756	0.5086	0.2943
Obs.	2856	1456	1400

Note: The dependent variable is log standard deviation in dollar price. All variables are defined in Appendix. t -values are in parentheses.

From Table 5-2, we see that the Store Type variable is highly significant in all the three models with a positive coefficient, showing that the price dispersion is higher for MCRs than for Dotcoms, consistent with our findings in Section 4 and in the earlier simple regression analysis. The variable MLP is also highly significant in all models, indicating the importance of controlling the individual title effect when comparing the price dispersion. The dummy variable PTitle is not significant, hence price dispersions for popular titles and random titles are about the same. The estimated coefficient of Store Type shows that the price dispersion for MCRs is about 74% higher than that of Dotcoms.

5.4. Analysis of Price Convergence

From Table 5-1, one can see that both time trends are significant and positively correlated with the price. This means that the prices go up with time for both MCRs and Dotcoms. However, the prices for the Dotcoms go up much faster than these of MCRs. In particular, the combined analysis shows that the price of Dotcoms goes up about 0.37% per

time period versus about 0.15% for MCRs; the analysis based on the popular titles shows 0.30% versus 0.23%, and the analysis based on random titles gives 0.44% versus 0.07%. This contrast seems especially sharp from the analysis of random titles, which is more than six times in magnitude. As MCRs charge higher prices than Dotcoms on average but the prices of Dotcoms move up with time faster than MCRs, we conclude that prices may converge over time between the two types of retailers. Such convergence speed may be particularly faster in random titles.

From Table 5-2, we note an interesting phenomenon: the signs of the coefficients of the two time trends are opposite, with t_M having a negative coefficient whereas t_D having a positive coefficient, and both are highly significant. This means that the price dispersion goes down with time for MCRs and up for Dotcoms (at a slower rate), consistent with the visual impression from Figure 2. It also reinforces the impression of possible price convergence from the previous analysis on prices.

On the other hand, the opposite signs of the t_M variable in the model of price (Table 5-1) and in the model of dispersion (Table 5-2) seem contradictory to the basic theory: high price and high dispersion, and low price and low dispersion. This is partly due to the colinearity effect between t_M and MLP variables and partly due to the 'irregular behavior' of the popular titles. Without MLP variable, combined analysis of prices gives an insignificant t_M with a positive coefficient, whereas the analysis with random titles gives a negative coefficient for t_M which is only close to being significant, and the analysis with popular titles gives a significant t_M with a positive coefficient. These results, together with the analysis given in Table 5-1, show that the price increase with time for MCRs is mainly due to the price increase in their popular titles.

5.5. Robustness Analysis

The analyses presented above are all based on the log scale. Do our qualitative conclusions remain the same if the analyses are done using different scale of data? Besides, the analyses presented above did not take into account of a possible serial correlation between the time periods. Given the high explanation power of the model, particularly for the analysis of price levels, the effect of serial correlation may not be significant as far as the qualitative conclusions are concerned. Nevertheless, it is important to check the robustness of our qualitative conclusions against error specifications.

First, we have repeated the analysis presented in Tables 5-1 and 5-2 based on the original dollar prices. The results (omitted for brevity) lead to the same qualitative conclusions with respect to price levels, price dispersions, and price convergence.

Second, we have considered different error specifications to address the issues of random effects, serial correlations and so forth. We have fitted models with a one-way random effect for time series, models with two-way random effects for both time series and cross-sections, and models with a moving average for time series, and so on. All the results lead to similar estimates of regression coefficients and similar qualitative conclusions. Thus, our results are quite robust with respect to model specifications and error specifications.

6. Conclusion

This study tracked the online DVD market for about one year on its price movement. We found that the online branches of multi-channel retailers still price significantly higher than their online-only counterparts, on average, consistent with the findings in Tang and Xing (2001). The other pattern identified in Tang and Xing (2001) that price dispersion is sharply lower for the pure Internet retailers than the online branches of the multi-channel retailers is also exhibited here. However, through applying more advanced statistic techniques on a

much longer-sequence data, this study finds that although the estimated price dispersion for MCRs is about 74% higher than that of Dotcoms, the price dispersion goes down with time for MCRs and up for Dotcoms (at a slower rate). As for the DVD titles, price dispersions for popular category and for random category are about the same. Furthermore, trend analysis clearly shows that the prices themselves go up with time for both MCRs and Dotcoms, with the Dotcom prices going up much faster. This is the first observation and documented evidence of possible price convergence in this market, as we know.

The significance of such a finding is obvious. It has been long argued that online markets should be competitive since it possesses all the good virtues of something close to a perfectly competitive market, namely, low search cost, easy access to market information, low transaction cost, low entry barrier, and so on. However, studies so far have produced only mixed results and most of them have concentrated to compare online pricing efficiency with offline pricing efficiency. Our methodology of market price evaluation to online retailer formats directly addresses the fundamental question whether the online markets would evolve close to the perfectly competitive market as economic theory would predict. It seems that the online DVD market is indeed moving towards such a direction, although significant pricing differentials still exist. Frictions in the conventional markets may move to the online markets in some way as Shapiro and Varian (1999) argued, however, our findings seem indicating that the online markets may still eventually evolve into some status much closer to the perfectly competitive market status than most conventional markets, due to the intense competition pressure online. It may not be as perfect as many early optimists in Business Week or the Economist advocated, because the channel coordination problem that any multi-channel retailer has to face may diminish some pricing efficiency of the Web – which also gives the Dotcoms a badly needed breath. Nevertheless, the overall pricing trend may still move to convergence. It remains a fascinating question whether such convergence would end

up at the marginal cost level as Bertrand model would predict. Our speculation is not. Most probably the online market price level would be somehow above the marginal cost level, since again the channel coordination issue facing any multi-channel retailer would add some frictions, and certain market power enjoyed by large online retailers such as Amazon seems unavoidable. It will be important to continue assessing the online market dynamics in different product categories.

References

- Bakos, Y. (1997). Reducing Buyer Search Costs: Implications for Electronic Marketplaces. *Management Science* 43 (December): 1676-92.
- Brynjolfsson, E. and Smith, M.D. (2000). Frictionless commerce? A Comparison of Internet and Conventional Retailers, *Management Science*, 46 (April): 563-85.
- Clay, K.; Krishnan, R.; and Wolff, E. (2001). Prices and Price Dispersion on the Web: Evidence from the Online Book Industry. *Journal of Industrial Economics*, 49(4): 521-40.
- Clemons, E. K.; Hann, I.-H.; and Hitt, L. M. (2002). Price Dispersion and Differentiation in Online Travel: An Empirical Investigation. *Management Science*, 48 4(April): 534-549.
- Darnay, A.J., and Piwowarski, J. (1999). *Wholesale and retail trade USA: industry analyses, statistics, and leading companies*, (eds) Detroit: Gale. Second edition.
- Goolsbee, Austan, and Chevalier, Judith (2002). Measuring Prices and Price Competition Online: Amazon and Barnes and Noble, Yale ICF Working Paper No. 02-23, June 2002.
- Morton, F.S.; Zettelmeyer, F.; and Silva-Risso, J. (2001), Internet Car Retailing, *Journal of Industrial Economics*, 49(4): 501-20.
- Nelson, P. (1970). Information and Consumer Behavior, *Journal of Political Economy*, 78(2): 311-29.

- Pratt, J.W., Wise, D.A., and Zeckhauser, R. (1979). Price Differences in Almost Competitive Markets, *The Quarterly Journal of Economics*, 93(2): 189-211.
- Reichheld, F.F., and Schefter, P. (2000). E-Loyalty: Your Secret Weapon on the Web, *Harvard Business Review*, July-August 2000: 105-113.
- Salop, Steven C. (1979). Monopolistic Competition with Outside Goods. *Bell Journal of Economics*, 10 (1), 141-156.
- Shapiro, Carl, and Varian, Hal R. (1999). *Information Rules: A Strategic Guide to the Network Economy*, Boston, Mass.:Harvard Business School Press.
- Smith, M. D., and Brynjolfsson, E. (2001). Consumer Decision-Making at an Internet Shopspot: Brand Still Matters, *Journal of Industrial Economics*, 49(4): 541-558.
- Sorensen, A.T. (2000). Equilibrium Price Dispersion in Retail Market for Prescription Drugs. *Journal of Political Economy*, 108(4): 833-850.
- Stigler, G. (1961). The Economics of Information, *Journal of Political Economy*, 69(3): 213-225.
- Tang, F.-F. and Xing, X (2001). Will the Growth of Multi-Channel Retailing Diminish the Pricing Efficiency of the Web? *Journal of Retailing*, 77: 319-333.
- Ward, M. and Lee M. (2000). Internet Shopping, Consumer Search and Product Branding. *Journal of Product and Brand Management* 9(1): 6-18.

Appendix

Definition of the Variables:

Price: the price of DVD.

Store Type: a dummy variable for retailer type, taking value 1 if the retailer involved is an MCR and 0 otherwise.

Store 1: a dummy variable for the retailer: Borders. It takes value 1 if the retailer involved is Borders, 0 otherwise.

Store 2: a dummy variable for Musicland

Store 3: a dummy variable for TransWorld

Store 4: a dummy variable for Tower

Store 6: a dummy variable for Amazon

Store 7: a dummy variable for BigStar

Store 8: a dummy variable for Buy.com

Store 9: a dummy variable for DVDempire

Store 10: a dummy variable for DVDplanet

t_M : time trend for MCR retailers

t_D : time trend for Dotcom retailers

MLP: maximum list price

PTitle: a dummy variable for the popular titles, assuming value 1 if the DVD is a popular title, 0 otherwise.

Note: as a 'Store Type' dummy is specified, only four dummies are allowed for the five MCRs and five dummies for the six Dotcoms. When the four MCR dummies all assume value of zero, the analysis corresponds to the 5th MCR. Likewise, when the five DotCom dummies are zero, it corresponds to the 6th DotCom.

Figure 4.1. Plots of Dollar Prices

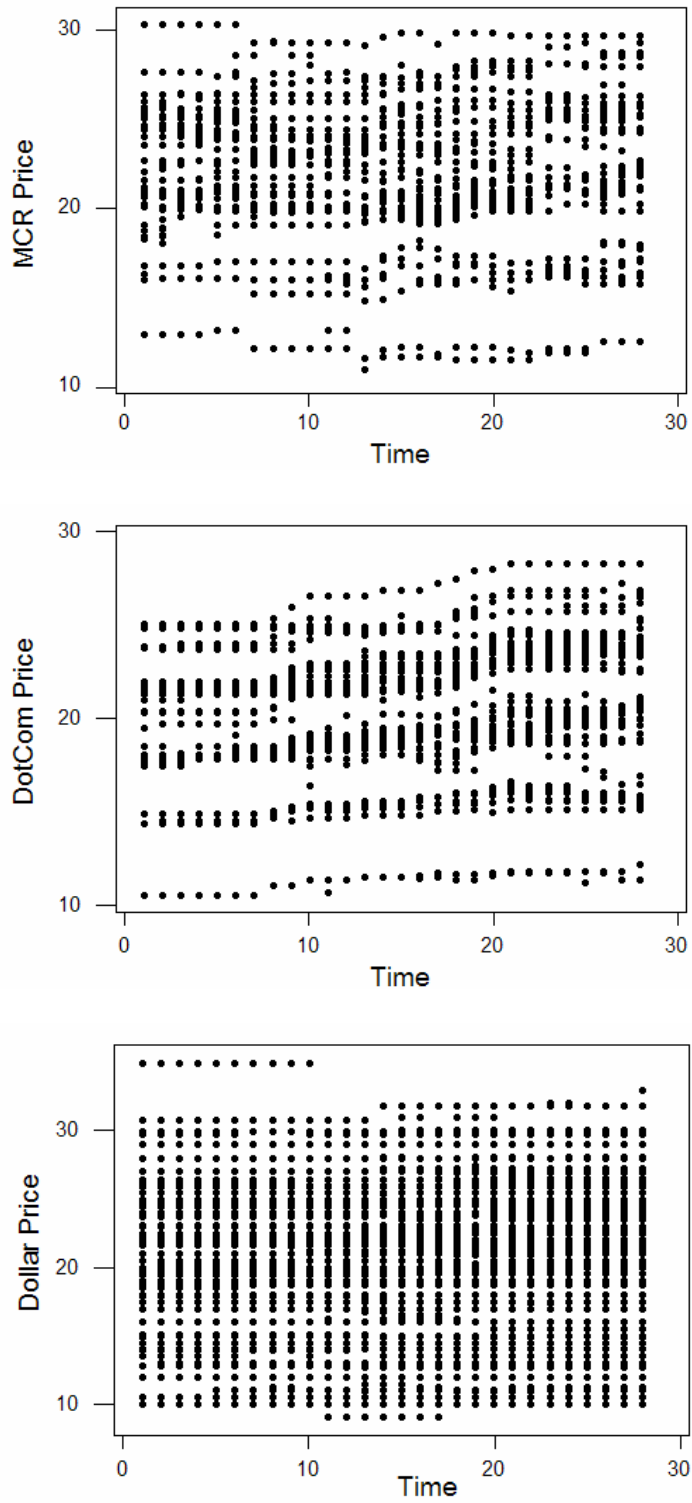


Figure 4.2. Plots of SDs in Dollar Prices

