Technology Shocks in Multi-Sided Markets:
The Impact of Craigslist on Local Newspapers[*]

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Abstract

We investigate the impact of Craigslist, a website providing classified-advertising services, on local newspapers' pricing strategies. We exploit temporal and geographical variation in Craigslist's entry to show that newspapers with greater reliance on classified-ad revenue experience a larger drop in classified-ad rates after Craigslist's entry. The impact of Craigslist's entry propagates to the subscriber and display-ad sides of these newspapers: These newspapers experience an increase in subscription prices, a decrease in circulation shares, and a decrease in display-ad rates. These findings are consistent with a model that treats the newspaper industry as a three-sided market. We also find evidence that these newspapers are less likely to make their content available online as a result of Craigslist's entry. Finally, we estimate that Craigslist's entry results in $7.7 billion in savings to classified-ad buyers during 2000-2007.

1. Introduction

The fate of traditional media, such as radio, TV, and newspapers, has received much attention since the advent of the Internet (e.g., Athey et al. 2010). On one hand, the number of voices warning of traditional media's demise has increased over the years, given the growing popularity of online media. On the other hand, traditional media have in the past survived shocks from, and learned to coexist with, new technologies. For instance, the newspaper industry successfully responded to shocks from new technologies such as radio in the 1920s and TV in the 1950s (e.g., Jackaway 1995; George 2008). Quantifying the Internet's impact on traditional media is difficult for several reasons. First, the Internet's diffusion is likely to be correlated with many macro trends (e.g., Forman, Goldfarb and Greenstein forthcoming) that also affect demand for traditional media. Second, traditional media such as newspapers serve both consumers and advertisers, and products or services available on the Internet may affect these sides of the market in different ways. For example, social media, such as blogs and video-sharing sites, draw consumers away from traditional media and the low costs of online advertising reduces the attractiveness of traditional media to advertisers. It is therefore difficult to link responses by traditional media firms to the diverse mechanisms through which the Internet affects traditional media.

In this study, we take advantage of the temporal and geographical variation in entry by Craigslist, a website providing classified-ad services, to examine its impact on local US newspapers. We consider the expansion of Craigslist to be a technology shock to the newspaper industry as its emergence as a disruptive competitor to newspapers' classified-ad business is enabled by advances in the Internet technology. Craigslist offers classified ads for free in most cases.[1] In addition, ads on Craigslist are easy to search and are updated in real time, unlike a newspaper. We therefore expect Craigslist's entry to significantly reduce newspapers' attractiveness to classified-ad buyers.

We first identify local newspapers for which classified ads are likely to be a significant fraction of their revenue by whether or not they have a classified-ad manager. For newspapers without classified-ad managers, classified-ad revenue is likely not their major source of revenue. Even if Craigslist enters their markets, these newspapers are less likely to respond.[2] Hence, we consider newspapers that have classified-ad managers and are located in markets where Craigslist eventually enters as 'affected' newspapers. We consider all other newspapers, i.e., those newspapers that do not have classified-ad managers or are not located in markets where Craigslist eventually enters, as 'control' newspapers. We adopt a difference-in-differences approach that compares these affected newspapers before and after Craigslist's entry to these control newspapers. Following Craigslist's entry, we show that these affected newspapers drop their classified-ad rates more than control newspapers. This finding complements a finding in Kroft and Pope (2008) who show that Craigslist caused a reduction in the Conference Board's Help-Wanted Index, a measure of job classifieds in 51 major print newspapers.

Newspapers are platforms that link together three different groups: subscribers, classified-ad buyers, and display-ad buyers.[3] We therefore next examine how the impact of Craigslist's entry on the classified-ad side propagates to the other two sides of the market. We find that, following Craigslist's entry, affected newspapers *increase* subscription prices relative to control newspapers. This finding is in sharp contrast to those in many one-sided markets, where competition typically leads to a *decrease* in prices. As a result of this increase in subscription price, circulations of affected newspapers decrease. Because of the decrease in circulations, we find that display-ad rates of affected newspapers decrease as well. This result is consistent with the explanation that the display-ad buyers now reach fewer eyeballs for each ad they place in these newspapers and their willingness to pay decreases. Additional analysis reveals

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[1] Craigslist charges for job listings in a small number of cities, and for apartment listings in New York City. Source: http://www.craigslist.org/about/factsheet, accessed May 2011.

[2] Our empirical analysis serves as a test for this assumption. We find that indeed these newspapers without classified-ad managers are much less likely to respond to Craigslist's entry.

[3] Businesses use display ads, which often contain graphics or other artwork, to promote their products and services; such ads are displayed alongside regular editorial content. In contrast, classified ads typically have no pictures or other graphics. They are grouped entirely in a distinct section. In the classified-ads section, ads are usually grouped under headings classifying the products or services, such as Automobiles, For Sale, and For Rent.

that the effect of Craigslist entry affects the classified-ads side of the market first, before eventually affecting the display-ad side of the market. We also develop a simple analytical model that treats the newspaper industry as a three-sided market to illustrate how the impact of entry by an online competitor on the classified-ad side propagates to the subscriber and display-ad sides.

We provide two extensions to our main findings. First, we explore the extent to which Craigslist's entry affects newspapers' likelihood of offering their content online. While offering content online allows newspapers to retain their readers and generate additional revenue from selling ads online, it cannibalizes newspapers' offline business. This move is particularly unattractive for newspapers that try to generate more revenue from print subscriptions. Consistent with this intuition, we find that these affected newspapers are less likely to make their content available online. As a second extension, we gather additional data on the quantities for newspaper classified ads for a subset of newspapers in our sample. Using this dataset, we estimate that Craigslist's entry leads to a total saving of $7.7 billion to classified-ad buyers during 2000-2007.

1.1. Related Literature

Our study contributes to several streams of research. First, we add to a nascent stream of research on multi-sided markets (e.g., Caillaud and Jullien 2003; Rochet and Tirole 2003; Parker and Van Alstyne 2005; Armstrong 2006; Hagiu 2006; Weyl 2010). Most of this literature focuses on markets with two sides.[4] One fundamental theoretical finding from the two-sided market setting is that as a result of cross-side network effects, a platform's price choices on the two sides are linked to each other, and it is often profit maximizing for a platform to undercut its price below cost on one side of the market to attract more consumers on that side, thereby increasing the willingness of pay of consumers on the other side, and make more money from the other side. The relative price elasticity on each side determines which side is subsidized. The interdependence of price choices on the two sides suggests that changes in market conditions (e.g., competition intensity) of one side of the market will affect not only the platform's price choice on that side but also its price choice on the other side.

Consistent with this intuition, a few theoretical studies show that an increase in competition on one side of a two-sided market can lead to an increase in price on the other side (Godes et al. 2009; Hagiu 2009). Anecdotal evidence also supports this theoretical finding. Most newspaper websites in the 1990s, for example, offered their content for free and financed themselves exclusively by advertising revenues. As the number of online content sites increased, thereby increasing competition on the advertising side of

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[4] Much of this literature studies competition between platforms (e.g., Casadesus-Masanell and Ghemawat 2006; Economides and Katsamaks 2006), the platform provider's decision about how much to open its platform to create a platform ecosystem (Boudreau and Lakhani 2009; Boudreau 2010; Boudreau forthcoming; Ceccagnoli et al. 2012; Huang et al. 2011) and platform providers' optimal choices of business models (e.g., Chen, Fan and Li 2011).

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the market, many newspaper websites, such as the websites of the *New York Times* and the *Los Angeles Times*, have switched to subscription-based business models (Casadesus-Masanell and Zhu 2010).[5] The websites choose to increase prices on the reader side because competition for advertisers reduces the return per reader from the ad market, making them less willing to underprice content to increase readership.

A number of empirical studies have examined platforms' pricing decisions in two-sided markets. For example, Kaiser and Wright (2006) and Song (2011) show that in the magazine industry, prices for readers are subsidized and magazines make most of their money from advertisers. Argentesi and Filistrucchi (2007) find a similar pattern in the Italian newspaper industry. In the case of the TV industry, Wilbur (2008) finds that the price elasticity of advertising demand in the TV industry is substantially more elastic than 30 years ago, and Goettler (2012) finds that advertising prices depend on audience composition. Bolt and Tieman (2005) find that the observed pattern of debit card pricing in the Netherlands is consistent with the assumption that retailers are much less price elastic in their demand for debit card services than consumers. In general, these studies find support for the skewed pricing structures on different sides of a two-sided market.

On the other hand, few empirical studies except Jin and Rysman (2012) provide direct tests of how changes in competition on one side of the market affects platform pricing on other sides.[6] Jin and Rysman (2012) study sportcards conventions and show that prices to consumers drop but prices to dealers may increase as competition between platforms (the conventions) increases. The direction of price changes hinges on the relative intensity of competition on each side of the market. Jin and Rysman use variation in geographic distance between conventions to infer an asymmetric degree of competition for consumers and dealers.

Our empirical setting differs in several aspects. First, Craigslist's entry directly affects only one side of the newspaper's market because Craigslist provides classified ads and not editorial content. Hence our empirical analysis provides a sharp test of how increased competition on one side of the market affects other sides. Second, our study employs a difference-in-differences research design that uses panel data on newspapers together with Craigslist's temporal and geographical entry patterns. This research design helps rule out multiple alternative explanations. Third, anecdotal evidence suggests that

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[5] For other examples, see http://paidcontent.org/article/419-taking-the-plunge-how-newspaper-sites-that-charge-are-faring/, accessed August 2011, for a partial list of newspaper sites charging fees to readers.

[6] Much of the empirical literature on multi-sided markets focuses on quantifying indirect network effects in these markets (e.g., Nair et al. 2004; Kaiser and Song 2009; Wilbur 2008), evaluating exclusive contracting between platforms and application developers (e.g., Corts and Lederman 2009), and examining conditions under which tipping occurs (e.g., Cantillon and Yin 2008). Chandra and Collard-Wexler (2009) study changes to subscription prices following newspaper mergers. Their analysis focuses on changes in competition between platforms, rather than changes in competition on one side of a platform's market.

Craigslist's entry is exogenous with respect to newspaper responses. As we describe below, the founder and CEO of Craigslist do not appear to maximize profits. Moreover, our own empirical analyses show that Craigslist's entry depends on certain demographics in a market, but not characteristics of its incumbent newspapers. Finally, while much of the literature focuses on two-sided markets, many platforms often serve markets with more than two sides. Our paper is the first empirical paper that examines a market with more than two sides and investigates platform responses in all three sides. Our analysis shows that the direction of price change in a three-sided market depends on the interdependency across different sides. In our setting, the display-ad side does not interact directly with the classified-ad side; they are linked to each other through the subscriber side. Display-ad rates drop as an *indirect* result of increased competition on the classified-ad side.

Our study contributes to a second stream of literature that examines how the Internet affects firms and consumers in offline settings. At a broad level, a number of studies have argued that online intermediaries reduce buyer search costs, thereby improving the efficient matching of buyers and sellers (e.g., Bakos 1997; Kroft and Pope 2008). Studies in a variety of contexts have examined whether online and offline channels substitute or complement each other (e.g., Zentner 2005; Kaiser 2006; Gentzkow 2007; Simon and Kadiyali 2007; Forman, Ghose, and Goldfarb 2009; Danaher et al. 2010; Choi and Bell 2011; Goldfarb and Tucker 2011a, 2011b; Liebowitz and Zentner forthcoming). Studies have also shown that the reduction of search cost owing to the advent of online channels may reallocate market shares from high- to low-cost producers (Goldmanis et al. 2010). Our study complements these studies by examining how the diffusion of the Internet affects newspapers' pricing decisions. Our finding that Craigslist leads to a significant reduction in newspapers' classified-ad rates suggests that Craigslist acts as a substitute for newspapers' classified services, and we calculate a lower bound for the savings gained by classified-ad buyers that switch to this substitute. In addition, we provide evidence that affected newspapers are less likely to make their content available online as a result of Craigslist's entry, suggesting that the impact of the Internet on offline firms goes beyond product pricing or sales.

The rest of the article is organized as follows. Section 2 describes our empirical setting. Section 3 describes our data. Section 4 presents our empirical results and robustness checks. Section 5 presents a simple model of a three-sided market that illustrates how the impact of Craigslist's entry in the classified-ad side of the newspaper market propagates to the subscriber and display-ad sides. Section 6 presents extensions to our main findings. We conclude in Section 7.

2. Empirical Setting

A key empirical challenge in examining the interdependence of platform strategies across different sides of its market is the identification of causal relationship: as different sides of the market are inter-linked, it

is difficult to identify the magnitude of effect in each direction. In addition, changes in competitive intensity in the market are endogenous in most cases (for example, the entry of a new platform could depend on its expectation of future market outcomes). We therefore need to rely on some shocks that exogenously change competition intensity on one side of the market to estimate the causal effect across different sides of the market.

To address these issues, we study the local US newspaper industry during 1997–2007. There are several features of this industry which make it an appealing empirical setting. First, the circulation for most local newspapers has limited geographic reach effectively segmenting the US into hundreds of non-overlapping geographic markets which is useful from a research design point of view. Second, we are able to collect price data on all three sides of the newspaper market. One of the empirical challenges associated with studying multi-sided markets is collecting price data on all sides of the market. For example, video games are a canonical example of a two-sided market, but researchers do not observe the contractual agreements on royalty rates between console providers and game publishers.

Historically, revenues from classified ads accounted for 40% of a newspaper's total revenues on average (Vogel 2011).[7] However, during the time period studied, the industry experienced a severe shock to its business model due to the rapid entry of Craigslist, a website specializing in online classified listings. As of 2010, Craigslist serves over twenty billion page views per month, and is the 7th most-visited web site in the United States.[8] With over fifty million new classified advertisements each month,[9] as well as about sixty million unique visitors in the US each month,[10] Craigslist is the leading classified-ad service in any medium. Craigslist began its service in 1995 as an email distribution list of friends in the San Francisco Bay Area, before becoming a web-based service in 1996. Craigslist expanded into eight more US markets in 2000, four in 2001 and 2002 each, twelve in 2003, and many more markets in recent years.[11] As of 2010, Craigslist is available for more than 700 local markets in 70 countries.[12]

The expansion of Craigslist into a newspaper's local market has the potential to be incredibly disruptive, leading to an almost immediate drop in a large portion of classified-ad revenue. Indeed, Craigslist has been criticized for stealing a massive chunk of the classified market from established local newspapers and is frequently referred as a "newspaper killer."[13] Craigslist's entry into different markets has had other effects. For example, Chan and Ghose (2011) show that Craigslist's entry into a market is

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[7] See also: Swarts, Will. "Craigslist: Stopping the Presses?" at *Smart Money*, September 7, 2005. Source: http://sm.wsj.com/PuBTWy, accessed July 2011.

[8] http://www.alexa.com/siteinfo/craigslist.org, accessed July 2010.

[9] http://www. craigslist.org/about/factsheet, accessed July 2010.

[10] http://siteanalytics.compete.com/craigslist.org/, accessed July 2010.

[11] http://www.craigslist.org/about/expansion, accessed July 2010.

[12] http://www.craigslist.org/about/factsheet, accessed July 2010.

[13] See, for example, http://bit.ly/LzcNFZ, http://bit.ly/RSl6e, http://bit.ly/L1La1Q, and http://onforb.es/rQ3XS, accessed July 2011.

associated with an increase in sexually transmitted diseases in that market and Kroft and Pope (2008) show that Craigslist's entry into a market is associated with a reduction in real estate vacancy rates.

Craigslist provides only classified-ad listings, not editorial content or display ads. We therefore operate under the assumption that the main effect of Craigslist entry is on the classified-ad side of the newspaper's market, and that any effects on the subscriber or display-ad side are secondary effects. As such, the empirical setting closely matches the conditions described in theoretical work that studies how an increase in competition on one side of the market may affect price choices on other sides.

The temporal and geographical variation in Craigslist's expansion into different markets allows us to establish a causal relationship and rule out alternative explanations. For example, websites such as eBay.com, an online auction site, and monster.com, a job-listing website, also attract classified advertisers away from newspapers, and content sites, such as blogs and Google news, attract newspaper readers away from newspapers. Unlike Craigslist, these sites contemporaneously serve consumers in all regions in the US. In our setting, temporal and geographical variation in entry allow us to use year dummies interacted with newspaper types to control for the overall effects these types of websites have on newspapers as well as the disproportionate effects these websites have on different types of newspapers.

Finally, Craigslist's product is similar across markets in a given year, making it easy to compare entry events. The Craigslist webpage for Boston in February 2003, for example, is nearly identical to that for Chicago in February 2003.[14] One noticeable difference across these web pages is the number of posts in each category, perhaps indicating heterogeneity in Craigslist's diffusion across markets. In the results section below we show that our findings are robust to controlling for these cross-market differences.

3. Data and Summary Statistics

We collect data from several sources. Table 1 reports summary statistics of all variables constructed. Information on the date of Craigslist's entry into different markets is from Craigslist. During the time period we study, Craigslist enters 308 markets.[15] Using this information, we create a dummy variable *craigslist entry$_{it}$* that equals one for all years after Craigslist enters newspaper *i*'s local market, and zero otherwise. We define the relevant market to be the county in which the newspaper is based, an approach consistent with other research in this area (e.g., Gentzkow and Shapiro 2010) and consistent with Craigslist's product offerings, which sometimes vary by county or by state region.[16] For example, Craigslist has separate pages for La Salle County, Illinois; Fairfield County, Connecticut; Western

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[14] Historical screen shots of Craigslist are available via internetarchive.org. For examples, see historical Boston and Chicago sites: http://web.archive.org/web/20030129082927/boston.craigslist.org/ and http://web.archive.org/web/20030205062029/http://chicago.craigslist.org/, accessed June 2012.

[15] The company lists the dates and locations of its expansion here: http://www. craigslist.org/about/expansion.

[16] The relevant newspaper market has been alternately defined at other levels including the zip code (Chandra, 2009) and metropolitan statistical area (George and Waldfogel, 2006).

Maryland; and Eastern North Carolina, to name a few. Information on classified-ad rates is from the *SRDS Newspaper Advertising Source* (SRDS) for years 1999-2006. SRDS has been used in other media studies (e.g., Ekelund et al. 2000).

Information on each newspaper's yearly circulation, subscription price, display-ad rate, year founded, political leaning, and editor or ad-manager type is from *Editor & Publisher International Yearbooks* (E&P) for years 1997, 1998, 2000, 2002, 2003, 2004, 2005 and 2007. The yearbooks contain data on virtually every newspaper in the US, and have been used extensively for newspaper studies (e.g., George and Waldfogel 2006; Chandra 2009; Gentzkow and Shapiro 2010). Such data are also used by the US census to compile summary statistics for the annual *Statistical Abstract of the United States.* We focus on newspapers that have a predominantly local focus and therefore exclude large national papers including the *Wall Street Journal*, *New York Times* and *USA Today* from all our analyses.

We construct the variable *classified*$_{it}$ from a field that lists positions in the advertising-sales management team. If one or more positions include the word "classified," we code *classified*$_{it}$ as one; otherwise we code it as zero.[17] We use this variable to indicate those newspapers that rely heavily on classified ads, and hence we expect those newspapers to be significantly affected by Craigslist's entry. 34% of newspapers have a classified-ad manager. The dummy variable *independent*$_i$ equals one if the newspaper's self-declared political affiliation in 2005 is independent, and zero otherwise.[18] Similar to Goh et al. (2011), we find that although many newspapers exhibit political leaning, 92% of newspapers declare themselves to be "independent." The continuous variable *newspaper age*$_{it}$ is the difference between the year in the sample and the year the newspaper was founded. We also categorize each content editor's title into one of the following types: art, business, entertainment, home, local, national, opinion, special, sports, and technology. To measure newspapers' content variety, we construct a variable *total positions*$_{it}$, which is the total number of editor types at a newspaper. We also construct a dummy variable, *online editor*$_{it}$, which indicates whether newspaper i has an editor for online content in year t. About 20% of newspapers have an online editor. Finally, we construct a dummy variable, *mis manager*$_{it}$, which indicates whether newspaper i has a Management Information Systems (MIS) manager position in year t. 56% of newspapers have an MIS manager in our sample.

We collect demographic data on *age*$_i$, *population*$_i$, *pct college degree*$_i$, *per capita income*$_i$ and *pct renters*$_i$ at the county level for the year 2000 from the US Census Bureau.[19] Following George and Waldfogel (2006), we use the population data as a denominator to transform the circulation variable into

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[17] Examples of other position titles include: Advertising Department Manager, Advertising Sales Director, Retail Sales Manager, Advertising Coordinator for Special Sections, and Advertising Manager for Major Accounts.

[18] We construct this variable using data from 2005 only. There is no evidence that a newspaper's political leaning changes over our time period.

[19] Available for download from the US Census Bureau at http://factfinder.census.gov, last accessed May 2011.

circulation share, and use it as one of our dependent variables. We also collect information on the number of high-speed internet service providers (ISPs) at the zip code for 2000-2007 from the Federal Communications Commission (FCC).[20] This information is then averaged across all zip codes in the county. The population data are used as a denominator to transform the number of ISPs in the county into the variable *average ISPs$_{it}$*. Wallsten and Mallahan (2010) show that the number of ISPs in a market is positively correlated with broadband quality and negatively correlated with broadband price. Hence, this variable is included to control for diffusion of the Internet within the relevant market, which may affect newspapers' strategies.

We use internetarchive.org to access historical pages of Craigslist for each year for all of the markets in our sample, and from these pages we gather counts of the number of posts in each category. For example, in Boston on February 7, 2003 under the category "sale/wanted," there were 2,725 posts listed under "general for sale" and 730 posts listed under "items wanted."[21]These category counts are then aggregated up to the market level to create a variable *number of posts$_{it}$*, which we use in the robustness checks described below. Over the years, Craigslist has added new categories, such as personals. To ensure that we can compare the number of posts on Craigslist in different years, we only aggregate counts in four categories (community, housing, jobs, and sales/wanted) that Craigslist has had since its inception. When internetarchive.org archives the same Web page multiple times in a single year, we take the average of these counts in each year.

We also provide split sample statistics based on whether Craigslist enters the newspaper's market or not in Table 1. T-tests reveal differences for most of the variables across the split samples. These results suggest that it is important to control for newspaper fixed-effects in our analysis so that we can focus on the change in these variables. We also undertake a number of robustness tests to ensure that our results are not driven by observable or unobservable differences across these samples.

Table 2 provides additional summary statistics for classified-ad rates, subscription prices, circulation shares, and display-ad rates before and after Craigslist's entry, broken out separately for newspapers with and without a classified-ad manager. There is substantial variation across newspapers for each of these four measures (see Table 1), which is addressed using newspaper fixed effects in the econometric models discussed below. To address this heterogeneity in Table 2, before computing their averages, we standardize these measures (to measures with mean 0 and standard deviation 1) for each newspaper. We compute the summary statistics for newspapers with and without a classified-ad manager in the year of Craigslist's entry separately. We find that classified-ad rates, subscription prices, and display-ad rates increase for newspapers over time, but that circulation shares decrease over time. We also

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[20] Available for download from the FCC at http://www.fcc.gov/wcb/iatd/comp.html, last accessed May 2011.

[21] http://web.archive.org/web/20030129082927/boston.craigslist.org/, last accessed June 2012

compute the changes for newspapers before and after Craigslist's entry and compare newspapers with classified-ad managers in Craigslist's entry year to those without. We find that those newspapers that are more likely to be affected by Craigslist's entry have greater decreases in classified-ad rates, circulation shares, and display-ad rates, as well as greater increases in subscription prices. One-tailed t-tests show that the differences are significant for all measures except for display-ad rates.

4. Empirical Results

4.1 Main Results

Our empirical design relies on a difference-in-differences approach that compares classified-ad rates after Craigslist's entry to rates before Craigslist's entry for affected and control newspapers. The specification is of the following form:

$$(1)\ \textit{classified-ad rate}_{it} = \beta_0 + \beta_1 \textit{craigslist entry}_{it} + \beta_2 \textit{craigslist entry}_{it} * \textit{classified}_{it} + \beta_3 \textit{classified}_{it} + X_{it}B +$$
$$\gamma_i + \eta_t + \varepsilon_{it},$$

where X_{it} is a vector of other market control variables, γ_i is a newspaper fixed effect, and η_t is a year fixed effect. Inclusion of the newspaper fixed effect controls for any fixed differences across newspapers, and the year dummies control for common macroeconomic shocks that affect all newspapers. Some macroeconomic shocks (e.g., the diffusion of monster.com, a job-listing website) may differentially affect newspapers with different degrees of reliance on classified-ad business. We therefore include interactions between $\textit{classified}_{it}$ and year dummies in X_{it}. These interaction variables also help control for any pre-existing trends. We also include a count of the number of Internet service providers in the market, $\textit{average ISPs}_{it}$, in X_{it} to address changes in the relative ease of Internet access, which might affect a local newspaper's classified-ad business. We cluster the error terms at the level of the newspaper to account for autocorrelation in the data within newspapers and over time (Bertrand et al. 2004).

Models 1-2 of Table 3 report regression results. All models include newspaper and year fixed effects. Model 1 replicates equation (1). Model 2 replicates Model 1 and includes $\textit{average ISPs}_{it}$; there are fewer observations because $\textit{average ISPs}_{it}$ is only available after 1999.[22] The coefficients on $\textit{craigslist entry}_{it} * \textit{classified}_{it}$ are negative and significant in both models. The results across models are similar;

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[22] As our data on classified-ad rates are from 1999-2006 and we miss data on classified-ad managers in 2001 and 2006, the years used in the regression are 1999, 2000, 2002, 2003, 2004 and 2005 when average number of ISPs are not included as a control, and 2000, 2002, 2003, 2004 and 2005 when average number of ISPs are included as a control. Similarly, when subscription prices, circulation shares, and display-ad rates are dependent variables, the years used in the analysis are 1997, 1998, 2000, 2002, 2003, 2004, 2005 and 2007 when average number of ISPs are not included as a control, and 2000, 2002, 2003, 2004, 2005 and 2007 when average number of ISPs are included as a control.

namely, newspapers with classified-ad managers are, on average, more likely to lower classified-ad rates (by about 20.7% based on Model 2) following entry by Craigslist.

We next investigate how the effect of Craigslist's entry propagates to the subscriber side and the display-ad side. This is accomplished by replacing classified-ad rate as the dependent variable in equation (1) with: newspaper's subscription prices, circulation shares, and display-ad rates. We replicate Models 1 and 2 (i.e., with and without *average ISPs$_{it}$*, respectively) for each of these dependent variables. We find that the coefficient on *classified$_{it}$*craigslist entry$_{it}$* is significant in all cases except Model 7, suggesting that Craigslist's entry into the newspaper's classified-ad side does influence the newspaper's subscriber side and display-ad side. In particular, we find that subscription prices of the affected newspapers increase by 3.3%, yearly circulations drop by 4.4%, and display-ad rates drop by 3.1% (based on Models 4, 6, and 8, respectively). It is worth noting that the magnitudes of the effects on the other sides are small relative to the effects on the classified-ad side. These results accord well with the idea that the direct effect of Craigslist's entry is to the newspaper's classified-ad business, and that Craigslist's entry has an indirect effect on the other sides of the market.

To further examine how the effect of Craigslist's entry propagates from the classified-ad side to the other sides, we next run a series of regressions that replace *craigslist entry$_{it}$* with dummy variables, *craigslist entry$^s_{it}$*, where $s \in \{0, 1, 2, 3\}$, indicating whether year *t* is the *s*th year since Craigslist's entry in newspaper *i*'s market. The omitted category from these regressions is the year of Craigslist's entry (*craigslist entry$^0_{it}$*), in which we also group those newspapers that never experience entry by Craigslist. Observations with greater than three years after Craigslist's entry are grouped with the three year dummy (*craigslist entry$^3_{it}$*). The results are presented in Table 4. The coefficients of interest are those on the interactions between *classified$_{it}$* and *craigslist entry$^s_{it}$*. The results show immediate impact of Craigslist's entry on classified-ad rate. For subscription price and circulation share, the effects show up in the year following Craigslist's entry. The effect on the display-ad side, however, remains small and insignificant until the third year following Craigslist's entry. Taken together, these results provide further evidence that the direct effect of Craigslist's entry is to the newspaper's classified-ad business, and that it takes time for the effect to propagate to the other sides of the market.

4.2. Robustness Checks[23]

This subsection outlines potential concerns with our results and the robustness tests undertaken to address each concern. The first concern we address is the potential endogeneity of Craigslist's entry. One goal of our paper is to provide an empirical test of existing theories on two-sided markets. To test the theories, we need a demand shock that primarily affects one side of the market directly. The ideal experiment in the

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[23] For brevity, some of the robustness results are presented in an appendix.

newspaper setting would provide such a demand shock randomly to some newspapers and not to other newspapers. While our research design, which exploits temporal and geographical variation in Craigslist's entry into newspaper markets, does not exactly replicate the ideal experiment, we believe it provides a close approximation. Although our fixed-effects specifications control for time-invariant unobservables specific to newspapers and locations, it is still possible that Craigslist's entry decisions may be correlated with some time-varying unobservables. We undertake several tests to address this concern and rule out alternative explanations.

First, we take advantage of temporal and geographical variation in Craigslist's entry to directly examine which factors influence Craigslist's entry decisions. The idea is that if these time-varying location-specific unobservables affect both Craigslist's entry decisions and newspapers' characteristics, we should observe correlation between Craigslist's entry decisions and newspapers characteristics. Table 5 presents the results of hazard models that predict Craigslist's entry into a newspaper's market as a function of county demographics in which the newspaper is located, as well as newspaper characteristics. Model 1 of Table 5 includes market characteristics such as age_i, $population_i$, $pct\ college\ degree_i$, $pct\ black_i$, $per\ capita\ income_i$, $pct\ renters_i$, and $average\ ISPs_{it}$. Model 2 adds in newspaper and market characteristics including $number\ of\ newspapers_{it}$ in the market, $independent_i$ and $newspaper\ age_{it}$. Finally, Model 3 adds in additional newspaper characteristics including $classified_{it}$, $number\ MIS\ positions_{it}$ and $total\ number\ of\ positions_{it}$. We find that $population_i$, $pct\ college\ degree_i$, $pct\ renters_i$ and $average\ ISPs_{it}$ are significant predictors of Craigslist's entry, and these factors are controlled in the foregoing analyses by the use of fixed effects and inclusion of $average\ ISPs_{it}$. The results of Table 5 therefore provide us with some confidence that Craigslist's entry decisions are not based on newspaper characteristics, particularly those that vary over time.

Second, we conduct a falsification test using Craigslist's entry patterns to examine the role of location-specific unobservables. We compare outcomes for affected newspapers to those of control newspapers prior to Craigslist's entry into their markets. If our assumption of the orthogonality between Craigslist's entry and time-varying local unobservables is violated in our fixed-effects specifications, our data will produce false positive associations between Craigslist's entry and the pricing strategies of these affected newspapers in periods prior to Craigslist's entry in their markets. To check this, we first create a new variable, $eventual\ entry_i$, which is one if Craigslist enters location i at any time before 2007, and zero otherwise. We then repeat our difference-in-differences analysis by replacing $craigslist\ entry_{it}$ with $eventual\ entry_i$ and only analyzing observations for which $craigslist\ entry_{it}$ is zero. The effect of $eventual\ entry_i$ is absorbed by the newspaper fixed effects. As reported in columns (1)-(4) of Table 6, we find that there is no significant correlation between each of the four outcome variables, $classified\ ad\ rate_{it}$, $subscription\ price_{it}$, $circulation\ share_{it}$, and $display\ ad\ rate_{it}$, and the interaction between $eventual\ entry_i$

and *classified_it* during periods prior to Craigslist's entry. The absence of such false positives further increases our confidence in the exogeneity assumption.

This analysis above, however, only examines the average differences between affected newspapers and control newspapers prior to Craigslist's entry. It is still possible that two groups exhibit different trends prior to Craigslist's entry and the different trends may cause the empirical patterns we observe after Craigslist's entry. We extend the analysis by including the interactions between the *eventual entry_i* and *classified_it* dummy and each of the year dummies. The three-way interactions capture the difference between affected newspapers and control newspapers in each year prior to Craigslist's entry. We report the results in columns (5)-(8) of Table 6. We find that for all outcome variables, all coefficients for the interactions are insignificant, suggesting that the affected and control newspapers do not exhibit different trends prior to Craigslist's entry.

Third, we provide robustness tests that use the number of posts on Craigslist, a continuous variable, in place of the dummy variable, *craigslist entry_it*. The variable *num craigslist posts_it* equals zero in all years before Craigslist enters a county and is some positive number in each year after Craigslist enters. Table 7 provides regression results for the four outcome variables, *classified ad rate_it*, *subscription price_it*, *circulation share_it*, and *display ad rate_it*. The signs on the coefficient *classified_it* * *craigslist entry_it* match the signs shown in Table 3. Thus, whereas heterogeneity in population tastes or in ease of access to the Internet across markets may lead Craigslist to be more popular in some areas than others, the main results hold even when accounting for these factors.

Fourth, we run a set of analyses that restricts the sample to only those markets which Craigslist enters before 2007 (the last year of our study period). The idea behind such a test is reduce selection bias that might arise from comparing outcomes in markets that experience Craigslist entry to outcomes in markets that do not experience Craigslist's entry. The temporal variation in Craigslist's entry provides us with enough variation to identify the effect of entry. Even if there are time-varying unobservables that are correlated with the entry decision of Craigslist, as long as these time-varying unobservables affect newspapers with and without classified-ad managers in a similar way, we can identify the effect of Craiglist's entry from the changing gap between affected newspapers (i.e., those with classified-ad managers) and unaffected, or less affected, newspapers (i.e., those without classified-ad managers) in these markets.[24] Our results are qualitatively unchanged.

Finally, we note that the concern about endogeneity of Craigslist's entry is somewhat alleviated by the peculiar nature of Craigslist's corporate mission. Craigslist is incorporated as a for-profit company,

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[24] The same strategy has been used in other studies such as George and Waldfogel (2006) where they examine the expansion effect of New York Times on sales of local newspapers in different education zones. Their identify strategy also hinges on the assumption that unobservables affect both targeted (i.e., those with more education) and nontargeted (i.e., those with less education) consumers in the same market in the same way.

but it still uses the ".org" domain, whereas a for-profit company would typically use the ".com" domain. According to Craigslist, the company does this because the ".org" domain "symbolizes the relatively non-commercial nature, public service mission, and non-corporate culture of Craigslist."[25] Anecdotal evidence in the popular press provides additional support for the idea that Craigslist may focus on objectives other than profits. For example, in its annual ranking of top private digital companies, Silicon Alley Insider estimates that Craigslist generated about \$150M in ad revenue in 2009, but could have generated at least \$1B.[26] Thus, given the anecdotal evidence that the company does not try to maximize profits, but instead some other public service mission-oriented objective, it is plausible that Craigslist's entry into local markets is orthogonal to the financial performance of the newspapers in those markets.

A second potential concern is that the dummy variable $classified_{it}$ may not accurately capture newspapers' reliance on classified-ad revenue. To address this concern we investigate the correlation between the $classified_{it}$ variable and the number of pages of classified ads in a newspaper. We accomplish this by hand counting the number of total pages and number of classified-ad pages for a group of newspapers for each quarter from January 1999 to October 2006.[27] We then create an annual average across the quarters for each newspaper, and regress the annual average classified-ad pages (*num ad pages*$_{it}$) on the total number of pages, $classified_{it}$ and year dummies. The coefficient on $classified_{it}$ is positive and significant at the 5% level, indicating a strong correlation between $classified_{it}$ and the number of advertising pages.

We also perform robustness checks to rule out plausible alternative explanations for the result on the $classified_{it}$ variable. One alternative explanation could be that a large newspaper may have a classified-ad manager even if classified-ad revenue is only a small fraction of its total revenue. To address this concern, we normalize $classified_{it}$ by the total number of managerial positions each newspaper has on its ad sales team and then repeat the analyses as in Table 3. The results are qualitatively unchanged.

Another alternative explanation is that $classified_{it}$ could be endogenous as it is determined in the same time period as the pricing variables. In a robustness check, we fix the value of $classified_{it}$ to its value in 2000. We drop all counties where Craigslist entered on or before 2000 and then run regressions only with observations after 2000. Although the approach does not capture possible shifts in newspapers' reliance on classified-ad revenue, it frees us from the endogeneity concern as the reliance of these newspapers on classified-ad revenue is determined in an earlier period whereas newspaper responses to Craigslist's entry are examined for later periods. The results are similar to those presented in Table 3.

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[25] http://www.craigslist.org/about/factsheet, accessed May 22, 2010.
[26] http://www.businessinsider.com/sai-50-2009#5-craigslist-5, accessed August 3, 2010.
[27] The newspapers, which were chosen because of data availability, include: *Albany Times Union*, *Baltimore Morning Sun*, *Boston Globe*, *Cincinnati Enquirer*, *Cleveland Plain Dealer*, *Dallas Morning News*, *Denver Post*, *Detroit News*, *Houston Chronicle*, *Indianapolis Star*, *Kansas City Times-Star*, *Louisville Courier Journal, New Orleans Times Picayune*, *Oregonian*, *Rochester Democrat and Chronicle*, and *St. Louis Post Dispatch*.

Our third potential concern is the possibility that the observed newspaper responses are a result of other confounding factors. One natural candidate for such a confounding factor is the entry and exit of newspapers that may change the number of competing newspapers that a given newspaper faces. However, the large amount of temporal and geographical variation in Craigslist's entry pattern helps rule out this explanation because it is unlikely that new newspapers systematically enter the market the same time as Craigslist. We conduct a robustness test that includes a count of the number of newspapers in a market and obtain similar results as in Table 3.

Another potential candidate for a confounding factor is that the observed responses are a result of newspapers repositioning themselves after Craigslist's entry. Several studies have shown that newspapers may adjust their content in response to competition (George and Waldfogel 2006; Chandra 2009). Following the approach in these studies, we investigate the effect of Craigslist's entry on shares of different types of content editors at each newspaper. However, we find little evidence that any of the responses by these affected newspapers are driven by content shifts.

5. A Simple Model

In this section, we present a stylized model to study the impact of Craigslist's entry into newspaper markets. The purpose of the model is to show that our empirical findings can be predicted from a model with a set of simple assumptions. Since Craigslist only attracts away classified advertisers from newspapers, our model focuses its impact on newspapers for which classified-ad revenue is an important revenue source. In our empirical analysis, this corresponds to a focus on newspapers with a classified-ad manager (i.e., $classified_{it} = 1$).

Consider a situation where a newspaper charges a fixed fee of α to each classified advertiser, β to each display advertiser and p to each subscriber. For simplicity, we assume the marginal cost the newspaper incurs on each side of the market to be zero.

On the subscriber side, we assume that the market size is S and the demand for the newspaper, i.e., circulation, is $D = S - p$. Hence, the newspaper subscription profit will be Dp. Similar to Armstrong (2006), our functional form implicitly assumes that newspaper demand is independent of the number of ads in the newspaper. This assumption is consistent with empirical findings in Argentesi and Filistrucchi (2007).

When Craigslist is available in the market, classified advertisers have an additional channel to reach consumers. Craigslist is free and posting an ad on Craigslist requires little effort. In addition, Craigslist allows classified advertisers to reach many potential customers who are not newspaper readers. As a result, we assume that all classified advertisers will adopt Craigslist after its entry. Let λ be the fraction of the newspaper subscribers who will use Craigslist after its entry. λ thus measures the

penetration of Craigslist. Before Craigslist's entry, $\lambda = 0$; after Craigslist's entry, $\lambda \in (0,1]$. Hence, if the newspaper circulation is D, classified advertisers reach $(1-\lambda)D$ new consumers by advertising to the newspaper. As the demand from classified advertisers increases with the number of new customers they can reach, similar to Parker and Van Alstyne (2005), we assume the demand function to be $m(1-\lambda)D - \alpha$, where $m > 0$ is a constant and measures the extent to which classified advertisers care about the subscriber base of the newspaper. The newspaper profit from classified ads is thus $\alpha(m(1-\lambda)D - \alpha)$.

The setup is similar on the display advertiser side. Assume the demand of display advertisers is $nD - \beta$, where $n > 0$ is a constant. We similarly obtain the newspaper profit from display advertisers as $\beta(nD - \beta)$.

The total profit of the newspaper is thus:

$$\pi(\alpha, \beta, p) = Dp + \alpha(m(1-\lambda)D - \alpha) + \beta(nD - \beta),$$

where $D = S - p$. The newspaper maximizes its profit by setting p, α and β simultaneously. Taking the first-order conditions with respect to p, α and β, we have in equilibrium:

$$p = S(1 - \frac{2}{4 - n^2 - m^2(1-\lambda)^2}), \quad \alpha = \frac{mS(1-\lambda)}{4 - n^2 - m^2(1-\lambda)^2} \text{ and } \beta = \frac{nS}{4 - n^2 - m^2(1-\lambda)^2}. [28]$$

The equations are intuitive. As classified advertisers or display advertisers care more about the number of subscribers of the newspaper (i.e., m or n increases), it is optimal for the newspaper to lower the subscription price, p, to increase the number of subscribers, and charge higher rates, α and β, to the classified and display advertisers.

Comparing to the case without Craigslist (i.e., $\lambda = 0$), after Craigslist's entry ($\lambda > 0$), we find that subscription price, p, increases, and α and β decrease. In addition, we find that the newspaper circulation, the number of classified advertisers and the number of display advertisers all decrease with λ.

These results help interpret our empirical findings. They suggest that as Craigslist's entry decreases the attractiveness of a newspaper to classified advertisers, which now have an alternative channel to reach newspaper subscribers, the newspaper decreases the classified-ad rate. At the same time, as the newspaper no longer finds it as attractive as before to enlarge its circulation, it has a lower incentive to subsidize the subscriber side, and the subscription price increases. The increase in the subscription price in turn leads to lower circulation, making the newspaper less attractive to display advertisers. The display-ad rate drops as a consequence.

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[28] In our empirical setting, all prices are positive. Therefore, we consider only the case where $p > 0$, $\alpha > 0$ and $\beta > 0$ here. This is equivalent to assume that $n^2 + m^2(1-\lambda)^2 < 2$.

Our results build on existing literature on multi-sided markets (Godes et al. 2009; Jin and Rysman 2012) to show that in a multi-sided market setting, an increase in competition on one side does not necessarily increase prices on other sides. The direction of a price change depends on the interdependency across different sides. In our case, the display-ad side does not interact directly with the classified-ad side. Instead, they are linked to each other through the subscriber side.

6. Extensions

Our analysis thus far has focused on changes in newspapers' pricing strategies as a response to Craigslist's entry. The impact of Craigslist's entry on newspapers may go beyond pricing. We extend our findings by investigating how Craigslist's entry affects newspapers' online content strategies. Newspapers face the dilemma of whether to aggressively move their content online during our study period. On one hand, a growing number of readers obtain news online.[29] Offering content online thus allows newspapers to retain their readers and generate additional revenue from selling ads online. On the other hand, online content, which is often offered for free, is a substitute for print newspapers and cannibalizes newspapers' offline business. Cannibalization becomes a greater concern when newspapers try to generate more revenue from print subscriptions. Hence, we expect that these affected newspapers are less likely to move their content online.

To test this hypothesis, we re-run a set of regressions similar to equation (1) by replacing the dependent variable with *online editor$_{it}$* and *mis manager$_{it}$*, respectively, to examine whether these affected newspapers are more or less likely to have online content editors or MIS managers. One caveat of *mis manager$_{it}$* is that while the variable is positively correlated with *online editor$_{it}$* (correlation = 0.17), it could also capture IT investment unrelated to online content such as investment in the development of online subscription systems.

As our new dependent variables are dummy variables, we use the conditional fixed-effects logit model and report the results in the first two columns of Table 8. The coefficients on the interaction, *craigslist entry$_{it}$*classified$_{it}$*, are significantly negative in both models. Interaction variables in logit models, however, are hard to interpret (Hoetker 2007; Zelner 2009). We next repeat the analysis using the linear probability model. Angrist and Pischke (2009) show that in several empirical applications, there is little qualitative difference between limited dependent variables models and linear probability models. One major concern about the linear probability model is that predicted probabilities may lie outside the range of 0 and 1. In our case, 100% of the predicted probabilities of both dependent variables lie between zero and one. As a result, the linear probability models with robustness standard errors yield unbiased and

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[29] For example, according to the 2011 State of the News Media report by Pew's Project for Excellence in Journalism (available at http://www.stateofthemedia.org, accessed March 2011), in 2010, for the first time, more people obtained news online than from print newspapers.

consistent estimates in our case (Horrace and Oaxaca 2006). The last two columns of Table 8 report the results based on the linear probability models. The results show that Craigslist's entry reduces the likelihood of having an online content editor or an MIS manager by 6 to 7 percentage points for the affected newspapers, which is equivalent to a reduction of 33% and 14%, respectively.[30] In summary, we find that Craigslist's entry significantly reduces the likelihood of moving content online for the affected newspapers.

As another extension, we investigate the financial impact of Craigslist's entry on classified-ad buyers.[31] To estimate their potential savings, we first estimate the classified-ad revenue each newspaper should receive absent Craigslist's entry and aggregate this amount across all affected newspapers. We then multiply this number by the percentage drop in classified-ad revenue as a result of Craigslist's entry. To estimate each newspapers' classified-ad revenue, we first use the group of newspapers for which we have data on the number of classified advertising pages ($num\ ad\ pages_{it}$) to identify the relationship between classified-ad revenue, newspaper size and whether a newspaper has a classified-ad manager. We run a regression of the following form: log$(classified\text{-}ad\ rate_{it}* num\ ad\ pages_{it}) = \beta_0 + \beta_1$ log$(Circ_{it}) + \beta_2$ $classified_{it} + \eta_t + \varepsilon_{it}$, where $Circ_{it}$ is newspaper i's circulation in year t and η_t are year fixed effects, for periods before Craigslist's entry in their markets. We then allocate the total classified-ad revenue for the newspaper industry in 2000 ($19.6 billion[32]) to each newspaper in our dataset using the weights computed from the regression analysis (i.e., $\exp(\hat{\beta}_1 \log(Circ_{it}) + \hat{\beta}_2 classified_{it})$). We then use the coefficients from the year fixed effects (η_t) to compute the classified-ad revenue each newspaper would have been making each year, absent Craigslist's entry.

To estimate the percentage drop in classified-ad revenue, we next run another regression using the same group of newspapers to estimate the percentage drop in the number of classified-ad pages as a result of Craigslist's entry: log$(num\ ad\ pages_{it}) = \beta_0 + \beta_1 craigslist\ entry_{it} + \beta_2\ craigslist\ entry_{it}*classified_{it} + \beta_3 classified_{it} + \beta_4\ average\ ISPs_{it} + \eta_t + \varepsilon_{it}$. We find that for newspapers without classified-ad managers, there is no significant drop in the number of classified-ad pages, while for newspapers with classified-ad managers, Craigslist's entry leads to 11.6% drop in the classified-ad pages. We know from Table 3 that Craigslist's entry leads to 20.7% drop in the classified-ad rate for newspapers with classified-ad managers. Hence, the average drop in total classified-ad revenue for newspapers with classified-ad managers is 1-(1-20.7%)*(1-11.6%) = 30%.

The amount of savings for classified-ad buyers can thus be computed as the product of the total classified-ad revenue newspapers with classified-ad managers could have made after Craigslist's entry

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[30] The means of *online editor$_{it}$* and *mis manager$_{it}$* in Craigslist's entry years are 0.19 and 0.52, respectively.

[31] We have data on rates and prices, but would also need data on costs and quantities to conduct a full welfare analysis. Hence, we only estimate savings to classified-ad buyers.

[32] See http://bit.ly/wnsFK8, accessed June 2012.

and the average revenue drop as a result of Craigslist's entry. Using this approach, we find that Craigslist's entry leads to a total saving of $4.2 billion for years 2000 and 2002-2005 (i.e., years for which we have data on both classified-ad managers and classified-ad rates). We then compute the savings per capita by dividing the total saving by the total population affected by Craigslist's entry during this period. Assuming that savings per capita stays constant, we extrapolate total savings to the period 2000-2007, and find that Craigslist results in total savings of $7.7 billion to classified-ad buyers during 2000-2007.

Note that this estimate is likely to be a lower bound of savings for classified-ad buyers for two reasons. First, many classified-ad buyers could have been advertising to other offline outlets such as weekly newspapers and their savings are not reflected in this analysis. Second, as Craigslist continues to penetrate each market, more classified-ad buyers may switch to Craigslist's services. Hence, its impact may become more pronounced during 2006-2007. The analysis shows that while Craigslist's entry is disruptive to the newspaper industry, it provides significant cost savings to classified-ad buyers.

7. Discussion and Conclusion

Our study quantifies the impact of Craigslist on local newspapers' pricing decisions in the United States. We provide evidence that the effect of Craigslist's entry on newspapers with classified-ad managers leads to a decrease of 20.7% in classified-ad rates, an increase of 3.3% in subscription price, a decrease of 4.4% in circulation, and a decrease of 3.1% in display-ad rates. The responses are consistent with a model of a three-sided market. We also provide two extensions. First, we show that these affected newspapers are less likely to make their content available online. Second, we estimate the total savings to classified-ad buyers from Craigslist's entry during 2000-2007 to be $7.7 billion.

7.1 Managerial Implications

Our study illustrates the challenges faced by platforms in multi-sided markets. First, as different sides of a platform's market are often interdependent with each other, changes on one side of the market tend to propagate to other sides. As a result, platforms need to be cognizant of the multi-sidedness of their markets and consider all sides together when designing optimal strategies. Conventional wisdom from one-sided markets may be misleading in multi-sided markets. As we illustrate empirically in our study, sometimes a platform needs to *increase* its price on one side of its market as an optimal response to increased competition on another side.

Second, optimal strategies in one multi-sided market setting may not be immediately applicable to another multi-sided market setting. While we provide a three-sided model for the newspaper market, other multi-sided markets may involve different types of participants with different interdependencies

across the different sides of the market. For example, social networking sites such as Facebook typically have users, application developers and advertisers as different sides of their markets. As a result, optimal strategies used by newspaper firms to respond to online competition may not be the same for social networking sites. Platforms in other markets thus need to develop deep understanding of the nature of their business models, and then follow our approach to gain insights into their optimal strategies.

Our work also provides empirical evidence that the Internet has substantial impact on offline media firms. Offline media firms are not only affected by online content providers such as blogging sites and video-sharing sites that provide similar content, but are also affected by online service providers that compete away advertisers. More generally, our study helps build an understanding of how media platforms respond to shocks from technologically disruptive entrants from different industries. This issue is important because the boundaries between media industries are blurred today, as advertisers can reach relevant consumers through a variety of channels such as TV, the Internet, and mobile devices. Therefore, platforms are likely to be unprepared for competition if they rely on industry boundaries to identify their competitors. They also need to be cognizant that optimal responses sometimes involve changes in their business models towards charging more on the consumer side (e.g., from pure ad-sponsored business models to business models with both subscriptions and ads). Such changes can be particularly challenging in an environment such as the media industry where consumers are increasingly expecting their consumption to be free.[33]

7.2 Limitations and Future Research

Although we are able to take advantage of geographical and temporal variation in Craigslist's entry patterns to rule out a number of alternative explanations, a few limitations remain. For example, we observe that newspapers with classified-ad managers are more likely to experience a decline in display-ad rates, but we cannot identify whether this decline is caused by the decrease in newspaper subscribers, as suggested by our model, or because of some small display advertisers substituting away from higher-priced display ads to simple online classified ads after Craigslist's entry. Display advertisers are often less price-sensitive and care more about their brand image than classified advertisers, however, so we expect the effect from the latter case to be small.

Second, subscribers' substitution away from newspapers to other forms of media, such as Craigslist, may also contribute to the drop in newspaper circulation. This might occur, for example, if a portion of the circulation is to individuals who purchase newspapers to search classified ads for temporary-work opportunities. The interdependence of newspaper sales and the number of classified ads is more likely to exist for newspapers sold at newsstands. Our focus on yearly subscription prices and

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[33] Wray, Richard. 2010. Media consumption on the increase. Available at http://bit.ly/d7j8wZ, accessed June 2012.

circulation data helps alleviate this concern. Indeed, empirical studies (e.g., Argentesi and Filistrucchi 2007) using yearly data find no effect of ads on sales for daily newspapers.

Finally, we treat newspapers independent of each other, when in fact many newspapers are owned by the same parent firm. One possibility is that a newspaper with a parent that owns newspapers in other markets which experienced Craigslist's entry may have moved further down the learning curve (Lieberman 1987) and be able to react faster to Craigslist's entry. For example, such newspapers may drop classified-ad rates in anticipation of Craigslist's entry, in an attempt to lock in classified advertisers. To the extent this occurs, it biases against our finding a result, suggesting that the full effect of Craigslist's entry on newspaper classified-ad rates may be understated. A full understanding of how a newspaper group learns from Craigslist's entry is beyond the scope of the current article, but is an interesting area for future research.

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Table 1: Summary Statistics

Variable	All Observations				Craigslist Not Entered		Craigslist Entered		Mean Difference	Data Source
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Mean	Std. Dev.		
Craigslist Entry	0.04	0.19	0.00	1.00	0.00	0.00	0.32	0.47	-0.32***	Craigslist.org
Classified Rate	5.55	6.31	0.11	143.00	4.83	5.55	6.11	6.77	-1.28***	SRDS
Subscription Price	121.67	44.34	11.05	443.04	112.31	38.16	139.68	49.56	-27.37***	E&P
Circulation Share	0.18	0.12	0.00	0.88	0.18	0.12	0.18	0.12	0.00	E&P
Display-Ad Rate	53.13	100.58	3.70	3221.86	28.98	41.34	88.68	142.76	-59.69***	E&P
Classified-Ad Manager	0.34	0.47	0.00	1.00	0.28	0.45	0.45	0.50	-0.16***	E&P
Independent	0.92	0.27	0.00	1.00	0.90	0.30	0.95	0.23	-0.05***	E&P
Year Founded	1886.15	36.03	1764.00	2006.00	1886.73	33.99	1885.11	39.45	1.61*	E&P
Online Editor	0.20	0.40	0.00	1.00	0.19	0.39	0.23	0.42	-0.04***	E&P
MIS Manager	0.56	0.50	0.00	1.00	0.50	0.50	0.68	0.47	-0.18***	E&P
Total Positions	5.17	3.15	1.00	14.00	4.66	3.00	6.15	3.18	-1.48***	E&P
Average Number of ISPs	6.00	3.26	0.00	18.56	5.48	3.03	6.96	3.44	-1.49***	FCC
Number of Posts	939.23	9278.01	0.00	295932.00	2.59	87.81	8343.59	26551.43	-8341.00***	InternetArchive.org
Age (County)	37.09	2.76	23.30	54.30	37.48	2.58	36.37	2.92	1.11***	Census
Population (County)	361240.60	1061571.00	2681.00	9891484.00	154840.26	333656.63	739120.05	1663177.30	-584279.79***	Census
Pct. College Degree (County)	0.13	0.05	0.03	0.40	0.12	0.04	0.16	0.06	-0.04***	Census
Per Capita Income (County)	19481.77	4497.84	9872.00	44962.00	18680.40	4056.58	20948.93	4880.60	-2268.53***	Census
Pct. Rental (County)	0.30	0.08	0.12	0.80	0.28	0.06	0.35	0.09	-0.07***	Census

Notes: In the second to last column, we take the difference between the means for the markets that Craigslist enters and does not enter during our study period. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: Comparison of Newspaper Responses Before and After Craigslist's Entry

	With Classified-Ad Manager in Entry Year		Without Classified-Ad Manager in Entry Year		Difference in Differences
	Pre Entry	Post Entry	Pre Entry	Post Entry	
Classified-Ad Rate	-0.24	0.68	-0.44	0.90	-0.42***
Subscription Price	-0.27	0.86	-0.22	0.66	0.27**
Circulation Share	0.41	-1.02	0.28	-0.95	-0.20**
Display-Ad Rate	-0.37	0.92	-0.33	1.04	-0.08

Notes: In the last column, we take the difference between post-entry value and pre-entry value for newspapers with a classified-ad manager in Craigslist's entry year and compare it to the difference for those without a classified-ad manager in Craigslist's entry year. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Effect of Craigslist Entry on Newspaper Classified-Ad Rates and Propagation to Other Sides of Market (OLS Models)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Log Classified-Ad Rate		Log Price		Circ Share		Log Display-Ad Rate	
Craigslist Entry	0.089	0.068	-0.020**	-0.013	0.002	0.000	0.022*	0.011
	[0.077]	[0.071]	[0.009]	[0.008]	[0.002]	[0.001]	[0.013]	[0.012]
Classified	-0.005	0.028	-0.016	-0.026***	-0.001	-0.002	0.006	0.016
	[0.047]	[0.051]	[0.009]	[0.010]	[0.002]	[0.002]	[0.012]	[0.013]
Craigslist Entry*Classified	-0.230**	-0.207**	0.026**	0.033***	-0.008**	-0.006**	-0.009	-0.031**
	[0.092]	[0.091]	[0.012]	[0.011]	[0.003]	[0.003]	[0.016]	[0.015]
Average ISPs		-0.398		0.072**		-0.043**		-0.126**
		[0.247]		[0.034]		[0.019]		[0.053]
Newspaper Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Classified * Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,674	4,098	8,937	6,802	5,938	4,427	6,460	4,918
Number of Newspaper IDs	1,038	1,000	2,086	1,961	1,576	1,454	1,617	1,500
Adjusted R-squared	0.182	0.132	0.131	0.113	0.226	0.256	0.471	0.328

Notes: The table reports OLS results from regressions on log classified-ad rate, log price, circulation share and log display-ad rate. Craigslist Entry is a dummy variable that equals one for all years after Craigslist enters the county in which the newspaper is based, and zero otherwise. Classified is a dummy variable that equals one if the newspaper lists a classified-ad manager in that year, zero otherwise. Average ISPs is the average number of ISPs across all zip codes in the county, weighted by population size, in which the newspaper is located. Heteroskedasticity-adjusted standard errors, clustered at the newspaper level, are included in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Effect of Craigslist Entry Over Time (OLS Models)

Model	(1)	(2)	(3)	(4)
Dependent Variable	Log Classified-Ad Rate	Log Price	Circ Share	Log Display-Ad Rate
Craigslist Entry[1]	0.065	0.003	-0.002	0.018
	[0.060]	[0.012]	[0.001]	[0.018]
Craigslist Entry[2]	0.066	-0.014	0.002	0.01
	[0.096]	[0.008]	[0.002]	[0.015]
Craigslist Entry[3]	0.115	-0.008	-0.001	0.026
	[0.168]	[0.013]	[0.002]	[0.016]
Classified	0.028	-0.038**	-0.001	0.013
	[0.053]	[0.016]	[0.001]	[0.015]
Craigslist Entry[1]*Classified	-0.148**	0.023	-0.002	-0.018
	[0.075]	[0.019]	[0.002]	[0.021]
Craigslist Entry[2]*Classified	-0.261**	0.053***	-0.006***	-0.023
	[0.125]	[0.015]	[0.002]	[0.020]
Craigslist Entry[3]*Classified	-0.395*	0.035*	-0.010*	-0.061***
	[0.214]	[0.021]	[0.005]	[0.022]
Average ISPs	-0.304	0.084**	-0.042**	-0.122**
	[0.286]	[0.038]	[0.020]	[0.053]
Newspaper Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Classified * Year Dummies	Yes	Yes	Yes	Yes
Observations	4,098	6,802	4,427	4,918
Number of Newspaper IDs	1,000	1,961	1,454	1,500
Adjusted R-squared	0.132	0.116	0.252	0.329

Notes: The table reports OLS results from regressions on log classified ad rate, log price, circulation share and log display-ad rate. Craigslist Entry[s] is a dummy indicating whether the current year is the sth year after Craigslist's entry for each market. Year of Craigslist Entry (i.e., Craigslist Entry[0]) is the omitted category; newspapers which do not experience Craigslist Entry are categorized as Craigslist Entry[0]. Observations with greater than three year after Craigslist's entry are grouped with the three year dummy. Heteroskedasticity-adjusted standard errors, clustered at the newspaper level, are included in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Determinants of Craigslist Entry (Hazard Model; Marginal Effects Reported)

Model	(1)	(2)	(3)
Age	0.001	0.001	0.001
	[0.001]	[0.001]	[0.000]
Population	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.000]
Pct. College Degree	0.155**	0.152**	0.128**
	[0.071]	[0.068]	[0.056]
Pct. Black	-0.008	-0.008	-0.010
	[0.011]	[0.010]	[0.010]
Per Capita Income	-0.066	-0.064	-0.059
	[0.047]	[0.045]	[0.039]
Pct. Rental	0.092**	0.091**	0.078**
	[0.041]	[0.041]	[0.035]
Average ISPs	-0.068*	-0.067*	-0.048*
	[0.038]	[0.037]	[0.027]
Number of Papers		-0.000	-0.000
		[0.001]	[0.001]
Independent		0.005	0.005
		[0.004]	[0.004]
Newspaper Age		-0.000	-0.000
		[0.000]	[0.000]
Classified			0.001
			[0.002]
Online Editor			-0.004
			[0.003]
MIS Manager			0.004
			[0.002]
Total Positions			0.002
			[0.001]
Year Dummies	Yes	Yes	Yes
Observations	4,155	4,155	4,155
Pseudo R-squared	0.533	0.534	0.543

Notes: The table reports results from a hazard model predicting Craigslist's entry into a county. The dependent variable equals one when the county experiences Craigslist's entry, zero otherwise. Craigslist's entry is an absorbing state so the county is dropped from the sample in the years after the dependent variable becomes one. The controls include demographic variables at the county level and newspaper characteristics which have been averaged across all the newspapers in the county. Heteroskedasticity-adjusted standard errors are included in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Falsification Check: Difference Between Affected Newspapers and Control Newspapers Before Craigslist's Entry (OLS Models)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Log Classified-Ad Rate	Log Price	Circ Share	Log Display-Ad Rate	Log Classified-Ad Rate	Log Price	Circ Share	Log Display-Ad Rate
Classified	0.019	-0.034***	-0.001	0.010	0.017	0.000	0.004*	-0.019
	[0.054]	[0.011]	[0.002]	[0.016]	[0.039]	[0.009]	[0.002]	[0.018]
Eventual Entry*Classified	0.005	0.015	-0.003	0.018	-0.038	0.015	-0.004	0.035
	[0.062]	[0.011]	[0.003]	[0.018]	[0.065]	[0.013]	[0.005]	[0.022]
Average ISPs	-0.414*	0.061*	-0.037*	-0.080	-0.046	0.067*	-0.037**	-0.086
	[0.248]	[0.036]	[0.019]	[0.059]	[0.305]	[0.036]	[0.019]	[0.060]
Year 2002*Eventual Entry*Classified					-0.003	-0.004	0.001	-0.033
					[0.062]	[0.009]	[0.003]	[0.022]
Year 2003*Eventual Entry*Classified					-0.007	0.006	0.003	-0.035
					[0.067]	[0.012]	[0.004]	[0.021]
Year 2004*Eventual Entry*Classified					0.097	-0.004	0.001	-0.031
					[0.067]	[0.012]	[0.003]	[0.022]
Year 2005*Eventual Entry*Classified					0.086	-0.000	-0.002	-0.021
					[0.170]	[0.018]	[0.003]	[0.028]
Newspaper Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Classified * Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,905	6,097	3,884	4,359	3,905	6,097	3,884	4,359
Number of Newspaper IDs	978	1,892	1,404	1,457	978	1,892	1,404	1,457
Adjusted R-squared	0.132	0.106	0.243	0.273	0.140	0.108	0.236	0.274

Notes: The table reports OLS results from regressions on log classified-ad rate, log price, circulation share and log display-ad rate. Eventual entry is a dummy variable that equals one for all newspapers that ever experience entry by Craigslist into their county, and zero otherwise. Its main effect is absorbed by newspaper fixed-effects. Year 2000*Eventual Entry*Classified is used as the comparison group. When log price, circulation share and log display-ad rate are the dependent variables, because the value of Eventual Entry is zero for all observations in 2007, Year 2007*Eventual Entry*Classified is dropped. Heteroskedasticity-adjusted standard errors, clustered at the newspaper level, are included in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Robustness Check: Use Number of Posts to Measure Diffusion of Craigslist (OLS Models)

Model	(1)	(2)	(3)	(4)
Dependent Variable	Log Classified-Ad Rate	Log Price	Circ Share	Log Display-Ad Rate
Number of Posts	0.008	-0.001	0.000	0.002
	[0.005]	[0.001]	[0.000]	[0.002]
Classified	0.027	-0.030***	-0.003	0.019
	[0.052]	[0.010]	[0.002]	[0.014]
Number of Posts*Classified	-0.019**	0.004**	-0.001***	-0.005*
	[0.008]	[0.002]	[0.000]	[0.002]
Average ISPs	-0.384	0.069**	-0.041**	-0.123*
	[0.248]	[0.034]	[0.019]	[0.053]
Newspaper Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Classified * Year Dummies	Yes	Yes	Yes	Yes
Observations	4,061	6,735	4,367	4,858
Number of Newspaper IDs	995	1,953	1,443	1,487
Adjusted R-squared	0.130	0.115	0.253	0.327

Notes: The table reports OLS results from regressions on log classified-ad rate, log price, circulation share and log display-ad rate. Number of posts is a count of the average number of posts on the local Craigslist website across the year. Heteroskedasticity-adjusted standard errors, clustered at the newspaper level, are included in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Effect of Craigslist Entry on Newspapers' Online Strategies

Model	(1)	(2)	(3)	(4)
Dependent Variable	Online Editor	MIS Manager	Online Editor	MIS Manager
Specification	Logit	Logit	OLS	OLS
Craigslist Entry	0.123	0.480**	-0.019	0.056**
	[0.329]	[0.217]	[0.020]	[0.024]
Classified	1.083***	0.992***	0.048*	0.130***
	[0.407]	[0.289]	[0.028]	[0.033]
Craigslist Entry*Classified	-1.361***	-0.605*	-0.061**	-0.070**
	[0.478]	[0.343]	[0.029]	[0.035]
Average ISPs	-2.614	-3.359***	0.100	-0.407***
	[1.738]	[0.909]	[0.063]	[0.106]
Newspaper Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Classified * Year Dummies	Yes	Yes	Yes	Yes
Observations	7,512	7,512	7,512	7,512
Number of Newspaper IDs	2,117	2,117	2,117	2,117
Adjusted R-squared			0.058	0.024

Notes: The table reports logit and OLS results from regressions on indicators for the presence of an online editor or an MIS manager at a newspaper. Heteroskedasticity-adjusted standard errors, clustered at the newspaper level, are included in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.