ESSAYS ON NEWSPAPER ECONOMICS

by

Adithya B. Pattabhiramaiah

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Doctoral Committee:

Assistant Professor S Sriram, Chair
Professor Daniel A. Ackerberg
Professor Francine Lafontaine
Professor Puneet Manchanda
Assistant Professor Shrihari Sridhar

DEDICATION

To my family and friends, and my pet dog Goofy.

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ABSTRACT

Essays on Newspaper Economics

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This dissertation consists of two chapters that focus on estimating the economic impact of two major pricing changes witnessed recently in the U.S. newspaper industry. The first chapter investigates the optimality of the decision adopted by print newspaper publishers to increase subscription prices notwithstanding a declining preference among readers for newspaper consumption. Further, it proposes and evaluates theoretical explanations for the increasing subscription price trajectory in this market. Of the three available subscription options in print (Daily, Weekend and Sunday only), subscription prices increased more steeply for the Daily option; this is consistent with the view that newspapers are driving away low valuation Daily option readers but not Sunday, as Sunday contributes higher ad revenues. As an extreme case of this strategy, several newspapers have adopted a policy change by limiting production/distribution of the newspaper only to weekends. A counterfactual simulation shows the implications of such a policy change and offers implications for effective newspaper product portfolio management. Second, over the last few years, another popular strategy

among newspaper publishers operating online editions is the creation of paywalls (i.e., the practice of charging online readers a subscription fee for accessing news content). News publishers' objectives from setting up paywalls are believed to be threefold: a) creating a new revenue stream by monetizing online news content in the reader market, b) preserving the more lucrative print subscription revenues by discouraging print readers from switching to free online newspapers, and c) increasing the newspaper's ability to charge higher ad rates by promoting a subscription base of paying readers. It is unclear whether charging readers for online access will unambiguously serve all the expected objectives especially since the paywalls run the risk of leading to heavy attrition of readers and hence, advertisers. The second chapter employs readership and advertising data for the New York Times, a newspaper that has been cited in the media for its successful paywall execution, to investigate the effects of its paywall launch on online readership, print circulation and online advertising revenues.

CHAPTER I

Rising Prices under Declining Preferences: The case of the U.S. Print Newspaper Industry

1.2 Abstract

Between 2006 and 2011, daily print newspapers in the U.S. lost 20% of their paid subscribers, partly due to the increasing availability of alternative sources of news, especially free content provided on newspaper websites and by news aggregators such as Yahoo. However, contrary to the expectation that firms respond to softening demand by lowering prices, newspapers increased subscription prices by 40-60% during this period. These increasing prices might accelerate the decline in circulation, in turn adversely affecting advertising revenue, which has typically contributed 80% of newspaper revenues. We ask two questions in this paper - Is the newspaper industry's decision to increase subscription prices indeed optimal? What factors explain the price increases? To answer these questions, we calibrate models of readership and advertising demand using data from a top-50 U.S. regional print newspaper. Conditional on these demand models, we comment on whether the increase in subscription prices and the concomitant decrease in ad rates are mainly rationalized by: a) the news-

paper's strategic decision to drive away low willingness to pay readers or b) its reduced incentive to subsidize readers at the expense of advertisers, due to softening demand for newspaper advertising. We find that the optimal subscription price trajectory conditional on the estimated readership and advertising demand models is increasing, consistent with the pattern in the observed data. Furthermore, the decline in the ability of the newspaper to subsidize readers by extracting surplus from advertisers is the primary reason why subscription prices increase, suggesting that newspapers are moving towards a more balanced revenue model with readership revenues contributing a higher proportion of total revenues. Of the three available subscription options (Daily, Weekend and Sunday only), subscription prices increased more steeply for the Daily option; this is consistent with the view that the newspaper is driving away low valuation Daily option readers but not Sunday, as Sunday contributes higher ad revenues. As an extreme case of this strategy, several newspapers are limiting production/distribution of the newspaper only to the weekends. We perform a counterfactual simulation based on our model estimates to study the implications of such a policy change and thus offer implications for effective newspaper product portfolio management.

1.3 Introduction

The U.S. newspaper industry is facing unprecedented challenges due to dramatic losses in revenue and profitability. As a result of the increasing availability of free news content through newspaper websites and news aggregators such as Yahoo, readers are increasingly less willing to pay for the print newspaper (Fallows, 2010; George, 2008). Most U.S. newspaper publishers have responded by increasing subscription prices by 40-60% during this

period.[1] With increasing competition, it is typically optimal to lower prices. The rationale is that declining willingness to pay (WTP) and the associated higher price elasticity render it optimal to lower prices (Tirole, 2007). Furthermore, as two-sided platforms, newspapers derive their revenue from both readers and advertisers, with traditionally 80% coming from the latter. Since ad revenue is tied to readership, the concern is that raising prices might accelerate the decline in print circulation and lead to further erosion in advertising revenues.[2] Thus, it might be important to preserve the readership base by lowering subscription prices.

A common explanation for increasing prices under declining overall WTP is that firms strategically set prices to exploit differences in WTP among consumers (Hauser and Shugan, 1983); while newspapers served a broader group of readers in the past, decline in the overall WTP for the print newspaper might have rendered readers with lower WTP less profitable to serve. Consequently, the higher margins realized by catering only to high WTP readers might offset any loss in profits from not serving the low value readers. This explanation is consistent with the views of industry experts (e.g., Weber and Poyar, 2012; Filloux, 2012) that newspapers should stabilize circulation revenues by catering to a smaller but more loyal readership base.

We advance a second rationale that is heretofore under-investigated. Specifically, we argue that the optimality of increasing prices is based on the two-sided nature of the newspaper industry. Since advertisers value access to readers more than readers value newspaper advertising, newspapers have historically subsidized readers and extracted premium prices from advertisers (Rochet and Tirole, 2003; Gabszewicz et al., 2005; Parker and Van Alstyne,

[1] As we discuss subsequently, the approximately 5% increase in marginal costs cannot explain the 40-60% increase in subscription prices during this period. Also, commonly used quality metrics (Berry and Waldfogel, 2010) such as the size of the newsroom and the average number of newspages have declined over time. Therefore, increase in quality cannot explain the price increases either.

[2] Report "Circulation Pricing" dt. Mar 17, 2009 retrieved from the NAA's website: www.naa.org.

2005). However, the advent of alternative media options such as search advertising has made print newspapers less attractive to advertisers. Thus, the waning preference among advertisers for print newspaper advertising might have lowered the incentive to subsidize readers at the expense of advertisers.[3]

In this paper, we investigate whether it is optimal for newspapers to increase subscription prices, especially given that there are theoretical arguments both in favor of and against such price increases. Further, if the price increases are indeed optimal as observed, we aim to empirically study the extent to which reader heterogeneity and lower incentive to subsidize readers with ad revenues, drives this pattern. By doing so, we examine claims in highly-publicized industry reports (Weber and Poyar, 2012; Filloux, 2012) that newspapers' price-based segmentation strategies are primarily responsible for the steep increase in subscription prices. Furthermore, equipped with data on demand for the newspaper on different days of the week, we offer some key insights into newspapers' effective product portfolio management strategies, especially pertaining to managing readership on different days of the week.

We use unique data from a top-50 regional U.S. newspaper that serves a large metropolitan area. Our data span 72 months, from January 2006 through December 2011, and contain the following key information:

1. Monthly print subscriptions and prices for the three most popular options: Daily, Weekend, and Sunday only, corresponding to print newspaper subscription on all seven days, Fri/Sat/Sun, and Sunday respectively, broken down geographically by the sub-

[3]A third explanation is that when newspapers increase print subscription prices, they also consider the consequent migration of print readers to the online newspaper. For newspapers, such as ours, that do not operate newspaper paywalls, the migration of readers can bring in additional online advertising revenue even if these online readers do not directly generate subscription revenues. Subsequently we discuss this alternative explanation (in section 1.8.4.1) and show that this explanaton does not have a big influence on print subscription prices.

markets (counties) served by the newspaper. Access to sub-market and bundle-level subscription data enables us to characterize the readership demand model and identify heterogeneity in readers' willingness to pay for the newspaper. The bundle level data also help us account for reader substitution across bundles and allow us to study differences in pricing implications for each bundle.

2. Monthly data on print advertising revenues and ad rates on the three types of advertising, displays, inserts, and classifieds, to inform a model of advertiser demand. These data help us characterize how the demand for each type of advertising changes with ad rates and readership. In addition, access to data spanning several years enables us to allow the advertising demand to vary from year to year as a result of exogenous changes in competition in the advertising market.

To answer our research questions, we propose a model that describes the behavior of three agents: readers, advertisers, and the newspaper. Readers choose between one of the three available subscription bundles or the outside option of not subscribing to the print newspaper. Advertisers choose the amount of advertising to place in the three possible advertising types. Conditional on readership and advertising demand, the newspaper sets subscription prices for readers for the three bundles and ad rates for each advertising type. We estimate the readership and advertising models using GMM while accounting for the simultaneity of the decisions made by readers, advertisers, and the newspaper by employing appropriate exclusion restrictions. Conditional on the estimated readership and advertising demand model parameters, we trace the temporal trajectories of the newspaper firm's optimal price-cost margins for readers and advertisers, and compare them with the observed path. If the optimal subscription price is indeed increasing as observed, we can assess the extent

to which the two competing explanations drive print subscription prices upwards.

Based on our calibration of the readership demand model, we recover two distinct segments - a small segment consisting of about 8.5% of households in the market (33% of subscribing households) with high WTP for newspaper subscription. We find that the percentage of high WTP subscribers increases over time as the low WTP readers quit subscribing. Moreover, there are significant differences in the proportion of high WTP subscribers across the three subscription options; the daily bundle draws a disproportionately high number of high WTP readers. More importantly, these subscription options (bundles) also differ in terms of the extent to which they lose the low WTP subscribers over time; options that provide access to the newspaper only during the weekends tend to lose a lower proportion of low WTP readers than the daily subscription option. Estimates from our advertising model point to a declining intrinsic attractiveness among advertisers for print newspaper advertising. This pattern suggests a declining incentive for newspapers to subsidize readers at the expense of advertisers.

Based on our estimates from the readership and advertising demand models, we find that the optimal subscription prices for all options ought to have increased, while the ad rates ought to have decreased during the period of our analysis. In our data, subcription prices increased for all subscription alternatives, while advertising rates corresponding to each ad type decreased over our analysis duration. Therefore, the observed trajectories of subscription and advertising prices are consistent with the optimal prices suggested by our empirical analysis. Next, the commonly suspected reader heterogeneity in WTP argument only explains a small fraction of the increase in subscription prices. On the other hand, 80% of this increase can be traced back to a declining incentive to subsidize readers at the expense of advertisers due to an exogenous year-on-year drop in advertising demand due to dynamics

in the competitive environment (i.e., after accounting for the ad rates and readership).

We also find that in the absence of exogenous changes in advertising demand, the subscription prices should have increased only for the daily subscription option, but not for the weekend-only subscription options. This suggests that the newspaper ought to be using steeper price increases to induce low WTP readers to switch away from weekday subscription, while preserving readership on weekends, a pattern that is also consistent with the data. We argue that, with shrinking advertising, the daily subscription option is unable to generate significantly more revenue per reader than the Sunday-only option in order to justify the higher cost of printing and distributing the newspaper on six additional days each week. This is consistent with the high production/distribution costs facing the print newspaper industry, as stated in popular press reports, which also suggest that newspapers are actively restructuring their product portfolio decisions (Lendon, 2008; Carmichael, 2010). Specifically, many newspapers have adopted an extreme case of this strategy by limiting production/distribution of the newspaper only to the weekends. We perform a counterfactual simulation based on our model estimates to study the implications of such a policy change for the newspaper.

Overall, our findings provide key insights into the functioning of newspapers. When the traditional newspaper model was to maintain a large readership base, it made sense to keep subscription prices relatively low, while charging advertisers premium prices for access to readers. However, after facing years of declining circulation, it is optimal for print newspapers to move towards a more balanced subscription-cum-advertiser funded model.[4] A premium pricing strategy aimed at charging loyal readers higher prices is possibly the

[4]Print newspaper circulation has recently encountered an all time low. The last time newspaper circulation was at current levels was in the mid-1940s, when the population of the U.S. was half its current size - see http://www.journalism.org/node/1414.

way of the future for newspapers;[5] this is especially true in times of declining advertising. From a theoretical perspective, we find that price increases in two-sided markets could stem from the platform's need to balance revenues from both sides of the market, as opposed to heterogeneity in WTP (the commonly advanced argument in one-sided market situations).

The rest of the paper proceeds as follows. In section 1.4, we briefly provide a conceptual background to our research question. Section 1.5 describes the data used in the estimation and provides descriptive evidence as a motivation for our research question. In section 1.6, we discuss details of our proposed model. Section 1.7 discusses identification and the estimation strategy. Results from the model, robustness checks and related counterfactual simulations are presented in section 1.8, and section 1.9 concludes.

1.4 Conceptual Background

Our research is related to two emerging streams of literature: (a) work studying the impact of consumer heterogeneity on firms' pricing decisions and (b) pricing in two-sided markets.

Our first explanation for the observed price increase is the commonly advanced one, i.e., due to heterogeneity among readers in terms of their WTP. In this regard, our research is related to papers that have investigated the role of consumer heterogeneity on the trajectory of optimal prices. In contexts where customers exit the market subsequent to making a purchase, the trajectory of optimal prices can either increase or decrease over time based on whether high WTP consumers have an incentive to purchase early or late. In the context of video games and game consoles wherein high WTP consumers tend to purchase early, Nair

[5] http://www.thedrum.com/news/2011/09/19/guardianrsquos-editor-chief-robustly-justifies-his-newspaperrsquos-latest-cover

(2007) and Liu (2010) argue that firms face a shrinking market and a remaining pool of low WTP buyers over time. As a result, firms employ inter-temporal price discrimination by initially charging premium prices to high WTP customers and reduce prices subsequently to serve the low WTP consumers. In contrast, in his investigation of airline ticket purchases, Lazarev (2013) documents that high WTP business travelers tend to purchase their tickets later in order to reduce the uncertainty around their travel. In such a scenario, airlines find it optimal to increase prices over time.

In settings where customers make repeat purchases, the optimal price trajectory would respond to the changing composition of customers, possibly due to the entry of new alternatives. For example, Frank and Salkever (1997) and Ching (2010) show that prices of branded pharmaceutical drugs can increase when generics enter, although consumers are, on average, less willing to pay premium prices for branded drugs. They argue that with the entry of generics, price sensitive customers switch to cheaper generics. As a result, branded drugs serve only the high WTP consumers, which renders it optimal to increase prices subsequent to the entry of generics. Hauser and Shugan (1983) offer a similar rationale for why it might be optimal to increase prices in response to competitive entry. Our context bears resemblence to this line of reasoning: the decline in the overall WTP for the print newspaper, possibly due to the availability of alternative sources of news, might have rendered it less profitable to serve low WTP readers. Consequently, the higher margins realized by catering only to readers who are willing to pay more for the newspaper offsets any loss in profits from not serving the low value readers.

We draw our second explanation for increasing subscription prices from the literature on two-sided markets. Since newspapers derive their revenues from two sources, i.e., readers and advertisers, with at least one side valuing the presence of the other, they operate in

two-sided markets (Rochet and Tirole, 2003). An implication of two-sidedness is that the markup on one side will depend on the elasticity of the response on both sides of the market and the markup charged to the other side (Rysman, 2004; Kaiser and Wright, 2006; Wilbur, 2008; Song, 2012; Fan, 2013). As a result, theoretical work in the area of two-sided markets (Parker and Van Alstyne, 2005; Rochet and Tirole, 2003) predicts that the prices on one side (e.g., reader) may be subsidized at the expense of the other side (e.g., advertiser).

An implication of this cross-subsidy rationale is that a change in the demand characteristics on one side of the market can trigger a change in the optimal price charged on both sides of the market. In the context of newspapers, researchers (e.g., Sridhar and Sriram, 2013) have documented that the growth in media options such as search advertising has resulted in advertisers substituting away from the print newspaper, which, in turn, could have rendered it optimal for the newspaper to increase subscription prices. In fact, Angelucci et al. (2013) and Seamans and Zhu (2013) empirically document that an exogenous negative shock to newspaper advertising results in higher prices to readers. However, they do not discuss the optimality nor systematically explain the drivers of such price increases. Our objective, on the other hand, is to investigate the optimality of price increases, as well as discuss implications for newspaper product portfolio management.

Furthermore, since we consider multiple explanations for the price increase, we seek to infer the extent to which reader heterogeneity vs. decreasing advertising demand drove the increase in subscription prices. Moreover, both Seamans and Zhu (2013)'s and Angelucci et al. (2013)'s data focus on newspaper markets prior to 2006; nevertheless, the U.S. newspaper industry experienced the steepest decline in advertising revenues starting in 2006, the year of the newspaper advertising trough (see Edmonds et al., 2013). Thus given these changes, our time horizon offers unique advantages to studying our research questions. Fur-

ther, access to data on multiple revenue sources (display, inserts, and classifieds) ensures better coverage of our advertising data than those used in these prior studies. This helps us provide valuable managerial insights into the importance and role played by display, inserts, and classifieds advertising on newspaper pricing and product portfolio management decisions.

1.5 Data

We perform our empirical analysis using data from a leading regional U.S. newspaper that prefers to remain anonymous. The data span 72 months from January 2006 through December 2011. The newspaper ranks among the top 50 in the country by paid circulation and is a local monopoly in its market.[6] In addition to offering the print newspaper, the firm operates an online news website that was free for readers during the period of our analysis. In this period, the ad revenues from the newspaper's website accounted for less than 5% of the firm's total revenues.

On the readership side, we have monthly data on paid subscriptions for the newspaper's five major sub-markets (top five counties by circulation) for the three most popular subscription options: Daily, Weekend, and Sunday. Subscribers residing in these sub-markets accounted for 93.4% of the newspaper's total subscription base, and the newspaper's top three bundles accounted for 95.6% of its paying subscribers. Although the total circulation of newspapers typically consists of paid subscriptions and single-copy (newsstand) sales, we have data at the sub-market level only for subscriptions. Hence, we use subscription data as a proxy for readership in our empirical analysis.[7] Subsequently, we investigate the robustness

[6]Blair and Romano (1993) and Dertouzos and Trautman (1990) report that most daily newspapers exist as the only published newspaper in their local markets.

[7]Henceforth, we use the terms subscription, readership, and circulation interchangeably.

of our results to the inclusion of single-copy sales in section 1.8.4.

While circulation data are at the sub-market (county) level, the subscription prices do not vary at this level of disaggregation. For each subscription option, the firm charges different prices to readers residing in regions within and outside the newspaper's designated market. In our data, two counties fall within the newspaper's designated market (henceforth, NDM) and account for 80-85% of subscribers. The remaining three counties fall outside the NDM (henceforth ONDM). We compiled monthly subscription prices for each bundle within and outside the NDM from the Alliance for Audited Media's Audit Reports.

The newspaper provided us with access to monthly ad revenues and rates on the print newspaper in three advertising formats: a) run-of-print (ROP, or display advertising), b) pre-print (PPT, or newspaper inserts), and c) classifieds (CLAS) advertising. These three advertising types generally constitute over 96% of newspapers' advertising revenues. Advertisers that opt for display advertising are generally business establishments with prespecified advertising budgets. Classifieds advertisers, on the other hand, are generally small business owners or individuals who prefer to post information about products (e.g., "for sale-telephones", "wanted-kitchen appliances") or services (e.g., "moving services", "truck rental"). There is generally very little overlap between newspapers' display and classified advertising revenue streams (Seamans and Zhu, 2013). A majority of advertisers that purchase newspaper inserts include grocery stores and retail establishments (Smith and Wiltse, 2005). Further, across the three types, there are differences in ad placement/ad appearance. While display ads include graphics/firm logos and typically go alongside newspaper editorial text, classified ads generally appears in a pre-specified section of the newspaper (the "Classifieds" section). Newspaper inserts, which generally include product information or intimate consumers about promotions, appear as a separate add-on to newspapers (hence the name

insert).

Although our research question is motivated by the industry-wide phenomenon of increasing print subscription prices, the data used in our empirical analysis come from one newspaper. We assess the representativeness of the focal newspaper by considering the temporal patterns in the total circulation and advertising revenues of the focal newspaper with those for all U.S. newspapers. To this end, we collected the data on the U.S. print newspaper industry from the Newspapers Association of America (website: www.naa.org). We present these temporal patterns in Figure 1. These patterns suggest that the trends in circulation and advertising revenues reflect the general state of the U.S. newspaper industry. Furthermore, the correlation in both total circulation and advertising revenues of the focal newspaper with those metrics for all U.S. newspapers is high (0.967 and 0.998 respectively). Together, these data patterns suggest that the focal newspaper is representative of the population of U.S. print newspapers.

1.5.1 Descriptive Analyses

1.5.1.1 Readership Data

As discussed before, our readership data contain information on newspaper subscription for the three most popular bundles at its five major sub-markets (counties). Access to dissaggregate readership data enables us to explore heterogeneity in subscription behavior across bundles and sub-markets. During our analysis timeframe (2006-2011), 14% of households in the newspaper's market subscribed to the focal newspaper. Cross-sectionally, the NDM contained a higher percentage of subscribing households (18.9%) than the ONDM (3.6%). The small circulation share in ONDM sub-markets suggests that the relatively few readers residing outside the NDM may have a higher valuation for newspaper subscription. Moreover,

subscription prices outside the NDM are higher, possibly also to offset the higher delivery costs outside the NDM.[8]

Subscription to the daily bundle provided home-delivery of the newspaper on all seven days of the week and is the most expensive option (see section A in Table 1). The daily bundle is also the most popular option among subscribers both within and outside the NDM. Conditional on subscribing to the focal newspaper, 72.4% (71.6%) of readers within (outside) the NDM opt for the daily bundle. The corresponding numbers for the Weekend and Sunday only bundles are 5.4% (4.4%) and 22.2% (23.9%), respectively.

Between 2006-2011, prices for all three bundles increased steeply. In Table 2, we present the percentage increase in inflation-adjusted subscription prices over this duration for the Daily, Weekend, and Sunday only bundles, both within and outside the NDM. The Daily bundle witnessed the steepest price increase of nearly 77%, both within and outside the NDM, while prices of the Weekend and Sunday only bundles also increased by 52% and 38%, respectively.

We divide the bundle-level subscription data for each sub-market by the number of households in that sub-market (# county households as reported by the U.S. Census Bureau) to compute the corresponding subscription shares. Section (A) in Table 1 shows that there is substantial cross-sectional variation in the subscription shares for each bundle within and outside the NDM. Further, the temporal pattern for subscription shares in Figure 2 demonstrates that there is significant cross-sectional heterogeneity across the different sub-

[8]Many newspapers have been restricting delivery to geographic regions with very low demand, to potentially save on delivery costs to these far flung areas (Mutter, 2009). To assess whether the magnitude of such endogenous/"self-inflicted" circulation losses is economically significant, we collected annual data for the newspaper at the zipcode level for our analysis period from the AAM Audit Reports. We found that less than 5% of zipcodes drop out from the sample over the duration of our data (a zipcode would not figure in our dataset or the AAM's Audit Reports for that year if the newspaper stopped serving readers from that zipcode, or if that zipcode accounted for less than 25 subscribers).

markets within the newspaper's market.

Since subscription prices vary by NDM/ONDM, we plot the share evolution by pooling across sub-markets corresponding to these regions. From Figure 3, we see that the majority of the decline in print subscriptions arise from within the NDM and for the Daily bundle, which also has the largest readership base.[9] To track the temporal evolution of bundle-level circulation at each sub-market, we computed the average annual percentage change in subscriptions over time at the five sub-markets for all three bundles. We present these in Figure 4. Figure 4 shows that subscription shares for the Daily bundle decay at a faster rate (between 8-11%) in sub-markets within the NDM compared to those outside (between 3-7%). Subscription shares for the newspaper's Sunday only bundle are relatively stable (and even weakly increasing) especially in sub-markets outside the NDM. This suggests that some readers may be substituting from daily subscription to the cheaper Sunday only subscription over time. On average, across the three bundles, the newspaper's circulation witnessed steep year-on-year declines within (outside) the NDM of between 7-10% (2-6%).

Examining the temporal path of newspaper subscriptions in this market, we conjecture that readers' WTP for news might be declining over time. Nevertheless, the concomitant increase in subscription prices might also have contributed to the decline in subscription, thereby making the case for declining WTP less obvious. Further, one explanation for the higher rates of decline observed for Daily subscriptions is that this option witnessed steeper price increases (77% relative to the 40-50% for the other two bundles). This correlational pattern suggests that the newspaper may be using a price-based segmentation approach aimed at driving away some low WTP readers for the Daily option by charging higher prices.[10]

[9] We plot the nominal subscription prices (i.e., pre-inflation adjustment) for each bundle in Figure 3 for comparison.

[10] We discuss this intuition in detail in Section 1.6.3

This motivates our exploration of the role of consumer heterogeneity in the subscription price increases.

1.5.1.2 Advertising Data

The newspaper sets advertising rates for ROP and CLAS in dollars per column inch of advertising while ad rates for PPT are in dollars per 1000 newspaper inserts. By dividing the revenues by these ad rates, we computed the quantity of advertising in terms of the number of column inches for ROP and classifieds, and thousands of inserts for PPT. We present temporal patterns in advertising revenues, rates, and quantity in Figure 5. From the first panel in Figure 5, we see that the revenues from the all three types of advertising declined. Section (B) in Table 1 presents the firm's average ad revenues from each of these advertising types in years 2006 and 2011. ROP advertising on newspapers constitutes the largest form of advertising and typically accounts for over 60% of ad revenues (NAA.org). While ROP and PPT lost 57.7% and 43.4%, respectively during our analysis period, Classifieds ad revenues experienced the steepest decline of 88.3%. The steep decline in display and classifieds advertising has been attributed to the increasing shift in both advertiser and consumer interest towards non-newspaper media such as Google/Yahoo (Sridhar and Sriram, 2013) and Craigslist (Seamans and Zhu, 2013), respectively. On the other hand, industry experts have argued that newspaper inserts have remained relatively stable in the face of external competition primarily due to their higher targeting ability (Sullivan, 2012; Maynard, 2011).

Between 2006 and 2011, classifieds ad rates at the newspaper declined by 66%, possibly as a result of the growing popularity of Craigslist. The rates for display ads and inserts experienced smaller declines of 16.7% and 10.8% respectively. The decline in advertising rates is very likely to have had an adverse effect on the newspaper's advertising margins, thereby

lowering their incentive to subsidize readers at the expense of advertisers. As advertisers typically use a cost per reader (CPM) metric to inform their advertising decisions, we present the CPM for each of the advertising options in Table 3 to track variations in CPM over the course of our analysis. While the CPM for PPT was largely stable, that for ROP (CLAS) increased (decreased) over time.[11] In our estimation, we use alternative formulations for readership to compute CPM based on two plausible alternative scenarios, and explore their implications on our pricing conclusions. These scenarios correspond to different percentage contributions of the Sunday newspaper towards total ad revenues, as discussed in industry reports.

Lastly, in order to to internalize the actual impact of the decline in advertising, we present the relative average susbcription and advertising revenue per reader in Table 4. While advertising constituted 87% of the revenue contribution per reader in 2006, its share decreased to 69% in 2011, suggesting a shift towards a more balanced revenue model. This important pattern motivates our study of the role played by advertising subsidy in determining price increases to readers.

1.5.1.3 Changing costs

The observed path of increasing prices underscores the importance of considering the role of changing marginal costs. As we do not have data on costs incurred by the focal newspaper, we referred to the Inland newspaper database to estimate the newspaper's marginal costs, which mainly constitute the cost of printing and delivering the newspaper to readers. The Inland Press Association compiles information on newspaper subscriptions, advertising and

[11] We present these numbers considering the total readership of the Sunday newspaper, as we discuss subsequently. The trajectory of CPM calculated using reweighted readership was identical.

circulation revenues, costs and margins for a wide panel of small and medium-sized U.S. newspapers (Picard, 1989, p. 110). A cross-sectional comparison of newspapers in the Inland sample showed that larger newspapers incurred higher cost per reader. Thus, we used a circulation-weighted estimate of the average cost per reader for each year, in the Inland database to arrive at estimates of the focal newspaper's marginal costs. By comparing these estimates, we found that the cost per reader increased only marginally at 5% over the duration of our analysis. Thus, changing marginal costs cannot solely explain the steep increase in subscription prices.

1.5.1.4 Changing quality

An alternative explanation for the increase in subscription prices is that the overall quality of the newspapers is increasing over time. Sutton (1991) and Berry and Waldfogel (2010) discuss the possibility that firms can make fixed investments aimed at improving product quality, which, in turn can result in higher prices. In the context of newspapers, researchers (e.g., Berry and Waldfogel, 2010; Fan, 2013) have used the size of the newsroom and the average number of news pages as measures of quality. However, industry reports suggest that the overall quality of newspapers measured along these dimensions declined the period of our analysis.[12] Thus, it is unlikely that changes in quality led to higher subscription prices.

[12]The PEW Journalism Institute reports that full-time professional newsroom employment at newspaper firms fell by 30% since 2000 and by 6.4% just over the last couple of years (http://www.journalism.org/2014/03/26/state-of-the-news-media-2014-key-indicators-in-media-and-news/, http://stateofthemedia.org/2013/overview-5/). Based on our data, the average number of news pages dropped by 27% between 2006-2011. Further, the avg. number of pages containing ads also dropped by 52% during the period.

1.6 Model

In this section, we discuss the decisions made by the three agents in our framework: readers, advertisers and the newspaper firm. Readers choose either one of three newspaper subscription options (Daily, Weekend, and Sunday only) or the outside option of not subscribing. Advertisers make quantity choices on the three available advertising types: ROP, PPT, and CLAS. The newspaper decides subscription prices for the three options and advertising rates for each of the three advertising types. Of the three decisions, we take the first two, those of readers and advertisers, to the data. Conditional on these estimates, we characterize the optimal subscription prices and ad rates and compare their temporal trajectory with the observed data. This enables us to comment on the optimality of the observed price trajectories. Below, we discuss how we model these decisions.

1.6.1 Readership Model

We begin by specifying the utility that reader i who belongs to sub-market l derives from subscribing to the print newspaper option $m \in$ {Daily (Mon through Sun), Weekend (Fri, Sat, Sun), Sun only} during month t as:

$$U_{ilmt} = \alpha_{ilmt} + \beta_{0i}\, p_{lmt} + \beta_{1i}\, newspgs_{\,t} + \xi_{lmt} + \varepsilon_{ilmt}, \tag{1.6.1}$$

where α_{ilmt} is the intrinsic preference that reader i living in sub-market l has for subscription to newspaper option m at time t. p_{lmt} is the inflation-adjusted price paid by the reader in sub-market l for a month's subscription of option m at time t and $newspgs_t$ is the number of pages of news content (i.e., non-advertising pages) available in the newspaper at time t.

We use the number of pages of news (termed the news hole in the literature - cf. Fan, 2013) as a proxy for the quality of the newspaper as perceived by readers (Berry and Waldfogel, 2010).[13] The indirect utility from the outside option is normalized to be $U_{i0t} = \varepsilon_{i0t}$. Given the nature of the decline in circulation faced by print newspapers and the general shift in consumer interest towards outside news options, ex ante, we expect to find declining intrinsic preferences (α_{ilmt}) for newspaper subscription.[14] The term ε_{ilmt} is an i.i.d type-1 extreme value distributed error that captures user i's idiosyncratic taste for newspaper bundle m at time t. The term ξ_{lmt} captures the effect of aggregate demand shifters unobserved to the econometrician, but observed by the reader and the newspaper firm. Examples of such unobserved factors include any price promotions offered to subscribers, or unobserved factors influencing news quality (trenchant coverage of popular market events such as the local basketball team's victory, or any changes to the newspaper's popular op. ed. contributor team). We recognize that the unobserved demand shifters are correlated with prices and the number of news pages, which might render these variables in Equation 1.6.1 endogenous. As we discuss subsequently, we control for this endogeneity by using instrumental variables.

In the econometric model, we adopt a specification for α_{ilmt} in Equation 1.6.1 of the form:

$$\alpha_{ilmt} = \alpha_{im} + \gamma_l X_{lt} + \delta_t^d I_t, \tag{1.6.2}$$

[13]Conversations with the newspaper firm revealed that it mainly relied on local reporting (typically funded by the newspaper itself) to source news beats, and did not see big changes over time in the amount of news gathered from syndicated agencies (e.g., PTI, Reuters...). Note that the news hole also indirectly captures the effect of shrinking newspaper size as it becomes increasingly expensive for the news publisher to print newspaper pages.

[14]We found that the number of pages in the newspaper containing ads also dropped by 52% over our analysis window. The correlation between the number of pages containing news and those containing ads was +0.98. This argues against the possibility that the newspaper increased the number of ad pages at the expense of news pages (or vice versa), impacting the newspaper's quality.

where α_{im} is the time-invariant component of utility that reader i derives from subscribing to bundle m, X_{lt} is a vector of demographic characteristics at sub-market l at time t, that can shift the intrinsic preference from subscribing to the newspaper. In our specification, we use the time-varying median income in each sub-market as a shifter of the intrinsic preference.[15] For added flexibility, we allow the effect of the demographic characteristics on the intrinsic preference (i.e., γ_l) to vary by submarket l. In addition, we allow for temporal evolution in the intrinsic preference by using flexible non-parametric controls in the form of year fixed effects (I_t). The year fixed effects control for changes in newspaper subscription preferences over and beyond the role played by changing consumer demographics at each sub-market. As discussed in the Data section, we observe different rates of decay in subscription shares across sub-markets within and outside the NDM (see Figure 3). In order to account for this, we allow the δ's to vary over time differently across sub-markets within and outside the NDM (d=1, 0 to signal within and outside, respectively). For identification, we set I_t for the year 2006 to zero. We also allow the price sensitivity parameter to vary for sub-markets within and outside the NDM to allow for differences in the rate of change of subscription shares at sub-markets within and outside the NDM as a function of NDM/ONDM subscription price increases.

In our empirical specification, we express α_{im} as the sum of three components: (a) utility from Monday through Thursday subscription (b) utility from Friday and Saturday subscription, and (c) utility from Sunday subscription. A reader who subscribes to the newspaper's daily bundle derives benefits corresponding to (a), (b) and (c), while a Sunday only subscriber would only derive the utility corresponding to (c). As opposed to using alternative specific fixed effects, the proposed approach enables us to isolate the "part-worth"

[15]We compiled these county-level median income data from the U.S. Census Bureau's American Community Survey database.

that readers derive from subscribing to the print newspaper on different subsets of the days of the week. This, in turn, will enable us to perform counterfactual analyses wherein the newspaper restricts circulation to certain days of the week. However, an implicit assumption in the proposed specification is that the utility from (a), (b) and (c) above are additive.

The specification in equation (1.6.1) assumes that consumers' utility is not affected by the levels of advertising in the newspaper. The rationale for this assumption is as follows: conceptually, it has been argued that newspaper readers are not influenced by advertising levels primarily because newspaper ads can be more easily skipped when compared to some other media (Argentesi and Filistrucchi, 2007; Gabszewicz et al., 2004; Rosse, 1970). To empirically test for this using our data, we allowed the levels of advertising (proxied by total advertising quantity) to influence consumer utility. We found that its effect is negative, small and statistically insignificant. We provide details of the various alternative model formulations we adopted in Appendix B. Thus, we assume that advertising levels do not influence readership decisions. This assumption also helps us break the circularity problem introduced by the cross-dependency between advertising and readership systems, in determining optimal prices. Furthermore, this is a common assumption made by papers studying the newspaper industry (Argentesi and Filistrucchi, 2007; Fan, 2013; Gentzkow, 2007), motivated by a similar empirical finding that newspaper advertising quantity does not influence readers' decisions.

Given our assumption that ε_{ilmt} follows an extreme value distribution, the probability that consumer i choses bundle m is given by:

$$P_{ilmt} = \frac{exp(\alpha_{ilmt} + \beta_{0i}\, p_{lmt} + \beta_{1i}\, newspgs_{\,t} + \xi_{lmt})}{1 + \sum_{h=1}^{3} exp(\alpha_{ilht} + \beta_{0i}\, p_{lht} + \beta_{1i}\, newspgs_{\,t} + \xi_{lht})}.$$

In Equations (1.6.1) and (1.6.2), we allow for heterogeneity in three sets of parameters, the intrinsic preference for news consumption (α_{im}), price-sensitivity (β_{0i}), and response to the number of news pages (β_{1i}). In our empirical application, we capture heterogeneity in these parameters in the form of discrete segments similar to Besanko et al. (2003), Nair (2007) and Liu (2010).

Our assumption of extreme-value distributed errors and a discrete distribution for the heterogeneous parameters generates the following expression for subscription shares for sub-market l and bundle m:

$$S^d_{lmt} = \sum_{s=1}^{S'} \lambda^s \frac{exp(\alpha^s_m + \beta^{s,d}_0 p_{lmt} + \beta^s_1 newspgs_{\,t} + \gamma_l X_{lmt} + \delta^d_t I_t + \xi_{lmt})}{1 + \sum_{h=1}^{3} exp(\alpha^s_h + \beta^{s,d}_0 p_{lht} + \beta^s_1 newspgs_{\,t} + \gamma_l X_{lht} + \delta^d_t I_t + \xi_{lht})}, \tag{1.6.3}$$

where λ^s corresponds to the proportion (or size) of the market comprised by consumers belonging to one of s=1...S' discrete segments. Equation (1.6.3) provides the expression for readership subscription shares that we take to the data.

1.6.2 Advertising Model

We adopt a constant elasticity specification for aggregate advertising demand similar to Rysman (2004) and Fan (2013). Formally,

$$ln(q_{kt}) = \mu_{kt} + \varphi_k ln(r_{kt}/R_t) + \iota_{kt}, \tag{1.6.4}$$

where q_{kt} is the advertising quantity for ad type k, which is calculated by dividing the ad

revenues for each type by the respective ad rates in period t. Recall that we define quantity in terms of the total number of column inches for ROP and Classifieds, and thousands of inserts for PPT. The term r_{kt} is the inflation-adjusted advertising rate charged by the newspaper for ad type $k = \{1, 2, 3\}$ standing for ROP, PPT, and CLAS advertising, respectively at time t. The term R_t is the focal newspaper's readership level (in thousands) at time t obtained by summing over all county level readerships. Together, r_{kt}/R_t represents the cost per 1000 readers (CPM) incurred in placing ads in the print newspaper at time t and φ_k captures the corresponding elasticity.[16] Since the CPM is a composite metric that captures both the cost of placing ads and the size of the audience, advertisers typically use it to compare alternative media options.[17] The parameter μ_{kt} represents the intrinsic attractiveness of each advertising type k as perceived by advertisers and is allowed to vary over time to capture exogenous changes in the competitive environment (e.g., the growth of Outdoor, Hispanic and Internet advertising options). Therefore, while φ_k captures the shape of the advertising demand curve as a function of the CPM, μ_{kt} allows this demand curve to shift over time. ι_{kt} is a normal mean-zero i.i.d error term for advertising quantity.

As discussed earlier, we define R_t, which, in turn, is used to compute the CPM, based on alternative assumptions regarding the metric of readership that advertisers use while deciding on the advertising quantity. The metrics differ in terms of the relative weighting of the Sunday and Weekday circulation figures. For the first measure of R_t, based on discussions with managers at the newspaper and industry reports, we determined that 50% of the

[16] Since the ad rates for PPT are already in CPM, we do not divide them by readership in equation 1.6.4.

[17] Changing composition of readers in terms of their WTP can induce externalities for advertising demand, partly because advertisers might value high and low WTP readers differently (Chen and Xie, 2007). To explore this further, we tried alternative flexible specifications that allowed different CPM elasticities for each readership segment. However, the estimation could not discern significant differences in elasticities for the different segments of subscribers.

newspaper's ad revenues came from the Sunday newspaper.[18] Based on this assumption, we computed R_t as a weighted average of the number of readers in each subscription option such that the weights satisfied the constraint that the Sunday newspaper is responsible for half the ad revenues. We we provide further details on this weighting in Appendix A. For the second measure of R_t, we used the sum of the number of subscribers for all bundles. Since Sunday delivery is included in all three subscription options, the R_t term corresponds to the total number of readers reached by the focal newspaper's Sunday edition. The rationale is that this metric is prominently displayed in the Alliance for Audited Media's Audit Reports as well as on newspapers' websites, both of which are intended to serve as guidelines for advertisers. We verify the robustness of our results to these alternative assumptions regarding R_t in section 1.8.4.2.

Before proceeding further, a brief discussion regarding our restriction of zero cross-price elasticities between the three types advertising is warranted. This assumption implies that advertisers do not substitute or perceive synergies between the three types of advertising. This assumption is partly dictated by the empirical reality that the CPMs for the three types of advertising are highly collinear, which precludes us from identifying separate own- and cross-price effects. Moreover, the assumption that advertisers do not substitute between different types of advertising is reasonable in our context because the three ad types are different in advertising form, the nature of target advertisers and advertising objective (as discussed earlier). Furthermore, our conversations with managers at the newspaper revealed that advertisers rarely switch between ad types, suggesting that substitution is unlikely to be sizable. Nevertheless, it is conceivable that advertisers may perceive synergies between the advertising types. Such synergies are likely to arise if advertisers employ multiple types

[18] http://stateofthemedia.org/2013/newspapers-stabilizing-but-still-threatened/

of advertising simultaneously. However, our interviews with managers at the newspaper suggested that a very small proportion of advertisers (<10%) generally invest in more than one advertising type in each year.

In order to study the role of exogenous changes in the ad market on subscription prices, it is important to account for the temporal evolution of intrinsic advertising attractiveness of advertising in each option. The intrinsic attractiveness reflects the relative effectivess of advertising in that option, as perceived by advertisers; the advent of alternative media options for advertising might have altered the perceived relative effectiveness of these options over time. In our econometric model for advertising demand, we adopt the following specification for intrinsic advertising attractiveness μ_{kt}:

$$\mu_{kt} = \mu_k + \vartheta_{kt} Y_{kt} + \varrho_k \widetilde{Y}_{kt}, \tag{1.6.5}$$

where the Y_{kt} are advertising type-specific year dummies. As in the readership model, these year dummies capture changes in advertising levels across years, with year 2006 as base. The term $\widetilde{Y}_{kt}$ incorporates controls for month-to-month changes in advertising demand in the form of a within year time-trend. We estimate a common elasticity (φ) for the three advertising options during estimation. Ex ante, we expect Y_{kt} to decline over time, resulting in the overall advertising demand curve shifting downwards as a result of increasing competition. Recovering a declining intercept for print advertising would help us evaluate the possibility that the decline in advertising subsidy contributed to price increases faced by readers of the print newspaper as discussed in detail in section 1.6.3.

1.6.3 Pricing

We now discuss the optimal newspaper prices as a function of the readership and advertising demand parameters. The profit function of the newspaper monopolist is of the form:[19]

$$\pi_t = (p_1^N - c_1^N)R_1^N + (p_2^N - c_2^N)R_2^N + (p_3^N - c_3^N)R_3^N + (p_1^O - c_1^O)R_1^O + (p_2^O - c_2^O)R_2^O + (p_3^O - c_3^O)R_3^O + (r_{1t} - \ddot{\kappa}_{1t})q_{1t} + (r_{2t} - \ddot{\kappa}_{2t})q_{2t} + (r_{3t} - \ddot{\kappa}_{3t})q_{3t}, \quad (1.6.6)$$

where $R_{(1...3),\,t}$ and $p_{(1...3),\,t}$ refer to the newspaper's print circulation and subscription price for the three bundles respectively (with the N and O superscripts indexing NDM and ONDM costs, prices and readership) and $q_{(1...3),\,t}$ and $r_{(1...3),\,t}$ refer to the advertising quantity and advertising rate corresponding to ROP, PPT, and Classifieds advertising. The terms $c_{(1...3),\,t}$ and $\ddot{\kappa}_{(1...3),\,t}$ refer to the marginal costs at time t associated with printing and distribution of the newspaper and the marginal cost of selling ad space and printing advertising. The first order condition (FOC) for the prices to readers and advertisers is:

[19] As discussed before in footnote 6, almost all U.S. daily newspapers are local monopolies. However, these local newspapers may face competition from National newspapers and other news/advertising outlets within their local markets. The outside option in our demand model helps us account for this competition. However, our characterization of pricing assumes away competitive responses to price changes at the focal newspaper. We assume that the impact on pricing of such competitive effects is small. A similar assumption is made by other papers studying newspapers' pricing decisions (Blair and Romano, 1993; Gentzkow, 2007; Fan, 2013).

$$\begin{bmatrix} p_{1t}^N - c_{1t}^N \\ p_{2t}^N - c_{2t}^N \\ p_{3t}^N - c_{3t}^N \\ p_{1t}^O - c_{1t}^O \\ p_{2t}^O - c_{2t}^O \\ p_{3t}^O - c_{3t}^O \\ r_{1t} - \ddot{\kappa}_{1t} \\ r_{2t} - \ddot{\kappa}_{2t} \\ r_{3t} - \ddot{\kappa}_{3t} \end{bmatrix} = - \begin{bmatrix} \frac{\partial R_{1t}^N}{\partial p_{1t}^N} & \frac{\partial R_{2t}^N}{\partial p_{1t}^N} & \frac{\partial R_{3t}^N}{\partial p_{1t}^N} & 0 & 0 & 0 & \left(\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p_{1t}^N}\right) & \left(\frac{\partial q_{2t}}{\partial R_t}\frac{\partial R_t}{\partial p_{1t}^N}\right) & \left(\frac{\partial q_{3t}}{\partial R_t}\frac{\partial R_t}{\partial p_{1t}^N}\right) \\ \frac{\partial R_{1t}^N}{\partial p_{2t}^N} & \frac{\partial R_{2t}^N}{\partial p_{2t}^N} & \frac{\partial R_{3t}^N}{\partial p_{2t}^N} & 0 & 0 & 0 & \left(\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p_{2t}^N}\right) & \left(\frac{\partial q_{2t}}{\partial R_t}\frac{\partial R_t}{\partial p_{2t}^N}\right) & \left(\frac{\partial q_{3}}{\partial R_t}\frac{\partial R_t}{\partial p_{2t}^N}\right) \\ \frac{\partial R_{1t}^N}{\partial p_{3t}^N} & \frac{\partial R_{2t}^N}{\partial p_{3t}^N} & \frac{\partial R_{3t}^N}{\partial p_{3t}^N} & 0 & 0 & 0 & \left(\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p_{3t}^N}\right) & \left(\frac{\partial q_{2t}}{\partial R_t}\frac{\partial R_t}{\partial p_{3t}^N}\right) & \left(\frac{\partial q_{3t}}{\partial R_t}\frac{\partial R_t}{\partial p_{3t}^N}\right) \\ 0 & 0 & 0 & \frac{\partial R_{1t}^O}{\partial p_{1t}^O} & \frac{\partial R_{2t}^O}{\partial p_{1t}^O} & \frac{\partial R_{3t}^O}{\partial p_{1t}^O} & \left(\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p_{1t}^O}\right) & \left(\frac{\partial q_{2t}}{\partial R_t}\frac{\partial R_t}{\partial p_{1t}^O}\right) & \left(\frac{\partial q_{3t}}{\partial R_t}\frac{\partial R_t}{\partial p_{1t}^O}\right) \\ 0 & 0 & 0 & \frac{\partial R_{1t}^O}{\partial p_{2t}^O} & \frac{\partial R_{2t}^O}{\partial p_{2t}^O} & \frac{\partial R_{3t}^O}{\partial p_{2t}^O} & \left(\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p_{2t}^O}\right) & \left(\frac{\partial q_{2t}}{\partial R_t}\frac{\partial R_t}{\partial p_{2t}^O}\right) & \left(\frac{\partial q_{3}}{\partial R_t}\frac{\partial R_t}{\partial p_{2t}^O}\right) \\ 0 & 0 & 0 & \frac{\partial R_{1t}^O}{\partial p_{3t}^O} & \frac{\partial R_{2t}^O}{\partial p_{3t}^O} & \frac{\partial R_{3t}^O}{\partial p_{3t}^O} & \left(\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p_{3t}^O}\right) & \left(\frac{\partial q_{2t}}{\partial R_t}\frac{\partial R_t}{\partial p_{3t}^O}\right) & \left(\frac{\partial q_{3t}}{\partial R_t}\frac{\partial R_t}{\partial p_{3t}^O}\right) \\ 0 & 0 & 0 & 0 & 0 & 0 & \frac{\partial q_{1t}}{\partial r_{1t}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{\partial q_{2t}}{\partial r_{2t}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{\partial q_{3t}}{\partial r_{3t}} \end{bmatrix}^{-1}$$

$$\begin{bmatrix} R_{1t}^N \\ R_{2t}^N \\ R_{3t}^N \\ R_{1t}^O \\ R_{2t}^O \\ R_{3t}^O \\ q_{1t} \\ q_{2t} \\ q_{3t} \end{bmatrix}. \quad (1.6.7)$$

The zeros in the first six columns in rows 7 through 9 in the markup matrix Ω in Equation (1.6.7) are a result of our assumption that the subscription decision does not depend on the quantity of advertising. Note that the zeros in the off-diagonal elements corresponding to

the last three columns of rows 7 through 9 are a result of our assumption that advertisers do not substitute between the three types of advertising.

We re-write the FOC for subscription option m, $m = 1, 2, 3$, for the NDM as

$$\left(p^N_{mt} - c^N_{mt}\right) = \underbrace{-\frac{R^N_{mt}}{\left(\frac{\partial R^N_{mt}}{\partial p^N_{mt}}\right)}}_{1} \underbrace{-\sum_{m' \neq m} \frac{R^N_{m't}}{\left(\frac{\partial R^N_{m't}}{\partial p^N_{mt}}\right)}}_{2}$$
$$\underbrace{-\frac{(r_{1t} - \ddot{\kappa}_{1t})\frac{\partial q_{1t}}{\partial R_t}\frac{\partial R_t}{\partial p^N_{mt}}}{\left(\frac{\partial R^N_t}{\partial p^N_{mt}}\right)}}_{3} \underbrace{-\frac{(r_{2t} - \ddot{\kappa}_{2t})\frac{\partial q_{2t}}{\partial Rt}\frac{\partial R_t}{\partial p^N_{mt}}}{\left(\frac{\partial R^N_t}{\partial p^N_{mt}}\right)}}_{4} \underbrace{-\frac{(r_{3t} - \ddot{\kappa}_{3t})\frac{\partial q_{3t}}{\partial R_t}\frac{\partial R_t}{\partial p^N_{mt}}}{\left(\frac{\partial R^N_t}{\partial p^N_{mt}}\right)}}_{5}. \quad (1.6.8)$$

The FOC from equation (1.6.6) with respect to advertising rates for type k are given by:

$$(r_{kt} - \ddot{\kappa}_{kt}) = -\frac{q_{kt}}{\left(\frac{\partial q_{kt}}{\partial r_{kt}}\right)}. \quad (1.6.9)$$

Equation (1.6.8) governs the subscription pricing rule for the newspaper firm. Recall that the term c_{mt} is the marginal cost of serving a reader of bundle m at time t and $(p_{mt} - c_{mt})$ represents the firm's price-cost margin. The first term on the right hand side in Equation 1.6.8 captures the extent to which the the readership of a subscription option changes with a unit increase in its own price. The second term captures the positive offset derived from bundle m readers substituting to the other two subscription options due to the increase in bundle m prices. The terms 3, 4, and 5 correspond to the effect of ROP, PPT, and CLAS

advertising subsidy on bundle m's subscription prices.

The price-cost markup for advertising in Equation 1.6.9 is a function of both the price response of advertising demand and actual levels of advertising demand. Note that because we assume that readers are not influenced by the levels of advertising in the newspaper, the above expression does not contain a "direct" effect of readership on ad rates. However, from equations (1.6.4) and (1.6.9), we can see that the optimal price-cost margin for advertising will decrease with declining readership since advertising demand is a function of readership.

We now discuss how reader heterogeneity and changing demand conditions on the advertising side can affect subscription prices. First, consider the heterogeneity argument. If we only consider the pricing of a single bundle without advertising externalities, the first order condition will reduce to the first term in Equation (1.6.8). The optimal price for bundle m is a decreasing function of how readership responds to subscription prices, i.e., $\left|\frac{\partial R_{mt}}{\partial p_{mt}}\right|$. If the market comprises of two segments of customers in terms of their WTP, then, $\frac{\partial R_{mt}}{\partial p_{mt}} = \lambda^1 \frac{\partial R^1_{mt}}{\partial p_{mt}} + \lambda^2 \frac{\partial R^2_{mt}}{\partial p_{mt}}$, where λ^1 and $\lambda^2 (= 1 - \lambda^1)$ are the relative sizes of the high and low WTP customer segments respectively, and $\frac{\partial R^1_{mt}}{\partial p_{mt}}$ and $\frac{\partial R^2_{mt}}{\partial p_{mt}}$ are their corresponding subscription responsiveness to prices. Given their lower WTP for the newspaper, we expect that $\left|\frac{\partial R^2_{mt}}{\partial p_{mt}}\right| > \left|\frac{\partial R^1_{mt}}{\partial p_{mt}}\right|$. With the arrival of alternative sources of news over time, the low WTP subscribers are more likely to quit, leading to lower λ^2, and hence higher λ^1. The resulting decrease in $\left|\frac{\partial R_{mt}}{\partial p_{mt}}\right|$ would render it optimal to increase subscription prices as low WTP readers quit.

Let us now consider the role of ad subsidy. If declining attractiveness of the print newspaper relative to alternative media options lowers advertisers' WTP for advertising, it would decrease the optimal advertising price-cost margin (see the FOC for ad rates in Equation 1.6.9). This, in turn, would reduce the newspaper's incentive to subsidize readers at

the expense of advertisers. In our empirical specification, we capture the second mechanism by allowing μ_{kt} to change over time via year fixed-effects.

1.7 Estimation

1.7.1 Overview of the Estimation

We use GMM employing instrumental variables (discussed in the next section) to estimate the readership demand parameters. Estimation proceeds similar to Berry et al. (1995) where the mean utility for each bundle is recovered via contraction mapping. Besanko et al. (2003) provide a detailed discussion of the estimation strategy. The parameters to be estimated in the readership system are: a) the heterogeneous parameters: mean estimate for Segment 1 (${\bar{\alpha}^1}_m$), and deviation from Segment 1's mean for Segment 2 corresponding to readers' preferences for newspaper subscription on the specific days of the week, price sensitivity, and responsiveness to changes in news pages, b) the parameters governing the temporal variation in reader preferences, viz., year dummies (δ_t^d), effect of demographic shifters - average income - on readership (γ^l), and c) the parameter corresponding to the relative size of Segment 1 (λ^s). The advertising demand parameters to be estimated are: a) elasticity of advertising demand to changes in readership adjusted prices (φ), b) advertisers' intrinsic attractiveness for ROP, PPT and CLAS advertising, and parameters governing their temporal evolution (the year dummies corresponding to each advertising type) - μ_{kt}. We estimate the advertising demand parameters using GMM, employing the orthogonality of demand shocks and instrumental variables as moment conditions. We estimate the readership and advertising demand equations sequentially in order to obviate concerns that a misspecification in one

equation may contaminate the other (Villas-Boas, 2007).

1.7.2 Identification

We ask two questions in this paper: (a) are the observed trajectories of subscription and advertising prices optimal? and (b) if optimal, to what extent do subscriber heterogeneity and the decreasing incentive to subsidize readers at the expense of advertisers drive the increase in subscription prices? The key challenge in answering these questions is that we are dealing with a system of simultaneous decisions made by three agents: readers (subscription decision), advertisers (advertising quantity decisions), and the newspaper (decision to set subscription and advertising prices and the number of pages of news). Therefore, part of our discussion on identification revolves around the exclusion restrictions needed to break this simultaneity. The rest of the discussion deals with recovering aspects of the demand model that are essential to answering our second research question. While answering the first question, we do not assume that the observed prices are optimal. Rather, we compare the optimal price trajectory implied by the FOCs (Equations 1.6.8 and 1.6.9), conditional on the estimated readership and advertising demand equations, with the observed prices in order to comment on the first question. Nevertheless, although we do not take a stance on the data generating process behind the pricing and the number of news pages decisions, we need to control for their endogenous nature while estimating the readership and advertising demand equations.

The endogeneity of prices arises because the newspaper anticipates readership and advertising demand shocks such as periodic sports seasons while setting the respective prices. In order to break this endogeneity, we need instruments that shift subscription prices and

ad rates, but are not related to the demand shocks. In order to account for the endogeneity of the subscription prices and the number of news pages, we use the costs associated with printing and distributing newspapers as instruments, viz., producer price index for printing ink manufacturing (NAICS 32591), the cost of output from paper mills (NAICS 32212), average wages of workers involved with producing and distributing print newspapers (NAICS 32323), and producer price indices of firms in industries that share similar cost structures, such as book publishers (NAICS 511130). The premise is that while these costs will drive subscription prices and the number of news pages, they are unlikely to be related to the readership demand shocks, conditional on the endogenous variables. Liu (2010) uses similar instruments to resolve the endogeneity of prices in the video games market. In order to verify the strength of these instruments, we report the results from the first-stage regression of the endogenous variables on the instruments in Table (5) section (A). These results suggest that the instruments, along with other exogenous variables, explain 86% (96%) of the variation in prices (number of news pages), with many instruments exhibiting statistical significance. Compared to the first stage regression with only the exogenous variables, but excluding the instruments, the proposed instrumental variables improve the R-squared for prices by 38%. Therefore, we believe that our instruments are relatively strong (Rossi, 2014).

Similar to the subscription prices, the newspaper is likely to have set advertising rates in anticipation of the realized demand shocks. In order to control for this endogeneity, we use instrumental variables consisting of the factor cost of lithographic/offset printing ink manufacturing (NAICS 325910) and producer price indices of advertising agencies (NAICS 541810). We collected these data from the Bureau of Labor Statistics (www.bls.gov). In order to verify the strength of these instruments, we report the results from the first-stage regression of the endogenous variables on the instruments in Table (5) section (B). These

results suggest that the instruments, along with other exogenous variables, explain 76% of the variation in ad rates. Compared to the first stage regression with only the exogenous variables, but excluding the instruments, the proposed instrumental variables improve the R-squared by 12%. Therefore, we believe that our instruments are relatively strong.

The other endogeneity concern in estimating the readership and advertising demand equations arises from the interlinked nature of these two decisions. Our restriction that advertising quantity does not influence the subscription decision implies that the readership demand model is identified without the need for additional exclusion restrictions. On the other hand, readership enters the advertising demand model as a covariate in the form of the CPM variable (r_{kt}/R_t term in Equation 1.6.4). This might lead to an endogeneity problem if factors that are omitted from the advertising demand equation are also correlated with readership. The premise is that factors such as an upcoming local election, local events such as restaurant weeks or popular street fairs may increase demand for local newspaper consumption among readers, as well as for local advertising. Therefore, the advertising demand shocks are likely to be correlated with readership, thereby resulting in biased estimates for the advertising demand model.

If the advertising demand shocks are induced by local events, the readership of print versions of national newspapers in the local market is likely to be a viable instrument. The premise is that readership of national newspapers is a proxy for preference for print newspaper consumption in the local market, and should hence be related to the readership of the focal newspaper. However, given that 76% of advertising for the focal newspaper accrues from local advertisers, it is unlikely that the local readership of the national print newspapers is related to the demand shocks for advertising in the focal newspaper, especially, if they represent local omitted variables discussed above. However, if the advertising demand shocks

at the focal newspaper include components that are correlated with the local readership of national newspapers, such as national elections, the validity of the instrument is likely to be questionable. In order to minimize this concern, we incorporate strong temporal controls in the form of year fixed effects and parametric controls for within year changes in our advertising demand models.

Based on the above rationale, we use the percentage of readers in the local market that subscribe to the New York Times and the Wall Street Journal, as an excluded variable.[20] We find that the correlation between the subscription of the local newspaper and the local subscription of these national newspapers is 0.8, suggesting that it is not a weak instrument. We present results from the first-stage regression of prices and readership on instruments in Table (5) section (B). These results suggest that the instruments, along with other exogenous variables, explain 83% of the variation in readership. Compared to the first stage regression with only the exogenous variables, but excluding the instruments, the proposed instrumental variables improve the R-squared by 82%. Therefore, we believe that our instrument is reasonably strong.

The identification of the extent to which two alternative explanations drove the increase in subscription prices warrants further discussion. We answer this question by simulating the optimal subscription and ad prices under two counterfactual scenarios: (a) without heterogeneity in WTP and (b) holding the intrinsic preference for advertising in each option at the same level as in 2006. Therefore, decomposing the relative effects of these two drivers cleanly depends on our ability to identify heterogeneity in WTP and the change in intrinsic preference for advertising in each option over time. Of these, the identification of the

[20]Note that the demographic characteristics (median county income) also implicitly act as exclusion restrictions and aid in the identification of the effect of readership on advertising demand.

change in intrinsic preference for advertising in each option over time is relatively straightforward: while the type specific year fixed effects capture any year-on-year changes in the corresponding ad demand, the within year controls capture the remaining variation.

Given that we use aggregate data on subscription, the heterogeneity distribution in the readership demand model is identified based on how the observed substitution in response to price changes between bundles and the outside options deviates from that predicted under IIA. There are three sources of variation that enable the identification of heterogeneity in this manner: (a) cross-sectional variation in subscription and prices across the three subscription options, (b) cross-sectional variation in subscription and prices geographically across submarkets, and (c) temporal variation in subscription shares and prices. Intuitively, conditional on the non-heterogeneous parameters, the functional form of the logit model would dictate how low- and high-WTP readers would react to changes in subscription prices. Mapping these predicted responsiveness to price changes to those observed in the data helps us in pinning down the heterogeneity distribution.

1.8 Results

1.8.1 Readership Results

As discussed earlier, we employ a discrete heterogeneity structure for readership demand. Following previous work (Besanko et al., 2003; Liu, 2010), we identify the appropriate number of segments by adding segments until one of the segments sizes becomes statistically insignificant. In our model calibration, we recover two distinct segments. We present these results in Table 6. Segment 1 comprises 8.5% of the market, and has a higher preference

for newspaper subscription than segment 2. The remaining 91.5% of the market has lower preference for subscribing to the focal newspaper and is also relatively more price sensitive. Amongst subscribing households, 33% belonged to segment 1, on average, while the remaining belonged to segment 2. For example, the preference for the Daily bundle (as obtained by summing over the intercepts corresponding to M-Thurs, Fri/Sat, and Sun) is less negative for segment 1 when compared to segment 2. We present the actual parameters for segment 1 and segment 2 in Table 6 for ease of interpretation, though we recover the deviation from segment 1 for segment 2 in our estimation. We computed the standard errors using a bootstrap procedure with 1000 replications.

We find that the portion of readers' utility attributable to their newspaper consumption on Monday-Thursday is positive while those for Fri/Sat and Sunday are negative. These results are driven by the fact that the Daily bundle has significantly more subscribers than the Sunday and Weekend bundles. As discussed before, under the assumption of additive utility, the intrinsic preference for the daily bundle is the sum of the intercepts corresponding to Mon-Thurs, Fri/Sat and Sun. The corresponding estimate for the Weekend bundle is the sum of intercepts for Fri/Sat and Sun.

Most year-dummies are negative and significant, suggesting that subscription preferences in later years were lower than those in 2006. To further visualize the effect of declining preferences, we plot the subscription for each bundle in markets within and outside the NDM, broken down by segment in Figure 6. Consistent with our discussion regarding the steeper decline in Daily bundle readership, we see that Daily bundle readership in the low-type segment (Segment 2) decreases relatively substantially. This result supports the argument that low-valuation readers of this bundle exit the market when faced with higher subscription prices. Another way to visualize this is by inspecting a plot of the proportion of high-type

readers belonging to each bundle (conditional on subscribing to the print newspaper) in NDM/ONDM markets (Figure 7). On average, across the three bundles, the ONDM sub-markets consist of a higher proportion of loyal readers. This finding is also consistent with the raw pattern in the data that showed marginally lower percentage decline in subscription at ONDM sub-markets (Figure 4). Further, we see that the percentage of low-WTP readers of the Daily newspaper within the NDM decreased from 61% in 2006 to 38% in 2011. As these low valuation readers exit the market, we see that the relative proportion of high WTP readers of the Daily bundle exhibits an increasing trend over time. On the other hand, there is little or no attrition in the proportion of low WTP readers for the other two subscription bundles. We discuss the pricing implications of differences in the evolution of readership segment composition in detail in Section 1.8.3.1.

1.8.2 Advertising Results

We present the results from our advertising model in Table 7. The estimated advertising demand price elasticity is -1.13, which is similar to that reported by Fan (2013) for a wide panel of U.S. newspapers. When we omit the controls for within year variations in advertising demand, the price elasticity of demand increases to -1.72%. Nevertheless, the key substantive findings are similar across both specifications.[21] The type-specific year fixed effects for all advertising types are negative and significant. Moreover, these fixed-effects are monotonically decreasing for all three types of advertising, suggesting a decline in intrinsic attractiveness, possibly driven by lower perceived attractiveness of print advertising relative to outside media options. As discussed earlier, the constant elasticity functional form would imply that the

[21]Our final pricing conclusions are not sensitive to including or excluding these within-year temporal controls - the contribution of each explanation changes only at the first decimal point when we ignore within year variations to calibrate the explanations.

advertising sensitivity to readership ($\partial q/\partial R$ term in Equation 1.6.8) would decline over time as the intrinsic attractiveness of print advertising options decrease. Together, the decline in intrinsic attractiveness and lower $\partial q/\partial R$ lower the newspaper's incentive to subsidize readers at the expense of advertisers.

1.8.3 Optimal Prices

Earlier, we asked whether the observed trajectories of increasing subscription prices and declining ad rates are indeed optimal. In order to assess this, conditional on the estimated readership and advertising demand parameters, we compute the optimal markups on both sides of the market, as described in Equation (1.6.7).

We present the percentage change, between 2006-2011 in the optimal subscription and advertising markups implied by equations (1.6.8) and (1.6.9) in Table 8. These results suggest that the trajectory of optimal markups on both sides is similar to those observed in the data; optimal subscription markups exhibit an increasing trend while optimal advertising markups decline substantially. As a second check, we use the values of the optimal subscription markups and marginal costs (collected from the Inland database, as discussed before in section 1.5.1.3) to compute optimal prices. Given the increasing trajectory of optimal markups and costs, we find that the optimal prices that the newspaper ought to charge its subscribers also increase during the period of our analysis. We also find that this trajectory of optimal prices is quite similar to that of the actual prices observed in our data (the correlation between the two is 0.88). Therefore, increasing prices to readers is consistent with optimal pricing behavior.

1.8.3.1 What explains the increase in subscription prices?

Recall that we had advanced reader heterogeneity and lower incentive to subsidize readers at the expense of advertisers as two reasons why it might be optimal for the newspaper to increase its subscription prices. Given the optimal trajectory of subscription prices and ad rates are consistent with the observed data, similar to to Liu (2010), we perform counterfactual analyses to understand the extent to which the two mechanisms are responsible for the increase in subscription prices.

We first consider the role of reader heterogeneity. In order to assess the extent to which reader heterogeneity contributed to changes in the firm's pricing, we first compute the predicted level of readership generated by the model when there is no reader heterogeneity. As in Liu (2010), we compute a homogeneous equivalent model using the segment-size-weighted average of the heterogeneous parameters. We then calculate the corresponding advertising demand using Equation (1.6.4). In order to assess the extent to which the decline in the intrinsic attractiveness of advertising led to increases in subscription prices, we use the advertising demand parameters to arrive at a predicted level of advertising demand generated by maintaining perceived advertising attractiveness at the 2006 level by switching off the estimated year fixed effects for 2007-2011 at their original levels (as they were in year 2006). Recall that these year fixed effects capture the extent to which the advertising demand curve shifts downward from year to year. Using the predicted advertising demand, we can compute what the markups for the newspaper firm would have been without the witnessed decline in the intrinsic attractiveness of advertising.

We present the subscription prices for each subscription option for years 2006, 2011 and the dollar contribution of each explanation towards the price increase between 2006

and 2011, in Table 10.[22] Let us first consider average price across all three subscription options. These results suggest that within the NDM, reader heterogeneity contributed to about 20% of the increase in subscription prices. On the other hand, nearly 80% of the increase in subscription prices between 2006 and 2011 can be traced back to the decreasing incentive on the part of the newspaper to subsidize readers at the expense of advertisers. The results for the counties outside the NDM exhibit a similar pattern; reader heterogeneity can only explain 12.43% of the increase in subscription prices. Overall, these results suggest a conscious shift on the part of the newspaper from being heavily dependent on advertising to a more balanced model where readers make a sizeable contribution too; while advertising accounted for 87% of the revenue generated by a average reader in 2006, this share decreased to 69% in 2011.

We further explore the decreasing role of advertising subsidy and the extent to which the resulting increase in subscription prices can be traced back to different types of print advertising. We report the relative extent to which different types of advertising contributed to the price increase in Table 9. These results suggest that the decline in ROP and Classifieds advertising primarily drove the subscription price increases. Thus, our results add to the limited literature that has attempted to document the influence of the classifieds advertising trough on the changes to newspapers' marketing mix (Seamans and Zhu, 2013). Note that while Seamans and Zhu (2013) document a much smaller impact of classifieds advertising decline on subscription prices (3.3%), the end date of their analysis (i.e., 2007) corresponds to the period when newspapers had just started increasing subscription prices. Overall, these results suggest that the increase in subscription prices represent a structural shift from a model where the newspaper used advertising revenue to subsidize readers, to a more

[22]Note that as we present the relative magnitude of the two explanations here, taken together, the two magnitudes explain the difference between 2011 and 2006 prices.

balanced revenue model.

We now explore the subscription price increases at the level of individual subscription options. The results in Table 10 indicate that, for the daily bundle, reader heterogeneity led to a \$2.57 (\$1.80) increase within (outside) the NDM. As a result of the exit of low WTP readers, the proportion of high WTP readers of the daily bundle increased from about 39% (62%) in 2006 to about 62% (82%) in 2011 within (outside) the NDM. These results are consistent with the higher rate of exit of low type customers of the daily bundle (as seen in Figure 6).

The effect of attrition of lower valuation readers is less pronounced for the other two subscription options. While reader heterogeneity accounted for about 30.25% (18.76%) of the increase in daily bundle prices, within (outside) the NDM, in the absence of heterogeneity in WTP among readers of the Weekend and Sunday only bundles, the firm would actually have charged them a higher price. Thus, reader heterogeneity kept prices lower for these bundles as the firm continues to serve even the low-type readers of these bundles. This is consistent with our earlier discussion that the composition of readers of each of the three bundles evolved differently over the course of our analysis. Therefore, the newspaper seems to keen be to retain the low valuation readers during weekends but wean them out of weekdays. The rationale is that as a result of shrinking advertising, the gap between the daily and Sunday-only subscription options, in terms of the revenue generated per reader, has reduced over time; while the daily option generated \$35.13 (\$0.81) more in advertising (circulation) revenue per reader than the Sunday-only option in 2006, the gap shrank (increased) to \$18.95 (\$3.15) in 2011.[23] Thus, while the average daily bundle reader contributed \$35.94

[23]The ad revenue per reader is also based on the assumption that the Sunday newspaper brought in 50% of the ad revenue.

in 2006, that number dropped to $22.10 in 2011. When we consider the cost of printing and distributing the newspaper for six additional days, the relative profitability of the daily option relative to the Sunday-only option is likely to have decreased over time.

In sum, results from our model suggest that the decline in advertising subsidy was an instrumental driver of the steep subscription price increases faced by newspaper readers over the last five years. As a result, the newspaper is moving to a more balanced revenue model where readers and advertising contribute equally in generating revenues. Further, the newspaper is using price as a lever to motivate low WTP readers of the Daily bundle to migrate to more profitable weekend subscription options. Subsequently, we discuss an extreme version of this strategy where newspapers restrict circulation of the print newspaper to weekends, a strategy adopted by many U.S. newspapers, in section 1.8.5.

1.8.4 Robustness Checks

1.8.4.1 The Effect of Online Ad Revenue

The above analyses assume that the readers that quit the print newspaper as a result of increasing subscription prices do not generate any revenue. However, it is conceivable that some of the readers that quit the print version migrate online. Although the newspaper in question did not charge online visitors for news consumption, these marginal readers could still generate advertising revenue. If this extra online ad revenue is substantial and the newspaper internalized this while increasing its subscription prices, our explanation for these price increases is likely to be contaminated.

Nevertheless, incorporating the additional ad revenue formally would require us to (a) characterize the switching pattern between online and print news, albeit within the same

newspaper and (b) parse out the extent to which the subscribers quitting the print newspaper and moving online are incremental online readers. Since we only have aggregate data on print and online readership, the case for the inference of these two effects is likely to be tenuous. In order to circumvent this problem, we make the following generous assumptions on the extra online ad revenue generated as a result of print subscription price increases: a) all the print subscribers that quit the print newspaper move to the newspaper's online edition and b) these readers are all incremental readers of the online newspaper. In reality, given that there in typically some overlap in print and online readership, not every incoming online reader would be incremental.[24] We obtained monthly online ad expenditures for the newspaper from the firm and backed out the advertising revenue generated by each unique visitor to the newspaper's website. Then we use price elasticities based on our model to compute the switching rate corresponding to a unit price increase to the daily newspaper.

Based on these assumptions, we compute the projected online revenue for this new higher level of online readership. We find an incremental online revenue of 2% in 2006, which drops down to 1.1% for 2011,[25] given the switching patterns. This represents a rather insignificant 0.04% (0.29%) increase over print advertising (circulation) revenues. As a final reality check, we compute optimal markups for the three subscription alternatives if the firm considered online revenues as an additional revenue source while setting print subscription prices. We then compare these markups, as earlier, to quantify the contribution of each of the three explanations.[26] We present this comparison in column (1) in Table 12. The relative contribution of the motive to gain online advertising revenues is less than 5% when

[24]Interviews with managers at the newspaper revealed that between 20-25% of print readers also visited the online edition over our analysis horizon.

[25]We provide these numbers for the Daily bundle. The numbers for the other two bundles are similar, and even smaller.

[26]We present the comparison of markups for the case with readership reweighting, with Sunday accounting for 50% of ad revenues.

compared with those of our two proposed explanations.

1.8.4.2 Alternative Assumptions Regarding the Ad Revenue Generated During Different Days of the Week

In our empirical specification, we computed the total readership metric based on the assumption that 50% of the ad revenue came from the Sunday newspaper. Given that our advertising data were not broken down by the days of the week, the cleanest approach to addressing the differential extent to which circulation on various days of the week generate ad revenues would be infer how advertising changes in response to variation in readership on different days of the week over time. The premise is that the cross-sectional and temporal variation in subscriptions during different days of the week will help us infer how advertisers value readers within a week. However, empirically, we were unable to uncover significant differences in advertiser sensitivity to readership on different days of the week.

In order to verify the robustness of the results to our assumption that the Sunday newspaper generates 50% of the ad revenue, we use an alternative specification that uses the sum of all three subscription options as a metric of readership (to compute the CPM). Since all three subscription options receive the Sunday newspaper, their sum corresponds to the reach of the Sunday newspaper. Therefore, in this case our advertising model would implicitly assume that 100% of advertising arose only from the Sunday newspaper. The premise is that the reach on Sunday is prominently displayed in AAM Newspaper Audit Reports and in other promotional materials the newspaper provides to advertisers. Therefore, advertisers probably base their advertising decisions on this readership metric. In Table 11, we explore the robustness of our results to this assumption.

We find that the advertising demand elasticities with this reweighted readership (column 3 in Table 7) are largely consistent with those reported earlier. Based on these revised elasticities, we recomputed the optimal subscription and advertising markups. We present the results from this analysis in the last column of Table 11. Overall, these results are consistent with our earlier finding that heterogeneity in readers' WTP and the decline in advertising were largely responsible for price increase between 2006 and 2011, respectively.

We also verify the sensitivity of the key substantive findings to alternative assumptions regarding the extent to which weekday vs. Sunday editions of the newspaper contribute to the total advertising revenue (please see Table 11).[27] We see that our results are robust to various plausible levels of Sunday advertising contribution (50-100%). Further, as we increase the weight on the Daily bundle, the influence of heterogeneity in governing subscription prices becomes more salient. This is consistent with the raw patterns in our data that indicate a higher rate of exit among Daily bundle readers, as well as our model-based findings that indicate that low valuation readers primarily of the Daily bundle switch to other bundles or the outside option when faced with price increases. This underscores the importance of accounting for heterogeneity among readers of the Daily bundle.

1.8.4.3 Accounting for Single Copy Sales

As discussed earlier, while we have subscription data at a relatively granular level of geographic disaggregation, the single copy (newsstand) sales are only at the overall market level. In reality, the total circulation of the newspaper would comprise of both subscription and single copy sales. Since the cross-sectional variation in subscription and prices that ge-

[27]Per the publishing industry's pricing policies, advertisers are generally charged differential rates for Sunday vs. other days. Hence the dichotomous classification of Sunday vs. other days (titled 'Weekdays' for simplicity).

ographic disaggregation yields is useful to identify reader heterogeneity, we considered only the subscription information in our empirical analysis. In order to investigate the robustness of our results to the inclusion of single copy sales, we used the single copy sales data at the market level to scale up the county level subscription shares. We treated this as a proxy for county-level circulation, including both subscription and single copy sales. The assumption here is that the single copy sales at different counties are proportional to their respective subscription levels. We then reestimated the readership and advertising demand models using these rescaled circulation figures. With these new estimates we recomputed the relative magnitudes of the two explanations. As in earlier analyses, we find that the optimal subscription (advertising) prices increase (decrease) during the period of our analysis. We present the results on the relative extent to which reader heterogeneity and advertising subsidy played a role in driving up subscription prices in column (2) of Table 12. We see that heterogeneity and the decline in advertising subsidy explain 32.5% and 67.5% of the price increases respectively, suggesting that our results are robust to the inclusion/exclusion of single-copy sales.

1.8.5 Counterfactual Simulation - The impact of suspending print circulation on certain days of the week

Our results suggest that the newspaper in question has attempted to migrate low WTP readers from the daily subscription to receiving the newspaper only during weekends, especially Sundays by employing steeper price increases for daily subscriptions. While price is one of the available tools to effect such a substitution of readers, the newspaper can accomplish a similar result by restricting printing and distribution of the newspaper to only a few days

of the week. The main benefit is likely to be cost savings, which account for approximately 52% of publishers' overall costs (Vogel, 2011 p. 371). During the last couple of years, several daily newspapers such as the New Orleans newspaper Times-Picayune, The Detroit Free Press, and The Detroit News, have restricted product and distrubution to a few days of the week, while several other newspapers are reportedly considering such a shift (Ingram, 2012). In this section, we use the structure of preferences recovered from the readership demand model (presented in Table 6) to assess implications for newspaper publishers from restricting circulation of the print newspaper to a subset of the days of the week.

Specifically, we compare the firm's price-cost margins for the two cases where the firm maintains or discontinues newspaper delivery on Monday through Thursday, as a benchmark counterfactual product portfolio restructuring strategy.[28] Demand for newspaper advertising is known to be higher on Sundays, though we could not collect advertising data by days of the week from the firm for this analysis. To this effect, we use parameter estimates from the readership demand model, conditional on the assumption of additive seperability of utilities from newspaper consumption for different days of the week, to offer upper and lower bounds on the impact of restricting newspaper access to a few days in the week. Using the estimates of the intercepts corresponding to the reader's utility from newspaper subscription on Fri/Sat and Sun only, we compute subscription shares for the counterfactual market where readers have the option of choosing only between the Weekend and Sunday only bundles. We then use these computed shares to calculate the levels of predicted advertising demand (using the reweighted readership described earlier, to ensure the 50% contribution of the Sunday newspaper to advertising revenues) which in turn enable us to compute the counterfactual markups for the Weekend/Sunday-only prices.

[28]Due to non-availability of reliable cost-data at the bundle level, we do not estimate the impact of the newspaper's decision to suspend circulation during a subset of the days of the week on its profitability.

The net benefit of restricting distribution to a few days of the week would depend on the how much revenue the newspaper stands to lose. Furthermore, the new optimal subscription and ad rates would depend on the number of customers that would switch to other subscription options within the newspaper versus those that would quit. The substitution would depend on whether we treat this as the newspaper (a) ceasing to offer a daily subscription option or (b) offering a second version of the Friday, Saturday, and Sunday option. Given our model formulation, the former would predict a very high customer migration to the outside option, while the latter would make a much more optimistic projection that a higher proportion of daily subscribers will move to the remaining subsription options. The reality is likely to be somewhere between these two scenarios.

We present the results from the counterfactual simulation in Table 13. We present the mean absolute percent deviation (MAPD) in all metrics for the most current year (2011) in our data.[29] While scenario 1 implies a reduction in overall circulation of 60% (68%) within (outside) the NDM, scenario 2 implies that this loss is smaller at 49% (62%). Therefore, this policy decision suggests losses to overall circulation that range between 50% and 70%. These circulation losses would imply a decline of between 77% in scenario 2 and 82% in scenario 1 in advertising demand. These declines in advertising demand translate to a decrease in advertising markups by approximately 77% and 82% respectively. This implies a corresponding increase in the markups for the Weekend (Sunday-only) subscription options to an extent of 204% (217%) - Scenario 2 and 215% (228%) - Scenario 1, on account of this change to the newspaper's product mix, resulting primarily from the decline in advertising subsidy due to the lower advertising markups. Thus, our results suggest that a decision involving shutting down weekday newspaper production would not only imply increases in newspaper subscrip-

[29]There is no meaningful difference in the MAPD computed for all years (2006-2011) on all these metrics.

tion prices but further decreases to the corresponding advertising markups on account of a decline in the overall readership (which results from a portion of daily option readers exiting the market). Overall, our model predicts a decline in overall revenues resulting from this policy decision of between $9.64 - $10.39 MM.

This reflects an approximate loss of $83 - $109 loss in revenues to the newspaper *per reader* from this policy change. The optimality of restricting newspaper subscription to three days in a week would depend on whether the corresponding cost savings are greater than the revenue loss. The fact that several newspapers have implemented such shutdowns suggests that these cost savings might be substantial (even though the focal newspaper has not jumped on this bandwagon as yet). This notion is also in alignment with the claim that newspapers could save a lot of money if the primary access to news was via the internet, as online distribution helps save on newspaper production and delivery costs (Varian, 2010). While shutting down print newspaper production entirely may seem extreme given that over 85% of newspapers' overall revenues still come from print editions, the substantial losses in revenues may have prompted some newspapers to restrict printing and distribution, as an intermediate step in restructuring their product portfolio decisions, in order to save on costs. An essential caveat to this analysis is that it does not consider the negative consequences to the brand from the decision of moving away from a daily newspaper model, owing to consumer backlash as in the case of some newspapers such as the Times Picayune.

1.9 Discussion and Conclusion

In spite of facing declining demand, newspaper publishers have increased print subscription prices for readers. The overall revenue implications for the publisher from raising prices for

readers may be especially nuanced in this industry as nearly three-fourths of its revenues derive from advertising, which depends critically on the presence of readers. So why have subscription prices substantially increased? Are these price increases optimal? We propose and estimate a model to answer these questions, allowing for the influence of externalities created by the firm's subscription price-setting process on its advertising revenues. We model both reader and the advertiser demand for the print newspaper, and tie them to a model of the newspaper's pricing decision.

Our results suggest that decline in advertising subsidy was a big reason for why readers are increasingly facing higher subscription prices today. Thus, we supplement extant literature that mainly attributes price increases to heterogeneity in WTP, i.e., we show that price increases in two-sided markets also stem from the platform's need to balance revenues from both sides of the market.

We also find some evidence that the newspaper firm adopted a price-based segmentation strategy focused on charging higher prices in order to serve only the loyal readers of its most popular bundle, possibly in an attempt at coping with the large revenue decline it has witnessed over the last five years. This indicates that newspapers may be becoming a more niche product serving a smaller readership base. Further, this result is also suggestive of a change in the mainstream information dissemination role played by newspapers in the society (Weibull, 1992). Finally, a shift in newspapers' traditionally advertising-supported revenue structures towards a more "balanced" subscription-cum-advertiser-funded model appears to be an appropriate strategy especially given the nature of decline in newspaper advertising.

An appealing feature of our study is that the readership and advertising data used in the estimation are similar to data that are typically available to newspaper firms. This makes the model managerially useful as newspaper firms can apply our model to readily

available data to inform their pricing policy decisions. However, our study also has some limitations, several of which can be attributed to the nature of data we have available. First, the access to detailed panel data on individual level subscription behavior would enable the estimation of a richer demand model that is better equipped to generate implications for targeted pricing (third-degree price discrimination) for the firm based on observable reader characteristics. On the advertising side, our ability to capture richer interactions between demand for the three advertising options, or to specify a demand model aimed at modeling individual advertisers' choice rules is restricted by the aggregate nature of advertising data we have available. Our proposed modeling framework focuses mainly on accounting for newspapers' distinct advertising revenue sources and their role in the firm's subscription pricing process.

A limitation of our model is its inability to account for all the rich dynamics in the newspaper advertising market. For example, equipped with data on ad rates for Sunday vs. Weekday newspapers, one could study the different implications of changing reader WTP for newspapers' Weekday vs. Sunday ad rate setting decisions. Future work focused on enriching the two demand models to include these features could generate interesting pricing implications for the firm. Other examples of this include - a) estimating the optimal advertising markups at the advertiser segment (Local vs. National advertisers) level, to inform potential targeted pricing rules for the publisher, and b) specifying a richer structure to capture the heterogeneity in different advertisers' willingness-to-pay for access to higher willingness-to-pay readers. It is very likely that such implications would be valuable to marketing managers at newspaper firms as they design strategies to salvage their dwindling readership base and advertising revenues.

Previous work studying the newspaper industry (Fan, 2013) has discussed the role of

changes in market structure (e.g., newspaper consolidations/mergers) in influencing newspaper prices. Thus, newspaper consolidations may indeed have contributed to some of the price increases in the print newspaper industry especially over a longer-horizon.[30] Our ability to account for such explanations is constrained by the nature of our data, i.e. the newspaper that shared the data used in this analysis is not part of a large multi-newspaper or mass-media group franchise. Thus, though prices in the focal newspaper's market are unlikely to be influenced by similar changes in market structure over the time frame of our analysis, it is possible that prices at other large newspapers may be. In sum, we hope our empirical study has shed academic and managerial light on price setting practices in newspaper/media markets, and more generally in two-sided markets.

[30]Fan (2013) documents that over 75% of newspaper consolidations in her data (which range from 1998-2005) occurred in the period 1998-2002.

Tables and Figures

(A) Readership				
	Avg. subscription share (% of households subscribing to the newspaper)		Avg. subs. price (inflation adjusted) ($/month)	
Bundle	Within the NDM	Outside the NDM	Within the NDM	Outside the NDM
Daily	13.24%	2.62%	16.28	18.28
Weekend	0.98%	0.16%	11.76	12.48
Sun only	3.97%	0.86%	10.12	10.88

(B) Advertising Revenues			
Advertising Type	Year 2006 (in Mill. $)	Year 2011 (in Mill. $)	Change (%, with year 2006 as base)
ROP	9.10	3.85	-57.7%
PPT	3.95	2.26	-43.38%
CLAS	4.04	0.47	-88.27%

Table 1: Descriptive Statistics

% increase in inflation-adjusted prices between 2006-2011		
Bundle	Within NDM	Outside NDM
Daily	77.22%	77.45%
Weekend	52.73%	52.52%
Sun only	37.74%	43.70%

Table 2: Subscription price increases for each bundle

Year	ROP	PPT	CLAS
2006	0.44	59.60	1.83
2007	0.42	57.27	1.75
2008	0.48	56.85	1.82
2009	0.50	54.88	0.98
2010	0.53	58.20	0.94
2011	0.57	59.30	0.97

Table 3: CPM for each Advertising Option

CPM for ROP and CLAS is computed by dividing the corresponding ad rate (in $ per col. inches) by the number of readers (in thousands); those for PPT are in cost per thousand inserts.

Revenue contribution per reader	Year 2006 (%)	Year 2011 (%)
Subscription	12.62	31.19
Advertising	87.38	68.81

Table 4: Relative contribution of reader and advertiser side of the newspaper market

(A) Readership Model

	Endogenous variable							
	Subscription Prices				# News pages			
Parameter	Est.	SE	Est.	SE	Est.	SE	Est.	SE
PPI Daily Newspaper Publishers			5.82***	1.16			0.17	0.11
PPI Book Publishers			-4.76	14.51			0.46	1.35
PPI Printing Ink Mfg.			6.61	9.82			-2.68**	0.91
Avg Weekly Payroll Newspaper Industry			-4.74***	0.94			0.88***	0.09
Dummies for each bundle	√		√		√		√	
R^2	0.48		0.86		0.91		0.96	

(B) Advertising Model

	Endogenous variable							
	Advertising Rates				Readership			
Parameter	Est.	SE	Est.	SE	Est.	SE	Est.	SE
PPI Advertising Agencies			-0.76	0.76			-2.18	2.58
PPI Lithographic/Offset Printing Ink			1.38**	0.59			-2.21	1.99
% Readership of other newspapers			0.98**	0.35			1.08***	0.12
Advertising type dummies	√		√		√		√	
R^2	0.64		0.76		0.01		0.83	

** p<0.01, *p<0.05, + p<0.1

Table 5: First stage regressions of endogenous variables on instruments

	WITHOUT HETEROGENEITY				WITH HETEROGENEITY			
Parameter	**OLS**		**IV**		**Seg - 1**		**Seg - 2**	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Pref (M-Thurs)	2.15**	0.18	2.32**	0.25	4.07**	0.04	1.45**	0.01
Pref (Fri,Sat)	-1.83**	0.08	-1.75**	0.11	-1.81**	0.01	-1.72**	0.00
Pref (Sun)	-6.83**	0.47	-6.68**	0.50	-5.62**	0.01	-7.00**	0.01
NDM price	-0.04**	0.01	-0.05*	0.02	-0.01*	0.00	-0.10**	0.00
ONDM price	-0.01	0.01	-0.02	0.02	-0.05**	0.00	-0.12**	0.00
# of news pgs	0.52**	0.11	0.43**	0.15	0.14**	0.01	0.67**	0.00
C1-Income	0.64**	0.07	0.64**	0.07	0.73**		0.02	
C2-Income	0.46**	0.08	0.46**	0.08	0.62**		0.02	
C3-Income	0.29**	0.09	0.29**	0.09	0.42**		0.02	
C4-Income	0.58**	0.08	0.58**	0.08	0.65**		0.02	
C5-Income	0.13^{+}	0.08	0.13^{+}	0.08	0.26**		0.02	
NDM Y2007	-0.31**	0.06	-0.29**	0.06	-0.31**		0.01	
NDM Y2008	-0.48**	0.07	-0.48**	0.07	-0.49**		0.02	
NDM Y2009	-0.17**	0.06	-0.15*	0.07	-0.03**		0.01	
NDM Y2010	-0.18**	0.06	-0.15*	0.07	-0.02		0.01	
NDM Y2011	-0.31**	0.07	-0.27**	0.07	-0.19**		0.02	
ONDM Y2007	-0.18**	0.05	-0.17**	0.05	-0.17**		0.01	
ONDM Y2008	-0.30**	0.06	-0.30**	0.06	-0.31**		0.01	
ONDM Y2009	-0.02	0.06	-0.01	0.06	0.21**		0.03	
ONDM Y2010	0.03	0.06	0.06	0.06	0.34**		0.03	
ONDM Y2011	0.02	0.06	0.05	0.07	0.33**		0.03	
Seg. membership					-2.37**		0.30	
Seg. size					8.57%		91.43%	

** p<0.01, *p<0.05, $^{+}$ p<0.1

Table 6: Readership model results

	USING RAW READERSHIP				USING REWEIGHTED READER-SHIP	
Parameter	**(1)**		**(2)**		**(3)***	
	Est.	SE	Est.	SE	Est.	SE
Intercept ROP	10.26**	0.36	9.89**	0.41	9.48**	0.64
Intercept PPT	15.48**	1.71	18.07**	1.97	15.47**	1.71
Intercept CLAS	9.93**	0.28	10.11**	0.29	9.15**	0.05
ln(CPM)	-1.13**	0.42	-1.72**	0.49	-1.12**	0.42
Y 2007-ROP	-0.11**	0.04	-0.14**	0.04	-0.11**	0.04
Y 2008-ROP	-0.27**	0.04	-0.24**	0.04	-0.27**	0.04
Y 2009-ROP	-0.54**	0.05	-0.47**	0.06	-0.54**	0.05
Y 2010-ROP	-0.54**	0.06	-0.46**	0.07	-0.54**	0.06
Y 2011-ROP	-0.63**	0.07	-0.52**	0.09	-0.63**	0.07
Y 2007-PPT	-0.10*	0.05	-0.13*	0.07	-0.10**	0.05
Y 2008-PPT	-0.15*	0.07	-0.24**	0.09	-0.15**	0.07
Y 2009-PPT	-0.46**	0.08	-0.55**	0.09	-0.46**	0.08
Y 2010-PPT	-0.60**	0.07	-0.65**	0.09	-0.60**	0.07
Y 2011-PPT	-0.71**	0.07	-0.76**	0.09	-0.71**	0.07
Y 2007-CLAS	-0.20**	0.05	-0.26**	0.07	-0.20**	0.05
Y 2008-CLAS	-0.62**	0.07	-0.71**	0.10	-0.63**	0.07
Y 2009-CLAS	-1.71**	0.30	-2.14**	0.35	-1.71**	0.29
Y 2010-CLAS	-1.82**	0.32	-2.27**	0.37	-1.81**	0.32
Y 2011-CLAS	-2.00**	0.31	-2.44**	0.36	-2.00**	0.31
Within year variations - ROP	Yes		-		Yes	
Within year variations - PPT	Yes		-		Yes	
Within year variations - CLAS	Yes		-		Yes	

* - Using reweighted readership (with Sunday contribution at 50%) to calculate CPM

** p<0.01, *p<0.05, $^+$ p<0.1

Table 7: Advertising model results

Between 2006-2011	**Readership**		
	Daily	**Weekend**	**Sun**
Change in subscription prices (data)	+77.3%	+52.6%	+38.18%
Change in optimal markups	+85.4 %	+63.0 %	+63.2 %
Between 2006-2011	**Advertising**		
	ROP	**PPT**	**CLAS**
Change in ad rates (data)	-16.7%	-10.8%	-66.0%
Change in optimal markups	-22.26%	-30.15%	-67.62%

Table 8: Optimal Subscription and Advertising Markups

Explanation	**Measure**
Heterogeneity in Readers' WTP	20.77%
Decline in Advertising subsidy	79.23%
of which:	
Display advertising contributed	38.48%
Pre-print advertising contributed	10.23%
Classifieds advertising contributed	31.37%

Table 9: What explains the price increases?

$ contribution of each explanation	**NDM**				**ONDM**			
	Overall	Daily	Weekend	Sunday	Overall	Daily	Weekend	Sunday
Price in 2006 ($)	10.26	11.02	8.66	7.93	11.40	12.39	9.25	8.34
Heterogeneity	1.31	2.57	-0.03	-0.04	0.36	1.80	-0.01	-0.02
Advertising subsidy	5.27	5.93	4.60	3.04	7.08	7.80	4.86	3.67
Price in 2011 ($)	16.84	19.53	13.22	10.93	18.84	21.99	14.10	11.99

Table 10: Components of the price increase for each bundle

Explanation	Readership Re-weighting: with Sunday revenue contribution (Weekday revenue contribution) at		
	100% (0%)	90% (10%)	10% (90%)
Heterogeneity in Readers' WTP	9.94%	11.81%	53.18%
Decline in Advertising Subsidy	90.06%	88.19%	47.82%

Table 11: Robustness Checks (A)

Explanation	Considering the best case scenario where all exiting print readers migrate to the online newspaper	Using readership rescaled to include single-copy sales, keeping Sunday advertising contribution at 50%
	(1)	(2)
Heterogeneity in Readers' WTP	20.56%	32.50%
Decline in Advertising Subsidy	74.94%	67.50%
Gain in Online Advertising Revenues	4.51%	N/A

Table 12: Robustness Checks (B)

MAPD (Mean Absolute Percent Deviation)	**2 Options**		**3 Options**	
	NDM	ONDM	NDM	ONDM
Overall Change in Readership (%)	-60	-68	-49	-62
Change in Advertising Demand (%)	-82		-77	

	Weekend	Sunday	Weekend	Sunday
Change in Subscription Markups (%)	215	228	204	217
Change in Advertising Markups (%)	-82		-77	
Change in Revenues	- $ 10.39 MM		- $ 9.64 MM	

Table 13: Counterfactual Simulation - Effect of shutting off Monday-Thursday circulation

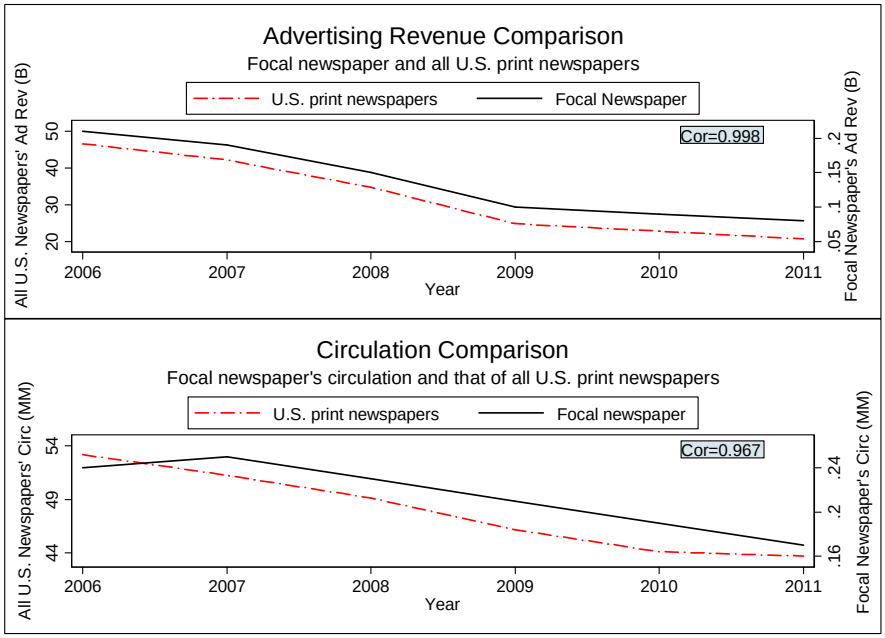

Figure 1: Comparison of Readership and Advertising Revenue trends of the Focal newspaper with those of the U.S newspaper industry

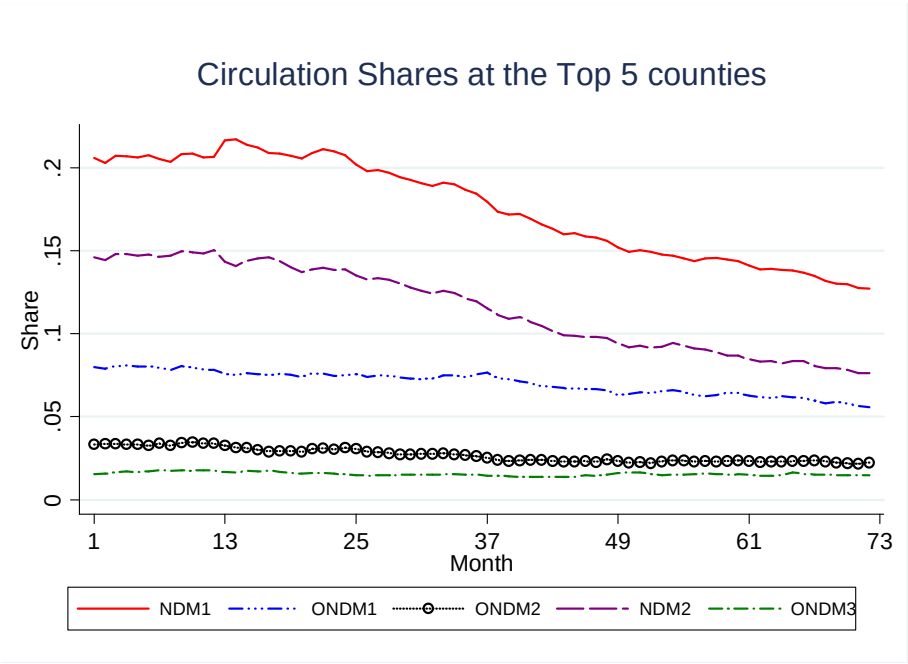

Figure 2: County circulation shares

Month 1 corresponds to Jan 2006 and 72 to Dec 2011.

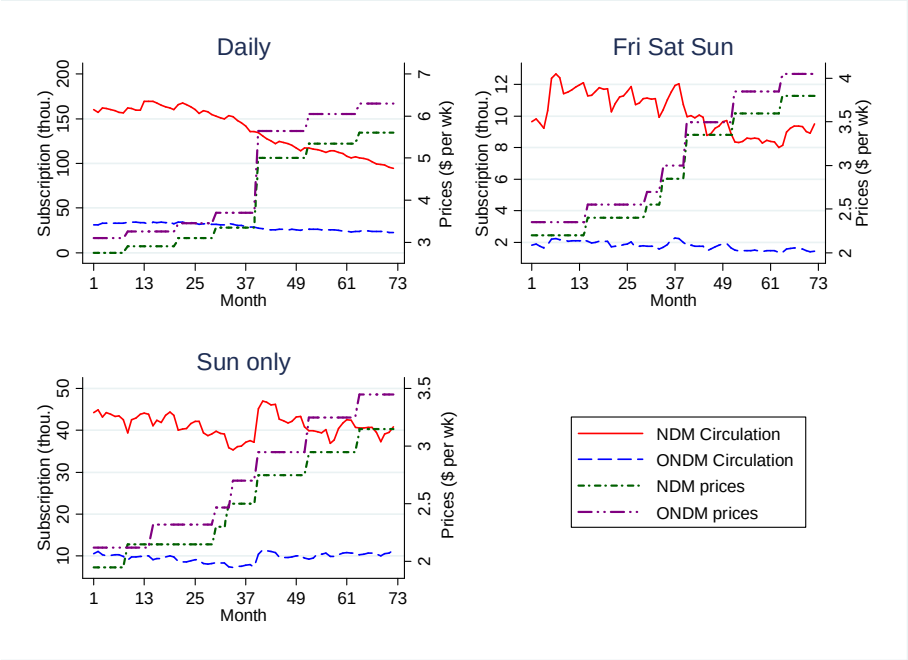

Figure 3: Temporal pattern of subscriptions within and outside the newspaper's designated market.

Month 1 corresponds to Jan 2006 and 72 to Dec 2011.

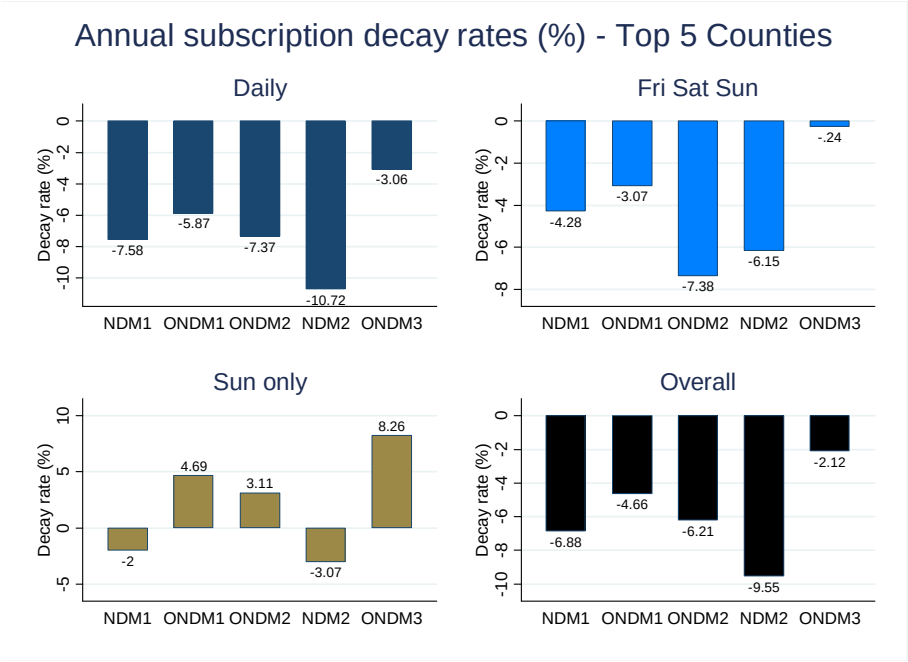

Figure 4: Plots of the average year-on-year % decay rates in circulation shares across counties within and outside the NDM (between 2006-2011).

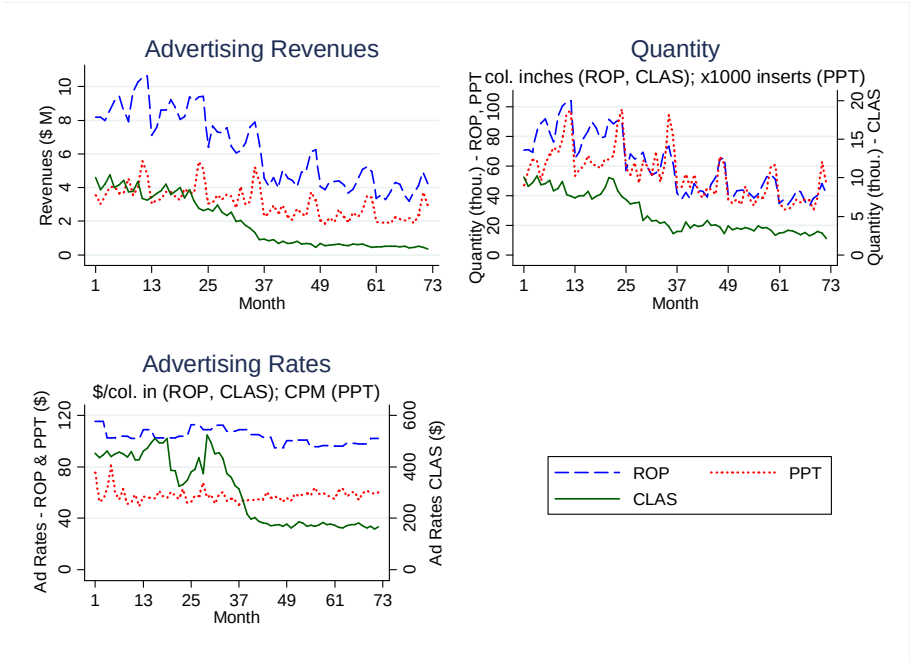

Figure 5: Advertising at the focal newspaper

Month 1 corresponds to Jan 2006 and 72 to Dec 2011.

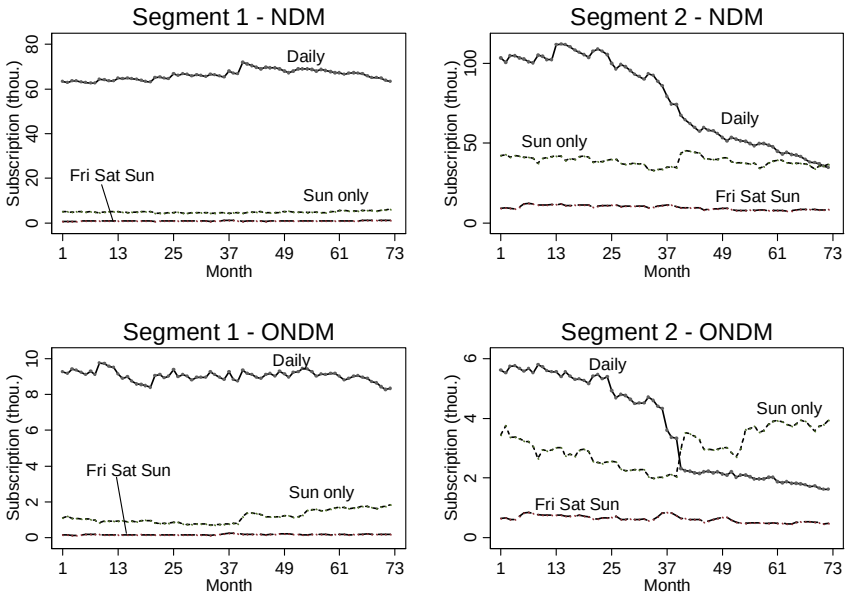

Figure 6: Subscription by segment - within and outside the NDM

Month 1 corresponds to Jan 2006 and 72 to Dec 2011.

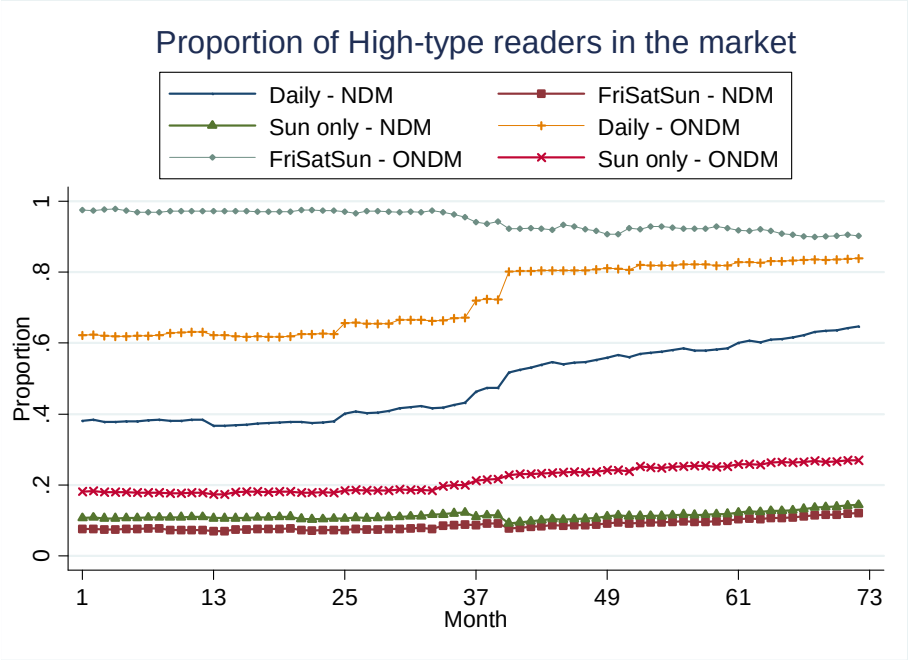

Figure 7: Proportion of High-type readers in the market (conditional on subscription to the print newspaper)

Month 1 corresponds to Jan 2006 and 72 to Dec 2011.

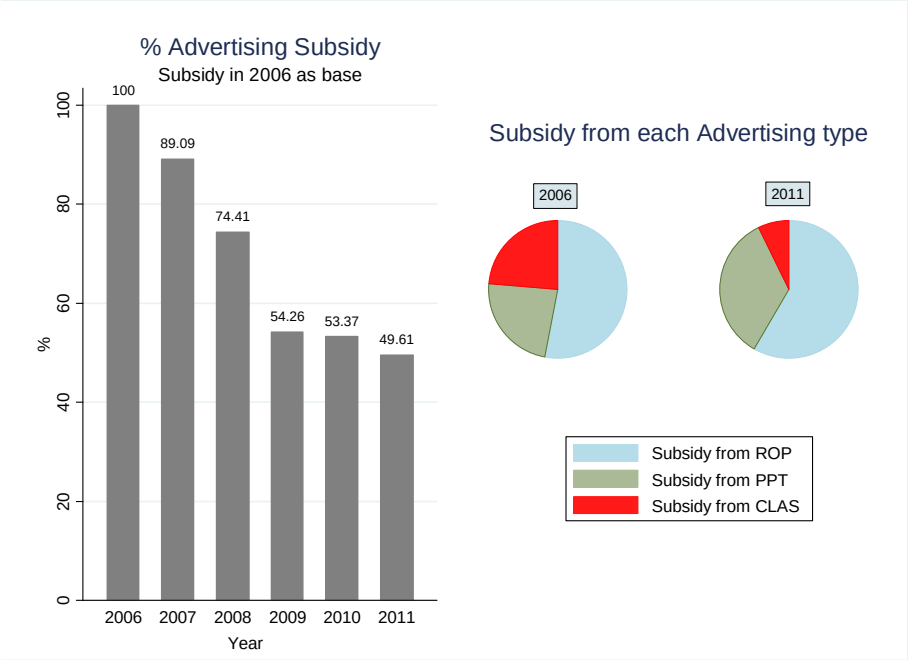

Figure 8: Changes in advertising subsidy

CHAPTER II

Exploring the Effects of Newspaper Paywalls

2.3 Abstract

Growth in online readership and the corresponding decline in the circulation base of print newspapers have prompted newspaper publishers to identify opportunities to monetize online content. As a result, several newspapers have begun charging readers for access to online news content by erecting paywalls. In this paper, we study the overall implications to newspaper revenues from operating paywalls, by using readership and advertising data for the New York Times before and after it launched a paywall in March 2011. The overall effect of erecting pay walls on newspaper readership and revenues is unclear. Recent surveys of readers of free online newspapers found that a significant percentage (82%) of readers were ready to substitute away to other freely available news options (e.g., blogs, TV, radio) if they had to start paying for access to news, suggesting that the decision to charge online readers may influence their readership decisions. Further, it is well known that newspaper advertising revenues depend heavily on readership, which also puts these revenues at risk if paywalls lead to reader attrition. Lastly, paywalls are believed to serve an equally important objective of stemming the declines in print newspaper readership, by preventing paying print subscribers from switching to the free newspaper. By exploiting the structural break implied by the paywall launch, we assess its effects on both print and online newspaper readership as well as newspaper advertising.

2.4 Introduction

Over the last five years, newspapers in the U.S. have witnessed a decline in their overall revenues of up to 50%. While circulation and advertising revenues associated with the core product, the print newspaper, have monotonically decreased in this period, those associated with most newspapers' online versions have increased. However, on average, online revenues for most newspapers still account for a relatively small proportion (10%) of overall revenues. A recent media article reported that for every advertising dollar gained online, newspaper firms are still losing nearly sixteen dollars on print advertising (Thompson, 2013). The substantial nature of these losses to print revenues has prompted several newspaper bankruptcies and in most cases, major restructuring decisions.

The objectives of U.S. newspaper firms' major marketing mix reallocation decisions can be broadly classified into three categories: a) preservation of existing revenue streams. As a first step towards preserving advertising revenue streams, newspapers have dropped advertising rates. Between 2006-2011, advertising rates for print newspapers have fallen by 15 % (in case of display and pre-print advertising) to 50% (in case of newspaper classifieds). b) shifting the balance to reduce the reliance on advertising revenues. Most daily news publishers across the country have reacted to the declining print ad revenues by effecting steep increases to print subscription prices. Both subscription and single copy prices in the U.S increased by 40-60% over the last decade, with the most sizeable increases occuring in the last five years, possibly on account of newspaper firms' intention to stabilize print circulation revenues.[31] This shift is believed to be an effort aimed at correcting the U.S. newspaper industry's historical overdependence on advertising revenues, when compared to

[31]Report "Circulation Pricing" dt. Mar 17, 2009 retrieved from the Newspaper Association of America website: http://naa.org

newspapers in the rest of the world: While advertising contributed 87% of revenues in 2006, this number dropped to 69% in 2011, compared to the worldwide number of 57% (see Figure 9). c) exploring new sources of revenues. Over the last five years, the most popular strategy among online newspapers is charging their online readers a subscription fee for access to news content. As of 2013, digital pay plans have been adopted at 450 of the country's 1380 dailies (Edmonds et al., 2013). Industry reports suggest that when combined with print subscription and single-copy price increases, the launch of digital paywalls has led to circulation revenues stabilizing or even rising.

Moreover, there have been many anecdotal claims that publishers can use newspaper paywalls to signal the high purchasing power of their online readers to advertisers. There are early indications from the results of survey-based journalism research reports that advertisers are willing to pay higher advertising rates for their ads in paid online newspapers.[32] Notwithstanding the potential advertising gains, these added circulation revenues are believed to potentially help with rebalancing the industry's historic over-dependence on advertising.

Notably, however, not all newspapers that have decided to charge readers for online access have succeeded in boosting their overall revenues. Several newspapers have lost online traffic (Chiou and Tucker, 2013) as well as print circulation after launching paywalls. Prominent examples include the Dallas Morning-News' losing circulation by 9 million/month after it instituted a paywall, the Memphis Commercial Appeal's witnessing a 30% decrease in traffic to get 1000 paywall subscribers, and the Columbia Tribune's losing 25% of its traffic and a shift to a local, free rival in order to secure $80k in revenue.[33] When one considers the fact that newspaper advertising is highly linked to readership (Sridhar et al.,

[32]http://sabramedia.com/blog/newspapers-battle-between-paywall-and-advertising
[33]See Blankenhorn (2013).

2011; Fan, 2013; Pattabhiramaiah et al., 2014), firms that launch online paywalls may risk losing online advertising revenues if paywalls lead to heavy reader attrition. Research in the area of newspaper advertising has found that the increasing advertiser adoption of outside (non-newspaper) media can influence big declines in newspaper advertising revenues (Sridhar and Sriram, 2013; Seamans and Zhu, 2013). Thus newspapers' advertising revenues may be especially vulnerable in current times, suggesting the importance of considering the impact on advertising revenues, of any pricing changes on the readers' side of the market.

Lastly, a reason hotly debated in media articles about the second objective of commissioning newspaper paywalls is the preservation of print readership, by preventing paying print subscribers from switching away to the free newspaper. A recent quote made by a newspaper industry expert underscores this effect -

"The paywall at the Times of London's web site has led to a drop of at least 65 percent in the newspaper's online readership. By most normal measures, losing two-thirds of your readership would seem like a huge blow, but managers at the newspaper are said to be satisfied with that figure. This is because the newspaper's paywall is likely just as much about keeping existing print readers in as it is about keeping freeloading web readers out."

Print newspapers still account for about 80% of most newspapers' revenues, suggesting that the second objective of the paywall, namely, preserving the more valuable revenue stream provided by print readers, may be important to this ailing industry. However, the evidence of newspaper paywalls' improving their print circulation is far from conclusive. Thus, it is unclear whether charging online readers a price will unambiguously serve all the expected objectives. In this paper, we use readership and advertising data for the New York Times (henceforth NYT, a newspaper that has been cited in the media for its successful paywall execution) to investigate the effects of launch of NYT's paywall on its online readership,

print circulation and online advertising revenues.

2.5 Data

We employ a mix of proprietary web analytics data collected from Comscore, for the period Jan 2009-Mar 2013 (two years before and after the pay wall launch), and data we supplement from various sources as described below. The web analytics data consist of traffic information to the New York Times' website, at the designated market area (DMA) level and contain activity behaviors of users. We track activity of users belonging to the top 25 DMAs (by NYT readership, the list of DMAs is presented in Table 15) - these DMAs together account for about 50% of the total traffic to NYT's website. The data include variables such as the monthly number of unique visitors, page views and average time spent. A unique feature of these data is that they provide a proxy for the newspaper readers' online engagement levels over time. Lambrecht and Misra (2014) use similar data to track online engagement behavior of paying (vs. non-paying) users of ESPN.com.

The availability of DMA level data helps us account for the role of changing market conditions (e.g., internet access) and user characteristics (e.g., income, age) in explaining differences in website activity. To provide a benchmark for inferring the effect of the paywall on the website's traffic, we collected corresponding data for another National newspaper website, USA Today. We believe the USA Today serves as an appropriate control group for three reasons: a) USA Today is a National newspaper with a readership base most closely comparable to that of the NYT (See Table 14),[34] b) it is believed to be a close substitute

[34]Note that as the USA Today does not produce Sunday versions of the print newspaper, it is a closer competitor to the NYT in terms of the weekday print edition. The NYT is the most popular Sunday newspaper in the U.S. when measured purely by circulation numbers.

to the NYT in terms of content and subscriber base (Kraten, 2013), and c) the USA Today has been cited in the media for its abstinence from launching a paywall (Killoran, 2013). We compiled data on the number of paid subscribers to NYT's news website from journalism research articles and online news sources.

Online advertising data consist of information on the number of impressions served and aggregate monthly ad expenditure by advertisers who advertise on NYT's website. These data are broken down into 17 categories, as listed in Table 16. These categories are collectively exhaustive and represent 100% of the ad expenditure on NYTimes.com. In order to provide a baseline for the temporal evolution of NYT's online ad expenditure, we compiled data on online ad expenditure on all U.S. newspapers from the Newspaper Association of America's website (naa.org). Further, to enable tracking the effect of the paywall on print readership, we also collected data on print circulation at the DMA level and subscription prices from the Alliance for Audited Media's annual Audit Reports for the NYT.

2.5.1 Descriptive Evidence

2.5.1.1 Online activity behaviors before and after the paywall

We present summary statistics for unique visitors, page views, duration and page views per visitor for the NYT and USA Today in Table 17. The number of unique visitors to the NY Times appears to have dropped sizably in periods following launch of the paywall, while page views increased over time following a temporary downward blip (also see Figure 11). In comparison, the unique visitors and page views of USA Today's website increased. It is interesting to note that the average NYT and USA Today user spent more number of minutes on the respective websites in the period following the pay wall's inception. While

the page views per visitor to NYT's website increased, those of USA Today appears to have dropped marginally.

2.5.1.2 Paid Subscriptions to NYT (after the paywall)

As seen in Figure 10, NYT witnessed an increase in the number of paid subscribers in each quarter after the paywall was launched in March 2011. NYT is reported to be successful in amassing a sizable base of over 500,000 digital subscribers in just eighteen months after the paywall was set up.[35]

2.5.1.3 NYT's Advertising Revenues

As discussed earlier, our data consist of ad expenditure and advertising levels, broken down by 17 advertiser categories. In Table 16, we present the cross-sectional variation in expenditures and advertising levels (number of impressions served) among advertisers belonging to each of these categories.

We provide a plot of the temporal evolution of ad revenues, impressions and rates in Figure 12 by pooling across all advertiser categories. We see that the total impressions served on NYT increased in the period following the paywall, as did total ad expenditure (obtained by summing over all category level ad expenditures in each period). The avg online ad rate (measured in CPM or the cost per 1000 impressions) appears to also have increased marginally since the paywall's inception. These patterns are consistent with the possibility that the paywall had a positive externality on online advertising.

[35] Haughney (2013).

2.5.1.4 Print Circulation Before and After the Paywall

As seen in Figure 13, paid circulation of both newspapers has been decreasing during our analysis period. However, it appears that the circulation of NY Times is decreasing at a slightly slower rate, relatively. This pattern is also consistent with the relative position data in Table 14 where NYT overtook USA Today in overall circulation towards the end of our analysis period (year 2013).

2.6 Research Design

The utility that a reader i residing in market j derives from reading online newspaper s in month t is of the form:

$$U_{ijst} = \widetilde{\alpha}_{jst} + \delta_j X_{jst} + \varepsilon_{ijst} \tag{2.6.1}$$

To quantity the effect of NYT's paywall on overall online newspaper readership, we employ a panel specification of the form:

$$R_{jst} = \alpha_{js} + \beta_{j\tau} + \gamma I_{s\tau} + \delta_j X_{jst} + \varsigma_t + \varepsilon_{jst} \tag{2.6.2}$$

where I_τ: is a time-indicator signifying pre/post paywall launch. As discussed before, we use online readership of USA Today to establish a baseline for the effect of NYT's paywall (hence the s subscript in the notation). We use four dependent variables (the vector R) consisting of the number of unique visitors, total page views, average time spent on the web site, and the number of page views per visitor, for the analysis. The vector X includes observable market characteristics (e.g., business density), and user characteristics (e.g., income, education) at the DMA level. The α captures reader preference for newspaper consumption

in each market, while the β captures any time specific effects of the post-period (common to both newspapers). γ is our coefficient of interest and measures the causal average effect of pay wall on online reader behavior. We include non-parametric controls for any seasonal/unaccounted time variations within the pre/post periods ς_t in the form of month fixed effects. The identifying assumption here is that the pre-period trends are similar across the two newspapers. As we discuss subsequently in section 2.8, we find that these trends are similar.

Between 2011-2013, the NYT introduced two policy changes to the number of free news articles offered to users, as follows. Starting March 28, 2011, the monthly number of free articles offered to readers of its online newspaper was limited to 20 (with the advent of the paywall). The 20 free article limit was set to ensure that its more loyal user base paid a fee to access news content (generating a new source of revenue to NYT). The limit was set high to preserve visits to the newspaper by ad-hoc visitors (which generated advertising revenues). In April 2012, the NYT revised the number of free articles downwards to 10, possibly to motivate a higher proportion of online readers to start paying for online access. The month fixed effects in our model specifications capture any changes to online newspaper demand caused by this policy change.

To capture changes in the influence of the paywall on NYT's advertising market, we also specify a model of advertising demand. We specify the utility of advertiser f in month t as:

$$U_{fkt} = \mu_{kt} + \Theta \widetilde{R}_t + \eta r_{kt} + \epsilon_{fkt} \tag{2.6.3}$$

where r is the advertising rate, μ captures the advertisers' preference for advertising on the newspaper, and $k = 1...17$ signify the category that advertiser f belongs to (as discussed

before in the data section). $\widetilde{R} = f(R_t, \aleph_t)$ where $R_t = \sum_{j=1}^{J} R_{jt}$ (page views in each market). $\aleph$: contains the cumulative total of paying subscribers to NYT's online newspaper. Thus we allow advertisers' utility to be influenced both by the number of page views (in line with the cost per impression pricing of newspaper display ads) as well as the number of paying subscribers (who arguably comprise a higher WTP segment of customers). The estimation equation for advertising demand is of the form:

$$q_{kt} = \mu_{kt} + \theta_\tau R_t + \vartheta\left(\aleph_t\right) + \eta r_{kt} + \epsilon_{kt} \tag{2.6.4}$$

The dependent variable q consists of the total online impressions in category k (in log form) in each month t. The ϑ captures the increase in advertisers' valuation for newspaper ads with increase in number of paid readers. The θ captures the effect of aggregate page-views on advertising demand. Note that equation (2.6.4) does not have an s subscript as we only have advertising data for the NYT. The change in θ from pre to post indicates any changes in the effect of online readership on advertising revenues. Estimating the parameter θ can help us answer the question "do newspaper pay walls motivate a loss in ad revenue (as page views decline)?" The parameter ϑ can help answer whether pay walls can help newspapers command premium rates (i.e., through their ability to "signal" to advertisers the access to a higher WTP readership base, as discussed before). The overall effect of pay walls on newspaper advertising is given by $(\theta + \vartheta)$. Given the absence of the control group in this analysis, we employ strict controls in the form of month of the year fixed effects, in the model to account for time-specific shocks to NYT's advertising demand. We also employ advertising expenditure on all online newspapers to establish a baseline for the analysis as a robustness check (discussed in the following section).

The model/design for assessing the influence of the paywall on print newspaper readership is similar in specification to that for online readership:

$$\ddot{R}_{jst} = \ddot{\alpha}_{jst} + \ddot{\beta}_{j\tau} + \gamma \ddot{I}_{s\tau} + \ddot{\delta}_j \ddot{X}_{jst} + \ddot{\varepsilon}_{jst} \tag{2.6.5}$$

where $\ddot{I}_\tau$: is a time-indicator signifying pre/post paywall launch. j, s and t stand for market, newspaper (NYT/USA Today), and time subscripts, as before. We use print readership of USA Today to establish a baseline for the effect of NYT's paywall. We use two dependent variables (as part of the vector $\ddot{R}$) consisting of the weekday and weekend newspaper print circulation share (i.e., the % readership in each market, which is constructed by dividing the market level circulation by the number of households) for the analysis. The vector $\ddot{X}$ includes observable market characteristics (e.g., business density), and user characteristics (e.g., income, education). The $\ddot{\alpha}$ captures reader preference for newspaper consumption in each market, while the $\ddot{\beta}$ captures any time specific effects of the post-period (common to both newspapers). $\ddot{\gamma}$ is our coefficient of interest and measures the causal average effect of the pay wall on print newspaper readership.

2.7 Results

2.7.1 Online Newspaper Readership

In order to measure the impact of the paywall on online readership (the treatment effect), we regress the logged readership metrics on a NYT (treatment) indicator, a post period indicator, an interaction of these, including demographic controls, as well as market specific

and temporal controls. We employ strict temporal controls in the form of month fixed effects (i.e., for each month in the data) to control for the influence of unobserved demand shifters (for e.g., any changes to the NYT's pricing policy as discussed earlier in the data section). We present the regression results in Table 18. The paywall appears to have a negative effect on the number of unique visitors to NYT's website. Thus, the paywall appears to have detered many casual/low willingness to pay readers from reading the newspaper, as the unique visitors drops by 18% after the paywall.[36]

The NYT's paywall has been referred to as "porous" or "leaky" in that some of its (more sophisticated) readers were aware of an option of by-passing the paywall in lieu of subscribing, after exhausting their monthly limit of free articles. Examples of strategies that allowed by-passing the paywall include altering the browser URL, clearing/disabling cookies during browsing, and downloading specialized custom utilities aimed at subverting paywalls.[37] However, the actual effect of paywall avoidance is likely small as the average NYT reader was unlikely to have been aware of some advanced paywall subversion strategies.[38] Nonetheless, we conjecture that, in the absence of the paywall's leakiness, it is likely that the paywall may have prompted a greater exit of visitors and led to a higher number of paying subscribers, especially if the paywall were successful in "sorting" between low and high willingness to pay readers.[39]

Notably, we find a null effect of the paywall on page views. However, in order to track engagement behavior of NYT's readers over time, we track the evolution in visit duration

[36]This effect is approximately 16% for year 2012 (when we consider April 2011 - Dec 2012 as the post period).

[37]http://lifehacker.com/5783043/how-to-keep-reading-the-ny-times-for-free

[38]http://blog.sethroberts.net/2013/10/08/the-emperors-new-clothes-and-the-new-york-times-paywall/, http://blogs.reuters.com/felix-salmon/2011/08/12/how-the-nyt-paywall-is-working/

[39]On the other hand, the effect on online ad revenues is likely lower, given that it is probably closely linked to the overall effect of a more strictly enforced paywall on page views to NYTimes.com.

as well as the number of pages viewed per visitor to these websites. We see that, in the period following the paywall, the average reader of the NYT appears to stay 13% longer on the website, as well as view 16% more number of pages, highlighting the possible online engagement benefits of NYT's paywall.

2.7.2 Online Advertising

We present the results from the regression using logged online ad expenditure, ad rate and advertising levels (# of impressions) as dependent measures in Table 19. The specification mainly allows us to track how these measures evolved over time. We find that online ad expenditure, online ad rates and online ad levels increased in the period following the paywall. To help establish a baseline for tracking online advertising expenditure (especially since this analysis lacks a control group), we compute the % share of online advertising on NYT as a proportion of advertising expenditure on all online newspapers in the U.S. (data compiled from NAA.org). This allows us to assess whether NYT's online advertising grew over and beyond the category after the paywall. We find similar results when we use advertising shares, highlighting the benefit of the paywall on NYT's online advertising.

The high correlation (0.83) between page views and cumulative online subscriber base over time precluded us from using subscriber base as a covariate in the model. Further, note that by design, the count of the paid subscriber base is available only after the paywall's inception. This invalidates using the post-period indicator as well as the subscriber base contemporaneously in the model. We estimated alternative model specifications omitting the post period dummy and including the subscriber base, but found the effect to be non-significant. Thus, we do not include the subscriber base as a covariate in the online ad

demand model. One of the key online analytics metrics said to influence online advertising decisions is the number of page views of the website (Lambrecht and Misra, 2014). Confirming expectation, we find a positive significant impact of page views in predicting advertising levels. Thus, while it is theoretically possible that if the paywall had an adverse impact on the newspaper's page views, this can lead to a decline in advertising as well. However, we find that, in all cases, NYT witnessed increases in advertising in the period following the paywall. This can be partially rationalized by the fact that the decline in NYT's page views was not substantial (the effect is non-significant, as discussed earlier) on account of the paywall.

In sum, our results of higher online engagement of NYT's readers after the paywall are consistent with the observed increase in online advertising. An essential caveat to these results may be in order: our choice of NYT was motivated mainly based on media reports of its success with executing a paywall. While these media reports did not discuss specifics especially on the advertising gains for NYT from the paywall, our results appear to be consistent with claims in these media reports. However, the extensibility of these results to cases involving other local newspapers' paywalls may be nuanced as NYT is one of the more popular National newspapers. In fact, it is quite likely that the ability of the NYT to charge premium advertising rates as well as attract paying subscribers, rests on its reputation and its unique and differentiated content offering.

2.7.3 Print Readership

We report results of regressions employing weekday and weekend print newspaper circulation share as dependent variables in Table 20. Similar to our previous setup, we employ the

print readership of USA Today as a control group for studying the evolution of NY Times' circulation share in the period following the paywall. We also include demographic controls (political leaning, education, income, business density etc.) to help account for market-specific variation in subscription shares of the newspapers. We find evidence of the NY Times' print circulation decreasing at a slower rate compared to USA Today, as indicated by a positive significant coefficient on the (NYT*post_paywall) interaction term for both weekday and weekend share regressions. These results suggest a positive effect of the paywall on print newspaper circulation, especially for NYT. Thus, our results are consistent with the second objective of the paywall: stemming the decline in print readership. As discussed earlier, preserving a print reader is believed to be about 16 times as valuable, in revenue terms, than an online reader. Thus, newspaper paywalls may also stand to provide an important allied benefit of slowing the decline in print readership, thus helping preserve a legacy revenue source.[40]

2.8 Robustness Checks

In this section, we verify the robustness of the effect of the paywall on print readership by: a) exploiting a larger sample of markets and a longer analysis time window, and b) exploring the implication of alternative definitions of control group to benchmark the effect of the paywall. First, we collect data on weekday and weekend print newspaper readership for a longer time window (2005-2012) and a larger sample of DMAs (N=202, which includes all available DMAs in the U.S. for the NYT). We collect the corresponding information for the newspaper we previously chose as our control group: USA Today. In addition, we collect

[40] As discussed earlier, nearly 80% of revenues are believed to accrue from print editions, underscoring the importance of this legacy revenue source for newspaper publishers.

these data for Wall Street Journal (WSJ). The WSJ commissioned a paywall back in 1997, which remained in effect over the course of our analysis. This gives us the opportunity to benchmark the results of the paywall on NYT's print readership against that of two newspapers: one that did not offer a paywall (USA Today) and one that did (WSJ). From these analyses, we choose to employ the more conservative estimate of the gain in NYT's print readership in our calculation of the revenue impact of its paywall.

We present the results from these models in Tables 21 and 22. As discussed earlier, the identification of the effect of the paywall depends on extent to which the pre-period trends for the NYT is similar to that for the control group newspapers. We present the average annual % change in circulation share for each newspaper in the pre-period in Table 23 - we see that these numbers are similar, by and large. While the average annual % change in circulation for NYT and WSJ are more similar, the WSJ's print circulation appears to have decayed at a slightly slower rate overall. We include a newspaper specific time trend in the model to account for any differences in the temporal evolution in each newspaper's circulation share, in order to avoid any biases introduced by differential trends in circulation on our estimates. To verify that the observed patterns in print subscription shares were not primarily on account of changes in print subscription prices, we also incorporate the subscription prices of the respective newspapers in each period in the model, as a covariate. Thus, our estimate of the paywall's effect on print readership is obtained by exploiting the residual variation in shares after accounting for those motivated by changes in print prices. We account for the potential endogeneity of price using instrumental variables: e.g., producer price indices for printing ink manufacturing (NAICS 32591), the cost of output from paper mills (NAICS 32212), and producer price indices of firms in industries that share similar cost structures, such as book publishers (NAICS 511130). Overall, we find a significant positive

effect of the paywall on NYT's print newspaper readership, while considering either USA Today or WSJ as the control group.[41]

Effect of temporary breaks in NYT's paywall: The NYT and the WSJ temporarily took down their paywalls for a brief period once each in October 2012 - following the Hurricane Sandy, and November 2012 - due to the upcoming Elections (Fiegerman, 2012). This change may have resulted in higher visits and/or page views to both newspapers' websites as users did not face the paywall upon encountering their free article limit. The effect of such a upward shift in demand, though temporary, would normally be picked up by the corresponding month fixed effect in the online readership demand model.[42] However, as we may be more interested in accurately attributing these temporary shifts in demand to the paywall, we re-estimate the model by switching off the post-paywall indicator variable ("post") for these two months. With this change, the effect of NYT's paywall on its unique visitors (page views per visitor) drops to 16% (11%) from the 18% (16%) seen earlier. By and large, we find that the results are substantively invariant to attributing these temporary changes to the paywall or to seasonal demand variations.

2.9 Revenue Implication of the Paywall

What is the impact of the NYT's paywall on its overall revenues? In order to answer this question, we employ industry data as well as our model estimates to compute the revenue

[41] Note that the effect drops to marginal significance when we include the newspaper specific time trends. However, in all cases, the p-values are quite close to the 5% significance levels (the p-values range from 0.052 to 0.055), except for the regression on NYT's weekend circulation shares when we use USA Today as the control group.

[42] Also note that the change in traffic prompted by such a policy change would potentially be more concerning if only one (but not both) of these newspapers had chosen to temporarily take down the paywall in this period, than otherwise.

impact of the paywall. We first consider online subscriptions, which is a new source of revenue to newspapers on account of the paywall. At the end of our analysis period in 2013, 500,000 readers had signed up for NYT's paid membership. While the NYT offered various pricing tiers for different subscription plans ($3.75 per week for access to NYTimes.com, $5 per week for online+iPad access, $8.75 per week for unlimited access on all devices),[43] we do not have information on the distribution of paid subscriptions across these pricing plans. Thus, we use the price of the cheapest plan ($3.75 per week) to arrive at the most conservative estimate for NYT's online subscription revenues. Using this metric, we compute that the NYT gained approximately $97.5 million in online subscription revenues in 2013. We next discuss the impact on online advertising. Given that the NYT gained approximately 3% in online revenues (compared to the category level baseline of online newspaper advertising), we can attribute $5.16 million (3% of the $172 million in online ad revenues) to the paywall.

To quantify the effect on print readership, we multiply NYT's paid subscriber base in 2013: 1.35 million with the revenue per reader: $405.6 per year (subscription price of $7.8 per week * 52 weeks). We then multiply this with the effect of the paywall on print readership (considering the conservative estimate of 9.9%) to arrive at the revenue estimate for the paywall's effect on print subscription. Thus, the paywall contributed $54.4 million in print subscription revenue to NYT.

The net benefit from the paywall can be computed as the sum of the three revenue components: online subscription, online advertising and print subscription, which together amount to a gain of approximately $157 million. This revenue increment represents 12% of NYT's total revenues in 2013. Thus, this research is one of the first to offer empirical evidence for a positive economic return from newspaper paywalls, by documenting that the

[43] http://www.nytimes.com/subscriptions/Multiproduct/lp5558.html – retrieved May 2013.

NYT paywall was responsible for at least a 12% gain in its total revenues within a period of two years since its inception.[44]

Caveats and Limitations

A few caveats and limitations are in order. First, it is important to note that the above revenue impact does not consider the effect of print advertising, due mainly to non-availability of print advertising data. Given that we find a positive effect of the paywall on print readership, it is likely that the paywall also had a positive effect on print advertising revenues (assuming print advertisers value the access to a larger base of readers, which generally holds true). However, if advertisers are actively switching between print and online newspaper versions, it is possible that the observed growth in online advertising due to the paywall may be in part due to advertiser substitution away from print advertising. While this may be plausible, Sridhar and Sriram (2013) report that this substitution effect is likely quite small, viewed in the light of advertiser substitution between newspaper and non-newspaper media, which is the more consequential substitution effect.

Second, two explanations could be responsible for the observed revenue bump: higher engagement of online readers, and self-selection. The higher engagement explanation would state that the average paying subscriber stays longer on the NYT website, and visits more frequently, thus possibly contributing more advertising. On the other hand, the paywall could also work as a sorting mechanism between low and high willingness to pay readers, with low WTP readers switching away upon encountering the paywall (the selection explanation). We are unable to disentangle these two effects in our data, owing mainly to our inability to

[44]When we calculate the revenue benefit for 2012, we find very similar results, with the paywall contributing approximately 10% of year 2012 revenues.

separate out paying and non-paying readers' contributions to online page views as well as advertising. However, note that from the news publisher's more pragmatic perspective, it probably matters less which of these two explanations is driving the economic returns from the paywall.

Finally, an important overarching question pertains to the timing of the paywall launch. Given the fast evolving market conditions and shrinking industry revenues, it is possible, and indeed likely, that the paywall's launch was an endogenously determined decision by the newspaper. Compared to the newspaper industry's heyday in the period before it faced steep competition for consumer/advertiser attention from new media sources (such as Google, Craigslist, news aggregators, Facebook etc.), online news was kept free possibly with a view of monetizing the gains in online ad revenues on account of the larger readership base accessing the newspaper's free online offering. Over the last five years, however, motivated mainly by a steep decline in their primary source of revenues: advertising, newspapers have actively pursued alternative revenue streams to ensure survival. Newspaper paywalls can be viewed as a prominent effort in this direction. Rather than offering normative nor prescriptive guidelines for setting up paywalls or managing their timing, this research aims to empirically quantify the impact on the firm's revenues conditional on its decision to charge readers for online news content. The fact that close to a third of all newspapers (450 out of 1380) have recently set up paywalls makes studying the revenue impact of such strategies a topical and important question.

2.10 Conclusion

Newspaper paywalls are becoming an increasingly prevalent phenomenon, with over 50% of newspapers in the U.S. having either implemented or actively considering setting up a paywall. The popular belief is that paywalls may provide a much welcome new source of revenue: online subscriptions. However, as suggested by various surveys of newspaper readers, newspapers stand the risk of driving away readers who are not willing to pay for online news. As online ad revenues are heavily linked to newspaper readership, newspapers also stand to putting these revenues at risk if the paywall leads to heavy reader attrition. Thus, the overall impact of setting up newspaper paywalls is far from conclusive. In this study, we employ data on online readership and advertising, and print readership of New York Times to assess the overall impact of the paywall it instituted in March 2011. We find that NYT's pay wall appears to have driven away some readers, as evidenced by a decline in the number of unique visitors to its website after the paywall. On the other hand, our results suggest that, following the paywall, the average NY Times reader visits the website more frequently and also stays longer, implying that paywalls may provide a key advantage of greater engagement of online readers. Overall, this research is the first of its kind to offer empirical evidence for positive economic returns accrued to information media firms from the decision to charge readers for access to online news content.

Tables and Figures

Comparison of NYT and USA Today's newspaper readership (print + online)

Newspaper	Rank in 2010	Rank in 2011	Rank in 2013	Circulation in 2011	Circulation in 2013
Wall Street Journal	1	1	1	2,069,169	2,378,827
USA Today	**2**	**2**	**3**	**1,784,242**	**1,674,306**
New York Times	**3**	**3**	**2**	**1,150,589**	**1,865,318**
LA Times	4	6	4	605,677	653,868
San Jose Mercury News	5	4	5	572,998	583,998

Table 14: Top Newspapers in the U.S. by circulation
Source: Alliance for Audited Media's annual Newspaper Audit Reports;
http://www.thepaperboy.com/usa-top-100-newspapers.cfm

Rank	DMA	Rank	DMA	Rank	DMA	Rank	DMA	Rank	DMA
1	New York	6	Washington D.C.	11	Minneapolis - St. Paul	16	Tampa - St. Pete - Sarasota	21	Cleveland
2	Los Angeles	7	San Fran - Oakland - San Jose	12	Phoenix	17	Orlando - Daytona Beach - Melbourne	22	Pittsburgh
3	Chicago	8	Dallas - Ft. Worth	13	Detroit	18	Indianapolis	23	Miami - Ft. Lauderdale
4	Boston	9	Atlanta	14	Houston	19	Denver	24	Sacramento - Stockton - Modesto
5	Philadelphia	10	Seattle - Tacoma	15	Portland	20	Hartford - New Haven	25	Charlotte

Table 15: Top 25 DMAs for NYT

Category	Avg expenditure ($)	Avg impressions served (millions)	Avg ad rate ($ per 1000 impressions)
Automotive	335,333.39	23.88	13.82
Business Services	60,968.42	3.86	15.40
Computers & Tech	500,483.30	34.94	13.91
Consumer Goods	207,366.20	14.59	13.83
Education	204,868.28	14.33	13.91
Finance	2,118,209.36	148.53	13.83
Government	206,599.25	11.67	14.59
Health	129,021.56	9.09	13.84
Media & Entertainment	1,414,117.27	112.59	13.84
Multi-Category	5,333,347.83	817.52	6.90
Online Media	839,434.78	531.94	1.88
Public Services	169,680.47	11.73	14.89
Retail	1,065,373.87	72.09	13.89
Sports & Rec	57,638.59	4.29	13.90
Telecommunications	290,454.41	22.09	13.80
Travel	708,689.67	52.75	13.89

Table 16: Advertising data broken down by category

	NY Times		USA Today	
	Pre	Post	Pre	Post
Uniq Visitors	701,330	670,543	318,012	367,986
Page Views (millions)	11.70	13.30	2.90	3.50
Duration (min)	12.90	20.10	2.63	3.40
Page Views Per Visitor	15.50	17.70	9.92	9.71

Table 17: Summary statistics before and after the paywall

DV=	ln (uniq visitors)		ln (pg views)		ln (duration)		ln (pg views per visitor)	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
NYT	0.669**	0.011	1.185**	0.036	1.376**	0.039	0.509**	0.032
Post	0.052	0.042	0.491**	0.135	-0.166	0.146	0.105	0.120
NYT*Post	-0.188**	0.016	-0.036	0.052	0.130**	0.056	0.159**	0.046
Political Leaning in 2012 election	-0.349**	0.019	-0.261**	0.060	-0.120^{+}	0.064	0.083	0.054
Population in 2012, DMA	0.000**	0.000	0.000**	0.000	0.000**	0.000	0.000**	0.000
Median age, DMA	0.008*	0.004	0.026*	0.013	0.035**	0.014	0.019**	0.011
Business density	0.000**	0.000	0.000**	0.000	0.000**	0.000	0.000**	0.000
High school education attainment	0.041**	0.003	0.025*	0.011	0.033**	0.012	-0.016^{+}	0.010
Median hhl income	0.000**	0.000	0.000**	0.000	0.000**	0.000	0.000**	0.000
Percent foreign born	0.019**	0.002	0.007	0.005	0.007	0.005	-0.012**	0.004
Percent below poverty level	0.055**	0.005	0.075**	0.015	0.053**	0.016	0.021	0.014
DMA dummies	√		√		√		√	
Month dummies	√		√		√		√	
R^2	0.91		0.65		0.66		0.29	

** p<0.01, *p<0.05, + p<0.1

Table 18: Effect of the Paywall on Online Newspaper Readership

DV=	ln(Ad Spend)		% Ad Spend on All Online Newspapers in the U.S.		ln(Ad Rate)		ln(Impressions)			
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Post	1.29**	0.09	0.03**	0.01	0.32**	0.02	0.97**	0.10	0.64**	0.12
Category dummies	√		√		√		√		√	
Month of the year dummies	√		√		√		√		√	
ln (page views)									2.55**	0.42
ln (ad rate)									0.07	0.19
R^2	0.55		0.53		0.77		0.60		0.62	

** p<0.01, *p<0.05, + p<0.1

Table 19: Effect of the Paywall on Online Advertising

DV=	Weekday circulation share		Weekend circulation share	
	Est.	SE	Est.	SE
NYT	-0.907**	0.250	-0.422	0.352
Post	-0.258**	0.026	-0.265**	0.024
NYT*Post	0.109*	0.054	0.144**	0.047
Political Leaning Elections 2012	0.018	0.166	0.247	0.248
Median Age, DMA	-0.025	0.034	-0.058	0.053
Business density	1.29**	0.577	2.26**	0.910
High school Attainment 2012	0.056^{+}	0.029	0.058	0.044
Median hhl income	0.299	0.175	0.193	0.195
Pct foreign born	0.025**	0.009	0.021^{+}	0.012
Pct below poverty level	0.055	0.032	0.082^{+}	0.044
R^2	0.39		0.24	

SEs clustered by DMA; ** p<0.01, *p<0.05, + p<0.1

Table 20: Effect of the Paywall on Print Readership

All DMAs, USA Today as control group								
DV=	Weekday circulation share				Weekend circulation share			
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
NYT	-1.083**	0.039	-0.922**	0.153	-0.356**	0.113	-0.223	0.489
Post	-0.281**	0.029	-0.225**	0.041	-0.334**	0.037	-0.148**	0.056
NYT*Post	0.337**	0.034	0.102^{+}	0.052	0.523**	0.049	0.065	0.074
p$^{\flat}$	-0.134**	0.013	-0.272**	0.055	-0.125**	0.013	-0.194**	0.065
Time trend (NYT)			0.055**	0.010			0.129**	0.023
Time trend (Control)			0.027	0.021			-0.026	0.026
DMA dummies	√		√		√		√	
R^2	0.79		0.79		0.71		0.71	

$^{\flat}$: using instruments to resolve the endogeneity in price; ** p<0.01, *p<0.05, + p<0.1

Table 21: Robustness checks - 1 - (Effect of paywall on print readership): Assessing the role of alternate sampling strategies

All DMAs, WSJ as control group								
DV=	Weekday circulation share				Weekend circulation share			
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
NYT	-0.799**	0.020	-1.033**	0.077	-0.136**	0.061	-0.583**	0.219
Post	-0.198**	0.032	-0.129**	0.037	-0.144**	0.033	-0.073^{+}	0.042
NYT*Post	0.153**	0.036	0.099^{+}	0.051	0.181**	0.038	0.106^{+}	0.059
p$^{\flat}$	-0.041**	0.009	0.039	0.029	-0.052**	0.008	0.000	0.030
Time trend (NYT)			0.039**	0.013			0.022*	0.011
Time trend (Control)			-0.064**	0.020			-0.048**	0.021
DMA dummies	√		√		√		√	
R^2	0.71		0.71		0.69		0.69	

$^{\flat}$: using instruments to resolve the endogeneity in price; ** p<0.01, *p<0.05, + p<0.1

Table 22: Robustness checks - 2 - (Effect of paywall on print readership): Using WSJ as the control group

Print Circulation for each Newspaper						
	NYT Weekend	NYT Weekday	USAT Weekend	USAT Weekday	WSJ Weekend	WSJ Weekday
Pre	1,686,020	1,034,263	2,454,332	2,207,041	1,919,427	2,039,218
Post	1,419,153	766,656	1,856,428	1,661,160	1,491,028	1,551,209
Avg Annual Decay Rate in Pre Period Circulation	-3.18%	-4.19%	-4.41%	-3.47%	-2.59%	-1.59%

Table 23: Circulation trends for each newspaper

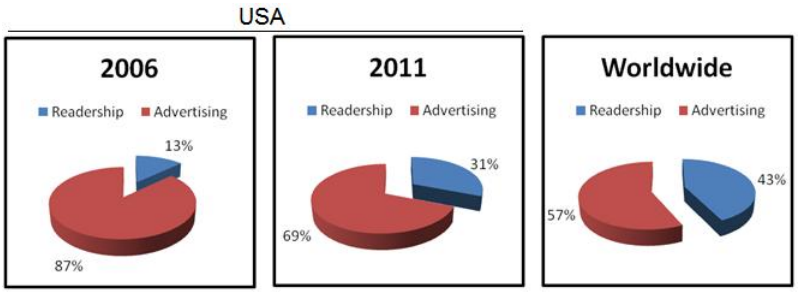

Figure 9: Shifting balance away from reliance on advertising revenues

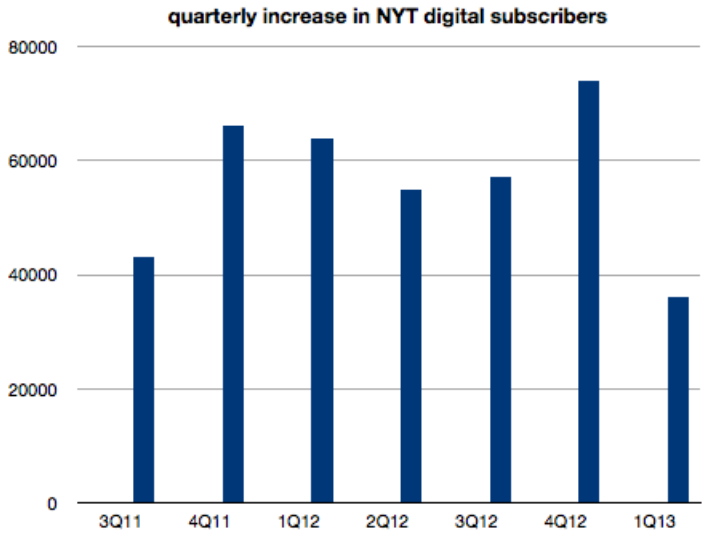

Figure 10: Growth in paid subscribers to NYT's website

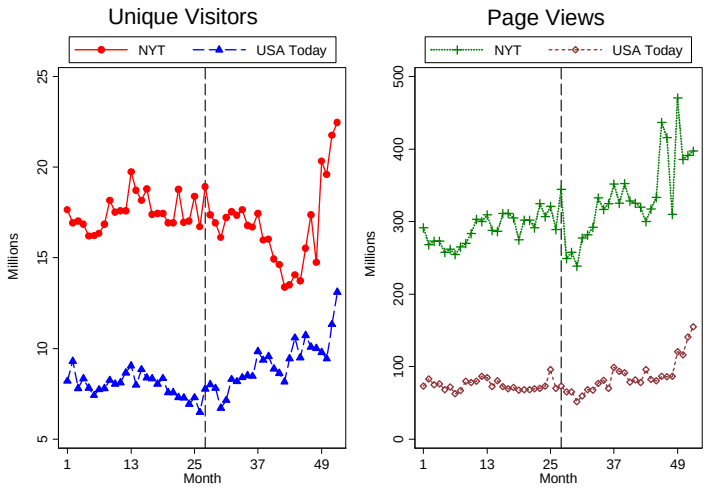

Figure 11: Online newspaper visitation before and after launch of the paywall (NY Times and USA Today)

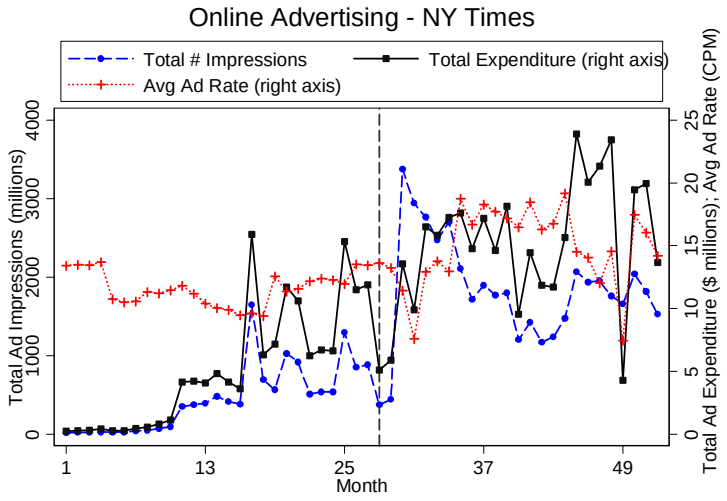

Figure 12: Temporal Evolution of Online Ad Revenues, Rates and Ad Levels

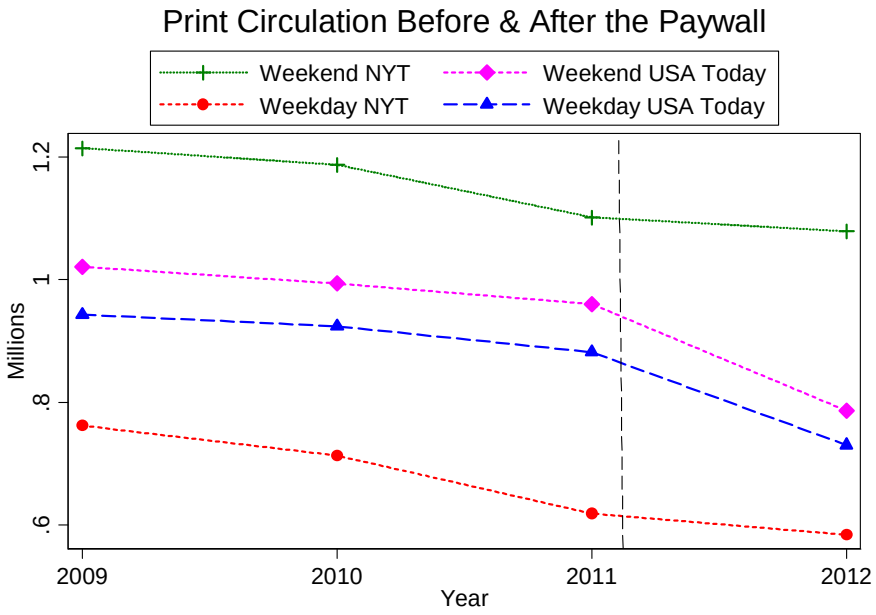

Figure 13: Print Circulation - NY Times and USA Today

APPENDICES

APPENDIX A

Readership Reweighting

Readership re-weighting to account for differential advertising contribution of the Weekday/Sunday newspapers

We consider the case where the Sunday version of the newspaper contributes 50% of the newspaper's total advertising revenues (the industry benchmark). Let ϖ and $\ddot{s}$ denote the per-reader advertising contribution of the Weekday and Sunday newspaper respectively. If the Sunday edition is responsible for 50% of total advertising revenues, we have

$$\frac{(R_{Daily} + R_{Wknd} + R_{Sun})\ddot{s}}{R_{Daily}(6\varpi + \ddot{s}) + R_{Wknd}(2\varpi + \ddot{s}) + R_{Sun}\ddot{s}} = \frac{1}{2}$$

This can be used to compute an expression for $\varpi/\ddot{s}$, which can further be used to reweight readership according to the expression: $R_t = R_{Daily} * 6\,(\varpi/\ddot{s} + 1) + R_{Wknd} * 2(\varpi/\ddot{s} + 1) + R_{Sun}$ in the advertising demand model to account for the differential advertising contribution of the Sunday newspaper.

APPENDIX B

Does newspaper advertising influence subscription decisions?

To try to answer this question with our data, we estimated the readership model allowing the levels of advertising (proxied by total advertising quantity) to influence consumer utility. We found that its effect is negative, small and statistically insignificant (last column in Table A.1). However, it is possible that readers' subscription decisions may be influenced differentially by the three advertising types: Display ads, Inserts, and Classifieds. To explore this possibility we estimated alternative model specifications where we allowed the three advertising types to influence readers' decisions individually.[45] We found that the coefficients on the advertising terms were insignificant in all cases. We found no difference in the result based on whether or not we allowed the advertising effect to vary by bundle (Table A.2), or allowed these coefficients to be heterogeneous.[46] Further, as we described in the Estimation section, in our empirical specification for readership demand, we specify year-fixed effects to flexibly capture the temporal evolution of readers' preferences. Therefore, the insignificant effect of advertising on readership just suggests that the within year variation in advertising might not have an effect on readership. A concern is that these year fixed effects may also be capturing the significant influence of year-on-year changes in advertising on subscription decisions. To assess the validity of this concern, we also estimated alternative model specifications for readership demand with advertising included as a covariate, but without year fixed effects. We found that the advertising coefficients were statistically insignificant even after excluding the year fixed effects. We provide these results in Table A.2. This helps us place more faith in our assumption that newspaper subscription decisions are not influenced by advertising levels.

[45]Given the high temporal correlation (0.55-0.85) between the three types of advertising, we could not estimate a model that allowed for the simultaneous influence of all three advertising quantities.

[46]These results can be obtained from the authors on request.

Does advertising influence readers' subscription decisions?

Parameter	**ROP**		**PPT**		**CLAS**		**Total Advertising**	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Pref (M-Thurs)	2.30***	0.26	2.28**	0.25	2.29**	0.26	2.29**	0.26
Pref (Fri,Sat)	-1.77***	0.12	-1.77**	0.11	-1.77**	0.12	-1.77**	0.12
Pref (Sun)	-6.67***	0.50	-6.68**	0.50	-6.76**	0.56	-6.67**	0.50
NDM price	-0.05*	0.02	-0.05*	0.02	-0.05*	0.02	-0.05*	0.02
ONDM price	-0.02	0.01	-0.02	0.01	-0.02	0.01	-0.02	0.01
# of news pgs	0.44**	0.16	0.45**	0.15	0.45**	0.15	0.45**	0.15
C1-Income	0.64**	0.07	0.64**	0.07	0.64**	0.07	8.98**	0.07
C2-Income	0.46**	0.08	0.46**	0.08	0.46**	0.08	5.58**	0.08
C3-Income	0.29**	0.09	0.29**	0.09	0.29**	0.09	3.36**	0.09
C4-Income	0.58**	0.08	0.58**	0.08	0.58**	0.08	7.73**	0.08
C5-Income	0.13^{+}	0.08	0.13^{+}	0.08	0.13^{+}	0.08	1.61**	0.08
NDM Y2007	-0.30**	0.06	-0.30**	0.06	-0.29**	0.06	-0.30**	0.06
NDM Y2008	-0.48**	0.08	-0.48**	0.07	-0.45**	0.11	-0.48**	0.07
NDM Y2009	-0.16^{+}	0.09	-0.16*	0.07	-0.12	0.12	-0.17*	0.08
NDM Y2010	-0.16	0.10	-0.16*	0.08	-0.11	0.12	-0.17^{+}	0.09
NDM Y2011	-0.29*	0.11	-0.29**	0.08	-0.23^{+}	0.14	-0.29**	0.10
ONDM Y2007	-0.17**	0.05	-0.17**	0.05	-0.17**	0.05	-0.17**	0.05
ONDM Y2008	-0.30**	0.07	-0.30**	0.06	-0.27**	0.10	-0.30**	0.07
ONDM Y2009	-0.02	0.08	-0.02	0.06	0.02	0.12	-0.02	0.07
ONDM Y2010	0.04	0.10	0.04	0.07	0.09	0.12	0.04	0.08
ONDM Y2011	0.03	0.10	0.03	0.08	0.08	0.14	0.03	0.09
ROP Advertising	-0.03	0.14						
PPT Advertising			-0.05	0.10				
CLAS Advertising					0.64	2.02		
Total Advertising							-0.21	0.59

** p<0.01, *p<0.05, $^{+}$ p<0.1

Table A.1: Appendix - Alternative specifications for the readership model (1)

	Allowing for different effects of advertising for Daily, Weekend and Sunday bundles		**Effect of advertising excluding year dummies and demographic controls**							
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Pref (M-Thurs)	0.63	1.29	0.62	1.03	0.54	1.03	0.64	1.01	0.59	1.03
Pref (Fri,Sat)	-2.72**	0.64	-2.52**	0.47	-2.56**	0.47	-2.50**	0.46	-2.54**	0.47
Pref (Sun)	-6.01**	1.22	-5.77**	0.90	-5.72**	0.90	-5.95**	0.94	-5.74**	0.90
NDM price	0.18*	0.06	0.16**	0.05	0.16**	0.05	0.17**	0.06	0.16**	0.05
ONDM price	0.03	0.05	0.02	0.05	0.02	0.05	0.03	0.05	0.02	0.05
# of news pgs	1.50	0.98	1.42*	0.64	1.48**	0.64	1.37*	0.62	1.45**	0.64
ROP Advertising			-0.10	0.32						
PPT Advertising					-0.27	0.37				
CLAS Advertising							1.16	2.71		
Total Advertising									-0.81	1.72
Total Advertising-Daily	-0.82	7.75								
Total Advertising-Weekend	2.51	3.87								
Total Advertising-Sunday	-0.06	3.19								

** p<0.01, *p<0.05, + p<0.1

Table A.2: Appendix - Alternative specifications for the readership model (2)

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