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# Merger Simulation in a Two-Sided Market:The Case of the Dutch Daily Newspapers*

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**Abstract**

We develop a structural econometric framework that allows us to simulate the effects of mergers among two-sided platforms selling differentiated products. We apply the proposed methodology to the Dutch newspaper industry. Our structural model encompasses demands for differentiated products on both sides of the market and profit maximization by competing oligopolistic publishers who choose subscription and advertising prices, while taking the interactions between the two-sides of the market into account. We measure the sign and size of the indirect network effects between the two sides of the market and simulate the effects of a hypothetical merger on prices and welfare.

**JEL Classification:** L13, L40, L82.

**Keywords:** Two-sided markets, newspapers, advertising, network effects, merger simulation, SSNIP test.

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# 1. Introduction

The newspaper market is a typical example of a so-called two-sided market as the demand for advertisements in a newspaper depends positively on its circulation (Anderson and Gabszewicz, 2008). In such situations, there is a wealth of open questions for competition policy, for example how a proposed merger between two such platforms should be evaluated. This is because the policy conclusions that are drawn from theoretical models do not only depend on own- and cross-price elasticities of demand on both sides of the market, but also on the own- and cross-elasticities of demand on one side with respect to demand on the other side. For example, in the newspaper market, when considering to increase the subscription price, newspapers will take into account that such an increase not only has a negative effect on subscription revenues through its negative effect on circulation, but also a negative effect on advertising revenues through decreased circulation. Hence, it is important to know how, in equilibrium, advertisers' demand for slots in a newspaper reacts to an increase in the circulation of that newspaper and of other newspapers, in addition to how readers' demand for a newspaper depends on advertising in that newspaper and in other newspapers.

In this paper, we develop a structural econometric framework that allows us to assess the effects of mergers among two-sided platforms selling differentiated products on prices and welfare. Our structural model encompasses demands for differentiated products on both sides of the market and profit maximization by competing oligopolistic publishers who choose subscription and advertising prices, while taking the interactions between the two sides of the market into account. We discuss different ways in which such a merger can be assessed and then implement the proposed methods for a hypothetical merger among two Dutch newspaper companies.

Argentesi and Filistrucchi (2007) use a similar framework to test for collusion in the Italian newspaper market when readership demand does not depend on the amount of advertising. In this paper, we not only address another competition policy issue, namely merger assessment, but also extend their framework to the more general case of a two-sided market with two network effects. In this case, not only advertising demand depends on the number of readers but also readership demand depends on the amount of advertising in the newspaper.[1] In particular, we specify demand on each side of the market to be given by a logit model. We show how marginal costs can be recovered and how a merger can be assessed by either performing a SSNIP test or solving for the new equilibrium following a hypothetical merger.[2]

Theoretical work on mergers among two-sided platforms is very scarce. Chandra and Collard-Wexler (2009) present an economic model of the newspaper market which shows that it is not necessarily the case that a monopolist will choose to set higher prices than competing duopolists on either side of the platform. A recent paper by Leonello (2010) analyses mergers in a similar setting. Her model also has differentiated products à la Hotelling on both sides of the market and two oligopolistic platforms merging into a monopoly. She finds that, even in the absence of efficiency gains, because of the existence of indirect network externalities, merging platforms have the incentive to keep their prices low after the merger at least on one side of the market.

Empirical work on mergers involving two-sided platforms is also scarce. Evans and Noel (2008) point out that, as the Lerner pricing formula does not hold in such markets, traditional merger simulation models are wrongly specified if applied without modifications to two-sided or multi-sided platforms. They also perform an analysis of the merger between Google and DoubleClick (the first empirical analysis in the literature of a merger in a two-sided industry). They show that relying on conventional methods would have led to significantly different results than using methods that explicitly incorporate the two-sided nature of this market. Nevertheless, they only perform a calibration exercise due to lack of data.

Also Chandra and Collard-Wexler (2009) assess mergers in the Canadian newspaper market, but their analysis is mainly an ex-post merger evaluation exercise; they use a two-sided

[1] Previous studies show that it may or may not be necessary to consider this case (Sonnac, 2000). For instance, whereas Argentesi and Filistrucchi (2007) find no effect of advertising on the number of readers of daily newspapers in Italy and Fan (2010) reaches the same conclusion for US daily newspapers, Kaiser and Wright (2006) and Kaiser and Song (2009) find that advertising increases readers demand for magazines in Germany.

[2] SSNIP stands for “Small but Significant and Non-transitory Increase in Price”, see below.

Hotelling model to explain their finding that greater concentration did not lead to higher prices neither for readers nor to advertisers; yet they do not build and estimate a structural econometric model; their framework therefore, cannot be used to simulate mergers.

The closest paper to ours is Fan (2010). While devoid of a competition policy objective and not referring at all to the two-sided markets literature, she presents a structural model of demand for newspapers which she uses to assess ex-post some mergers among US newspapers. Whereas our framework to analyse merger effects on prices is more general than hers, her model would allow to account for changes in the quality of the newspapers after the merger, provided data on quality are indeed available.

This paper proceeds as follows. In Section 2 and 3, we present the model and our approach to merger assessment. We provide information on the data and background information on the market for Dutch daily newspapers in Section 4 and 5, respectively, present our demand estimates in Section 6, and perform an example of a merger simulation in Section 7. Section 8 concludes.

# 2. The model

## 2.1. Readership and advertising demand

Key inputs into the economic analysis are estimates of the responsiveness of readership demand with respect to newspaper prices and the advertising intensity, and the responsiveness of advertising demand with respect to advertising prices and the number of readers of a newspaper. In this section, we discuss how demand and marginal costs can be estimated using market level data. As circulation data for free newspapers are only available at the national level we obtain our main results using national level data with a Berry (1994)-type multinomial logit specification and then compare parts of them to results obtained using regional level data.

For readership demand for daily newspapers we assume that each consumer buys at most one newspaper. The utility from buying a newspaper depends, among other things, on the price of that newspaper and the percentage advertising in that newspaper. Formally, the utility of consumer $i$ from buying newspaper $j$ in $t$ is given by[3]

$$u^n_{ijt} = \alpha p^n_{jt} + \beta q^a_{jt} + \xi^n_{jt} + \varepsilon^n_{ijt}.$$

Throughout, the superscript "$n$" stands for "newspaper" (as in utility derived by readers of that newspaper or price of that newspaper) and the superscript "$a$" stands for "advertisement" (as in utility of placing a particular advertisement or the price of an advertisement). In the above utility function, $\alpha p^n_{jt} + \beta q^a_{jt}$ is the part of the utility that stems from the two observed characteristics price, $p^n_{jt}$, and advertising, $q^a_{jt}$. $\xi^n_{jt}$ is the part of the utility that stems from unobserved characteristics, and finally $\varepsilon^n_{ijt}$ is the part of the utility derived from buying newspaper $j$ that is specific to individual $i$ at time $t$. We assume that $\varepsilon^n_{ijt}$ is distributed according to the type I extreme value distribution independently across $j$ and $t$ and introduce the outside good $j = 0$, buying no newspaper, that yields average utility 0, i.e. $u^n_{i0t} = \varepsilon_{0t}$.

To determine the market shares we need to define the potential market size, which we will denote by $M^n$. We assume that the hypothetical market size for readership demand is the population, i.e. we assume that every individual buys at most one newspaper.

Define the vectors $p^n_t$, $q^a_t$ and $\xi^n_t$, which contain the prices, amounts of advertising, and unobserved characteristics of all newspapers, respectively. We assume that consumers buy the one newspaper, or none, that yields the highest utility. Then, we have that the probability that newspaper $j$ is chosen is

$$\Pr\left(n = j \mid p^n_t, q^a_t, \xi^n_t\right) = \frac{\exp\left(\alpha p^n_{jt} + \beta q^a_{jt} + \xi^n_{jt}\right)}{1 + \sum_{l=1}^{J} \exp\left(\alpha p^n_{lt} + \beta q^a_{lt} + \xi^n_{lt}\right)}. \qquad (1)$$

[3]Sometimes, utility is stated as depending on a choice-specific constant. Here, the mean of $\xi^n_{jt}$ over time, later denoted as $\alpha^n_j$ , serves the same purpose.

Likewise, for the outside good we have

$$\Pr\left(n = 0 \mid p^n_t, q^a_t, \xi^n_t\right) = \frac{1}{1+\sum_{l=1}^{J}\exp\left(\alpha p^n_{lt}+\beta q^a_{lt}+\xi^n_{lt}\right)}.$$

Notice that all of the above is still formulated on the individual level. However, the probability to buy newspaper $j$ at time $t$ is equal to the observed market share of that product, which we will denote by $s^n_{jt}$. The market share for the outside good is denoted by $s^n_{0t}$. Using a well-known result of Berry (1994), we then have that

(2) $$\ln\left(s^n_{jt}\right) - \ln\left(s^n_{0t}\right) = \alpha p^n_{jt}+\beta q^a_{jt}+\xi^n_{jt},$$

i.e., the difference between the natural logarithm of the market share of good $j$ and the natural logarithm of the market share of the outside good is equal to the utility from observed characteristics $p^n_{jt}$, $q^a_{jt}$, and the unobserved characteristic $\xi^n_{jt}$. Importantly, the left hand side of this equation is observed because $s_j$ and $s_0$ are observed.[4]

We assume that

$$\xi^n_{jt}=\alpha^n_j+\alpha^n_t,$$

which means that there is a newspaper fixed effect $\alpha^n_j$ and a time fixed effect $\alpha^n_t$. Under this assumption, we can estimate $\alpha$ and $\beta$ by regressing $\ln\left(s^n_{jt}\right) - \ln\left(s^n_{0t}\right)$ on $p^n_{jt}$ and $a^n_{jt}$ once we use the within-group estimator, where the observational unit is a newspaper, and additionally control for time fixed effects that are the same across all newspapers. This is a suitable procedure to control for endogeneity of prices if the endogeneity arises due to unobserved differences across newspapers that stay the same over time.

Now, having obtained estimates of $\alpha$ and $\beta$, using the observed market shares, we can cal-

[4]In our data, some of the explanatory variables are not available for all newspapers. In order to make as much use as possible from the available data, we calculate the market shares $s^n_{jt}$ before dropping observations with missing information on observable newspaper characteristics because otherwise the log-difference on the left hand side of the estimation equation is mismeasured.

culate the responsiveness of readership demand with respect to own prices,

$$\frac{\partial s^n_{jt}}{\partial p^n_{jt}} = s^n_{jt}\left(1 - s^n_{jt}\right)\alpha,$$

prices of other newspapers,

$$\frac{\partial s^n_{jt}}{\partial p^n_{kt}} = -s^n_{jt} s^n_{kt}\alpha,$$

own advertising,

$$\frac{\partial s^n_{jt}}{\partial q^a_{jt}} = s^n_{jt}\left(1 - s^n_{jt}\right)\beta,$$

and advertising in other newspapers,

$$\frac{\partial s^n_{jt}}{\partial q^a_{kt}} = -s^n_{jt} s^n_{kt}\beta.$$

We proceed analogously for advertising demand. Here, the utility from placing ad $i$ into newspaper $j$ at time $t$ is

$$u^a_{ijt} = \gamma p^a_{jt} + \delta q^n_{jt} + \xi^a_{jt} + \varepsilon^a_{ijt}.$$

The market size $M^a$ is the total amount of advertising in all print media. The characteristics are the price of advertising, $p^a_{jt}$, and the number of readers, $q^n_{jt}$. We also assume that $\varepsilon^a_{ijt}$ follows a type I extreme value distribution and that

$$\xi^a_{jt} = \alpha^a_j + \alpha^a_t.$$

Then, we can estimate $\gamma$ and $\delta$ by regressing $\ln\left(s^a_{jt}\right) - \ln\left(s^a_{0t}\right)$ on $p^a_{jt}$ and $q^n_{jt}$ using the within-group estimator once we also control for time fixed effects. Finally, as we have done for readership demand we can calculate the responsiveness of advertising demand with respect to own prices, $\partial s^a_{jt}/\partial p^a_{jt}$, prices of other newspapers, $\partial s^a_{jt}/\partial p^a_{kt}$, own readership, $\partial s^a_{jt}/\partial q^n_{jt}$, and readership of other newspapers, $\partial s^a_{jt}/\partial q^n_{kt}$.

## 2.2. Markups and marginal costs

Towards recovering marginal costs we assume that firms $f$ maximize profits by choosing advertising prices $p^a_{jt}$ and subscription prices $p^n_{jt}$ for all newspapers $j$ in their newspaper portfolio $\mathcal{F}_f$. Assuming constant marginal costs for simplicity, $mc^a_{jt}$ and $mc^n_{jt}$, their profit function for variable profits is[5]

$$\Pi_{ft} = \sum_{l \in \mathcal{F}_f} \{(p^a_{lt} - mc^a_{lt})\, M^a_t s^a_{lt} + (p^n_{lt} - mc^n_{lt})\, M^n s^n_{lt}\}\,.$$

The first term are advertising profits from newspaper $l$. They are given by the mark-up times the advertising quantity, which itself is given by the market size times the market share. The market share is equal to the analogue of (1) for advertising demand. It therefore depends on the vector of all advertising prices, $p^a_t$, and the vector of all readership demands, denoted by $q^n_t$.

Similarly, the second term are readership profits. The number of readers is given by the market share in the subscriptions market, which itself depends on the vector of all subscription prices, $p^n_t$, and all advertising quantities, $q^a_t$.

Assuming the existence of a pure-strategy Nash equilibrium in prices with strictly positive prices we have that the prices $p^a_{jt}$ and $p^n_{jt}$ satisfy the first-order conditions

$$\frac{\partial \Pi_{ft}}{\partial p^a_{jt}} = 0$$

and

$$\frac{\partial \Pi_{ft}}{\partial p^n_{jt}} = 0.$$

It is important at this point to realize that we have

$$q^n_t = M^n_t s^n_t\,(p^n_t, q^a_t)$$

[5]We assume throughout that $\mathcal{F}_f$ does not change over time. Then, fixed costs are irrelevant to the firm's maximization problem.

and

$$q_t^a = M_t^a s_t^a \left(p_t^a, q_t^n\right).$$

This is a nonlinear system of $2J$ equations with $2J$ unknowns, and therefore we cannot obtain the first-order conditions by simply substituting the equations above into the profit functions and calculating first derivatives. However, we show in Appendix A that we can instead use the implicit function theorem to obtain the first-order conditions.

In the empirical analysis, we can take another approach because readership demand does not depend on the advertising quantity, as in Argentesi and Filistrucchi (2007). Then, using

$$\frac{\partial q_{jt}^a}{\partial p_{kt}^a} = M^a \cdot \frac{\partial s_{jt}^a}{\partial p_{kt}^a}$$

and

$$\frac{\partial q_{jt}^n}{\partial p_{kt}^n} = M^n \cdot \frac{\partial s_{jt}^n}{\partial p_{kt}^n}.$$

we have the first-order conditions

$$M^a s_{jt}^a + \sum_{l \in \mathcal{F}_f} \left\{ \left(p_{lt}^a - mc_{lt}^a\right) M^a \frac{\partial s_{lt}^a}{\partial p_{jt}^a} \right\} = 0 \tag{3}$$

and

$$M^n s_{jt}^n + \sum_{l \in \mathcal{F}_f} \left\{ \left(p_{lt}^n - mc_{lt}^n\right) M^n \frac{\partial s_{lt}^n}{\partial p_{jt}^n} + \sum_k \left(p_{lt}^a - mc_{lt}^a\right) M^a \frac{\partial s_{lt}^a}{\partial q_{kt}^n} \cdot M^n \cdot \frac{\partial s_{kt}^n}{\partial p_{jt}^n} \right\} = 0 \tag{4}$$

for $j = 1, \ldots, J$. These are obtained as derivatives of the profit function with respect to the prices.

Generally, a marginal price increase has three effects. The first effect is that profits increase because the margin increases. This effect is associated with the term $M^a s_{jt}^a$ in (3), and $M^n s_{jt}^n$ in (4). Secondly, a price increase, say for advertising in newspaper $j$, affects advertising demand for all newspapers because a particular advertisement is placed in only one newspaper, or in none. This effect is associated with the term $(p^a_{lt} - mc^a_{lt})M^a \partial s^a_{lt}/\partial p^a_{jt}$ , representing the mark-up times the effect of the price change on the advertising quantity $M^a s^a_{lt}$ for newspaper $l$. This effect is taken into account by the firm for all newspapers it owns, hence we sum over $l \in \mathcal{F}_f$. A similar argument holds for a change in the subscription price.

Finally, there are network effects that define the two-sidedness of the market. In general, a price increase affects subscription revenues because it affects advertising demand, and readership demand depends on the amount of adverting in the newspaper. Here, consistent with our empirical findings, we assume that this network effect is not present. However, we allow advertising demand to depend on readership so that a subscription price increase will affect advertising demand in all newspapers, denoted as $k$, and not only on the ones that are owned by the firm. This will in turn have an effect on advertising revenues. So, $\sum_k (p^a_{lt} - mc^a_{lt})M^a(\partial s^a_{lt}/\partial q^n_{kt}) \cdot M^n \cdot (\partial s^n_{kt}/\partial p^n_{jt})$ is the effect of a change in $p^n_{jt}$ on advertising profits in newspaper $l$. To obtain the effect on firm profits we sum over $l \in \mathcal{F}_f$.

There are $J$ newspapers and two prices for each newspaper. Hence, there are $2J$ first-order conditions with $2J$ unknown variables, namely the marginal costs of an advertisement and the marginal cost of producing and delivering a newspaper copy. It is convenient to express this system of equations in a compact way.

For this, we define the following $J \times J$ matrices. A Nevo (2001)-type ownership matrix $\Omega^*$, a matrix of marginal effects of advertising prices on advertising demand $S^a$, a matrix of marginal effects of subscription prices on newspaper demand $S^n$, a matrix of network effects, $N^n$, and interactions between those matrices and the ownership matrix, $\Omega^{S^a}$, $\Omega^{S^n}$, and $\Omega^{N^a}$. In particular, let $\Omega^*_{jr} = 1$ if products $j$ and $r$ are owned by the same firm, 0 otherwise, and

$$\begin{aligned}
S^a_{jr} &= \frac{\partial s^a_{rt}}{\partial p^a_{jt}}, \\
\Omega^{S^a}_{jr} &= \Omega^*_{jr} \cdot S^a_{jr} \\
S^n_{jr} &= \frac{\partial s^n_{rt}}{\partial p^n_{jt}}, \\
\Omega^{S^n}_{jr} &= \Omega^*_{jr} \cdot S^n_{jr} \\
N^a_{jr} &= \sum_k \frac{\partial s^a_{rt}}{\partial q^n_{kt}} \cdot \frac{\partial s^n_{kt}}{\partial p^n_{jt}} \\
\Omega^{N^a}_{jr} &= \Omega^*_{jr} \cdot N^a_{jr}.
\end{aligned}$$

Then, we can express the set of first-order conditions as

$$s^a_t + \Omega^{S^a} (p^a_t - mc^a_t) = 0$$

and

$$s^n_t + \Omega^{S^n} (p^n_t - mc^n_t) + M^a \Omega^{N^a} (p^a_t - mc^a_t) = 0,$$

where $s^a_t$, $s^n_t$, $p^a_t$, $p^n_t$, $mc^a_t$, and $mc^n_t$ are now all $J \times 1$ vectors of market shares, prices, and marginal costs for advertisements and newspaper copies, respectively.

To solve this system of equations for the unknown $(p^a_t - mc^a_t)$ and $(p^n_t - mc^n_t)$ we define

$$\Omega = \begin{pmatrix} \Omega^{S^a} & 0 \\ \Omega^{S^n} & M^a \Omega^{N^a} \end{pmatrix},$$

$$s_t = \begin{pmatrix} s^a_t \\ s^n_t \end{pmatrix}$$

and

$$(p_t - mc_t) = \begin{pmatrix} p_t^a - mc_t^a \\ p_t^n - mc_t^n \end{pmatrix}.$$

Using this we can write the first-order conditions as

$$s_t + \Omega \cdot (p_t - mc_t) = 0$$

and solve for

$$(p_t - mc_t) = -\Omega^{-1} s_t,$$

which shows that it is possible to recover an estimate of the mark-ups based on additional appropriate assumptions on firms' behaviour in the market, from the observed market shares, the ownership structure and the estimated parameters of demand.

Using these estimated mark-ups one can then obtain marginal costs by subtracting the estimated mark-ups from the observed prices, as

$$mc_t = p_t - (p_t - mc_t).$$

# 3. Assessing unilateral merger effects in a two-sided market

This section discusses whether and how one should perform merger simulation in a two-sided market. From the point of view of economics, the correct way to evaluate whether a merger is likely to lead to higher prices would be to specify a model of the market in question, estimate demand in order to recover values for the parameters of the model and then use the models and the estimated parameters to predict the price chosen by the firms after the merger. One can then compare the prices, consumer surplus and/or total welfare in the new equilibrium with those in the old equilibrium. We conduct such an exercise below.

However, all this can often be very time consuming. As a result, in practice a full simulation is often not performed. In fact, it is often the case that a similar exercise to the SSNIP test or the HM test, which were originally designed to define the relevant market, is performed.[6] The idea is to measure the likelihood of a substantial non transitory increase in price by the merging parties. Practitioners therefore simulate a given price increase above the current level by the merging parties, assuming rivals do not change their prices and check whether that price increase is profitable or not. If it is profitable, it is judged to be likely to take place.

In order to compare our full simulation results we also conduct such an exercise below. In doing that we use the extension of the SSNIP test to two-sided markets developed in Filistrucchi (2008) for market definition.[7] The test is modified in such a way as to take into account the presence of the indirect network effects in order to correctly assess the competitive constraints faced by the merged firm and therefore the profitability of a price increase. So that for instance in assessing whether an increase in the cover price of a newspaper leads to a loss in profits one takes into account that not only a higher cover price will lead to lower demand from readers but also a lower readership will lead to lower demand and profits from advertisers. Indeed, as we will see, positive indirect network effects between the different sides of the platform reduce the profitability of any price increase. In addition we allow the merged firm to optimally adjust the price on the advertising side when the cover price is raised. As a result the only difference with respect to the full merger simulation above is not allowing rivals to react to the price increase.[8]

[6] In the EU the test used in market definition is the "Small Significant Non-transitory Increase in Price" (SSNIP) test, in the US it is called the "Hypothetical Monopolist" (HM) test The one just described above is the test in the EU. In the US one is supposed to calculate the optimal price increase above the current level by the merging parties keeping rivals' prices constant. As in the case of market definition, the difference between the SSNIP and the HM test appears to be very small at first sight and it is a matter of debate whether this difference is in practice relevant or not. In practice, both in the EU and in the US, the test is conducted using formulas derived under the assumption of constant marginal costs and either linear or iso-elastic demand. See Tilec and Howrey (2010) for further discussion.

[7] For an application of the SSNIP test for two-sided markets to the daily newspapers market in Italy, see Argentesi and Filistrucchi (2010).

[8] A further simplification could have been not to allow the merged firm to optimally adjust the price structure. Then the profitability of the rise in prices would be lower, as any adjustment will tend to reduce the loss in profits due to the increase in prices.

### 3.1. SSNIP Test

The SSNIP test determines whether an increase of the subscription prices by the merging parties of 5% is profitable. In order to assess this, we need to determine optimal advertising prices as a function of subscription prices. The associated first-order condition for firm $f$ is, as stated already above,[9] are

$$M^a s^a_{jt} + \sum_{l \in \mathcal{F}'_f} \left\{ (p^a_{lt} - mc^a_{lt}) \, M^a \frac{\partial s^a_{lt}}{\partial p^a_{jt}} \right\} = 0.$$

Notice that the set of products of the merged firm is $\mathcal{F}'_f$, instead of $\mathcal{F}_f$ before. Importantly, $s^a_{jt}$ depends on $q^n = M^n s^n_t (p^n_t, q^a_t)$, which will change due to the increase in the subscription price. We have shown above that $\partial s^a_{j't} / \partial p^a_{jt}$ depends on $s^a_t (p^a_t, q^n_t)$, and hence on $s^n_t (p^n_t, q^a_t)$.

Observe that we have, by (2),

$$\hat{\xi}^a_{jt} = \ln \left( s^a_{jt} \right) - \ln \left( s^a_{0t} \right) - \hat{\gamma} p^a_{jt} - \hat{\delta} q^n_{jt}$$

and

$$\hat{\xi}^n_{jt} = \ln \left( s^n_{jt} \right) - \ln \left( s^n_{0t} \right) - \alpha p^n_{jt} - \beta q^a_{jt},$$

which are expressed in terms of the observed market shares, prices, and quantities and where estimated quantities are denoted by hats. Having obtained those we can calculate market shares using the logit formulas

$$s^n_t (p^n_t) = \frac{\exp \left( \hat{\alpha} p^n_{jt} + \hat{\xi}^n_{jt} \right)}{1 + \sum_{l=1}^J \exp \left( \hat{\alpha} p^n_{lt} + \hat{\xi}^n_{lt} \right)}$$

for the readership side, now already imposing $\beta = 0$, and

$$s^a_t (p^a_t, q^n_t) \, , \; = \frac{\exp \left( \hat{\gamma} p^a_{jt} + \hat{\delta} q^n_{jt} + \hat{\xi}^a_{jt} \right)}{1 + \sum_{l=1}^J \exp \left( \hat{\gamma} p^a_{lt} + \hat{\delta} q^n_{lt} + \hat{\xi}^a_{lt} \right)}$$

for the advertising side.

[9] Recall that this is for the case in which readership demand does not depend on the advertising quantity.

This shows that we can solve the first-order conditions for the adjusted prices $p_{jt}^{a*}$ using the estimates of the marginal costs that were obtained before. In the logic of the SSNIP test this is done only for the merging parties using the adjusted ownership matrix. These prices, together with the new quantities and the new subscription prices, are then used to calculate the change in profits. Notice that here we do not solve for the new equilibrium because in the logic of the SSNIP test in the logic of the SSNIP test we exogenously rise the subscription prices of the merging parties by 5%, while keeping the other prices constant.

## 3.2. Full simulation and welfare analysis

For a full welfare analysis we need to solve the $2J$ first-order conditions for the new optimal subscription prices after the parties have merged. From these first-order conditions we have

$$p_t^{PM} = -\Omega^{-1}\left(p_t^{PM}\right) s_t(p_t^{PM}) + mc_t.$$

Note that in this case both the matrix $\Omega$ and the market shares $s_t$ are those corresponding to the optimal post-merger prices $p_t^{PM}$. It is generally difficult to solve analytically for the optimal post merger prices as a function of estimated parameters. However, we can solve for them numerically.[10] Therefore, it is possible to evaluate whether and to what extent prices would be raised on each side of the market as a result of the merger in the absence of efficiency gains.

Readers' welfare can be calculated using the standard welfare formula for the multinomial logit model and the estimated parameters,

$$W^n(p_t^n) = \ln\left(1 + \sum_{l=1}^{J} \exp\left(\hat{\alpha} p_{lt}^n + \hat{\xi}_{lt}^n\right)\right).$$

Using this equation we can evaluate both consumers welfare using the initially observed prices

[10]One way to do this is to iterate, i.e. to first solve for the optimal advertising prices of all firms given last iteration's advertising and subscription prices, then for the optimal subscription prices given last iteration's advertising prices, and so on.

and the prices in the new optimum, and evaluate the welfare change due to the change in prices.

Similarly, advertisers' welfare can be calculated as

$$W^a\left(p_t^a, q_{jt}^n\right) = \ln\left(1 + \sum_{l=1}^{J} \exp\left(\hat{\gamma} p_{lt}^a + \hat{\delta} q_{lt}^n + \hat{\xi}_{lt}^a\right)\right).$$

It is also possible to calculate the change in firm profits due to the merger, under the assumption that fixed costs are unchanged. However, as surely a merger would eliminate duplication of some of these fixed costs, the change of producer profits would then be underestimated. Nevertheless, since the merger assessment in the EU follows a consumers' welfare standard and not a total welfare standard, this is arguably less of an issue in the present context.

## 3.3. Efficiency gains

Finally, in case one finds that despite the indirect network effect the merger would tend to reduce consumer welfare, one could also estimate the size of the (productive) efficiency gains necessary to counterbalance the post-merger tendency to increase prices and to leave consumer surplus unchanged.

The efficiency gains which would leave the prices unaffected by the merger can be obtained as

$$\Delta mc_t = (mc_t - mc_t^*)$$

where the hypothetical lower marginal costs are obtained by subtracting from the pre-merger price the estimated post merger margins

$$mc_t^* = p_t - (p_t - mc_t)^{PM}.$$

Note these efficiency gains would also leave consumer welfare unchanged on each side of the market, so that $W(p_t^n)^{PM} = W(p_t^n)$ and $W(p_t^a)^{PM} = W(p_t^a)$. However, the reverse is not true in that there might be other combinations of prices which leave consumer welfare unchanged on each side.

Alternatively, one might be interested in the efficiency gains that more generally leave the sum of the two welfares unchanged. These can be obtained as

$$\Delta mc_t = (mc_t - mc_t^*),$$

where the hypothetical lower marginal costs $mc_t^*$ are obtained by subtracting the estimated post merger margins from any pre-merger price which would leave total consumers' welfare unchanged

$$mc_t^* = p_t - (p_t - mc_t)^{PM}$$

$$\text{s.t. } \forall p_t : \; W(p_t^n)^{PM} + W(p_t^a)^{PM} = W(p_t^n) + W(p_t^a).$$

Note that the latter conditions defines a continuum of couples $(p_t^n,\ p_t^a)$.

# 4. Data

In order to estimate the parameters of interest using market level data, we need data on newspaper circulation, newspaper prices, the amount of advertising in the respective newspapers, newspaper specific advertising prices, and the market size for the market for newspapers and advertising. In principle, it could be useful to have data on additional newspaper characteristics. However, these data are only of value if there is variation in those variables over time, as we control for time invariant heterogeneity through $\alpha_j^n$ and $\alpha_j^a$, and any characteristic that is observable but time invariant is thus already controlled for.

In our main specifications, we use quarterly newspaper circulation data from HOI (Het Oplage Instituut), in particular, we use data on the total circulation, including the free copies. The vast majority of the circulation for the non-free newspapers, 91% in our data, is paid circulation. We also use annual circulation data on the regional level in a set of robustness checks.

These data, however, lack information for the free newspapers. In addition, we use quarterly newspaper subscription prices. This is reasonable because the vast majority of the circulation consists of subscriptions.

For advertising quantities and spending we use Nielsen data. These data contain advertising quantity measured in pages and column millimetres, as well as the total advertising spending and the total number of pages of the respective newspapers. We use the data on the total number of pages of advertising and the total number of pages to calculate the percentage of advertising in that newspaper. At any given point in time and per newspaper, the number of pages and the number of column millimetres are directly related. We use column millimetres when estimating advertising demand because this is the industry standard when it comes to describing advertising quantities. Finally, from the total spending on advertising and the total number of column millimetres we can calculate the average price that was spent on a column millimetre of advertising. This is common practice, but there are several points worth mentioning. Firstly, total spending is actually generated by Nielsen from list prices. This means that we abstract from price discounts here. Secondly, the average price that was actually paid is generally not the same as the price for an average hypothetical advertisement in a newspaper.

Advertising demand is allowed to depend on the characteristics of the readers of a newspaper, which we extract from the NOM print monitors. Characteristics are gender, age, wealth, region, how many readers are bread winners, and how many readers shop for groceries.

In addition, we use three time series, for the total population, the number of households, and the consumer price index. All three are obtained from CBS (Statistics Netherlands). The price index is used to deflate prices because only real prices are of interest for readership and advertising demand. Thus, all prices are deflated by the consumer price index and expressed in Euros of the third quarter of 1999. The quarterly time series with the population data is used as a measure of market size. The idea is that every member of the population buys at most one newspaper. This is an approximation as kids are not expected to buy any newspapers. Therefore, we also use the number of households in a robustness check. For this, only yearly data are available.

# 5. The Dutch market for daily newspapers

In this section, we provide descriptive statistics on the readership and advertising markets to put the structural analysis into perspective. In particular, we document that newspaper prices have increased more than the consumer price index and production costs, that readership demand has decreased most likely due to the availability of high speed internet access, that the total amount spent on advertising has remained constant, and that free newspapers have become a serious competitor to traditional for-pay newspapers.

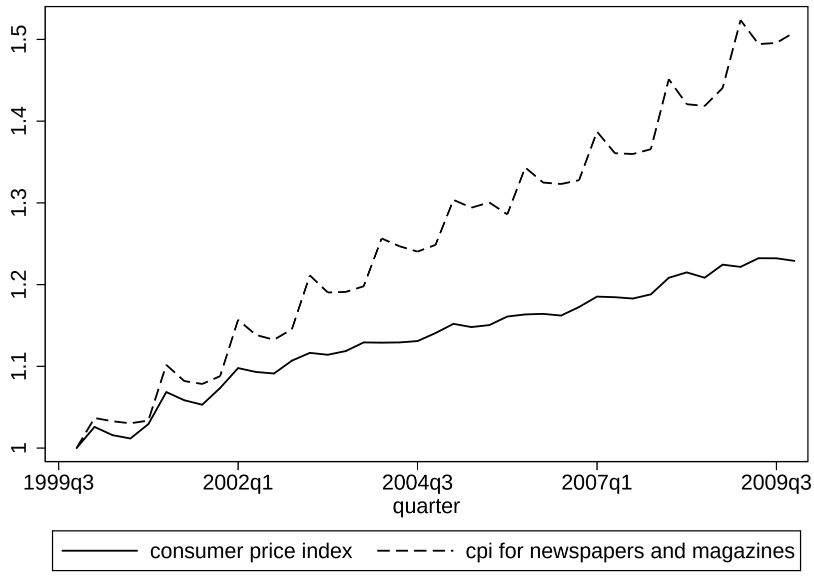
## 5.1. Economic environment

It is interesting to compare the evolution of the consumer price index to the evolution of a price index for newspapers and magazines that was also obtained from CBS. Figure 1 shows that newspaper and magazine prices have been rising more than twice as much as consumer prices.

Figure 2 shows how newsprint costs evolved until 2007. Unfortunately, these data were not available for the Netherlands, and therefore we show the FOEX cost measure for Europe, and the corresponding Italian newsprint costs. The figure suggests that the increase in newsprint prices as reflected in the previously shown price index for newspapers and magazines was not driven by increases in printing cost. It also suggests that movements in those costs do not differ greatly across countries as the Italian index moves in the same way as the European one, although there is a difference in the levels.

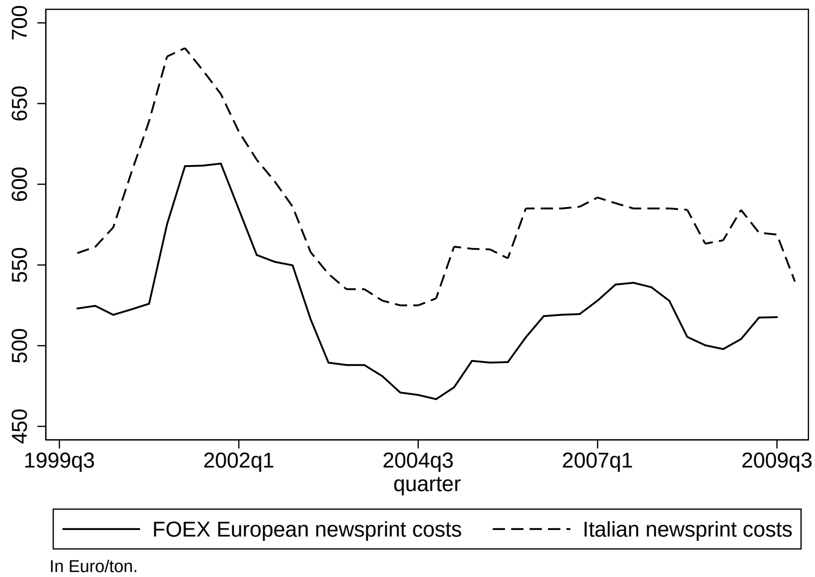
Figure 3 shows indices that are related to cost components, in particular wages and wood prices. These have been deflated by the consumer price index and normalized to 1 in the first quarter of the year 2000. We chose this base quarter because this is the first year in which the collective labour agreement (CAO) wage index for graphic media is available.[11] Neither wages

[11]The CAO wage index is from CBS, the wood price index is the soft wood index for the US and from the IMF,



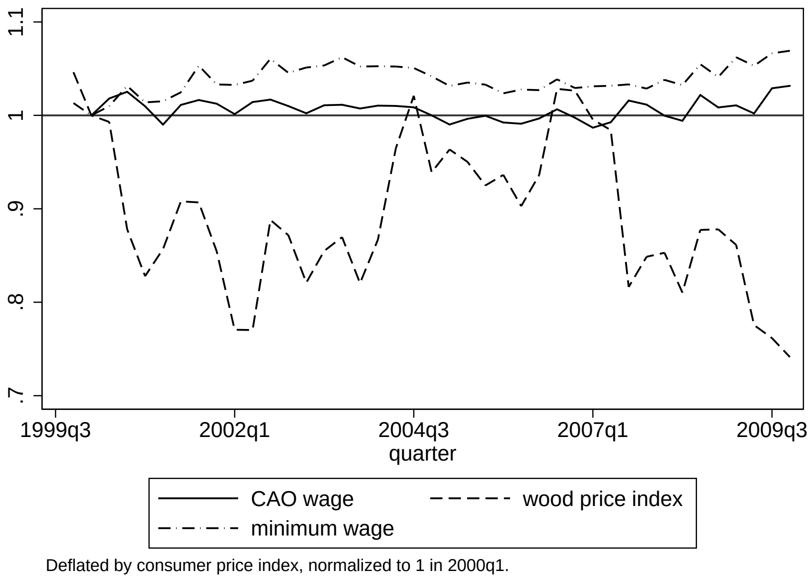

Data source: Statistics Netherlands.

Figure 1: Price indices




Data source: FOEX.

Figure 2: Newsprint price indices




The CAO wage index is from CBS, the wood price index is the soft wood index for the US and from the IMF, and the minimum wage is from the Ministry of Social Affairs. Deflated by the consumer price index and set to 1 in the first quarter of 2000.

Figure 3: Newsprint costs

nor wood prices caused the high costs around 2001.

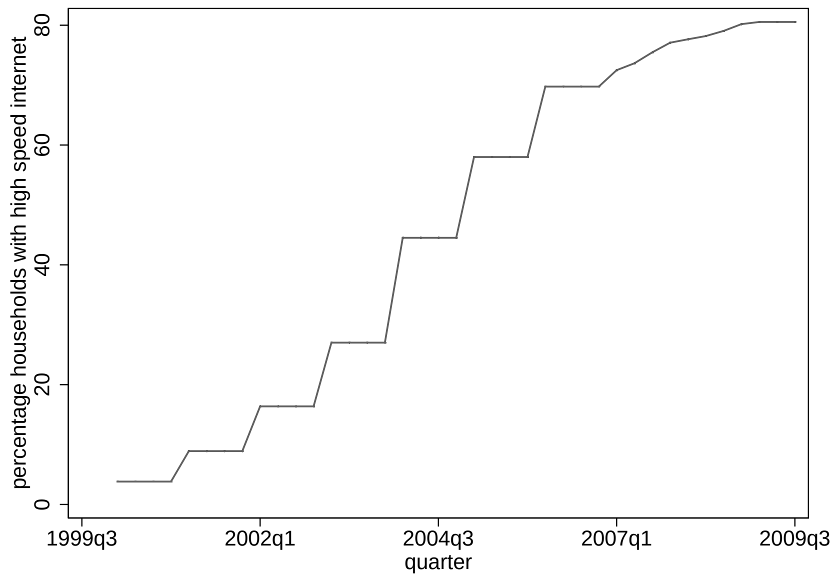
An important development for newspapers is that the internet has become more and more important as a competitor. This is due to the attractiveness of reading news online and is related to the availability of websites and of high speed internet access. Figure 4 shows the percentage of households that had a high speed internet connection in the Netherlands.[12]

## 5.2. Readership and advertising demand

Figure 5 shows how newspaper circulation changed over time. The top line shows the total circulation for all newspapers which have circulation data available. These data have been used to calculate market shares $s_{jt}^{n}$ and the share of the outside good. The two lines below that show total circulation for our sample of newspapers. The sample covers considerably less of

and the minimum wage is from the Ministry of Social Affairs.

[12]The data on the number of households with high speed internet connection are from the ICT research department of the Netherlands Organisation for Applied Scientific Research (TNO). They are yearly until the end of 2006, and quarterly thereafter, and are combined with yearly data on the number of households from CBS.



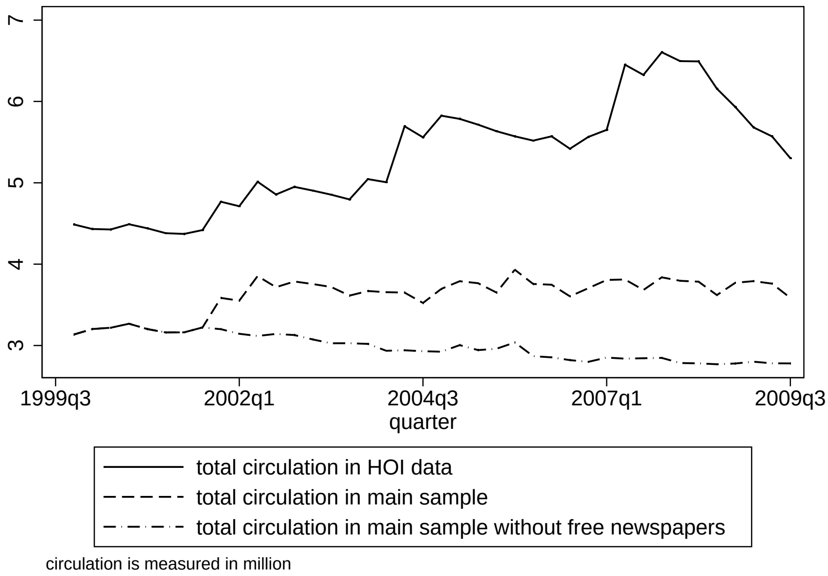

The data on the number of households with high speed internet connection are from the ICT research department of the Netherlands Organisation for Applied Scientific Research (TNO). They are yearly until the end of 2006, and quarterly thereafter, and are combined with yearly data on the number of households from CBS.

Figure 4: Internet usage

the market in terms of circulation because of either missing information on advertisements or subscription prices. Here, we make an additional distinction between free newspapers and non-free newspapers to show that the combined market share for paid newspapers has actually been declining, at least in our estimation sample.

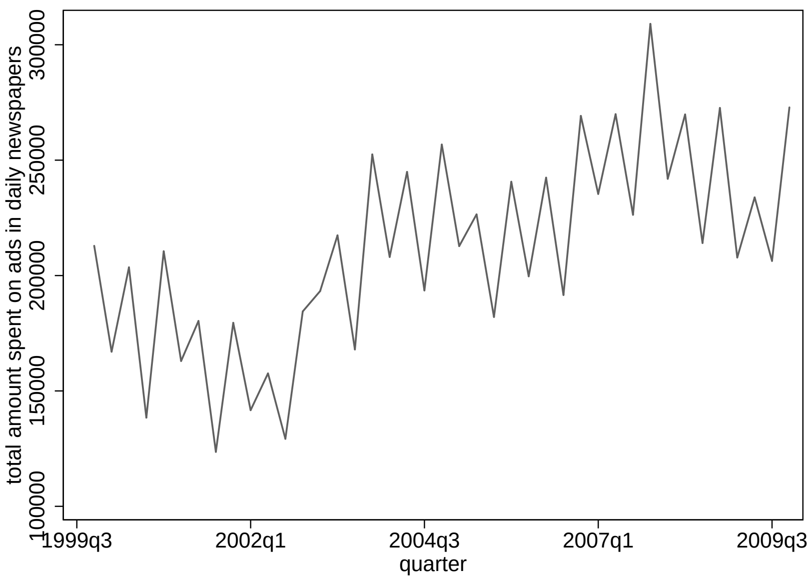
The next figure shows that the total amount spent on advertisements in daily newspapers actually increased over the study period. This time series is from Nielsen and amounts are in thousands of (real 3rd quarter of 1999) Euros.

Finally, we look at the evolution of average advertising quantities and prices for our estimation sample. Advertising prices are per column millimeter and divided by circulation in millions. It is meaningful to look at advertising prices per reader once newspapers merge. In the study period, in September 2005, there has been a big merger between the Algemeene Dagblad and Rijn en Gouwe, De Dordtenaar, Rotterdams Dagblad, Haagsche Courant, Utrechts Nieuwsblad, Goudsche Courant and Amersfoortse Courant. Figure 7 shows that advertising



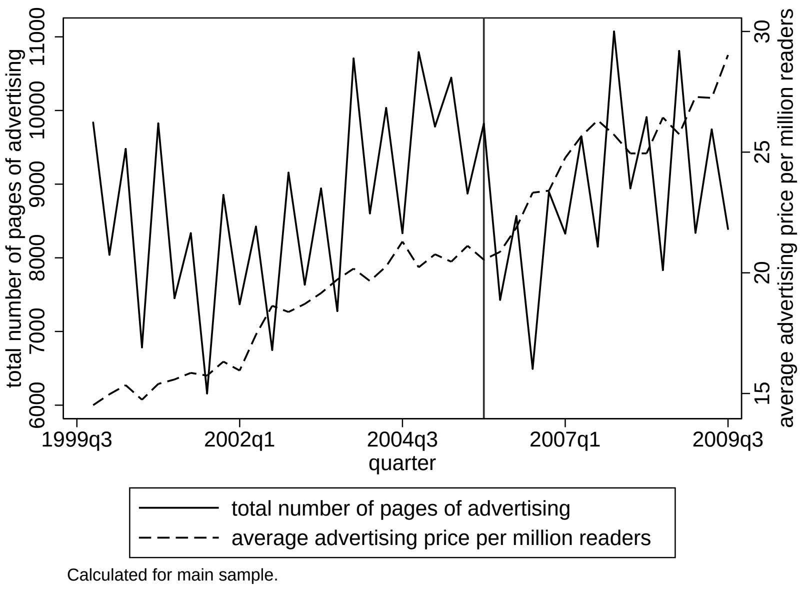

Data source: Het Oplage Instituut (HOI).

Figure 5: Circulation




Data source: Nielsen.

Figure 6: Spending on advertising



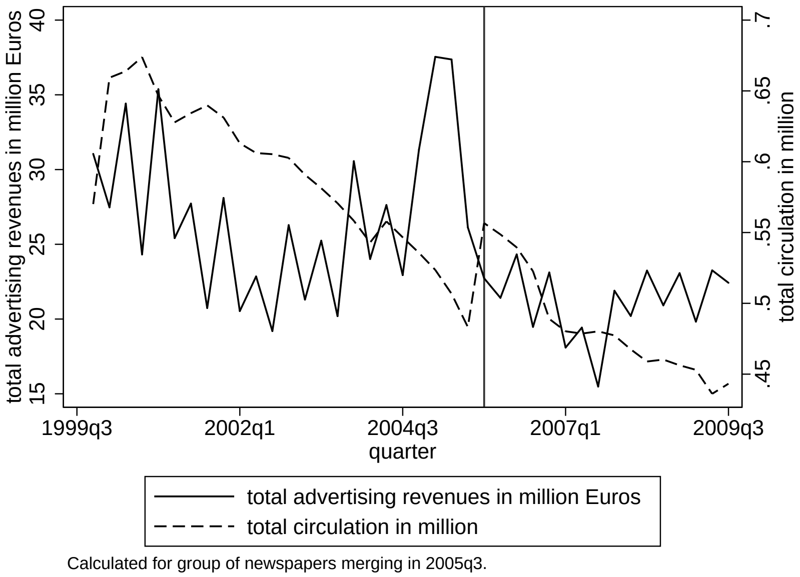

Data source: Nielsen.

Figure 7: Advertising spending and prices for estimation sample

quantities have stayed roughly the same, while average prices (deflated by the consumer price index) increased throughout. Here, we calculate a weighted average, where the weights are proportional to circulation. The vertical line indicates the time of the merger (4th quarter of 2005).

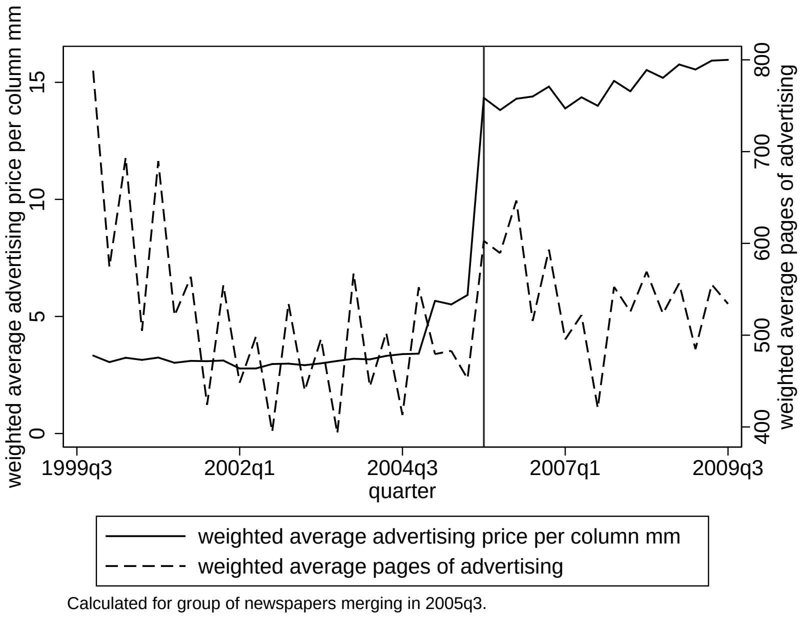
To further investigate the effects of the merger, we now plot the weighted average advertising price and the weighted average number of pages of advertising against time. This is done for the group of newspapers merging in 2005. Weights are again proportional to circulation. Figure 8 shows that the average price of advertising has increased at the time of the merger.

Finally, Figure 8 shows that at the same time and for the same group, both circulation and advertising revenues have decreased over time.




Data source: Nielsen.

Figure 8: 2005 merger: spending on advertising and prices




Data source: Nielsen.

Figure 9: 2005 merger: weighted spending on advertising and prices

# 6. Demand estimates

Table 1 presents readership demand estimates.[13] In our baseline specification, (1), we specify the mean utility from buying a newspaper to depend on the subscription price, the advertising intensity, and the total number of pages. In addition, we include a linear time trend.

We find the price to have a negative impact on utility. Moreover, we find that the effect of an increase in advertising intensity does not significantly affect utility, a common finding in this literature (Argentesi and Filistrucchi, 2007; Fan, 2010, e.g.). However, readers value the amount of content as measured by the number of pages.

To assess how robust these results are we first use a more flexible time trend in specification (2) and additionally allow the impact of price to change over time. In particular, we control for a full set of interactions between newspaper type and quarter dummies. Using this specification, utility is estimated to depend on price in a positive way.[14] This shows that such a specification is arguably too flexible. The reason for this is that variation in the price of a given newspaper is used to estimate the dependence of readers' utility on price, and there is only little such variation once we control for a flexible time trend and a dependence of price effects on time.

Another concern may be that even after controlling for fixed effects and time trends preference shocks $\varepsilon^n_{ijt}$ are correlated between newspapers of the same type. We therefore estimate a nested logit model (see Berry, 1994, for details) by including the log of the within group market share as additional regressors. The results show that this concern is valid as the coefficient on this additional variable is significantly different from 1(it is 1 in the standard multinomial logit model).[15] Still, coefficient estimates are similar.

Next, we assess whether our results are sensitive to the choice of the market size. We address this by using, in specification (4), the number of households instead of the total population as

[13] Throughout, the number of observations across newspapers and quarters is 775.

[14] This also holds for the majority of the quarters when we use a simpler linear time trend instead, but allow for the effect of price on utility to depend on time. The reason is that the coefficient on price is then positive but the coefficient on the interaction term is negative.

[15] The coefficient estimate is 0.004 with a standard error of 0.021.

Table 1: Readership demand parameters (quarterly national level data

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| subscription price per quarter in Euros of 1999Q4 | -.00804473*** | .00004173 | -.00803837*** | -.00975216 | .00271742* |
| interacted with linear time trend | | .00007212* | | | |
| percentage advertising | .00014852 | -.00023369 | .00014918 | .00093102* | -.00009771 |
| total number of pages | .01874337** | .01382039* | .01858579** | .12869453*** | .01058924* |
| linear time trend | .00071884 | | .00074595 | .01830889*** | -.01078501*** |
| quarter dummies fully interacted with free/regional | no | yes | no | no | no |
| log of the within group share | | | .00389189 | | |

Notes: This table shows readership demand parameters that were obtained by regressing the difference between the log of the market share and the log of the market share of the outside good on the explanatory variables in the first column of this table. We also control for newspaper fixed effects. Specification (1) through (3) use total circulation and the market size is given by the total population. Specification (4) instead uses the number of households as the market size. In specification (5), we use paid circulation, and the market size is again given by the total population.

the measure for the market size. The magnitude of the price coefficient is similar to the one in the other specifications, but the standard error is bigger so that the estimate is no longer significantly different from zero. Apart from that, the effects of the percentage advertising and the number of pages are higher, and the effect of advertising is now significantly different from zero. From this we conclude that our results are indeed somewhat sensitive to the choice of the market size.

Finally, in specification (5) we assess whether results change when we use total paid circulation instead of total circulation to construct the market share. Obviously, here we have to exclude the free newspapers. It can be expected that the magnitudes of the effects change since price is evidently more predictive of paid circulation than it is of total circulation. This is found here for national newspapers. However, results are unreasonable as price effects are estimated to be positive (although the effect is only significant at the 10 % level).

Table 2 contains demand estimates that were obtained using regional level data. Here, we estimate the model on first-differenced data on the regional- and national newspaper level. This means that we regress changes in the dependent variable for each newspaper within each region on changes in the explanatory variables. For this we sort the data by region, newspaper, and year, and then regress changes in the log-difference on changes in the observed characteristics, respectively. Using these data, the price effect is again estimated to be negative for national newspapers and positive for regional newspapers. We find a negative dependence of the price effect on time. Here, we are able to include additional interaction terms between the type of newspaper because the sample size is bigger. However, we only have circulation data for national and regional newspapers, therefore the results should be compared to specification (5) in Table 1. Throughout, the percentage advertising has no significant effect on demand and the estimated coefficients are similar.

Table 3 contains the results for advertising demand. Our baseline specification relates the utility of the advertisers to the price of advertising, the circulation, and a linear time trend. We find negative price effects and positive effects of a higher circulation.

Table 2: Readership demand parameters (yearly regional level data) data

| | (1) | (2) | (3) |
|---|---|---|---|
| subscription price per quarter in Euros of 1999Q4 | -.01377033*** | -.00635731 | -.02037003 |
| interacted with linear time trend | -.00242847*** | -.00247141*** | -.00262318*** |
| interacted with indicator for regional newspaper | | .04223737 | .06104784 |
| percentage advertising | .00007554 | .00008385 | -.00013486 |
| interacted with indicator for regional newspaper | | -.00066263 | -.00011817 |
| total number of pages in thousands | .03689737*** | .03837949*** | .04044864*** |
| interacted with indicator for regional newspaper | -.04928149*** | -.04778169* | -.05136854* |
| linear time trend | | -.00910125 | |
| interacted with indicator for regional newspaper | | -.0547944 | |

Notes: This table shows readership demand parameters that were obtained by regressing the difference between the log of the market share and the log of the market share of the outside good on the explanatory variables in the first column of this table. We also control for newspaper fixed effects. We use total circulation, and the market size is given by the total population.

To assess the robustness of these estimates, in specification (2) we additionally control for reader characteristics.[16] In specification (3), we allow the price effect to depend on time and additionally control for flexible newspaper type specific time trends. Generally, unlike with newspaper demand, we don't find evidence for changing price sensitivity over time. Specification (4) is again a nested logit specification, where the nests are once more national, regional, and free newspapers. The coefficients on the log of the within group share is 0.766 and the price coefficient is smaller in terms of magnitude.

Overall, price effects differ again across specifications. We picked (1) as our baseline specification because it is the simplest one that generates the main predictions that are shared by the other specifications.

# 7. Merger simulation: an example

For illustration purposes, we analyse the effects of a hypothetical merger between NRC Handelsblad, NRC.next, De Telegraaf, Gooi- en Eemlander, Noordhollands Dagblad, and Sp!ts.

As for the parameter vector we use the estimated value $\delta$= 1.4079054 and, also based on the

[16]The number of observations in specification (1) is 775. Due to missing data on reader characteristics it is 582 in specification (2) through (4).

Table 3: Advertising demand parameters (quarterly national level data

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| advertising price per column millimeter | -.02109908 | -.01418761 | .00223756 | -.00094349 |
| interacted with linear time trend | | | .00005125 | |
| circulation in million | 1.4079054*** | 1.4001053*** | -.63536502 | 1.3084028*** |
| linear time trend | .00691174*** | .00490422* | | .00107462 |
| percentage male | | -.34853751 | .61748767 | -.96418029** |
| percentage bread winner | | .22283096 | -.11061814 | .36703078 |
| percentage grocery shopper population | | -.13726338 | .48378657 | -.1494132 |
| percentage three biggest cities | | 1.4330467*** | .98748822** | .55192105 |
| percentage North | | -1.4684984 | -2.519561*** | -.97898382 |
| percentage East | | -.51603964 | -.23225476 | -.18463349 |
| percentage South | | -1.1714999 | -2.7776828*** | .12077974 |
| percentage age 35-49 | | -.00048669 | -.46316518 | .72672485* |
| percentage age 50-64 | | 1.1356761** | .59822425 | .85338151** |
| percentage age 60+ | | -.34952494 | -1.3083404** | .35165916 |
| percentage wealth class 2 and 3 | | -.43679923 | -.88684576*** | -.00299449 |
| percentage wealth class 4 and 5 | | -.34826247 | .24492609 | -.26313755 |
| quarter dummies fully interacted with free/regional | no | no | yes | no |
| log of the within group share | | | | .76551338*** |

Notes: This table shows advertising demand parameters that were obtained by regressing the difference between the log of the market share and the log of the market share of the outside good on the explanatory variables in the first column of this table. We also control for newspaper fixed effects. The market share is given by the number of column millimetres of advertising in particular divided by the total number of column millimetres in all print media, which defines the market size.

empirical results, impose $\beta$= 0. We set $\alpha$= 0 and $p^n_{jt}$= 0 for the free newspapers, i.e. they are assumed to remain free. Besides, we use the market shares, market sizes, prices and ownership structure of the last quarter of 2009 as the initial situation and perform the SSNIP test for different combinations of $\alpha$ and $\gamma$. For each of those combinations, marginal costs are recovered from the first-order conditions, as described above.

## 7.1. SSNIP test

Between the last period in our data, the fourth quarter of 2009, and the time of the hypothetical merger, PCM (currently De Persgroep Nederland) had to sell NRC Handelsblad andNRC.next. For the SSNIP test we need to use an observed state with observed prices and quantities as the initial situation. Therefore, we implement the SSNIP test for a change in the ownership structure from the situation in the fourth quarter of 2009 to the new situation after the aforementioned newspapers have been sold and NRC Handelsblad and NRC.next have merged with De Telegraaf, Gooi- en Eemlander, Noordhollands Dagblad, and Sp!ts. Table 6 in Appendix B shows that for values of $\gamma$ above -0.2 the marginal costs of an advertisment are negative, which is clearly unreasonable. Likewise, for values of $\alpha$ above -0.010, the marginal costs of producing and distributing a copy of a newspaper are estimated to be negative.[17]

Table 4 shows the results of the SSNIP test. The details on the implementation have been given above. A number in that table is the percentage change in profits due to a 5% increase in the price of the merging parties, with optimal adjustment of the advertising prices only by the merging parties. The table shows that for all reasonable combinations of the parameters, as argued above, a price increase by 5% on the subscriptions market has no economically relevant effect on profits. The reason for this is that advertising prices and market shares in the newspaper market hardly change.

[17]The threshold value for the mark-up to become negative on the readership side depends on the size of the network effect. In order to quantify the dependence we have tripled the parameter $\delta$, thereby tripling the elasticity of advertising demand with respect to the number of subscriptions. We find that the dependence on the network effect is not too big, justifying the approach we take here, namely to only alter the two parameters $\alpha$ and $\gamma$.

Table 4: SSNIP test

| $\gamma$ | | -1.000 | -0.500 | -0.333 | -0.250 | -0.200 |
|---|---|---|---|---|---|---|
| | -0.050 | -0.009 | -0.004 | -0.001 | 0.002 | 0.004 |
| | -0.025 | -0.002 | 0.000 | 0.002 | 0.003 | 0.004 |
| $\alpha$ | -0.017 | -0.001 | 0.001 | 0.002 | 0.003 | 0.004 |
| | -0.013 | 0.000 | 0.001 | 0.002 | 0.003 | 0.003 |
| | -0.010 | 0.000 | 0.001 | 0.002 | 0.002 | 0.003 |

Notes: This table shows the percentage change in profits due to a 5% change in subscription prices. Shown for different combinations of $\alpha$ and $\gamma$. Calculated for $\beta = 0$ and $\delta$= 1.4079054 and the market shares, market sizes, prices and ownership structure of the last quarter of 2009.

### 7.2. Full merger simulation

Table 7 in Appendix B summarizes the effects of the merger on prices, market shares, and profits. This table is for $\alpha = -0.017$ and $\gamma$=-0.333. The second column in that table indicates whether the newspaper was in the product portfolio of one of the merging parties. The main effect of the merger is a price increase in the newspapers owned by the merging parties. However, there is no substantial effect on market shares, and hence not on the advertising market. This is because advertising prices and market shares only depend on the market shares of the newspaper market, but not on subscription prices.

Finally, Table 5 summarizes the effects of the merger on prices, market shares and profits. Generally, the effects are bigger for prices and market shares of the merging newspapers, but still relatively small. The last two columns report results when we ignore that advertising demand depends on circulation, i.e. when we set $\delta = 0$. The effect of this turns out to be small.

## 8. Summary and conclusions

We develop a structural econometric framework that allows to simulate the unilateral (or non-coordinated effects) of mergers among two-sided platforms selling differentiated products. This framework is general enough to allow for different demand specifications on both sides of the

Table 5: Summary merger simulation

| | correct specification | | ignoring network effect | |
|---|---|---|---|---|
| | merged | others | merged | others |
| subscription price | 4.0% | 0.0% | 3.9% | 0.0% |
| readership market share | -3.3% | 0.3% | -3.2% | 0.2% |
| advertising price | 1.4% | 0.0% | 1.4% | 0.0% |
| advertising market share | -2.3% | 0.1% | -1.4% | 0.0% |
| profits | 0.0% | 0.2% | 0.0% | 0.2% |

Notes: This table shows the average percentage change in subscription prices, the readership market share, advertising price, and advertising market share. The average is taken across newspapers, with equal weight. Profits are summed across all profits and then the percentage change is reported. Reported separately for merging newspapers and others. The last two columns are the results when the network effect is ignored, i.e. when $\delta = 0$ is imposed.

market. Although we discuss the case of price competition, the methodology can be easily extended to the case of platforms competition on quantities on both sides or to the case of competition in prices on one side and competition in quantities on the other.[18]

We apply the proposed framework to the Dutch newspaper industry. Our structural model encompasses demands for differentiated products on both sides of the market and profit maximization by competing oligopolistic publishers who choose subscription and advertising prices, while taking into account that advertisers willingness to pay for an ad increases with the newspaper circulation.

We therefore estimate demand on each side of the market using a logit specification. We estimate the sign and size of the indirect network effects between the two sides of the market. We find that whereas a higher readership is associated with a higher demand for advertising, a higher level of advertising does not lead neither to a decline nor to a rise in readership. So that readers would seem to be on average indifferent to advertising. The finding is in line with Argentesi and Filistrucchi (2007) for the Dutch daily newspapers market and with those of Fan (2010) for the US daily newspapers market. We therefore proceed under the assumption that advertising has no effect on circulation.

[18]The case of price competition among two-sided platforms has always been recognized as the most difficult one to address due to the feedback loop it may generate.

We then use the estimated parameters and our theoretical model to simulate the effects of a hypothetical merger on prices and welfare. The results of the merger simulation indicate that in our case the projected effects of the merger on prices are generally lower once the two-sidedness of the market is taken into account. This is consistent with the newspaper market being characterized by a positive indirect network effect of readership on advertising demand. Since raising the newspaper price is likely to lead not only to a loss in readers but also to a loss in advertising, the post-merger tendency to increase prices will be lower. Overall, in our case, the effects of the hypothetical merger on prices and welfare are found to be small.

# Appendix A: Formulas for markups when there are two indirect network effects

In Section 3, we made the simplifying assumption that readers are indifferent with respect to advertising quantity in their newspaper. This is a common assumption that is supported by the empirical literature on daily newspapers and, more importantly, our empirical results. Nevertheless, in this appendix, we show how one can recover marginal costs without making this assumption.

We still assume that firm $f$ maximizes profits by choosing advertising prices $p^a_{jt}$ and subscription prices $p^n_{jt}$ for all newspapers $j$ in their newspaper portfolio $\mathcal{F}_f$. That is, it maximizes

$$\Pi_{ft}=\sum_{l\in\mathcal{F}_f}\{(p^a_{lt}-mc^a_{lt})\,M^a_t s^a_{lt}+(p^n_{lt}-mc^n_{lt})\,M^n s^n_{lt}\},$$

knowing that

$$q^n_t=M^n_t s^n_t\,(p^n_t,q^a_t)$$

and

$$q^a_t=M^a_t s^a_t\,(p^a_t,q^n_t)\,.$$

i.e. knowing how the market share in the advertising market depends on the vector of all advertising prices, $p_t^a$, and the vector of all readership demands, $q_t^n$ , and how the market share in the subscriptions market depends on the vector of all subscription prices, $p_t^n$, and all advertising quantities, $q_t^a$.

As already noted, this is a non-linear system of $2J$ equations in $2J$ unknowns. Were it linear or log-linear we could obtain expressions for the quantities $q_t^n$ and $q_t^a$ as explicit functions of the prices $p_t^n$ *and* $p_t^a$:

$$q_t^n = M_t^n \widehat{s_t^n} \left(p_t^n, p_t^a\right)$$

$$q_t^a = M_t^a \widehat{s_t^a} \left(p_t^a, p_t^n\right).$$

Notice that here, we denote these functions with hats. Using them, one could rewrite the profit function of firm $f$ as

$$\Pi_{ft} = \sum_{l \in \mathcal{F}_f} \left\{ \left(p_{lt}^a - mc_{lt}^a\right) M_t^a \widehat{s_t^a} \left(p_t^a, p_t^n\right) + \left(p_{lt}^n - mc_{lt}^n\right) M^n \widehat{s_t^n} \left(p_t^n, p_t^a\right) \right\}.$$

The first-order conditions $\frac{\partial \Pi_{ft}}{\partial p_{jt}^a} = 0$ and $\frac{\partial \Pi_{ft}}{\partial p_{jt}^n} = 0$, involve the following derivatives of quantities on the two-sides of the market with respect to prices:[19]

$$\frac{\partial q_{jt}^a}{\partial p_{kt}^a} = M^a \cdot \frac{\partial \widehat{s_{jt}^a}}{\partial p_{kt}^a}$$

$$\frac{\partial q_{jt}^n}{\partial p_{kt}^n} = M^n \cdot \frac{\partial \widehat{s_{jt}^n}}{\partial p_{kt}^n}$$

$$\frac{\partial q_{jt}^a}{\partial p_{kt}^a} = M^a \cdot \frac{\partial \widehat{s_{jt}^a}}{\partial p_{kt}^a}$$

$$\frac{\partial q_{jt}^n}{\partial p_{kt}^n} = M^n \cdot \frac{\partial \widehat{s_{jt}^n}}{\partial p_{kt}^n}.$$

[19]Note that $\partial \hat{s}_{jt}^a / \partial p_{kt}^a$ are now total derivatives that account for the network effect, whereas in Section 3 $\partial s_{jt}^a / \partial p_{kt}^a$ were partial derivatives that did not account for the network effect.

Using those, one can write the first-order conditions as

$$M^a s^a_{jt} + \sum_{l\in\mathcal{F}_f} (p^a_{lt} - mc^a_{lt})\, M^a \frac{\partial \widehat{s^a_{lt}}}{\partial p^a_{jt}} + \sum_{l\in\mathcal{F}_f} (p^n_{lt} - mc^n_{lt})\, M^n \frac{\partial \widehat{s^n_{lt}}}{\partial p^a_{jt}} = 0$$

and

$$M^n s^n_{jt} + \sum_{l\in\mathcal{F}_f} (p^n_{lt} - mc^n_{lt})\, M^n \frac{\partial \widehat{s^n_{lt}}}{\partial p^n_{jt}} + \sum_{k\in\mathcal{F}_f} (p^a_{lt} - mc^a_{lt})\, M^a \frac{\partial \widehat{s^a_{lt}}}{\partial p^n_{jt}} = 0$$

for $j = 1, \ldots, J$.

The derivatives $\frac{\partial \widehat{s^a_{jt}}}{\partial p^a_{kt}}, \frac{\partial \widehat{s^n_{jt}}}{\partial p^n_{kt}}. \frac{\partial \widehat{s^a_{jt}}}{\partial p^a_{kt}}, \frac{\partial \widehat{s^n_{jt}}}{\partial p^n_{kt}}$ can be obtained using the implicit function theorem. For this, we define the following matrix we wish to obtain

$$\widehat{S} = \begin{pmatrix} \widehat{S}^{nn} & \widehat{S}^{an} \\ \widehat{S}^{na} & \widehat{S}^{aa} \end{pmatrix},$$

where the block $\widehat{S}^{aa}$ is the matrix of marginal effects of advertising prices on advertising demand, $\widehat{S}^{an}$ a matrix of marginal effects of advertising prices on newspaper demand, $\widehat{S}^{nn}$ is a matrix of marginal effects of subscription prices on newspaper demand, and $\widehat{S}^{an}$ a matrix of marginal effects of subscription prices on newspaper demand, so that

$$\widehat{S}^{aa}_{jk} = \frac{\partial \widehat{s^a_{jt}}}{\partial p^a_{kt}}$$

$$\widehat{S}^{nn}_{jk} = \frac{\partial \widehat{s^n_{jt}}}{\partial p^n_{kt}}.$$

$$\widehat{S}^{na}_{jk} = \frac{\partial \widehat{s^a_{jt}}}{\partial p^a_{kt}}$$

$$\widehat{S}^{an}_{jk} = \frac{\partial \widehat{s^n_{jt}}}{\partial p^n_{kt}}$$

Define also the matrix

$$B = \begin{pmatrix} -I & N^{an} \\ N^{na} & -I \end{pmatrix},$$

where $N^{na}$ is a matrix of externalities of readership on advertising and $N^{an}$ is a matrix of externalities of advertising on readership (the one we assume to be equal to zero in the main text), such that

$$N^{na}_{jk} = \frac{\partial s^a_{jt}}{\partial q^n_{kt}}$$

$$N^{an}_{jk} = \frac{\partial s^n_{jt}}{\partial q^a_{kt}}.$$

Finally, define the matrix

$$S = \begin{pmatrix} S^n & 0 \\ 0 & S^a \end{pmatrix},$$

where, as in the main text, $S^a$, is a matrix of marginal effects of advertising prices on advertising demand and $S^n$ is a matrix of marginal effects of subscription prices on newspaper demand.

By the implicit function theorem,

$$\widehat{S} = \begin{pmatrix} \widehat{S}^{nn} & \widehat{S}^{an} \\ \widehat{S}^{na} & \widehat{S}^{aa} \end{pmatrix} = B^{-1}S = \begin{pmatrix} -I & N^{an} \\ N^{na} & -I \end{pmatrix} \begin{pmatrix} S^n & 0 \\ 0 & S^a \end{pmatrix},$$

which shows that such derivatives exist if the matrix $B$ is non-singular and therefore invertible.

One can then define, as before, a Nevo (2001)-type ownership matrix $\Omega^*$, such that $\Omega^*_{jr} = 1\ if\ products\ j\ and\ r\ are\ owned\ by\ the\ same\ firm$, 0 *otherwise*, and also define interactions between those and the ownership matrix, $\Omega^{S^{na}}$, $\Omega^{S^{an}}$, $\Omega^{S^{aa}}$ and $\Omega^{S^{nn}}$, such that:

$$\widehat{\Omega}^{S^{aa}}_{jr} = \Omega^*_{jr} \cdot \widehat{S}^{aa}_{jr}$$

$$\widehat{\Omega}^{S^{nn}}_{jr} = \Omega^*_{jr} \cdot \widehat{S}^{nn}_{jr}$$

$$\widehat{\Omega}_{jr}^{S^{an}} = \Omega_{jr}^{*} \cdot \widehat{S}_{jr}^{an}$$

$$\widehat{\Omega}_{jr}^{S^{na}} = \Omega_{jr}^{*} \cdot \widehat{S}_{jr}^{na}$$

Using these one can rewrite the first-order conditions as

$$s^a + \widehat{\Omega}^{S^{aa}} (p^a - mc^a) + \widehat{\Omega}^{S^{an}} (p^n - mc^n) = 0$$

and

$$s^n + \widehat{\Omega}^{S^{nn}} (p^n - mc^n) + \widehat{\Omega}^{S^{na}} (p^a - mc^a) = 0,$$

where, as before, $s^a$, $s^n$, $p^n$, $p^a$, $mc^n$, and $mc^a$ are all $J \times 1$ vectors of market shares, prices, and marginal costs for newspapers and advertisements, respectively.

To solve this system of equations for the unknown $(p_t^a - mc_t^a)$ and $(p_t^n - mc_t^n)$ define

$$\widehat{\Omega} = \begin{pmatrix} \widehat{\Omega}^{S^{aa}} & \widehat{\Omega}^{S^{an}} \\ \widehat{\Omega}^{S^{na}} & \widehat{\Omega}^{S^{nn}} \end{pmatrix},$$

$$s_t = \begin{pmatrix} s_t^a \\ s_t^n \end{pmatrix}$$

and

$$(p_t - mc_t) = \begin{pmatrix} p_t^a - mc_t^a \\ p_t^n - mc_t^n \end{pmatrix}.$$

Using this we can write the first-order conditions as

$$s_t + \widehat{\Omega} \cdot (p_t - mc_t) = 0$$

and solve for

$$(p_t - mc_t) = -\widehat{\Omega}^{-1} s_t.$$

Finally, one can obtain marginal costs by subtracting the estimated mark-ups from the observed prices, as

$$mc_t = p_t - (p_t - mc_t)\,.$$

# Appendix B: Additional tables

Table 6: Price elasticities and ratio of marginal cost to price for different parameter combinations

| $\alpha$ | -1/20 | -1/40 | -1/60 | -1/80 | -1/100 |
|---|---|---|---|---|---|
| subscription price elasticity | -3.298 | -1.649 | -1.099 | -0.824 | -0.660 |
| subscription marginal cost/price ($\gamma = -1$) | 0.758 | 0.474 | 0.19 | -0.094 | -0.377 |
| subscription marginal cost/price ($\gamma = -0.5$) | 0.784 | 0.5 | 0.217 | -0.067 | -0.351 |
| subscription marginal cost/price ($\gamma = -1/3$) | 0.811 | 0.527 | 0.243 | -0.041 | -0.324 |
| subscription marginal cost/price ($\gamma = -1/4$) | 0.837 | 0.553 | 0.27 | -0.014 | -0.298 |
| subscription marginal cost/price ($\gamma = -1/5$) | 0.864 | 0.58 | 0.296 | 0.012 | -0.272 |
| $\gamma$ | -1 | -1/2 | -1/3 | -1/4 | -1/5 |
| advertising price elasticity | -5.173 | -2.587 | -1.724 | -1.293 | -1.035 |
| advertising marginal cost/price | 0.803 | 0.606 | 0.409 | 0.212 | 0.015 |

Notes: This table shows price elasticities and ratio of marginal cost to price for different combinations of $\alpha$ and $\gamma$. Calculated for $\beta = 0$ and $\delta$= 1.4079054 and the market shares, market sizes, prices and ownership structure of the last quarter of 2009.

Table 7: Effects of hypothetical merger

| | | $p^n$ | | $s^n$ | | $p^a$ | | $s^a$ | | $\Pi$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| newspaper | merged | before | after | before | after | before | after | before | after | before | after |
| De Telegraaf | yes | 66.969 | 68.463 | 0.0419 | 0.0410 | 11.945 | 11.965 | 0.0109 | 0.0106 | 45343586 | 45369030 |
| Gooi- en Eemlander | yes | 68.932 | 70.261 | 0.0017 | 0.0016 | 0.634 | 0.654 | 0.0063 | 0.0063 | 6482457 | 6485351 |
| Noordhollands Dagblad | yes | 68.943 | 70.203 | 0.0084 | 0.0082 | 2.552 | 2.572 | 0.0074 | 0.0074 | 13599035 | 13609058 |
| NRC Handelsblad | yes | 85.164 | 89.967 | 0.0129 | 0.0119 | 6.399 | 6.489 | 0.0052 | 0.0049 | 15741387 | 15718898 |
| NRC.next | yes | 51.888 | 56.310 | 0.0054 | 0.0050 | 3.496 | 3.586 | 0.0018 | 0.0017 | 6619551 | 6613221 |
| Sp!ts | yes | 0.000 | 0.000 | 0.0207 | 0.0207 | 9.255 | 9.275 | 0.0049 | 0.0049 | 359284 | 357090 |
| Algemeen Dagblad | no | 69.230 | 69.226 | 0.0273 | 0.0273 | 15.942 | 15.942 | 0.0058 | 0.0058 | 30277740 | 30356211 |
| Barneveldse Krant | no | 50.402 | 50.399 | 0.0007 | 0.0007 | 0.361 | 0.361 | 0.0041 | 0.0041 | 3714741 | 3718814 |
| Dagblad van het Noorden | no | 66.504 | 66.497 | 0.0085 | 0.0085 | 2.933 | 2.933 | 0.0114 | 0.0114 | 15848734 | 15878292 |
| De Gelderlander | no | 70.801 | 70.798 | 0.0090 | 0.0090 | 5.042 | 5.042 | 0.0075 | 0.0075 | 13873539 | 13902134 |
| de Volkskrant | no | 75.325 | 75.326 | 0.0154 | 0.0155 | 6.936 | 6.936 | 0.0049 | 0.0049 | 18613479 | 18658704 |
| Financieele Dagblad | no | 135.751 | 135.749 | 0.0038 | 0.0038 | 5.871 | 5.871 | 0.0022 | 0.0022 | 5283726 | 5294856 |
| Het Parool | no | 68.814 | 68.820 | 0.0054 | 0.0055 | 2.562 | 2.562 | 0.0051 | 0.0051 | 9067812 | 9085620 |
| Metro | no | 0.000 | 0.000 | 0.0279 | 0.0279 | 16.221 | 16.221 | 0.0040 | 0.0040 | -1624025 | -1628788 |
| Nederlands Dagblad | no | 78.801 | 78.800 | 0.0018 | 0.0018 | 0.656 | 0.656 | 0.0015 | 0.0015 | 2827445 | 2832904 |
| PZC | no | 69.248 | 69.250 | 0.0033 | 0.0033 | 1.708 | 1.708 | 0.0080 | 0.0081 | 9215325 | 9229012 |
| Reformatorisch Dagblad | no | 72.452 | 72.449 | 0.0032 | 0.0033 | 0.821 | 0.821 | 0.0038 | 0.0038 | 5818748 | 5829291 |
| Stentor | no | 70.750 | 70.749 | 0.0079 | 0.0079 | 4.482 | 4.482 | 0.0069 | 0.0069 | 12516551 | 12541844 |
| Trouw | no | 81.332 | 81.339 | 0.0064 | 0.0064 | 3.067 | 3.067 | 0.0027 | 0.0027 | 8432412 | 8451431 |
| Twentsche Courant Tubantia | no | 68.200 | 68.199 | 0.0068 | 0.0068 | 2.996 | 2.996 | 0.0075 | 0.0075 | 11951717 | 11974528 |

Notes: This table shows the effects of a hypothetical merger. Calculated for $\alpha = -0.017$, $\beta = 0$, $\gamma = -0.333$ and $\delta = 1.4079054$. The initial situation is characterized by the market shares, market sizes, prices and ownership structure of the last quarter of 2009.

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