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NEWSPAPERS AND ADVERTISING: THE EFFECTS OF AD-VALOREM TAXATION UNDER DUOPOLY

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Abstract

Newspapers are two-sided platforms that sell their product both to readers and advertisers. Media firms in general, and newspapers in particular, are considered important providers of information, culture and language in most countries. Newspapers are therefore given preferential tax treatment. We show that lower ad valorem taxes lead newspapers to become more differentiated. Thereby the competitive pressure falls, possibly resulting in higher newspaper prices and reduced quality investments.

JEL Code: D4, D43, H21, H22, L13.

Keywords: two-sided markets, ad-valorem taxes.

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1 Introduction

Conventional wisdom in public economics holds that governments can lower end-user prices by reducing commodity taxes. Relying on this insight, most countries give newspapers preferential tax treatment in the form of low ad-valorem taxes.[1] The rationale for such lenient tax treatment is that newspapers are considered to be important providers of information, culture and language, and should be provided to readers at low prices. Little or no attention has been devoted to the possibility that preferential taxation may affect newspapers' choice of profiles (local versus global news coverage, say, or political versus non-political) and their investments to become more attractive to the readers ("quality investments").[2]

A particular feature of the newspaper business is that it derives income from two groups of customers: advertisers and readers.[3] Since advertisers find it more attractive to place ads in a newspaper the larger its circulation, newspapers are a prime example of a platform in a two-sided market.[4] A key result in the literature on two-sided markets is that the platform may find it profit-maximizing to charge prices from one customer group that are below marginal costs (think about free newspapers). Since profit-maximizing prices on the two sides of the market are interlinked, taxation of newspapers may have unconventional effects on strategic variables.

[1] For example, in Germany newspapers are subject to a rate of 7% in contrast to the regular rate of 16%, whilst countries like the UK, Denmark and Norway exempt newspapers from value-added taxation (European Commission, 2004). Newspapers are also either fully or partially exempted from sales taxes in a number of U.S. states.

[2] The lack of analysis of these issues is surprising, since taxation is known to affect quality choice and the intensity of competition. See e.g., Anderson, de Palma, and Kreider (2001a,b) and Delipalla and Keen (1992).

[3] The share of advertising in total revenue in the press industry differs across countries, but is typically around 50 percent. See Albarran and Chan-Olmstead (1998).

[4] See Evans (2003a,b) or Rochet and Tirole (2003) for examples and classifications of two-sided platform firms.

In this paper we argue that the preferential tax treatment of newspapers increases media diversity, but may lead to higher newspaper prices and lower investments in quality. In order to show this we use a Hotelling-type framework with two competing newspapers and a continuum of consumers uniformly distributed along the unit line. The newspapers' choice of location on the line can be interpreted as describing their profiles, and we consider a three-stage game. At stage 1 each newspaper decides on its location on the Hotelling line and how much to invest in quality. At stage 2 the ad level is determined, and ad-revenue is assumed to be proportional to the number of readers. Then at stage 3 the newspapers compete in prices. A reduction in the ad-valorem tax rate for newspapers implies that the profitability of selling newspapers increases relative to the profitability of selling advertisements. As a consequence, it becomes less imperative for the newspapers to attract a large audience in order to sell advertising space. Instead, each newspaper wants to increase its earnings from the reader side of the market. It can do so by choosing a profile that differentiates it further away from its competitor in order to reduce the competitive pressure. Other things equal, this allows the newspaper to charge higher prices from its readership and to reduce quality investments.

Our analysis is related to a growing literature on the price-setting behavior of firms in two-sided markets,[5] but this literature typically abstracts from taxation issues. The literature on commodity taxation, on the other hand, does not consider two-sided markets.[6] One exception is Kind *et al* (2006), who compare the effects of ad-valorem and specific taxes on newspapers in a monopoly setting. They find, contrary to popular beliefs, that a lower ad-valorem tax may increase the price of the newspaper and reduce sales, while a per-unit subsidy (or a lower specific tax) has the opposite effect. More closely related to our analysis is Gabszewicz *et al*

[5]See for instance Rochet and Tirole (2003, 2004), Crampes, Haritchabalet and Jullien (2005), and Armstrong (2005).

[6]E.g., Keen and Delipalla (1992), Dierickx, Matutes and Neven (1998) and Anderson *et al* (2001a, 2001b). For a survey, see Fullerton and Metcalf (2002).

(2001, 2002), who use the Hotelling model to analyze how the size of the advertising market affects the political profiles of newspapers. They find that the larger the ad-market, the more important it is for the newspapers to moderate their political profile. Thereby the newspapers are better able to serve the mass market and raise income from the advertising market.

This paper is organized as follows. The formal model is presented in Section 2, and Section 3 derives the newspapers' equilibrium prices, quality investments and profile choices. Section 4 analyzes the effects of changing the ad-valorem tax rate levied on newspapers and ads. Section 5 concludes.

2 The Model

We employ a standard Hotelling model with two competing media firms each selling a newspaper to readers and ad-inserts to advertisers. The readers are uniformly distributed along the unit line according to their political view; a consumer who is located at point 0 in Figure 1 is extremely left-wing, whilst a consumer located at 1 is extremely right-wing. Consumers with more moderate views are located closer to the center of the unit line. We assume that each reader buys the newspaper which has the profile which best corresponds to his political view.

The political profiles of newspapers 1 and 2 are given by points x_1 and x_2, respectively, as illustrated in Figure 1. Throughout the paper, we assume that newspaper 2 is located to the right of newspaper 1; $(1 - x_2) \geq x_1$. The newspapers are perfect (horizontal) substitutes if $x_1 + x_2 = 1$ and maximally (horizontally) differentiated if $x_1 = x_2 = 0$. More generally, an increase in x_1 and/or x_2 means that the newspapers become less horizontally differentiated, and vice versa.

The further away a newspaper profile is from the "ideal position" of a specific reader, the smaller is his utility from reading it. We shall model this utility loss by a distance cost parameter, $t > 0$. Letting $p_i \geq 0$ denote the price and $q_i \geq 0$ the quality level of newspaper $i = 1, 2$, we thus assume that the utility level of a consumer located at point x who buys newspaper i is given by

$$U = v + q_i - p_i - t(x - d_i)^2, \tag{1}$$

where $d_1 = x_1$, $d_2 = 1 - x_2$, and v is a positive constant. The squaring of the last term in (1) means that distance costs increase quadratically with the distance from the most preferred location.

Consumers have unit demand, and we assume that the parameter v is sufficiently large to ensure complete market coverage. This means that each consumer buys either newspaper 1 or newspaper 2. Let $\tilde{x}$ denote the location of the consumer who is indifferent between buying newspaper 1 and newspaper 2; $v+q_1-p_1-t(x_1-\tilde{x})^2 = v+q_2-p_2-t(1-x_2-\tilde{x})^2$. Consumers located to the left of $\tilde{x}$ $(x < \tilde{x})$ consequently prefer newspaper 1, while consumers to the right of $\tilde{x}$ $(x > \tilde{x})$ prefer newspaper 2. From this we find that demand D_i for newspaper i equals

$$D_i = x_i + \frac{1 - x_1 - x_2}{2} + \frac{p_j - p_i}{2t(1 - x_1 - x_2)} + \frac{q_i - q_j}{2t(1 - x_1 - x_2)}; i, j = 1, 2; i \neq j. \tag{2}$$

Advertisers may buy inserts in either or both newspapers, and newspaper i's gross advertising income is given by A_i. The willingness to pay for advertising depends on the number of readers and the advertising volume. We follow Peitz and Valletti (2004) and Anderson and Coate (2005) in assuming that newspaper i faces a simple downward-sloping demand curve for advertising per viewer. More specifically, letting r_i be the price of advertising per viewer and a_i the advertising volume, we have

$$r_i = \alpha - \beta a_i \qquad (\alpha, \beta > 0). \tag{3}$$

With D_i readers, we consequently find that advertising income equals

$$A_i = \left(\frac{\alpha - \beta a_i}{1+T} - c_A \right) a_i D_i, \tag{4}$$

where $c_A \geq 0$ is the marginal cost of adverts, and $T \geq 0$ is the ad-valorem tax on advertising. A higher α or a smaller β can be interpreted as though the size of the ad market has increased.[7]

The profit level of newspaper i is given by

$$\pi_i = \left(\frac{p_i}{1+\tau} - c_N \right) D_i + A_i - \frac{\phi}{2} q_i^2, \tag{5}$$

where $\tau \geq 0$ is the ad-valorem tax rate on newspaper sales and $c_N \geq 0$ is the marginal cost of printing and distributing the newspaper. The last term in (5) represents quality investment costs. We assume that the constant $\phi > 0$ is sufficiently large to fulfill all second-order conditions for profit maximization.

3 Equilibrium

We use a sequential game with three stages, where at stage 1 each media platform decides on its newspaper profile and level of quality investment. Then at stage 2 they choose advertising levels, while newspaper prices are determined at stage 3.[8] Since newspaper prices and thus the number of copies sold are the outcome of the final stage, the sequencing of the game implies that the platforms cannot commit to a certain number of readers or write contracts with advertisers which depend on the number of copies. However, we assume that the advertisers correctly anticipate the number of readers. In practice a proxy for such anticipation is the use of weekly, monthly and yearly circulation numbers that newspapers in most countries make available for advertisers.

[7] An increase in α means that the willingness to pay for advertising becomes higher, while a reduction in β is equivalent to an increase in the number of advertisers.

[8] Gabszewicz et al. (2001, 2002) study newspapers choice of political profile, but do not model quality investments or taxes.

Stage 3. Solving the game backwards, at stage 3 each newspaper takes profiles, quality investments and advertising levels as given when it decides on the newspaper price. Using (2) and (5) to solve $\partial \pi_i / \partial p_i = 0$ we find

$$p_i = c_N(1+\tau) + \frac{t\,(1 - x_i - x_j)\,(3 + x_i - x_j)}{3} + \frac{q_i - q_j}{3}, i, j = 1, 2;\ i \neq j. \qquad (6)$$

where $i, j = 1, 2$ and $i \neq j$.

Equation (6) shows that the price of newspaper i depends positively on how differentiated it is from its rival, both horizontally and vertically ($\partial p_i / \partial x_i < 0$ and $\partial p_i / \partial q_i > 0$). We also see that the consumer price is increasing in newspaper taxes ($\partial p_i / \partial \tau > 0$) for given locations and quality investments. Apparently, this lends support to a public policy of imposing low value-added taxes on newspapers in order to reduce their prices.

Stage 2. At the second stage each platform sells advertising space. Substituting equations (4) and (6) into (5) and solving $\partial \pi_i / \partial a_i = 0$, we find that the profit-maximizing advertising volume equals

$$a_i = \frac{\alpha - c_A\,(1+T)}{2\beta}. \qquad (7)$$

From (7) we see that the level of advertising (a_i) is decreasing in the ad-valorem tax T, but increasing in the size of the advertising market (α). Making use of equation (7) in (4), we can rewrite total advertising profit for each platform as

$$A_i = \frac{[\alpha - c_A\,(1+T)]^2}{4\,(1+T)\,\beta} D_i. \qquad (8)$$

From equations (5) and (8) we can now derive revenue per reader R_i in each platform as

$$R_i = \left(\frac{p_i}{1+\tau} - c_N \right) + \frac{[\alpha - c_A\,(1+T)]^2}{4\,(1+T)\,\beta},$$

where it is useful to note that revenue per reader falls following a rise in either of the two ad-valorem tax rates.[9]

[9] It is easily verified that $\partial R\,(\tau, T)\,/\partial \tau < 0$ and $\partial R\,(\tau, T)\,/\partial dT < 0$.

Stage 1. At the first stage the two media platforms choose their profiles and quality investment levels. The first-order conditions are found by solving $\partial\pi_i^*/\partial x_i = \partial\pi_i^*/\partial q_i = 0$ $(i = 1, 2)$, where π_i^* denotes profits given optimal prices and ad levels.

Starting with each newspaper's choice of profile (horizontal dimension), we note that

$$\frac{\partial \pi_i^*}{\partial x_i} = \underbrace{\left(\frac{p_i}{1+\tau} - c_N\right)\left[\overbrace{\frac{\partial D_i}{\partial x_i}}^{\text{direct effect}} + \overbrace{\frac{\partial D_i}{\partial p_j}\frac{dp_j}{dx_i}}^{\text{strategic effect}}\right]}_{\text{(I) Reader market (-)}} + \underbrace{\frac{\partial A_i}{\partial D_i}\frac{dD_i}{dx_i}}_{\text{(II) Ad market (+)}} . \tag{9}$$

Terms (I) and (II) in equation (9) measure the marginal profit for newspaper i in the reader and ad market, respectively, of choosing a profile which is closer to that of the rival. Following the convention in the Hotelling literature, the two terms in the square bracket of equation (9) are labelled the direct and the strategic effect, respectively. The direct effect is positive, other things equal, and captures the fact that the newspaper increases its market share by moving closer to its rival. However, the smaller the distance between the firms, the lower is the price that the rival will charge ($dp_j/dx_i < 0$). The strategic effect is therefore negative.

It is well known from the principle of *maximum differentiation* that the strategic effect dominates over the demand effect (*e.g.* Tirole, 1988). Expression (I) in equation (9) is therefore negative. Expression (II), on the other hand, is positive (see Appendix for a proof). The reason is that the newspaper gets a larger readership and consequently earns a higher profit in the ad market if it moves closer to its rival. A large ad market may therefore give rise to the principle of *minimum differentiation*, as discussed by Gabszewicz *et al* (2001, 2002).

Next, differentiating profit with respect to quality investments (the vertical dimension) we find

$$\frac{\partial \pi_i^*}{\partial q_i} = \underbrace{\left(\frac{p_i}{1+\tau} - c_N\right)\left[\overbrace{\frac{\partial D_i}{\partial q_i}}^{\text{direct effect}} + \overbrace{\frac{\partial D_i}{\partial p_j}\frac{dp_j}{dx_i}}^{\text{strategic effect}}\right]}_{\text{(I): Reader market (+)}} + \underbrace{\frac{\partial A_i}{\partial D_i}\frac{dD_i}{dq_i}}_{\text{(II): Ad market (+)}} - \phi q_i \qquad (10)$$

The square bracket in (10) shows that there is a direct and a strategic effect also for quality investments; demand for newspaper i increases if it invests more in quality, but the rival will respond by reducing its newspaper price. The latter reduces the positive effect of quality improvements, but the total effect is unambiguously positive. Therefore Expression (I) in (10) is positive (see Appendix).

Expression (II) is positive, too. The reason is that a higher investment level increases the size of the readership and thus revenue from ad-inserts: formally, we have

$$\frac{\partial A_i}{\partial D_i} = \left(\frac{\alpha - \beta a_i}{1+T} - c_A\right) a_i > 0$$

and

$$\frac{dD_i}{dq_i} = \frac{1}{6t\left(1 - x_1 - x_2\right)} > 0. \qquad (11)$$

Equation (11) contains the important message that dD_i/dq_i is increasing in x_1 and x_2. This means that the demand-expanding effect of a given quality improvement is larger if the newspapers are good substitutes than if they are poor substitutes. The intuitive explanation is that the better substitutes the newspapers are, the more prone consumers are to shift from a low-quality to a high-quality newspaper. As we shall see later, this gives rise to a business-stealing effect which implies that each newspaper has greater incentives to make quality investments in order to capture readers from its rival the closer the newspapers are located on the Hotelling line.

In order to characterize the optimal profile and investment level we set (9) and (10) equal to zero. This yields the first-order conditions

$$x_i^* = -\frac{1}{4} + \frac{\left(\alpha - c_A\left(1+T\right)\right)^2\left(1+\tau\right)}{16\beta\left(1+T\right)t}, \qquad (12)$$

and

$$q_i^* = \frac{4t\beta\left(1+T\right)}{\left[12t\beta\left(1+T\right) - \left(\alpha - c_A\left(1+T\right)\right)^2\left(1+\tau\right)\right]\left(1+\tau\right)\phi}. \tag{13}$$

In order for (12) and (13) to describe an equilibrium the second-order condition for an optimum must hold (see Appendix). In addition, we must impose a restriction on the willingness to pay for advertising (α) which guarantees that $x_i^* \in [0, 1/2]$. This restriction amounts to requiring

$$\begin{aligned} \underline{\alpha} \;&\leq\; \alpha \leq \bar{\alpha}, \\ \underline{\alpha} \;&\equiv\; \sqrt{\frac{4t\beta(1+T)}{1+\tau}} + c_A(1+T), \\ \bar{\alpha} \;&\equiv\; \sqrt{\frac{12t\beta\left(1+T\right)}{1+\tau}} + c_A\left(1+T\right). \end{aligned} \tag{14}$$

If demand for advertising is sufficiently small ($\alpha \leqslant \underline{\alpha}$) equation (12) implies that the newspapers will be located at each end of the Hotelling line. However, the larger the advertising market, the closer the firms will locate to each other, and in the limit when α approaches $\bar{\alpha}$ we have $x_i = 1/2$.

The advertisers do not care about the quality of the newspaper *per se*; their only concern is the number of readers. The size of the ad market therefore has no direct effect on the firms' investment incentives. However, the newspapers will be less differentiated the larger the advertising market, and we know from equation (11) that less horizontal differentiation makes the business stealing motive for investing in quality improvements stronger. This explains why equation (13) implies that q_i^* is increasing in the size of the advertising market.

Summing up, we have:

Proposition 1 *The newspapers will be less differentiated and make higher quality investments the larger the advertising market ($dx_i^*/d\alpha > 0$, $dx_i^*/d\beta < 0$ and $dq_i^*/d\alpha > 0$, $dq_i^*/d\beta < 0$).*

The equilibrium values in the consumer and advertising markets are now found by inserting for (12) and (13) into (2), (6) and (8):

$$p_i^* = \frac{3}{2}t + c_N(1+\tau) - \frac{(\alpha - c_A(1+T))^2(1+\tau)}{8\beta(1+T)} \tag{15}$$

$$A_i^* = \frac{(\alpha - c_A(1+T))^2}{8\beta(1+T)} \tag{16}$$

From (15) we immediately see the following:

Corollary 1 *The newspaper price is decreasing in the size of the advertising market.*

Corollary 1 simply reflects the fact that each media firm is willing to accept a low newspaper price in order to attract a larger number of readers if the advertising market is very profitable.

4 Effects of taxing media products

This section analyzes how higher ad-valorem taxes affect the newspapers' strategic choices. For this purpose, we treat locations, quality investments and newspaper prices as functions of the two exogenous tax rates, *i.e.*, $x_i^*(\tau, T), q_i^*(\tau, T), p_i^*(\tau, T)$. Let us first consider the newspapers' choice of location. From equation (12) we find that

$$\frac{dx_i^*}{d\tau} = \frac{[\alpha - c_A(1+T)]^2}{16t\beta(1+T)} > 0. \tag{17}$$

Equation (17) reflects the fact that higher value-added taxes on newspapers make the advertising market relatively more important for the media firms. Thereby it becomes more valuable to attract a large number of readers, inducing each newspaper to locate closer to its competitor. This *relocation effect* is clearly stronger the larger is the advertising market (higher α, smaller β).

What happens to the newspaper price if τ goes up? Differentiating equation (15) we find

$$\frac{dp_i^*}{d\tau} = c_N - \frac{[\alpha - c_A(1+T)]^2}{8\beta(1+T)}. \tag{18}$$

As in a one-sided market, the direct effect of a higher τ is to increase the newspaper price if marginal costs are positive. This is captured by the first term on the right-hand side of (18). However, the fact that the newspapers endogenously become less horizontally differentiated when τ increases, means that there will be tougher price competition between the newspapers. This in turn tends to reduce the newspaper price, as shown by the second term on the right-hand side of (18).

The net effect depends on the relative strength of these two effects, and cannot be signed in general. However, equation (18) shows that the newspaper price is more likely to dominate and lead to a price reduction the larger the advertising market (because the relocation effect is then stronger). Specifically, it can be shown that $dp_i^*/d\tau > 0$ if $\alpha > \alpha_1 \equiv \sqrt{8\beta\left(1+T\right)c_N} + c_A\left(1+T\right)$. This condition holds always if marginal costs are equal to zero ($c_A = c_N = 0$).

The consequences of a higher τ for the quality level of the newspapers are also ambiguous. On the one hand, the profit margin of the newspapers falls subsequent to a tax increase, other things equal. This has a negative effect on the incentives to invest in quality improvements. On the other hand, we have seen that the newspapers will locate closer to each other if τ increases. To clearly see the implications of the latter for quality investments, we differentiate equation (13) to find

$$\frac{dq_i^*}{d\tau} = 3\left(1+\tau\right)\phi q_i^2\left(\frac{8}{3}\frac{dx_i^*}{d\tau} - \frac{1}{1+\tau}\right). \tag{19}$$

The larger $dx_i^*/d\tau$, the less differentiated the newspapers will be, and the stronger each newspaper's incentive will be to invest in quality in order to capture readers from its rival (business-stealing effect). This explains why the change in quality investments is proportional to the relocation effect. Since the relocation effect in turn is stronger the larger the advertising market, we find that a higher newspaper tax increases quality investments if the ad market is sufficiently large - combining equations (17) and (19) we have $dq_i^*/d\tau > 0$ if $\alpha > \alpha_2 \equiv \sqrt{\frac{6\beta(1+T)t}{1+\tau}} + c_A\left(1+T\right)$.

We can now state:

Proposition 2 *Suppose that the value-added tax on newspapers increases. Then*

- *the newspapers become less differentiated* ($dx_i^*/d\tau > 0$),
- *the newspaper price falls if* $\alpha > \alpha_1$ ($dp_i^*/d\tau < 0$), *and*
- *the quality level increases if* $\alpha > \alpha_2$ ($dq_i^*/d\tau > 0$).

In most countries newspapers are taxed at a reduced rate or fully exempt from taxation in order to lower their prices. Proposition 3 shows that a fall in the ad-valorem tax leads to greater media diversity, but may imply higher newspaper prices and lower investments in quality. Although the Hotelling duopoly model does not allow us to analyze the effects on circulation, previous studies in the context of monopoly with general functional forms show that a reduction in the VAT rate may increase the newspaper price and lower the number of copies sold (see Kind *et al* (2006)).[10] The same can be shown to apply for a Hotelling monopoly model where the market is uncovered. This indicates that there might be a policy trade-off between achieving media diversity, high quality investments and large newspaper circulations.

Figure 2, which measures the size of the advertising market as captured by α on the horizontal axis, provides a numerical illustration of Proposition 2. With the chosen parameter values (see Appendix) we find that $dp_i^*/d\tau < 0$ if $\alpha > \frac{4}{5}\sqrt{5} \approx 1.79$, while the upward-sloping curve shows that $dq_i^*/d\tau > 0$ if $\alpha > \sqrt{3} \approx 1.73$.[11] For $\alpha > \frac{4}{5}\sqrt{5}$ a higher ad-valorem tax will thus reduce the newspaper price and increase quality investments.

[10] We use the terms VAT and ad-valorem tax interchangeably.

[11] As shown by equation (17), x_i^* is monotonically increasing in α. For the parameter values used in Figure 2, we have $x_i^* = -1/4 + \alpha^2/8$. This means that $x_i^* = 0.111$ at $\alpha = 1.7$ and $x_i^* = 0.155$ at $\alpha = 1.8$.

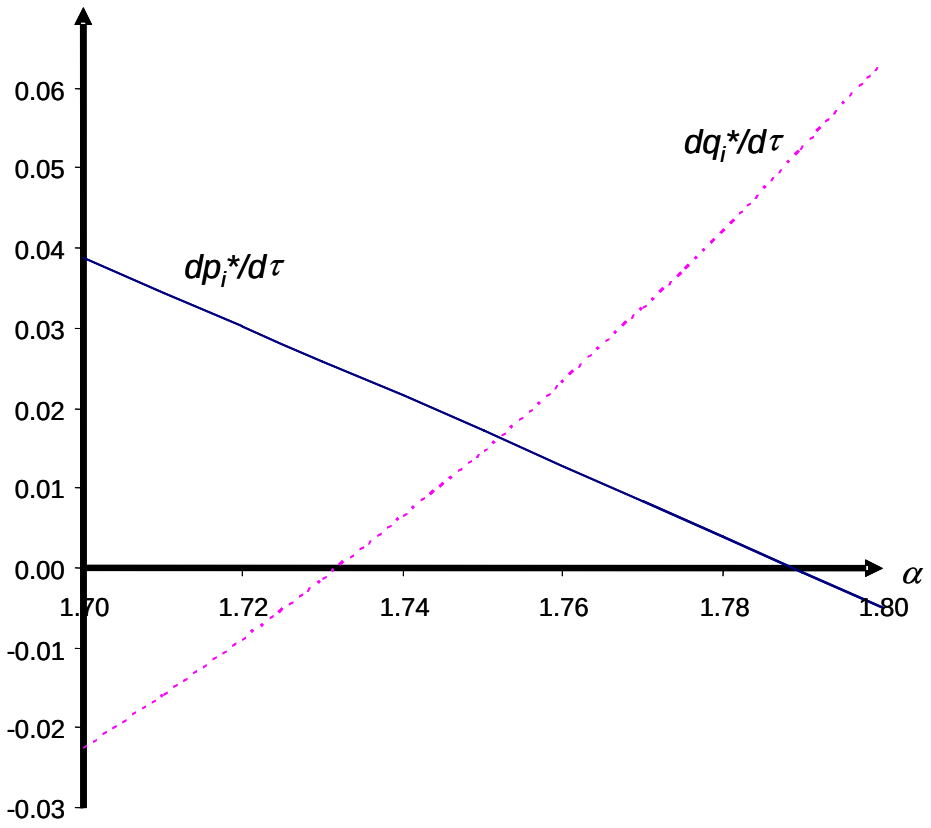

Figure 2: *Value added taxes on newspapers: price and quality responses.*

Finally, let us consider the effects of increasing T. Higher ad-valorem taxes on ads make the advertising market relatively less profitable for the newspapers, and will therefore lead to increased differentiation:

$$\frac{dx_i^*}{dT} = -\frac{\left(\alpha^2 - c_A^2\left(1+T\right)^2\right)\left(1+\tau\right)}{16t\beta\left(1+T\right)^2} < 0.$$

Recall that taxes on ads do not enter the newspaper price p_i at the final stage of the game; see equation (6). We nonetheless find that higher advertising taxes increase the newspaper price. This is due to the relocation effect: since the newspapers end up being more differentiated if T increases, the competitive pressure falls. This unambiguously allows the newspapers to increase their prices. Additionally, the lower competitive pressure reduces the newspapers' incentive to make quality

investments. We therefore have

$$\begin{aligned}\frac{dp_i^*}{dT} &= \frac{(1+\tau)(\alpha - c_A(1+T))(2c_A + (1+T))}{1+T} > 0 \\ \frac{dq_i^*}{dT} &= -\frac{4t\beta\left((\alpha - c_A(1+T))^2 + 2c_A(1+T)^2\right)}{\phi\left(12t\beta(1+T) - (\alpha - c_A(1+T))^2(1+\tau)\right)} < 0.\end{aligned}$$

The effects of taxing advertising can be summarized as follows:

Proposition 3 *Suppose that the value-added tax on ads increases. Then*

- *the newspapers become more differentiated ($dx_i^*/dT < 0$),*
- *the newspaper price increases ($dp_i^*/dT > 0$), and*
- *quality investments fall ($dq_i^*/dT < 0$).*

Comparing Propositions 2 and 3 we see that the two taxes have very different effects. A reduction in the ad-valorem tax on newspapers (the reduced-rate regime in many countries) makes each platform differentiate its profile further. In contrast, a fall in the tax on ads has the opposite effect; it leads to less differentiation. The impact on quality and the newspaper price may also be of opposite signs, but depends on the importance of advertising as a source of revenue.

5 Concluding remarks

Advertising supported media such as newspapers is based on a two-sided business model. The newspaper creates content that is used to attract readers. The readers are then used to attract advertisers. This interrelationship is of importance when policy implications are considered. Governments in democratic countries typically consider media pluralism as a benefit, and in this paper we have shown how a reduced-rate regime for newspapers makes the press industry become more differentiated. Contrary to what one should expect, however, the basic insight in one-sided markets that a fall in taxes lowers end-user prices, need not hold. On the contrary,

we show that a fall in the VAT rate on newspapers may lead to a higher end-user price on newspapers. Our results further suggest that there might be a trade-off between having a press industry that is differentiated in profile and one that has high quality investments if the VAT rate is the government's only instrument.

6 Appendix

Proof that $\frac{\partial A_i}{\partial D_i}\frac{dD_i}{dx_i} > 0$ *(equation (9))*

Differentiating equation (8) with respect to D_i we find that

$$\frac{\partial A_i}{\partial D_i} = \left(\frac{\alpha - \beta a_i}{1+T} - c_A\right) a_i. \tag{20}$$

Inserting (6) into (2) it further follows that

$$\frac{dD_i}{dx_i} = \frac{1}{6}\frac{t\left(1-x_1-x_2\right)^2 - q_j + q_j}{t\left(1-x_1-x_2\right)^2}.$$

In a symmetric equilibrium ($x_i = x_j$ and $q_i = q_j$) we consequently have

$$\left(\frac{\partial A_i}{\partial D_i}\frac{dD_i}{dx_i}\right)\Bigg|_{sym} = \left(\frac{\alpha - \beta a_i}{1+T} - c_A\right)\frac{a_i}{6} > 0.$$

Proof that $\frac{\partial \pi_i^*}{\partial q_i} > 0$ *(equation (10))*

Differentiating π_i with respect to q_i and using the envelope theorem (which implies that $\left(\partial \pi_i / \partial p_i\right) / \left(\partial p_i / \partial q_i\right) = 0$) we have

$$\frac{\partial \pi_i^*}{\partial q_i} = \left(\frac{p_1}{1+\tau} - c_N\right)\left(\frac{\partial D_i}{\partial q_i} + \frac{\partial D_i}{\partial p_j}\frac{dp_j}{dq_i}\right) + \frac{\partial A_i}{\partial D_i}\frac{dD_i}{dq_i} - \phi q_i. \tag{21}$$

We further find

$$\left(\frac{\partial D_i}{\partial q_i} + \frac{\partial D_i}{\partial p_j}\frac{dp_j}{dq_i}\right)\Bigg|_{sym} = \frac{1}{3t\left(1-2x_i\right)} > 0$$

and

$$\frac{\partial A_i}{\partial D_i}\frac{dD_i}{dq_i}\Bigg|_{sym} = \left(\frac{\alpha - \beta a_1}{1+T} - c_A\right)\frac{a_i}{2t\left(1-2x_i\right)} > 0.$$

The two first terms on the right-hand side of (10) are thus positive. Q.E.D.

Second-order conditions

The second-order conditions for the third and the second stage are straight forwardly calculated. However, the second-order conditions for the first stage are more complex (and will obviously not be satisfied if ϕ is too small), and require that

$$\frac{\partial^2 \pi_i}{\partial q_i^2} = -\frac{9t\phi\left(1+\tau\right)\left(1-x_1-x_2\right)-1}{9\left(1+\tau\right)t\left(1-x_1-x_2\right)} < 0 \tag{22}$$

$$\begin{aligned} 0 \;>\; \frac{\partial^2 \pi_i}{\partial x_i^2} = -\Bigg\{ & \frac{4\beta t^2\left(5+3x_i-x_j\right)\left(1-x_1-x_2\right)^3\left(1+T\right)}{36t\beta\left(1+\tau\right)\left(1-x_1-x_2\right)^3\left(1+T\right)} \\ & -\frac{\left(q_i-q_j\right)\left(4\beta\left(1+T\right)\left(q_i-q_j\right)-3\left(\alpha-c_A\left(1+T\right)\right)^2\left(1+\tau\right)\right)}{36t\beta\left(1+\tau\right)\left(1-x_1-x_2\right)^3\left(1+T\right)} \Bigg\} \end{aligned} \tag{23}$$

and

$$\left(\frac{\partial^2 \pi_i}{\partial q_i^2}\right)\left(\frac{\partial^2 \pi_i}{\partial x_i^2}\right) - \left(\frac{\partial^2 \pi_i}{\partial q_i \partial x_i}\right)^2 > 0 \tag{24}$$

where

$$\left(\frac{\partial^2 \pi_i}{\partial q_i \partial x_i}\right)^2 = \frac{\left(8\beta\left(1+T\right)\left(\left(q_i-q_j\right)+t\left(1-x_1-x_2\right)^2\right)+3\left(A-c_N\left(1+T\right)\right)^2\left(1+\tau\right)\right)^2}{5184\left(1+\tau\right)^2 t^2\left(1-x_1-x_2\right)^4\left(1+T\right)^2\beta^2}. \tag{25}$$

A necessary condition for the second-order conditions to be satisfied is that $\phi > \left[9t\left(1+\tau\right)\left(1-x_1-x_2\right)\right]^{-1}$. Otherwise, the costs if quality investments are so low that $\partial^2 \pi_i / \partial q_i^2$ is non-negative.

Parameter values Parameter values in Figure 2: $T = \tau = c_N = 0$, $t = 1/2$, $\phi = 2$, $c_A = 4/10$ and $\beta = 1$. Using equations (22) - (25) it can be verified that all second-order conditions are satisfied within the range of α shown in the figure.

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