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Content Provision and Multi-Homing

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by

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Content Provision and Multi-Homing

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Abstract

We analyze the effects of multi-homing consumers on content provision by media firms. We develop a model where media firms compete on content provision and advertising revenues, and consumers enjoy network effects from consuming content that other consumers also consume. Media firms have to choose if they are single-content or multi-content, and in the latter case how much content to offer. Competition for advertising revenues gives a two-sided market nature to our model, since advertisers prefer media firms with more demand. As such, media firms would like to increase demand to increase advertising revenues. Offering more content increases demand because more consumers can consume their ideal variety without paying transport costs. We show that, relatively to the case with single-home consumers, media firms provide less content with multi-homing consumers. The reason is that with multi-homing consumers, competition between media firms is weakened. Multi-homing consumers consume from all media firms, and therefore media firms have lower incentives to provide content to attract demand, and advertising revenues. As a result, social welfare tends to be higher under the multi-homing case relatively to the single-homing case, when the advertising market is large, and when the network effects are large relative to the intensity of consumers' preferences.

Keywords: Content Provision; Two-Sided Markets; Multi-Homing.
JEL Classification: D43, L13, L82, L86.

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1 Introduction

One of the main concerns for media regulators is the diversity of content provided by media firms. A media market with a diverse provision of content is seen to contribute to consumer welfare because from one side it satisfies consumers' diverse preferences, and from the other side it can contribute to a better function market economy and democracy, since consumers can be more informed (see Coase, 1974; Hayek, 1945; and Mill, 1859). A diverse media market is however not a guarantee of well-informed consumers, since as argued by Downs (1957), it can be rational for consumers to not incur in the costs to acquire information[1]. Accordingly, when the costs to acquire information are very high, and the impact that an informed consumer can have on economic and political outcomes is small, then, it might be optimal from an individual point of view to not search for information[2].

In this paper, we do not analyze consumers' incentives to acquire information, we focus instead on the impact that informed consumers can have on media firms' incentives to provide content. Imagine that a share of consumers likes to be informed, and are therefore willing to search for information from different media outlets. What are the effects of these informed consumers on media firms' choice regarding content provision? Is it that informed consumers increase or decrease media firms' incentives to provide a more diversified content in the media market?

The literature in media economics usually assumes that consumers have a strong preference for a given variety and therefore they only consume from one media firm. This is a direct consequence of the workhorse model of media economics, the Hotelling model (Hotelling, 1929). However, as noted by Caillaud and Jullien (2003) and Rochet and Tirole (2003), consumers are seldom single-homing consumers. Rather consumers are very often multi-homing consumers in that they consume from different media outlets.

In this paper, we adopt the modeling strategy of multi-homing consumers of Doganoglu and Wright (2006, 2010)[3]. In addition to this, our model has

[1] See also Becker (1983, 1985), Coate and Morris (1995), Downs (1957), Feddersen and Pesendorfer (1997), Martinelli (2006), Wittman (1989).

[2] According to this view, uniformed consumers can have a negative impact on political and economic choices. For empirical evidence, see for instance Eisensee and Strömberg (2007), Feddersen and Pesendorfer (1997), Prat and Strömberg (2005, 2011), Rothbauer and Sieg (2013), Snyder and Strömberg (2010), Strömberg, D. (2001, 2004a, 2004b, 2007, 2008).

[3] Doganoglu and Wright (2006, 2010) analyze the effects of multi-homing on compat-

two more blocks. The first block considers a two-sided market, in the sense that media firms derive revenues from advertising (see for instance Rochet and Tirole, 2003; Anderson and Coate, 2005; Peitz and Valletti, 2008; von Ehrlich and Greiner, 2013; and Kind et al., 2007). Advertisers prefer media firms that have more consumers, and therefore media firms would like to attract more demand to increase advertising revenues.

The second block takes into account that media firms can choose to follow a single-content or a multi-content strategy. With a single-content strategy, media firms only provide one type of content (a point in the Hotelling line). With a multi-content strategy, media firms provide different types of content (a segment in the line), and therefore they have to decide on the diversity of content offered.

The diversity of content that is available in a media market is a central question in media economics. However, to the best of our knowledge, this issue has only been studied in the context of single-content firms and single-homing consumers. When media firms are single-content, the question that arises is if the media market will offer minimum differentiation (just one type of content) or maximum differentiation (two type of contents). On this approach, see for instance Gabszewicz et al. (2001, 2002). Garcia Pires (2013, 2014) departs from the limitations of single-content media firms and considers the case with multi-content media firms. Garcia Pires (2013, 2014) shows that the interaction of multi-content media firms with two-sided markets carries some implications that have been previously ignored. Offering more content increases demand because more consumers can consume their ideal variety of content without paying transport costs. As such, in a two-sided market, the question is not only about minimum *versus* maximum differentiation but also about the level of content offered. However, Garcia Pires (2013, 2014) analyzes only the case of single-homing consumers.

In this paper, we merge multi-homing consumers, with multi-content media firms in a two-sided market. In this set up, we show that relatively to the case with single-homing consumers, media firms provide less content with multi-homing consumers. The reason is that with multi-homing consumers, competition between media firms is weakened. Multi-homing consumers consume from all media firms, and therefore media firms have lower incentives

ibility and exclusive dealing, respectively. In turn, Choi (2010) considers the case of multi-homing from the side of content providers in the Internet. Carrillo and Tan (2006) analyze multi-homing from both the side of consumers and content providers.

to provide content to attract demand, and advertising revenues. As a result, social welfare tends to be higher under the multi-homing case relatively to the single-homing case, when the advertising market is large, and when the network effects are large relative to the intensity of consumers' preferences.

Our results have as such some implications not only for media markets but also for the discussion on rational ignorance. As discussed above, to have consumers that are not willing to incur costs to be informed can have negative consequences on political outcomes. However, to have consumers that are willing to incur in the costs to acquire information, because they derive some extra benefits from being informed, like network and information benefits, can in turn be detrimental to the diversity of content that finds voice in media markets.

The rest of the paper is organized as follows. In the next section, we present the base model. In section 3, we analyze the case of single-homing. In section 4, we look at the multi-homing case. In section 5, we discuss the main findings.

2 Model

The model in this paper is based in the Hotelling competition model (Hotelling, 1929). To this model, we add advertising (like in Anderson and Coate, 2005, and Peitz and Valletti, 2008), multi-content media firms (like in Garcia Pires, 2013, 2014), and multi-homing consumers (like in Doganoglu and Wright, 2006, 2010).

The media sector is made up of two media firms, media firm 1 and media firm 2. The media firms provide content, for instance information and news, to the media market. Consumers can subscribe to media firm 1, to media firm 2 (single-homing) or to both (multi-homing). As in Doganoglu and Wright (2006, 2010) consuming content from a media firm give extra benefits, N, like network and information effects, where N is the number of consumers in the media market. In terms of network and information effects, we can think for instance that a consumer can extract benefits from interacting with other consumers that also consume the same type of content, or that information has a value in social, economic, and political interactions. We assume that the media market has two type of consumers according to their marginal valuation of the extra benefits, which are denoted as b. A share $0 < \lambda < 1$ of consumers give a high valuation to these extra benefits, and have $b = b_H$. A

share $1-\lambda$ of consumers give a low valuation to these extra benefits, and have $b = b_L$, with $b_H > b_L > 0$. Following our discussion on rational ignorance, we can think of the high type consumers, as consumers that are willing to incur in the costs to acquire information.

Consumers are uniformly distributed on a line of length one, $[0, 1]$, and they have heterogeneous preferences in the Hotelling manner. The line represents consumers' preferences, and the mass of consumers is normalized to one.

Like in Doganoglu and Wright (2006, 2010), media firm 1 is located at point 0 in the Hotelling line and media firm 2 is located at point 1. We fix locations because the aim of the paper is not the choice of location in the product space, but rather the choice of the diversity of content. In the discussion section of the paper, we discuss the implications of firms choosing also location in the Hotelling line.

In what concerns content, we allow media firms to provide more than just one type of content. In other words, contrary to standard Hotelling models, media firms are not limited to be located in just a point in the line (single-content strategy). Like in Garcia Pires (2013, 2014), media firms can choose to cover a line segment (multi-content strategy), where the size of the line segment is indicated by $0 < d_i < 1$.

When deciding between the single-content strategy (a point in the line) and the multi-content strategy (a line segment), a media firm weights the costs and the benefits of these two strategies. The benefits of a multi-content strategy are to increase demand, given that consumers do not have to incur transport costs to consume their ideal-content. The costs of a multi-content strategy are to incur in extra costs to cover more than one point in the line. These costs equal:

$$C_i = \frac{\gamma d_i^2}{2}, i = 1, 2, \tag{1}$$

where γ is a parameter that captures the technological costs to follow a multi-strategy strategy. In this way, to model multi-content media firms, we follow the approach by Alexandrov (2008) to "fat products." With fat products, a firm offers just one product that contains a set of characteristics amongst which consumers can select at no extra cost. An example of a fat product is a software program where consumers can choose between different applications. In other words, fat products are defined as access products: when consumers access a given product, they can pick up amongst what

is offered "inside" the product. In the context of the media market, "fat content" refers to the case where a media outlet caters to different preferences by providing different content, for instance on its website, and consumers can decide what to consume from this set of content offerings.[4]

In addition, we assume that a media firm can only follow a multi-content strategy that is contiguous to their location in the line, i.e. for media firm 1, the multi-content choice has to be contiguous to the point 0; and for media firm 2 the multi-content choice has to be contiguous to point 1. One reason for this to occur can be due to diseconomies of scope. For instance, a media firm when moves content contiguously along the line, it only needs to incur in the costs expressed in equation 1. However, if a media firm provides content discontinuously along the line, it has to incur in extra sunk cost for each new location and associated multi-content segment. This sunk cost might be tough to be prohibitive[5].

The utility of a consumer of type b located outside the multi-content segments of the two media firms, when the consumer only consumes from media firm i (single-homing) is:

$$U(x, b, N_i) = v - t_i\,(x, d_i) + bN_i, \tag{2}$$

where v is the intrinsic value of consuming content from media firm i, t represents the intensity of consumers' preferences (transport costs in the Hotelling terminology), and d_i stands for the amount of content supplied by media firm i. We assume that v is sufficiently high so that the media market is cover, i.e. all consumers consume content from at least one media firm.

[4]Dewan et al. (2003) have a similar set-up to Alexandrov (2008). The difference is that Dewan et al. (2003) model product customization. Customization and fat products are related but not identical concepts. With customization, a firm adapts a standard product and transforms it into several customized products. A customized product can be acquired at an additional price to that of the standard product. An example of a customized product is a personal computer, where consumers can choose between different components at different prices. Then, under customization, and contrary to fat products, price discrimination is central. In the case of the internet media market, it seems more appropriate to think in terms of fat products than of customization, since for instance, an internet website is always just one product and price discrimination, in spite of some attempts, is not the standard business practice in the industry.

[5]For example, a media firm to provide content away from its location, it might need to hire a complete new staff and respective administrative structure that specializes in this different content area. Conversely, when a media firm provides content contiguous to its location in the line, it might be able to continue to use the same staff and structure.

In addition, $t_1(x, d_1) = t(x - d_1)$ and $t_2(x, d_2) = t(1 - x - d_2)$. Also, if a consumer is located inside the multi-content segment of a media firm, his/her utility simplifies to $U(x, b, N_i) = v + bN_i$, since he/she does not need to incur transport costs to consume his/her preferred variety of content.

In turn, the utility of a consumer of type b located outside the multi-content segments of the two media firms, when he/she consumes from both media firms (multi-homing) is:

$$U(x, b, N) = v - t_1(x, d_1) - t_2(x, d_2) + bN. \tag{3}$$

Since $N = 1$ and $-t_1(x, d_1) - t_2(x, d_2) = -t(x - d_1) - t(1 - x - d_2)$, we have that $U(x, b, N) = v - t((1 - d_1 - d_2)) + b$. Again, if a consumer is located inside the multi-content segment of a media firm, his/her utility simplifies to $U(x, b, N_i) = v + bN$, given that he/she does not need to incur transport costs to consume his/her preferred variety of content.

In this way, consumer surplus under both the single-homing and multi-homing cases is:

$$CS =$$
$$(v + bN_1) N_1 - t \int_{d_1}^{N_1} (x - d_1)\, dx + (v + bN_2) N_2 - t \int_{N_1}^{1-d_2} ((1 - x) - d_2)\, dx \tag{4}$$

Note that only the consumers that do not find in the media market their preferred type of content suffer disutility from t (transportation costs related with the intensity of consumers' preferences). As such, for media firm 1, the consumers situated in the interval $[0, d_1]$ do not incur in transport costs. And the same, for media firm 2, the consumers situated in the interval $[1 - d_2, 1]$ do not incur in transport costs.

We look now at advertising. We assume that media firms derive all their revenues from advertising. We decided to abstract from price competition, since competition amongst content providers in the Internet is nowadays mostly competition for advertising revenues. In the discussion section of the paper, we discuss the implications of media firms competing also on prices. As in Anderson and Coate (2005), and Peitz and Valletti (2008), the demand for ads for the media firm i is:

$$r_i = \alpha - \beta a_i,\ i = 1, 2, \tag{5}$$

where r_i is the price of advertising per consumer, a_i is the advertising volume, and the parameters α and β represent the size of the advertising market. Accordingly, a large α and a small β represent a large advertising market, and *vice-versa*.

Gross advertising income is then:

$$A_i = \left(\left(\alpha - \beta a_i\right) a_i\right) N_i,\ i = 1, 2, \tag{6}$$

where N_i is the number of consumers that buy content i. We can then see that advertising introduces a two-sided market nature to the model. This is so because, from one side advertisers prefer to buy ads in media firms that attracts more audience (N_i). From the other side, media firms would like to increase audience in order to generate more advertising revenue (A_i).

In this way, the profits of media firm i equal:

$$\Pi_i = A_i - C_i,\ i = 1, 2. \tag{7}$$

Social welfare in both the single-homing and multi-homing cases can then be written as:

$$W = \Pi_1 + \Pi_2 + CS. \tag{8}$$

The timing of the game is the following. In the first stage, the media firms choose the diversity of content to offer to consumers, d_i ($i = 1, 2$). In the second stage, media firms decide on advertising prices, a_i.

In the next sections, we derive the equilibrium of the model. We first look to the case where all consumers are single-homing consumers. We then turn to the case with multi-homing consumers.

3 Single-Homing

To solve the model, we follow the usual strategy with Hotelling models. We first find the indifferent consumer. Note that in the model in this paper, we have two indifferent consumers, one for each segment, high and low types. After, we solve for adverting rates. Then, we solve for the choice of content.

Indifferent consumer In what concerns the indifferent consumer, note that in the model in this paper, we have two indifferent consumers, one for each segment, high and low types. In addition, in the single-homing

case, a consumer consumes either from media firm 1 or from media firm 2. Since there are λ high types and $(1-\lambda)$ low types, the total number of consumers for media firm 1 equals $N_1 = \lambda s_1 + (1-\lambda) n_1$, while for media firm 2, the total number of consumers is $N_2 = \lambda s_2 + (1-\lambda) n_2$. As such, the indifferent consumers in each segment, high and low types, are the ones that make $U_1(s_1, b_H, N_1) = U_2(s_1, b_H, N_2)$ and $U_1(s_1, b_L, N_1) = U_2(s_1, b_L, N_2)$, respectively. Note also that $s_2 = (1-s_1)$ and $n_2 = (1-n_1)$. For the high types, the indifferent consumer equals:

$$\begin{aligned} & v - t(s_1 - d_1) + b_H(\lambda s_1 + (1-\lambda) n_1) \\ &= v - t(1 - s_1 - d_2) + b_H(\lambda(1-s_1) + (1-\lambda)(1-n_1)). \end{aligned} \tag{9}$$

While for the low types, the indifferent consumer equals:

$$\begin{aligned} & v - t(n_1 - d_1) + b_L(\lambda s_1 + (1-\lambda) n_1) \\ &= v - t(1 - n_1 - d_2) + b_L(\lambda(1-s_1) + (1-\lambda)(1-n_1)). \end{aligned} \tag{10}$$

Solving for s_1 and n_1, we obtain:

$$\begin{aligned} s_1 &= \tfrac{(b_H(1-2(1-\lambda)n_1) - t(1-d_2+d_1))}{2(\lambda b_H - t)} \\ n_1 &= \tfrac{(b_L(1-2\lambda s_1) - t(1-d_2+d_1))}{2(b_L(1-\lambda) - t)}. \end{aligned} \tag{11}$$

We then have two equations in two unknowns, s_1 and n_1. Solving simultaneously for s_1 and n_1, we have:

$$\begin{aligned} s_1 &= \tfrac{\left(t(1+d_1-d_2) + (d_1-d_2)(b_H-b_L)(1-\lambda) - \Delta^{SH}\right)}{2(t-\Delta^{SH})} \\ n_1 &= \tfrac{(1+d_1-d_2)(t-\lambda(b_H-b_L)) - b_L}{2(t-\Delta^{SH})}. \end{aligned} \tag{12}$$

Note that $\Delta^{SH} = (\lambda b_H + (1-\lambda) b_L)$ is the average value of the network and information benefits parameter b under the single-homing case. To avoid corner solutions, we assume that the intensity of consumers' preferences is higher than the average value of the network and information benefits, i.e. $t > (\lambda b_H + (1-\lambda) b_L)$.

Advertising We turn now to advertising. To find the advertising rates, we need to solve for the first order conditions (FOCs) for advertising, $a_i = 1, 2$. We can show that the FOCs for advertising equal[6]:

$$\begin{aligned} \frac{d\pi_1}{da_1} &= \frac{\left(t(1-d_2+d_1)-\Delta^{SH}\right)(\alpha-2\beta a_1)}{2(t-\Delta^{SH})} \\ \frac{d\pi_2}{da_2} &= \frac{\left(t(1-d_1+d_2)-\Delta^{SH}\right)(\alpha-2\beta a_2)}{2(t-\Delta^{SH})}. \end{aligned} \tag{13}$$

Solving simultaneously for a_1 and a_2, we obtain:

$$a_1 = a_2 = \frac{\alpha}{2\beta}. \tag{14}$$

Next, we turn to the choice of content by media firms.

Content In what concerns the choice of content, we have to solve the FOCs for content provision, $d_i = 1, 2$. We can show that the FOCs for content provision equal:

$$\begin{aligned} \frac{d\pi_1}{dd_1} &= \frac{\left(t\alpha^2-8d_1\gamma\beta\left(t-\Delta^{SH}\right)\right)}{8(t-\Delta^{SH})\beta} \\ \frac{d\pi_2}{dd_2} &= \frac{\left(t\alpha^2-8d_2\gamma\beta\left(t-\Delta^{SH}\right)\right)}{8(t-\Delta^{SH})\beta}. \end{aligned} \tag{15}$$

Solving simultaneously for d_1 and d_2, we obtain:

$$d_1 = d_2 = \frac{\alpha^2 t}{8(t-\Delta^{SH})\beta\gamma}. \tag{16}$$

Since we assume that $t > (\lambda b_H + (1-\lambda) b_L)$, then, media firms provide positive levels of media content, i.e. $d_1 = d_2 > 0$.

Furthermore, the level of content provided by media firms has the following relations with the parameters in the model:

[6] The second order conditions (SOCs) are in appendix. All SOCs are satisfied.

$$\begin{aligned}
\frac{d(d_i)}{d\alpha} &= \frac{\alpha t}{4(t-\Delta^{SH})\beta\gamma} > 0 \\
\frac{d(d_i)}{d\beta} &= -\frac{\alpha^2 t}{8(t-\Delta^{SH})\beta^2\gamma} < 0 \\
\frac{d(d_i)}{dt} &= -\frac{\Delta^{SH}\alpha^2}{8(t-\Delta^{SH})^2\beta\gamma} < 0 \\
\frac{d(d_i)}{db_H} &= \frac{\lambda\alpha^2 t}{8((t-\Delta^{SH}))^2\beta\gamma} > 0 \\
\frac{d(d_i)}{db_L} &= \frac{(1-\lambda)t\alpha^2}{8((t-\Delta^{SH}))^2\beta\gamma} > 0 \\
\frac{d(d_i)}{d\lambda} &= \frac{(b_H-b_L)t\alpha^2}{8((t-\Delta^{SH}))^2\beta\gamma} > 0, \text{ with } i = 1, 2. \qquad (17)
\end{aligned}$$

We can see that the provision of content increases with the size of the advertising market (high α and low β), with the valuation that consumers give to the network and information effects (high b_H and high b_L), the number of high type consumers (high λ). In turn, the provision of content decreases with the intensity of consumers' preferences (high t).

4 Multi-Homing

We now turn to the case where consumers can multi-homing, i.e.: they can consume from both media firms. We follow Doganoglu and Wright (2006) in assuming that all high types multi-home and all low types single-home. The case where only some high types multi-home and the case where some low types multi-home are not qualitatively different from the case analyzed in this section. We can think of the case considered in this section as a benchmark case, in the sense that increasing the number of consumers that can multi-home strengths the results in this section in what concerns comparisons with the single-homing case, and *vice-versa*. As in the previous section, we start by finding the indifferent consumer, we then turn to advertising rates, and we then go to the choice of content.

Indifferent consumer Since all high types multi-home, we have that $s_i = 1$, with $i = 1, 2$. Therefore $N_1 = \lambda + (1-\lambda) n_1$ and $N_2 = \lambda + (1-\lambda) n_2$. In turn, the share of single-homing consumers that join media firm 1 equals $U_1(n_1, b_L, N_1) = U_2(n_1, b_L, N_2)$. The indifferent consumer is the one that makes:

$$\begin{aligned} & v - t\left(n_1 - d_1\right) + b_L\left(\lambda + \left(1-\lambda\right) n_1\right) \\ = & v - t\left(1 - n_1 - d_2\right) + b_L\left(\lambda + \left(1-\lambda\right)\left(1 - n_1\right)\right). \end{aligned} \tag{18}$$

Solving for n_1, we obtain:

$$n_1 = \frac{\left(t(1-d_2+d_1) - \Delta^{MH}\right)}{2(t-\Delta^{MH})}. \tag{19}$$

Note that $\Delta^{MH} = (1-\lambda)\, b_L$ is the average value of the network and information benefits parameter b under the multi-homing case.

For media firm 2, we have that $n_2 = 1 - n_1$. From n_1, it is straightforward to derive total demand for media firm 1, since $N_1 = \lambda + (1-\lambda)\, n_1$:

$$N_1 = \frac{(t(\lambda(1+d_2-d_1)+(1+d_1-d_2))) + b_L(\lambda-1)(\lambda+1)}{2(t-\Delta^{MH})}. \tag{20}$$

Advertising We find now the advertising rates. As in the previous section, in order to do this, we need to solve the model for the FOCs for advertising. The FOCs for a_1 and a_2 equal[7]:

$$\begin{aligned} \frac{d\pi_1}{da_1} &= \frac{((t(\lambda(1+d_2-d_1)+(1+d_1-d_2)) - b_L(1-\lambda)(\lambda+1)))(\alpha - 2\beta a_1)}{2(t-b_L(1-\lambda))} \\ \frac{d\pi_2}{da_2} &= \frac{(t(1+d_2-d_1) - b_L(1-\lambda))(\alpha - 2\beta a_2)(1-\lambda)}{2(t-b_L(1-\lambda))}. \end{aligned} \tag{21}$$

Solving simultaneously for a_1 and a_2, we obtain the same advertising levels as in the single-homing case: $a_1 = a_2 = \frac{1}{2}\frac{\alpha}{\beta}$.

Content We analyze now the choice of content of the two media firms. As in the previous section, in order to this we look at the FOCs for content. The FOCs for d_1 and d_2 equal:

$$\begin{aligned} \frac{d\pi_1}{dd_1} &= \frac{\alpha^2 t(1-\lambda) - 8d_1\gamma\beta(t - b_L(1-\lambda))}{8\beta(t-b_L(1-\lambda))} \\ \frac{d\pi_2}{dd_2} &= \frac{\alpha^2 t(1-\lambda) - 8d_2\gamma\beta(t - b_L(1-\lambda))}{8\beta(t-b_L(1-\lambda))}. \end{aligned} \tag{22}$$

Solving simultaneously for d_1 and d_2, we obtain:

[7] The second order conditions (SOCs) are in appendix. All SOCs are satisfied.

$$d_1 = d_2 = \frac{(1-\lambda)t\alpha^2}{8((t-\Delta^{MH})\beta\gamma)}. \tag{23}$$

We can then see that $d_1 = d_2 > 0$ if $t > (1-\lambda)\, b_L$. This is always the case since we assume that $t > (\lambda b_H + (1-\lambda)\, b_L)$. Then also in the multi-homing case, media firms always provide positive levels of content.

As in the previous section, we also analyze how the level of content is affected by the different parameters in the model. It follows that:

$$\begin{aligned}
\frac{d(d_i)}{d\alpha} &= \frac{(1-\lambda)t\alpha}{4(t-\Delta^{MH})\beta\gamma} > 0 \\
\frac{d(d_i)}{d\beta} &= -\frac{(1-\lambda)t\alpha^2}{8(t-\Delta^{MH})\beta^2\gamma} < 0 \\
\frac{d(d_i)}{dt} &= -\frac{(1-\lambda)^2\alpha^2 b_L}{8(t-\Delta^{MH})^2\beta\gamma} < 0 \\
\frac{d(d_i)}{db_L} &= \frac{(1-\lambda)^2 t\alpha^2}{8(t-\Delta^{MH})^2\beta\gamma} > 0 \\
\frac{d(d_i)}{d\lambda} &= -\frac{\alpha^2 t^2}{8(t-\Delta^{MH})^2\beta\gamma} < 0, \text{ with } i = 1, 2.
\end{aligned} \tag{24}$$

We can see that, apart from one important exception, content provision in the multi-homing case behaves in a similar way to the parameters of the model as in the single-homing case. As in the single-homing case, under the multi-homing case content provision increases with the size of the advertising market (high α and low β), and with the valuation that low type consumers give to the network and information effects (high b_L), and decreases with the intensity of consumers' preferences (high t). In addition, now the valuation that high type consumers give to the network and information effects (b_H) does not influence content provision, since all high type consumers multi-home.

Differently from the single-homing case, however, under the multi-homing case, content provision decreases with the size of consumers that are of high type (high λ). The reason for this is that multi-homing consumers reduce competition between media firms, given that they consume from all media firms and therefore media firms do not have to compete to capture them. As a result, media firms can offer less content, given that lower content will not reduce demand, and therefore advertising revenues (and profits) will not be reduced.

Due to this, and comparing the levels of content provision under the single-homing case and the multi-homing case, we have that:

$$d_i^{SH} - d_i^{MH} = \frac{(t+(b_H-b_L)(1-\lambda))t\alpha^2\lambda}{8(t-\Delta^{SH})(t-\Delta^{MH})\beta\gamma} > 0, \tag{25}$$

where d_i^{SH} and d_i^{MH} represent the levels of content provision under the single-homing and the multi-homing cases, respectively. We can see that the level of content provision is higher under the single-homing case than under the multi-homing case. The reason is that, as we have said above, multi-homing consumers, by reducing competition between media firms, reduce the need for media firms to provide content.

5 Profits, Consumer Surplus and Social Welfare

Single-Homing We can show that profits under the single home case equal:

$$\Pi_1^{SH} = \Pi_2^{SH} = \frac{\alpha^2}{8\beta} - \frac{t^2\alpha^4}{128(t-\Delta^{SH})^2\beta^2\gamma}, \tag{26}$$

where SH stands for single-homing.

For consumer surplus, we have:

$$CS^{SH} = \frac{\left(4v-t+2\Delta^{SH}\right)}{4} + \frac{t^2\alpha^2}{8(t-\Delta^{SH})\beta\gamma}\left(1 - \frac{t\alpha^2}{8(t-\Delta^{SH})\beta\gamma}\right). \tag{27}$$

As such, social welfare under single homing is:

$$W^{SH} = \frac{\alpha^2}{4\beta} + \frac{\left(4v-t+2\Delta^{SH}\right)}{4} + \frac{t^2\alpha^2}{8(t-\Delta^{SH})\beta\gamma}\left(1 - \frac{\alpha^2}{8(t-\Delta^{SH})\beta}\left(\frac{t}{\gamma}+1\right)\right). \tag{28}$$

Multi-Homing For the multi-homing case, profits are:

$$\Pi_1^{MH} = \Pi_2^{MH} = \frac{(\lambda+1)\alpha^2}{8\beta} - \frac{\alpha^4t^2(1-\lambda)^2}{128(t-\Delta^{MH})^2\beta^2\gamma}, \tag{29}$$

where MH stands for multi homing.

Consumer surplus is:

$$CS^{MH} = \frac{\alpha^2t^2(1-\lambda)}{8(t-\Delta^{MH})\beta\gamma}\left(1 - \frac{\alpha^2t(1-\lambda)}{8(t-\Delta^{MH})\beta\gamma}\right) + \frac{\left(\left(4v-\left(\lambda^2+1\right)(t-2\lambda)+2b_L(1-\lambda)\left(\lambda^2+1\right)\right)\right)}{4}. \tag{30}$$

As a result, social welfare equals:

$$W^{MH} = \frac{(\lambda+1)\alpha^2}{4\beta} + \frac{\left(\left(4v-\left(\lambda^2+1\right)(t-2\lambda)+2b_L(1-\lambda)\left(\lambda^2+1\right)\right)\right)}{4} + \frac{\alpha^2 t^2(1-\lambda)}{8(t-\Delta^{MH})\beta\gamma}\left(1-\frac{\alpha^2(1-\lambda)}{8(t-\Delta^{MH})\beta}\left(\frac{t}{\gamma}+1\right)\right). \quad (31)$$

Single-Homing versus Multi-Homing In terms of profits, consumer surplus and social welfare, we are interested in comparing the two cases analyzed in the paper, single-homing and multi-homing. In terms of profits, we have:

$$\Pi^{SH} - \Pi^{MH} = -\frac{\alpha^2\lambda}{8\beta} + \frac{((1-\lambda)(\lambda b_H+(2-\lambda)b_L)-t(2-\lambda))(t+(1-\lambda)(b_H-b_L))t^2\alpha^4\lambda}{128(t-\Delta^{SH})^2((t-\Delta^{MH}))^2\beta^2\gamma} < 0. \quad (32)$$

It can be seen that $\Pi^{SH} - \Pi^{MH} < 0$. To show this note that the first term in equation 32 is always negative. This term captures the effect of the size of the advertising market, which is more important when α is much larger than β. In what concerns the second term, we have that all terms are positive with the exception of $(\lambda b_H + b_L(2-\lambda)) - t(2-\lambda)$. This term is negative for $t > \frac{(1-\lambda)(\lambda b_H+b_L(2-\lambda))}{(2-\lambda)}$. Since $\Delta^{SH} - \frac{(1-\lambda)(\lambda b_H+b_L(2-\lambda))}{(2-\lambda)} = \frac{b_H\lambda}{(2-\lambda)} > 0$, the result above follows.

In this way, we have that profits are always lower under single-homing than under multi-homing. The reason for this is that with multi-homing competition is softer and firms have higher demand, since a share of consumers consume from both media firms. This fact contributes positively in two ways for profits under the multi-homing case relatively to the single-homing case. First, due to lower competition in the multi-homing case, media firms need to invest less in content, leading to lower costs. Second, due to higher demand in the multi-homing case, media firms have higher advertising revenues.

In what relates to consumer surplus, we have:

$$CS^{SH} - CS^{MH} = \frac{\lambda(\lambda(t-2\lambda(1-b_L))+2(b_H-\lambda b_L-1))}{4} + \frac{t^2\alpha^2\lambda(t+(1-\lambda)(b_H-b_L))}{8(t-\Delta^{SH})((t-\Delta^{MH}))\beta\gamma}\left(1-\frac{\alpha^2 t(t(2-\lambda)-(1-\lambda)(\lambda b_H+(2-\lambda)b_L))}{8(t-\Delta^{SH})((t-\Delta^{MH}))\beta\gamma}\right). \quad (33)$$

Two effects are present when comparing consumer surplus in the single-homing case and the multi-homing case. First, as we have seen above, media firms provide more content under single-homing than under multi-homing.

Second, under multi-homing, network effects can be larger, since some consumers consume from both media firms and therefore they benefit from network effects from all consumers in the market. The first effect contributes to higher consumer surplus in the single-homing case than in the multi-homing case. The second effect pushes to higher consumer surplus under the multi-homing case than under the single homing case. The first effect tends to be stronger than the second when the intensity of consumers' preferences (t) is high in relation to the network effects (b_H and b_L).

From equations 32 and 33, we can also calculate the difference in social welfare between the single-homing and multi-homing cases:

$$W^{SH} - W^{MH} = -\frac{\alpha^2\lambda}{4\beta} + \frac{\lambda(\lambda(t-2\lambda)+2(b_H-\lambda(1-\lambda)b_L)-2)}{4} + \left(1 - \frac{\alpha^2(t+\gamma)(t(2-\lambda)+(\lambda-1)(\lambda b_H+(2-\lambda)b_L))}{8(t-\Delta^{SH})(t-\Delta^{MH})\beta\gamma}\right)\frac{(t+(1-\lambda)(b_H-b_L))t^2\alpha^2\lambda}{8(t-\Delta^{SH})(t-\Delta^{MH})\beta\gamma}. \quad (34)$$

The same forces uncovered above for profits and consumer surplus affect social welfare under the multi-homing and the single-homing cases. Social welfare tends to be higher in the multi-content case than in the single-homing case, when the advertising revenues are high (i.e. the larger α in relation to β), and when the intensity of consumers' preferences (t) is high relatively to the network effects (b_H and b_L).

Figure 1 shows the case with a large advertising market (α large in relation to β). Figure 2 depicts the case with a small advertising market (α small in relation to β). We can then see that when the advertising market is large, the multi-homing case tends to do better in all dimensions (profits, consumer preferences, and social welfare). With the exception of profits, which as we have seen above are always smaller under the single-homing case relatively to the multi-homing case, the opposite tends to occur with a small advertising market.

Figure 3 shows the case where the intensity of consumers' preferences is low relatively to the network effects (small t in relation to b_H and b_L). Figure 4 depicts the case where the intensity of consumers' preferences is high relatively to the network effects (large t in relation to b_H and b_L). We can see that when the intensity of consumers' preferences is low relatively to the network effects, the multi-homing case tends to do better in all dimensions (profits, consumer preferences, and social welfare). The opposite tends to occur when the intensity of consumers' preferences is high relatively to the

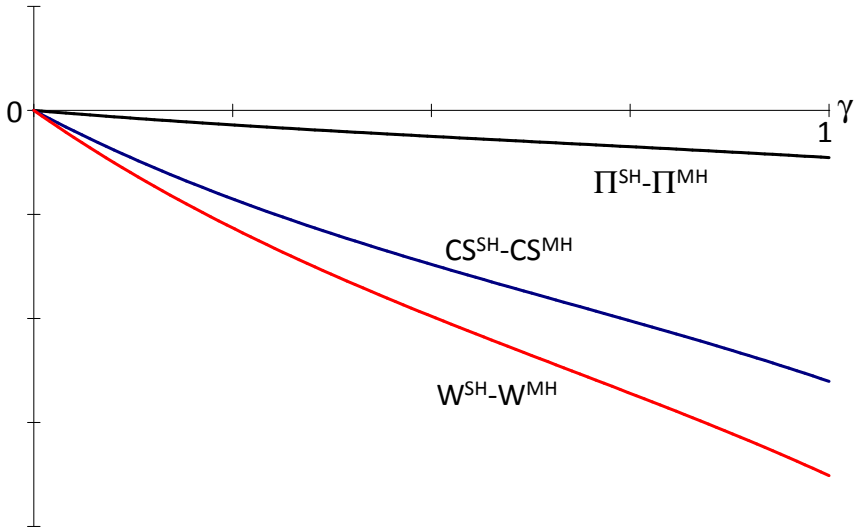

Figure 1: Profits, Consumer Surplus, Social Welfare: Large Advertising Market

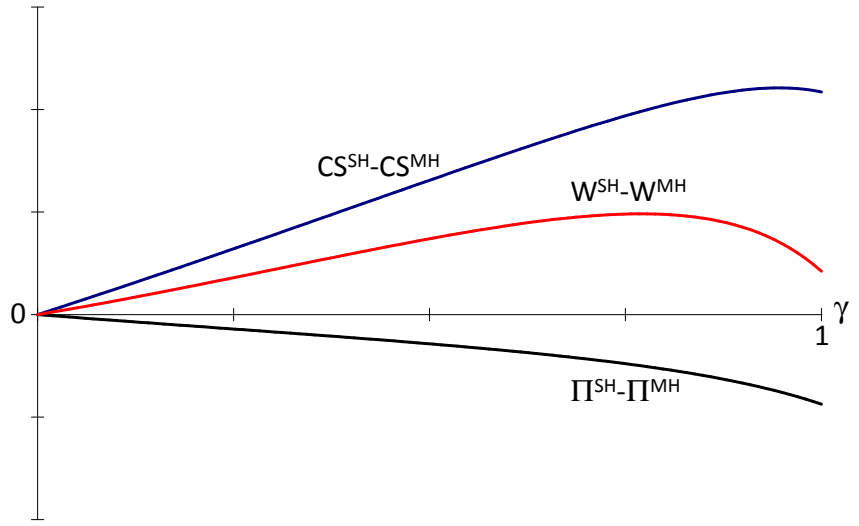

Figure 2: Profits, Consumer Surplus, Social Welfare: Small Advertising Market

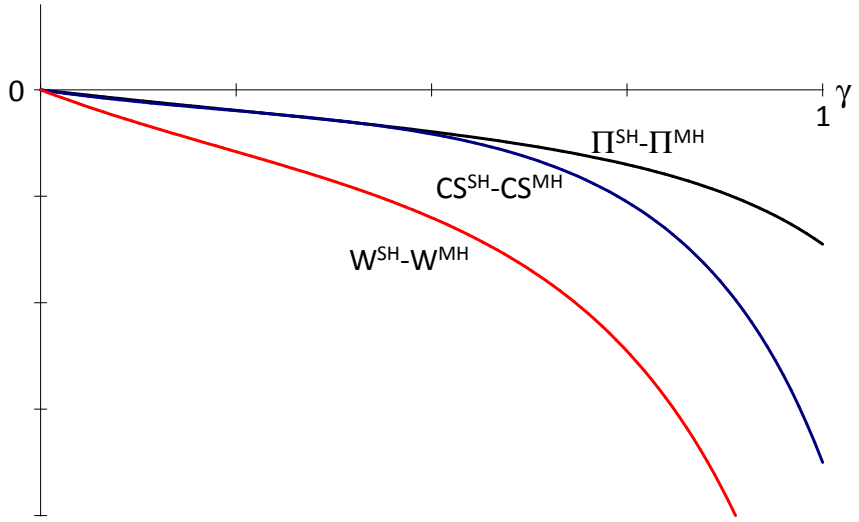

Figure 3: Profits, Consumer Surplus, Social Welfare: Low intensity of consumers' preferences relatively to the network effects

network effects, again with the exception of profits, which are always lower under the single-homing case relatively to the multi-homing case.

6 Discussion

In this paper, we have analyzed the effects of multi-homing consumers on the provision of content by media firms. Contrary to single-homing consumers, which consume from just one media firm, multi-homing consumers consume from more than one media firm. Multi-homing consumers are ubiquitous, for instance in the Internet, but large part of the literature on media economics has focused mostly in single-homing consumers.

From the supply side, we have introduced two central characteristics of media markets in the Internet. First, competition for advertising revenues. Second, competition for content. The first characteristic captures the two-sided nature of media markets. Advertisers prefer to advertise in media firms with higher audience, since this allows them to expose their message to more consumers. As such media firms have strong incentives to increase demand, in order to increase advertising revenues.

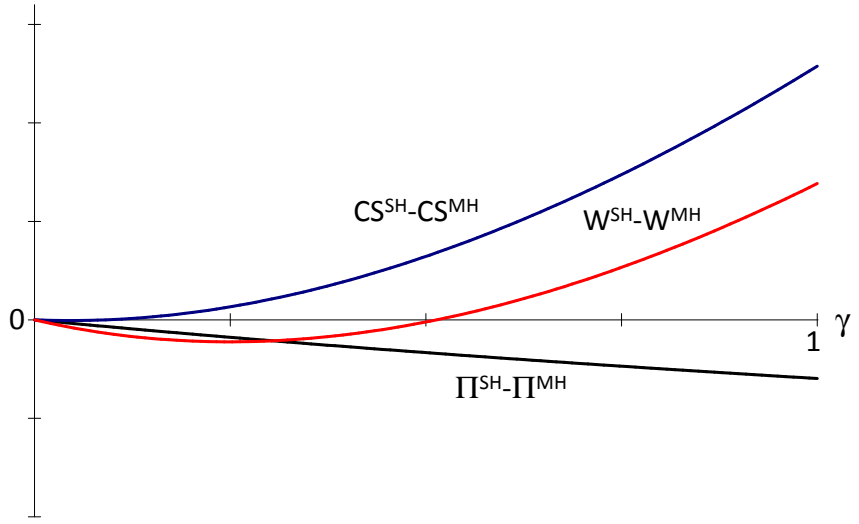

Figure 4: Profits, Consumer Surplus, Social Welfare: High intensity of consumers' preferences relatively to the network effects

The second characteristic tries to tackle a limitation of many models of media markets, where is usually assumed that media firms only provide one type of content. In reality, however, and especially in what concerns the Internet, most media firms are multi-content. The incentives for media firms to be multi-content are that this strategy might allow them to capture more demand (and therefore advertising revenues). A multi-content strategy is in this sense a way for media firms to cater to diverse consumer preferences.

We show that the level of media content diversity is lower with multi-homing consumers than with single-homing consumers. The reason for this is that multi-homing consumers, by consuming from different media firms, reduce competition in the media market, since media firms no longer have to compete to attract these consumers. As a result, media firms have less need to provide a more diversified content to attract demand, and therefore advertising revenues. As a result, social welfare tends to be higher under the multi-homing case relatively to the single-homing case, when the advertising market is large, and when the network effects are large relative to the intensity of consumers' preferences.

In this sense, our results raise a series of challenges for media authorities

and media regulators, since they put a lot of emphasis on the provision of diversified content by media firms. The media authorities and media regulators have only instruments to deal with the supply side of the market, and therefore they can do little to tackle the demand side. The question that arises is if supply side instruments can deal with demand side forces that reduce media content. This is in our view an interesting avenue to explore in the future.

In addition, our results add also to the discussion on rational ignorance. According to the rational ignorance theory, consumers have very low incentives to search for information because searching is costly, and individually each consumer can do very little to change the equilibrium of the market or political outcomes. However, we show that the presence of consumers that like to be informed (and are therefore willing to search for information and to consume information from different sources), can have adverse effects on the provision of content in media markets. In other words, at same time that these consumers can reduce the rational ignorance problem since they like to be informed, they can also aggravate it because less type of content finds voice in the media market. This is so given that, consumers that like information (and therefore consume information from many sources) are captured by media firms, since media firms do not have to compete for them. As such, media firms have less need to provide more content to attract demand (and advertising revenues), which reduces media diversity in media markets.

In this paper, we make two simplifying assumptions. Media firms do not choose location along the content space (they only choose content level); and media firms compete only on advertising, but not on prices. We can think what would happen if media firms also choose location in the content space and compete in prices. As shown by Gabszewicz et al. (2001, 2002) when media firms compete in prices and choose location, price competition is a force for maximum differentiation, while advertising is a force for minimum differentiation. However, as demonstrated by Garcia Pires (2014) if in addition, we also consider multi-content media firms, when minimum differentiation ensues (due for instance to a large advertising market), media firms choose a multi-content strategy. In this way, we can say that introducing price competition would reduce the incentives of media firms to provide a multi-content strategy, since they would be less dependent on advertising revenues. In turn, introducing the choice of location by media firms would only matter with single-homing consumers, because with multi-homing consumers, competition is, as we have shown, reduced.

A Appendix

Single-Homing: Second Order Conditions (SOCs). SOCs for advertising:

$$\begin{aligned} \frac{d^2\Pi_1}{da_1^2} &= -\frac{(t(1-d_2+d_1)-(\lambda b_H+b_L(1-\lambda)))\beta}{(t-(\lambda b_H+b_L(1-\lambda)))} \\ \frac{d^2\Pi_2}{da_2^2} &= -\frac{(t(1+d_2-d_1)-(\lambda b_H+b_L(1-\lambda)))\beta}{(t-(\lambda b_H+b_L(1-\lambda)))}. \end{aligned} \tag{35}$$

We can see that at the symmetric equilibrium $d_1 = d_2$, the SOCs for advertising are always satisfied.

SOCs for content:

$$\frac{d^2\Pi_1}{dd_1^2} = \frac{d^2\Pi_2}{dd_2^2} = -\gamma. \tag{36}$$

The SOCs for content are then always satisfied.

Multi-Homing: Second Order Conditions (SOCs). SOCs for advertising:

$$\begin{aligned} \frac{d^2\Pi_1}{da_1^2} &= -\frac{(t((1+d_1-d_2)+\lambda(1+d_2-d_1))-b_L(1-\lambda)(1+\lambda))\beta}{(t-b_L(1-\lambda))} \\ \frac{d^2\Pi_2}{da_2^2} &= -\frac{(t(1+d_2-d_1)-b_L(1-\lambda))(1-\lambda)\beta}{(t-b_L(1-\lambda))}. \end{aligned} \tag{37}$$

We can see that at the symmetric equilibrium $d_1 = d_2$, the SOCs for advertising are always satisfied.

SOCs for content:

$$\frac{d^2\Pi_1}{dd_1^2} = \frac{d^2\Pi_2}{dd_2^2} = -\gamma. \tag{38}$$

The SOCs for content are then always satisfied.

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An exploratory study of business model design and customer value in heterogeneous network services
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Structural conditions for business model design in new information and communication services – A case study of multi-play and MVolP in Denmark and Norway
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On revenue and welfare dominance of ad valorem taxes in two-sided markets
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Price-dependent profit-shifting as a channel coordination device
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Efficiency enhancing taxation in two-sided markets
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In this paper, we analyze the effects of multi-homing consumers on content provision by media firms. We develop a model where media firms compete on content provision and advertising revenues, and consumers enjoy network effects from consuming content that other consumers also consume. Media firms have to choose if they are single-content or multi-content, and in the latter case how much content to offer. Competition for advertising revenues gives a two-sided market nature to our model, since advertisers prefer media firms with more demand. As such, media firms would like to increase demand to increase advertising revenues. Offering more content increases demand because more consumers can consume their ideal variety without paying transport costs. We show that, relatively to the case with single-homing consumers, media firms provide less content with multi-homing consumers. The reason is that with multi-homing consumers, competition between media firms is weakened. Multi-homing consumers consume from all media firms, and therefore media firms have lower incentives to provide content to attract demand, and advertising revenues. As a result, social welfare tends to be higher under the multi-homing case relatively to the single-homing case, when the advertising market is large, and when the network effects are large relative to the intensity of consumers' preferences.

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