Content provision in the media market with single-homing and multi-homing consumers

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Abstract

In this paper, we analyze the effects on content provision in the news market of single-homing readers (i.e. that consume news from just one outlet) and multi-homing consumers (i.e. that can choose to consume news from competing outlets). Media firms compete on content provision and on advertising revenues. Readers have an ideal variety of content and experience a disutility from consuming news that differs from their ideal variety. In addition, readers have a preference for single-homing and for multi-homing. In this set-up, we show that media firms only diversify content with single-home readers. The reason for this is that competition for readers and advertising is lower under multi-homing than under single-homing, since multi-homing readers consume from all media outlets. We derive the effects of this for profits, consumer surplus and social welfare and discuss the implications for the current debate in the media market related with social media and echo chambers.

Keywords: Social Media; Echo Chambers; Content Provision; Two-Sided Markets; Multi-Homing.

JEL Classification: D43, L13, L82, L86.

1 Introduction

In the last decade, the news media sector has been facing three main trends. First, the migration from print to digital. Second, the rise in importance of social media for the provision of media content. Third, the escalation of divisive politics as shown by "echo chambers"[1].

Regarding the first trend, it is well known that in recent years there has been a large reduction in subscriptions to print newspapers. One of the main reasons

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[1] According to Del Vicario et al. (2016), "echo chambers" refer to the phenomena where media consumers focus on specific narratives and join homogeneous groups that are very polarized in relation to others. In these groups, competitive views are often censored, rejected, or underrepresented.

is that it is now possible to read news online (mostly free) and, as a result, news readership has migrated from print to digital. The main consequence has been a reduction in advertising revenues for media firms, because the increase in online advertising has not yet compensated for the reduction in print advertising. As a result, employment in the media sector has also been in retreat in the last decade, and this has led to a reduction in investigative journalism. In the US for example, according to the Pew Research Center (2016), average weekday newspaper circulation, both print and digital, fell by 7% in 2015. Digital circulation increased by 2%, but accounted for only 22% of total circulation. Furthermore, total advertising revenues declined by 8% in 2015, including both print and digital. Not surprisingly, in 2015 employment at newspapers decreased by 10%. In practical terms, this means that nowadays, newspapers in the US have 20,000 fewer employees than 20 years ago.

According to the Pew Research Center (2016), 62% of US adults access news from social media sites. As a result, social media outlets receive a larger share of advertising revenues in the industry. In fact, despite a 20% growth in total digital advertising spending in 2015 (approximately $60 billion), newspapers have not been the primary beneficiaries. In particular, 65% of digital advertising revenues belong to just five tech companies, such as Facebook, Google, and Twitter. This has important consequences for content provision, because the consumption of news on social media sites has some important differences compared with traditional media. One of the main differences is that in social media, readers care about what news other readers talk about and discuss (Goyal, 2012). For instance, some current political issues can spread very quickly in social media ("informational cascades") because the topics that are more popular are the ones that attract more views. This demonstrates the emergence of network effects in the consumption of news.

In turn, as the last presidential elections in the US has shown (see also Brexit in the UK), political discussions have become more divisive. This, together with social media, has changed the way news is consumed. Many media analysts talk about "echo chambers" in the sense that people in the digital realm consume only news that fits their ideological preferences and biases (Sunstein, 2007; 2016). The empirical evidence confirms the filtering of news on the Internet according to political views (see Wallsten, 2005; Jamieson and Cappella, 2008; Del Vicario et al., 2016; Quattrociocchi et al., 2016). This means that consumers of news have become more single-homing, in the sense that they only consume news from outlets that confirm their views, rather than multi-homing (i.e. readers that access news from different outlets with diverse political leanings).

Importantly, readers are not the only ones to filter news, the algorithms developed by social media websites also promote filtering. The consequence of this has been the creation of "informational cascades" within identified groups of readers (network effects together with echo chambers), focus of readers on their preferred narratives ("confirmation bias"), and the resulting polarization in society, because readers ignore (or wrongly refute and manipulate) relevant information that goes against their preferred views.

In this paper, we analyze the effects of single-homing readers (i.e. that consume news from just one media outlet, ending up in an echo chamber) and multi-homing readers (i.e. that can choose to consume news from competing media outlets) on content provision in the news market.

In order to do this, we develop a model where media firms compete on content and advertising. Readers incur a disutility from consuming content that differs from their ideal type. As such, following Hotelling (1929), we assume that readers pay a transport cost when they do not find their ideal variety in the media market. In addition, like in Kim and Serfes (2006), consumers have a preference for single-homing and a preference for multi-homing[2].

In addition to the above, the model developed in this paper has two more pillars. The first pillar considers a two-sided market, in the sense that media firms derive revenues from advertising and readers suffer a disutility from advertising (see for instance, Rochet and Tirole, 2003; Anderson and Coate, 2005; Esteban et al., 2006; Kind et al., 2007; Peitz and Valletti, 2008; von Ehrlich and Greiner, 2013; and Esteban and Hernández, 2016). Advertisers prefer media firms that have greater demand, because their message reaches a larger audience, and therefore media firms would like to attract more readers in order to increase advertising revenues.

The second pillar takes into account that media firms can choose to follow a single-content or a multi-content strategy, as in Garcia Pires (2013; 2014). With a single-content strategy, media firms only provide one type of content (a point on the Hotelling line). With a multi-content strategy, media firms provide different types of content (a segment on the Hotelling line), and therefore must decide on the diversity of content offered to readers. To illustrate, consider a right-wing newspaper. A single-content strategy would occur if the right-wing newspaper were to cover all political news (from taxation, to migration, to environment) only from a given right-wing political perspective; for example, center-right on all issues from migration to economics. A multi-content strategy would in turn mean that the right-wing newspaper could give different nuances to different political issues. For example, a newspaper can be more to the right on taxation and more to the center on the environment. In contrast, a newspaper even on a single topic, such as migration, can cover many different opinions, some more to the right and others more to the center.

In this setup, we show that under multi-homing media firms do not diversify content. As a result, content provision tends to be higher under single-homing than under multi-homing, especially when the advertisement market is sufficiently large. This might come as a surprise, as we would expect that multi-homing readers would promote content provision, because they increase

[2] Doganoglu and Wright (2006; 2010), in turn, model multi-homing in terms of the size of the market for each media platform. Doganoglu and Wright (2006; 2010) analyze the effects of multi-homing on compatibility and exclusive dealing. Choi (2010) considers the case of multi-homing from the side of content providers on the Internet. Carrillo and Tan (2006) analyze multi-homing from the perspective of consumers and content providers. Anderson et al. (2016) introduce vertical differentiation (quality differences) in the multi-homing choice of consumers.

demand for media firms. The reason for this result is that multi-homing readers reduce competition (for readers and therefore advertising) between media firms, since they consume news from all outlets. As a result, media firms do not need to diversify content to attract readers and advertising. In other words, under multi-homing, media firms have lower incentives to provide content to attract demand, because reducing content does not necessarily reduces readership (and as such advertising revenues).

In terms of profits, consumer surplus and social welfare we have the following. First, profits are always higher under multi-homing than under single-homing. The reason for this is that, as mentioned above, competition for readers and advertisement is fiercer under single-homing than multi-homing.

Second, single-homing tends to be better than multi-homing in terms of consumer and social surplus, when the advertising market is larger, when the disutility of advertising is high, when consumers have a high preference for content diversification, when transport cost are high, and when the costs to produce content is low. The reasons for this are the following. A large advertising market helps to finance content diversification under single-homing, allowing to pay the costs to provide content, and increasing consumer surplus. High disutility of advertising penalizes multi-homing, since consumers are more exposed to advertising under multi-homing than under single-homing. A high preference for content diversification makes readers better off under single-homing, since under single-homing media firms provide more content than under multi-homing. High transport costs makes multi-homing less attractive for readers, since with high transport costs readers show a higher disutility for consuming content that differs from theirs ideal variety. Low costs to produce content is beneficial for the single-homing case, since media firms under single-homing save on the costs to provide content. Such positive effect does not arise under multi-homing, since media firms under multi-homing do not diversify content.

The plan for the rest of the paper is as follows. In the next section, we discuss content provision and multi-homing. In Section 3, we present the base model. In Section 4, we analyze the equilibrium of the model for the single-homing case. In Section 5, we analyze the equilibrium of the model for the multi-homing case. In Section 6, we compare the single-homing and multi-homing case in terms of profits, consumer surplus and social welfare. In section 7, we discuss the main findings.

2 Content Provision and Multi-Homing

In media markets, as noted by Caillaud and Jullien (2003) and Rochet and Tirole (2003), multi-homing consumers (i.e. those who consume from competing media firms) are the norm rather than the exception (for empirical evidence, see Berry and Waldfogel, 2001; Gentzkow et al., 2014). However, the literature in media economics has mostly considered single-homing consumers (i.e. those who only consume from one media firm). The main reason for this is mainly technical, because the preferred workhorse model in media economics, the Hotelling

model (1929), was initially developed for single-homing consumers. Recent contributors, such as Doganoglu and Wright (2006; 2010) and Kim and Serfes (2006), have however allowed the possibility of incorporating multi-homing in the Hotelling model. Building on these new contributions, we analyze the impact that multi-homing readers can have on media firms' incentives to provide diverse content.

The diversity of content provided by media firms is a central concern for media research, media policy, and media regulators. The argument goes that a media market with a diverse provision of content contributes positively to consumer welfare. On the one hand, a diverse media market satisfies consumers' diverse preferences. On the other hand, it supports a well-functioning market economy and democracy, because consumers can become better informed (see Coase, 1974; Hayek, 1945; and Mill, 1859)[3].

The diversity of content in a media market is then a central question in media economics, and this is in particular the case for media competition on the Internet (see Peitz and Reisinger, 2014)[4]. However, to the best of our knowledge, the media literature has only looked at media diversity in the context of single-content media firms. When media firms are only single-content, the question that arises is if the media market will offer minimum differentiation (just one type of content by two competing media firms) or maximum differentiation (two types of content, one for each media duopolist). For 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 of multi-content media firms. Garcia Pires (2013; 2014) shows that the interaction of multi-content media firms with two-sided markets carries some new implications for content provision that are not present when only single-content media firms are modeled. In particular, offering more content increases demand because more readers can consume their ideal variety of content without incurring transport costs. As a result, media firms can also attract more advertising revenues. The drawbacks for media firms of providing more content are that it increases competition (because of tougher competition for the indifferent reader) and costs (because producing content is costly). As such, in a two-sided market, the question is not only about minimum *versus* maximum differentiation, but also about the diversity of content offered by each media firm. Garcia Pires (2013; 2014), however, analyzes only content provision in the context of single-homing consumers.

[3] The media diversity literature is in this sense related to the literature on media bias. Media bias refers to the bias of the press in the selection of which events are reported and how they are covered (see for instance Mullainathan and Shleifer, 2005; Anand et al., 2007; Yildirim, et al., 2013). Therefore, more media content can reduce media bias, but this is not always the case. For empirical evidence on these issues, see for instance Eisensee and Strömberg (2007), Prat and Strömberg (2005; 2011), Rothbauer and Sieg (2013), Snyder and Strömberg (2010), and Strömberg (2001; 2004a; 2004b; 2007; 2008).

[4] The decisions that media outlets must make in relation to content provision go beyond the amount of content to provide to the media market. These decisions also include, for instance, the design of news products or the number of news stories covered. On these issues, see for instance, Xiang and Soberman (2014).

The empirical evidence from journalistic studies supports the view that news firms follow a multi-content strategy, rather than a single-content strategy (see for example, Gans, 1999; Gitlin, 1999; O'Neill and Harcup, 2009; and Coleman et al., 2009). Note, however, that this is done within the limits of the political area that the news outlets defend (Gans, 1999). In other words, left-leaning newspapers often adapt political news to the center, but rarely cross to the right-wing political side.

Newspapers provide multi-content for several reasons. First, by adapting news to readers' political preferences, newspapers can satisfy a larger share of the audience (Gans, 1999). Second, readers' political opinions can change and therefore newspapers need to adapt to them (Gitlin, 1999). Third, newspapers have incomplete information about readers' political preferences, which means that covering different political leanings, rather than just a limited one, is usually a good business strategy (O'Neill and Harcup, 2009). Fourth, newspapers try to set a political agenda in the public arena, and in order to achieve this, they publish different articles about a topic to arouse discussion, usually giving different (but close) political leanings to different articles (Coleman et al., 2009). A multi-content strategy is particularly evident in online editions of newspapers. For instance, for important topics it is very common to find folders that contain many articles, usually with different views, perspectives, and political leanings on the given topic.

3 The Model

The model has four pillars: Hotelling (1929) preferences, advertising competition (as in Anderson and Coate, 2005; Peitz and Valletti, 2008), multi-content media firms (as in Garcia Pires, 2013; 2014) and multi-homing consumers (as in Kim and Serfes, 2006).

The media sector consists of two media firms, media firm 1 and media firm 2. Media firms compete on advertising revenues and the diversity of content provided. Readers are uniformly distributed on a line of length one, $[0, 1]$, and they have heterogeneous preferences in the Hotelling manner. In other words, each reader has an ideal content variety and readers incur a disutility (transport costs) in consuming content that differs from their ideal one. The line represents readers' preferences, and we normalize the mass of readers to one. Media firm 1 is located at point 0 and media firm 2 is located at point 1 on the Hotelling line[5].

We analyze two cases in what relates to readers: (1) single-homing; and (2) multi-homing. In the single-homing case, readers can only choose to consume from one media firm, media firm 1 or media firm 2. In the multi-homing case, readers can (endogenously) choose to consume from just one media firm (media

[5] 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 addition, with endogenous location we would need to introduce price competition, which is not central in the market for news online.

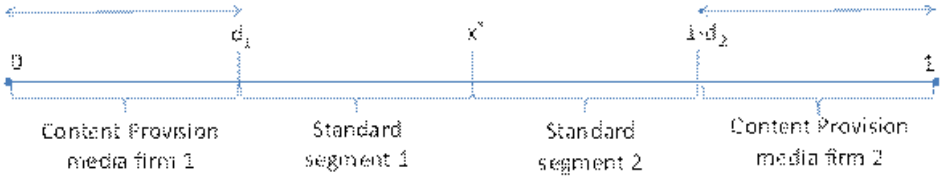

Figure 1: News Content Provision: Single-Homing

firm 1 or media firm 2), or from both media firms.

We follow the formalization of Kim and Serfes (2006) in what refers to multi-homing. In this formalization, consumers have a preference for single-homing and for multi-homing. If the preference for multi-homing is larger than the preference for single-homing, this can be interpreted in two ways. First, it might be that readers like to access different sources of information with diverse points of view. This can be thought as information effects, because it indicates how open readers are to content that differs from their ideal content. Second, readers might enjoy interacting with the maximum amount of readers in the media market, which is facilitated by accessing content from different sources, i.e. with multi-homing. This can be thought as network effects, similar to what occurs in social media (for evidence, see Sismeiro and Mahmood, 2018). If readers have a stronger preference for single-homing relatively to multi-homing, this might arise because readers dislike to be exposed to content that differs from their ideal variety, similar to what occurs with echo chambers.

Content Provision Regarding 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 being located at just one point on the line (single-content strategy). Instead, as 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 $0 \leq d_i \leq 1$. Figure 1 shows an example of a media market where media firms are multi-content and readers are single-homing, with x^* representing the indifferent reader. Figure 2 shows an example of a media market where media firms are multi-content and some readers are multi-homing, with x_L and x_R representing the indifferent readers (note that, Figure 1 and Figure 2 do not necessarily represent the equilibrium of the model). Below we explain in more detail why the single-homing case has one indifferent consumer, and the multi-homing case has two indifferent consumers.

When deciding between the single-content strategy (a point on the line) and the multi-content strategy (a line segment), a media firm weighs the pros and cons of these two strategies. The benefits of a multi-content strategy ensue from an increase in demand, given that readers face lower transport costs, i.e. readers inside the content provision segment of the media firm do not incur transport costs in order to consume their ideal content, while readers outside the content

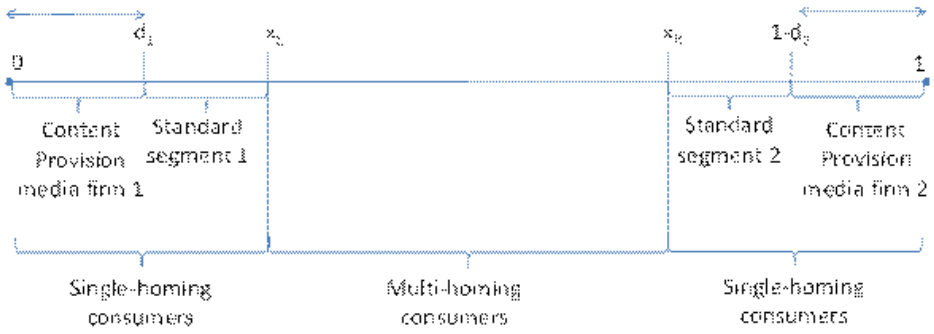

Figure 2: News Content Provision: Multi-Homing

provision segment of a given media firm face lower transport costs. In turn, the drawbacks of a multi-content strategy accrue on the one hand from increased competition (i.e. tougher competition for the indifferent reader) and, on the other hand from higher costs (i.e. costs increase with the amount of content supplied to the market). The costs of providing content, as in Alexandrov (2008) and Dewan et al. (2003), equal:

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

where γ is a parameter that captures the technological costs of following a multi-content strategy. In this way, to model multi-content media firms, we follow the approach of Alexandrov (2008) to "fat products." With fat products, a firm offers just one product that contains a set of characteristics that consumers can select at no extra cost. An example of a fat product is a software program for which consumers can choose between different applications. In other words, fat products are access products: when consumers access a given product, they can choose what is on offer "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 readers can decide what to consume from this set of content offerings[6].

Next, we present some examples of a multi-content strategy using the case of political content. A right-oriented media outlet is said to follow a multi-

[6]Dewan et al. (2003) have a similar setup 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. To acquire a customized product, consumers have to pay a price above 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 market for news on the Internet, it seems more appropriate to think in terms of fat products rather than product customization, because price discrimination, despite some attempts, is not the standard business practice in the industry.

content strategy when, for instance, it is inclined more to the right with respect to taxation and more to the center with respect to competition policy. Another possibility is that a media firm can give voice to different (although similar) political opinions about taxation policy (or any other policy, such as climate change). This occurs frequently in newspapers, in particular, opinion columns, editorials, and important news issues such as elections, political reforms, and political scandals. As argued in the previous section, journalistic studies confirm that media firms usually follow a multi-content strategy (see Gans, 1999; Gitlin, 1999; O'Neill and Harcup, 2009; and Coleman et al., 2009).

In addition, the journalistic studies literature also shows that media firms tend to adapt news only near their core political area (i.e. right-wing newspapers may cover issues closer to the center, but usually not to the left). Consequently, media firms can only follow a multi-content strategy that is contiguous to their location on the line (i.e. for media firm 1, the multi-content choice is contiguous to point 0; for media firm 2, the multi-content choice is contiguous to point 1). One economic reason for this to occur is diseconomies of scope. In terms of the model, this means that when providing content continuously along the line, a media firm, only needs to incur the costs expressed in equation 1. However, if a media firm provides content discontinuously along the line, it will incur extra sunk costs for each new location and for each associated multi-content segment. The sunk costs might be seen as prohibitive[7]. In fact, we can show that in the context of our model (i.e. even without sunk costs), media firms never choose a discontinuous line segment in equilibrium, because this strategy increases advertising competition (relative to the continuous case) and therefore, reduces revenues.

Advertising Market We now look at advertising. We assume that media firms derive all their revenues from advertising[8]. As in Anderson and Coate (2005), and Peitz and Valletti (2008), the demand for advertisements for media firm i is:

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

where r_i is the price of advertising per reader, 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*[9].

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

[8] As already mentioned, we focus on advertising competition and ignore price competition, because competition in the online news media market has been so far more about the first than the latter. On the importance of advertising revenues on content provision, see Sun and Zhu (2013).

[9] In this way, the formalization of the advertising market is relatively simple. First, we do not introduce target advertising (see Esteves and Resende, 2016). Second, we do not consider the effects of multi-homing in advertising, given that advertisers only care about the demand

Gross advertising income is then:

$$A_i = \left(\left(\alpha - \beta a_i\right) a_i\right) N_i,\ i = 1, 2, \tag{3}$$

where N_i is the number of readers of media firm i. With advertising, the model then becomes a two-sided market model. This is because advertisers prefer to buy advertisements in media firms that attract a bigger audience (N_i), and media firms would like to increase their audience in order to generate more advertising revenues (A_i).

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

$$\Pi_i = A_i - C_i,\ i = 1, 2. \tag{4}$$

Single-homing versus multi-homing In the single-homing case, readers only consume news from one media outlet. The utility of a reader who only consumes from media firm 1 and is located outside the multi-content segment of media firm 1, is:

$$U_S = V_S - t\left(x - d_1\right) - \eta a_1, \tag{5}$$

where V_S is the intrinsic value of consuming content from just media firm i (single-homing), t the intensity of readers' preferences for a type of content (transport costs), d_1 the amount of content supplied by media firm 1, η the disutility of advertising, and a_1 the advertising volume of media firm 1.

We assume that V_S is sufficiently high so that the media market is covered (i.e. all readers consume content from at least one media firm). Similarly, when a reader only consumes from media firm 2 (and is located outside the multi-content segment of media firm 2), $U_S = V_S - t\left(1 - x - d_2\right) - \eta a_2$. Furthermore, if a reader is located inside the multi-content segment of a media firm, his utility simplifies to $U_S = V_S - \eta a_i$ (with $i = 1, 2$), because he does not need to incur transport costs to consume his preferred variety of content[10].

In the multi-homing case, a reader can (endogenously) choose to consume news from just one media outlet, or from both media outlets. The utility of a

of each newspaper (see Reisinger et al., 2009; Athey et al., 2018; Ambrus et al., 2016). Target advertising would force us to introduce consumers with different preferences for advertisers' products. This would make a difference if firms could price discriminate between consumers. However, as we have already argued above, price discrimination is not widespread in the online news media market. Introducing duplication of advertisement efforts would reduce the size of the ad market and, as we will see below, would make the single-homing case less profitable for media firms.

[10] We are therefore assuming that a reader inside the multi-content segment of a media firm does not pay transport costs even if he consumes news that differs from his ideal variety. Note that this is an innocuous simplification. We could build a more complex version where the disutility of a reader would equal the sum of the distance to all the different points in the multi-content segment. In this case, it can be easily seen that a reader inside the multi-content segment would still incur lower transport costs than a reader outside it. The idea that we want to capture is then that readers inside the multi-content segment face lower transport costs than readers outside it.

reader, located outside the multi-content segments of the two media firms and who consumes from both media firms is:

$$U_M = V_M - t\left((x - d_1) - (1 - x - d_2)\right) - \eta\left(a_1 + a_2\right), \tag{6}$$

where V_M is the intrinsic value of consuming from both firms (multi-homing). In Kim and Serfes (2006) $V_M > V_S$, since in there consumers like to multi-home. This case could be equivalent to having information effects, where consumers like to be informed about different views. Another interpretation is that when $V_M > V_S$ consumers have a strong preference for network effects, i.e. utility increases with the number of consumers one can interact, like in social media. In turn, if $V_M < V_S$, readers have a stronger preference for single-homing over multi-homing. This case could then capture the effect of echo chambers, where consumers dislike to be exposed to opposing views.

Again, if a reader is located inside the multi-content segment of a media firm, his utility simplifies to $U_M = V_M$, given that he does not need to incur transport costs to consume his preferred variety of content. A reader then faces the following trade-off. If he chooses single-homing, he incurs lower transport costs than with multi-homing, because he only pays transport costs once to access one media outlet, not twice to access two media outlets ($-t\left(x - d_1\right)$ *versus* $-t\left(x - d_1\right) - t\left(1 - x - d_2\right)$). He can however have lower network and information effects, because he can only interact with readers from one media outlet instead of two media outlets (V_S *versus* V_M).

In this way, under single-homing, the indifferent reader, $\hat{x}$, equals:

$$V_S - t\left(\hat{x} - d_1\right) - \eta a_1 = V_S - t\left(1 - \left(\hat{x} + d_2\right)\right) - \eta a_2. \tag{7}$$

With multi-homing, in turn, there are two indifferent readers. The first indifferent reader, x_L, is indifferent between consuming from media firm 1 only or consuming from both media firms (media firm 1 and media firm 2). The second indifferent reader, x_R, is indifferent between consuming from media firm 2 only or consuming from both media firms. The first indifferent reader, x_L, equals:

$$V_S - t\left(x_L - d_1\right) - \eta a_1 = V_M - t\left(\left(x_L - d_1\right) - \left(1 - \left(x_L + d_2\right)\right)\right) - \eta\left(a_1 + a_2\right). \tag{8}$$

Then for the second indifferent reader, x_R equals:

$$V_S - t\left(1 - \left(x_R + d_2\right)\right) - \eta a_2 = V_M - t\left(\left(x_R - d_1\right) + \left(1 - \left(x_R + d_2\right)\right)\right) - \eta\left(a_1 + a_2\right). \tag{9}$$

If $x_L = x_R$, we fall back into the single-homing case. Then multi-homing only arises if $x_L \neq x_R$.

Consumer surplus under single-homing equals:

$$CS = V_S - \eta a_1 \hat{x} - t\int_{d_1}^{\hat{x}} \left(x - d_1\right) dx - t\int_{\hat{x}}^{1-d_2} \left(1 - \left(x + d_2\right)\right) dx - \eta a_2 \left(1 - \hat{x}\right), \tag{10}$$

Consumer surplus under multi-homing equals:

$$CS = \int_0^{x_L} (V_S - \eta a_1)\, dx + \int_{x_L}^{x_R} (V_M - \eta (a_1 + a_2))\, dx + \int_{x_R}^{1} (V_S - \eta a_2)\, dx$$
$$-t\int_{d_1}^{x_L} (x - d_1)\, dx - t\int_{x_R}^{1-d_2} (1 - (x + d_2))\, dx$$
$$-t\int_{x_L}^{x_R} ((x - d_1) + (1 - (x + d_2)))\, dx. \quad (11)$$

Social Welfare Social welfare is measure in the standard way, where it equals, in both the single-homing and multi-homing case, the sum of profits and consumer surplus:

$$W = \Pi_1 + \Pi_2 + CS. \quad (12)$$

4 Equilibrium of the Model: Single-Homing

We start by looking at the single-homing case. In the next section, we analyze the multi-homing case. Afterwards, we compare the two cases, single-homing and multi-homing, in terms of profits, consumer surplus, and social welfare.

As usual, we solve the model by backward induction. We start with the indifferent reader, then advertising levels and then content provision.

Indifferent Reader It is straightforward to check that for the indifferent reader in the single-homing scenario, we have:

$$\hat{x} = \frac{t(d_1 - d_2 + 1) - \eta(a_1 - a_2)}{2t}. \quad (13)$$

Advertising It can be shown that the FOCs in relation to advertising (a_i with $i = 1, 2$) are:

$$\frac{d\Pi_i}{da_i} = \frac{t(d_i - d_j + 1)(\alpha - 2\beta a_i) + \beta\eta a_i(3a_i - 2a_j) - \alpha\eta(2a_i - a_j)}{2t},\ i, j = 1, 2 \text{ with } i \neq j. \quad (14)$$

The SOCs for advertising are in appendix.

Solving $\frac{d\Pi_1}{da_1}$ and $\frac{d\Pi_2}{da_2}$ from equation 14 for a_1 and a_2, we obtain:

$$a_i = \frac{t(d_i - d_j + 3)}{3\eta},\ i, j = 1, 2 \text{ with } i \neq j. \quad (15)$$

Content We next find the content provision levels of the two media firms under single-homing. We can show that the FOCs for content provision are:

$$\frac{d\Pi_i}{dd_i} = -\frac{t(d_i - d_j + 3)(t\beta(d_i - d_j + 3) - 2\alpha\eta) + 18\gamma\eta^2 d_i}{18\eta^2},\ i, j = 1, 2 \text{ with } i \neq j. \quad (16)$$

The SOCs for content are in appendix.

Solving $\frac{d\Pi_1}{dd_1}$ and $\frac{d\Pi_2}{dd_2}$ from equation 16 for d_1 and d_2, we obtain:

$$d_i = \frac{t(2\alpha\eta - 3t\beta)}{6\gamma\eta^2} > 0,\ i, j = 1, 2. \tag{17}$$

The following proposition can then be stated.

Proposition 1 *In a media market, where consumers are single-homing, media firms diversify content ($d_1 = d_2 > 0$) if the advertising market is sufficiently large, i.e. if $\alpha > \frac{3t\beta}{2\eta}$. Otherwise, if $\alpha < \frac{3t\beta}{2\eta}$, media firms do not diversify content ($d_1 = d_2 = 0$).*

We then have two cases: 1) If $\alpha > \frac{3t\beta}{2\eta}$, media firms diversify content; 2) $\alpha < \frac{3t\beta}{2\eta}$, media firms diversify content.

If media firms diversify content (if $\alpha > \frac{3t\beta}{2\eta}$), content provision behaves in the following way:

$$\begin{aligned}
\frac{\delta d_i}{\delta \alpha} &= \frac{t}{3\gamma\eta} > 0 \\
\frac{\delta d_i}{\delta \beta} &= -\frac{t^2}{2\gamma\eta^2} < 0 \\
\frac{\delta d_i}{\delta \gamma} &= -\frac{t(2\alpha\eta - 3t\beta)}{6\gamma^2\eta^2} < 0 \\
\frac{\delta d_i}{\delta t} &= \frac{(\alpha\eta - 3t\beta)}{3\gamma\eta^2} > 0 \\
\frac{\delta d_i}{\delta \eta} &= -\frac{t(\alpha\eta - 3t\beta)}{3\gamma\eta^3} < 0,\ i, j = 1, 2 \text{ and } \alpha > \frac{3t\beta}{2\eta}.
\end{aligned} \tag{18}$$

The following proposition can then be stated.

Proposition 2 *In a media market, where consumers are single-homing and firms diversify content, content provision increases with the size of the advertising market (high α and low β) and with transport costs (t), and decreases with the costs of providing content (high γ) and the disutility of advertising (high η).*

The rationale for this is the following. A large advertising market makes it possible to finance more content. Large transport costs makes it more attractive for media firms to develop content to not loose readers to rivals. High cost to produce content makes it less profitable to provide content. Large disutility of advertising reduces the size of the advertising market, decreasing therefore the revenues to finance content.

Having d_1 and d_2, we can find advertising levels. We can easily see that advertising levels are the same irrespective of media firms diversify content or not, i.e. whether $\alpha > \frac{3t\beta}{2\eta}$ or $\alpha < \frac{3t\beta}{2\eta}$. In particular, we have:

$$a_i = \frac{t}{\eta},\ i, j = 1, 2. \tag{19}$$

As a result:

$$\begin{aligned} \frac{\delta a_i}{\delta t} &= \frac{1}{\eta} > 0 \\ \frac{\delta a_i}{\delta \eta} &= -\frac{t}{\eta^2} < 0,\ i,j = 1,2. \end{aligned} \tag{20}$$

The following proposition can then be stated.

Proposition 3 *In a media market, where consumers are single-homing, advertising increases with transport costs (high t) and decrease with the disutility of advertising (high η).*

The reason for this is the following. When consumers dislike advertising, the advertising market is smaller. When transport costs are high (i.e. consumers have a strong preference for their preferred variety), advertising increases since it is less likely that a consumer changes to the rival because of the nuisance of advertising.

5 Equilibrium of the Model: Multi-Homing

We turn now to the multi-homing scenario. As in the previous section, we solve the model by backward induction. We start with the indifferent reader, then advertising levels and then content provision.

Indifferent Reader As mentioned above, while in the single-homing scenario there is just one indifferent reader, in the multi-homing scenario, there are two indifferent readers. We can show that in the multi-homing case, the first indifferent reader, x_L, is:

$$x_L = \frac{t(1-d_2)-(V_M-V_S)+\eta a_2}{t}. \tag{21}$$

The second indifferent reader, x_R, is:

$$x_R = \frac{td_1+(V_M-V_S)-\eta a_1}{t}. \tag{22}$$

As mentiones above, in order for multi-homing to arise in equilibrium, we need that $x_L \neq x_R$. If $x_L = x_R$, we fall back to the single-homing case. In particular, for multi-homing to emerge, we have to have $x_R - x_L > 0$. This is so if:

$$\begin{aligned} x_R - x_L &= \frac{2(V_M-V_S)-t(1-d_1-d_2)-\eta(a_1+a_2)}{t} > 0 \\ &\Leftrightarrow \quad (V_M - V_S) > \frac{t(1-d_1-d_2)+\eta(a_1+a_2)}{2}. \end{aligned} \tag{23}$$

Since $\frac{t(1-d_1-d_2)+\eta(a_1+a_2)}{2} > 0$, then if $V_M - V_S < 0$, multi-homing never arises in equilibrium. $V_M < V_S$ can take place, as we have argued above, when

readers dislike different views from their own, as in echo chambers. Only for $V_M > V_S$ multi-homing can arise. $V_M > V_S$ can occur, as we have defended above, when readers like information (information effects) or enjoy to have network effects of being connected with many readers as possible, like in social media. Since we want to compare single-homing with multi-homing, in the following we focus in the case where $V_M > V_S$.

We can see that multi-homing is more likely to arise, i.e. equation 23 is more easily satisfied, the lower are the transport costs (t), the lower is the disutility from advertising (η), the lower are the advertising levels in the market ($a_1 + a_2$), and the higher is diversity of content provided in the market ($1 - d_1 - d_2$). The reasons for this are the following. With high transport costs, readers have a strong preference for their ideal variety, and therefore they dislike more to multi-home. With high disutility of advertising, readers dislike more multi-homing, since under multi-homing they are exposed to more advertising (i.e. they get advertising from both media outlets). With high levels of advertising, readers suffer higher disutility under multi-homing since, as just mentioned, they are exposed to advertising from both media outlets. A high diversity of content increases the attractiveness of multi-homing, since readers access more content.

Advertising It can be shown that the FOCs in relation to advertising (a_i with $i = 1, 2$) are:

$$\frac{d\Pi_i}{da_i} = \frac{((V_M - V_S) + td_i)(\alpha - 2\beta a_i) - \eta a_i(2\alpha - 3\beta a_i)}{t},\ i, j = 1, 2. \tag{24}$$

The SOCs for advertising are in appendix.
Solving $\frac{d\Pi_1}{da_1}$ and $\frac{d\Pi_2}{da_2}$ from equation 24 for a_1 and a_2, we obtain:

$$a_i = \frac{\alpha(V_M - V_S) + t\alpha d_i}{2((\alpha\eta + t\beta d_i) + \beta(V_M - V_S))},\ i, j = 1, 2. \tag{25}$$

Content We next find the content provision levels of the two media firms under multi-homing. We can show that the FOCs for content provision are:

$$\frac{d\Pi_i}{dd_i} = -\gamma d_i + \alpha^2 (V_M - V_S + td_i)$$
$$\left(\begin{array}{c} \frac{\left(4\alpha^3\eta^3 + \beta(V_M - V_S)\left(13\alpha^2\eta^2 + 2\beta(V_M - V_S)(4\alpha\eta + \beta(V_M - V_S))\right)\right)}{8(\alpha\eta + \beta(V_M - V_S) + t\beta d_i)^4} \\ + \frac{\left(t\beta d_i\left(13\alpha^2\eta^2 + 2t\beta d_i(4\alpha\eta + t\beta d_i) + 2\beta(V_M - V_S)(8\alpha\eta + 3\beta(V_M - V_S) + 3t\beta d_i)\right)\right)}{8(\alpha\eta + \beta(V_M - V_S) + t\beta d_i)^4} \end{array} \right),$$
$$i, j = 1, 2. \tag{26}$$

The SOCs for content are in appendix.
Solving $\frac{d\Pi_1}{dd_1}$ and $\frac{d\Pi_2}{dd_2}$ from equation 26 for d_1 and d_2, we obtain:

$$d_i = -\frac{(\alpha\eta + \beta(V_M - V_S))}{t\beta} < 0,\ i, j = 1, 2. \tag{27}$$

The following proposition can then be stated.

Proposition 4 *In a media market with the presence of multi-homing readers, media firms do not diversify content.*

The reason for this is that multi-homing readers reduce competition between media firms, given that they consume from all media outlets. Therefore, media firms do not have to compete to capture multi-homing readers. As a result, given that less content does not reduce demand, media firms can offer less content without jeopardizing advertising revenues (and therefore profits).

As a result, the advertising levels equal:

$$a_i = \frac{\alpha(V_M - V_S)}{2(\alpha\eta + \beta(V_M - V_S))},\ i, j = 1, 2. \tag{28}$$

We can see that:

$$\begin{aligned}
\frac{\delta a_i}{\delta V_M} &= \frac{\eta\alpha^2}{2(\alpha\eta+\beta(V_M-V_S))^2} > 0 \\
\frac{\delta a_i}{\delta V_S} &= -\frac{\eta\alpha^2}{2(\alpha\eta+\beta(V_M-V_S))^2} < 0 \\
\frac{\delta a_i}{\delta \alpha} &= \frac{(V_M-V_S)^2\beta}{2(\alpha\eta+\beta(V_M-V_S))^2} > 0 \\
\frac{\delta a_i}{\delta \beta} &= -\frac{(V_M-V_S)^2\alpha}{2(\alpha\eta+\beta(V_M-V_S))^2} < 0 \\
\frac{\delta a_i}{\delta \delta} &= -\frac{(V_M-V_S)\alpha^2}{2(\alpha\eta+\beta(V_M-V_S))^2} < 0,\ i, j = 1, 2.
\end{aligned} \tag{29}$$

The following proposition can then be stated.

Proposition 5 *In a media market with the presence of multi-homing readers, advertising increases with the preference for multi-homing (large $V_M - V_S$), and with the size of the advertising market (large α and small β), and decreases with the disutility of advertising (δ).*

The reasons are the following. When the preference for multi-homing is large, more consumers multi-home and therefore advertising can cater to a large audience. When the advertising market is large, the market for advertising can sustain more advertising. When the disutility form advertising is large, the advertising market is smaller, reducing therefore advertising levels.

6 Profits, Consumer Surplus, and Social Welfare

In this subsection, we examine profits, consumer surplus, and social welfare. We start with the single-homing scenario, thereafter the multi-homing scenario, and then we compare the two.

Single-Homing In the single-homing case, there are two scenarios: 1) for $\alpha > \frac{3t\beta}{2\delta}$, $d_i > 0$, $i, j = 1, 2$; 2) for $\alpha < \frac{3t\beta}{2\delta}$, $d_i = 0$, $i, j = 1, 2$. Start with $\alpha < \frac{3t\beta}{2\delta}$. In this scenario, profits equal:

$$\Pi^{SH} = \tfrac{(\alpha\delta - t\beta)t}{\delta^2}, \text{ if } \alpha < \tfrac{3t\beta}{2\delta},$$

where $\Pi_1^{SH} = \Pi_1^{SH} + \Pi_2^{SH}$, where SH stands for single-homing.
Consumer surplus equal:

$$CS^{SH} = V_S - \tfrac{5t}{4}, \text{ if } \alpha < \tfrac{3t\beta}{2\delta}.$$

Social welfare then is:

$$W^{SH} = V_S + \tfrac{(\delta(4\alpha - 5\delta) - 4t\beta)t}{4\delta^2}, \text{ if } \alpha < \tfrac{3t\beta}{2\delta}.$$

Look now at the case with $\alpha > \frac{3t\beta}{2\delta}$. In this case, profits equal:

$$\Pi^{SH} = \tfrac{\left(4\delta^2\alpha(9\gamma\delta - t\alpha) - 3\beta t\left(3t^2\beta + 4\delta(3\gamma\delta - t\alpha)\right)\right)t}{36\delta^4\gamma}, \text{ if } \alpha > \tfrac{3t\beta}{2\delta}. \tag{30}$$

With respect to consumer surplus, we have:

$$CS^{SH} = V_S - \tfrac{3\beta t^2\left(t(3t\beta - 4\alpha\delta) + 6\gamma\delta^2\right) + \delta^2\left(4\alpha t(t\alpha - 3\gamma\delta) + 45\gamma^2\delta^2\right)}{36\delta^4\gamma^2}, \text{ if } \alpha > \tfrac{3t\beta}{2\delta}. \tag{31}$$

In terms of social welfare, we have:

$$W^{SH} = V_S + \tfrac{\delta^2\left(4\alpha t(3\delta\gamma(3\gamma+1) - \alpha t(\gamma+1)) - 45\gamma^2\delta^2\right) - 3\beta t^2\left(3\beta t^2(\gamma+1) + 2\delta(3\delta\gamma(2\gamma+1) - 2\alpha t(\gamma+1))\right)}{36\delta^4\gamma^2}, \text{ if } \alpha > \tfrac{3t\beta}{2\delta}. \tag{32}$$

Multi-Homing In the multi-homing scenario, profits equal:

$$\Pi^{MH} = \tfrac{(2\beta(V_M - V_S) + \alpha\delta)(\beta(V_M - V_S) + 2\alpha\delta)(V_M - V_S)^2\alpha^2}{4((\beta(V_M - V_S) + \alpha\delta))^3 t}, \tag{33}$$

where $\Pi_1^{MH} = \Pi_1^{MH} + \Pi_2^{MH}$, where MH stands for multi-homing.
Consumer surplus, in turn, equals:

$$CS^{MH} = \tfrac{(V_M - V_S)^2(2\beta(V_M - V_S) + \alpha\delta)^2 - 2t(V_M - 2V_S)(\alpha\delta + \beta(V_M - V_S))^2}{2(\beta(V_M - V_S) + \alpha\delta)^2 t} - \tfrac{(\alpha\delta + 2\beta(V_M - V_S))^3(V_M - V_S)^3}{12(\beta(V_M - V_S) + \alpha\delta)^3 t^2}. \tag{34}$$

Social welfare in the multi-homing scenario is then:

$$W^{MH} = \tfrac{(V_M - V_S)^2(2\beta(V_M - V_S) + \alpha\delta)^2 - 2t(V_M - 2V_S)(\alpha\delta + \beta(V_M - V_S))^2}{2(\beta(V_M - V_S) + \alpha\delta)^2 t} + \tfrac{\left(\delta\alpha^2(6t\alpha - \delta(V_M - V_S)) - \beta(V_M - V_S)\left(4(V_M - V_S)(\beta(V_M - V_S) + \alpha\delta) - 3t\alpha^2\right)\right)}{12(\beta(V_M - V_S) + \alpha\delta)^3 t^2 (2\beta(V_M - V_S) + \alpha\delta)^{-1}(V_M - V_S)^{-2}}. \tag{35}$$

Single-Homing versus Multi-Homing We now compare the single-homing and the multi-homing cases in terms of profits, consumer surplus, and social welfare. Since in the single-homing case, we have two scenarios, with $\alpha < \frac{3t\beta}{2\delta}$ (media firms do not diversify content) and with $\alpha > \frac{3t\beta}{2\delta}$ (media firms diversify content), we need also to compare the single-homing and the multi-homing cases under these two scenarios.

Start with the scenario where $\alpha < \frac{3t\beta}{2\delta}$. In this case, media firms do not diversify content in both the single-homing and the multi-homing cases. The difference in profits between the single-homing case and the multi-homing case is:

$$\Pi^{SH} - \Pi^{MH} = \frac{(\alpha\delta - t\beta)t}{\delta^2} - \frac{(2\beta(V_M - V_S) + \alpha\delta)(\beta(V_M - V_S) + 2\alpha\delta)(V_M - V_S)^2\alpha^2}{4((\beta(V_M - V_S) + \alpha\delta))^3 t}, \text{ if } \alpha < \frac{3t\beta}{2\delta}. \tag{36}$$

The difference in consumer surplus between the single-homing case and the multi-homing case is:

$$CS^{SH} - CS^{MH} = V_S - \frac{5t}{4} - \frac{(V_M - V_S)^2(2\beta(V_M - V_S) + \alpha\delta)^2 - 2t(V_M - 2V_S)(\alpha\delta + \beta(V_M - V_S))^2}{2(\beta(V_M - V_S) + \alpha\delta)^2 t} + \frac{(\alpha\delta + 2\beta(V_M - V_S))^3(V_M - V_S)^3}{12(\beta(V_M - V_S) + \alpha\delta)^3 t^2}, \text{ if } \alpha < \frac{3t\beta}{2\delta}. \tag{37}$$

The difference in social welfare between the single-homing case and the multi-homing case is:

$$W^{SH} - W^{MH} = V_S + \frac{(\delta(4\alpha - 5\delta) - 4t\beta)t}{4\delta^2} - \frac{(V_M - V_S)^2(2\beta(V_M - V_S) + \alpha\delta)^2 - 2t(V_M - 2V_S)(\alpha\delta + \beta(V_M - V_S))^2}{2(\beta(V_M - V_S) + \alpha\delta)^2 t} - \frac{\left(\delta\alpha^2(6t\alpha - \delta(V_M - V_S)) - \beta(V_M - V_S)\left(4(V_M - V_S)(\beta(V_M - V_S) + \alpha\delta) - 3t\alpha^2\right)\right)}{12(\beta(V_M - V_S) + \alpha\delta)^3 t^2 (2\beta(V_M - V_S) + \alpha\delta)^{-1}(V_M - V_S)^{-2}}, \text{ if } \alpha < \frac{3t\beta}{2\delta}. \tag{38}$$

Turn now to the case with $\alpha > \frac{3t\beta}{2\delta}$. In this case, media firms diversify content in the single-homing case, but not diversify content in the multi-homing case. The difference between profits in the single-homing and the multi-homing scenario equals:

$$\Pi^{SH} - \Pi^{MH} = \frac{\left(4\delta^2\alpha(9\gamma\delta - t\alpha) - 3\beta t\left(3t^2\beta + 4\delta(3\gamma\delta - t\alpha)\right)\right)t}{36\delta^4\gamma} - \frac{(2\beta(V_M - V_S) + \alpha\delta)(\beta(V_M - V_S) + 2\alpha\delta)(V_M - V_S)^2\alpha^2}{4((\beta(V_M - V_S) + \alpha\delta))^3 t}, \text{ if } \alpha > \frac{3t\beta}{2\delta}. \tag{39}$$

We turn now to consumer surplus. The difference in consumer surplus between the single-homing and the multi-homing scenario is:

$$CS^{SH} - CS^{MH} = V_S - \frac{3\beta t^2\left(t(3t\beta-4\alpha\delta)+6\gamma\delta^2\right)+\delta^2\left(4\alpha t(t\alpha-3\gamma\delta)+45\gamma^2\delta^2\right)}{36\delta^4\gamma^2}$$
$$-\frac{(V_M-V_S)^2(2\beta(V_M-V_S)+\alpha\delta)^2-2t(V_M-2V_S)(\alpha\delta+\beta(V_M-V_S))^2}{2(\beta(V_M-V_S)+\alpha\delta)^2t}$$
$$+\frac{(\alpha\delta+2\beta(V_M-V_S))^3(V_M-V_S)^3}{12(\beta(V_M-V_S)+\alpha\delta)^3t^2}, \text{ if } \alpha > \frac{3t\beta}{2\delta}. \quad (40)$$

With respect to social welfare, we have:

$$W^{SH} - W^{MH} = V_S$$
$$+\frac{3\beta t^2\left(t(4\alpha\delta-3t\beta)(\gamma+1)-6\delta^2\gamma(2\gamma+1)\right)+\delta^2\left(4\alpha t(3\delta\gamma(3\gamma+1)-\alpha t(\gamma+1))-45\gamma^2\delta^2\right)}{36\delta^4\gamma^2}$$
$$-\frac{(V_M-V_S)^2(2\beta(V_M-V_S)+\alpha\delta)^2-2t(V_M-2V_S)(\alpha\delta+\beta(V_M-V_S))^2}{2(\beta(V_M-V_S)+\alpha\delta)^2t}$$
$$-\frac{\left(\delta\alpha^2(6t\alpha-\delta(V_M-V_S))-\beta(V_M-V_S)\left(4(V_M-V_S)(\beta(V_M-V_S)+\alpha\delta)-3t\alpha^2\right)\right)}{12(\beta(V_M-V_S)+\alpha\delta)^3t^2(2\beta(V_M-V_S)+\alpha\delta)^{-1}(V_M-V_S)^{-2}},$$
$$\text{if } \alpha > \frac{3t\beta}{2\delta}. \quad (41)$$

Equations 36 to 41 are not easy to sign. We have then to use numerical methods. Note however that we base the simulations in the SOCs. This makes the simulations less ad-hoc. From the SOCs for advertising and content under single-homing, we need that the following relation is satisfied (see appendix):

$$\frac{\beta t}{\eta} < \alpha < \frac{3t^2\beta+9\gamma\eta^2}{\eta t}. \quad (42)$$

Note also that $\frac{\beta t}{\eta} < \frac{3t\beta}{2\delta}$. Then for $\frac{\beta t}{\eta} < \alpha < \frac{3t\beta}{2\delta}$, under single-homing, media firms do not diversify content. For $\alpha > \frac{3t\beta}{2\delta}$ under single-homing, media firms diversify content.

From the SOCs for advertising and content from the multi-homing case, the following equation needs to be satisfied (see appendix):

$$(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta}. \quad (43)$$

We proceed in the following way. We set values for η (disutility of advertising), γ (cost to provide content), t (transport costs), and β (size of the ad market). From here, we can find values of α (size of the ad market) that satisfy equation 42. Having found α, we can obtain the values of $V_M - V_S$ (the relation between the preference for multi-homing and the preference for single-homing) that satisfy equation 43. With this we can solve equations 36 to 41 and plot them in the $V_M - V_S$ space[11]. In appendix, we report some of the parameter values used in our simulations.

[11] For example, if we set $\eta = .3$; $\gamma = 1$; and $t = 1$, and $\beta = 45$, we have from equation 42 that $150 < \alpha < 452.7$. As a result, for $150 = \frac{\beta t}{\eta} < \alpha < 225 = \frac{3t\beta}{2\delta}$, media firms do not diversify content; and for $225 = \frac{3t\beta}{2\delta} < \alpha < 452.7$, media firms diversify content. We then make simulations for parameter values under these two intervals. Setting for instance $\alpha = 400$, which represents a large add market and that media firms diversify content under

We discuss next the results of the numerical simulations. Figures 3 to 5 show the results in terms of the difference in profits, consumer surplus and social welfare between the single-homing and the multi-homing case, as a function of $V_M - V_S$. We consider first the case where media firms diversify content under single-homing, i.e. $\alpha > \frac{3t\beta}{2\delta}$. Three cases are shown: for high, medium and low disutility of advertising (η).

The first thing to note is that profits are always lower under single-homing than under multi-homing. We have already discussed above the reason for this to occur. In particular, under multi-homing competition between media firms is much lower than under single-homing, since multi-homing consumers are in a way captive since they consume from both media firms. We should expect lower profits in markets where competition is fiercer.

The second thing is that multi-homing tends to be better than single-homing in terms of consumer surplus and social welfare for low η (low disutility of advertising). For high η (high disutility of advertising), the opposite occurs, consumer surplus and social welfare tends to be higher under single-homing than under multi-homing. The reason for this is that when η is high, competition for advertising and for readers is very fierce. Since readers are more exposed to ads under multi-homing (consumers that multi-home receive ads from both media firms), consumers suffer a higher disutility under multi-homing than under single-homing. When the disutility for ads is low, consumer surplus is not much affected under multi-homing, in spite of the fact that consumers are more exposed to ads under multi-homing than under single-homing.

For medium η (medium disutility of advertising), single-homing tends to be better than multi-homing in terms of consumer surplus and social welfare for high $V_M - V_S$ (consumers have a high preference for multi-homing), and the opposite for low $V_M - V_S$. The reason for this is that for high $V_M - V_S$, consumers tend to multi-home, but since media firms do not diversify content, consumer surplus is lower under multi-homing than under single-homing. When $V_M - V_S$ is low, readers do not care that much about content diversification, and therefore consumer surplus tend to be high under multi-homing than under single-homing.

Having studied how profits, consumer surplus and social welfare behave in relation to η and $V_M - V_S$, we still need to analyze two other things. First, we have study the behavior of profits, consumer surplus and social welfare in relation to the remaining parameters, the size of the advertising market (α and β), the costs to provide content (γ) and transport costs (t). Second, we also need to investigate what happens when content diversification does not arise under single-homing (i.e. $\frac{\beta t}{\eta} < \alpha < \frac{3t\beta}{2\delta}$). Start with the parameters α, β, γ and

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single-homing, from equation 43, we must have that $V_M - V_S > \frac{4(\sqrt{57}+7)}{3}$. We then plot equations 36 to 41 in the interval $V_M - V_S > \frac{4(\sqrt{57}+7)}{3}$. We proceed in the same way with different values of the parameters, to check for high and low η, for high and low γ; for high and low t, and for high and low α in relation to β. Since we plot equations 36 to 41 in the $V_M - V_S$, we do not need to do simulations for high and low values of $V_M - V_S$, since this can be seen from the figures.

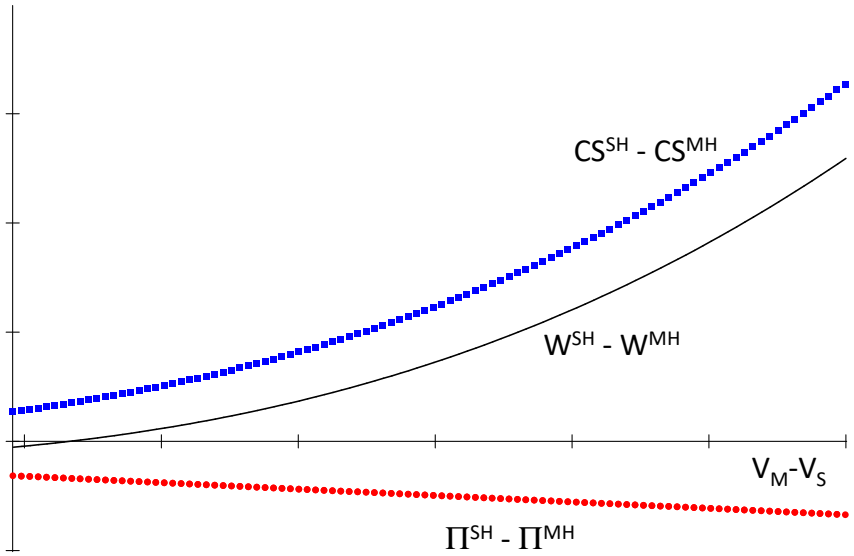

Figure 3: High disutility of advertising

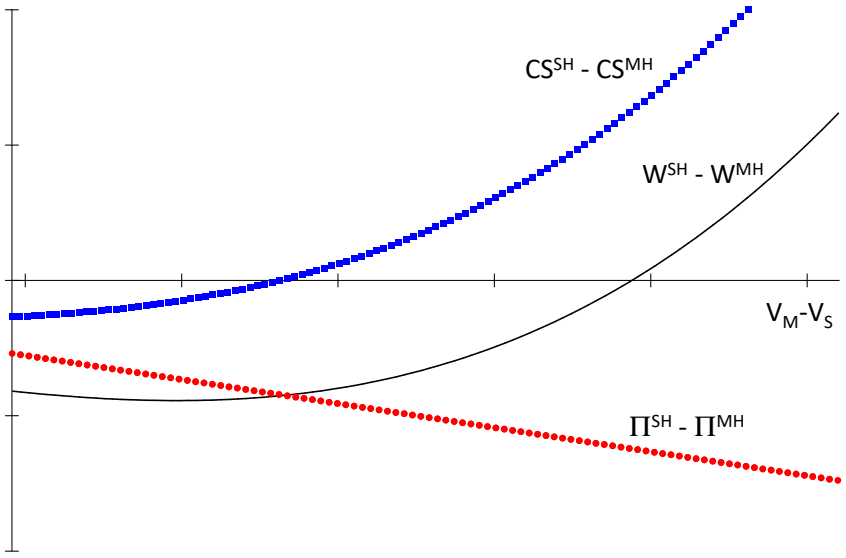

Figure 4: Medium disutility of advertising

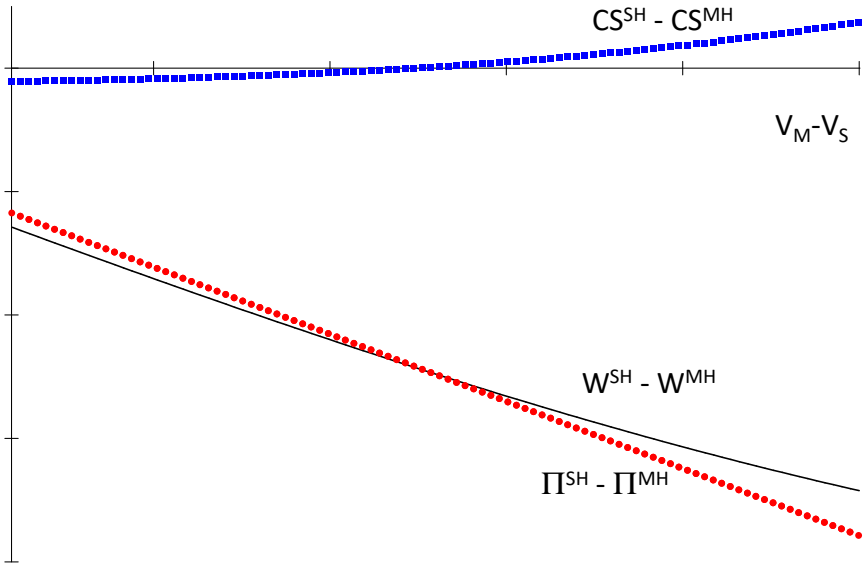

Figure 5: Low disutility of advertising

t.

When the advertising market is large (high α in relation to β), single-homing tends to be better than multi-homing, and the opposite for a small advertising market. This means that for high α in relation to β emerges figure 3; for low α in relation to β instead arises figure 5. The reason is that a high advertising market helps media firms to finance content diversification under single-homing. When the advertising market is small, media firms face more difficulties to finance content diversification under single-homing and therefore multi-homing tends to be better for profits and consumer surplus and in the end also social welfare, since less content is produced.

When the costs to provide content are high (high γ), multi-homing tends to surpass single-homing, and the reverse occurs when the costs to provide content are low. This implies that for high γ emerges figure 5; for low γ instead arises figure 3. The reasons for this is that when the costs to provide content are high, profits tend to be high under multi-homing than under single-homing, since under multi-homing media firms do not diversify content. In addition, with high γ, is more costly for media firms under single-homing to diversify content, and as a result consumer surplus is not much increased under single-homing. The reverse occurs when the costs to provide content are low.

When transport costs are high (high t) single-homing tends to be better than multi-homing, and the reverse for low transport costs. As a result, for high t emerges figure 3; for low t instead arises figure 5. The reason for this is the following. When transport costs are high, readers have a strong preference for

their ideal variety, and as a consequence, readers have a higher disutility under multi-homing than under single-homing. The opposite occurs when transport costs are low.

We turn now to the case, when media firms do not diversify content under single-homing, i.e. when $\frac{\beta t}{\eta} < \alpha < \frac{3t\beta}{2\delta}$. In this case, the same patterns arise as before for $\alpha > \frac{3t\beta}{2\delta}$. The only difference is that now single-homing is less likely to be better than multi-homing, since under the two regimes media firms do not diversify content. As a result, we get less extreme scenarios like figure 3 and 5 (where either single-homing or multi-homing clearly dominates) and more scenarios like figure 4, where neither single-homing nor multi-homing are clearly better than the other.

7 Discussion

In this paper, we have analyzed the effects single-homing readers (that consume from just one media outlet) and multi-homing readers (that can choose to consume from more than just one media outlet) on content provision in the news market. Multi-homing readers are ubiquitous, for instance on the Internet, but a large part of the literature on media economics focuses just on single-homing consumers. We have also interpreted our model and our results in terms of the current debate in the media sector regarding echo chambers, information effects, and network effects in social media.

From the supply side, we have introduced two central characteristics of media markets on 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 a larger audience, because this allows them to expose their message to more consumers. As such, media firms have strong incentives to increase demand (via an increase in content provision) in order to attract advertising revenues.

The second characteristic tries to tackle a limitation of many media models that usually assume that media firms only provide one type of content. In reality, however, and especially regarding the Internet, most media firms are multi-content. The incentives for media firms to be multi-content are that this might allow them to capture more demand (and therefore, advertising revenues). This is so because when media firms provide multi-content, readers incur lower transportation costs (lower disutility) to consume their ideal variety than when media firms only provide single-content. A multi-content strategy is in this sense a way for media firms to cater to diverse readers' preferences.

In this set-up, we show that media firms do not diversify content under multi-homing. In turn, media firms diversify content under single-homing if the advertising market is sufficiently large. The reason for this is that multi-homing reduces competition for readers and advertising relatively to the single-homing case, since multi-homing readers consume from all firms in the market. Accordingly, under single-homing media firms have to diversify content in order to attract readers from rivals and as such increase advertising revenues. Such

incentives are lower under multi-homing, since multi-homing readers consume from all media firms.

We believe that our results raise a series of challenges for media policy, because one of its main objectives is to have a media market with diversified content. Media regulators, however, only have instruments to deal with the supply side of the market (such as competition law), and can therefore do little to tackle the demand side. The question that arises is whether supply side instruments can counteract demand side forces that reduce media content. If not, regulation of media markets may need to be considered. This is in our view an interesting avenue to explore further. All these issues are especially relevant in a world where social media makes network effects a central feature of media markets and where politics are more divisive because people are less tolerant of opinions that do not agree with their own, making information effects weaker, and echo chambers more pervasive.

A Appendix

Single-Homing: SOCs. SOCs for advertising:

$$\frac{d^2\Pi_i}{da_i^2} = -\frac{\alpha\eta+t\beta(d_i-d_j+1)-\beta\eta(3a_i-a_j)}{t} < 0,\ i,j=1,2. \tag{44}$$

We can see that at the symmetric equilibrium the SOC simplifies to:

$$\frac{d^2\Pi_i}{da_i^2} = -\frac{\alpha\eta+t\beta-2\beta\eta a_i}{t} < 0,\ i=j=1,2. \tag{45}$$

The SOC is satisfied if $\alpha > \frac{2\beta\eta a_i - t\beta}{\eta}$, $i=j=1,2$. Since $a_i = \frac{t}{\eta}$, then the SOC is satisfied if $\alpha > \frac{\beta t}{\eta}$.

SOCs for content:

$$\frac{d^2\Pi_i}{dd_i^2} = -\frac{t^2\beta(d_i-d_j+3)-\eta(t\alpha-9\gamma\eta)}{9\eta^2} < 0,\ i,j=1,2. \tag{46}$$

At the symmetric equilibrium, the SOC equals:

$$\frac{d^2\Pi_i}{dd_i^2} = -\frac{3t^2\beta-\eta(t\alpha-9\gamma\eta)}{9\eta^2} < 0,\ i=j=1,2. \tag{47}$$

The SOC is satisfied if $\alpha < \frac{3t^2\beta+9\gamma\eta^2}{\eta t}$. As a result the game is valid for $\frac{\beta t}{\eta} < \alpha < \frac{3t^2\beta+9\gamma\eta^2}{\eta t}$.

Multi-Homing: SOCs. SOCs for advertising:

$$\frac{d^2\Pi_i}{da_i^2} = -2\frac{\alpha\eta+\beta(V_M-V_S+td_1-3\eta a_1)}{t},\ i=1,2. \tag{48}$$

Substituting for $a_i = \frac{\alpha(V_M-V_S)}{2(\alpha\eta+\beta(V_M-V_S))}$ and $d_i = 0$, we obtain:

$$\frac{d^2\Pi_i}{da_i^2} = -\frac{\beta(V_M-V_S)(2\beta(V_M-V_S)+\alpha\eta)+2\alpha^2\eta^2}{(\beta(V_M-V_S)+\alpha\eta)t} < 0,\ i=1,2. \tag{49}$$

Then the SOC is always satisfied since $(V_M - V_S) > 0$.
SOCs for content:

$$\frac{d^2\Pi_1}{dd_1^2} = -t\alpha^4\eta^2 \frac{\beta(V_M-V_S)(\beta(V_M-V_S)-7\alpha\eta+2t\beta d_i)-2\alpha^2\eta^2-t\beta d_i(7\alpha\eta-t\beta d_i)}{4(\alpha\eta+\beta(V_M-V_S)+t\beta d_i)^5} - \gamma < 0,\ i = 1, 2. \tag{50}$$

Substituting for $d_i = 0$, we obtain:

$$\frac{d^2\Pi_1}{dd_1^2} = -t\alpha^4\eta^2 \frac{\beta(V_M-V_S)(\beta(V_M-V_S)-7\alpha\eta)-2\alpha^2\eta^2}{4(\alpha\eta+\beta(V_M-V_S))^5} - \gamma < 0,\ i = 1, 2. \tag{51}$$

The SOCs for content is satisfied if $\gamma > -t\alpha^4\eta^2 \frac{\beta(V_M-V_S)(\beta(V_M-V_S)-7\alpha\eta)-2\alpha^2\eta^2}{4(\alpha\eta+\beta(V_M-V_S))^5}$. We can see that the numerator has two solutions in relation to $(V_M - V_S)$: $\frac{\alpha\beta\eta\left(7+\sqrt{57}\right)}{2\beta^2} > 0$ and $\frac{\alpha\beta\eta\left(7-\sqrt{57}\right)}{2\beta^2} < 0$. Furthermore, the numerator is convex in $(V_M - V_S)$. As such the numerator is always positive for $(V_M - V_S) > \frac{\alpha\beta\eta\left(7+\sqrt{57}\right)}{2\beta^2} > 0$ and for $(V_M - V_S) < \frac{\alpha\beta\eta\left(7-\sqrt{57}\right)}{2\beta^2} < 0$. When this occurs $-t\alpha^4\eta^2 \frac{\beta(V_M-V_S)(\beta(V_M-V_S)-7\alpha\eta)-2\alpha^2\eta^2}{4(\alpha\eta+\beta(V_M-V_S))^5} < 0$ and the SOC is as a result satisfied, since $\gamma > 0$.

Note that if $(V_M - V_S) < \frac{\alpha\beta\eta\left(7-\sqrt{57}\right)}{2\beta^2} < 0$, multi-homing does not arise in equilibrium (see equation 23). In other words, we fall back in the single-homing case, and therefore there are no differences between the single-homing and the multi-homing case. Since we are interested in comparing what happens in a media market where readers single-home and where readers multi-home, we look at the case where $(V_M - V_S) > \frac{\alpha\beta\eta\left(7+\sqrt{57}\right)}{2\beta^2} > 0$.

Parameter Values for the Simulations Here we report some of the parameter values that we have used for the numerical exercise. As mentioned in the text, the simulation exercise uses the SOCs to restrict the value of the parameter values. We start with the SOCs for the single-homing case (equation 42) to find the interval set of α (size of the advertising market) where the single-homing case is valid. Having this, from the SOCs for the multi-homing case (equation 43), we can find the interval set of $V_M - V_S$, where the multi-homing case is valid. After having this, we can play around with the remaining parameters. We are particular interested in checking how profits, consumer surplus and social welfare vary with the disutility of advertising (η), with the size of the advertising market (α and β), with relation between the preference for multi-homing and the preference for single-homing $(V_M - V_S)$, with the costs to provide content (γ) and with transport costs (t). As mentioned in the main text, note that since the figures are constructed as a function of $V_M - V_S$, the relation between different values of $V_M - V_S$ (high or low) can be inferred from the figures. There is then no need to do simulations for different values of $V_M - V_S$.

High disutility of ads (high η): $\alpha = 70$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = 1$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 45 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 144$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{701\left(\sqrt{57}+7\right)}{902}$.

Medium disutility of ads (medium η): $\alpha = 700$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = .1$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 90 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 275$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{2001\left(\sqrt{57}+7\right)}{1804}$.

Low disutility of ads (low η): $\alpha = 200$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = .5$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 451 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 1353$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{7001\left(\sqrt{57}+7\right)}{9020}$

Large advertising market (high α in relation to β): $\alpha = 140$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = 1$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 45 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 144$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{1401\left(\sqrt{57}+7\right)}{902}$.

Small advertising market (low α in relation to β): $\alpha = 230$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = .3$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 150 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 453$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{6903\left(\sqrt{57}+7\right)}{9020}$.

Very small advertising market (very low α in relation to β), i.e. no diversification of content under single-homing: $\alpha = 46$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = 1$**; and** $t = 1$**.** Note that under single-homing and the parameter values above, media firms do not diversify content for $\alpha < \frac{3t\beta}{2\delta} = 67$.

The SOCs are: $\frac{\beta t}{\eta} = 45 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 144$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{230\left(\sqrt{57}+7\right)}{451}$.

Low costs of providing content (low γ): $\alpha = 350$**;** $\beta = 45$**;** $\gamma = .2$**;** $\eta = .3$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 150 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 451$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{525\left(\sqrt{57}+7\right)}{451}$.

High costs of providing content (high γ): $\alpha = 350$**;** $\beta = 45$**;** $\gamma = 5$**;** $\eta = .3$**; and** $t = 1$**.** The SOCs are: $\frac{\beta t}{\eta} = 30 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 103$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{525\left(\sqrt{57}+7\right)}{451}$.

Low transport costs (low t): $\alpha = 60$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = .3$**; and** $t = .2$**.** The SOCs are: $\frac{\beta t}{\eta} = 150 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 453$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{90\left(\sqrt{57}+7\right)}{451}$.

High transport costs (low t): $\alpha = 4000$**;** $\beta = 45$**;** $\gamma = 1$**;** $\eta = .3$**; and** $t = 10$**.** The SOCs are: $\frac{\beta t}{\eta} = 1503 < \alpha < \frac{3t^2\beta + 9\gamma\eta^2}{\eta t} = 4510$ and $(V_M - V_S) > \frac{\alpha\eta\left(7+\sqrt{57}\right)}{2\beta} = \frac{6000\left(\sqrt{57}+7\right)}{451}$.

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