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Media Plurality: Private versus Mixed Duopolies

Armando J. Garcia Pires

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by

Armando J. Garcia Pires

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Media Plurality: Private versus Mixed Duopolies

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Abstract

In this paper, we analyze the effects on media plurality of competition between a private news firm that maximizes profits and a publicly owned news firm that maximizes social welfare. We show that when the costs to adapt news to readers' political preferences are high relatively to the intensity of the readers' political preferences, profits in the industry are lower, but prices, media plurality, consumer surplus, and social welfare are higher in the mixed duopoly than in the private duopoly case. The contrary is true when the costs to adapt news to readers' political preferences are low relatively to the intensity of the readers' political preferences. This result is confirmed with the introduction of advertising and inefficiencies of the public firm.

Keywords: Media Plurality, Media Firms, Private Duopoly, Mixed Duopoly.

JEL Classification: H42, L13, L82.

1 Introduction

Media plurality refers to the diversity of political opinions with a voice in the news market. Many defend the view that media plurality increases social welfare, since it satisfies readers' diverse political preferences and promotes

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democracy (see Coase, 1974; Downs, 1957; Hayek, 1945; and Mill, 1859). However, some fear that news markets with only private actors cannot guarantee media plurality, since private actors mostly follow profit motives (Herman and Chomsky, 1998). This may be so mainly for two reasons. First, the provision of media plurality can increase the costs of news firms due to the extra costs of gathering information and adapting news to the readers' political preferences. Second, the provision of media plurality can imply that news firms have to focus on non-mainstream political opinions that generate less demand and therefore less revenue.

Some argue that governments can try to solve this market failure by the introduction of publicly owned news firms whose objective it is to maximize social welfare and that compete directly with private news firms that maximize profits. Markets characterized by the presence of both public firms and private firms are usually called mixed oligopolies. The idea behind mixed oligopolies in the news market is that by maximizing social welfare, publicly owned news firms could balance the news market between the need to generate profits and provide media plurality. In particular, the role of the publicly owned news firms would be to influence the behavior of privately owned news firms in terms of media plurality. If the presence of a public news firm promotes media plurality, then, according to the literature on mixed oligopolies, we say that the mixed oligopoly has achieved "regulation by participation" (see Harris and Wiens, 1980; Vickers and Yarrow, 1988; Bös, 1991; Cremer et al., 1989; De Fraja and Delbono, 1990; Estrin and de Meza, 1995; and Matsumura, 1998).

In fact, the literature on mixed oligopolies starts from the premise that when private actors do not provide the market with some socially desirable good, such as for instance media plurality, governments have two options. The first option is to introduce a regulatory body that regulates and controls industry behavior in terms of providing such a good. The second option is to introduce a publicly owned firm that produces this good and that competes directly with the private firms. In the news market, the media industry fiercely opposes the first option, since one of the founding principles of journalism is independence and freedom of the press, and an external regulator might in some cases have to intervene directly in the editorial decisions of a newspaper. See for instance the debate in England about the phone-hacking scandal in the News of the World (The Economist, 2012). However, mixed oligopolies in the news market are a very widespread phenomenon across many countries (e.g., the BBC in England).

In this paper, we study the proposition that markets with publicly owned news firms can contribute to increased media plurality.[1] In particular, we analyze the effects on media plurality of competition between a private news firm that maximizes profits and a publicly owned news firm that maximizes social welfare, when news firms can adapt news to readers' political preferences.

In order to do this, we use the standard modeling strategy of the media plurality literature, the Hotelling (1929) model (see Kaitatzi-Whitlock, 1996; Gabszewicz et al., 2001, 2002; and Roger 2009).[2] In this sense, news firms' political orientation and readers' political preferences are presented on the Hotelling (1929) line. Readers subscribe to an ideal-political ideology and they experience disutility when consuming news, which does not conform to their political views.

We differ from the standard media literature that uses the Hotelling model in two ways. First, we introduce the possibility for news firms to adapt news to readers' political preferences. Media firms can choose between a single-ideology strategy (i.e., a point on the Hotelling line), or a multi-ideology strategy by adapting news to readers' political preferences (i.e., a line segment). In order to model this, we follow the product adaptation set up for consumer markets by Alexandrov (2008). In particular, when a news firm decides to adapt its products it has to weight the costs of adaptation (i.e., the cost related with adapting news products to readers' political preferences) with the benefits (i.e., extra demand).

[1] Publicly owned news firms can arguably also be more prone to political pressure. We are therefore implicitly assuming that publicly owned news firms are only restricted to maximize welfare (news firms' profits plus consumer surplus), but apart from this they have the freedom to choose editorial political orientations. The empirical evidence shows that there are some examples of independent publicly owned news firms, like the BBC, but also of publicly owned news firms in countries like Russia that are controlled by the government (see Djankov et al., 2003).

[2] In this way, we follow the literature on media plurality. This literature tries to disentangle what can affect the level of media plurality in a market. Some of the factors that influence media plurality are the following: the concentration of the media industry (Kaitatzi-Whitlock, 1996; and George, 2007 and Roger, 2009); advertising (Gabszewicz et al., 2001, 2002; Argentesi and Filistrucchi, 2007; Ellman and Germano, 2009; Affeldt et al., 2013; and Garcia Pires, 2013); the diversity of readers' political preferences (Garcia Pires, 2013); market structure (Steiner, 1952; George and Waldfogel, 2003; and George and Oberholzer-Gee, 2011); subsidies (Lerocha and Wellbrock, 2011); party political competition (Noam, 1987; and Schulz and Weimann, 1989); and technology (Gentzkow, 2007; and George and Hogendorn, 2012).

Second, we consider two different market structures: a private duopoly, with only privately owned news firms that maximize profits; and a mixed duopoly, with a private news firm that maximizes profits and a publicly owned news firm that maximizes social welfare (profits of the private and the public news firms and consumer surplus).

In this set up, we show that the difference between the private duopoly and the mixed duopoly holds for the relation between the costs to adapt news to readers' political preferences and the intensity of the readers' political preferences. When the costs of adapting news to readers' political preferences are high relatively to the intensity of the readers' political preferences, profits in the industry are lower, but prices, media plurality, consumer surplus, and social welfare are higher in the mixed duopoly than in the private duopoly. The contrary is true when the costs to adapt news to readers' political preferences are low relatively to the intensity of the readers' political preferences. In other words, in the news market "regulation by participation" is not always achieved.

The reason for this is that news firms compete both on prices and media plurality. Accordingly, if news firms were to compete only on prices "regulation by participation" would more easily be achieved (see Harris and Wiens, 1980; Vickers and Yarrow, 1988; Bös, 1991; Cremer et al., 1989; De Fraja and Delbono, 1990; Estrin and de Meza, 1995; and Matsumura, 1998). When the public firm increases media plurality (increasing consumer surplus) it also increases price competition between firms (reducing consumer surplus and profits). As a result, the capacity of a public firm to attain "regulation by participation" depends on the relation between the costs of providing media plurality and the intensity of readers' political preferences.

In fact, when the costs of adapting news to readers' political preferences are high relatively to the intensity of the readers' political preferences, news firms in the private duopoly reduce media plurality (reducing consumer surplus) in order to restrain price competition (increasing profits). In the mixed duopoly, the public news firm increases media plurality (to increase consumer surplus) even at the costs of fierce price competition (that decreases profits), given that the objective of the public news firm is to maximize social welfare, and not only profits. However, the positive effects of media plurality on consumer surplus can dominate the negative effects of higher prices on profits when the costs of providing media plurality are high. In this way, only when the costs of adapting news to readers' political preferences are high relatively to the intensity of the readers' political preferences, can a publicly owned

news firm achieve "regulation by participation."

We make two robustness tests of the results in the benchmark case in our model: inefficiencies in the provision of media plurality by the public firm and the presence of an advertising market. We find that when the public firm is not as efficient as the private firm in providing media plurality, the mixed duopoly is more favorable than the private duopoly if the public firm disadvantage is not too large.

In turn, when news firms derive revenues from advertising as well (and not only from selling news), the equilibrium of the model depends on the size of the advertising market. This is due to the two-sided nature of the news market. In a two-sided news market, advertisers prefer to buy ad space in the news firm with the larger audience. Therefore, news firms have incentives to adapt news to readers' political preferences, since this can increase audiences, and thereby increase advertising revenues. However, this comes at a cost, given that firms have to incur higher costs to adapt news to readers' preferences.

Besides, when the advertising market is small, the revenues from selling news are more important than the revenues from selling ads. The opposite is the case when the size of the advertising market is large. As a result, when the advertisement market is small, we obtain the same results from the benchmark case. When the advertising market is large, in turn, media plurality and consumer surplus are always lower, but profits are always higher under the mixed duopoly than in the private duopoly. Social welfare, however, is similar to the benchmark case. The differences between the large and the small advertising market arise because with a large advertising market, news firms can support fierce price competition with the revenues from advertising. Therefore, in the private duopoly when the advertising market is large, news firms over-invest in media plurality. In the mixed duopoly, the public news firm considers these effects and restricts the investment in media plurality in order to reduce price competition and thereby increase profits of all the news firms.

We organize the rest of the paper as follows. In the next section, we present the base model of media plurality. In section three, we analyze the benchmark case for the private and the mixed duopoly case. In section four, we study the case where the public firm is inefficient relatively to the private firm in providing media plurality. In section five, we introduce advertising. In section six, we discuss our main results.

2 The Model

In this paper, we study the effects on media plurality of the participation of publicly owned news firms in media markets with private actors. In order to do this, we adopt the standard model in the media plurality literature, the Hotelling (1929) duopoly model (see for instance Kaitatzi-Whitlock, 1996, Gabszewicz et al., 2001, 2002, and Roger, 2009).[3] The political preferences of readers are distributed on the Hotelling line as shown in figure 1. To the Hotelling model, we add the standard assumption of the mixed duopoly literature. In particular, we assume that while private news firms maximize profits, publicly owned news firms maximize social welfare, measured as the sum of consumer surplus and the profits of the news firms in the media market (private plus public). See Harris and Wiens (1980), Vickers and Yarrow (1988), Bös (1991), Cremer et al. (1989), De Fraja and Delbono (1990), Estrin and de Meza (1995), and Matsumura (1998). We then consider two cases: (1) a private duopoly where both news firms are privately owned and maximize profits; and (2) a mixed duopoly with a privately owned news firm that maximizes profits and a publicly owned news firm that maximizes social welfare.

We differ from the standard media plurality approach of Gabszewicz et al. (2001) in one important way. With the aim of studying the effects on media plurality of mixed duopolies (i.e., markets with both private and public news firms), we depart from the framework with single-ideology media firms by considering multi-ideology media firms. In other words, media firms can choose between a single-ideology and a multi-ideology strategy. Single-ideology news firms only cover a point on the line, while multi-ideology news firms cover a line segment (see figure 1).

To model multi-ideology media firms (i.e., adaptation of news to readers' political preferences), we follow the approach by Alexandrov (2008) to fat

[3]The media plurality literature is 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 Groseclose and Milyo, 2005; Mullainathan and Shleifer, 2005; Baron, 2006; Gentzkow and Shapiro, 2006; Reuter and Zitzewitz, 2006; DellaVigna and Kaplan, 2007; Ellman and Germano, 2009; Stone, 2011; Durante and Knight, 2012; and Germano and Meier, 2013). Higher media plurality can conduce to lower media bias, since the news market covers more political opinions. However, higher media plurality does not necessarily always lead to lower media bias since even when many opinions are covered in the media market, the truth might still not emerge (see Gentzkow and Shapiro, 2008; and Gentzkow et al., 2012).

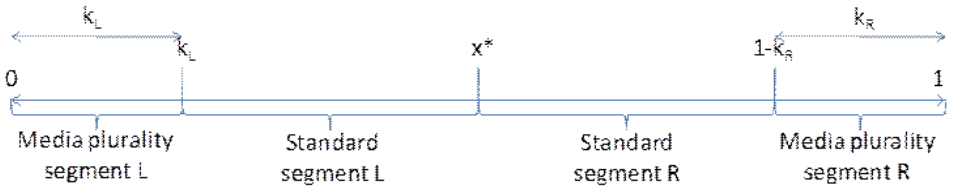

Figure 1: Media plurality: L located at 0 and R at 1

products. Fat products can be defined as products that contain a set of characteristics amongst which consumers can choose without being charged extra for this. In the context of the news market, we talk about fat news when the same media outlet caters to different political opinions, and each reader can pick what they prefer more[4].

Readers' Preferences. As in Hotelling (1929), readers are uniformly distributed on a line of length one: $[0, 1]$. The line represents political orientation (see figure 1). The different political orientations are ordered from left to right: 0 represents far left and 1 represents far right. We define t as the intensity of the readers' political preferences (i.e., transport costs in Hotelling). Readers patronize only one media outlet (i.e., readers have unit demands). In this way, readers have an ideal-political opinion and they incur a disutility cost from buying a newspaper with a different political orientation from their ideal one.

The location of a media firm on the line represents the political orientation(s) covered by the news firm. The two news firms are labeled $i = L, R$. We assume that newspaper L is left-oriented and newspaper R is right-oriented and that the two media firms are located at the opposite extremes of the line: news firm L is located at point $x_L = 0$ and news firm R is located

[4]A related, but not identical, concept to fat products is customized products (see Dewan et al., 2003). Customized products are products that consist of a standard product that can be transformed into different customized products, which consumers can acquire at an additional price. Then, under customization, and contrary to fat products, price discrimination is central. In the case of media markets, it seems more adequate to think in terms of fat products than customization, since price discrimination, in spite of some attempts, is not the standard business practice in the industry. For this reason, price discrimination is not present in our formalization.

at point $1 - x_R = 1$ (see figure 1)[5].

To our knowledge, with the exception of Garcia Pires (2013), the models that use the Hotelling framework to study media plurality assume that media firms can only supply the media market with one political opinion, x_i, with $i = L, R$ (i.e., single-ideology media firms). In this sense, media firms sell the same political view to different readers. We differ from this approach by opening up for media firms to adapt news to readers' political preferences. In particular, in our set up news firms can become multi-ideology news firms by covering different political locations.

To model multi-ideology media firms, we adapt the approach by Alexandrov (2008) for fat products for media markets. In particular, we denote by k_i the media plurality scope of news firm i, which equals the length of the Hotelling line covered, $0 \leq k_i \leq 1$, with $i = L, R$. Media firms can then decide to adopt a single-ideology strategy or a multi-ideology strategy. A single-ideology strategy corresponds to a single point on the line ($x_L = x_R = 0$), while a multi-ideology orientation corresponds to a line segment ($[0, k_L]$ and $[1 - k_R, 1]$)[6]. This is depicted in figure 1, where newspapers L and R are located at points 0 and 1, respectively. Reader x^* is indifferent between buying from L or R. Point k_L is the end point of the set of political opinions offered by L. If $k_L = 0$, L only offers political opinion 0 and all readers between $[0, x^*]$ consume 0. If $k_L > 0$, L offers the set of political opinions $[0, k_L]$. In this case, readers located on $[0, k_L]$ consume the political opinion that they prefer, while readers on $[k_L, x^*]$ consume k_L. Similar interpretation holds for

[5] In this way, we follow the literature in media economics in that media outlets only give voice to one political area, i.e.: a media outlet does not provide two opposite political ideas. This can be so for at least three reasons. First, newspaper owners might prefer a given political ideology. For instance, all newspapers and TV channels belonging to Rupert Murdoch (the News Inc. group) move in the conservative area. Second, it can be very costly for a newspaper to report in opposite political areas, given that investigative journalism is expensive. The idea is that for a newspaper to report in two different political areas has very little economies of scope. Third, a newspaper that reports in opposite political ideologies can lose credibility amongst readers. In fact, readers seem to be very sensitive about news biased to the opposite of the political area that they support.

[6] We therefore assume that a newspaper does not adapt news away from where they are politically located. The reasons for this to be the case can be the same as the ones mentioned in the previous footnote in relation to a newspaper supporting more than one political ideology. In addition, note that in the context of the Hotelling model, when firms move in the direction of the line, they increase price competition. Consequently, for a news outlet it is always preferable to adapt news starting from their political location rather than away from it, because the effects on price competition are smaller.

new firm R.

With a single-ideology strategy, a media firm only reports one political orientation and therefore offers standard news to readers with different political orientations. In turn, with a multi-ideology strategy, a media firm covers different political ideologies and, as such, it offers adapted news to readers located inside its media plurality segment, and standard news to readers outside its media plurality segment (see figure 1). In other words, readers located inside the media plurality segment of a news firm consume the news reflecting exactly the political orientation that they subscribe to, while readers located outside the media plurality segment consume the news that is closest to their ideal-opinion. Below we present the specific technology available to media firms to adapt news to readers' political preferences.

The utility of a reader x located in the left hand side segment of the line outside the media plurality segment of news firm L is:

$$U = v - p_L - t\left(x - k_L\right), \tag{1}$$

where k_L is the end point of the media plurality segment of news firm L, v is a positive constant that captures readers' reservation price, t is the intensity of the readers' political preferences and p_L is the price charged by news firm L. A similar expression applies for a reader x' located in the right hand side segment of the line outside the media plurality segment of news firm R. In this sense, a higher t represents the fact that readers have higher disutility from consuming news that does not conform to their political preferences. Note also that if reader x is located inside the multi-ideology segment of news firm L, the reader's utility is: $U = v - p_L$, since $t = 0$ (i.e., the reader's ideal opinion is offered).

Like in Dewan (2003), we assume that in order to provide media plurality, news firms have to incur an adaptation cost (C) that equals:

$$C_i = \tfrac{\gamma k_i^2}{2},\ i = L, R, \tag{2}$$

where γ represents the informational and flexibility costs to adapt news to the readers' political preferences. In this way, the adaptation costs increase with the level of media plurality offered. Also the higher the informational and flexibility costs to adapt news to the readers' political preferences (γ), the more costly it becomes for news firms to provide different political opinions in the news market.

Profits for news firm i are then:

$$\pi_i = p_i D_i - C_i,\ i = L, R, \tag{3}$$

where D_i is the demand for newspaper i. Accordingly, $D_L = x^*$ and $D_R = 1 - x^*$, where x^* is the reader indifferent between buying from news firm L or from news firm R.

We define consumer surplus (CS) as:

$$CS = (v - p_L)\, x^* - t \int_{k_L}^{x^*} (x - k_L)\, dx + (v - p_R)\,(1 - x^*) - t \int_{x^*}^{1-k_R} ((1 - x) - k_R)\, dx. \tag{4}$$

In turn, we measure social welfare (W) as the sum of the two news firms' profits ($\pi_L + \pi_R$) and consumer surplus (CS):

$$W = \pi_L + \pi_R + CS. \tag{5}$$

The reader who is indifferent between buying from news firm L or from news firm R, x^*, is the one that makes:

$$v - p_L - t\,(x^* - k_L) = v - p_R - t\,(1 - k_R - x^*)\,. \tag{6}$$

Solving for x^*, and noting that $D_L = x^*$ and $D_R = 1 - x^*$, we find that D_i equals:

$$D_i = \tfrac{p_j - p_i + t(1 - k_j + k_i)}{2t},\ i, j = L, R \text{ and } i \neq j. \tag{7}$$

Consumer surplus then simplifies to:

$$CS = \tfrac{(p_R - p_L)^2 - t\left(t(k_L + k_R - 1)^2 + 2(p_L - 2v + p_R + (p_R - p_L)(k_R - k_L))\right)}{4t}. \tag{8}$$

The timing of the game is the following. In the first stage, editors select k_i. In the second stage, news firms choose p_i.

The model above represents the benchmark case in this paper. In subsequent sections, we will check the robustness of the results in the benchmark case to the introduction of inefficiencies by the public firm and a two-sided market with advertising. Next, we present the main changes in the benchmark case with these two cases.

Inefficiencies of the Public Firm. We assume that the private firm is more efficient than the public firm in providing media plurality. This can be due for example to the public firm having a non-professional management, or other type of political constraints, such government control. We then have that $\gamma_L > \gamma_R$, i.e., the costs of adapting news are firm-specific:

$$C_i = \frac{\gamma_i k_i^2}{2},\ i = L, R, \tag{9}$$

where γ_i are now the informational and flexibility costs to adapt news to the readers' political preferences by the media firm $i = L, R$.

Advertising. In the advertising case, news firms derive revenues from selling news and from selling advertising space. In other words, the news market has a two-sided nature. Like in Anderson and Coate (2005) and Peitz and Valletti (2008), we assume that the demand for ads for the news firm i is:

$$r_i = \alpha - \beta a_i,\ i = L, R, \tag{10}$$

where r_i is the price of advertising per reader and a_i is advertising volume. In turn, α and β are parameters related with the size of the advertising market.

Gross advertising income is then:

$$A_i = (\alpha - \beta a_i)\, a_i D_i,\ i = L, R, \tag{11}$$

where D_i is the demand for the news firm i. Accordingly, $D_L = x^*$ and $D_R = 1 - x^*$ (remember that x^* is the reader who is indifferent between buying news from L or from R).

As will be seen more clearly below, in this set up ad demand depends on the size of the news firm's audience. More precisely, ad demand is positively correlated with the size of the news firm's audience. This feature gives our model a two-sided market framework since there are positive externalities between the consumer and the advertising markets.

Profits for news firm i are now:

$$\pi_i = p_i D_i - C_i + A_i,\ i = L, R. \tag{12}$$

The timing of the advertising game is the following. In the first stage, editors select k_i; in the second stage, news firms decide a_i; in the third stage, editors choose p_i.

3 Benchmark Case

In this section, we analyze the benchmark case for the private and mixed duopoly case.

3.1 Benchmark: Private Duopoly

In this subsection, we analyze the benchmark case with two private editorial outlets, $i = L, R$, which are located at point 0 and point 1, respectively. The two firms have as their only objective to maximize profits. As usual, we solve the model by backward induction.

Stage 2: Prices. In the second stage, news firms choose prices p_i, with $i = L, R$. Prices are found by maximizing the profit expression (equation 3) with respect to p_i. The first order condition (FOC) for prices equals[7]:

$$\frac{\partial \pi_i}{\partial p_i} = \frac{(t(k_i - k_j + 1) + (p_j - 2p_i))}{2t},\ i, j = L, R \text{ and } i \neq j. \tag{13}$$

Solving $\frac{d\pi_i}{dp_i}$ and $\frac{d\pi_j}{dp_j}$ simultaneously for p_i and p_j, we obtain:

$$p_i = \frac{t(k_i - k_j + 3)}{3},\ i, j = L, R \text{ and } i \neq j. \tag{14}$$

Stage 1: Media Plurality. In the first stage, news firms choose media plurality levels k_i, with $i = L, R$. The FOC for media plurality equals:

$$\frac{d\pi_i}{dk_i} = \frac{\partial \pi_i}{\partial k_i} + \frac{\partial \pi_i}{\partial p_j}\frac{dp_j}{dk_i},\ i, j = L, R \text{ and } i \neq j. \tag{15}$$

The choice of the media plurality levels has two effects. The first is the direct effect of media plurality k_i on profits π_i. The second is the indirect effect of media plurality k_i on profits π_i, via the effects on the rival's prices p_j. It can be shown that:

$$\frac{\partial \pi_i}{\partial k_i} = \left(\frac{p_i}{2} - \gamma k_i\right) + \left(\frac{p_i}{2t}\right)\left(-\frac{t}{3}\right),\ i, j = L, R \text{ and } i \neq j. \tag{16}$$

We can see that the indirect effect is negative. This is so because an increase in media plurality by firm i leads to fierce price competition with the rival j (i.e.: lower p_j), which in turn reduces the profits of firm i (i.e.:

[7] The second order conditions (SOCs) are in the Appendix A.

lower π_i). In turn, the direct effect will depend on the relation between prices (p_i) and the costs of media plurality (γk_i).

We can further simplify the FOC for media plurality (equation 16) by substituting for p_i from equation 14:

$$\frac{d\pi_i}{dk_i} = \frac{t(3-k_j+k_i)}{9} - \gamma k_i,\ i,j = L,R \text{ and } i \neq j. \tag{17}$$

Solving $\frac{d\pi_i}{dk_i}$ and $\frac{d\pi_j}{dk_j}$ simultaneously for k_i and k_j (with $i,j = L,R$ and $i \neq j$), we obtain the equilibrium media plurality levels:

$$k_i = \frac{t}{3\gamma} > 0,\ i = L,R. \tag{18}$$

We can then note that in the benchmark private duopoly case, the positive effects of media plurality (higher demand) dominate the negative effects (fierce price competition and higher costs). As a result, media firms adapt news to readers' political preferences and media plurality is increased relatively to the standard case in the literature where news firms are restricted to a single-ideology strategy.

To derive equilibrium prices substitute for k_i ($i = L,R$) from equation 18 in equation 14:

$$p_i = t,\ i = L,R. \tag{19}$$

The price of the standard product (p_i) in a private duopoly with exogenous choice of location then equals the level of intensity of the readers' political preferences (t). More interesting, as we have seen, the duopolists always choose positive levels of media plurality (see equation 18). Furthermore, media plurality increases with the intensity of the readers' political preferences (t), but decreases with the informational and flexibility costs of adapting news to the readers' political preferences (γ). We also note that, given the prices in equation 19 and media plurality levels in equation 18, the demand levels D_i are always positive, since $D_i = \frac{1}{2}$, with $i = L,R$ (i.e., the news firms divide the news market in half).

We have also to ensure that the media plurality segments of the two news firms do not overlap. It can be shown that $k_i \leq D_i = \frac{1}{2}$ ($i = L,R$) for $\gamma \geq \frac{2t}{3}$. In this respect, for $\gamma = \frac{2t}{3}$ all possible political opinions on the line are covered, since $k_i = \frac{1}{2}$ ($i = L,R$). This is the case when the costs of media

plurality are not too large relatively to the intensity of the readers' political preferences.

3.2 Benchmark: Mixed Duopoly

In this subsection, we assume that news firm L is a publicly owned news firm that maximizes social welfare, while news firm R is a private news firm that maximizes profits. We continue to assume that the two editorial outlets, L and R are located at point 0 and point 1, respectively. Given the symmetry of the model, the results are the same if the publicly owned news firm is located at point 1, and the private news firm is located at point 0 on the line.

Stage 2: Prices. In the second stage, news firms choose prices p_i, with $i = L, R$. For news firm R, the privately owned news firm, prices are obtained by maximizing the profit expression (equation 3) with respect to p_i. It is straightforward to check that the FOC for prices for news firm R is the same as in the private duopoly case (equation 13).

For news firm L, the publicly owned news firm, the FOC is found by substituting D_L from equation 7 in the social welfare function (equation 5). It results:

$$\frac{\partial W_L}{\partial p_L} = \frac{(p_R - p_L)}{2t}. \tag{20}$$

Solving $\frac{\partial W_L}{\partial p_L}$ and $\frac{d\pi_R}{dp_R}$ simultaneously for p_L and p_R, we obtain:

$$p_L = p_R = t\left(k_R - k_L + 1\right). \tag{21}$$

Stage 1: Media Plurality. In the first stage, news firms choose media plurality levels k_i, with $i = L, R$. The FOC for media plurality for the private news firm is the same as in the private duopoly case (equation 16). We can then simplify the FOC for media plurality for the privately owned news firm (equation 16) by substituting for p_R from equation 21:

$$\frac{d\pi_R}{dk_R} = \frac{1}{3}\left(t\left(k_R - k_L + 1\right)\right) - \gamma k_R. \tag{22}$$

In turn, for the publicly owned news firm, after substituting for p_L and p_R from equation 21, we have that the FOC for media plurality equals:

$$\frac{dW_L}{dk_L} = \frac{1}{2}\left(t\left(1-(k_L+k_R)\right)-2\gamma k_L\right). \tag{23}$$

Solving $\frac{d\pi_L}{dk_L}$ and $\frac{d\pi_R}{dk_R}$ simultaneously for k_L and k_R, we obtain the equilibrium levels of media plurality:

$$\begin{aligned} k_L &= \frac{(3\gamma-2t)t}{(2t+3\gamma)(2\gamma-t)} \\ k_R &= \frac{2\gamma t}{(2t+3\gamma)(2\gamma-t)}. \end{aligned} \tag{24}$$

We can derive equilibrium prices by substituting for k_i $(i = L, R)$ from equation 24 in equation 21:

$$p_L = p_R = \frac{6\gamma^2 t}{(2t+3\gamma)(2\gamma-t)}. \tag{25}$$

From equations 24 and 25, we obtain the demand levels for news firm L and news firm R:

$$\begin{aligned} D_L &= \frac{(t+\gamma)(3\gamma-2t)}{(2t+3\gamma)(2\gamma-t)} \\ D_R &= 1-\frac{(t+\gamma)(3\gamma-2t)}{(2t+3\gamma)(2\gamma-t)}. \end{aligned} \tag{26}$$

We need to restrict demand levels to being positive, otherwise, there is no demand for news. We can see that D_L and D_R are positive for:

$$\gamma \geq \frac{2t}{3}. \tag{27}$$

We assume that this condition holds in the rest of this section.

Next, we would also like to know the relation between k_L and k_R:

$$k_L - k_R = \frac{(\gamma-2t)t}{(2t+3\gamma)(2\gamma-t)}. \tag{28}$$

It can be shown that $k_L < k_R$ for $\frac{2t}{3} < \gamma < 2t$, and $k_L > k_R$ for $\gamma > 2t$. Then the publicly owned news firm only provides more media plurality than the privately owned news firm when the costs of adapting news are high in relation to the intensity of readers' political preferences. The contrary occurs when the costs of adapting news to readers' political preferences are low in relation to the intensity of readers' political preferences.

The reason for this is the following. When γ is low in relation to t, the private news firm has no difficulties in providing media plurality without

reducing profits significantly, since the costs of adapting news are relatively low. Therefore, the publicly owned news firm can reduce price competition by reducing the level of media plurality it provides. In fact, as we have seen in equation 16, when the news firms approach the center of the line due to an increase in media plurality, price competition becomes fiercer. In turn, when γ is high in relation to t, the privately owned news firm reduces the level of media plurality, since adaptation of news is now relatively more costly. Due to this, the publicly owned news firm increases the level of media plurality in order to increase consumer surplus. In other words, the publicly owned news firms only "intervenes" in media plurality when the private news firm reduces the level of media plurality it provides. This is the case when the costs to adapt news are higher relatively to the readers' intensity of political preferences.

As in the private duopoly case, we also have to guarantee that the media plurality segments of L and R do not overlap. Since the publicly owned news firm and the privately owned news firm provide different levels of media plurality (see equation 24), we now need two conditions for the two media plurality segments of the news firms to not overlap: $k_L \leq D_L$ and $1 - k_R \geq D_L$. We can show that these two conditions are satisfied if $\gamma \geq \frac{2t}{3}$. This is the same needed for demand levels to be positive, which we assume is always satisfied. The two media plurality segments will then never overlap in the mixed duopoly case.

3.3 Benchmark: Private Duopoly versus Mixed Duopoly

In this subsection, we compare the equilibrium of the private duopoly and the mixed duopoly cases in terms of prices, media plurality, consumer surplus, and social welfare.

We can start by showing that the difference between prices in the private duopoly case and the mixed duopoly case is:

$$\Delta P = p_{MD} - p_{PD} = -\frac{(\gamma - 2t)t^2}{(2t+3\gamma)(2\gamma - t)}, \tag{29}$$

where the subscripts PD and MD stand for the private duopoly case and the mixed duopoly case, respectively. Given that we assume that $\gamma \geq \frac{2t}{3}$, it results that $p_{MD} < p_{PD}$ for $\frac{2t}{3} < \gamma < 2t$, and $p_{MD} > p_{PD}$ for $\gamma > 2t$ (see figure 2). We then have that only when the costs of adapting news to readers' political preferences (γ) are low in relation to the intensity of readers' political

preferences (t), prices are lower in the mixed duopoly case than in the private duopoly case. The contrary is true for high γ in relation to t, where prices are higher in the mixed duopoly case. In order to understand this outcome, we need to proceed to compare media plurality in the private and in the mixed duopoly cases.

We have that the difference between media plurality in the private duopoly case and the mixed duopoly case equals:

$$\Delta K = K_{MD} - K_{PD} = \frac{(3\gamma-2t)(\gamma-2t)t}{3(2t+3\gamma)(2\gamma-t)\gamma}, \tag{30}$$

where $K_{MD} = k_{MD,L} + k_{MD,R}$ and $K_{PD} = k_{PD,L} + k_{PD,R}$. As shown in figure 2, we have that $K_{MD} < K_{PD}$ for $\frac{2t}{3} < \gamma < 2t$, and $K_{MD} > K_{PD}$ for $\gamma > 2t$ (see Appendix B for proof). As such, when the costs of adapting news to readers' political preferences (γ) are high relatively to the intensity of readers' political preferences (t), media plurality is higher in the mixed duopoly case than in the private duopoly case. The contrary is true for low γ in relation to t. Therefore, only for high γ in relation to t, can participation in the news market of a publicly owned news firm that maximizes social welfare achieve "regulation by participation" in terms of media plurality. In other words, for high γ in relation to t, the public news firm can influence the behavior of the private news firm and conduce to higher media plurality than when only privately owned news firms are active in the news market. When this is so, there is no need for the government to intervene in the industry through a regulator that controls the level of media plurality in the industry.

We can now also understand the behavior of prices in the private and in the mixed duopoly cases. For $\frac{2t}{3} < \gamma < 2t$, prices are higher and media plurality is lower under the mixed duopoly than under the private duopoly case. The contrary is true for $\gamma > 2t$, where prices are lower and media plurality is higher under the mixed duopoly than under the private duopoly case. This occurs because when media plurality is higher, price competition is fierce since news firms move in the direction of the center of the line. In other words, news firms have to compete more aggressively on prices for readers since their political offers are less differentiated.

From the above, when comparing the mixed and the private duopoly cases, we have two combinations of prices and media plurality. First, higher prices and lower media plurality under the mixed duopoly than under the private duopoly case for $\frac{2t}{3} < \gamma < 2t$. Second, lower prices and higher media plurality under the mixed duopoly than under the private duopoly case for

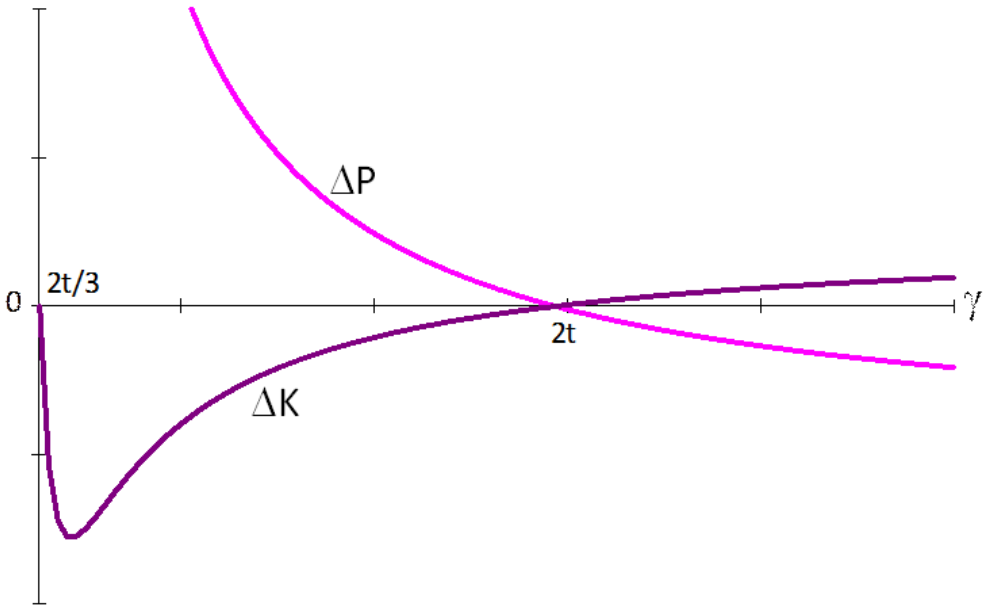

Figure 2: Prices and Media Plurality: Mixed versus Private Duopoly

$\gamma > 2t$.

Lower prices and higher media plurality increase consumer surplus, while the opposite is true for higher prices and lower media plurality. However, lower prices can either increase or decrease profits, given that while it reduces revenues per newspaper sold, it also increases demand. In addition, lower media plurality can either increase or decrease profits, since on the one hand it reduce costs of adapting news to readers' political preferences but on the other hand it can reduce demand. The opposite effects on profits arise for higher prices and higher media plurality.

Looking at profits under the two regimes, we have:

$$\Delta\Pi = \Pi_{MD} - \Pi_{PD} = \frac{\left(\gamma\left(2t(19t+12\gamma)-153\gamma^2\right)-4t^3\right)(\gamma-2t)t^2}{18(2t+3\gamma)^2(2\gamma-t)^2\gamma}, \tag{31}$$

where $\Pi_{MD} = \pi_{MD,L} + \pi_{MD,R}$ and $\Pi_{PD} = \pi_{PD,L} + \pi_{PD,R}$. It can be shown that $\Pi_{MD} > \Pi_{PD}$ for $\gamma < 2t$, and $\Pi_{MD} < \Pi_{PD}$ for $\gamma > 2t$ (see Appendix B).

We then have that profits under the mixed duopoly case are higher than profits under the private duopoly case when the costs of adapting news to readers' political preferences (γ) are low relatively to the intensity of readers' political preferences (t). This coincides with higher prices and lower media plurality under the mixed duopoly case. Furthermore, this indicates that the lower costs associated with lower levels of media plurality dominate the lower revenues from lower prices, and that the lower demand that results from lower levels of media plurality dominates the higher demand due to lower prices. The opposite arises for high γ relatively to t, where profits and prices are lower but media plurality is higher under the mixed duopoly case. This means that the extra demand due to higher levels of media plurality and higher demand due to lower prices dominate the extra costs and the fierce price competition associated with higher levels of media plurality.

In terms of consumer surplus, we have that the difference between consumer surplus under the private duopoly case and the mixed duopoly case is:

$$\Delta CS = CS_{MD} - CS_{PD} = \frac{\left(4t^3(7\gamma-2t)+9\gamma^2\left(\gamma(36\gamma-11t)-6t^2\right)\right)(\gamma-2t)t^2}{36(2t+3\gamma)^2(2\gamma-t)^2\gamma^2}. \tag{32}$$

It can be shown that $CS_{MD} < CS_{PD}$ for $\gamma < 2t$, and $CS_{MD} > CS_{PD}$ for $\gamma > 2t$ (see Appendix B). We then have that consumer surplus under the mixed duopoly case is higher than the consumer surplus under the private

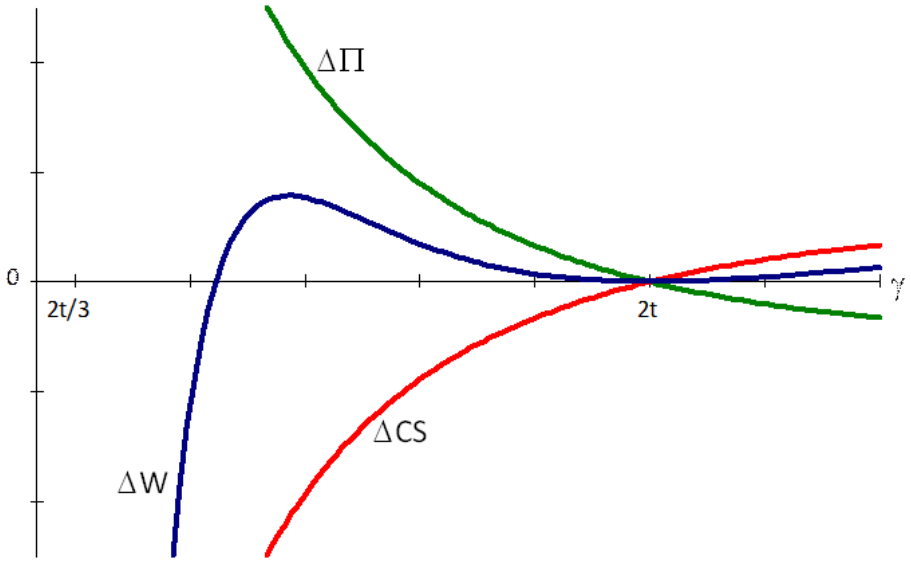

Figure 3: Consumer Surplus, Profits and Social Welfare: Mixed versus Private Duopoly

duopoly case when the costs of adapting news to readers' political preferences (γ) are high relatively to the intensity of readers' political preferences (t). This coincides with lower prices and higher media plurality under the mixed duopoly case. The opposite occurs for high γ relatively to t, where consumer surplus and media plurality are lower and prices are higher under the mixed duopoly case.

In turn, in terms of social welfare (consumer surplus plus news firms' profits), we have that the difference between social welfare under the private duopoly case and the mixed duopoly case is:

$$\Delta W = W_{MD} - W_{PD} = \frac{(\gamma-2t)^2\left(4t^3+\gamma\left(18\gamma^2-t(8t+15\gamma)\right)\right)t^2}{36(2t+3\gamma)^2(2\gamma-t)^2\gamma^2}. \tag{33}$$

It can be shown that $W_{MD} - W_{PD}$ can only be negative for $\frac{2}{3}t < \gamma < \frac{\left(5+\sqrt{89}\right)t}{12}$ (see Appendix B). In figure 3, we summarize the results in terms of profits, consumer surplus and social welfare.

We can now conclude that social welfare is higher under the private duopoly case when the costs of adapting news to readers' political prefer-

ences are low relatively to the readers' intensity of political preferences (i.e., low γ in relation to t). In turn, social welfare is higher under the mixed duopoly case when the costs of adapting news to readers' political preferences are high relatively to the readers' intensity of political preferences (i.e., high γ in relation to t). This occurs because, as we have seen above, when γ is low relatively to t, private firms can profitably provide media plurality. As a result, when γ is low relatively to t, a private duopoly provides more media plurality than a mixed duopoly, which is reflected in lower profits in the former relatively to the latter market structure. Accordingly, when γ is low relatively to t, in the mixed duopoly the public firm reduces the level of media plurality in order to increase the profits of the media firms. However, the increase in profits does not compensate for the reduction in consumer surplus.

In this sense, it only seems worthwhile for the government to participate in the news market via a publicly owned news firm, when the costs of adapting news to readers' political preferences are high relatively to the readers' intensity of political preferences. Accordingly, when γ is low relatively to t, private news firms provide sufficient levels of media plurality. In this way, "regulation by participation" in terms of media plurality is not always guaranteed in the news markets. This might seem like a surprising result, since the publicly owned news firm maximizes social welfare. The reason for this is that in contrast to the mixed duopoly literature where firms compete usually only on prices, here firms compete on both prices and media plurality. Furthermore, since more media plurality means fierce price competition, the public firm has to balance this trade-off. In addition, this trade-off only justifies the presence of a public firm when the private firms abstain from providing due to higher costs of media plurality relatively to readers political preferences.

4 Inefficiencies of the Public Firm

In the benchmark case, the public firm has no inefficiencies. As we have seen, in spite of this, the model generates an area where the private duopoly provides higher social welfare than the mixed duopoly. In other words, even when the public firm is as efficient as the private firm, it is not guaranteed that the presence of a public firm will bring higher social welfare than in a private duopoly.

We can ask what happens if the public firm has a higher cost of providing media plurality (higher γ) than the private firm. We might think that this can be the case because either the public news firm is subject to political pressure or because it has a non-professional management appointed by the government (i.e.: either a bureaucrat or a politician). When such scenario emerges, the public firm will find it more costly to provide media plurality than the private firm. As a result of this reasoning, we assume that $\gamma_L > \gamma_R$.

Note first that the equilibrium of the private duopoly case is not changed, since we continue to have $\gamma_L = \gamma_R$. We therefore only need to investigate the mixed duopoly case.

4.1 Inefficiencies: Mixed Duopoly

Stage 2: Prices. In the second stage, news firms choose prices p_i, with $i = L, R$. For news firm R, the privately owned news firm, prices are obtained by maximizing the profit expression (equation 3) with respect to p_i. It is straightforward to check that the FOC for prices for news firm R is the same as in the private duopoly case, see equation 13 (noting that now $\gamma = \gamma_R$).

For news firm L, the publicly owned news firm, the FOC is found by substituting D_L from equation 7 in the social welfare function (equation 5). It can be seen that it is obtained the same FOC as in the benchmark case, equation 20. As a result, the price expressions, p_L and p_R, are also the same as in the benchmark case (equation 21).

Stage 1: Media Plurality. In the first stage, news firms choose media plurality levels k_i, with $i = L, R$. The FOC for media plurality for the private news firm is the same as in the private duopoly case (equation 16). We can then simplify the FOC for media plurality for the privately owned news firm (equation 16) by substituting for p_R from equation 21:

$$\frac{d\pi_R}{dk_R} = \frac{1}{3}\left(t\left(k_R - k_L + 1\right)\right) - \gamma_R k_R. \tag{34}$$

In turn, for the publicly owned news firm, after substituting for p_L and p_R from equation 21, we have that the FOC for media plurality equals:

$$\frac{dW_L}{dk_L} = \frac{1}{2}\left(t\left(1 - \left(k_L + k_R\right)\right) - 2k_L\gamma_L\right). \tag{35}$$

Solving $\frac{d\pi_L}{dk_L}$ and $\frac{d\pi_R}{dk_R}$ simultaneously for k_L and k_R, we obtain the equilibrium levels of media plurality:

$$\begin{aligned} k_L &= \frac{(3\gamma_R - 2t)t}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))} \\ k_R &= \frac{2t\gamma_L}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))}. \end{aligned} \tag{36}$$

We can derive equilibrium prices by substituting for k_i $(i = L, R)$ from equation 36 in equation 21:

$$p_L = p_R = \frac{6\gamma_L\gamma_R t}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))}. \tag{37}$$

From equations 36 and 37, we obtain the demand levels for news firm L and news firm R:

$$\begin{aligned} D_L &= \frac{(3\gamma_R - 2t)(t + \gamma_L)}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))} \\ D_R &= 1 - \frac{(3\gamma_R - 2t)(t + \gamma_L)}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))}. \end{aligned} \tag{38}$$

We need to restrict the demand levels to being positive, otherwise, there is no demand for news. We can see that D_L and D_R are positive if:

$$\gamma_R \geq \frac{2t}{3}. \tag{39}$$

We assume that this condition holds in the rest of this section.

Next, we would also like to know the relation between k_L and k_R:

$$k_L - k_R = \frac{(3\gamma_R - 2\gamma_L - 2t)t}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))}. \tag{40}$$

It can be shown that $k_L < k_R$, if $\frac{2t}{3} < \gamma_R < \frac{2}{3}(t + \gamma_L)$, and $k_L > k_R$, if $\gamma_R > \frac{2}{3}(t + \gamma_L)$ (see Appendix B). Then the publicly owned news firm only provides more media plurality than the privately owned news firm when the cost advantage of the private firm is not too large.

We need again to guarantee that the media plurality segments of L and R do not overlap. We can show that this is the case if $\gamma_R \geq \frac{2t}{3}$. This is the same condition needed to guarantee that demand levels are positive, which we assume is always satisfied. Then the two media plurality segments never overlap in the mixed duopoly case.

4.2 Inefficiencies: Private Duopoly versus Mixed Duopoly

We now compare the equilibriums of the private duopoly and the mixed duopoly cases, in terms of prices, media plurality, consumer surplus, and social welfare.

We can start by showing that the difference between prices in the private duopoly case and the mixed duopoly case is (note that in the private duopoly case $\gamma_L = \gamma_R$):

$$\Delta P = p_{MD} - p_{PD} = -\frac{(3\gamma_R - 2\gamma_L - 2t)t^2}{(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))}. \tag{41}$$

It can be shown that $p_{MD} > p_{PD}$ for $\frac{2t}{3} < \gamma_R < \frac{2}{3}(t + \gamma_L)$, and $p_{MD} < p_{PD}$ for $\gamma_R > \frac{2}{3}(t + \gamma_L)$ (see Appendix B). In other words, the mixed duopoly can only generate lower prices than the private duopoly, when the public firm does not differ very much from the private firm in terms of the efficiency in providing media plurality (see also figure 2).

We have that the difference between media plurality in the private duopoly and the mixed duopoly equals:

$$\Delta K = K_{MD} - K_{PD} = \frac{(3\gamma_R - 2\gamma_L - 2t)(3\gamma_R - 2t)t}{3(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))\gamma_R}. \tag{42}$$

We have that $K_{MD} < K_{PD}$ for $\frac{2t}{3} < \gamma_R < \frac{2}{3}(t + \gamma_L)$, and $K_{MD} > K_{PD}$ for $\gamma_R > \frac{2}{3}(t + \gamma_L)$. In other words, the mixed duopoly can only generate more media plurality than the private duopoly, when the public firm does not differ very much from the private firm in terms of the efficiency in providing media plurality. In this sense, when the public firm has some inefficiencies, the difference between the private and the mixed duopoly in terms of prices and media plurality is similar to the benchmark case (see also figure 2).

Looking at profits under the two regimes, we have:

$$\Delta\Pi = \Pi_{MD} - \Pi_{PD} = \frac{\left(2t(t - 9\gamma_R)(3\gamma_R - 2t)^2 + \gamma_L\left(16t^3 + 8t^2\gamma_L + 3\gamma_R\left(204t\gamma_R - 40t\gamma_L + 84\gamma_L\gamma_R - 84t^2 - 135\gamma_R^2\right)\right)\right)t^2}{18(2\gamma_L(3\gamma_R - t) + t(3\gamma_R - 2t))^2\gamma_R}. \tag{43}$$

We can show that $\Pi_{MD} > \Pi_{PD}$ for sufficiently low levels of γ_R, and the reverse $\Pi_{MD} < \Pi_{PD}$ for sufficiently high levels of γ_R (see Appendix B). In other words, the mixed duopoly case can only generate more profits than the private duopoly case, when there is not a great difference between the private and the public firm in terms of the efficiency in providing media plurality.

In terms of consumer surplus, we have that the difference between consumer surplus under the private duopoly case and the mixed duopoly case is:

$$\Delta CS = CS_{MD} - CS_{PD} = \frac{\left(t(3\gamma_R-2t)\left(4t^2+3\gamma_R(15\gamma_R-4t)\right)+\gamma_L\left(324\gamma_R^3-2t\left(117\gamma_R^2-4t(9\gamma_R-t)\right)\right)\right)(3\gamma_R-2\gamma_L-2t)t^2}{36(2\gamma_L(3\gamma_R-t)+t(3\gamma_R-2t))^2\gamma_R^2}. \quad (44)$$

We can demonstrate that $CS_{MD} > CS_{PD}$ for sufficiently high levels of γ_R, and the reverse, $CS_{MD} < CS_{PD}$, for sufficiently low levels of γ_R (see Appendix B). In other words, the mixed duopoly case can only generate more consumer surplus than the private duopoly case, when there is not a great difference between the private and the public firm in terms of the efficiency in providing media plurality.

In turn, in terms of social welfare (consumer surplus plus news firms' profits), we have that the difference between social welfare under the private duopoly and the mixed duopoly is:

$$\Delta W = W_{MD} - W_{PD} = \frac{t\left(4t^2-8t\gamma_R+9\gamma_R^2\right)(3\gamma_R-2t)^2-4\gamma_L^2\left(36\gamma_R^3-4t^3-57t\gamma_R^2+32t^2\gamma_R\right)+2\gamma_L(3\gamma_R-2t)\left(27\gamma_R^3-8t^3-48t\gamma_R^2+40t^2\gamma_R\right)}{36(2\gamma_L(3\gamma_R-t)+t(3\gamma_R-2t))^2\gamma_R^2t^{-2}}. \quad (45)$$

It can be shown that $W_{MD} < W_{PD}$ for lower values of γ_R, and $W_{MD} > W_{PD}$ for higher values of γ_R (see Appendix B). In other words, the mixed duopoly case can only generate more social welfare than the private duopoly case, when there is not a great difference between the private and the public firm in terms of the efficiency in providing media plurality. In the case where the public firm has some inefficiencies, then, the behavior in terms of profits, consumer surplus and social welfare is similar to the one under the benchmark case (see figure 3).

5 Advertising

So far, we have abstracted from a central characteristic of media markets: advertising. However, as is well known, advertising is a very important source

of revenues in media markets. Since news firms derive revenues from selling news and advertising, the media market can be considered a two-sided market. In this section, we look at the consequences of advertising in our model.

5.1 Advertising: Private Duopoly

In this subsection, we analyze the private duopoly case with advertising.

Stage 3: Prices. In the second stage, news firms choose prices p_i, with $i = L, R$. Prices are found by maximizing the profit expression (equation 12) with respect to p_i. It can be checked that the FOC for prices in the advertising model is the same as in the benchmark case. Therefore equations 13 and 14 continue to apply.

Stage 2: Advertising. In the second stage, the news firms choose advertising levels a_i, with $i = L, R$. The FOC for a_i is:

$$\frac{d\pi_i}{da_i} = \frac{(p_j - p_i + t + tk_i - tk_j)(\alpha - 2\beta a_i)}{2t},\ i, j = L, R \text{ and } i \neq j. \tag{46}$$

Substituting for p_i and p_j from equation 14, we can simplify $\frac{d\pi_i}{da_i}$ to:

$$\frac{d\pi_i}{da_i} = \frac{(3 - k_j + k_i)(\alpha - 2\beta a_i)}{6},\ i, j = L, R \text{ and } i \neq j. \tag{47}$$

Solving $\frac{d\pi_i}{da_i}$ and $\frac{d\pi_j}{da_j}$ simultaneously for a_i and a_j (with $i, j = L, R$ and $i \neq j$), we obtain:

$$a_i = \frac{\alpha}{2\beta},\ i = L, R. \tag{48}$$

Gross advertising income (A_i) can be found by substituting for a_i from equation 48 in equation 11:

$$A_i = \frac{\alpha^2}{4\beta} D_i,\ i = L, R. \tag{49}$$

Advertising income, then, increases with the demand for news (D_i). This shows the two-sided nature of the news market in the advertising model, since there are positive externalities between the market for news and the market for advertising. In other words, news firms with higher sales are more attractive for advertisers. As such, news firms have incentives to increase the demand for news in order to augment the demand for ads.

Stage 1: Media Plurality. In the first stage, news firms choose media plurality levels k_i, with $i = L, R$. The FOC for media plurality equals:

$$\frac{d\pi_i}{dk_i} = \frac{\partial \pi_i}{\partial k_i} + \frac{\partial \pi_i}{\partial p_j}\frac{dp_j}{dk_i} + \frac{\partial A_i}{\partial k_i},\ i, j = L, R \text{ and } i \neq j. \tag{50}$$

The only difference to the benchmark case is the term $\frac{\partial A_i}{\partial k_i}$, the effect of media plurality on advertising. Solving the FOC, we obtain:

$$\frac{\partial \pi_i}{\partial k_i} = \frac{1}{3}p_i - \gamma k_i + \frac{\alpha^2}{8\beta}, i, j = L, R \text{ and } i \neq j. \tag{51}$$

The important thing to note relatively to the benchmark case is that media plurality has a positive effect on advertising, since $\frac{\partial A_i}{\partial k_i} = \frac{\alpha^2}{8\beta} > 0$. This is because when a firm provides media plurality, readership increases, which attract advertisers.

We can simplify the FOC for media plurality (equation 51) by substituting for p_i from equation 14:

$$\frac{d\pi_i}{dk_i} = \frac{t(3-k_j+k_i)}{9} + \frac{\alpha^2}{8\beta} - \gamma k_i,\ i, j = L, R \text{ and } i \neq j. \tag{52}$$

Solving $\frac{d\pi_i}{dk_i}$ and $\frac{d\pi_j}{dk_j}$ simultaneously for k_i and k_j (with $i, j = L, R$ and $i \neq j$), we obtain the equilibrium media plurality levels:

$$k_i = \frac{\left(8t\beta + 3\alpha^2\right)}{24\beta\gamma} > 0,\ i = L, R. \tag{53}$$

As in the benchmark case, the duopolists always choose positive levels of media plurality. Furthermore, media plurality increases with the intensity of the readers' political preferences (t), and with the size of the advertising market (high α and low β), but decreases with the informational and flexibility costs of adapting to the readers' political preferences (γ).

To derive equilibrium prices, substitute for k_i ($i = L, R$) from equation 53 in equation 14. It can be shown that the price in the advertising model is the same as in the benchmark case (equation 19), i.e.: $p_i = t$, $i = L, R$.

In addition, as in the benchmark case, the demand levels D_i are always positive and the news firms divide the news market in half, i.e.: $D_i = \frac{1}{2}$, with $i = L, R$. We also need to ensure that the media plurality segments do not overlap. It can be shown that $k_i \leq D_i = \frac{1}{2}$ ($i = L, R$) for:

$$\gamma \geq \frac{8t\beta + 3\alpha^2}{12\beta}. \tag{54}$$

In the rest of this section, we assume that this condition holds.

5.2 Advertising: Mixed Duopoly

In this subsection, we derive the advertising model for the mixed duopoly case.

Stage 2: Prices. In the second stage, news firms choose prices p_i, with $i = L, R$. For news firm R, the privately owned news firm, prices are obtained by maximizing the profit expression (equation 12) with respect to p_i. It is straightforward to check that the FOC for prices for news firm R is the same as in the private duopoly case in the benchmark and advertising cases (equation 13).

For news firm L, the publicly owned news firm, the FOC is found by substituting D_L from equation 7 in the social welfare function (equation 5). It results:

$$\frac{\partial W_L}{\partial p_L} = \frac{(p_R - p_L + (a_R - a_L)(\alpha - \beta(a_L + a_R)))}{2t}. \tag{55}$$

Solving $\frac{\partial W_L}{\partial p_L}$ and $\frac{d\pi_R}{dp_R}$ simultaneously for p_L and p_R, we obtain:

$$\begin{aligned} p_L &= t(k_R - k_L + 1) - 2(a_R - a_L)(\beta(a_L + a_R) - \alpha) \\ p_R &= t(k_R - k_L + 1) - (a_R - a_L)(\beta(a_L + a_R) - \alpha). \end{aligned} \tag{56}$$

Stage 2: Advertising. In the second stage, the news firms choose advertising levels a_i, with $i = L, R$. The private firm, R, has the same FOC for advertising as in the private duopoly case, i.e.: equation 46. The same is the case for the public firm. Substituting for p_L and p_R from equation 56, we can simplify $\frac{dW_L}{da_L}$ and $\frac{d\pi_R}{da_R}$ to:

$$\begin{aligned} \frac{dW_L}{da_L} &= \frac{(t(1 + k_L - k_R) + (a_L - a_R)(\alpha - \beta(a_L + a_R)))(\alpha - 2\beta a_L)}{2t} \\ \frac{d\pi_R}{da_R} &= \frac{(t(1 - k_L + k_R) + (a_R - a_L)(\alpha - \beta(a_L + a_R)))(\alpha - 2\beta a_R)}{2t}. \end{aligned} \tag{57}$$

Solving $\frac{dW_L}{da_L}$ and $\frac{d\Pi_R}{da_R}$ simultaneously for a_L and a_R (with $i, j = L, R$ and $i \neq j$), we obtain the same levels of advertising as in the private duopoly case[8], i.e.: $a_i = \frac{\alpha}{2\beta}$, $i = L, R$.

[8] There are four more solutions, but they do not satisfy the SOCs for advertis-

Stage 1: Media Plurality. In the first stage, news firms choose media plurality levels k_i, with $i = L, R$. The FOC for media plurality for the private news firm is the same as in the private duopoly case (equation 51). We can then simplify the FOC for media plurality for the privately owned news firm (equation 51) by substituting for p_R from equation 56:

$$\frac{d\pi_R}{dk_R} = \frac{t(k_R - k_L + 1) - (a_R - a_L)(\beta(a_L + a_R) - \alpha)}{3} + \frac{\alpha^2}{8\beta} - \gamma k_R. \tag{58}$$

In turn, for the publicly owned news firm, after substituting for p_L and p_R from equation 51, we have that the FOC for media plurality equals:

$$\frac{dW_L}{dk_L} = \frac{t(1 - k_R - k_L) - 2\gamma k_L + (a_R - a_L)(\beta a_L - \alpha + \beta a_R)}{2}. \tag{59}$$

Solving $\frac{dW_L}{dk_L}$ and $\frac{d\pi_R}{dk_R}$ simultaneously for k_L and k_R, we obtain the equilibrium levels of media plurality:

$$\begin{aligned} k_L &= \frac{\left(24\beta\gamma - 3\alpha^2 - 16t\beta\right)t}{8(2t+3\gamma)(2\gamma - t)\beta} \\ k_R &= \frac{\left(16t\beta\gamma + 3t\alpha^2 + 6\alpha^2\gamma\right)}{8(2t+3\gamma)(2\gamma - t)\beta}. \end{aligned} \tag{60}$$

We can derive equilibrium prices by substituting for k_i $(i = L, R)$ from equation 60 into equation 56:

$$p_L = p_R = \frac{3\left(t\alpha^2 + \alpha^2\gamma + 8\beta\gamma^2\right)t}{4(2t+3\gamma)(2\gamma - t)\beta}. \tag{61}$$

From equations 60 and 61, we obtain the demand levels for news firm L and news firm R:

$$\begin{aligned} D_L &= \frac{\left(24\beta\gamma - 16t\beta - 3\alpha^2\right)(t+\gamma)}{8(2t+3\gamma)(2\gamma - t)\beta} \\ D_R &= 1 - \frac{\left(24\beta\gamma - 16t\beta - 3\alpha^2\right)(t+\gamma)}{8(2t+3\gamma)(2\gamma - t)\beta}. \end{aligned} \tag{62}$$

We need to restrict demand levels to being positive, otherwise, there is no demand for news. We can see that D_L and D_R are positive for:

ing. These solutions are: $a_L = \frac{\left(\alpha \pm 2\beta^2\sqrt{\frac{t}{\beta^3}(k_L - k_R + 1)}\right)}{2\beta}, a_R = \frac{\alpha}{2\beta}$; $a_L = \frac{\alpha}{2\beta}, a_R = \frac{\left(\alpha \pm 2\beta\sqrt{\frac{t}{\beta}(-k_L + k_R + 1)}\right)}{2\beta}$.

$$\gamma \geq \frac{2t}{3} + \frac{3\alpha^2}{24\beta}. \tag{63}$$

We assume that this condition holds in the rest of this section. In addition, we have also to guarantee that the media plurality segments of L and R do not overlap. Since the publicly owned news firm and the privately owned news firm provide different levels of media plurality (see equation 60), we need two conditions for the two media plurality segments of the news firms not to overlap: $k_L \leq D_L$ and $1 - k_R \geq D_L$. We can show that these two conditions are satisfied if $\gamma \geq \frac{2t}{3} + \frac{3\alpha^2}{24\beta}$. This is the same condition needed to guarantee that demand levels are positive, which we assume is always satisfied.

Next, we would also like to know the relation between k_L and k_R:

$$k_L - k_R = \frac{\big(4\beta t(\gamma - 2t) - 3\alpha^2(t+\gamma)\big)}{4(2t+3\gamma)(2\gamma - t)\beta}. \tag{64}$$

As shown in appendix B, when the advertising market is large ($\beta < \frac{3\alpha^2}{4t}$), $k_L < k_R$. When the advertising market is small ($\beta > \frac{3\alpha^2}{4t}$), $k_L < k_R$ for $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \gamma < \frac{3t\alpha^2 + 8t^2\beta}{4t\beta - 3\alpha^2}$, and $k_L > k_R$ for $\gamma > \frac{3t\alpha^2 + 8t^2\beta}{4t\beta - 3\alpha^2}$. Then the public news firm only provides higher media plurality than the news firm when the advertising market is small, and the costs of adapting news are relatively high.

5.3 Advertising: Private Duopoly versus Mixed Duopoly

In this subsection, we compare the equilibriums of the private duopoly and the mixed duopoly in terms of prices, media plurality, consumer surplus, and social welfare.

We can start by showing that the difference between prices in the private duopoly and the mixed duopoly is:

$$\Delta P = p_{MD} - p_{PD} = \frac{\big(3\alpha^2\gamma + t\big(3\alpha^2 - 4\beta(\gamma - 2t)\big)\big)t}{4(2t+3\gamma)(2\gamma - t)\beta}. \tag{65}$$

As shown in appendix B, when the advertising market is large ($\beta < \frac{3\alpha^2}{4t}$), $p_{MD} > p_{PD}$. When the advertising market is small ($\beta > \frac{3\alpha^2}{4t}$), $p_{MD} > p_{PD}$ for $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \gamma < \frac{3t\alpha^2 + 8t^2\beta}{4t\beta - 3\alpha^2}$, and $p_{MD} < p_{PD}$ for $\gamma > \frac{3t\alpha^2 + 8t^2\beta}{4t\beta - 3\alpha^2}$. The mixed duopoly then only has a lower price level than in the private duopoly when

the advertising market is small, and the costs of adapting news are relatively high.

We have that the difference between media plurality in the private duopoly and the mixed duopoly equals:

$$\Delta K = K_{MD} - K_{PD} = \frac{\left(t\left(3\alpha^2-4\beta(\gamma-2t)\right)+3\alpha^2\gamma\right)(2t-3\gamma)}{12(2t+3\gamma)(2\gamma-t)\beta\gamma}. \tag{66}$$

As shown in appendix B, when the advertising market is large ($\beta < \frac{3\alpha^2}{4t}$), $K_{MD} < K_{PD}$. When the advertising market is small ($\beta > \frac{3\alpha^2}{4t}$), $K_{MD} < K_{PD}$ for $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \gamma < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$, and $K_{MD} > K_{PD}$ for $\gamma > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$. Then the mixed duopoly only provides higher media plurality than the private duopoly, when the advertising market is small, and the costs of adapting news are relatively high.

In this way, when the advertising market is small ($\beta > \frac{3\alpha^2}{4t}$), ΔK and ΔP behave in the same way as in the benchmark case (see figure 2). The only difference is that the threshold level for ΔK and ΔP being positive or being negative is now $\gamma > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$. In turn, when the advertising market is large ($\beta < \frac{3\alpha^2}{4t}$), ΔK and ΔP appear as shown in figure 4.

In turn, looking at profits under the two regimes (mixed duopoly versus private duopoly), we have:

$$\Delta\Pi = \Pi_{MD} - \Pi_{PD} = \frac{\left(t\left(3\alpha^2-4\beta(\gamma-2t)\right)+3\alpha^2\gamma\right)\left(27\alpha^2\gamma^3-2t\left(18\gamma^2\left(\alpha^2-17\beta\gamma\right)+t\left(6\gamma\left(8\beta\gamma+\alpha^2\right)-t\left(3\alpha^2-4\beta(19\gamma-2t)\right)\right)\right)\right)}{288(2t+3\gamma)^2(2\gamma-t)^2\beta^2\gamma}. \tag{67}$$

As shown in appendix B, when the advertising market is large ($\beta < \frac{3\alpha^2}{4t}$), $\Pi_{MD} > \Pi_{PD}$. When the advertising market is small ($\beta > \frac{3\alpha^2}{4t}$), $\Pi_{MD} > \Pi_{PD}$ for sufficiently low values of γ, and $\Pi_{MD} < \Pi_{PD}$ for sufficiently high values of γ. In this way, when the advertising market is large, profits are always higher in the mixed duopoly. The mixed duopoly then only provides lower profits than the private duopoly when the advertising market is small, and the costs of adapting news are relatively high.

In terms of consumer surplus, we have that the difference between consumer surplus under the private duopoly case and the mixed duopoly case is:

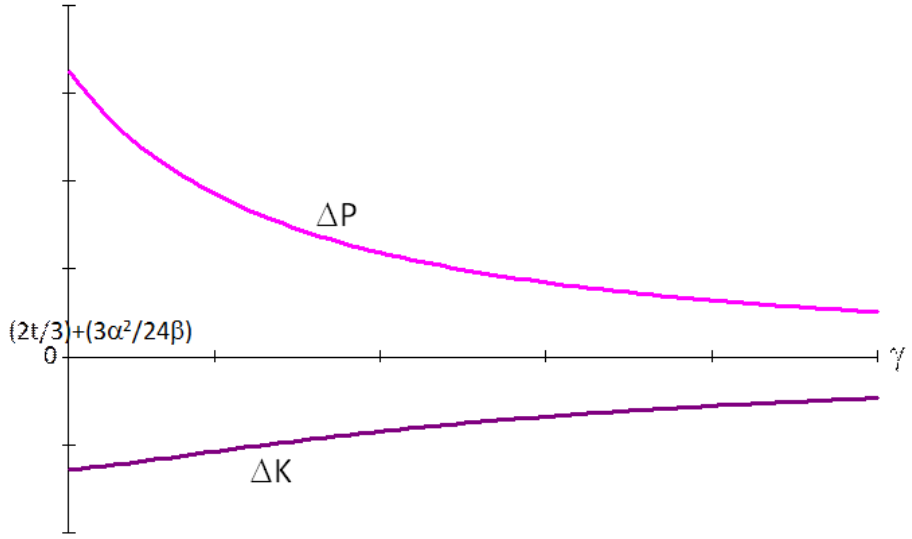

Figure 4: Prices and Media Plurality: Mixed versus Private Duopoly (Large Advertising Market)

$$\Delta CS = CS_{MD} - CS_{PD} = \frac{\left(4\beta t(\gamma-2t)-3\alpha^2(t+\gamma)\right)\left(4\beta\left(324\gamma^4-8t^4-99t\gamma^3+28t^3\gamma-54t^2\gamma^2\right)-3\alpha^2(3\gamma-2t)\left(t(\gamma-2t)+9\gamma^2\right)\right)t}{576(2t+3\gamma)^2(2\gamma-t)^2\beta^2\gamma^2}. \quad (68)$$

As shown in appendix B, when the advertising market is large ($\beta < \frac{3\alpha^2}{4t}$), $CS_{MD} < CS_{PD}$. When the advertising market is small ($\beta > \frac{3\alpha^2}{4t}$), $CS_{MD} < CS_{PD}$ for sufficiently low values of γ, and $CS_{MD} > CS_{PD}$ for sufficiently high values of γ. In this way, when the advertising market is large, consumer surplus is always lower in the mixed duopoly. The mixed duopoly then only provides higher consumer surplus than the private duopoly when the advertising market is small, and the costs of adapting news are relatively high.

In turn, in terms of social welfare (consumer surplus plus news firms' profits), we have that the difference between social welfare under the private duopoly case and the mixed duopoly case is:

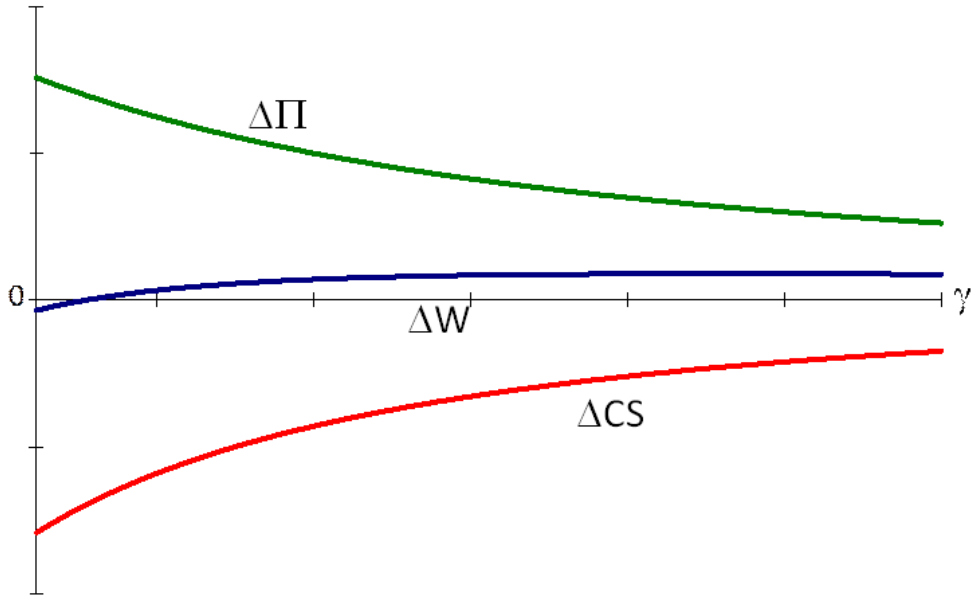

Figure 5: Profits, Consumer Surplus and Social Welfare: Mixed versus Private Duopoly (Large Advertising Market)

$$\Delta W = W_{MD} - W_{PD} = \frac{\left(4\beta t(\gamma-2t)-3\alpha^2(t+\gamma)\right)^2\left(4t^3+18\gamma^3-15t\gamma^2-8t^2\gamma\right)}{576(2t+3\gamma)^2(2\gamma-t)^2\beta^2\gamma^2}. \tag{69}$$

It can be shown that, as in the benchmark case, independently of the size of the advertising market ΔW is only positive for sufficiently high values of γ (see Appendix B). Then, in spite of the size of the advertising market being important for profits and consumer surplus under the mixed and private duopoly cases, this does not affect social welfare relatively to the benchmark case (see figure 3). The only difference is that a large advertising market makes it more likely that the mixed duopoly case provides higher social welfare, but does not eliminate the area where the private duopoly has higher welfare than the mixed duopoly. In addition, the area where the private duopoly has higher welfare than the mixed duopoly still arises for sufficiently low γ (see figure 5).

6 Discussion

In this paper, we have analyzed the effects on media plurality of competition between a private news firm that maximizes profits and a public news firm that maximizes social welfare (news firms' profits plus consumer surplus).

We show that media plurality is only higher in the mixed duopoly than in the private duopoly when the costs of adapting news to readers' political preferences are high relative to the intensity of readers' political preferences. When the costs of adapting news to readers' political preferences are low relative to the intensity of readers' political preferences, a mixed duopoly provides lower media plurality than a private duopoly.

Furthermore, industry profits are lower in the mixed duopoly relatively to the private duopoly when the costs of adapting news to readers' political preferences are high relative to the intensity of readers' political preferences. The contrary is true for consumer surplus and social welfare. Then, when the costs of adapting news to readers' political preferences are low relative to the intensity of readers' political preferences, the presence of a public firm that has an objective to maximize social welfare does not fulfill its purpose.

Contrary to the literature on mixed duopolies, in the news market publicly owned news firms can only achieve "regulation by participation" in terms of media plurality and social welfare when the costs of adapting news to readers' political preferences are high relative to the intensity of readers' political preferences. This difference relatively to the literature on mixed duopolies arises because in media markets news firms compete both on prices and media plurality. Accordingly, since increasing media plurality also increases price competition, it is more difficult to achieve "regulation by participation" in media markets than in markets where firms just compete on prices.

The relation between the costs of adapting news to readers' political preferences and the intensity of readers' political preference brings the Internet into the discussion. Some media experts argue that the Internet is changing the way of doing business in the news market, since amongst other things, it is boosting media firms' capacity to adapt news to readers' political preferences and of readers' capacity to access more content (Gentzkow, 2007; and George and Hogendorn, 2012). If this is the case, the Internet is reducing the costs of adapting news to readers' political preferences. However, at same time readers seem to show a stronger attachment to their own preferred ideology (Sunstein, 2006; and Pew Project for Excellence in Journalism, 2010). This indicates that the intensity of readers' political preferences has also

increased. It is thus not clear, whether or not news market dominated by private news firms have become more inclined to provide media plurality. In other words, we cannot dismiss totally the role of public news firms in "regulation by participation" in terms of media plurality.

The model in this paper assumes a very simplified version of media markets. First, like all standard models of media plurality based on the Hotelling model, the distribution of demand on the line is uniform. If there are peaks of demand on the line (due for example to mainstream political opinions), the incentives to provide media plurality can be reduced relatively to the case where the demand is uniformly distributed on the line (see Mullainathan and Shleifer, 2005). Second, we have not introduced supply side pressures that reduce media plurality, such as interest groups and political parties (Baron, 2006; and Besley and Prat, 2006). When interest groups and political parties control news firms, media plurality can decrease, since news firms might then end up publishing only the views supported by these groups. However, these effects can be attenuated if there is competition between interest groups and political parties for media control. Third, media outlets in our model have a fixed political location. If media firms can choose their political location, the incentives to adapt news to readers' political preferences may be affected, since price competition may become fiercer as media outlets choose locations closer to the center of the line.

Future work should try to extend our model to tackle some of the limitations that we have just discussed, such as non-uniform demand, interest groups, and choice of political location. It would also be interesting to analyze empirically when the presence of publicly owned news firms in media markets contributes to more media plurality and when it does not, i.e., when public news firms can achieve "regulation by participation" in terms of media plurality.

A Appendix

Appendix A: Second Order Conditions (SOCs). - Benchmark Case Private Duopoly:

SOC for prices: $\frac{d^2\pi_i}{dp_i^2} = -\frac{1}{t} < 0$, $i = L, R$.

SOC for media plurality: $\frac{d^2\pi_i}{dk_i^2} = -\gamma < 0$, $i = L, R$.

- Benchmark Case Mixed Duopoly:

The SOC for prices for the news firm L equals $\frac{d^2W_L}{dp_L^2} = -\frac{1}{2t} < 0$.

The SOC for media plurality for the news firm L is $\frac{d^2W_L}{dk_L^2} = -\frac{(t+2\gamma)}{2} < 0$.

- Inefficiencies Case Mixed Duopoly

The SOC for media plurality for the news firm L is $\frac{d^2W_L}{dk_L^2} = -\frac{(t+2\gamma_L)}{2} < 0$.

- Advertising Case Private Duopoly

The SOC for advertising levels is $\frac{d_i^2\pi}{da_i^2} = -\frac{\beta(3+k_i-k_j)}{3} < 0$, $i = L, R$.

The SOC for media plurality equals $\frac{d^2\pi_i}{dk_i^2} = -\gamma < 0$, $i = L, R$.

- Advertising Case Mixed Duopoly

The SOC for prices for the news firm L is $\frac{d^2W_L}{dp_L^2} = -\frac{1}{2t} < 0$.

SOCs for advertising are: $\frac{d^2W_L}{da_L^2} = -\frac{2t\beta(1+k_L-k_R)+\left(6\beta a_L(\alpha-\beta a_L)-2\beta a_R(\alpha-\beta a_R)-\alpha^2\right)}{2t} < 0$ and $\frac{d^2\pi_R}{da_R^2} = -\frac{2t\beta(1+k_R-k_L)+\left(6\beta a_R(\alpha-\beta a_R)-2\beta a_L(\alpha-\beta a_L)-\alpha^2\right)}{2t} < 0$.

The SOC for media plurality for the news firm L is $\frac{d^2W_L}{dk_L^2} = -\frac{(t+2\gamma)}{2} < 0$.

Appendix B: Other Proofs. Equation 30: Since $\gamma \geq \frac{2t}{3}$, the sign of this expression depends only on the numerator. The numerator of equation 30 has two solutions, $\frac{2t}{3}$ and $2t$, and is a convex function. The proof then follows.

Equation 31: The sign of this expression depends only on the numerator. The second term in the numerator, $(\gamma - 2t)$, is positive for $\gamma > 2t$, and negative for $\gamma < 2t$. We can also show that the first term is always negative in the interval, $\gamma \geq \frac{2t}{3}$, where our model is valid. To see this note that $(2t\,(19t + 12\gamma) - 153\gamma^2)$ has two solutions, $\frac{t\left(4-\sqrt{662}\right)}{51}$ and $\frac{t\left(4+\sqrt{662}\right)}{51}$, and is a concave function in γ. Since $\frac{2t}{3} > \frac{t\left(4+\sqrt{662}\right)}{51} > \frac{t\left(4-\sqrt{662}\right)}{51}$, the proof follows.

Equation 32: The sign of the expression only depends on the numerator. The second term in the numerator, $(\gamma - 2t)$, is positive for $\gamma > 2t$, and negative for $\gamma < 2t$. We can also show that the first term is always positive in the interval, $\gamma \geq \frac{2t}{3}$, where our model is valid. To see this note first that $4t^3\,(7\gamma - 2t)$ is always positive for $\gamma \geq \frac{2t}{3}$. The same occurs with the term $(\gamma\,(36\gamma - 11t) - 6t^2)$. In fact, $(\gamma\,(36\gamma - 11t) - 6t^2)$ has two solutions, $\frac{t\left(11-\sqrt{985}\right)}{72}$ and $\frac{t\left(11+\sqrt{985}\right)}{72}$, and is a convex function in γ. Since $\frac{2t}{3} > \frac{t\left(11+\sqrt{985}\right)}{72} > \frac{t\left(11-\sqrt{985}\right)}{72}$, the proof follows.

Equation 33: ΔW can only be negative for $\frac{2}{3}t < \gamma < \frac{\left(5+\sqrt{89}\right)t}{12}$. To see this note that all terms in equation 33 are unambiguously positive with

the exception of $18\gamma^2 - t\left(8t + 15\gamma\right)$. This term has two solutions, $\frac{\left(5-\sqrt{89}\right)t}{12}$ and $\frac{\left(5+\sqrt{89}\right)t}{12}$. Furthermore, $18\gamma^2 - t\left(8t + 15\gamma\right)$ is a convex function. Note also that our model is valid in the interval $\gamma \geq \frac{2t}{3}$, and that $\frac{\left(5-\sqrt{89}\right)t}{12} < \frac{2t}{3} < \frac{\left(5+\sqrt{89}\right)t}{12}$. Then the proof follows.

Equation 40: The denominator of the expression is always positive since $\gamma_R \geq \frac{2t}{3}$. In turn, the numerator is negative, i.e.: $k_L < k_R$, if $\gamma_R < \frac{2}{3}\left(t + \gamma_L\right)$. The proof follows.

Equation 41: The denominator of the expression is always positive since $\gamma_R \geq \frac{2t}{3}$. In turn, the numerator is positive, i.e.: $p_{MD} < p_{PD}$, if $\gamma_R > \frac{2}{3}\left(t + \gamma_L\right)$. The proof then follows.

Equation 42: The denominator of the expression is always positive since $\gamma_R \geq \frac{2t}{3}$. In turn, the numerator is positive, i.e.: $K_{MD} > K_{PD}$, if $\gamma_R > \frac{2}{3}\left(t + \gamma_L\right)$. The proof then follows.

Equation 43: The denominator is always positive. In turn, the numerator is decreasing function in γ_R. To see this note that the term in numerator at $\gamma_R = \frac{2t}{3}$ equals $40t^2\gamma_L^2$ (i.e.: $\Delta\Pi > 0$ at $\gamma_R = \frac{2t}{3}$), and at $\gamma_R = \frac{2}{3}\left(t + \gamma_L\right)$ equals $8\gamma_L^2\left(t + \gamma_L\right)\left(2t - \gamma_L\right)$ (i.e.: $\Delta\Pi < 0$ at $\gamma_R = \frac{2}{3}\left(t + \gamma_L\right)$). Furthermore, $40t^2\gamma_L^2 > 8\gamma_L^2\left(t + \gamma_L\right)\left(2t - \gamma_L\right)$. This means that $\Delta\Pi$ is negative for higher values of γ_R, and positive for smaller values of γ_R.

Equation 44: The denominator is always positive. The second term in the numerator is positive for $\gamma_R > \frac{2}{3}\left(t + \gamma_L\right)$. In turn, the second term in the numerator is increasing in γ_R. To see this note that the first term in numerator at $\gamma_R = \frac{2t}{3}$ equals $32\gamma_L t^3$, and at $\gamma_R = \frac{2}{3}\left(t + \gamma_L\right)$ equals $32\gamma_L\left(t + \gamma_L\right)\left(4t\gamma_L + 2t^2 + 3\gamma_L^2\right)$. Furthermore, $32\gamma_L t^3 < 32\gamma_L\left(t + \gamma_L\right)\left(4t\gamma_L + 2t^2 + 3\gamma_L^2\right)$. This means that ΔCS is negative for lower values of γ_R, and positive for higher values of γ_R.

Equation 45: The denominator is always positive. In turn, the term in the numerator is increasing in γ_R. To see this note that the first term in numerator at $\gamma_R = \frac{2t}{3}$ equals $-\frac{32}{3}\gamma_L^2 t^3$, and at $\gamma_R = \frac{2}{3}\left(t + \gamma_L\right)$ equals $\frac{32}{3}\gamma_L^2\left(\gamma_L - 2t\right)\left(t + \gamma_L\right)^2$. Furthermore, $-\frac{32}{3}\gamma_L^2 t^3 < \frac{32}{3}\gamma_L^2\left(\gamma_L - 2t\right)\left(t + \gamma_L\right)^2$. This means that ΔW is negative for lower values of γ_R, and positive for higher values of γ_R.

Equation 64: The denominator is positive for $\gamma > \frac{t}{2}$, which is always the case since $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{t}{2}$. The numerator has a solution $\gamma = \frac{\left(3t\alpha^2 + 8t^2\beta\right)}{\left(4t\beta - 3\alpha^2\right)}$. Furthermore, since $0 < \frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2 + 8t^2\beta}{4t\beta - 3\alpha^2}$ for $\beta > \frac{3\alpha^2}{4t}$ (i.e.: small advertising

market), and $\frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2} < 0 < \frac{2t}{3} + \frac{3\alpha^2}{24\beta}$ for $\beta < \frac{3\alpha^2}{4t}$ (i.e.: large advertising market), the result follows.

Equation 65: The denominator is positive for $\gamma > \frac{t}{2}$, which is always the case since $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{t}{2}$. The term in the numerator has the solution $\gamma = \frac{\left(3t\alpha^2+8t^2\beta\right)}{(4t\beta-3\alpha^2)}$. Furthermore, since $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta < \frac{3\alpha^2}{4t}$ (i.e.: large advertising market), while $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta > \frac{3\alpha^2}{4t}$ (i.e.: small advertising market), the result follows.

Equation 66: The denominator is positive for $\gamma > \frac{t}{2}$, which is always the case since $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{t}{2}$. The second term in the numerator is negative for $\gamma > \frac{2t}{3}$, which again is always the case since $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{2t}{3}$. The first term in the numerator has the solution $\gamma = \frac{\left(3t\alpha^2+8t^2\beta\right)}{(4t\beta-3\alpha^2)}$. Furthermore, since $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta < \frac{3\alpha^2}{4t}$ (i.e.: large advertising market), while $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta > \frac{3\alpha^2}{4t}$ (i.e.: small advertising market), the result follows.

Equation 67: The denominator is always positive. The first term in the numerator is positive for $\gamma_R > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$. In turn, the second term in the numerator is decreasing in γ_R. To see this note that the first term in numerator at $\gamma_R = \frac{2t}{3} + \frac{3\alpha^2}{24\beta}$ equals $\frac{\left(9\alpha^4+144t\alpha^2\beta+640t^2\beta^2\right)\left(32t\beta+3\alpha^2\right)\left(4t\beta+3\alpha^2\right)}{1536\beta^3}$, and at $\gamma_R = \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ equals $\frac{3\left(4t\beta+3\alpha^2\right)\left(32t\beta+3\alpha^2\right)\left(8t\beta+3\alpha^2\right)\left(88t\beta+15\alpha^2\right)t^3}{(4t\beta-3\alpha^2)^3}$. Furthermore, $\frac{\left(9\alpha^4+144t\alpha^2\beta+640t^2\beta^2\right)\left(32t\beta+3\alpha^2\right)\left(4t\beta+3\alpha^2\right)}{1536\beta^3} > \frac{3\left(4t\beta+3\alpha^2\right)\left(32t\beta+3\alpha^2\right)\left(8t\beta+3\alpha^2\right)\left(88t\beta+15\alpha^2\right)t^3}{(4t\beta-3\alpha^2)^3}$. Since, $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta < \frac{3\alpha^2}{4t}$ (i.e.: large advertising market), while $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta > \frac{3\alpha^2}{4t}$ (i.e.: small advertising market), then we have the following. For $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$, $\Delta\Pi$ is always positive. For $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$, $\Delta\Pi$ is positive for lower values of γ, and negative for higher values of γ.

Equation 68: The denominator is always positive. The first term in the numerator is positive for $\gamma_R > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$. In turn, the second term in the numerator is increasing in γ_R. To see this note that the first term in numerator at $\gamma_R = \frac{2t}{3} + \frac{3\alpha^2}{24\beta}$ equals $\frac{\left(32t\beta+3\alpha^2\right)^2\left(32t\beta+9\alpha^2\right)\left(4t\beta+3\alpha^2\right)}{1536\beta^3}$, and at $\gamma_R = \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ equals $\frac{6\left(8t\beta+3\alpha^2\right)^2\left(4t\beta+3\alpha^2\right)\left(32t\beta+3\alpha^2\right)\left(88t\beta+15\alpha^2\right)t^3}{(4t\beta-3\alpha^2)^4}$. Furthermore, $\frac{6\left(8t\beta+3\alpha^2\right)^2\left(4t\beta+3\alpha^2\right)\left(32t\beta+3\alpha^2\right)\left(88t\beta+15\alpha^2\right)t^3}{(4t\beta-3\alpha^2)^4} > \frac{\left(32t\beta+3\alpha^2\right)^2\left(32t\beta+9\alpha^2\right)\left(4t\beta+3\alpha^2\right)}{1536\beta^3}$. Since,

$\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta < \frac{3\alpha^2}{4t}$ (i.e.: large advertising market), while $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ for $\beta > \frac{3\alpha^2}{4t}$ (i.e.: small advertising market), we have the following. For $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$, ΔCS is always negative. For $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$, ΔCS is negative for lower values of γ, and positive for higher values of γ.

Equation 69: The denominator in this equation is always positive. The same is also the case with the first term in the numerator. In turn, the second term in the numerator is made up of two terms $4t^3$ (which is always positive) and $\gamma\left(18\gamma^2 - 15t\gamma - 8t^2\right)$. The term $\left(18\gamma^2 - 15t\gamma - 8t^2\right)$ has two solutions, $\frac{t\left(5-\sqrt{89}\right)}{12}$ and $\frac{t\left(5+\sqrt{89}\right)}{12}$, and is a convex function. Since, $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{t\left(5+\sqrt{89}\right)}{12} > \frac{t\left(5-\sqrt{89}\right)}{12}$, then the proof follows, whether $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} > \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$ or $\frac{2t}{3} + \frac{3\alpha^2}{24\beta} < \frac{3t\alpha^2+8t^2\beta}{4t\beta-3\alpha^2}$.

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Øystein Foros Kåre P. Hagen Hans Jarle Kind	*Price-dependent profit-shifting as a channel coordination device* SNF Working Paper No 05/08 Management Science, Vol. 8, August 2009, 1280-1291
Hans Jarle Kind Marko Koethenbuerger Guttorm Schjelderup	*Efficiency enhancing taxation in two-sided markets* SNF Working Paper No 01/08 Journal of Public Economics 92(2008) 1531-1539

In this paper, we analyze the effects on media plurality of competition between a private news firm that maximizes profits and a publicly owned news firm that maximizes social welfare. We show that when the costs of adapting news to readers' political preferences are high relatively to the intensity of the readers' political preferences, profits in the industry are lower, but prices, media plurality, consumer surplus, and social welfare are higher in the mixed duopoly than in the private duopoly case. The contrary is true when the costs of adapting news to readers' political preferences are low relatively to the intensity of the readers' political preferences. This result is confirmed with the introduction of advertising and inefficiencies of the public firm.

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