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Keywords: advertising, online platforms, content sharing, journalism.

JEL Classification: L52, L82

Arthur Campbell: Department of Economics, Monash University, Australia (email: arthur.campbell@monash.edu); Geoffrey Go: Commonwealth Treasury, Australia (email: Geoffrey.Go@treasury.gov.au); Chengsi Wang: Department of Economics, Monash University, Australia (email: chengsi.wang@monash.edu).

Pay as you share: content, platforms, and regulation*

Arthur Campbell † Geoffrey Go‡ Chengsi Wang§

Abstract

Content creators produce original work, while digital platforms share secondary versions to generate ad revenue, often without compensating them. This imbalance may reduce incentives for creating high-quality content, leading to government interventions aiming to re-balance the bargaining strengths. This paper examines how enhancing content creators' bargaining strength affects investments in primary and secondary content and subscription prices. While it directly boosts secondary content quality, the intervention's impact on primary content is ambiguous due to the opposite awareness and pricing effects. Cannibalization between primary and secondary contents may contribute to or impede quality improvement. These dynamics hold across subscription- and advertising-based models and the analysis extends to two-sided investments.

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†Department of Economics, Monash University, Australia, arthur.campbell@monash.edu.
‡Commonwealth Treasury, Australia, Geoffrey.Go@treasury.gov.au.
§Department of Economics, Monash University, Australia, chengsi.wang@monash.edu.

1 Introduction

In today's digital landscape, platforms such as Google, Facebook, and X (formerly Twitter) play a vital role in the distribution of news and other content. Often, content can be categorized into primary content and related secondary content. For example, they respectively correspond to full articles in a newspaper and a set of snippets if the creator is a news media company, movies or songs and trailers if the creator is a film or music production company, and e-books and sample chapters if the creator is a book content creator.[1] The interplay between primary and secondary content introduces a key tension: while secondary content can drive traffic to primary sources, it may also lead to cannibalization, where users rely on summaries or previews and never access the full content. This issue is particularly acute in the news industry, where platforms often leverage the secondary content of news to enhance user engagement on their own sites, leading to complex interdependencies and power imbalances between platforms and news companies.

In response to complaints from news businesses about Google and Facebook using their content through links and snippets to boost user engagement, governments have introduced policies to mandate payments from platforms to news companies for their content. Australia's News Media and Digital Platforms Mandatory Bargaining Code (also referred to as News Media Bargaining Code or NMBC), enacted in 2021, requires platforms to negotiate payments, with arbitration if agreements fail. This model has influenced similar initiatives, such as Canada's Online News Act (2023), and policies under consideration in the U.S., U.K., and EU. These measures have led to licensing agreements but also sparked controversy, including instances where platforms have withdrawn or restricted news services, such as Facebook's temporary news ban in Australia. Recently, Facebook's parent company, Meta, announced that it would cease payments to Canadian content creators after 2024 and has made similar statements regarding its participation in Australia's code once the current agreements expire. Additionally, there are concerns about platforms prioritizing foreign or unregulated content to minimize compliance costs.

While these interventions strengthen the bargaining power of content creators, particularly larger ones, with platform companies, it remains uncertain whether they will effectively support high-quality content and, if so, through which specific mechanisms. In this paper, we seek to address these questions by drawing on the implications of a theoretical model of

[1]Here are some additional examples. Podcasts hosted on Spotify or other listening platforms exemplify secondary content, as episodes are freely available to users. In contrast, creators often provide exclusive, subscription-based primary content through platforms such as Patreon. Similarly, in the music industry, secondary content includes songs available on Spotify, governed by established revenue-sharing agreements with artists, while primary content encompasses live performances and other exclusive experiences.

media competition, particularly within the context of primary and secondary content production. Specifically, we explore how an increase in a content creator's bargaining power influences investment in, and ultimately the quality of, both primary and secondary content. We identify several channels through which interventions, such as Australia's bargaining code, may impact content quality in opposing directions, explaining why the net effect of such interventions is generally ambiguous and depends on market fundamentals. We provide answers for both subscription-based and advertising-based business models.

We begin our analysis by considering a content creator who produces both primary and secondary content at a cost, generating profits through a subscription price. Potential viewers fall into two categories: the aware viewers, who are familiar with the primary content, and the unaware viewers, who are not yet exposed to it. The unaware viewers may be individuals who are not accustomed to reading serious news or have not encountered the subscription model. All viewers, however, are aware of a digital platform and can access it at will. In the absence of any intervention, the platform can freely use the creator's secondary content to attract more viewers, with advertising revenue increasing in proportion to the number of users it draws. Once on the platform, unaware viewers may discover the existence of primary content by consuming the secondary content and may subscribe if they perceive a significant quality difference relative to the subscription price and time cost. If the content creator adopts an advertising-based business model, the primary content is offered for free, and the creator's revenue is tied to how many viewers engage with the primary content. We are interested in whether the investment in content quality increases if the content creator's bargaining strength increases, i.e., its share of the platform's additional profit due to sharing secondary content increases.

Our first result shows that the enhanced bargaining strength of the content creator directly impacts only the return to secondary content, leading to increased investment in its quality. With a larger share of the advertising revenue generated from the secondary content on the platform, the creator is motivated to enhance its quality to capture a higher marginal return. While this re-balancing of bargaining powers has no direct effect on primary content quality or the subscription price, it can influence them indirectly through the improved quality of secondary content. Even without a pricing effect, higher-quality secondary content impacts primary content through channels with opposing effects. On the one hand, improved secondary content attracts more platform engagement, converting more unaware viewers to aware ones and incentivizing the creator to boost primary content quality to generate subscriptions. Conversely, better secondary content can reduce the quality gap with primary content, cannibalizing the primary content's value; the direction of this effect depends on the responsiveness of conversions to this reduced quality gap. Thus, even with a fixed subscription price, the net effect of increased bargaining strength on primary quality remains ambiguous. Lastly, the effect on subscription pricing can also go either direction: while greater viewer awareness might suggest raising the subscription price, the creator may hesitate if the marginal cost of enhancing primary content quality increases fast. We show in certain circumstances the effects on primary content quality and subscription price become clearer.

We extend the baseline model in several directions to incorporate additional key aspects of content creation and diffusion. In the baseline model, only the content creator makes investments and its investment decisions for primary and secondary content are independent from each other. We then consider an extension where the content creator makes a single investment decision, and the qualities of the two types of content are perfectly correlated. We show that, in this scenario, an increase in the content creator's bargaining strength encourages greater investment in content quality, though its effect on subscription prices remains ambiguous. Next, we explore cases where the platform also contributes to improving content quality. When both the content creator and the platform can invest in secondary content quality, as in Google News Showcase, an increase in the content creator's bargaining strength has opposing effects on their respective investments. However, as long as the net effect on secondary content quality is positive, the impacts on primary content quality and subscription price remain consistent with the baseline model. In the special case where only the platform invests in secondary content quality, the increased bargaining strength of the content creator unambiguously reduces the investment in secondary content, while the effect on primary content quality depends on how effectively aware viewers are converted into subscribers. Finally, when the platform invests in monetizing traffic through advertising, stronger bargaining power for the content creator increases both primary and secondary content quality, provided the content creator's initial bargaining strength is sufficiently low.

In the ongoing bargaining code debate in the news industry, news companies and large platforms have argued strongly for and against government intervention respectively. Central to both sides' concerns is how the presence of snippets on the platform affects demand for the news companies' primary content (full news articles hosted on their own sites). On one hand, news companies claim that large media platforms and news aggregators (e.g. Google and Facebook) are stealing and making profit off their content, reducing demand for the full-length articles and incentives to invest in quality journalism / original content (we refer to this as the "cannibalization channel").[2,3] On the other hand, Google and Facebook

[2] https://www.accc.gov.au/system/files/News%20Corp%20Australia%20%28April%202018%29.pdf

[3] Rupert Murdoch, the founder of News Corp, likened the aggregation of news to 'theft' and accused Google of stealing from news content creators,(https://www.forbes.com/2009/04/03/rupert-murdoch-google-business-media-murdoch.html) while the Associated Press (AP) expressed their frustration

refute these claims, arguing that they provide value by driving billions of page-views to news content creators (we refer to this as the “awareness channel”).[4] Our analysis builds on both the cannibalization and awareness channels, while also accounting for less obvious factors such as price elasticity and cost convexity, offering a more comprehensive picture of the effects of media code bargaining.

Our findings shed light on whether the bargaining code is effective in sustaining quality journalism. First, our model shows that, even in the absence of any compensation, allowing digital platforms to use news snippets (i.e., secondary content) may not always decrease news companies’ incentives to invest in high-quality news (i.e., primary content). If the awareness effect is strong and the conversion rate is high, allowing the platform to display snippets for free may generate a considerable amount of extra subscriptions to the news companies and encourage them to improve the quality of full news articles. Second, our results suggest that in the current debate, both sides’ arguments are flawed. Platforms argue that content sharing benefits news companies by sending additional traffic to their website. This argument ignores how the reduced content quality gap changes the conversion from awareness to subscription. News companies acknowledge the cannibalization channel but argue that platforms’ use of news snippets always negatively affects news subscriptions due to the reduced content quality gap. We show that the cannibalization channel might work in the opposite direction by improving the rate of converting non-subscribers to subscribers. In fact, we find that a mild response of conversion rate to the reduced content quality gap is often essential for the bargaining code to improve news quality. Third, even though the general implication of an intervention like the News Media Bargaining Code is ambiguous, its impact on primary content quality can be determined for certain scenarios. For example, such an intervention is likely to improve news quality when the conversion rate has a mild response to the change in news quality gap and news companies adopt an advertising-based business model. However, if the platform can invest in monetizing its traffic, such an intervention may reduce news quality if the news company’s initial bargaining power is greater than a threshold.

In what follows, we review the related literature in Section 2. We present the baseline model in Section 3 and analyze it in Section 4. We illustrate the results using a micro-founded model in Section 5. A few extensions of the baseline model are studied in Section 6. Section 7 offers some concluding remarks. All the proofs are relegated to the appendix.

with how aggregators are ‘appropriating their content’.(https://www.forbes.com/2009/04/06/google-ap-newspapers-business-media-copyright.html?sh=40e334ba5542)

[4]In Australia, Facebook drives a substantial amount of traffic to news content creators, with 15% of visits to news content creator being driven by Facebook, compared to 12% globally (Lioudis, 2021).

2 Related Literature

There is a vast body of literature on media competition and advertising, pioneered by Anderson and Coate (2005). The earlier contributions focused on competition between TV channels and assume that viewers single-home and view ads sent by multi-homing advertisers as nuisance (Crampes et al., 2009, Choi, 2006, Gabszewicz et al., 2004, Peitz and Valletti, 2008). The more recent contributions explored the impact of viewer-side multi-homing (Ambrus et al., 2016, Anderson et al., 2018, and Athey et al., 2018). Our model also allows viewer-side multi-homing on both the platform and the content creator's website but enriches that by incorporating the possibility that some viewers only discover the content creator and start multi-homing after initially single-homing on the platforms.

Digital platforms' use of secondary content can be seen as a form of content bundling, combining the consumption of their core services with secondary content. The literature on content bundling has largely focused on the entry of news aggregators into the news industry and whether it contributes to intensifying competition between newspapers and improving news quality (Jeon, 2018, Jeon and Nasr, 2016, Dellarocas et al., 2013). The most closely related to our paper, De Corniere and Sarvary (2022) considers a digital platform's bundling of news content with viewer-generated content. The platform competes with the news media for viewer attention. The effect of this competition is to increase the dispersion of news quality among the news media—high quality media respond by investing more and low quality media respond by investing less. Conversely, under an intervention that strengthens the news media's bargaining position, the dispersion in news quality decreases as high-quality news media invests less and low-quality invest more.[5] The current paper complements De Corniere and Sarvary (2022) by introducing two new features to this environment. First, it differentiates between primary content, hosted directly by the content creator, and secondary content, which is lower-quality content bundled with the platform's own services. Second, it introduces consumers who are initially unaware but may become informed through exposure to secondary content on the platform. This feature allows us to analyze the awareness channel through which content creators benefit by increasing their visibility when their content is displayed on the platform. Moreover, we are able to distinguish between the direct effect of bargaining power on secondary content and the indirect effects it exerts on primary content through different channels.

Several recent papers focus more directly on the effect of the News Media Bargaining

[5] Bisceglia (2021) explored the impact of unbundling news articles on news quality. When competition between newspapers is on the per-article, instead of per-newspaper, basis, news quality declines as the quality increase in a single article does not increase the attractiveness of other articles, whereas the opposite is true when articles are bundled.

Code (hereafter, NMBC). In Sandrini and Somogyi (2022), advertisers are assumed to be single-homing. In the absence of NMBC, they choose to advertise on the platform instead of on the news website as the former is more effective in displaying ads. Due to a lack of advertising revenue, the news company stops producing news content that is valuable to society. The NMBC can help correct this inefficiency by requiring the platform to transfer a portion of its profits to the news company. When news quality is fixed, the bargaining code consistently improves efficiency. If news quality is endogenously determined, the NMBC weakly improves viewer welfare. Our current model abstracts away from competition on the advertiser side, which could arise from multi-homing by advertisers. Instead, the model considers a more involved viewer side: we allow for secondary content shared on the platform to generate awareness of the primary content. While we do not explicitly study the welfare consequences of the NMBC, we show that the effect of this type of intervention on primary content quality is in general ambiguous. Freimane (2022) empirically evaluated the impact of NMBC on news article composition in Australia. Using a difference-in-differences approach and data on Google News, she showed that NMBC leads to an increase in content share published by large foreign news companies. Gibbard (2024) evaluated various alternative policy tools that can be adopted to maintain quality journalism. In particular, he showed that a subsidy aiming at improving news quality will be always effective, while a subsidy aiming at expanding readership can fail to achieve the goal.

Finally, policies such as NMBC are a form of ex-ante regulation imposed on digital platforms. A burgeoning literature studies how to regulate digital platforms with many of them focusing on regulating platform fees (Gomes and Mantovani, 2024, Tirole and Bisceglia, 2023, Wang and Wright, 2024). Rather than focusing on policies that regulate how much surplus platforms extract from their users, this paper examines regulations that require platforms to transfer surplus to off-platform content creators. Regulation of other types of digital platform conducts identified by ex-ante regulations such as the Digital Market Act in the EU have also been studied, e.g., self-preferencing by Anderson and Bedre Defolie (2023), Hagiu et al. (2022) and Hervas-Drane and Shelegia (2024), price parity clauses in Edelman and Wright (2015) and Wang and Wright (2020), and tying in Choi and Jeon (2021), Choi et al. (2024) and De Cornière and Taylor (2024).

3 Model

We consider a market with two major players—a platform company P and a content-producing company M. P earns advertising revenue $a > 0$ per unit of time viewers spend on its website. M earns revenue $s > 0$ per subscription to its content (or per unit of time viewers spend on its website if it uses an ad-based business model). We will first focus on the subscription-based model for M unless explicitly mentioning the ad-based model. M produces two varieties of content, primary H (with aggregate quality θ_H) and secondary L (with aggregate quality θ_L), at cost $C(\theta_L, \theta_H)$, where costs are increasing and convex, i.e., $\frac{\partial C}{\partial \theta_j}, \frac{\partial^2 C}{\partial^2 \theta_j} > 0$ for $j = L, H$ and exhibit neither cost-based complementarities or substitutabilities, i.e., $\frac{\partial^2 C}{\partial \theta_H \partial \theta_L} = 0$. The primary content is accessible on M's website after paying a subscription price s, while the secondary content is freely available through P, provided M does not restrict P from displaying it. In practice, P could be a digital platform like a social network or search engine. The primary and secondary content could represent full articles and snippets if M is a news media company, movies/songs and trailers if M is a film or music production company, or e-books and sample readings if M is a book content creator.

Both parties benefit in different ways from the presence of M's secondary contents on P. First, viewers of P value consuming the secondary content, and will spend more time on P as a result, which is monetized by P through advertising revenue. The time viewers spend on P is given by $D_P(\theta_L)$ that is increasing in the aggregate quantity/quality of the secondary content, i.e., $\frac{\partial D_P}{\partial \theta_L} > 0$. Second, M benefits from having its secondary content consumed on P by generating greater awareness for its primary content among viewers of P. Specifically, we assume that *ex ante* only a fraction $\alpha \in (0, 1)$ of viewers are aware of M. Furthermore, a fraction $f(D_P)$ of the initially unaware viewers become aware of M's primary contents by consuming the secondary contents on P. This fraction of viewers increases in the time that they spend on P, i.e., $\frac{df(D_P)}{dD_P} > 0$. Let $q(\Delta\theta, s)$ be the probability of converting an aware viewer to a subscriber to M, which is a function of the quality difference between the primary and secondary contents $\Delta\theta \equiv \theta_H - \theta_L$ and the subscription price s. Naturally, the conversion rate increases in content quality difference and decreases in subscription price, i.e., $\frac{\partial q}{\partial \Delta\theta} > 0$ and $\frac{\partial q}{\partial s} < 0$. If M adopts the ad-financed business model, the conversion rate will be independent of s in which case we write it as $q(\Delta\theta)$. The demand for M's primary content is given by

$$D_M(\theta_H, \theta_L, s) = q(\Delta\theta, s)\left[\alpha + (1 - \alpha) f(D_P(\theta_L))\right]$$

where $\alpha + (1 - \alpha) f(D_P(\theta_L))$ is the *ex post* aware population, each choosing to be a subscriber to P with a probability $q(\Delta\theta, s)$.

Suppose that, as compensation for using M's secondary contents, P shares with M a portion $\beta \in (0, 1)$ of the profits generated from displaying the secondary contents. The parameter β, interpreted as a measure of M's bargaining power, may also capture a potential policy instrument such as a policy or regulation that mandates bargaining over the compensation for using the secondary content.[6] The shared profit, which is a fraction β of the incremental advertising revenue the presence of the secondary contents generates on P, is given by:

$$\beta a \left(D_P\left(\theta_L\right) - D_P\left(0\right)\right),$$

where $D_P\left(\theta_L\right) - D_P\left(0\right)$ captures the increase in viewing time on P due to the presence of the secondary content. M's profit is given by:

$$\pi_M = sq\left(\Delta\theta, s\right)\left[\alpha + \left(1-\alpha\right) f\left(D_P(\theta_L)\right)\right] - C\left(\theta_L, \theta_H\right) + \beta a\left[D_P\left(\theta_L\right) - D_P\left(0\right)\right], \qquad (1)$$

where the first term is the subscription revenue, the second term is the content production cost, and the last term is the transfer from P.

4 Analysis

We are interested in understanding how an increase in M's bargaining power (measured by β) and thus an increase in M's share in the profit generated by the secondaries present on P affects M's investment and pricing decisions. We assume that M's profits are maximized at an interior point, ensuring the sufficiency of the first-order conditions in determining the optimum. The system of first-order conditions of M's profit in (1) with respect to price s, primary investment θ_H, and secondary investment θ_L are:

$$\begin{bmatrix} \frac{\partial \pi_M}{\partial \theta_L} \\ \frac{\partial \pi_M}{\partial \theta_H} \\ \frac{\partial \pi_M}{\partial s} \end{bmatrix} = \begin{bmatrix} \frac{\partial q}{\partial \theta_L} s\left[\alpha + \left(1-\alpha\right) f\right] + sq\left(1-\alpha\right)\frac{\partial f}{\partial D_p}\frac{dD_p}{d\theta_L} + \beta a \frac{dD_p}{d\theta_L} - \frac{\partial C}{\partial \theta_L} \\ \frac{\partial q}{\partial \theta_H} s\left[\alpha + \left(1-\alpha\right) f\right] - \frac{\partial C}{\partial \theta_H} \\ s\frac{dq}{ds}\left[\alpha + \left(1-\alpha\right) f\right] + q\left[\alpha + \left(1-\alpha\right) f\right] \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \qquad (2)$$

The first-order condition for pricing includes the standard pricing terms. The first-order condition for primary investment has two components: the marginal effect on conversion to sales and the marginal cost of the investment. For secondary investment, the first-order condition consists of four components: first, the cannibalization of sales conversion due to secondary content quality ($\frac{\partial q}{\partial \theta_L} < 0$); second, the increased awareness from viewers spending more time on P due to improved secondary content quality; third, the additional revenue M earns from its revenue-sharing agreement with P; and finally, the marginal cost of secondary content investment.

[6]The news media bargaining code is an example of such a policy.

The profit-maximizing solution to M's problem is $s^*(\beta)$, $\theta_H^*(\beta)$, and $\theta_L^*(\beta)$, given the bargaining strength β. We are interested in the sign of $\frac{\partial s^*}{\partial \beta}$, $\frac{\partial \theta_H^*}{\partial \beta}$, $\frac{\partial \theta_L^*}{\partial \beta}$. These are found through the application of multivariate implicit function theorem to the system of equations in (2):

$$\begin{bmatrix} \frac{\partial \theta_L^*}{\partial \beta} \\ \frac{\partial \theta_H^*}{\partial \beta} \\ \frac{\partial s^*}{\partial \beta} \end{bmatrix} = -\begin{bmatrix} \frac{\partial^2 \pi_M}{\partial (\theta_L)^2} & \frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} & \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} \\ \frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} & \frac{\partial^2 \pi_M}{\partial (\theta_H)^2} & \frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \\ \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} & \frac{\partial^2 \pi_M}{\partial \theta_H \partial s} & \frac{\partial^2 \pi_M}{\partial (s)^2} \end{bmatrix}^{-1} \begin{bmatrix} \frac{\partial^2 \pi_M}{\partial \theta_L \partial \beta} \\ \frac{\partial^2 \pi_M}{\partial \theta_H \partial \beta} \\ \frac{\partial^2 \pi_M}{\partial s \partial \beta} \end{bmatrix} \tag{3}$$

Note that our assumption that the first-order conditions are sufficient ensures that the Jacobian in equation (3) is negative definite. First, we consider the direct effect of an increase in β on the strategic variables θ_L^*, θ_H^*, and s^*. We observe that $\frac{\partial^2 \pi_M}{\partial \beta \partial s} = \frac{\partial^2 \pi_M}{\partial \beta \partial \theta_H} = 0$ and $\frac{\partial^2 \pi_M}{\partial \beta \partial \theta_L} = a \frac{dD_P}{d\theta_L} > 0$. Therefore, the only direct effect of M's increased bargaining power is an increase in secondary investment and therefore its quality, θ_L.

Proposition 1 (Impact on secondary content)**.** *An increase in the content creator's bargaining strength directly increases the incentives for investing in the secondary content quality* θ_L.

The result in Proposition 1 is straightforward. The compensation M receives from P depends on the number of viewers P attracts, which is influenced by θ_L but not by s or θ_H. A greater bargaining strength of M generates more profit to M holding the quality of secondary content fixed, thereby providing M with further incentive to invest in enhancing the quality of secondary content.

We now turn to how the direct effect on θ_L leads to indirect effects on θ_H^* and s^*. It is straightforward to show from equation (3) that the signs of these indirect effects are determined by:

$$\text{sign} \begin{bmatrix} \frac{\partial \theta_H^*}{\partial \beta} \\ \frac{\partial s^*}{\partial \beta} \end{bmatrix} = \text{sign} \begin{bmatrix} \frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} - \frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} \frac{\partial^2 \pi_M}{\partial (s)^2} \\ \frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} \frac{\partial^2 \pi_M}{\partial \theta_H \partial s} - \frac{\partial^2 \pi_M}{\partial (\theta_H)^2} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} \end{bmatrix} \tag{4}$$

We first study the sign of $\frac{\partial \theta_H^*}{\partial \beta}$ in Section 4.1 and then the sign of $\frac{\partial s^*}{\partial \beta}$ in Section 4.2. The proofs of these results are relegated to Appendix A.1.

4.1 Primary content

First, consider the effect on primary investment, the sign of which is determined by

$$\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} - \frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} \frac{\partial^2 \pi_M}{\partial (s)^2}. \tag{5}$$

We can decompose this into the effect through $\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} \frac{\partial^2 \pi_M}{\partial (s)^2}$ and the effect through $\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s}$. We maintain the assumption that M's profit function is strictly concave in each strategic variable, hence, the term $\frac{\partial^2 \pi_M}{\partial (s)^2} = \left(2 \frac{\partial q}{\partial s} + s \frac{\partial^2 q}{\partial s^2} \right) \times (\alpha + (1-\alpha) f(D_P)) < 0$. Furthermore,

$$\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} = \frac{\partial q}{\partial \Delta \theta} s (1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{d D_p}{d \theta_L} - \frac{\partial^2 q}{\partial \Delta \theta^2} s (\alpha + (1-\alpha) f(D_P))$$

where we have used the relation $\frac{\partial q}{\partial \Delta \theta} = \frac{\partial q}{\partial \theta_H} = -\frac{\partial q}{\partial \theta_L}$. It is composed of two effects: (i) the *awareness effect*:

$$\frac{\partial q}{\partial \Delta \theta} s (1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{d D_p}{d \theta_L} > 0$$

which captures the greater incentive to invest in the primary content to improve conversion given a higher awareness due to greater secondary investment, and (ii) the *cannibalization effect*:

$$\frac{\partial^2 q}{\partial \Delta \theta^2} s [\alpha + (1-\alpha) f(D_P)] \gtreqless 0$$

which captures the change in the slope of the conversion function as better secondary content quality reduces the propensity of viewers to purchase the primary content. This effect can be positive or negative, depending on the curvature of the conversion function $q(\Delta\theta, s)$. To see the cannibalization effect, consider how a greater secondary content quality (smaller $\Delta\theta$) influences the returns from primary content investment through additional conversions (i.e., the slope of $q(\Delta\theta, s)$). We illustrate the concave and convex cases in Figures 1 and 2 respectively. In the concave case (Figure 1), cannibalization increases the returns to primary investment because the slope of the conversion function becomes larger as $\Delta\theta$ decreases. On the other hand, in a region of the conversion function that is convex, shown in Figure 2, the opposite is true. The net effect is driven by the balance of the awareness and cannibalization channels.

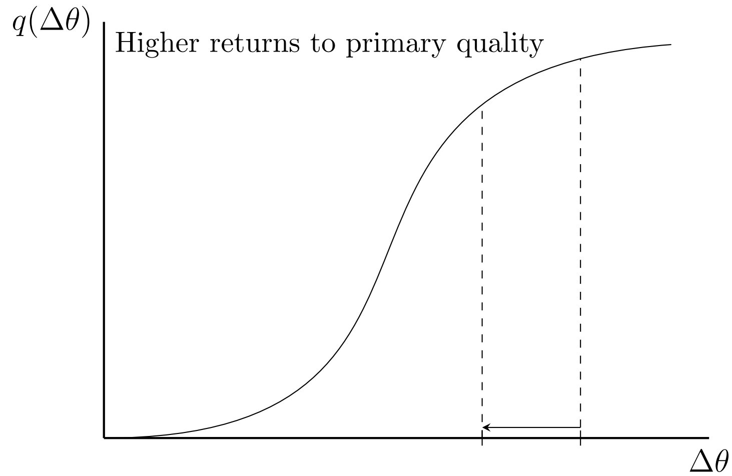

Figure 1: Higher returns to primary quality

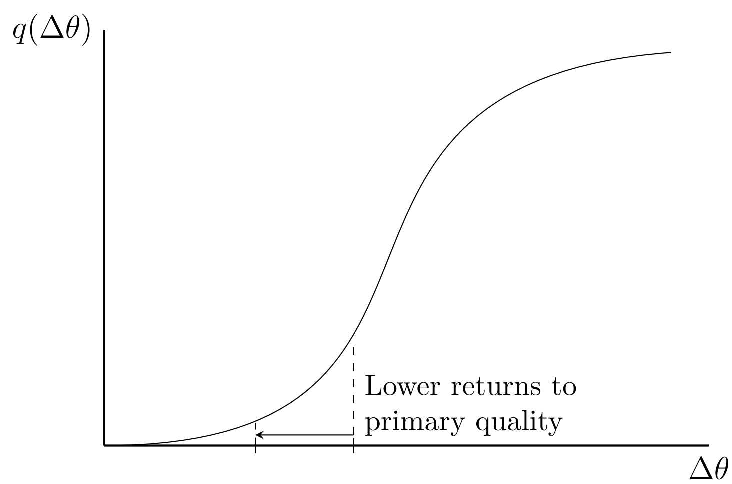

Figure 2: Lower returns to primary quality

The term $\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s}$ in (5) is the effect on primary investment that occurs through the endogenous adjustment of the subscription price. We refer to this as the *pricing channel*. It is straightforward to observe that $\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} = -\frac{\partial^2 \pi_M}{\partial \theta_L \partial s}$ and this effect is negative.

$$\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} = -\left[\left(s \frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta} \right) \left[\alpha + (1-\alpha) f(D_P) \right] \right]^2 < 0 \tag{6}$$

We summarize our findings on primary content investment in the following proposition.

Proposition 2 (Impact on primary content)**.** *The effect on the primary content quality of the bargaining parameter β through*

- *the awareness channel is positive;*

- *the pricing channel is negative;*
- *the cannibalization channel is ambiguous—positive if the conversion function is concave and negative if the conversion function is convex.*

Proposition 2 shows that a firm's bargaining strength can either increase or decrease its incentives to invest in primary content, depending on the relative influence of the awareness, cannibalization, and pricing channels. If the pricing channel is absent, due to either a fixed subscription price or M adopting an ad-financed business model (i.e., $\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \frac{\partial^2 \pi_M}{\partial \theta_L \partial s} = 0$), we can write the conversion function as $q(\Delta\theta)$ and arrive at more clear-cut result as in the next proposition. More details of the ad-financed model can be found in Appendix A.2.

Proposition 3 (Impact on primary content without pricing effect)**.** *Suppose the value of s is fixed. Then, increasing the content creator's bargaining strength β*

- *increases investment in primary content if the conversion function $q(\Delta\theta)$ is weakly concave in $\Delta\theta$;*
- *increases (decreases) investment in primary content if and only if the conversion function $q(\Delta\theta)$ is concave (convex) in $\Delta\theta$, provided α is sufficiently large.*

Proposition 3 sheds light on how a strengthened bargaining power of M affects content quality when M cannot adjust its subscriptions or advertising price. A greater bargaining strength of M always increases θ_L but only increases θ_H if the conversion rate $q(\Delta\theta)$ is not too convex.

4.2 Pricing

We now turn to how the content creator's bargaining strength affects the subscription price. Recall that the sign of the indirect effect on the subscription price is determined by:

$$\text{sign}\frac{\partial s^*}{\partial \beta} \quad = \quad \text{sign}\left(\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H}\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} - \frac{\partial^2 \pi_M}{\partial \left(\theta_H\right)^2}\frac{\partial^2 \pi_M}{\partial \theta_L \partial s}\right) \tag{7}$$

Evaluating the relevant terms in the Jacobian we find:

$$\begin{aligned}\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H}\frac{\partial^2 \pi_M}{\partial \theta_H \partial s} - \frac{\partial^2 \pi_M}{\partial \left(\theta_H\right)^2}\frac{\partial^2 \pi_M}{\partial \theta_L \partial s} = &\left(\frac{\partial q}{\partial \Delta\theta} s\left(1-\alpha\right)\frac{\partial f\left(D_P\right)}{\partial D_p}\frac{dD_p}{d\theta_L} - \frac{\partial^2 C}{\partial (\theta_H)^2}\right) \\ &\times\left(s\frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}\right)\left[\alpha + \left(1-\alpha\right) f\left(D_P\right)\right]\end{aligned} \tag{8}$$

The term $s\frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}$ in the second bracket in (8) is the effect of the primary-secondary quality difference on the pricing elasticity which, in general, could be positive or negative. An increase in β increases θ_L directly and the reduced content quality difference changes the pricing elasticity and therefore s. The term $\frac{\partial q}{\partial \Delta\theta} s\,(1-\alpha)\,\frac{\partial f(D_P)}{\partial D_p}\frac{dD_p}{d\theta_L}$ in the first bracket in (8) is the summation of the awareness and cannibalization effects from earlier, through the $\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H}$ term, and the concavity of profits with respect to primary quality, $\frac{\partial^2 \pi_M}{\partial (\theta_H)^2}$. It turns out that the cannibalization effect appears in both terms and cancels out so the sign of the first term in (8) boils down to a comparison between the awareness effect $\frac{\partial q}{\partial \Delta\theta} s\,(1-\alpha)\,\frac{\partial f(D_P)}{\partial D_p}\frac{dD_p}{d\theta_L}$ and the convexity of cost of primary investment $\frac{\partial^2 C}{\partial (\theta_H)^2}$. We summarize these insights in the following proposition.

Proposition 4 (Impact on subscription price)**.** *The effect on the subscription price of the bargaining parameter β through*

- *the awareness channel is positive;*
- *the cost convexity channel is negative;*
- *the price elasticity channel is ambiguous—positive if the content quality difference and subscription prices are complements in determining the conversion rate.*

The direct effect of increased bargaining power is to raise θ_L, thereby reducing $\Delta\theta$. If the cost convexity of primary investment is high (i.e., $\frac{\partial^2 C}{\partial \theta_H^2}$ is large), there will be a minimal adjustment to θ_H, making the net effect from the awareness and cost convexity channels negative. The subscription price adjustment depends on whether changes in $\Delta\theta$ increase or decrease the elasticity of demand for the primary content. However, the effect will reverse if the equilibrium adjustment to θ_H is significant enough that $\Delta\theta$ increases. The exact impact of an increase in β on s^* can be determined in the following special cases.

Proposition 5 (Impact on subscription price with separable $\Delta\theta$ and s)**.** *Suppose q is separable in $\Delta\theta$ and s, i.e., $\frac{\partial^2 q}{\partial \Delta\theta \partial s} = 0$. Then, increasing M's bargaining strength*

- *increases the subscription price if $C(\theta_L, \theta_H)$ is linear in θ_H;*
- *increases the subscription price if α is sufficiently large.*

5 Illustration

In this section, we micro-found the general model in Section 3 by exploring viewers' choices of P and M and then use the model to illustrate the nuanced effects of an increased bargaining strength of M on s, θ_L, and especially θ_H.

Suppose that viewers who use both platform P and content creator M incur a multi-homing cost of $c > 0$. There is an identical stand-alone benefit $v > c$ for visiting P (e.g., interacting with friends on social media or using a search engine) and a heterogeneous stand-alone benefit u for visiting M (e.g., consuming free news content on a news media website). Assume that u is distributed over the interval $[0, \overline{u}]$ according to a twice-continuously differentiable distribution function $G(u)$.[7]

The content qualities θ_L and θ_H are respectively selected from the intervals $[0, \overline{\theta}_L]$ and $[\underline{\theta}_H, \overline{\theta}_H]$, with $\overline{\theta}_L < \underline{\theta}_H$. Let viewers' time spent on P simply equal to $D_P(\theta_L) = \theta_L$, and let the probability of turning an unaware into an aware be $f(D_P) = \varphi D_P(\theta_L) = \varphi\theta_L$, where $\varphi \in [0, 1]$ is a scalar. Viewers have no outside options and must choose to join either P, M, or both. We will next consider three cases that differ in the availability of secondary content on P and possible transfers from P to M.

First, assume that the secondary content is unavailable on P, either because the regulator bans P from displaying it or because P and M fail to reach an agreement. In this case, all viewers receive a payoff of v from using P. For an aware viewer, the payoff from using only M is $\theta_H + u - s$, while the payoff from using both P and M is $v + \theta_H + u - c - s$. Aware viewers will choose to use both P and M if and only if $v + \theta_H + u - c - s \geq \max\{v, \theta_H + u - s\}$. Since $v > c$, this simplifies to:

$$u \geq c + s - \theta_H \tag{9}$$

Aware viewers will choose to only use P rather than M if and only if $u < c + s - \theta_H$, as $\theta_H + u - s < c < v$. Thus, the demand for P is equal to 1, while the demand for M is

$$\alpha(1 - G(c + s - \theta_H)) \tag{10}$$

This outcome captures how the emergence of P reduces M's demand compared to when P is absent, helping to explain the rapid decline in news companies' revenues since the introduction of digital platforms.

Second, consider the case where P displays the secondary content but does not compensate M. In this case, aware viewers use both P and M if and only if $v + \theta_H + u - c - s \geq$

[7] The specification in this section is for illustrative purposes only. Allowing both u and v to be heterogeneous but uncorrelated would not qualitatively alter the results but would significantly complicate the exposition.

$\max\{v+\theta_L, \theta_H+u-s\}$. Given that $v>c$, this requirement simplifies to:

$$u \geq c+s-\Delta\theta. \tag{11}$$

All aware viewers with $u \geq c+s-\Delta\theta$ use both P and M, while those with $u < c+s-\Delta\theta$ only use P.[8] By comparing (9) and (11), allowing P to display the secondary content leads to fewer multi-homing aware viewers, as some opt to stop using M given that they can consume the secondary content on P. Meanwhile, a fraction $\varphi\theta_L$ of initially unaware viewers become aware of M, and a proportion $q(\Delta\theta, s) = 1-G(c+s-\Delta\theta)$ of them start subscribing to M. Thus, M's total demand becomes

$$q(\Delta\theta, s)[\alpha+\varphi\theta_L(1-\alpha)] = (1-G(c+s-\Delta\theta))[\alpha+\varphi\theta_L(1-\alpha)]. \tag{12}$$

Comparing this with (10), allowing P to display the secondary content may reduce M's demand due to a lower conversion rate (i.e., $\Delta\theta < \theta_H$). However, it may also increase M's demand by raising the awareness of M (i.e., the additional term $\varphi\theta_L(1-\alpha)$). The latter effect is negligible if $\varphi\theta_L$ is sufficiently small or α is sufficiently large. This observation could explain why allowing digital platforms to display secondary content might harm well-established content creators when platform users do not prioritize high-quality news.

Finally, consider the case in which P uses the secondary content and pays a portion of the generated profits to M. M's demand is the same as in (12), but it also receives a transfer from P, equal to $a\beta(D_P(\theta_L)-D_P(0)) = a\beta\theta_L$. Let us further assume the cost functions take the quadratic form such that $C(\theta_L,\theta_H) = \frac{c_L(\theta_L)^2}{2} + \frac{c_H(\theta_H)^2}{2}$. The first-order conditions for M's maximization of (1) can be re-written as

$$\begin{aligned}
1-G(c+s-\Delta\theta) - sg(c+s-\Delta\theta) &= 0\\
g(c+s-\Delta\theta)\cdot(\alpha+(1-\alpha)\varphi\theta_L) - \frac{\theta_H c_H}{s} &= 0\\
-g(c+s-\Delta\theta)\cdot(\alpha+(1-\alpha)\varphi\theta_L) + (1-G(c+s-\Delta\theta))(1-\alpha)\varphi - \frac{\theta_L c_L - \beta a}{s} &= 0.
\end{aligned}$$

To simplify the analysis, consider the class of Generalized Pareto Distribution (GPD) of u.[9]

[8] Notably, under the ad-sponsored business model, the right-hand side of (11) simplifies to $c-\Delta\theta$, as the subscription becomes free.

[9] The class of Generalized Pareto Distributions encompasses many distributions such as Uniform, Exponential, Constant Elasticity, etc.

Under GPD,

$$G(u) = \begin{cases} 1 - (1 - \epsilon u)^{1/\epsilon}, & \text{if } \epsilon > 0 \\ 1 - e^{-u}, & \text{if } \epsilon = 0 \end{cases}$$

with $\epsilon \geq 0$ and $u \in [0, \frac{1}{\epsilon}]$. The corresponding density function is $g(u) = (1 - \epsilon u)^{\frac{1}{\epsilon} - 1}$ when $\epsilon > 0$ and $g(u) = e^{-u}$ when $\epsilon = 0$. Under GPD, the inverse hazard rate is linear in u, i.e., $\frac{1 - G(u)}{g(u)} = 1 - \epsilon u$. Using this property, the optimal subscription can be written as

$$s^* = \frac{1 - \epsilon(c - \theta_H + \theta_L)}{1 + \epsilon}.$$

Under GPD, the first-order conditions with respect to θ_L and θ_H imply

$$g\left(\frac{1 + c - \theta_H + \theta_L}{1 + \epsilon}\right) \cdot (\alpha + (1 - \alpha)\theta_L) - \frac{\theta_H c_H}{s} = 0,$$

and

$$\theta_L = \frac{[1 - \epsilon(c - \theta_H + \theta_L)][1 - \alpha + \epsilon(\theta_H - c)] + \beta a c_L(1 + \epsilon)}{[1 - \epsilon(c - \theta_H + \theta_L)][(1 - \alpha)\varphi + \epsilon] + c_L(1 + \epsilon)}.$$

The following two special cases indicate that the effect of an increase in β on θ_H would be ambiguous while its effect on θ_L is clear-cut.

■ **Example I: Exponential distribution of u.** If u is exponentially distributed, $\epsilon = 0$. Then, $s^* = 1$, $\theta_L^* = \frac{1 - \alpha + \beta a c_L}{(1 - \alpha)\varphi + c_L}$, and θ_H^* is determined by

$$e^{-(1 + c - \theta_H + \theta_L^*)}(\alpha + (1 - \alpha)\theta_L^*) - \theta_H c_H = 0.$$

In this special case, the optimal subscription price is constant, and the secondary content quality strictly increases the bargaining strength of M. However, the impact of M's bargaining strength on the primary content quality is still ambiguous. In particular, notice that an increase in β increases θ_L^*, which in turn increases the term $\alpha + (1 - \alpha)\theta_L^*$ (i.e., awareness channel) and decreases the term $e^{-(1 + c - \theta_H + \theta_L^*)}$ (i.e., cannibalization channel) simultaneously. In this special case, the cannibalization effect is negative, leading to an ambiguous net impact on primary content quality, even when the pricing channel is not present.

■ **Example II: Advertising-based model.** Assume M is financed purely by selling ads. We then interpret s as a fixed ad revenue per viewer for M. Moreover, viewers do not take into account s in making decisions. Given that s is fixed, M maximizes its profit by selecting its investment levels in both primary and secondary content. The optimal investment levels

θ_H^* and θ_L^* are determined by the first-order conditions:

$$g(c-\Delta\theta)\cdot(\alpha+(1-\alpha)\varphi\theta_L)-\frac{\theta_H c_H}{s}=0$$
$$-g(c-\Delta\theta)\cdot(\alpha+(1-\alpha)\varphi\theta_L)+(1-G(c-\Delta\theta))(1-\alpha)\varphi-\frac{\theta_L c_L-\beta a}{s}=0$$

Under GPD, the two equations above are simplified to

$$(1-\epsilon(c-\theta_H+\theta_L))^{\frac{1}{\epsilon}-1}\cdot(\alpha+(1-\alpha)\phi\theta_L)-\frac{\theta_H c_H}{s}=0 \tag{13}$$

and

$$\theta_L=\frac{s[1-\alpha+\epsilon(\theta_H-c)]+\beta a}{s[(1-\alpha)\varphi+\epsilon]+c_L} \tag{14}$$

Replace θ_L in (14) by using (13)

$$\begin{aligned}\left(1-\epsilon\left(c-\theta_H+\frac{s\left(1-\alpha+\epsilon(\theta_H-c)\right)+\beta a}{s\left((1-\alpha)\varphi+\epsilon\right)+c_L}\right)\right)^{\frac{1}{\epsilon}-1}&\\ \times\left[\alpha+(1-\alpha)\phi\frac{s\left(1-\alpha+\epsilon(\theta_H-c)\right)+\beta a}{s\left((1-\alpha)\varphi+\epsilon\right)+c_L}\right]-\frac{\theta_H c_H}{s}&=0\end{aligned} \tag{15}$$

Notice that $g(\cdot)$ is an increasing function if $\epsilon>1$. In this case, the left-hand side of (15) strictly increases in β. Moreover, the first term on the left-hand side of (15) increases in θ_H, while the second term $-\frac{\theta_H c_H}{s}$ decreases in θ_H. Thus, whether θ_H increases in β is generally ambiguous. If $\epsilon<1$ and therefore $g(\cdot)$ is a decreasing function, the relationship between β and θ_H is even less clearcut. In the very special case with $g(\cdot)=1$ and therefore u is uniformly drawn from $[0,1]$, one can show that θ_H decreases in β.

6 Extensions

In this section, we extend the baseline model in Section 5 to capture other important aspects of investment made by either the content creator or the platform.

6.1 Correlated content quality

In our baseline model, the qualities of the primary and secondary contents are independent. One may think that the qualities of primary and secondary contents are correlated. For example, the quality of a news snippet displayed on Facebook often reflects the calibre of the full article it is derived from. A well-crafted, informative article is more likely to produce a snippet that accurately captures key points, providing users with a reliable preview. Conversely, if the underlying article lacks depth or accuracy, the snippet may also fail to deliver meaningful or trustworthy information. We modify our model to explore such possibilities.

Suppose M chooses an investment level $\theta \in [0, 1]$ which simultaneously determines both θ_H and θ_L. Specifically, let $\theta_H = \theta$ and $\theta_L = \lambda(\theta)$ with $\frac{d\lambda(\theta))}{d\theta} > 0$ and $\lambda(\theta)) < \theta$ for all θ. With slight abuse of notation, we write the investment cost function as $C(\theta)$.

Given the profit-sharing agreement between P and M, M's total profit is given by

$$\pi_M = sq(\theta - \lambda(\theta), s)(\alpha + f(D_P(\lambda(\theta))))(1 - \alpha)) - C(\theta) + a\beta\left(D_P(\lambda(\theta)) - D_P(0)\right). \quad (16)$$

While an increase in β has an unambiguous impact on content investments, its impact on subscription price is undetermined. We summarize the findings in the proposition below.

Proposition 6 (Correlated content quality)**.** *When the qualities of primary and secondary content are perfectly correlated, increasing the content creator's bargaining strength increases the content quality but can either increase or decrease the subscription price.*

In the special cases where the quality difference does not affect the price elasticity of the conversion function q, i.e., $\frac{\partial^2 q}{\partial s \partial \Delta\theta} = 0$, an increase in M's bargaining strength increases the subscription price if and only if the quality increases in the secondary corresponding to the quality increase of the primary is less than one-to-one.

Corollary 1 (Correlated content quality with separable $\Delta\theta$ and s)**.** *Suppose the qualities of the primary and secondary content are correlated and q is separable in $\Delta\theta$ and s, i.e., $\frac{\partial^2 q}{\partial \Delta\theta \partial s} = 0$. Then, an increase in M's bargaining strength increases the subscription price if and only if $\frac{d\lambda}{d\theta} < 1$.*

If a greater β expands the quality difference between primary and secondary content, it reduces aware users' willingness to pay for the primary content, allowing M to charge a higher subscription price. If instead a greater β decreases the quality difference, less aware users would like to pay for the primary content and M has to reduce the subscription price.

6.2 Two-sided investments: content moderation

In the benchmark model, the platform has no strategic decision to make and only plays a passive role. In this section, we consider a setting where both M and P can enhance the quality of the secondary content, a case consistent with Google investing in moderating snippets after settling a deal with Australian news content creators. In the context of news content, P's investment in the secondary content can be interpreted as its investment in moderation, where organizing and presenting a coherent storyline composed of various snippets plays a more critical role in determining viewers' utility from reading the secondary content than the quality of the individual snippets themselves. As part of its response to increasing global pressure from regulators and content creators, Google launched Google News Showcase, a licensing program, in 2020 to allow content creators to display their content in panels across Google's platforms. This effort aimed to improve the user experience by ensuring that news from diverse sources is presented in a coherent and engaging manner.

Let the quality of the secondary content be additive in the investments made by M and P, i.e., $\theta_L = \theta_L^M + \theta_L^P$, where θ_L^M and θ_L^P are investments on secondary content made by M and P respectively. Let the investment cost functions be $C_M(\theta_L^M, \theta_H)$ and $C_P(\theta_L^P)$ for M and P respectively. We consider both the subscription and advertising business models adopted by M. M maximizes its profits through setting θ_L^M and θ_H under the advertising model and in addition through setting s under the subscription model. Finally, P chooses its investment in θ_L^P to maximize its profit, which is a share $1-\beta$ of the total advertising profit from displaying the secondary content.

$$\max_{\theta_L^P} \; a(1-\beta)\left(D_P(\theta_L) - D_P(0)\right) - C_P(\theta_L^P). \tag{17}$$

This results in the following first-order conditions that describe the Nash Equilibrium in the platform and content creator's choices.

$$\begin{bmatrix} \frac{\partial \pi_P}{\partial \theta_L^P} \\ \frac{\partial \pi_M}{\partial \theta_L^M} \\ \frac{\partial \pi_M}{\partial \theta_H} \\ \frac{\partial \pi_M}{\partial s} \end{bmatrix} = \begin{bmatrix} (1-\beta)\, a \frac{dD_P}{d\theta_L^P} - \frac{dC_P}{d\theta_L^P} \\ s\frac{\partial q}{\partial \theta_L^M}\left[\alpha + (1-\alpha) f\right] + sq\,(1-\alpha)\frac{\partial f}{\partial D_P}\frac{dD_P}{d\theta_L^M} + \beta a \frac{dD_P}{d\theta_L^M} - \frac{\partial C}{\partial \theta_L^M} \\ s\frac{\partial q}{\partial \theta_H}\left[\alpha + (1-\alpha) f\right] - \frac{\partial C}{\partial \theta_H} \\ s\frac{\partial q}{\partial s}\left[\alpha + (1-\alpha) f\right] + q\left[\alpha + (1-\alpha) f\right] \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

The final row is only required under the subscription business model. We can then derive the following comparative static relationships with respect to the bargaining power β where once again the final row and column are only relevant for the subscription business model:

$$\begin{bmatrix} \frac{\partial \theta_L^P}{\partial \beta} \\ \frac{\partial \theta_L^M}{\partial \beta} \\ \frac{\partial \theta_H^M}{\partial \beta} \\ \frac{\partial s}{\partial \beta} \end{bmatrix} = - \begin{bmatrix} \frac{\partial^2 \pi_P}{\partial \left(\theta_L^P\right)^2} & \frac{\partial^2 \pi_P}{\partial \theta_L^P \partial \theta_L^M} & 0 & 0 \\ \frac{\partial^2 \pi_M}{\partial \theta_L^P \partial \theta_L^M} & \frac{\partial^2 \pi_M}{\partial \left(\theta_L^M\right)^2} & \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M} & \frac{\partial^2 \pi_M}{\partial s \partial \theta_L^M} \\ \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P} & \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M} & \frac{\partial^2 \pi_M}{\partial (\theta_H)^2} & \frac{\partial^2 \pi_M}{\partial \theta_H \partial s} \\ \frac{\partial^2 \pi_M}{\partial s \partial \theta_L^P} & \frac{\partial^2 \pi_M}{\partial s \partial \theta_L^M} & \frac{\partial^2 \pi_M}{\partial \theta_H \partial s} & \frac{\partial^2 \pi_M}{\partial (s)^2} \end{bmatrix}^{-1} \begin{bmatrix} -1 \\ 1 \\ 0 \\ 0 \end{bmatrix} a\frac{dD_P}{d\theta_L} \tag{18}$$

We assume the model is well-behaved such that the inverse of the Jacobian is negative definite i.e. $Det < 0$ in the case of the advertising business model and $Det > 0$ in the case of the subscription model (e.g. a condition such as sufficiently large convexity of the cost functions C_P and C_M achieves this). This leads us to the following two propositions characterizing the direct and indirect effects of M's increased bargaining strength.

Proposition 7. *Under both business models, the direct effect of an increase in β is negative on the platform's and positive on the content creator's investment in secondary content quality. The net effect on overall quality $\frac{\partial \theta_L}{\partial \beta} = \frac{\partial \theta_L^P}{\partial \beta} + \frac{\partial \theta_L^M}{\partial \beta}$ is positive (negative) when the convexity of the investment costs into θ_L for the platform is greater (less) than that for the content creator.*

As in the one-sided investment model, the change of bargaining strengths only affects the split of the surplus created by the secondary content on the platform. When both sides can invest, the effect is to increase the incentives for the content creator and decrease the incentives for the platform to invest in the quality of the secondary content. Moreover, the net effect on secondary quality is determined by the comparison of the convexity of costs of the platform versus the content creator. Intuitively, it is the firm that has less convex costs that will adjust its investment more to changes in the split of the surplus. This now allows us to characterize the nature of the indirect effects on primary content quality and subscription price (under the subscription business model).

Proposition 8. *Under both business models, the indirect effect of an increase in β on primary content quality $\frac{\partial \theta_H}{\partial \beta}$ is the same as (opposite to) the one-sided investment model whenever the direct net effect on the secondary content quality is positive (negative). Similarly, under the subscription business model the effect on the subscription price $\frac{\partial s}{\partial \beta}$ is the same as (opposite to) the one-sided investment model whenever the direct net effect on the secondary content quality is positive (negative).*

In Proposition 2, we show that when only the content creator can invest in the secondary content quality the net effect of an increase in its bargaining strength on the primary content quality is jointly determined by the channels of awareness, cannibalization, and pricing, and its sign is in general ambiguous. When both sides can invest in the secondary content quality, the nature of the indirect effects on primary quality is determined by the same channels as in the one-sided investment model. Proposition 8 further confirms that whether the effect is in the same/opposite direction is entirely determined by whether the direct net effect on secondary content quality is in the same/opposite direction as in the one-sided investment model. As stated in Proposition 7, this is driven by the relative convexity of costs for the content creator and platform to improve secondary content quality. Similarly, Proposition 8 shows that the effect on the subscription price will be the same as in the one-sided investment model if the net effect on secondary content quality is positive and in the opposite direction otherwise. Recall that, in the one-died investment model, increasing the content creator's bargaining strength affects its subscription fee through the channels of awareness, cost convexity and price elasticity as identified in Proposition 4.

A notable special case of Propositions 7 and 8 arises when only the platform invests in secondary content quality. In the news media industry, this scenario is relevant when social media snippets provide minimal information about the news itself, yet their perceived quality is largely influenced by the platform's moderation. We illustrate how an increase in β affects content quality and subscription price in this case using Example III below. For simplicity, we focus on the ad-funded business model and follow the specification introduced in Example II.

■ **Example III: Platform moderation.** Suppose that M chooses θ_H and P chooses θ_L. Given that the investments are made independently, let $C_L(\theta_L)$ and $C_H(\theta_H)$ be the cost functions for P and M respectively. P's profit maximization problem is

$$\max_{b}\ a(1-\beta)(D_P(\theta_L)-D_P(0))-C_L(\theta_L)=a(1-\beta)\theta_L-C_L(\theta_L).$$

The first-order condition pins down the optimal θ_L^* as below

$$a(1-\beta)=C_L'(\theta_L^*).$$

Thus, consistent with Proposition 7, an increase in β causes P to lower θ_L as it has to share with M a higher share of return to its investment. M chooses θ_H to maximize

$$\begin{aligned}&s(\alpha+f(D_P(\theta))(1-\alpha))q(\Delta\theta)+a\beta(D_P(\theta_L)-D_P(0))-C_H(\theta_H)\\=&s(\alpha+\varphi\theta_L(1-\alpha))(1-G(c-\Delta\theta))+a\beta\theta_L-C_H(\theta_H)\end{aligned}$$

Note that the monetary transfer (the second term) does not depend on θ_H. The first-order condition pins down the optimal θ_H^*

$$s(\alpha+\varphi\theta_L^*(1-\alpha))g(c-(\theta_H^*-\theta_L^*))=C_H'(\theta_H^*). \tag{19}$$

The optimal θ_H^* only indirectly depends on β through θ_L^*. Totally differentiating the first-order condition in (19), we obtain

$$\frac{d\theta_H}{d\theta_L} = \frac{s\varphi\theta_L(1-\alpha)g + s(\alpha+\varphi\theta_L(1-\alpha))g'}{s(\alpha+\varphi\theta_L(1-\alpha))g' + C_H''}$$

The denominator is always positive due to the second-order condition. The numerator is positive if $G(\cdot)$ is convex, and can be negative if $G(\cdot)$ is sufficiently concave. Note that the convexity of G, and thus the curvature of $g(\Delta\theta)$, again plays an important role in determining the effect on θ_H via the cannibalization channel as in our baseline model. If $g' > 0$, $q(\Delta\theta)$ is concave in $\Delta\theta$ and the cannibalization effect results in a greater return to investing in the primary content in response to an increase in the secondary content quality. As a result, θ_H decreases if θ_L decreases. If $g' < 0$, $q(\Delta\theta)$ is convex in $\Delta\theta$ and the resulting negative cannibalization effect can be more than offset by the positive awareness effect when θ_L increases. Thus, a reduction in θ_L may lead to a higher θ_H.

The Google News Showcase has been praised by advocates of the News Media Bargaining Code as an innovative initiative enabling both platforms and content creators to collaboratively enhance news content quality. While it is still too early to fully evaluate the outcomes of this initiative, an important consideration is that Google may have weaker incentives to invest in moderating snippets when content creators receive a larger share of the additional advertising profits. However, despite the possibly lower snippet quality, the full articles' quality could improve under the bargaining code due to the cannibalization effect, where a wider quality gap between snippets and full articles incentivizes greater investment in enhancing the full articles' quality.

6.3 Two-sided investments: monetisation

In this section, we explore another key area of investment frequently undertaken by digital platforms: enhancing their monetization capabilities. Digital platforms such as Google and Facebook invest heavily in improving their ability to monetize user traffic, primarily to maximize advertising revenue. These investments often focus on enhancing the precision and effectiveness of ad targeting by leveraging vast amounts of user data and advanced algorithms. For example, Google continually refines its search algorithms and ad placement systems to deliver highly relevant ads based on user search intent and browsing behaviour. Similarly, Meta invests in machine learning technologies that enable advertisers to target specific audience segments based on detailed user profiles, interests, and online activities. In addition to targeting, both platforms develop sophisticated analytics tools and bidding systems, such as Google Ads and Meta Ads Manager, which help advertisers optimize their campaigns and improve return on investment.[10]

The content quality θ_L and θ_H are still chosen by M but for simplicity we assume their values are perfectly correlated as in Section 6.1. We also assume an advertising-based model for M as in Example II, i.e., $D_P(\theta_L) = \theta_L$, $\theta_H = \theta$, and $\theta_L = \lambda(\theta)$ with $\lambda'(\theta) \geq 0$. For simplicity, we further assume $G(u) = u$ for $u \in [0, 1]$ and M's investment cost as $C(\theta) = \frac{c_M \theta^2}{2}$ with $c_M > 0$.

The platform P invests in improving its ability to monetize platform traffic, converting user engagement into advertising revenue. Let b be the incremental advertising revenue per unit of viewer activity on P due to such investments, i.e., $a = a_0 + b$ where a_0 is the basic ad revenue per unit of activity on P. Its per-viewer investment cost is $C_P(b) = \frac{c_P b^2}{2}$ with $c_P > 0$. P's investment problem is

$$\max_b \ [(a_0 + b)(1 - \beta) - C_P(b)] \, (D_P(\theta) - D_P(0)).$$

The first-order condition yields P's optimal investment level

$$b = \frac{1 - \beta}{c_P}.$$

Using this expression, M's profit maximization problem becomes

$$\max_\theta \ s(\alpha + f\lambda(\theta)(1 - \alpha))(1 - (c - \theta + \lambda(\theta))) + \left(a_0 + \frac{1 - \beta}{c_P}\right) \beta\lambda(\theta) - \frac{1}{2} c_M \theta^2.$$

The first-order condition is given by

$$sfc_P\lambda'(1 - \alpha)(1 - (c - \theta + \lambda) + s(\alpha + f\lambda(1 - \alpha))c_P(1 - \lambda') + (a_0 c_P + 1 - \beta)\beta\lambda' - c_M c_P \theta = 0.$$

We are interested in how an increase in β affects θ. Define the left-hand side of the first-order condition above as $\Phi(\theta, \beta)$. The implicit function theorem implies $\frac{d\theta}{d\beta} = -\frac{d\Phi/d\beta}{d\Phi/d\theta}$. The second-order condition implies $\frac{d\Phi}{d\theta} < 0$. Thus, the sign of $\frac{d\theta}{d\beta}$ is the same as the sign of $\frac{d\Phi}{d\beta}$. We have

$$\frac{d\Phi}{d\beta} = (a_0 c_P + 1 - 2\beta)\lambda'.$$

Given $\lambda' > 0$, $\frac{d\theta^*}{d\beta} > 0$ if and only if $\beta < \frac{a_0 c_P + 1}{2}$.

[10]In the case of the News Media Bargaining Code, the underlying idea is that higher-quality news snippets encourage greater engagement from platform users. Increased user activity on the platform can, in turn, be monetized through higher advertising revenues.

Proposition 9. *When M's investments in θ_H and θ_L are perfectly correlated and P invests in monetization, an increase in β increases θ_H and θ_L if and only if $\beta < \frac{1+a_0 c_P}{2}$.*

Proposition 9 shows that an increase in M's bargaining strength encourages it to invest more if and only if its initial bargaining position is weak. In contrast, when P starts with strong bargaining power, a further increase in its bargaining strength significantly reduces its own incentive to invest. Given that P's and M's investments are complementary in this setting, this also dampens M's incentive to invest.

7 Managerial and policy implications

The rise of digital platforms has reduced the time internet users spend on certain content creators' websites, such as those of news media outlets. Content creators often attribute their declining revenues to platforms' unilateral use of secondary versions of their content. While this practice can have negative effects, this paper highlights a positive awareness channel through which content sharing may benefit creators. By exposing initially unaware users to secondary content, platforms can increase awareness of the primary content, leading to additional subscriptions or website visits and generating more revenue. As a result, it is not necessarily optimal for content creators to always prohibit content sharing, even in the absence of direct compensation. Instead, they must strategically weigh whether allowing platforms to share their content for free could yield net benefits.

Compensation from platforms—mandated by legislation in countries such as Australia and Canada—provides content creators with additional incentives to supply secondary content. In response, content creators are encouraged to enhance both the quality and quantity of this secondary content. However, they must also exercise caution when determining the optimal quality and quantity of their primary content. Despite the benefits of the awareness channel, the extent to which compensation increases the marginal profitability of primary content depends on how much the improved secondary content cannibalizes demand for the primary content. As the quality of secondary content rises and cannibalization intensifies, content creators may be compelled to lower subscription prices, which can further reduce the profitability of investing in primary content.

It is also crucial to evaluate the effectiveness of the awareness channel. Whether initially uninformed users, once exposed to secondary content on the platform, ultimately subscribe to the media company's primary content depends on more than just content quality and subscription prices. Other factors—such as users' budget constraints (particularly for younger users who make up a large share of the uninformed audience), consumption habits, and the availability of alternative content—play an important role. When these factors are significant, the awareness channel becomes less effective. In such cases, content creators may find it more viable to adopt an ad-supported business model and offer free access to their content.

A key application of our findings is in evaluating the impact of NMBC. These policies aim to sustain journalism quality by requiring platforms to compensate content creators through negotiated agreements. Our analysis shows that this policy objective can be achieved by incentivizing improvements in snippet quality, challenging the common perception that such interventions merely redistribute surplus without enhancing news quality. However, the degree to which these policies succeed in improving news quality depends not only on the effectiveness of the awareness channel but also on other critical factors, including cannibalization effects and subscription pricing dynamics.

Journalism quality is more likely to improve when the conversion rate from informed non-subscribers to subscribers is relatively insensitive to the quality gap between primary and secondary content. Under this condition, raising the quality of snippets does not significantly erode content creators' incentives to invest in their primary content. Additionally, the prospect of improved primary content quality under such policies is greater when the platform's subscription price remains relatively unresponsive to the enhanced quality of secondary content.

Another critical factor influencing the effectiveness of the policy is the nature of investment in content quality. As discussed in Section 6, when the platform controls the quality of secondary content, an increase in mandated compensation to content providers can inadvertently lead to a reduction in the quality of secondary content. This, in turn, may also diminish the quality of primary content, even though the content creator receives a larger share of the platform's additional profits from content sharing. This outcome underscores the complex relationship between mandated financial transfers and content quality, highlighting the need for careful policy design to avoid unintended consequences.

The current model focuses on a single content creator. In practice, however, policy interventions like the News Media Bargaining Code affect a broad spectrum of content creators, ranging from large TV networks to small independent video producers. While the code typically applies only to content creators that meet certain thresholds, it can also generate indirect effects on smaller creators, who collectively may have a significant influence on overall welfare. Moreover, platforms may respond strategically by substituting content for which they must pay with content that is exempt from such requirements. For instance, Freimane (2022) shows that Australia's News Media Bargaining Code significantly altered the composition of news content on platforms, with larger foreign content creators capturing a greater share of visibility at the expense of major domestic outlets.

Meta's refusal to renew its initial agreement and its apparent willingness to take the drastic step of removing news from its platform highlights a crucial issue: the bargaining code may violate the platforms' participation constraint. This problem could arise from the best-offer arbitration system, which may disproportionately favour news media. Our findings suggest that while such interventions can improve news quality, they are only effective if bargaining does not break down. This raises an important question: what is the optimal profit-sharing rule that strikes the right balance between incentivizing platform participation and improving news quality?

Alternative approaches, such as a "tech tax," have been proposed as potential substitutes for the bargaining code. Unlike the code, a tech tax would extend beyond news and could be redistributed to both large and small players in the news industry. Future research should closely examine the effects of a tech tax, as related work is beginning to emerge (see, for example, Gibbard (2024)).

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A Appendix for the main model

A.1 Proofs of Proposition 2 and 4.

The system of first-order conditions for M's profit maximization is given in (2). At the status quo, $\beta = 0$ and the solution is given by $s^*(0), \theta_H^*(0), \theta_L^*(0)$. **[CS: I am not sure why we have the last sentence. Does the analysis below only apply to β close to 0?]** We are interested in the sign of the derivative of the solution with respect to β, i.e., $\frac{\partial s^*}{\partial \beta}, \frac{\partial \theta_H^*}{\partial \beta}, \frac{\partial \theta_L^*}{\partial \beta}$. These are given by the multivariate implicit function theorem:

$$\begin{bmatrix} \frac{\partial s^*}{\partial \beta} \\ \frac{\partial \theta_H^*}{\partial \beta} \\ \frac{\partial \theta_L^*}{\partial \beta} \end{bmatrix} = -J^{-1} \begin{bmatrix} \frac{\partial^2 \pi_M}{\partial s \partial \beta} \\ \frac{\partial^2 \pi_M}{\partial \theta_H \partial \beta} \\ \frac{\partial^2 \pi_M}{\partial \theta_L \partial \beta} \end{bmatrix} = -J^{-1} \begin{bmatrix} 0 \\ 0 \\ a\frac{dD_p}{d\theta_L} \end{bmatrix},$$

where J^{-1} is the inverse of the Jacobian of the system of equations given by the first-order conditions in (2). Furthermore, $a\frac{dD_p}{d\theta_L} > 0$. Hence, to establish the sign of $\frac{\partial s^*}{\partial \beta}, \frac{\partial \theta_H^*}{\partial \beta}, \frac{\partial \theta_L^*}{\partial \beta}$, we need to establish the sign of the elements in the 3rd column of J^{-1}. To find these we need to find the Jacobian of the above system. Notice that the Jacobian J will be symmetric since the first-order conditions are themselves derived from the same objective function. We list the three columns of the Jacobian:

$$\begin{aligned}
J_{\cdot,1} &= \begin{bmatrix} 2\frac{\partial q}{\partial s}\left[\alpha + (1-\alpha) f\right] + s\frac{\partial^2 q}{\partial s^2}\left[\alpha + (1-\alpha) f\right] \\ s\frac{\partial^2 q}{\partial s \partial \theta_H}\left[\alpha + (1-\alpha) f\right] + \frac{\partial q}{\partial \theta_H}\left[\alpha + (1-\alpha) f\right] \\ s\frac{\partial^2 q}{\partial s \partial \theta_L}\left[\alpha + (1-\alpha) f\right] + \frac{\partial q}{\partial \theta_L}\left[\alpha + (1-\alpha) f\right] + (s\frac{\partial q}{\partial s} + q)(1-\alpha)\frac{df}{dD_p}\frac{dD_p}{d\theta_L} \end{bmatrix} \\
J_{\cdot,2} &= \begin{bmatrix} s\frac{\partial^2 q}{\partial s \partial \theta_H}\left[\alpha + (1-\alpha) f\right] + \frac{\partial q}{\partial \theta_H}\left[\alpha + (1-\alpha) f\right] \\ \frac{\partial^2 q}{\partial \theta_H^2} s\left[\alpha + (1-\alpha) f\right] - \frac{\partial^2 C}{\partial \theta_H^2} \\ \frac{\partial^2 q}{\partial \theta_H \partial \theta_L} s\left[\alpha + (1-\alpha) f\right] + \frac{\partial q}{\partial \theta_H} s(1-\alpha)\frac{df}{dD_p}\frac{dD_p}{d\theta_L} \end{bmatrix} \\
J_{\cdot,3} &= \begin{bmatrix} s\frac{\partial^2 q}{\partial s \partial \theta_L}\left[\alpha + (1-\alpha) f\right] + \frac{\partial q}{\partial \theta_L}\left[\alpha + (1-\alpha) f\right] + (s\frac{\partial q}{\partial s} + q)(1-\alpha)\frac{df}{dD_p}\frac{dD_p}{d\theta_L} \\ \frac{\partial^2 q}{\partial \theta_H \partial \theta_L} s\left[\alpha + (1-\alpha) f\right] + \frac{\partial q}{\partial \theta_H} s(1-\alpha)\frac{df}{dD_p}\frac{dD_p}{d\theta_L} \\ \frac{\partial^2 q}{\partial \theta_L^2} s[\alpha + (1-\alpha) f] + s(1-\alpha)\frac{df}{dD_p}\left(2\frac{\partial q}{\partial \theta_L}\frac{dD_p}{d\theta_L} + q\frac{d^2 D_P}{d\theta_L^2}\right) + \beta a\frac{d^2 D_P}{d\theta_L^2} - \frac{\partial^2 C}{\partial \theta_L^2} \end{bmatrix}
\end{aligned}$$

The expressions above can be simplified by noting that at the optimum $s\frac{\partial q}{\partial s}+q=0$.

$$J_{\cdot,1} = \begin{bmatrix} \left(2\frac{\partial q}{\partial s}+s\frac{\partial^2 q}{\partial s^2}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \left(s\frac{\partial^2 q}{\partial s\partial\theta_H}+\frac{\partial q}{\partial\theta_H}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \left(s\frac{\partial^2 q}{\partial s\partial\theta_L}+\frac{\partial q}{\partial\theta_L}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \end{bmatrix}$$

$$J_{\cdot,2} = \begin{bmatrix} \left(s\frac{\partial^2 q}{\partial s\partial\theta_H}+\frac{\partial q}{\partial\theta_H}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \frac{\partial^2 q}{\partial\theta_H^2}s\left[\alpha+(1-\alpha)f(D_P)\right]-\frac{\partial^2 C}{\partial\theta_H^2} \\ \frac{\partial^2 q}{\partial\theta_H\partial\theta_L}s\left[\alpha+(1-\alpha)f(D_P)\right]+\frac{\partial q}{\partial\theta_H}s(1-\alpha)\frac{\partial f(D_P)}{\partial D_p}\frac{dD_p}{d\theta_L} \end{bmatrix}$$

$$J_{\cdot,3} = \begin{bmatrix} \left(s\frac{\partial^2 q}{\partial s\partial\theta_L}+\frac{\partial q}{\partial\theta_L}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \frac{\partial^2 q}{\partial\theta_H\partial\theta_L}s\left[\alpha+(1-\alpha)f(D_P)\right]+\frac{\partial q}{\partial\theta_H}s(1-\alpha)\frac{\partial f(D_P)}{\partial D_p}\frac{dD_p}{d\theta_L} \\ \frac{\partial^2 q}{\partial\theta_L^2}s[\alpha+(1-\alpha)f]+s(1-\alpha)\frac{df}{dD_p}\left(2\frac{\partial q}{\partial\theta_L}\frac{dD_p}{d\theta_L}+q\frac{d^2 D_P}{d\theta_L^2}\right)+\beta a\frac{d^2 D_P}{d\theta_L^2}-\frac{\partial^2 C}{\partial\theta_L^2} \end{bmatrix}$$

Under the assumption that q is a function of $\Delta\theta$ and s, we have the following relationships for q in terms of M's choice variables:

$$\begin{aligned} \frac{\partial q}{\partial\Delta\theta} &= \frac{\partial q}{\partial\theta_H}=-\frac{\partial q}{\partial\theta_L} \\ \frac{\partial^2 q}{\partial\Delta\theta^2} &= \frac{\partial^2 q}{\partial\theta_H^2}=\frac{\partial^2 q}{\partial\theta_L^2}=-\frac{\partial^2 q}{\partial\theta_H\partial\theta_L} \\ \frac{\partial^2 q}{\partial\Delta\theta\partial s} &= \frac{\partial^2 q}{\partial\theta_H\partial s}=-\frac{\partial^2 q}{\partial\theta_L\partial s} \end{aligned}$$

we can substitute these into the previous relationships to find:

$$J_{\cdot,1} = \begin{bmatrix} \left(2\frac{\partial q}{\partial s}+s\frac{\partial^2 q}{\partial s^2}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \left(s\frac{\partial^2 q}{\partial\Delta\theta\partial s}+\frac{\partial q}{\partial\Delta\theta}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \left(-s\frac{\partial^2 q}{\partial\Delta\theta\partial s}-\frac{\partial q}{\partial\Delta\theta}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \end{bmatrix}$$

$$J_{\cdot,2} = \begin{bmatrix} \left(s\frac{\partial^2 q}{\partial\Delta\theta\partial s}+\frac{\partial q}{\partial\Delta\theta}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ \frac{\partial^2 q}{\partial\Delta\theta^2}s\left[\alpha+(1-\alpha)f(D_P)\right]-\frac{\partial^2 C}{\partial\theta_H^2} \\ -\frac{\partial^2 q}{\partial\Delta\theta^2}s\left[\alpha+(1-\alpha)f(D_P)\right]+\frac{\partial q}{\partial\Delta\theta}s(1-\alpha)\frac{\partial f(D_P)}{\partial D_p}\frac{dD_p}{d\theta_L} \end{bmatrix}$$

$$J_{\cdot,3} = \begin{bmatrix} \left(-s\frac{\partial^2 q}{\partial\Delta\theta\partial s}-\frac{\partial q}{\partial\Delta\theta}\right)\left[\alpha+(1-\alpha)f(D_P)\right] \\ -\frac{\partial^2 q}{\partial\Delta\theta^2}s\left[\alpha+(1-\alpha)f(D_P)\right]+\frac{\partial q}{\partial\Delta\theta}s(1-\alpha)\frac{\partial f(D_P)}{\partial D_p}\frac{dD_p}{d\theta_L} \\ \frac{\partial^2 q}{\partial\Delta\theta^2}s[\alpha+(1-\alpha)f]+s(1-\alpha)\frac{df}{dD_p}\left(-2\frac{\partial q}{\partial\Delta\theta}\frac{dD_p}{d\theta_L}+q\frac{d^2 D_P}{d\theta_L^2}\right)+\beta a\frac{d^2 D_P}{d\theta_L^2}-\frac{\partial^2 C}{\partial\theta_L^2} \end{bmatrix}$$

Profit being at a maximum implies that J is negative definite which implies $\det[J] < 0$

$$
\begin{aligned}
J^{-1}_{1:2;3} &= \begin{bmatrix} \frac{\partial s^*}{\partial \beta} \\ \frac{\partial \theta_H}{\partial \beta} \end{bmatrix} = -\frac{1}{\det[J]} \begin{bmatrix} J_{23}J_{12} - J_{22}J_{13} \\ -(J_{23}J_{11} - J_{21}J_{13}) \end{bmatrix} \\
&= -\frac{1}{\det[J]} \begin{bmatrix} \begin{bmatrix} \left(-\frac{\partial^2 q}{\partial \Delta\theta^2} s[\alpha + (1-\alpha) f(D_P)] + \frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L}\right) \left(s \frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}\right) [\alpha + (1-\alpha) f(D_P)] \\ -\left(\frac{\partial^2 q}{\partial \Delta\theta^2} s[\alpha + (1-\alpha) f(D_P)] - \frac{\partial^2 C}{\partial \theta_H^2}\right) \left(-s \frac{\partial^2 q}{\partial \Delta\theta \partial s} - \frac{\partial q}{\partial \Delta\theta}\right) [\alpha + (1-\alpha) f(D_P)] \end{bmatrix} \\ -\begin{bmatrix} \left(-\frac{\partial^2 q}{\partial \Delta\theta^2} s[\alpha + (1-\alpha) f(D_P)] + \frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L}\right) \left(2\frac{\partial q}{\partial s} + s\frac{\partial^2 q}{\partial s^2}\right) [\alpha + (1-\alpha) f(D_P)] \\ -\left[\left(s \frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}\right) [\alpha + (1-\alpha) f(D_P)]\right]^2 \end{bmatrix} \end{bmatrix} \\
&= -\frac{1}{\det[J]} \begin{bmatrix} \left(\frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L} - \frac{\partial^2 C}{\partial \theta_H^2}\right) \left(s \frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}\right) [\alpha + (1-\alpha) f(D_P)] \\ -\begin{bmatrix} \left(-\frac{\partial^2 q}{\partial \Delta\theta^2} s[\alpha + (1-\alpha) f(D_P)] + \frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L}\right) \left(2\frac{\partial q}{\partial s} + s\frac{\partial^2 q}{\partial s^2}\right) [\alpha + (1-\alpha) f(D_P)] \\ -\left[\left(s \frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}\right) [\alpha + (1-\alpha) f(D_P)]\right]^2 \end{bmatrix} \end{bmatrix}
\end{aligned}
$$

The term $-\frac{1}{\det[J]} > 0$ so the sign is determined by the terms to the right.

First, consider the expressions that determine the sign of $\frac{\partial \theta_H}{\partial \beta}$. The sign of the first term

$$\left(-\frac{\partial^2 q}{\partial \Delta\theta^2} s[\alpha + (1-\alpha) f(D_P)] + \frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L}\right) \left(2\frac{\partial q}{\partial s} + s\frac{\partial^2 q}{\partial s^2}\right) [\alpha + (1-\alpha) f(D_P)]$$

is determined by $-\frac{\partial^2 q}{\partial x^2} s[\alpha + (1-\alpha) f(D_P)] + \frac{\partial q}{\partial x} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L}$. This is because the second-order condition with respect to s must hold at the maximum such that $2\frac{\partial q}{\partial s} + s\frac{\partial^2 q}{\partial s^2} < 0$. This is the effect of β on θ_H if there was no effect coming through the endogenous response of s (i.e. s is independent of θ_L, θ_H). We discussed above the two elements of this effect: the positive awareness channel with $\frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L} > 0$ and the ambiguous cannibalization channel $-\frac{\partial^2 q}{\partial \Delta\theta^2} s[\alpha + (1-\alpha) f(D_P)]$. The second term is the effect on θ_H that occurs because of the endogenous response of s and it is straightforward to see that it is negative, i.e.,

$$-\left[\left(s\frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta}\right) [\alpha + (1-\alpha) f(D_P)]\right]^2 \leq 0.$$

Consider next the expressions that determine the sign of $\frac{\partial s^*}{\partial \beta}$. The term $\alpha + (1-\alpha) f(D_P) > 0$ so we can ignore it. Of the remaining terms, $\frac{\partial q}{\partial \Delta\theta} s(1-\alpha) \frac{\partial f(D_P)}{\partial D_p} \frac{dD_p}{d\theta_L} > 0$ (i.e., awareness channel), $-\frac{\partial^2 C}{\partial \theta_H^2} < 0$ (i.e., convex of cos), and $s\frac{\partial^2 q}{\partial \Delta\theta \partial s} + \frac{\partial q}{\partial \Delta\theta} \lesseqgtr 0$ which is the derivative of marginal profits with respect to $\Delta\theta$ and depends on the shape of q.

A.2 Details of ad-financed model

In this section, we consider the case where M makes all its profits from advertising and therefore s is interpreted as the advertising revenue per viewer on M. The abilities to monetize website traffic to advertising revenue of P and M may differ, reflected by the different advertising revenue per viewer, i.e., $a \neq s$.

As noted earlier, s no longer enters viewers' decision problem and the conversion rate is $q(\Delta\theta)$ when s is interpreted as advertising revenue. The media company's profit is given by

$$sq(\Delta\theta)\left[\alpha + (1-\alpha)f(D_p(\theta_L))\right] - C(\theta_L, \theta_H) + \beta a\left(D_P(\theta_L) - D_P(0)\right)$$

It chooses θ_H and θ_L to maximize its profit. The system of the first-order conditions gives

$$\begin{bmatrix} \frac{\partial \pi_M}{\partial \theta_H} \\ \frac{\partial \pi_M}{\partial \theta_L} \end{bmatrix} = \begin{bmatrix} \frac{\partial q}{\partial \theta_H} s\left[\alpha + (1-\alpha)f\right] - \frac{\partial C}{\partial \theta_H} \\ \frac{\partial q}{\partial \theta_L} s\left[\alpha + (1-\alpha)f\right] + sq(1-\alpha)\frac{\partial f}{\partial D_p}\frac{dD_p}{d\theta_L} + \beta a\frac{dD_p}{d\theta_L} - \frac{\partial C}{\partial \theta_L} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{20}$$

Apply the multivariate implicit function theorem to the system of equations in (20):

$$\begin{bmatrix} \frac{\partial \theta_H^*}{\partial \beta} \\ \frac{\partial \theta_L^*}{\partial \beta} \end{bmatrix} = -J^{-1}\begin{bmatrix} \frac{\partial^2 \pi_M}{\partial \beta \partial \theta_H} \\ \frac{\partial^2 \pi_M}{\partial \beta \partial \theta_L} \end{bmatrix} = -J^{-1}\begin{bmatrix} 0 \\ \frac{\partial^2 \pi_M}{\partial \beta \partial \theta_L} \end{bmatrix} = -J^{-1}\begin{bmatrix} 0 \\ a\frac{dD_P}{d\theta_L} \end{bmatrix} \tag{21}$$

Given M's profit is maximized, J is negative definite and $\det[J] > 0$. It is easy to check

$$\text{sign}\left[\frac{\partial \theta_H^*}{\partial \beta}\right] = \text{sign}\left[\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H}\right]$$

Since $\frac{\partial^2 \pi_M}{\partial \theta_L \partial \theta_H} = -s\frac{d^2 q}{d\Delta\theta^2}\left[\alpha + (1-\alpha)f(D_p(\theta_L))\right] + \frac{dq}{d\Delta\theta}s(1-\alpha)\frac{df}{dD_P}\frac{dD_P}{d\Delta\theta}$, which can be either positive or negative depending on the curvature of $q(\Delta\theta)$, we have $\frac{\partial \theta_H^*}{\partial \beta} \lesseqgtr 0$. Moreover,

$$\text{sign}\left[\frac{\partial \theta_L^*}{\partial \beta}\right] = \text{sign}\left[-\frac{\partial^2 \pi_M}{\partial \theta_L^2}\right],$$

which is positive.

B Appendix for extensions

B.1 Details for Section 6.1

Consider that claims in Proposition 6. M chooses s and θ to maximize this profit. The first-order conditions are given by

$$\begin{bmatrix} \frac{\partial \pi_M}{\partial s} \\ \frac{\partial \pi_M}{\partial \theta} \end{bmatrix} = \begin{bmatrix} q + s\frac{\partial q}{\partial s} \\ s\frac{\partial q}{\partial \Delta\theta}\left(1 - \frac{d\lambda}{d\theta}\right)(\alpha + f(1-\alpha)) + sq(1-\alpha)\frac{df}{dD_P}\frac{dD_P}{d\lambda}\frac{d\lambda}{d\theta} - \frac{dC}{d\theta} + a\beta\frac{dD_P}{d\lambda}\frac{d\lambda}{d\theta} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{22}$$

Apply the multivariate implicit function theorem to the system of equations in (22):

$$\begin{bmatrix} \frac{\partial s^*}{\partial \beta} \\ \frac{\partial \theta^*}{\partial \beta} \end{bmatrix} = -J^{-1}\begin{bmatrix} \frac{\partial^2 \pi_M}{\partial \beta \partial s} \\ \frac{\partial^2 \pi_M}{\partial \beta \partial \theta} \end{bmatrix} = -J^{-1}\begin{bmatrix} 0 \\ \frac{\partial^2 \pi_M}{\partial \beta \partial \theta} \end{bmatrix} = -J^{-1}\begin{bmatrix} 0 \\ a\frac{dD_P}{d\lambda}\frac{d\lambda}{d\theta} \end{bmatrix} \tag{23}$$

Given M's profit is maximized, J is negative definite and $\det[J] > 0$. It is easy to check

$$\text{sign}\left[\frac{\partial \theta^*}{\partial \beta}\right] = \text{sign}\left[-\frac{\partial^2 \pi_M}{\partial \theta^2}\right],$$

which has to be positive. Therefore, an increase in M's bargaining strength increases the quality of both primary and secondary content when the qualities of the two are correlated.

To determine how the subscription price is affected by a greater β, we have

$$\text{sign}\left[\frac{\partial s^*}{\partial \beta}\right] = \text{sign}\left[\frac{\partial^2 \pi_M}{\partial \theta \partial s}\right]$$

Note that

$$\frac{\partial^2 \pi_M}{\partial \theta \partial s} = \left(\frac{\partial q}{\partial \Delta\theta} + s\frac{\partial^2 q}{\partial s \partial \Delta\theta}\right)\left(1 - \frac{d\lambda}{d\theta}\right)$$

The first term is the effect of the primary-secondary quality difference on the pricing elasticity, which, in general, could be positive or negative. The second term measures the relative increase of θ_L when θ_H increases by one unit. It is negative if θ_L increases faster than θ_H, and vice versa.

B.2 Details for Section 6.2

B.2.1 Advertising Business Model

We start with the advertising business model. In this case, we find the following from equation (18):

$$\begin{bmatrix} \frac{\partial \theta_L^P}{\partial \beta} \\ \frac{\partial \theta_L^M}{\partial \beta} \\ \frac{\partial \theta_H^M}{\partial \beta} \end{bmatrix} = -\frac{1}{Det}\begin{bmatrix} \frac{\partial^2 \pi_M}{\partial (\theta_L^M)^2}\frac{\partial^2 \pi_M}{\partial (\theta_H)^2} - \left(\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\right)^2 & -\left(\frac{\partial^2 \pi_P}{\partial \theta_L^P \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial (\theta_H)^2}\right) & \cdot \\ -\left(\frac{\partial^2 \pi_M}{\partial \theta_L^P \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial (\theta_H)^2} - \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P}\right) & \frac{\partial^2 \pi_P}{\partial (\theta_L^P)^2}\frac{\partial^2 \pi_M}{\partial (\theta_H)^2} & \cdot \\ \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial \theta_L^P \partial \theta_L^M} - \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P}\frac{\partial^2 \pi_M}{\partial (\theta_L^M)^2} & -\left(\frac{\partial^2 \pi_P}{\partial (\theta_L^P)^2}\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M} - \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P}\frac{\partial^2 \pi_P}{\partial \theta_L^P \partial \theta_L^M}\right) & \cdot \end{bmatrix}$$
$$\times \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} a\frac{dD_P}{d\theta_L} \tag{24}$$

We ignore the elements in the third column of the matrix above as doing so does not affect the results. We assume the model is well-behaved resulting in such that $Det < 0$ (e.g. sufficiently large convexity of the cost functions C_P and C_M achieves this). The additive investments by the P and M into secondary quality result in the following relationships:

$$\begin{aligned}
\frac{\partial^2 \pi_M}{\partial\left(\theta_L^M\right)^2} &= \frac{\partial^2 \pi_M}{\partial \theta_L^P \partial \theta_L^M} - \frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2} \\
\frac{\partial^2 \pi_P}{\partial\left(\theta_L^P\right)^2} &= \frac{\partial^2 \pi_P}{\partial \theta_L^P \partial \theta_L^M} - \frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} \\
\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P} &= \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}
\end{aligned}$$

allowing us to find:

$$\begin{bmatrix} \frac{\partial \theta_L^P}{\partial \beta} \\ \frac{\partial \theta_L^M}{\partial \beta} \\ \frac{\partial \theta_H^M}{\partial \beta} \end{bmatrix} = -\frac{1}{Det} \begin{bmatrix} \frac{\partial^2 \pi_M}{\partial\left(\theta_L^M\right)^2}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2} - \left(\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\right)^2 & -\left(\frac{\partial^2 \pi_P}{\partial \theta_L^P \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2}\right) & . \\ -\left(\frac{\partial^2 \pi_M}{\partial \theta_L^P \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2} - \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P}\right) & \frac{\partial^2 \pi_P}{\partial\left(\theta_L^P\right)^2}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2} & . \\ \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L}\left(\frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2}\right) & -\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L}\left(-\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2}\right) & . \end{bmatrix} \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} a\frac{dD_P}{d\theta_L}$$

$$\begin{bmatrix} \frac{\partial \theta_L^P}{\partial \beta} \\ \frac{\partial \theta_L^M}{\partial \beta} \\ \frac{\partial \theta_H^M}{\partial \beta} \end{bmatrix} = -\frac{a\frac{dD_P}{d\theta_L}}{Det} \begin{bmatrix} \left(\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\right)^2 - \frac{\partial^2 \pi_M}{\partial\left(\theta_L^M\right)^2}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2} - \left(\frac{\partial^2 \pi_P}{\partial \theta_L^P \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2}\right) \\ \frac{\partial^2 \pi_M}{\partial \theta_L^P \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2} - \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^P} + \frac{\partial^2 \pi_P}{\partial\left(\theta_L^P\right)^2}\frac{\partial^2 \pi_M}{\partial(\theta_H)^2} \\ \frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\left(\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2}\right) \end{bmatrix}$$

First observe that the direct effect on secondary quality $\frac{\partial \theta_L}{\partial \beta} = \frac{\partial \theta_L^P}{\partial \beta} + \frac{\partial \theta_L^M}{\partial \beta}$ is given by:

$$\frac{\partial \theta_L}{\partial \beta} = -\frac{a\frac{dD_P}{d\theta_L}}{Det}\left[\frac{\partial^2 \pi_M}{\partial(\theta_H)^2}\left(\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2}\right)\right], \tag{25}$$

where the terms $-\frac{a\frac{dD_P}{d\theta_L}}{Det}$ and $\frac{\partial^2 \pi_M}{\partial(\theta_H)^2}$ are both positive, hence, the direct effect is determined by the difference in the convexity of costs for the P and M $\left(\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2}\right)$. Second, the indirect effect on primary quality is given by:

$$\frac{\partial \theta_H}{\partial \beta} = -\frac{a\frac{dD_P}{d\theta_L}}{Det}\left[\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}\left(\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2}\right)\right], \tag{26}$$

where the term $\frac{\partial^2 \pi_M}{\partial \theta_H \partial \theta_L^M}$ contains the awareness and cannibalization effects from earlier. Hence, the direction and channels of the effect of the increased β on primary investment is either the same as in the one-sided investment case when P's cost function is more convex than that of M's, $\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} > \frac{\partial^2 C}{\partial\left(\theta_L^M\right)^2}$ or in the opposite direction when P's cost function is more convex than that of M's.

B.2.2 Subscription Business Model

Consider the subscription business model. The impact of the increased β on the endogenous variables is given by in (18). We maintain the assumption that the Jacobian is negative semi-definite, implying its determinant $Det > 0$. This results in the following relationship for direct effect of the increased β on the investment of P and M into secondary content:

$$\begin{bmatrix} \frac{d\theta_L^P}{\partial\beta} \\ \frac{d\theta_L^M}{\partial\beta} \end{bmatrix} = -\frac{a\frac{dD_P}{d\theta_L}}{Det} \begin{bmatrix} -\begin{vmatrix} \frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} & -\begin{vmatrix} \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M} & 0 & 0 \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} \\ \begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} & \begin{vmatrix} \frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2} & 0 & 0 \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} \end{bmatrix}$$

This allows us to find

$$\begin{aligned} \frac{d\theta_L}{d\beta} &= -\frac{a\frac{dD_P}{d\theta_L}}{Det} \begin{vmatrix} \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} \left[\left(\frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} - \frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2}\right) + \left(\frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M}\right)\right] \\ \frac{d\theta_L}{d\beta} &= \frac{a\frac{dD_P}{d\theta_L}}{Det} \begin{vmatrix} \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} \left[\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C_M}{\partial\left(\theta_L^M\right)^2}\right], \end{aligned}$$

where $\frac{a\frac{dD_P}{d\theta_L}}{Det}, \begin{vmatrix} \frac{\partial^2\pi_M}{\partial(\theta_H)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_H} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} > 0$ implying the result of the direct effect. Now consider the indirect effect on primary quality investment:

$$\begin{aligned} \frac{d\theta_H^M}{\partial\beta} &= \frac{a\frac{dD_P}{d\theta_L}}{Det} \left[\begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} - \begin{vmatrix} \frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2} & \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M} & 0 \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix}\right] \\ &= \frac{a\frac{dD_P}{d\theta_L}}{Det} \left[\left(\frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} - \frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2}\right) \begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix}\right. \\ &\quad - \left(\frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2} - \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M}\right) \begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix} + \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} \begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} \end{vmatrix} \end{aligned}$$

Observe that $\frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} = \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M}; \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} = \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M}; \frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} - \frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2} = \frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2}; \frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2} - \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M} = \frac{\partial^2 C_M}{\partial\left(\theta_L^M\right)^2}$.We can simplify this to:

$$\frac{d\theta_H^M}{\partial\beta} = \frac{a\frac{dD_P}{d\theta_L}}{Det}\begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix}\left[\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C_M}{\partial\left(\theta_L^M\right)^2}\right]$$

Where $\begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\theta_H\partial s} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s^2} \end{vmatrix}$ contains the effects under the subscription business model in the one-sided investment case. This establishes the result for the indirect effect on primary investment. Finally, consider the indirect effect on the subscription price:

$$\frac{ds}{\partial\beta} = \frac{a\frac{dD_P}{d\theta_L}}{Det}\left[\begin{vmatrix} \frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} \end{vmatrix} - \begin{vmatrix} \frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2} & \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M} & 0 \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} \\ \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} & \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} \end{vmatrix}\right]$$

Observe that $\frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^P} = \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M}; \frac{\partial^2\pi_M}{\partial s\partial\theta_L^P} = \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M}; \frac{\partial^2\pi_M}{\partial\theta_L^P\partial\theta_L^M} - \frac{\partial^2\pi_P}{\partial\left(\theta_L^P\right)^2} = \frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2}; \frac{\partial^2\pi_M}{\partial\left(\theta_L^M\right)^2} - \frac{\partial^2\pi_P}{\partial\theta_L^P\partial\theta_L^M} = \frac{\partial^2 C_M}{\partial\left(\theta_L^M\right)^2}$. We can simplify this to:

$$\frac{ds}{\partial\beta} = \frac{a\frac{dD_P}{d\theta_L}}{Det}\begin{vmatrix} \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} \end{vmatrix}\left[\frac{\partial^2 C_P}{\partial\left(\theta_L^P\right)^2} - \frac{\partial^2 C_M}{\partial\left(\theta_L^M\right)^2}\right],$$

where $\begin{vmatrix} \frac{\partial^2\pi_M}{\partial s\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial s\partial\theta_H} \\ \frac{\partial^2\pi_M}{\partial\theta_H\partial\theta_L^M} & \frac{\partial^2\pi_M}{\partial(\theta_H)^2} \end{vmatrix}$ contains the effects under the subscription business model in the one-sided investment case, establishing the indirect effect result on the subscription price.