Targeted advertising of preventive medicine in Canada

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Abstract: Canada's universal health insurance system leads to the under-provision of disease prevention by consumers. This paper demonstrates that under general circumstances, a public health education campaign designed to increase coverage of preventive treatment can have the opposite effect. Using a model of targeted advertising, I derive conditions under which advertising by a pharmaceutical firm leads to better health care outcomes than a public health education campaign. The model assumes that an individual's risk of illness is common knowledge. Advertising affects a healthy consumer's perception of the pain and suffering that accompany disease. It is possible for a public campaign to improve health care outcomes. For this to happen, the government must be able to refrain from advertising to consumers with a high risk of illness.

1. Introduction

Canada has a publicly funded universal health care system. When a Canadian citizen falls ill, the government pays for medical treatment. If a Canadian citizen is healthy, but at risk of illness, she must pay for preventive treatment out of her own pocket. Both pharmaceutical firms and the government make use of advertising to convince citizens to spend money on preventive treatment.

This paper studies the interaction between public health education campaigns and direct-to-consumer advertising (DTCA) of preventive treatment in the Canadian setting. Canada boasts universal health care, paid for and managed by provincial governments. The province pays for medical treatment, but does not in general subsidize measures meant to prevent illness. Such treatment must be paid for by consumers. Though health care is funded through taxes, an individual patient's treatment has a negligible impact on total health care costs. Consumers therefore treat their health-related tax burden as fixed.

When deciding whether or not to purchase preventive treatment, the consumer does not take into account the financial cost of treating the illness once it manifests. This leads consumers to under-purchase prevention relative to the government's objectives. The government can try to correct this under-supply through public health education campaigns. Both the government and the pharmaceutical firm manufacturing the treatment have an incentive to increase the population's willingness to pay for prevention. However, the firm's profit-maximizing objective may conflict with the government's desire to reduce health care expenditure. High profits may not be compatible with a high level of prevention, and the firm may use its advertising campaign to raise prices and possibly lower coverage.

The Canadian government's traditional response to this conflict has been strict regulation of direct-to-consumer advertising by pharmaceutical firms. Among many other restrictions, an advertiser is allowed to either name the product, *or* its function – never both[1]. The former practice is referred to as 'reminder' advertising, and fulfils the informative function of reminding consumers of the product's existence. The latter is 'disease' advertising. Its purpose is to bring to the attention of consumers the perils of a particular disease, in the hopes that they will then be willing to pay for its prevention. By separating product identification from product characteristics, this legislation addresses the frequently-raised concerns that pharmaceutical advertising will lead to over-use of medication and higher prices.

In this paper, I consider an alternate approach to public health, in which DTCA may be used as a complement to or substitute for a public health education campaign. The interaction between public and private disease advertising has been largely ignored, and it is possible that through an appropriate choice of policy the government may be able to harness DTCA as a tool with which to achieve its cost-minimizing objective. For example, by targeting low-risk consumers with its advertising, the government may

[1] At times, firms have tried to bypass the advertising restrictions by publishing two advertisements on facing pages of a magazine, one with the drug's name and the other with its function. These have almost always been caught before publication. [citation]

induce a pharmaceutical firm to set a low price in order to capture this low end of the market[2], increasing coverage of preventive treatment.

The problem of public versus private advertising is quite general. In the present paper I restrict myself to the targeted advertising of a patented preventive treatment of a non-infectious disease in Canada. The treatment of preventable diseases is an increasingly important component of health care expenditure in Canada, as recognized by several recent government reports[3]. Heart disease, certain cancers and hepatitis are among those illnesses that can be avoided through appropriate lifestyle choices, vaccination or prophylactic use. Despite the availability of preventive treatment, incidence of these diseases remains high, in part because such treatments must usually be paid for by the patient. In recent years, patented vaccines for hepatitis and the human papillomavirus (HPV) have been the subject of intensive advertising campaigns by their manufacturers. Although Canada has strict laws concerning the style and content of such ads, it is not clear that these can be effectively enforced. In 1997, the United States relaxed its own DTCA legislation, leading to a surge in pharmaceutical advertising. Many of the ads produced in the United States' more favourable legal climate are seen by Canadian audiences, who receive American channels as part of a cable package or over the air. Further difficulties rise from the prominence of internet advertising, which allows for the private transmission of targeted advertising. Both vaccines mentioned above inoculate the patient against infectious diseases. When a disease is contagious, the decision to invest in prevention is complicated by the endogeneity of infection risk[4]. The present paper assumes that infection risk is exogenous, and therefore the preventable disease is non-infectious.

There is potential for conflict between the goals of patients, government and pharmaceutical firms. Curative health care is paid for by government, but preventive measures are usually paid for by consumers. When deciding whether or not to invest in

[2] For full details, see Section 3.2 below.
[3] For example, (Health Council of Canada, 2007)
[4] For a discussion of public and private treatment of an infectious disease, see (Geoffard and Philipson, 2001).

prevention, Canadian citizens do not take into account the financial cost of treating the illness once it manifests. Similarly, when paying for health care the province has an incentive to rely on cost-effective treatments, regardless of any private discomfort or inconvenience that must be endured by the patient. In the case of preventable disease, government and private advertisers have similar goals. Their aim is to convince members of the population who would not otherwise do so, to engage in treatment. The difference lies in that the firm controls not only the advertising message, but the price of treatment, and profit-maximization may be consistent with higher prices and lower coverage than that desired by the government.

In this paper, I investigate whether it is possible for government to use private DTCA as a tool in its efforts to minimize health care expenditure in a manner consistent with the Canadian setting. I assume that all consumers are at risk of contracting a preventable disease. An individual's risk of infection is common knowledge. If a consumer falls ill, the government pays the medical bill. A healthy consumer may buy preventive treatment from a pharmaceutical firm. Both government and firm may pay to increase a consumer's awareness of the disease, and thereby increase her willingness to pay for prevention.

The model assumes a setting in which citizens, government and firms are perfectly informed about any given individual's risk of infection, but where a healthy consumer's perception of the personal cost of disease is subjective, and subject to change. This assumption may seem out of place, since it is tempting to attribute inadequate levels of prevention to consumer myopia or a lack of information. Exercise today, for example, involves a certain expenditure of time and effort in exchange for uncertain health benefits in the future. An individual at high risk of a disease for which there is a vaccine might under-estimate the true risk of infection. Some consumers may not be aware of the existence of preventive treatment. Advances in mass media and information technology make these scenarios increasingly unlikely. Supermarket racks are filled with magazines touting the latest diets and health supplements. Television talk shows interview fitness experts and disease survivors in between advertisements for the latest vitamin

supplements. The internet provides a world of information in searchable format, and increasingly pharmaceutical advertisers target their messages to those consumers most likely to benefit from them. It is difficult for the modern Canadian consumer to plead ignorance regarding the existence of major preventable illnesses, and the steps which may be taken to avoid them.

I assume that advertising is costly and may be perfectly targeted. The advertiser is able to customize its message to an individual consumer. Ads are expensive, and it costs more than a dollar to raise willingness to pay by a dollar. Under this assumption, we will never see advertising to someone whose risk of contracting the disease is identically zero. This is true to the spirit of internet advertising and current marketing practices – it is possible for firms to obtain detailed information about the characteristics of individual consumers, and customize their marketing messages to them accordingly[5]. Such customization is costly (Schuh, 2000), which means it must be used strategically. The Canadian government's sources of information are different than those available to a private firm. However, demographic and other data allow for targeting advertising messages. Indeed, almost all advertising by the Canadian government is necessarily targeted. Canada is a bilingual, multi-cultural society. Messages sent by the government must be in the language spoken by their intended audience, and follow the correct cultural cues if they are to be effective[6].

My results hinge on the assumption that advertisements are able to influence a healthy consumer's assessment of the private cost of illness. There are many ways in which this might take place. If disease is perceived as something that may happen in the distant future, the framing of an advertisement's message may make the illness more immediate, and increase a consumer's willingness to pay for its prevention (Chandran *et al*, 2004). While consumers are assumed to know their risk of infection, this does not imply awareness of the consequences of an illness. For instance, it is possible for an individual

[5] For details, see (Zhang, 2004), (Gal-Or, 2005), (Montgomery, 1997) and (Rossi *et al*, 1996)
[6] For example, see (Larkin *et al*, 2007) on the need to tailor HIV awareness campaigns to the specific circumstances of aboriginal youth, (Messerlian and Derevensky, 2007) on customizing anti-gambling messages for young Canadian adults, and (Lagarde, 2004) on the complexities involved in a bilingual health education campaign.

to know that she has a 30% chance of developing colon cancer in the next ten years, without being aware of the pain and suffering that such a condition entails. Advertisements informing consumers of previously unknown negative outcomes may increase their willingness to engage in prevention.

I find that it is possible for public health campaigns to have an effect directly opposite to that intended, whether DTCA is allowed or forbidden. Under general circumstances, government-sponsored promotion of preventive treatment will lead to a higher price for such treatment, and lower coverage, than if the government had never advertised at all. Such an effect is not uncommon in campaigns intended to curtail vices such as gambling (Messerlian and Derevensky, 2007) or under-age drinking (Ringold, 2002). However, these 'boomerang effects' are largely due to psychological factors and imperfect targeting. Most commonly, a government campaign condemning an activity will increase its attraction to rebellious youth. In the present model, advertising is perfectly targeted by assumption, and this cannot happen. An advertising message sent to youth will, by assumption, properly take their personal characteristics into account and avoid a boomerang effect. The reduction in coverage seen in the present paper is independent of psychology. There is a natural temptation for government to advertise to consumers with a high infection risk, since their expected medical costs are highest. If government succumbs to this temptation, the pharmaceutical firm will set a high price and hold these consumers for ransom. Under the conditions of the model, the rise in price is such that treatment coverage is lower than it would have been, had the government never advertised.

The model predicts that DTCA will always increase treatment coverage over the case in which such advertising is banned. If the distribution of infection risk is sufficiently smooth, then for any given price, a pharmaceutical firm will always have an incentive to use advertising to increase coverage. This is illustrated in a simple case by the following example. Suppose that advertising is very expensive, so that it costs ten dollars to raise a consumer's willingness to pay by a dollar. Let the population consist of two individuals, one of whom is initially willing to pay $20 for treatment, and another who is only willing

to pay $19. Treatment is sold for $20. Although advertising is costly, the firm is willing to pay the required $10 in advertising in order to bring in an extra $20 in revenue. No matter how expensive advertising is, there is always a willingness to pay between 19 and 20 so that in our example, the cost of advertising is less than the additional revenue. This example ignores the interaction between the firm's choice of price and its choice of advertising. Below, I show that when this is taken into account, the firm will always choose a treatment coverage greater than that which prevails in the absence of advertising. By implication, DTCA by the firm can be a superior alternative to advertising by the government. However, DTCA does increase the cost of treatment. This must be taken into account in any policy decision.

It is possible for a government-sponsored advertising campaign to substantially improve health care outcomes, in the form of lower treatment costs and higher coverage. For this to happen, the government must advertise to consumers with a low to medium risk of infection, and be able to refrain from advertising to consumers with a high risk of infection. By assumption, consumers are perfectly informed of their infection risk without the need for advertising. By advertising to high-risk consumers, government makes it profitable for the firm to raise its price. If it advertises to lower-risk consumers, the government encourages the firm to lower its price in order to capture more of the market. Consider the following situation. The population consists of two consumers. One consumer has a 100% risk of contracting a disease, and the other has only a 25% risk. The disease may be prevented by purchasing treatment from a monopolist. Both consumers believe that a sick person incurs $10 of pain and suffering. In the absence of advertising, the firm will charge $10, and preventive treatment will be sold only to the high-risk consumer. Now suppose that the government is willing to use advertising to increase the willingness to pay of one of the two consumers by $5. If it advertises to the high-risk consumer, the firm will charge $15 and coverage will be unchanged from the case of no advertising. If it advertises to the low-risk consumer, the price of treatment will go down to $7.50 and both consumers will purchase treatment.

The link between public and private disease advertising has been largely ignored[7]. There is a large literature on direct-to-consumer advertising of pharmaceuticals[8], and in particular a large number of papers referring to Canada's experience. Most of these deal with the advertising of curative treatments, whereas the focus of the current paper is on preventive treatments. In general, it is found that DTCA is able to influence physician prescription decisions, and such marketing both raises the price of pharmaceuticals and shifts demand toward newer, more heavily advertised drugs, independently of their medical benefits. The literature on targeted advertising is small, and deals mostly with informative advertising[9]. Consumers are unaware of the price and existence of a product unless targeted. As a result, firms focus their advertising campaigns on those consumers with the highest likelihood of buying their product. This differs from the current model, in which consumers are assumed to be informed of the product's price and existence, and advertisers focus their efforts on marginal consumers. There has been some interesting work on American Health Maintenance Organizations (HMOs) and their coverage of preventive treatment[10]. Fundamental differences between the Canadian and American health care systems lead to substantially different results in the present paper. My focus is not on a shifting bundle of consumers who choose private health insurance providers, but on the interaction between public and private promotion of preventive treatment in the context of a government-funded universal provision of curative health care. The paper closest in spirit to the present one is (Rubin and Schrag, 1996), which examines agency problems arising from informative drug advertising. They find that HMOs will in general under-provide prescription drugs relative to the needs of their subscribers, but drug companies may use advertising to correct this agency problem.

The benefits of public advertising depend crucially upon the ability of the government to commit to an advertising strategy. If the government is capable of such commitment, then a public health education campaign will lead to high coverage at a low cost to consumers and government. If not, there will be a pseudo-'boomerang effect' as the

[7] For an exception, see (Geoffard and Philipson, 2001).
[8] For example, (Findlay, 2001), (Batchlor and Laouri, 2003) and (Brekke and Kuhn, 2006). This list is not exhaustive.
[9] See (Gal-Or, 2005), (Iyer *et al*, 2005) and (Esteban *et al*, 2004).
[10] (Rubin and Schrag, 1996), (Gohmann, 2005), (Dor, 2004) and (Michelli and Heffley, 2002)

pharmaceutical firm uses the government's willingness to advertise to hold high-risk consumers for ransom. These results are independent of whether or not there is a ban on advertising by the private sector. If the government abstains from advertising, the firm's campaign provides a middle path with prices, cost and coverage between the two choices provided by public advertising. Thus, if the government is not capable of commitment to a particular advertising campaign, it is best to allow the firm to advertise in its place[11].

2. The Model

Society consists of government, a pharmaceutical firm and a unit mass of consumers. Consumers are at risk of a preventable disease. Individuals differ only in their susceptibility to a non-infectious, preventable disease. An individual's infection risk, x, is common knowledge. This knowledge can be thought of in terms of the existence of a public database linking demographic characteristics to infection risk. Consumers are uniformly distributed on the unit line according to their infection risk. The number of consumers is normalized to unity.

Figure 1: Uniform distribution of consumers

[11] If the government has complete control the price of preventive treatment, then the coverage-reducing consequences of a lack of commitment may be avoided. However, the presence of the large American market to the south, and the popularity of cross-border shopping for pharmaceuticals constrain the Canadian government's ability to set the price of medication.

A monopolist offers preventive treatment at a price p. If a consumer pays for preventive treatment, her risk of infection becomes zero. There are no side effects.

The government offers curative treatment at no charge. If a consumer falls ill, the government pays for her medical treatment and incurs a financial cost g. There is pain and suffering associated with the illness. The true extent of this private harm from illness is only revealed to a consumer once the disease manifests. Initially, all consumers believe that the private cost of illness is equivalent to the loss of h dollars.

It is possible for either the firm or the government to engage in perfectly targeted disease advertising. An advertiser pays a fee a(x) to raise the perception of the private cost of illness of the consumer with infection risk x, by a(x). For example, suppose that the consumer with 48% risk of infection believes that the private harm from illness is 98 dollars. The government can pay 2 dollars to raise her estimation of the private harm of illness to 100 dollars. Advertising is additive in its effects. If a consumer is targeted with 2 dollars of advertising from the government and 3 dollars from the firm, her estimation of the private harm of the disease rises by 5 dollars.

Consumer utility is equal to the expected harm from illness, less the price paid for treatment. I assume that consumers are risk neutral.

The utility of an untreated consumer is

$$U(x) = -x(h + a^f(x) + a^g(x))$$

Here, x is the consumer's risk of infection, and h is her initial belief about the private cost of illness. This belief is common to all consumers. Advertisement by the firm and government are denoted a^f and a^g, respectively. Since advertising is targeted, it is written as a function of infection risk x.

The utility of a consumer who pays for treatment is independent of infection risk, and depends only on the price of treatment:

$$T(p) = -p$$

A consumer will pay for treatment if and only if $U(x)<T(p)$.

Government pays for the curative treatment of sick consumers, and for its own advertising campaign. Treatment of an ill consumer costs g dollars. The expected cost of illness from a consumer with infection risk x, is xg. The cost of advertising to the consumer at x is $a^g(x)$. The government's objective function is equal to the sum of its costs, and given by

$$G(p) = g\int_0^1 H(U(x) - T(p))xdx + \int_0^1 a^g(x)dx$$

Here, H( ) is the Heaviside step function and p is the price of preventive treatment.

The monopolist's profits are equal to its revenue from sales of preventive treatment less its advertising costs. By assumption, the preventive treatment is costless to manufacture. The firm's profit function is therefore

$$\Pi(p) = p\int_0^1 H(T(p) - U(x))dx - \int_0^1 a^f(x)dx$$

Here, $a^f(x)$ is the firm's expenditure on advertising to the individual with infection risk x.

g	Cost to the government of treating a diseased individual.
h	Private cost of the disease, or awareness, prior to advertising.
x	Risk of infection. $0 \le x \le 1$
$a^g(x)$	Advertising by the government to the individual with infection risk x.
$a^f(x)$	Advertising by the firm to the individual with infection risk x.
$h + a^f(x) + a^g(x)$	Private cost of the disease to the individual with infection risk x after advertising
K_j, K_j^*	K in Case j. An asterisk denotes an equilibrium value. For example, p_3^* is the equilibrium price for Case 3. Cases are defined in Table 2, below.

Table 1: Notation

Timing

Government begins by deciding upon the regulatory climate in which it and the firm will operate. It may choose whether or not to allow advertising by the firm, and whether or not to allow its own advertising. These choices are binding.

After this initial decision, the government may be either the first or second agent to move. When the government moves, it implements its advertising campaign, $a^g(x)$, provided that advertising by the government is not forbidden. When the firm moves, it implements its advertising campaign, $a^f(x)$, provided that such advertising is allowed. During its move, the firm also chooses the price of treatment, p.

The sequence of movement need not be interpreted literally. As in the Stackelberg model of quantity competition, being the first mover may be interpreted as an ability to commit to a particular strategy. An inability to commit places the government in the position of a follower.

Once firm and government finish their moves, consumers make their purchase decisions.

The disease will manifest after the consumer's purchase decision is made. The model does not look beyond the purchase of preventive treatment. It is to be understood that all costs associated with the future, such as the government's costs of treating the disease, are in present discounted terms.

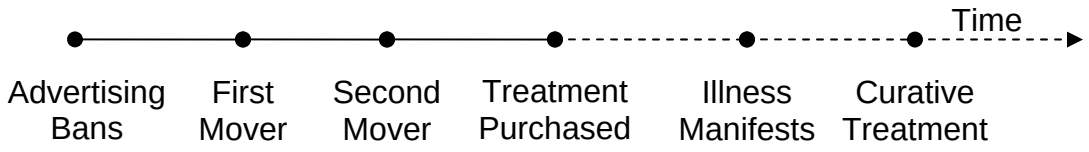

Figure 2: Timing

There are six distinct combinations of order of movement and regulatory climate to be considered. I will analyze the sub-game perfect Nash equilibrium to each of these cases in turn, taking the regulatory climate and order of movement as given. For example, when analyzing the case where all advertising is allowed and the government moves second, I will assume that government does not have the option of moving first. This approach is consistent with the primary goal of this paper, which is to find and categorize the environments in which private advertising is beneficial to government and health care outcomes.

	Firm			
Government		No ads	First Mover	Second Mover
	No ads	Case 1	Case 4	
	First Mover	Case 2		Case 5
	Second Mover	Case 3	Case 6	

Table 2: Cases

In Section 3, I consider those cases in which the firm is not allowed to advertise. Section 4 deals with the remaining cases. Section 6 provides a summary of findings and concluding remarks.

3. Advertising by the Firm is Forbidden

In this section, I examine Cases 1, 2 and 3. They hold in common that all advertising is done by the government, when any advertising is done at all.

3.1 Case 1: No advertising

Advertising is forbidden to both the government and the firm.

A unit mass of consumers is uniformly distributed along a line of length 1. Consumers differ only in their susceptibility to illness. Their address on the unit line corresponds to their chance of contracting the disease if left untreated.

Each consumer weighs her expected cost from illness, xh, against the cost of preventive treatment, p. If p<xh, the consumer pays for treatment. The consumer indifferent to treatment has infection risk

$$z_1 = \frac{p}{h}$$

Consumers pay for treatment if and only if their infection risk, x, is greater than z_1.

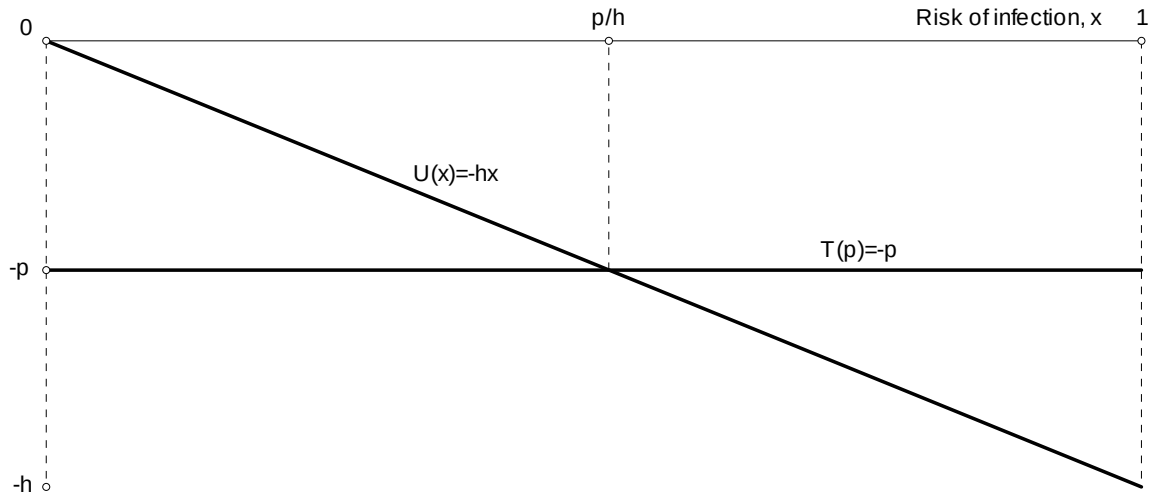

Figure 3: Case 1 Illustrated

A fraction $(1 - z_1)$ of consumers purchase treatment.

The firm's profits are equal to its revenue. The monopolist's profit function is given by

$$\Pi_1(p) = p(1 - z_1)$$

The profit-maximizing price is obtained by solving the firm's first-order conditions. Since there is no advertising in Case 1, this is the firm's only decision, and the profit-maximizing price is the Nash equilibrium:

$$p_1^* = \frac{h}{2}$$

This leads to profits of

$$\Pi_1^* = \frac{h}{4}$$

The indifferent consumer has an infection risk of

$$z_1^* = \frac{1}{2}$$

Since consumers with infection risks greater than ½ buy treatment, the government's costs consist only of the expected medical costs for consumers with x < ½. The government's objective function is therefore given by

$$G_1^* = g\int_0^{1/2} x dx = \frac{g}{2}$$

When neither the firm nor government advertise, treatment coverage will be 50%. Consumers pay for treatment if their infection risk exceeds 50%. The price of treatment is equal to half of the perceived private cost of illness, h. Government's expected costs are half of the cost of curative treatment for a single individual.

3.2 Case 2: Ex-Ante Advertising by the Government

Consider the two-stage game in which advertising by the firm is banned, the government advertises in the first stage and the firm sets the price of treatment in the second.

The government's advertising campaign consists of a complete specification $a^g(x)$ of its advertising expenditure to each consumer.

In the second stage, the firm observes the government's advertising, $a^g(x)$, and sets its price, p. The expected utility of a consumer who does not purchase treatment is

$$U_2(x) = -x\left(h + a_2^g(x)\right)$$

The utility of a consumer who purchases treatment is

$$T(p) = -p$$

Consumers will purchase treatment if and only if $U_2(x) < T(p)$, and so the firm's profits are given by

$$\Pi_2(p) = p\int_0^1 H(T(p) - U_2(x))dx$$

where H ( ) is the Heaviside step function. The firm's choice of price will therefore be conditional on the government's advertising campaign.

Now consider the government's choice of advertising in the first period. Let the price chosen by the firm in the second stage, upon observation of the government's campaign, be p^g. The government will not advertise to consumers who buy the treatment regardless of advertising. When the firm sets a price of p^g, the indifferent consumer is at p^g/h. The government will not advertise to consumers with $x>p^g/h$.

Lemma 1: Suppose government is the sole advertiser and first mover. Then in equilibrium all consumers advertised to have the same willingness to pay for treatment.

Proof: Let the price set by the firm in the second stage be p^g, and consider those x for which $a^g(x)>0$. If $U_2(x)<-p$ for some x, then the government would strictly prefer to set $U_2(x)=-p^g$, achieving treatment at a lower cost. If $U_2(x)>-p$ for some x, then the government may achieve the same result (non-treatment) by setting $a^g(x)=0$. ■

The government need only advertise to the extent that makes a targeted consumer indifferent to purchasing treatment. If it pays for more advertising, the additional expenditure is wasted, because the consumer would have bought treatment with less

advertising. If it pays for too little advertising, the outlay is wasted because the consumer will not purchase treatment.

That is, $a^g(x)$ is such that U(x) = T(p) and

$$a_2^g(x) = \frac{p^g}{x} - h$$

The government's goal is to increase treatment coverage, and thereby lower its expected health care costs. It will never choose a coverage target less than ½, since it can achieve 50% coverage by not advertising (as shown in Section 3.1). It is impossible to reach total coverage, because no amount of advertising will convince the consumer with infection risk x=0 to purchase treatment. Coverage in this case will therefore lie strictly between ½ and 1.

The government's advertising campaign will target a continuous swathe of consumers. Let z_2 be the lowest infection risk for which $a_2^g(x) > 0$. Then it must be the case that $a_2^g(x) > 0$ for all x greater than z_2 and less than p^g/h. Recall that the government must pay g dollars in medical costs if a consumer contracts the disease. If $a^g(z_2)>0$, this implies that the government's expected benefit from advertising, $z_2 g$, is greater than the cost of advertising to that consumer, $p^g/z_2 - h$. Since $(gx - (p^g/x - h))$ rises with x, this means that the benefit must exceed the cost for all $x>z_2$, as well. However, the government will not advertise to consumers with $x>p^g/h$, because they are willing to purchase treatment even without advertising.

Thus, in equilibrium, for a desired coverage of $(1-z_2)$, the government's advertising campaign must take the form

$$a_2^g(x, z_2) = \begin{cases} \frac{p^g}{x} - h & z_2 < x < \frac{p^g}{h} \\ 0 & \textit{otherwise} \end{cases}$$

Now consider the firm's choice of price. The government does not advertise to consumers with x>1/2, so it is possible for the firm to choose p=h/2 and earn profits of h/4, as in Case 1. These are its reservation profits. If the firm chooses a price p^g<h/2, as required for coverage greater than ½, then the profit from doing so must at least be equal to the firm's reservation profits.

If the firm chooses p = h/2, its profits are h/4. If the firm chooses p = p^g, then U(x) > 0 for all x>z, and the firm's profits are equal to $p^g(1-z_2)$. When $p^g = h/(4(1-z_2))$, the two are equal. If the government desires coverage of $(1-z_2)$, it must therefore choose its campaign such that

$$a_2^g(x, z_2) = \begin{cases} h\left(\frac{1}{4(1-z_2)x} - 1\right) & z_2 < x < \frac{1}{4(1-z_2)} \\ 0 & \textit{otherwise} \end{cases}$$

In the equilibrium for Case 1, the firm's surplus is equal to the sum of areas D and E in the diagram below. Through advertising, the government may raise awareness of the consumers on $[p^g/h, z_2]$ so that they are willing to pay for the treatment at a price p^g. The firm's surplus from setting a price p^g becomes A + B + C + D. If A + B + C is equal to E, then the firm will charge the lower price.

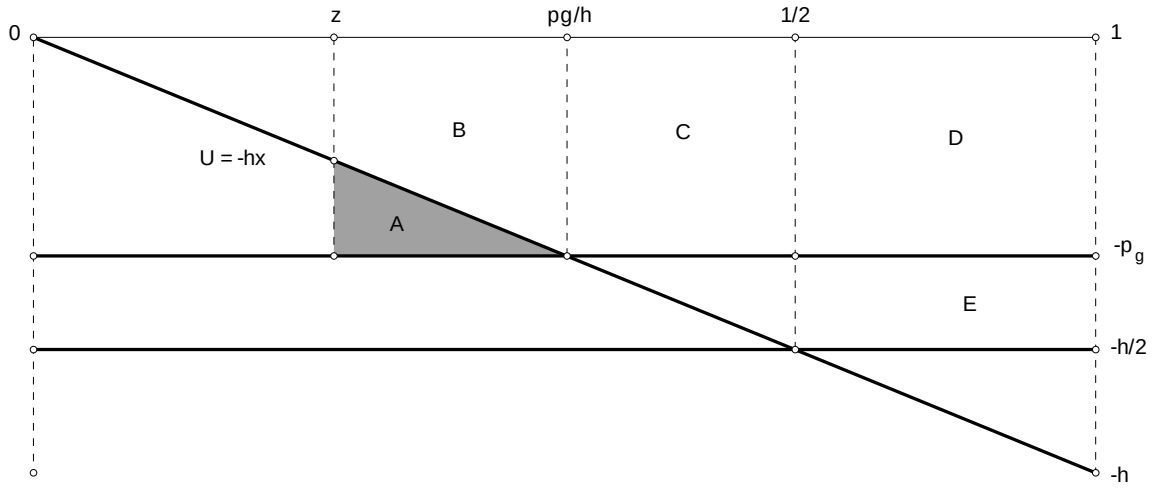

Figure 4: Case 2

Equating A + B + C to E uniquely determines p^g as a function of z_2. In the limit of full coverage (that is, $z_2=0$), $p^g = h/4$. This is the lower limit for prices under ex ante government advertising. In no case will we see $p^g>h/2$, since this would mean lower coverage than in the case of no advertising.

The government chooses the amount of coverage that minimizes its objective function, which is the sum of advertising costs and expected health care costs from non-treatment. That is,

$$G_2(z_2) = g\int_0^{z_2} x dx + \int_{z_2}^{1}\left(\frac{1}{4(1-z_2)x} - h\right)dx$$

In equilibrium, coverage rises with the cost of medical treatment, g, as the government becomes more willing to invest in disease prevention. For a constant g, coverage falls with the intrinsic private cost of illness, h, as this increases the firm's reservation profits and makes advertising more expensive. As shown in the theorem below, for an appropriately large value of g, coverage may be brought arbitrarily close to 1.

When advertising by the firm is banned, government advertises and the government is the first mover, health care expenditure is less than in Case 1. Coverage is higher than in

Case 1, and the price of treatment is lower, but firm profits – and therefore total consumer expenditure – remain at the levels established in the equilibrium to Case 1.

Theorem 1: (Case 2) Suppose government is the sole advertiser and first mover. Then the equilibrium price is lower than in Case 1, and treatment coverage is higher.

Proof: In the Appendix

3.3 Case 3: Ex-Post Advertising by the Government

In Case 3, advertising by the firm is forbidden, but advertising by the government is allowed. This regulatory environment is known to all agents.

The timing is such that the firm moves first, setting its price in full knowledge of the government's ability to advertise. It will therefore choose a higher price than in Case 1, where the government cannot advertise.

After the firm has set its price, the government implements its awareness campaign. Finally consumers make their purchase decisions.

The government takes the firm's price p as given. If it does nothing, then the indifferent consumer has infection risk p/h and treatment coverage is (1 – p/h). Through advertising, the government is able to raise the awareness of individual consumers so that they are indifferent to paying for treatment.

Letting $a^g(x)$ be government spending on advertising to the individual with infection x, the utility of an untreated consumer is

$$U_3(x) = -\left(h + a^g(x)\right)x$$

The utility of a treated consumer is T(p) = –p.

The advertising required to make a consumer indifferent to treatment is (p/x – h). The government will target all consumers who would not pay for treatment on their own, and for whom the benefit of treatment meets the cost of advertising. The expected benefit to the government of treating the consumer with infection risk x is in the form of forgone medical costs, xg.

The government's surplus from advertising to the individual with infection risk x is xg – p/x – h. This rises with x.

The lowest risk infection targeted by government ads, z_3, will be that at which benefit is equal to cost, so that $gz_3 - p/z_3 - h = 0$. There are two solutions to this equation, only one of which is positive, and so

$$z_3(p) = \frac{\sqrt{h^2 + 4gp} - h}{2g}$$

Advertising is illustrated in the diagram below.

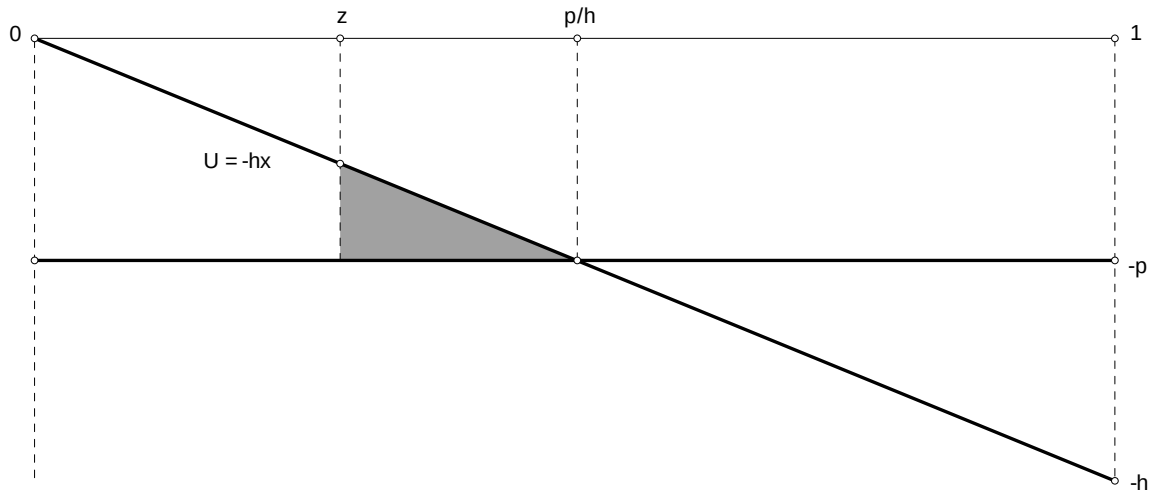

Figure 5: Case 3

The firm has no advertising costs, and so its profits are equal to revenue:

$$\Pi_1(p) = p(1 - z_3(p))$$

The firm's first-order conditions can be solved for the profit-maximizing price, p_3^*. The full expression is presented in the proof of Theorem 2.

In the case of ex-post advertising by the government, the price of treatment is never less than in the case of no advertising. The limit of p_3^* as g tends to zero is h/2, the equilibrium price in the case of no advertising, and the profit-maximizing price rises with g.

This rise in price will lead to a pseudo-boomerang effect. For positive g, coverage is always lower than in the absence of advertising. As g ranges from zero to infinity, $z_3(p_3^*)$ ranges from ½ to 2/3. Since prices are never lower and coverage is never higher, total health care costs are never less than in the case of no advertising.

If the government cannot commit to advertising before the firm sets its price, then it is best to not advertise.

Theorem 2: (Case 3) If the government is the sole advertiser and advertises after the firm sets its price, then in equilibrium the price of treatment is higher and coverage is lower than in Case 1.

Proof: In the Appendix.

4. Advertising by the Firm is Allowed

In this section, I examine Cases 4, 5 and 6, in which the firm is allowed to advertise.

4.1. Case 4: The Firm as sole advertiser

Advertising by the firm will lead to higher prices and higher coverage than in Case 1, where neither government nor firm are allowed to advertise.

Consider the case where the firm is sole advertiser. The monopolist advertises, then sets its price, after which consumers make their purchase decisions.

The firm's targeted advertising campaign consists of a complete specification $a^f(x)$ of advertising expenditure as a function of infection risk.

If a consumer purchases preventive treatment from the firm at a price t, her utility is $T(p) = -p$. If a consumer does not purchase treatment, her expected utility is

$$U_4(x) = -x(h + a^f(x))$$

where x is the risk of infection. Consumers will buy treatment if and only if the benefits of treatment exceed the cost, which happens when $T(p)>U_4(x)$.

For consumers with $x>p/h$, $T(p)>U_4(x)$ even when $a^f(x) = 0$. There is no benefit to the firm from advertising to these high-risk individuals, since they will buy the product on their own.

Low-risk consumers with $x<p/h$ will not buy treatment unless they are advertised to. The firm has no incentive to advertise to them past the point that makes them indifferent to purchasing the product. As such, whenever advertising is positive, $U_4(x) = T(p)$ and $a^f(x) = p/x – h$

The firm will advertise to consumers as long as advertising produces additional revenue in excess of its costs. This is true whenever $a^f(x)<p$. That is, when $x>p/(p+h)$. The firm's campaign thus takes the form

$$a_4^f(p,x) = \begin{cases} \frac{p}{x} - h & \frac{p}{p+h} \le x \le \frac{p}{h} \\ 0 & otherwise \end{cases}$$

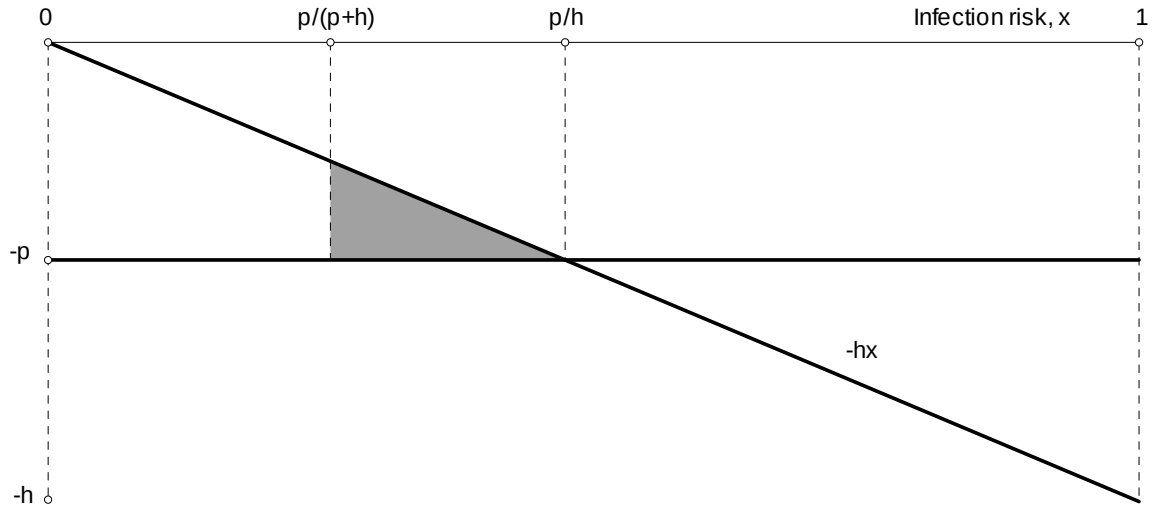

Figure 6: Case 4

Since it has no production costs, the firm's profits are equal to its revenue minus advertising costs. All consumers with x>p/(p+h) will pay for treatment. The firm must pay for advertisements sent to consumers with infection risks between p/(p+h) and p/h.

The firm's profit function can therefore be written in terms of price, as

$$\Pi_4(p) = p\int_{\frac{p}{p+h}}^{1} dx - \int_0^1 a^f(x)dx$$

$$\Pi_4(p) = p\left(1 - \frac{p}{p+h}\right) - \int_{\frac{p}{p+h}}^{\frac{p}{h}} \left(\frac{p}{x} - h\right)dx$$

Differentiating with respect to p and solving the first-order conditions yields a profit-maximizing value of p, p_4^*, equal to αh, where

$$\alpha \equiv \frac{1}{LambertW(1)} - 1$$

The Lambert W function is the transcendental inverse function of $f(x) = xe^x$, and α is about equal to 0.76.

The price obtained with the firm as sole advertiser is higher than the benchmark price of h/2 obtained in Case 1. When compared to Case 1, advertising by the firm raises the price of treatment by over 50%. However, for high medical costs, the price of preventive treatment in Case 4 is lower than the cost of treatment in Case 3, when the government is a follower and sole advertiser. In that situation, the price of treatment increases without bound as the cost of treating infected patients rises.

Although price of treatment rises linearly with the private cost of illness, coverage is independent of the value of h. When $p = \alpha h$, $p/(p+h) = \alpha/(1+\alpha)$. This is a constant, equal to about 0.43, and coverage is thus always about 57%. In Case 1, only 50% of consumers purchase treatment. Advertising by the firm provides greater coverage than in the benchmark case.

Government costs are lower than in Case 1, because the increase in coverage is paid for entirely by consumers and the firm.

Theorem 3: (Case 4) Suppose the firm is the sole advertiser. Then in equilibrium, price is αh and treatment coverage is $\frac{1}{1+\alpha}$ where $\alpha \equiv \frac{1}{LambertW(1)} - 1$.

Proof: In the Appendix.

Case 5: The firm as second advertiser

Consider the case where both the firm and the government are able to advertise, but the firm's advertising takes place after that of the government. In this situation, coverage

will be greater than when the firm is the sole advertiser, though the price of treatment will not necessarily be lower.

It is a two-stage game. In Stage 1, the government advertises to consumers. In Stage 2, the firm advertises, and sets it price. Finally, consumers make their purchase decisions.

The utility of a treated consumer is T(p) = - p. The utility of an untreated consumer with infection risk x is

$$U_5(x) = -x(h + a^f(x) + a^g(x))$$

Here, $a^f(x)$ is the firm's advertising expenditure on the consumer with infection risk x, and $a^g(x)$ is the government's.

A consumer will purchase treatment if and only if $T(p)>U_5(x)$.

In stage 2, the firm observes the government's advertising choices before making its own advertising decision. It will not target consumers that will purchase the good without additional advertising. The firm will advertise to consumers who would otherwise not purchase treatment so long as the benefit of doing so exceeds the cost. The benefit of convincing the consumer with infection risk x to purchase treatment is equal to the revenue from an extra sale, p. The cost of advertising is equal to the amount of advertising needed to make the consumer indifferent to purchasing treatment at price p. Firm advertising thus takes the form

$$a_5^f(x) = \begin{cases} 0 & -x(h + a^g(x)) < -p \\ 0 & \frac{p}{x} - h - a^g(x) > p \\ \frac{p}{x} - h - a^g(x) & \textit{otherwise} \end{cases}$$

The government's goal is to increase treatment coverage, and thereby lower its expected health care costs. It will never choose a coverage target less than $\frac{1}{1+\alpha}$ (about 57%), since by Theorem 3 it can achieve this coverage by not advertising. Total coverage is impossible, because the consumer with infection risk x=0 will never pay for treatment. Coverage in this case will therefore be strictly between $\frac{1}{1+\alpha}$ and 1. Consumers with an infection risk higher than $\frac{\alpha}{1+\alpha}$, the lowest infection risk that purchases treatment when the firm is the sole advertiser, will not be targeted by government advertising.

The government will not advertise to consumers that the firm is willing to fund entirely. When the government advertises, it will do so in such a way as to extract the firm's entire surplus.

This is illustrated in the diagram below – the government's contribution to awareness is area A, while that of the firm is B + C.

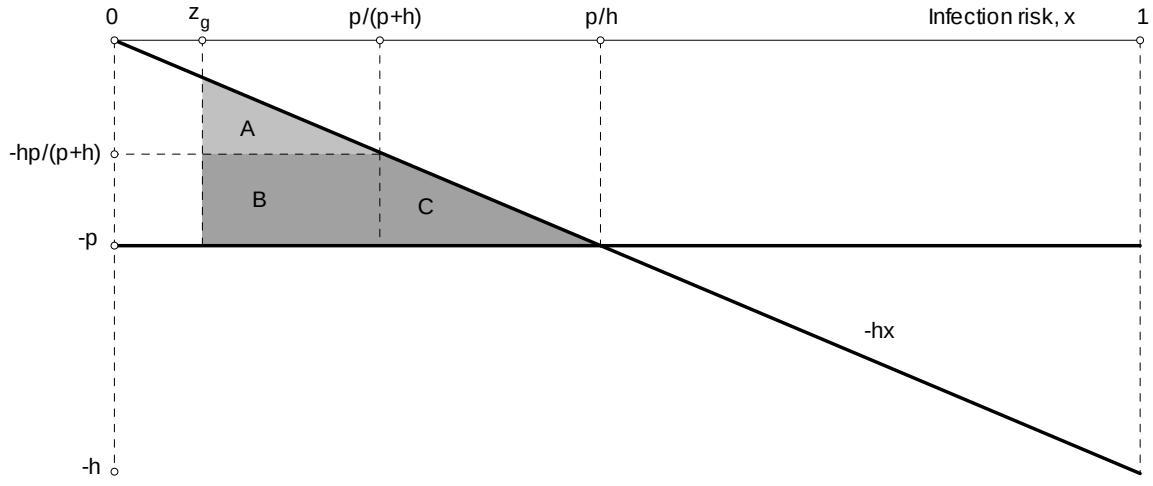

Figure 7: Case 5

As established above, if x<p/(p+h), the cost of advertising required to bring a consumer to indifference exceeds the price of treatment. The government can use advertising to 'top up' willingness to pay in this region to the lowest level required for the firm to be willing to pay for advertising. This top-up is more expensive for individuals with lower infection risks. When $x>z_g$, the government's benefit from preventive treatment is greater than the cost of advertising. If $x<z_g$, the government is unwilling to pay for additional treatment..

The government's advertising campaign takes the form

$$a_5^g(x)=\begin{cases}\frac{p}{x}-h-p & z_g \le x \le \frac{p}{p+h} \\ 0 & otherwise\end{cases}$$

Where

$$\frac{p}{z_g}-h-p \equiv z_g g$$

The firm's advertising campaign will be

$$a_5^g(x)=\begin{cases}\frac{p}{x}-h & \frac{p}{p+h} \le x \le \frac{p}{h} \\ p & z_g \le x \le \frac{p}{p+h} \\ 0 & otherwise\end{cases}$$

Now consider the firm's choice of price. The government does not advertise to consumers with $x>\frac{\alpha}{1+\alpha}$, so it is possible for the firm to choose p=αh and earn profits of

approximately h/3, as in Case 4. These are its reservation profits. If the firm chooses a lower price, then the profit from doing so must at least be equal to the firm's reservation profits.

While it is not possible to rule out prices lower than αh entirely, they are unlikely to form part of an equilibrium.

Suppose that in the second period, the firm sets a price p less than αh. If the government did not advertise, such a price would lead to profits less than those in Case 4. If the firm's profits are to be equal to reservation profits, then for some x the government must be providing advertising such that $a^g(x)>0$ and $p/x - h - a^g(x) < p$. That is, for some infection risk x, the government is paying for more advertising than is strictly necessary to convince the firm to capture that consumer. The government therefore has an incentive to deviate from its advertising strategy at that particular infection risk, weakening the stability of any possible equilibrium involving a price less than αh.

If we assume that the firm sets p= αh, as in Case 4, then all incentives are satisfied. The firm earns its reservation profits, and the government spends the minimum amount necessary on advertising. The price is by definition the same as when the firm is the sole advertiser, and coverage is necessarily higher.

4.2 Case 6: The firm as first advertiser

If the government cannot commit to advertising before the firm sets its price, then allowing advertising by the firm will increase coverage, but raise the price of treatment.

Consider the case where direct-to-consumer advertising by the firm is allowed, and the government advertises after the firm. Timing is as follows. In Stage 1, the firm sets its price and implements its advertising campaign. In Stage 2, the government takes the firm's advertising and price as given, and sets its own advertising campaign. Consumers then make their purchase decisions.

The utility of a treated consumer is T(p) = - p. The utility of an untreated consumer with infection risk x is

$$U_6(x) = -x(h + a^f(x) + a^g(x))$$

Here, $a^f(x)$ is the firm's advertising expenditure on the consumer with infection risk x, and $a^g(x)$ is the government's.

A consumer will purchase treatment if and only if $T(p)>U_6(x)$.

In stage 2, the government observes the firm's advertising choices before making its own advertising decision. It will not target consumers that will purchase the good without additional advertising. The government will advertise to consumers who would otherwise not purchase treatment so long as the benefit of doing so exceeds the cost. The benefit of convincing the consumer with infection risk x to purchase treatment is equal to the expected medical costs from leaving the individual untreated, xg. The cost of advertising is equal to the amount of advertising needed to make the consumer indifferent to purchasing treatment at price p. Government advertising thus takes the form

$$a_6^g(x) = \begin{cases} 0 & -x(h + a^f(x)) < -p \\ 0 & \frac{p}{x} - h - a^f(x) > xg \\ \frac{p}{x} - h - a^f(x) & otherwise \end{cases}$$

In stage 2, the government will advertise to consumers with $U_6(x)-a^g(x)>-p$ so long as the benefit of doing so, xg, exceeds the cost, $p/x - h - a^f(x)$.

In stage 1, the firm will not advertise to consumers with x>p/h, since they are willing to buy the treatment at price p. Neither will it advertise to consumers that the government is

willing to fund entirely. When it does advertise, it will do so in such a way as to extract the government's entire surplus.

This is illustrated in the diagram below – the firm's contribution to awareness is area A, while that of the government is B + C.

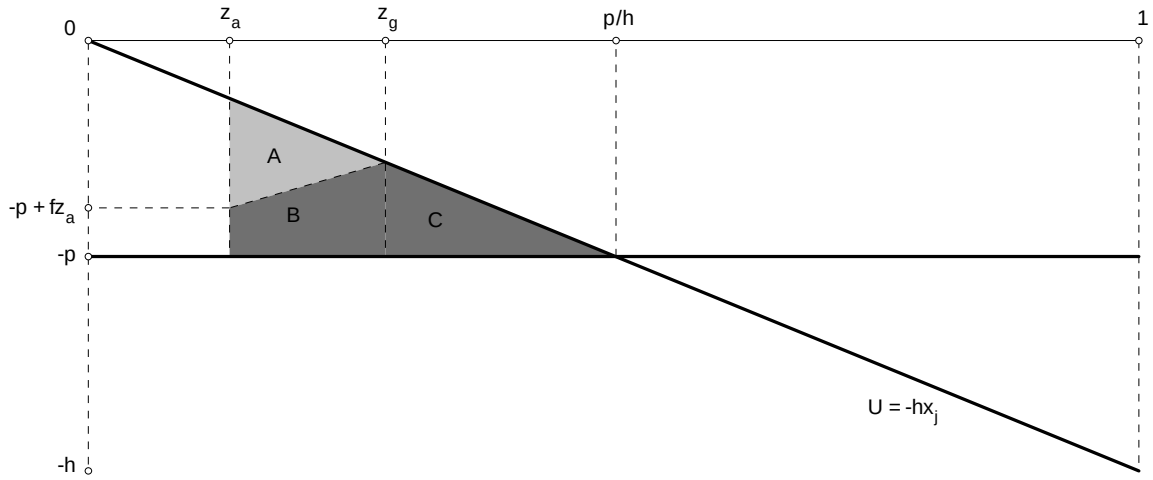

Figure 8: Case 6

When $x>z_g$, the government's benefit from preventive treatment is greater than the cost of advertising. If $x<z_g$, the government is unwilling to pay for additional treatment. The firm can use advertising to 'top up' willingness to pay in this region to the lowest level required for the government to be willing to pay for advertising. This top-up is more expensive for individuals with lower infection risks. When $x=z_a$, the cost of top-up is equal to the price of treatment, p.

The government's advertising campaign takes the form

$$a_6^g(x) = \begin{cases} \frac{p}{x} - h & z_g \le x \le \frac{p}{h} \\ gx & z_a \le x \le z_g \\ 0 & otherwise \end{cases}$$

The firm's advertising campaign is

$$a_6^f(x) = \begin{cases} \frac{p}{x} - h - gx & z_a \le x \le z_g \\ 0 & otherwise \end{cases}$$

The boundaries of each campaign are the points at which advertising cost becomes equal to the marginal benefit of coverage – z^g in the case of government, and z^a in the case of the firm:

$$\frac{p}{z_g} - h \equiv z_g g$$

$$\frac{p}{z_a} - h - gz_a \equiv p$$

All consumers with $x>z^a$ will purchase treatment at a price p. The firm's profit function is then equal to revenue minus advertising costs:

$$\Pi_6(p) = p(1 - z_a) - \int_{z_a}^{z_g} a^f(x)dx$$

It can be shown numerically that the profit-maximizing price is approximately $\alpha(f+h)$, implying treatment coverage between 0.43 and 0.56[12] - that is, between the coverage achieved by ex-post government advertising alone, and firm advertising alone. Coverage falls with medical costs g and rises with private costs h. When medical costs are high, the coverage-lowering effect of ex-post government advertising dominates. When they are low, the coverage-increasing effect of firm advertising is more important.

[12] The first-order conditions must be solved numerically, and this result is most easily shown using the 'guess and verify' method. Take the derivative of the profit function with respect to p. Substitute p=0.75(h+g). Taking limits as h and f tend to zero and infinity, this is always positive. Now substitute p=0.78(h+g). Taking the same limits, in this case the derivative is always negative. The profit-maximizing price is never less than 0.75(h+g) and never greater than 0.78(h+g).

5. Conclusion

Public health education campaigns intended to increase coverage of preventive treatment may well have the opposite effect. If a pharmaceutical firm engages in direct-to-consumer advertising (DTCA), it will always increase coverage and price of treatment when compared to the case where it does not advertise. Whether government can improve on DTCA depends on the government's ability to commit to a targeted advertising strategy that excludes patients at high risk of illness. The model developed in this paper assumes that an individual's risk of infection is common knowledge. High-risk individuals are the most willing to pay for preventive treatment. Advertising to this demographic, and increasing their willingness to pay, induces the pharmaceutical firm producing the treatment to set a high price. The resulting increase in price is sufficiently high to reduce coverage when compared to the case of no advertising. If instead, the government targets consumers with lower infection risks, the firm will have an incentive to lower its price in order to capture this segment of the market. In this case, the price of treatment will be lower, and coverage higher, than they would be in the absence of advertising. This is true regardless whether or not DTCA is banned. However, the government's advertising strategy is of crucial importance. If the government cannot credibly exclude high-risk consumers from its advertising, then it will not be possible to obtain the lower prices and higher coverage mentioned above.

Several important assumptions distance the model in this paper from reality. The model assumes that the government is not a purchaser of preventive treatment. Targeted subsidies of preventive treatment are a subset of this model, and the results of this paper continue to hold[13] for any form of subsidy that varies linearly with infection risk. The model also assumes that no advertiser can revise its campaign. A more dynamic setting, in which firm and government are allowed to launch multiple advertising campaigns, is left for further work. Finally, the model assumes that preventive treatment is provided by

[13] The original version of the model included a possibility of government purchases of preventive treatment, effectively a 100% targeted subsidy. The qualitative results thus obtained were not substantially different than those in the current paper.

a monopolist. Incorporating generic drugs and other competition into the model is an avenue for future research.

References

Adams, Ronald J. and Jennings, Kenneth M., "Media Advocacy: A Case Study of Philip Sokolof's Cholesterol Awareness Campaigns," *The Journal of Consumer Affairs*, Summer 1993, Vol. 27, No. 1, pp. 145-165.

Advertising Standards Canada, Canadian Code of Advertising Standards, December 2005, Toronto: Advertising Standards Canada. www.adstandards.com

Anderson, Simon P. and Renault, Regis, "Advertising Content," *The American Economic Review*, March 2006, pp. 93 – 112.

Avorn, Jeffrey, "Perspective: Advertising and Prescription Drugs: Promotion, Education, and the Public's Health," *Health Affairs – Web Exclusive*, 26 February 2003, pp. W3-104 – W3 – 108.

Azoulay, Pierre, "Do pharmaceutical sales respond to scientific evidence?" *Journal of Economics & Management Strategy*, Winter 2002, Vol. 11, No. 4, pp. 551 – 594.

Batchlor, Elaine and Laouri, Marianne, "Pharmaceutical Promotion, Advertising, And Consumers," *Health Affairs – Web Exclusive*, February 26th 2003, W3-109 – W3-111.

Bell, Robert A., Kravitz, Richard L. and Wilkes, Michael S., "Direct-to-consumer prescription drug advertising, 1989-1998: A content analysis of conditions, targets, inducements and appeals," *The Journal of Family Practice*, April 200, Vol. 49, No. 4, pp. 329 – 335.

Bhattacharya, Jayanta and Vogt, William B., "A simple model of pharmaceutical price dynamics," *Journal of Law and Economics*, October 2003, Vol. XLVI, pp. 599 – 626.

Bloch, Francis and Manceau, Delphine, "Persuasive advertising in Hotelling's model of product differentiation," *International Journal of Indsutrial Organization*, 1999, Vol. 17, pp. 557-574.

Bodenheimer, Thomas, "Perspective: Two Advertisements for TV Drug Ads," *Health Affairs – Web Exclusive*, February 26th 2003, W3-112 – W3 – 116.

Bos, Jasper, Beutels, Philippe, Annemans, Lieven and Postma, Maarten, "Valuing Prevention Through Economic Evaluation: Some Considerations Regarding the Choice of Discount Model for

Health Effects with Focus on Infectious Diseases," *Pharmacoeconomics*, 2004, Vol. 22, No. 18, pp. 1171-1179.

Brekke, Kurt R. and Kuhn, Michael, "Direct to consumer advertising in pharmaceutical markets," *Journal of Health Economics*, Vol. 25 (2006), pp. 102-130.

Buckley, Joan, "The need to develop responsible marketing practice in the pharmaceutical sector," *Problems and Perspectives in Management*, 2004, Vol. 4, pp. 92 – 103.

Calfee, John E., "Perspective: What do we know about direct to consumer advertising of prescription drugs?" *Health Affairs – Web Exclusive*, February 26th 2003, W3-116 – W3 – 119.

Chandran, Sucharita and Menon, Geeta, "When a day means more than a year: Effects of temporal framing on judgments of health," *Journal of Consumer Research*, 2004, Vol. 31, pp. 375 – 389.

Centre for Health Services and Policy Research, An assessment of the health system impacts of direct-to-consumer advertising of prescription medicines (DTCA), February 2002, Vancouver: Centre for Health Services and Policy Research.

Cropper, Maureen L., Haile, Mitiku, Lampietti, Julian, Poulos, Christine and Whittington, Dale, "The Demand for a Malaria Vaccine: Evidence from Ethiopia," *Journal of Development Economics,* Vol. 75 (2004), pp. 303-318.

Chen, Yuxin and Iyer, Ganesh, "Consumer Addressability and Customized Pricing," *Marketing Science*, Vol. 21, No. 2, Spring 2002, pp. 197 – 208.

Cropper, Maureen L., Haile, Mituku, Lampietti, Julian, Poulos, Christine and Whittington, Dale, "The demand for a malaria vaccine: evidence from Ethiopia," *Journal of Development Economics*, 2004, Vol. 75, pp. 303-318.

Davidson-Rada, Jiri, Caldis, Stephan and Tonkin, Shirley L., "New Zealand's SIDS Prevention Program and Reduction in Infant Mortality," *Health Education Quarterly*, May 1995, Vol. 22, No. 2, pp. 162-171.

Dor, Avi, "Optimal price rules, administered prices and supoptimal prevention: evidence from a medicare program," *Journal of Regulatory Economics*, 2004, Vol. 25, No. 1, pp. 81-104.

Dyer, Clare, "Incontinence campaign tests limits of advertising rules," *BMJ*, Volume 319, September 4th 1999, p. 591.

Edwards, Peggy, "No Country Mouse: Thirty Years of Effective Marketing and Health Communications," *Canadian Journal of Public Health*, May/June 2004, Vol. 95, Supplement 2, pp. S6 – S13.

Esposti, Luca Degli and Valpiani, Georgia, "Pharmacoeconomic burden of undertreating hypertension," *Pharmacoeconomics*, 2004, Vol. 22, No. 14, pp. 907-928.

Esteban, Lola, Gil, Agustin and Hernandez, Jose M., "Pricing with endogenous direct advertising in a monopoly," *Review of Industrial Organization*, 2004, Vol. 25, pp. 129-154.

Findlay, Steven D., "Direct-to-Consumer promotion of prescription drugs: Economic implications for patients, payers and providers," *Pharmacoeconomics*, 2001, Vol. 19, No. 2, pp. 109-119.

Flessa, Steffen, "Ressourcenallokation und Zeitpraeferenz in der Gesundheitsdistriktplanung von Entwicklungslaendern," *OR Spektrum*, 2001, Vol. 23, pp. 203 – 222.

Gal-Or, Esther and Gal-Or, Mordecai, "Customized Advertising via a Common Media Distributor," *Marketing Science*, Spring 2005, Vol. 24, No. 2, pp. 241-253

Gilbody, S., Wilson, P. and Watt, I, "Benefits and harms of direct to consumer advertising: a systematic review," *Qual Saf Health Care*, 2005, Vol. 14, pp. 246 – 250.

Gohmann, Stephan F., "Preventive Care and Insurance Coverage", *Contemporary Economic Policy*, October 2005, Vol. 23, No. 4, pp. 513 – 528.

Goldstein, Larry B., "Editorial Comment – Advertising Strategies to Increase the Public Knowledge of the Warning Signs of Stroke," *Stroke*, 2003, Vol. 34, pp. 1968-1969.

Health Council of Canada, Why Health Care Renewal Matters: Learning from Canadians with Chronic Health Conditions, March 2007, Toronto: Health Council. www.healthcouncilcanada.ca.

Health Council of Canada, Why Health Care Renewal Matters: Lessons from Diabetes, March 2007, Toronto: Health Council. www.healthcouncilcanada.ca.

Hu, Teh-Weh, Sung, Hai-Yen and Keeler, Theodore E., "The State Antismoking Campaign and the Industry Response: The Effects of Advertising on Cigarette Consumption in California," *The American Economic Review*, Vol. 85, No. 2, Papers and Proceedings of the Hundredth and Seventh Annual Meeting of the American Economic Association Washington, DC, January 6-8, 1995. (May, 1995), pp. 85-90.

Huh, Jisu, Delorme, Denise E. and Reid, Leonard N., "Perceived Third-Person Effects and Consumer Attitudes on Prevetting and Banning DTC Advertising," *The Journal of Consumer Affairs*, 2006, Vol. 40, No. 1, pp. 90 – 116.

Iyer, Ganesh, Soberman, David and Villas-boas, J. Miguel, "The Targeting of Advertising," *Marketing Science*, Summer 2005, Vol. 24, No. 3, pp. 461-476.

Kremer, Michael, "Pharmaceuticals and the Developing World," *Journal of Economic Perspectives*, Fall 2002, Vol. 16, No. 4, pp. 67 – 90.

Lagarde, Francois, "The Challenge of Bilingualism: ParticipACTION Campaigns Succeed in Two Languages," *Canadian Journal of Public Health*; May/Jun 2004, Vol. 95, Supplement 2, pp. S30-S32.

Larkin, June, Flicker, Sarah, Koleszar-Green, Ruth, Mintz, Susan, Dagnino, Michelle and Mitchell, Claudia, "HIV Risk, Systemic Inequities, and Aboriginal Youth: Widening the Circle for HIV Prevention Programming," *Canadian Journal of Public Health*, May-June 2007, Vol. 98, No. 3, pp. 179-182.

Mascie-Taylor, C.G.N. et al, "The cost-effectiveness of health education in improving knowledge and awareness about intestinal parasites in rural Bangladesh," *Economics and Human Biology*, 2003, Vol. 1, pp. 321-330.

Matraves, Catherine, "Market structure, R&D and advertising in the pharmaceutical industry," *The Journal of Industrial Economics*, June 1999, Vol. XLVII, No. 2, pp. 169 – 194.

Meier, Volker, "On the demand for preventive care," *OR Spektrum*, 2000, Vol. 22, pp. 381-402.

Messerlian, Carmen and Derevensky, Jeffrey, "Evaluating the Role of Social Marketing Campaigns to Prevent Youth Gambling Problems: A Qualitative Study," *Canadian Journal of Public health*, Mar/Apr 2007, Vol. 98, Vol. 2, pp. 101 – 104.

Miceli, Thomas J. and Heffley, Dennis, "Do HMOs encourage prevention? An analysis of alternative health care plans," *Contemporary Economic Policy*, October 2002, Vol. 20, No. 4, pp. 429-439.

Montgomery, Alan L., "Creating Micro-Marketing Pricing Strategies Using Supermarket Scanner Data," *Marketing Science*, 1997, Vol. 16, No. 4, pp. 315-337.

Morgan, Steven, Mintzes, Barbara and Barer, Morris, "The economics of direct-to-consumer advertising of prescription-only drugs: prescribed to improve consumer welfare?" *Journal of Health Services Research & Policy*, 2003, Vol. 8, No. 4, pp. 237-244.

Nayga, Rodolfo M. Jr., "Obesity and heart disease awareness: a note on the impact of consumer characteristics using qualitative choice analysis," *Applied Economics Letters*, 1997, Vol. 4, pp. 229-231.

Nunes, Jose Ferrara, "Cost-Effective Prevention of Hip Fractures," *International Advances in Economic Research*, 2005, Vol. 11, pp. 49-67.

Pines, Wayne L., "A history and perspective on direct-to-consumer promotion," *Food and Drug Law Journal*, Vol. 54, pp. 489 – 518.

Ringold, Debra Jones, "Boomerang Effects in Response to Public Health Interventions: Some Unintended Consequences in the Alcoholic Beverage Market," *Journal of Consumer Policy*, 2002, Vol. 25, pp. 27-63.

Rizzo, John A., "Advertising and Competition in the Ethical Pharmaceutical Industry: the Case of Antihypertensive Drugs," *Journal of Law and Economics*, April 1999, Vol. 42, No. 1, pp. 89-116.

Romer, Daniel and Kim, Stephen, "Health Interventions for African Americans and Latino Youth: The Potential Role of Mass Media," *Health Education Quarterly*, May 1995, Vol. 22, No. 2, pp. 172- 189.

Rossi, Peter E., McCulloch, Robert E. and Allenby, Greg M., "The Value of Purchase History Data in Target Marketing," *Marketing Science*, 1996, Vol. 15, No. 4, pp. 321-340.

Rubin, Paul H. and Schrag, Joel L., "Mitigating Agency Problems by Advertising, with Special Reference to Managed Health," *Southern Economic Journal*, 1999, Vol. 66, No. 1, pp. 39-60.

Schuh, Arnold, "Global Standardization as a Success Formula for Marketing in Central and Eastern Europe?" *Journal of World Business*, 2000, Vol. 35, No. 2, pp. 134-148.

Shaffer, Greg and Zhang, Z. John, "Competitive Coupon Targeting," *Marketing Science*, Vol. 14, No. 4, 1005, pp. 395 – 416.

UBC Centre for Health Services and Policy Research, When drug advertising works only too well: Direct to consumer advertising, 2003, Vancouver: UBC Centre for Health Services and Policy Research. www.chspr.ubc.ca

Vaithianathan, Rhema, "Supply-side cost sharing when patients and doctors collude," *Jouranl of Health Economics*, 2003, Vol. 22, 763-780.

Vitry, Agnes, "Is Australia free from direct-to-consumer advertising?" *Australian Prescriber*, February 2004, Vol. 27, No. 1, pp. 4 – 6.

Weissman, Joel S., Blumenthal, David, Silk, Alvin J., Zapert, Kinga, Newman, Michael and Leitman, Robert, "Consumers' reports on the health effects of direct-to-consumer drug advertising," *Health Affairs – Web Exclusive*, 26 February 2003, pp. W3-82 – W3-95.

White, Ronald F., "Direct-to-consumer advertising and the demise of the ideal model of health care," *The Independent Review*, Fall 2006, Vol. XI, No. 2, pp. 223-236.

Williams, Janice E., and Flora, June A., "Health Behavior Segmentation and Campaign Planning to Reduce Cardiovascular Disease Risk Among Hispanics," *Health Education Quarterly*, February 1995, Vol. 22, No. 1, pp. 36- 48.

Woloshin, Steven, Schwartz, Lisa M., Tremmel, Jennifer and Welch, H. Gilbert, "Direct-to-consumer advertisements for prescription drugs: what are Americans being sold?" *The Lancet*, October 6 2001, Vol. 358, pp. 1141 – 1146.

Zhang, Jie, "Customizing Promotions in Online Stores," *Marketing Science*, Fall 2004, Vol. 23, No. 4, pp. 561-578.

Appendix

Proof of Theorem 1:

The game is in two stages. In the second, the firm sets its price, taking government advertising as given. In the first, the government advertises. An equilibrium consists of an advertising function $a_2^g(x)$ and price p from which neither firm nor government has an incentive to deviate.

By Lemma 1, government ads bring consumers with utility greater than $-p^g$ to a utility of $-p_g$, where g is a positive constant. The address of the highest consumer advertised to is $-p^g/h$. Let the address of the lowest consumer be z_2.

Since the firm does not advertise, profits are equal to revenue.
Given g and z_2, profits in the second stage are

$$\Pi_2(p) = \begin{cases} p\left(1-\dfrac{p}{h}\right) & p > p^g \\ p(1-z_2) & z_2 h \le p \le p^g \\ p\left(1-\dfrac{p}{h}\right) & p < z_2 h \end{cases}$$

Since sales are independent of price for $z_2h<p<p^g$, the firm will prefer $p=p^g$ to all other values of p in this range.

We know from the analysis of Case 1 that p(1-p/h) is at a maximum when p=h/2. When $z_2h<h/2<p^g$, the firm will choose p=h/2. Otherwise, it will choose p=h/2 when profits from such are higher than $p^g(1-z)$. That is,

$$p_2^* = \begin{cases} \dfrac{h}{2} & z_2 h \le \dfrac{h}{2} \le p^g \\ \dfrac{h}{2} & p^g(1-z_2) \le \dfrac{h}{4} \\ p^g & p^g(1-z_2) \ge \dfrac{h}{4} \end{cases}$$

In stage 1, the firm will not set $z_2>1/2$, since the firm is willing to supply these customers. It will not set $p^g>h/2$, since for any given z this raises advertising costs without increasing coverage.

For any given $z_2<1/2$, the government must set g such that

$$p^g(1-z_2) = h/4$$

This implies that

$$p^g = \frac{h}{4(1-z_2)}$$

The government will advertise to all consumers with addresses greater than or equal to z and utility greater than g – that is, all consumers on $[z_2,p^g/h]$.

Advertising is done in the amount just needed to make consumers indifferent to the good at price p^g.

$$a_2^g(x) = \frac{p^g}{x} - h$$

Government health care costs are equal to the expected medical costs of the untreated consumers:

$$G_2(z) = g\int_0^{z_2} x dx + \int_{z_2}^{1}\left(\frac{1}{4(1-z_2)x} - h\right)dx$$

The government seeks to minimize total costs.

The first-order conditions may be solved for z_2^*. The solution is not reproduced here for reasons of length.

When g=0, z_2^* is ½ as it is never worthwhile for the government to advertise, and we are back to the benchmark case. When h=0, $z_2^*=0$ as advertising is costless.

The value of z_2^* falls with g and rises with h, and thus so does the price p_2^*[14]. (A higher h raises advertising costs for $x<p^g/h$.) For positive g, coverage is always greater than ½ and price is always less than h/2. ■

Proof of Theorem 2:

The game is in two stages. In Stage 1, the firm sets a price. In stage 2, the government advertises and consumers make their purchase decisions.

Stage 2

To make consumers indifferent between buying the product and not buying it, the government must set $a^g(x) = p/x - h$. It will not advertise to addresses greater than p/h. The lowest address advertised to, z_3, will have marginal benefit equal to advertising cost – the marginal benefit to the government from advertising is gx.

Solving, we find

$$z_3(p) = \frac{\sqrt{h^2 + 4gp} - h}{2g}$$

Firm profits in stage 1 are then

$$\Pi_3(p) = p(1 - z(p))$$

Solving the first-order conditions, we find that

$$p_3^* = \frac{1}{6g}\left(\frac{(2g+h)}{3}\left((2g+h) + 2\sqrt{(g+h)^2 - gh}\right) - h^2\right)$$

The limit of p_3^* as g → 0 is h/2, and this is greater than h/2 for g>0. When p=g+h, z=1, and so the price will be between h/2 and h+g. When h=0, p_3^*=4g/9. The limit of p_3^* as h→infinity is infinity. ■

Proof of Theorem 3:

Let the firm be the sole advertiser and first mover.

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[14] It may be verified that z_2^* depends only on the ratio h/f by making the substitution h=δf in the expression for $G_2(z)$. It is then easy to show that that for δ>0, z_2^* is independent of δ.

The utility of an untreated consumer who is not advertised to is –xh, where x is the risk of infection. The utility of a treated consumer is –p. Consumers with infection risk greater or equal to p/h are therefore willing to purchase treatment without being advertised to.

Consumers with x<p/h will not purchase treatment without being advertised to. The firm need only advertise to the extent that makes a consumer indifferent to purchasing treatment at price p. Since the utility of an untreated consumer is $U_4(x) = -x(h + a^f(x))$, this implies that when $a^f(x) > 0$, it takes the form $a^f(x) = p/x – h$.

Let $z_4 \leq \frac{p}{h}$ be the lowest infection risk targeted with advertising. The firm will advertise so long as the cost of doing so does not exceed revenue from an additional consumer, p. This means that at $a^f(z_4) = p$, and so $z_4 = p/(p+h)$. For $x>z_4$, $p>a^f(x)$. The firm will therefore advertise to all consumers on [p/(p+h),p/h].

A unit mass of consumers is uniformly distributed with respect to the risk of infection along the unit line. If all consumers with x>p/(p+h) purchase treatment, then a mass (1 – p/(p+h)) of consumers purchases treatment. Firm revenue is therefore p(1 – p/(p+h)).

The cost to the firm of its advertising campaign is

$$\int_0^1 a^f(x)dx = \int_{\frac{p}{p+h}}^{\frac{p}{h}} \left(\frac{p}{x} - h\right)dx$$

There are no costs of production, so firm profits are equal to revenue minus advertising costs:

$$\Pi_4(p) = p\left(1 - \frac{p}{h}\right) - \int_{\frac{p}{p+h}}^{\frac{p}{h}} \left(\frac{p}{x} - h\right)dx$$

This simplifies to

$$\Pi_4(p) = p\left(1 - \ln\left(1 + \frac{p}{h}\right)\right)$$

Solving the first-order conditions, we find this function is at a maximum when the price is equal to

$$p_4^* = \left(\frac{1}{LambertW(1)} - 1\right)h$$

If we define

$$\alpha \equiv \frac{1}{LambertW(1)} - 1$$

Then $p_4^* = \alpha h$ and coverage is $1 - \frac{p_4^*}{p_4^* + h} = 1 - \frac{\alpha h}{\alpha h + h} = \frac{1}{1+\alpha}$, as required. ■