Implications of a Negative Market Spillover

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Abstract

In recent years, several firms have decided to withdraw from profitable unhealthy good markets, believing the move will be beneficial for their overall business. For instance, CVS dropped tobacco products from its shelves in 2014, while Aldi dropped confectionery from its checkout lines in 2016. Findings from consumers' evaluation of such moves suggest there exists a negative market spillover from selling in an unhealthy good market, such that a firm's participation in an unhealthy good market reduces consumers' willingness to pay for the firm's goods in other markets. We build an analytical model of two competing firms to examine how firms react to a negative market spillover and find the conditions under which different firms would exit an unhealthy good market. Our analysis of how firms' profits are affected by negative market spillovers identifies the consumers' reservation value for the unhealthy good, the size of the unhealthy good market, and the magnitude of the market spillover as key factors determining which firms benefit from a negative market spillover. Interestingly, we find it is possible for both firms to make more profit with a negative market spillover compared to when there is no market spillover.

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1. Introduction

In September 2014, all CVS pharmacy locations stopped selling tobacco (Martin and Esterl 2014). While the move was estimated to cost CVS $2 billion from lost cigarette sales (Young 2014), CEO Larry Merlo stated that removing tobacco products could benefit CVS's overall business (Davis 2014). In

January 2016, Aldi announced plans to stop selling unhealthy snacks such as candy bars in their checkout lines, while Target started testing the same policy in some of its stores in September 2015 (Trotter 2016). Managers of these retailers and industry analysts have speculated that this move can increase profits (Harrison 2014); Senior Vice President of Merchandising for Target, Christina Hennington, viewed the move as “a huge business opportunity” (Stern 2015). This raises several interesting questions: when should a firm withdraw from a profitable market and how would this decision affect competition and profitability?

The examples of CVS, Aldi, and Target suggest that for some products, there is a negative market spillover. In other words, by selling in markets like tobacco and unhealthy foods, a firm can damage its ability to sell in other markets such as pharmaceuticals and groceries. Regarding CVS’s decision, many industry experts and analysts have also viewed this move as financially beneficial for CVS; for example, International Strategy and Investment Group has said in a message to investors “We believe the move will be viewed as a positive long-term decision” (Wahba and Steenhuysen 2014). A comparison of CVS’s revenue before and after the ban on tobacco shows a 9.7% increase in revenue as a result of higher pharmacy sales after this move (Calia 2014). Based on this study, the increase in sales of pharmaceuticals had offset the loss of cigarettes sales. A Gallup poll done on consumers’ reaction to CVS’s policy helps explain the increase in revenue: The poll shows that 83% of consumers that stated this policy affected their likelihood of shopping at CVS reported they would have been less likely to shop at this pharmacy if it still sold tobacco (Dvorak and Yu 2014). The results of these consumer surveys and profit analyses, coupled with opinions from industry experts, suggest the existence of a negative market spillover from the tobacco market to the pharmacy market, such that selling in the tobacco market reduces consumers’ willingness to pay for goods in the pharmacy market.

Aldi and Target are not the only retailers responding to a negative market spillover effect of selling unhealthy snacks. In Europe, major retailers such as Tesco and Lidl have removed unhealthy products from checkout lines. Tesco, UK’s largest retailer, banned all sweets and chocolates from its checkouts in

2014 after a survey of its consumers showed 65% of shoppers supported the removal of confectionery (Smithers 2014). Lidl’s decision came after a 10 week trial period, where some of its stores replaced candy at checkout lines. The results of Lidl’s trial period suggested that despite the lost sales of confectionery, their stores could benefit from removing these products, as sweet-selling checkouts received 17% fewer customers and 70% of consumers stated they would pick a sweet-free checkout over a sweet-selling one (Poulter 2014). The evidence from these surveys and trial results suggest the existence of negative market spillover such that selling confectionery at checkout lines reduces consumers’ willingness to pay for other goods in the grocery market.

These examples raise a broader question on how companies should respond to shifts in consumer preferences toward avoiding firms selling unhealthy goods. With consumers becoming more and more health conscious, many are showing a willingness to avoid shopping from stores they perceive as unhealthy (Olenski 2014). This would suggest that a negative market spillover could arise from products beyond tobacco and unhealthy snacks. For instance, it can be expected that unhealthy products, such as alcohol, or socially objectionable products, such as gambling, could also result in a negative market spillover. If this trend continues, more and more firms who operate in multiple markets may need to decide how to react to the emergence of negative market spillovers. Thus, it is important to understand the effect such market spillovers can have on firms and their consumers.

This paper develops an analytical model to examine the implications of negative market spillovers. We define the *unhealthy good market* as the market that creates the negative market spillover, and the *primary market* as the market affected by the spillover, typically representing the firm’s main business. This means the firm may profitably sell the unhealthy good (e.g. tobacco, confectionery), but at the cost of reduced willingness to pay from consumers in its primary market (e.g. pharmaceuticals, groceries).

This is consistent with our findings from conjoint analyses of the effect of a firm's participation in unhealthy good markets.[1]

While we reported several firms which have exited unhealthy good markets due to this negative market spillover, there are also several firms that continue to sell unhealthy goods, including pharmacies such as Rite Aid that keep selling tobacco, and grocery stores such as Safeway that keep selling confectionery at checkout lines. We aim to understand the drivers of this difference in different firms' reaction to negative market spillovers.

We recognize that firms vary in terms of their quality in the primary market and as such the market spillover may not have the same effect on all firms. For instance, one firm may have greater assortment or better trained employees who offer quicker, friendlier and/or more knowledgeable service. Especially for retailers, research shows the existence of considerable asymmetry among firms, evident from the emergence of "dominant retailers" (Geylani et al. 2007). We incorporate this quality asymmetry in our study to see how firms with different quality react to a negative market spillover. We refer to the firm with the higher quality in the primary market as the *superior* firm and the firm with the lower quality as the *inferior* firm. On the one hand, one might expect the superior firm to stay in the unhealthy good market, since its advantage in the primary market can help buffer it from the cost of a negative market spillover. On the other hand, one might expect the inferior firm to stay in the unhealthy good market, since it has less to lose in the primary market. We formalize a model to resolve this issue and also examine how a quality difference among firms in the penalized market affects firms' profitability and prices.

Specifically, this research addresses the following research questions:

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[1] A ratings-based conjoint (Schindler 2011) with 91 (101) subjects on Amazon Mechanical Turk showed consumers would pay an average of $4.41 ($0.61) less for travel immunization consulting (a healthy salad) from a pharmacy (grocery store) that sold tobacco (unhealthy snacks at checkouts). The estimates were statistically significant with 95% confidence.

1) When will it be optimal for the superior and/or inferior firm to withdraw from the unhealthy good market in response to a negative market spillover?
2) How does a negative market spillover affect industry profits?
3) How do the superior and the inferior quality firms' profits get affected differently by a negative market spillover?

To address these research questions, we develop an analytical model of competing firms who can choose whether or not to exit the unhealthy good market in the presence of a negative market spillover. We consider firms that are both horizontally and vertically differentiated, model consumers with heterogeneous taste for products in both markets, and solve for equilibrium strategies regarding selling in the unhealthy good market in the presence of a negative market spillover.

We find that the negative market spillover can cause none, one, or both firms to exit the unhealthy good market depending on the market conditions. We show that when the consumers' reservation value for the unhealthy good and the magnitude of the negative market spillover are high enough, the superior firm will choose to withdraw from the unhealthy good market, while the inferior firm stays. Interestingly, this result shows that although the inferior firm is losing the competition in the primary market to the superior firm, it still prefers to sell in the unhealthy good market and incur the negative market spillover that further weakens its position in the primary market. Also in this case, the superior firm decides to withdraw from a profitable market to avoid the negative market spillover in competition with an inferior firm weakened by the market spillover.

Regarding the strategic effects of a market spillover on profitability, it is not obvious how profits of different firms will be affected, since avoiding the negative market spillover comes at the cost of losing a profitable market. Also, participating in the unhealthy good market lowers consumers' willingness to pay in the firm's primary market. Thus, it may appear that the emergence of negative market spillover should always hurt firms' profits. However, we identify conditions for which the negative market spillover hurts both firms, hurts only one firm, or even allows both firms to make more profit than they would have made without the market spillover due to strategic forces. Based on our findings, a negative market spillover is not necessarily bad for participating firms, and managers may actually find it beneficial to encourage a negative market spillover in a competitive setting.

Surprisingly, the inferior firm can even earn a higher profit than the superior firm due to the market spillover, despite having no advantages in its offerings. This result occurs when the market spillover is not too large relative to the reservation value a product in the unhealthy good market provides to consumers. The model identifies the strategic mechanism behind this counterintuitive result. Our findings help managers assess how much a negative market spillover benefits their firm based on its relative quality compared to the competition.

The rest of this paper is organized in the following order. In §2, we relate our paper to the existing literature. Section 3 presents the model setup and in §4 we analyze the model to present the results. Finally, the results are discussed in §5.

2. Previous Literature

Our research considers firms selling in two distinct markets and examines their reaction to a negative market spillover. There are two bodies of literature most closely related. Previous research has considered competition among multiproduct firms, typically offering products with some level of substitutability. Previous research has also considered multimarket competition, where firms face the same competitors in separate markets. In this section, we describe how our paper contributes to each of these literatures.

First, we review related research on multiproduct firms. Margolis (1989) considers consumers of firms that sell more than one product and argues for the existence of cross-product effects, such that a firm's promotional efforts for one product affects the values consumers place on the firm's other products. Anderson and de Palma (1992) use a nested logit model of demand to capture competition among firms over the range of products produced. They show that in equilibrium, compared to socially optimum levels, the market will include too many firms, each offering too few products. Cachon et al. (2008) adds the assumption of costly product evaluations across firms and shows that it could lead to more product variety. Kuksov and Villas-Boas (2010) consider within-firm evaluation costs and show that monopolists offering too many products can cause consumers to avoid purchasing altogether. Liu and Dukes (2013) study competing multi-product firms in the presence of evaluation costs across-firms and within-firms. They show that less differentiation among firms can increase product variety offered by each firm, which contrasts with the result from our setting that as vertical differentiation between competing firms decreases, the range of market spillovers for which both firms participate in more than one market expands. Grossmann (2005) builds an oligopoly model of multi-product firms and shows that in equilibrium higher quality firms have larger product ranges. Our paper differs from previous multi-product literature in both its model and its results. Unlike most previous multi-product models, which assume substitutability among products of a firm such that one product's price and quality affects the other products' demand, our model of a negative market spillover does not require the products from the different markets to have any degree of substitutability. In other words, the mere existence of the unhealthy good among a firm's products is what causes the spillover to other products, and this spillover does not depend on the price or quality of the unhealthy good. Our model also produces unique results that differ from previous findings. For instance, we find that the higher quality firm will actually offer fewer products by withdrawing from the unhealthy good market, unlike what Grossmann (2005) suggests.

Next, we describe related papers examining multimarket competition among firms. Multimarket competition occurs when the same firms compete against each other in more than one market (Karnani and Wernerfelt 1985). The extent of overlap between two firms is represented by their multimarket contact which is defined as the aggregation of all contacts between the two firms in all markets (Gimeno and Woo 1996). Multimarket competition has been widely studied by researchers across many fields (Yu and Cannella 2013), and empirically examined in many industries such as the airline industry (Gimeno 1994), the telephone industry (Parker and Roller 1997), and the banking industry (Heggestad and Rhoades 1978).

Previous literature on multimarket competition has identified mutual forbearance as a form of tacit collusion among firms involved in multimarket competition that causes firms to decrease competitive attacks against each other because they fear that an attack in one market may be countered in another market (Edwards 1955). Bernheim and Whinston (1990) offer a model of multimarket competition showing that as long as the markets and the firms are considered to be identical, mutual forbearance will not happen. However, if the firms are allowed to have competitive advantages in heterogeneous markets, collusive agreements to avoid competition can be beneficial to both firms. Subsequent research shows mutual forbearance requires observability of firm actions (Thomas and Willig 2006) and coordination mechanisms (Jayachandran et al. 1999). Our research similarly finds that avoiding competition can be beneficial to firms in multimarket competition, but interestingly we find that this may arise as an unintended consequence of the market spillover and in the absence of collusive agreements. We also show that asymmetry between firms is not a necessary condition for this benefit.

The multimarket competition literature has also studied the decisions of the competing firms regarding exiting or entering certain markets and how these decisions affect competition. Baum and Korn (1999) suggest that entry decisions in multimarket competition follow an inverted U-shaped curve in relation to multimarket contact. Stephan et al. (2003) empirically support these theories using hospital data, showing firms as less likely to exit a market when their multimarket competitors exist in that market. Cai and Raju (2015) show that multimarket competition can cause competing firms to form alliances when entering a new market to benefit from each other's investment in the new market.

In summary, the literature on rivalry in multimarket competition suggests that mutual forbearance decreases competitive intensity and increases prices. The findings from this literature are similar to our results in that both predict competition can be dampened. However, the nature of this decrease is different in our research. Mutual forbearance is a form of collusive agreement between the firms, and its existence relies on such necessary conditions as observability of actions and coordination. But we find negative market spillovers can dampen competition not through agreements, but by affecting the consumers' willingness to pay for firms that participate in certain markets. From a modeling standpoint, the model for mutual forbearance relies on repeated games and future profits, while our model works independent of future periods.

3. Model

We consider a model where two firms, A and B, may compete in a *primary market* and an *unhealthy good market*. We consider a situation in which the firms have an established presence in each market but may react to the market spillover by costlessly exiting either market. Each firm can decide to continue participating in the unhealthy good market, but selling in this market comes at the cost of a negative market spillover to the primary market: A consumer's valuation of a product in the primary market is reduced by c when buying from a firm that also operates in the unhealthy good market. This assumption is consistent with the anecdotal evidence from the cases of CVS, Aldi's and Lidl's. To further validate this assumption, we also ran two ratings-based conjoint studies on Amazon Mechanical Turk that showed participants had a lower willingness to pay for travel immunizations (a salad bar) at a pharmacy (grocery store) that sold tobacco (unhealthy snacks at checkout). Procedure details and analysis are presented in the Appendix.

Each market is represented with a Hotelling model, with the two firms located at opposite ends of the unit lines. In the interest of parsimony, we assume sources of quality advantage can have high impact on the firm's primary market, while having no influence on its unhealthy good market. For instance, CVS is creating a competitive advantage in health service by expanding its accessible clinical services and providing unique health related loyalty programs such as the ExtraCare program (Schmalbruch 2015), which have little impact on the value of tobacco products sold at CVS. As such, we allow the two firms to offer products in the primary market with reservation values, denoted by v_A for firm A and v_B for firm

B such that $v_A \geq v_B$, while they offer similar products with the reservation value of v_2 in the unhealthy good market.[2] The price of firm *i*'s product in market *j* is p_{ij}, where $i \in \{A, B\}$ and $j \in \{1, 2\}$.

In the interest of parsimony, the two markets are assumed to be independent of each other. This will be true if the markets for each good include different customers or the same customers making separate purchase decisions. In Section 4.3, we solve the model relaxing this assumption.

The size of the primary market is normalized to one and the size of the unhealthy good market is denoted m, with the assumption of $0 \leq m \leq 1$ to capture larger market sizes for the primary market relative to the unhealthy good market. The transportation cost of consumers is denoted by t and is assumed constant across markets. The distance of consumers from the location of firm A is denoted by x in the primary market and by y in the unhealthy good market. Both x and y are independently and identically distributed uniformly between 0 and 1.

The utility a consumer located at y in the unhealthy good market gets from buying from firm i is

$$u_{i2}(y) = v_2 - p_{i2} - |y - L_i| t$$

where L_i represents the location of firm i such that $L_A = 0$ and $L_B = 1$.

For the primary market, the utility of a consumer located at x buying from firm i depends on whether that firm is also selling in the unhealthy good market or not.

$$u_{i1}(x) = v_i - p_{i1} - |x - L_i| t - D_i \times c$$

where $D_i = \begin{cases} 1 & \textit{if firm i stays in the unhealthy good market} \\ 0 & \textit{if firm i exits the unhealthy good market} \end{cases}$

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[2] Assuming the same firm that is superior in the primary market is also superior in the unhealthy good market would logically require a bigger market spillover for the superior firm to exit the unhealthy good market, but should preserve the qualitative insights derived from our more parsimonious model.

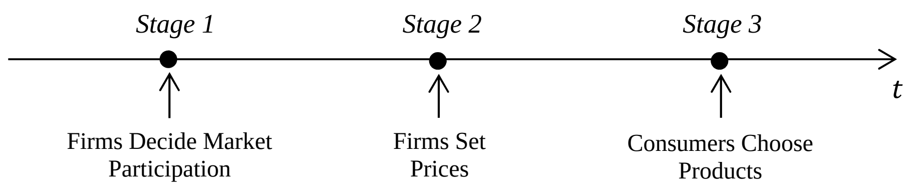
Each firm’s objective is to maximize the sum of its profits from the two markets. The marginal cost of production is assumed zero for both firms in both markets. The firms’ profit in each market equals the number of goods sold multiplied the price charged for each.

The game has three stages. In stage 1, each firm decides whether to exit the unhealthy good market. In stage 2, market participation is common knowledge and the firms simultaneously set their prices for their products in the markets in which they operate. In stage 3, consumers in each market decide from which firm to buy, maximizing their utility. Consumers in stage 3 are assumed to be fully informed about the firms’ decisions in stages 1 and 2. The timing of the model and decisions of players at each stage are shown in figure 1. Table 1 summarizes the notations used in the model.

Table 1. Summary of Notations.

Notation	**Definition**
Firm A	Superior firm
Firm B	Inferior firm
Market 1	Primary market
Market 2	Unhealthy good market
c	Negative Market spillover
p_{ij}	Price chosen by firm *i* in market *j*
q_{ij}	Quantity sold by firm *i* in market *j*
π_i	Total profit of firm *i*
v_A	Consumer reservation value for firm A’s primary good
v_B	Consumer reservation value for firm B’s primary good
v_2	Consumer reservation value for unhealthy good
m	Size of the unhealthy good market
t	Consumers’ per unit transportation cost
x	Consumer’s location in the primary market
y	Consumer’s location in the unhealthy good market

Figure 1. The Timeline of the Model



4. Analysis

In this section, we present the results of the model. We begin by finding the equilibrium strategies chosen by asymmetric firms in the presence of a market spillover. In section 4.2, we analyze the effect of market spillovers on firms' profits. We compare firm profitability in the presence of a negative market spillover to firm profitability in the absence of market spillovers. We also demonstrate how the results persist with symmetric firms. In section 4.3, we present and analyze a model extension allowing for dependency in demand across markets.

4.1. Equilibrium Strategies with a Negative Market Spillover

In this section, we study how firms with different levels of quality respond to market spillovers in order to find which of the two firms, if any, stay in the unhealthy good market with the emergence of a market spillover. We assume the quality advantage to be small enough such that there could still be a portion of consumers in the primary market who prefer to buy from the inferior firm; $v_A - v_B \leq 3t$.

This model has four subgames: (1) both firms sell the unhealthy good (2) only the superior firm (firm A) sells the unhealthy good, (3) only the inferior firm (firm B) sells the unhealthy good, and (4) neither firm sells the unhealthy good. We examine each of them below.

Both firms sell the unhealthy good. The marginal consumer in the unhealthy good market, who is indifferent between buying from each of the two firms, is located at y^* such that $v_2 - y^* t - p_{A2} = v_2 - (1 - y^*)t - p_{B2}$. Similarly in the primary market the marginal consumer's location can be found at x^* such that $v_A - x^* t - p_{A1} - c = v_B - (1 - x^*)t - p_{B1} - c$.

$$
\begin{aligned}
y^* &= (p_{B2} - p_{A2} + t)/2t \\
x^* &= (v_A - v_B + p_{B1} - p_{A1} + t)/2t
\end{aligned}
\tag{1}
$$

Given the size of the unhealthy good market is denoted by *m*, firm A maximizes the sum of its profits, $x^* p_{A1} + m y^* p_{A2}$, with respect to p_{A1} and p_{A2}, while firm B maximizes its profit, $(1 - x^*) p_{B1} + m(1 - y^*) p_{B2}$, with respect to p_{B1} and p_{B2}, where x^* and y^* are defined in equation (1).

Solving the first order conditions, we find the two firms set equal prices in the unhealthy good market and equally share that market; $p_{A2}^{SS} = p_{B2}^{SS} = t$, where the superscript SS denotes the subgame equilibrium when both firms sell the unhealthy good. These prices will cover the whole unhealthy good market if $v_2 > 3t/2$. Otherwise, for lower v_2, the marginal consumer gets negative utility at these prices and the corresponding equilibrium prices and profits are presented in the appendix. In the primary market, firm A chooses $p_{A1}^{SS} = (v_A - v_B)/3 + t$, and firm B chooses $p_{B1}^{SS} = (v_B - v_A)/3 + t$. The equilibrium profits in this subgame are

$$\begin{aligned} \pi_A^{SS} &= ((v_A - v_B)/3 + t)^2 / 2t + mt/2 \\ \pi_B^{SS} &= ((v_B - v_A)/3 + t)^2 / 2t + mt/2 \end{aligned} \tag{2}$$

Neither firm sells the unhealthy good. Firm A maximizes $x^* p_{A1}$ with respect to p_{A1} while firm B maximizes $(1 - x^*) p_{B1}$ with respect to p_{B1}, where x^* is as defined in equation (1). The subgame equilibrium prices are $p_{A1}^{NN} = (v_A - v_B)/3 + t$ and $p_{B1}^{NN} = (v_B - v_A)/3 + t$, where the NN superscript denotes both firms not selling the unhealthy good. Subgame equilibrium profits are

$$\begin{aligned} \pi_A^{NN} &= ((v_A - v_B)/3 + t)^2 / 2t \\ \pi_B^{NN} &= ((v_B - v_A)/3 + t)^2 / 2t \end{aligned} \tag{3}$$

Only firm B sells the unhealthy good. Since the market demands are assumed independent of one another (an assumption relaxed in the extension of Section 4.3), we may separately analyze firm B's pricing decision in the unhealthy good market from the primary market. Consumers for whom $v_2 - (1 - y^*)t - p_{B2} \geq 0$ will buy the unhealthy good from firm B and the remaining consumers in the unhealthy good market will abstain from purchase. Thus, firm B chooses p_{B2} to maximize $m(1-y^*)p_{B2}$ subject to the constraint that $y^* \leq 1$ where $y^* = 1-(v_2 - p_{B2})/t$. Solving the KKT conditions, firm B will choose $p_{B2}^{NS} = v_2/2$ if $v_2 < 2t$, and $p_{B2}^{NS} = v_2 - t$ otherwise. The latter implies that the unhealthy good market is fully covered. In the interest of parsimony, we assume high enough transportation costs such that one firm alone cannot sell to the whole unhealthy good market, and make assumption $v_2 < 2t$ from here on.

In the primary market, the marginal consumer's location can be found at x^* such that $v_A - x^* t - p_{A1} = v_B - (1-x^*)t - p_{B1} - c$.

$$x^* = (v_A - v_B + p_{B1} - p_{A1} + c + t)/2t \tag{4}$$

Using equation (4), firm A chooses p_{A1} to maximize $x^* p_{A1}$, while firm B chooses p_{B1} to maximize $(1-x^*)p_{B1}$. Taking the first order conditions we find that for $c \leq 3t-(v_A - v_B)$ there is an interior solution and both firms still sell in the primary market, but for $c > 3t-(v_A - v_B)$ a corner solution is reached and firm B effectively exits the primary market. For $c \leq 3t-(v_A - v_B)$, the primary market prices of the firms are $p_{A1}^{NSlowc} = (v_A - v_B + c)/3 + t$ and $p_{B1}^{NSlowc} = (v_B - v_A - c)/3 + t$. The corresponding total profits are

$$\begin{aligned} \pi_A^{NSlowc} &= ((v_A - v_B + c)/3 + t)^2/2t \\ \pi_B^{NSlowc} &= ((v_B - v_A - c)/3 + t)^2/2t + m{v_2}^2/4t \end{aligned} \tag{5}$$

For $c > 3t-(v_A - v_B)$, firm A sells exclusively to the primary market, setting the price at $p_{A1}^{NShighc} = v_A - v_B + c - t$. The corresponding total profits are

$$\begin{aligned} \pi_A^{NShighc} &= v_A - v_B + c - t \\ \pi_B^{NShighc} &= m{v_2}^2/4t \end{aligned} \tag{6}$$

Only firm A sells the unhealthy good. We may again examine these two markets independently. As before, the only firm selling the unhealthy good (firm A in this case) will choose $p_{A2}^{SN} = v_2 / 2$. In the primary market, the marginal consumer's location can be found at x^* such that $v_A - x^* t - p_{A1} - c = v_B - (1 - x^*)t - p_{B1}$.

Similar to the findings for the previous subgame, for $c \leq 3t + (v_A - v_B)$ there exists an interior solution and both firms still sell in the primary market, but for $c > 3t + (v_A - v_B)$ there is a corner solution in which firm A exits the primary market. For $c \leq 3t + (v_A - v_B)$, the primary market prices are $p_{A1}^{SNlowc} = (v_A - v_B - c)/3 + t$ and $p_{B1}^{SNlowc} = (v_B - v_A + c)/3 + t$. The corresponding total profits are

$$\begin{aligned} \pi_A^{SNlowc} &= ((v_A - v_B - c)/3 + t)^2 / 2t + m{v_2}^2 / 4t \\ \pi_B^{SNlowc} &= ((v_B - v_A + c)/3 + t)^2 / 2t \end{aligned} \tag{7}$$

For $c > 3t + (v_A - v_B)$, firm B sells exclusively to the primary market at $p_{B1} = v_B - v_A + c - t$ and the corresponding total profits are as follows.

$$\begin{aligned} \pi_A^{SNhighc} &= m{v_2}^2 / 4t \\ \pi_B^{SNhighc} &= v_B - v_A + c - t \end{aligned} \tag{8}$$

Examining the profits of the two firms in each subgame solution (see equations (2)-(8)), we solve the game and find the equilibrium unhealthy good market participation of each firm. The proofs of all lemmas and propositions are presented in the appendix.

LEMMA 1. *A market spillover affects unhealthy good market participation as follows:*

(a) *When the market spillover is sufficiently large, it reduces participation of firms in the unhealthy good market (i.e.,* $\exists c' \ s.t. \ c > c' \Rightarrow \{sell, sell\}$ *is not an equilibrium).*

(b) *When {sell, sell} is not an equilibrium, both firms leave the unhealthy good market if the consumers' reservation value for the unhealthy good is low (i.e.,* $v_2 < v_2'$*), otherwise one firm leaves the unhealthy good market.*[3]

This lemma confirms intuition that the market spillover can stop the unhealthy good market from being served, only if the reservation value consumers obtain from the unhealthy good (i.e., v_2) is sufficiently small. Otherwise, if v_2 is large enough, having monopoly power over the unhealthy good market is attractive enough that no market spillover can entirely stop the unhealthy good market from being served.

Now, we examine which of the two firms would choose to leave the market in the asymmetric equilibrium: the inferior firm or the superior firm. When both asymmetric equilibria exist, we use the risk-dominance equilibrium refinement to find the risk-dominant equilibrium. Risk dominance refinement is a mechanism for equilibrium selection introduced by Harsanyi and Selten (1988). This equilibrium selection is based on minimizing losses from the other player's deviation. As Straub (1995) shows, this theory successfully predicts the outcome of different types of games with multiple equilibria.

PROPOSITION 1. *Suppose the market spillover and consumers' reservation value for the unhealthy good are sufficiently high to result in asymmetric unhealthy good market participation.*

(a) *It is a unique equilibrium for only the inferior firm to stay in the unhealthy good market if c and* v_2 *are not too high, but it is never a unique equilibrium for only the superior firm to stay in the unhealthy*

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[3] The expressions for c' and v_2' are defined in the appendix.

good market (i.e., $\exists c'' \, and \, v_2'' \; s.t. \; for \, c' < c < c'' \, and \, v_2' < v_2 < v_2'' \Rightarrow \{not\, sell, sell\}$ *is the unique equilibrium).* [4]

(b) *The risk-dominant equilibrium involves only the inferior firm staying in the unhealthy good market when both asymmetric equilibria exist (i.e., only the inferior firm stays in the unhealthy good market in the risk-dominant equilibrium if* $c > c' \, and \, v_2 > v_2'$ *).*

Proposition 1 provides insight into which firm will react to the market spillover by withdrawing from the unhealthy good market. For moderate market spillovers and moderate reservation values in the unhealthy good market, the unique equilibrium calls for only the inferior firm staying in the unhealthy good market, with the superior firm withdrawing. For larger market spillovers and reservation values, either asymmetric equilibrium is possible, but only the inferior firm staying in the unhealthy good market is the risk-dominant equilibrium.

The intuition for why the inferior firm will be the only firm selling in the unhealthy good market is that the inferior firm has less profit to lose in the primary market from the market spillover. If the potential profit of the unhealthy good market is high enough, it exceeds the loss incurred in the primary market. The superior firm experiences higher losses in the primary market from the market spillover and thus is more inclined to exit the unhealthy good market. This amplifies the inferior firm's incentive to stay in the unhealthy good market because this firm gains monopoly power over the unhealthy good market.

The predictions of the model are depicted in Figure 2. The figure illustrates when both firms will opt to sell in the unhealthy good market, when both firms will opt not to sell in the unhealthy good market, and when only one firm will stay in the unhealthy good market. In the area northwest of the Oy curve, there exists an equilibrium where neither firm sells in the unhealthy good market. In the area constrained

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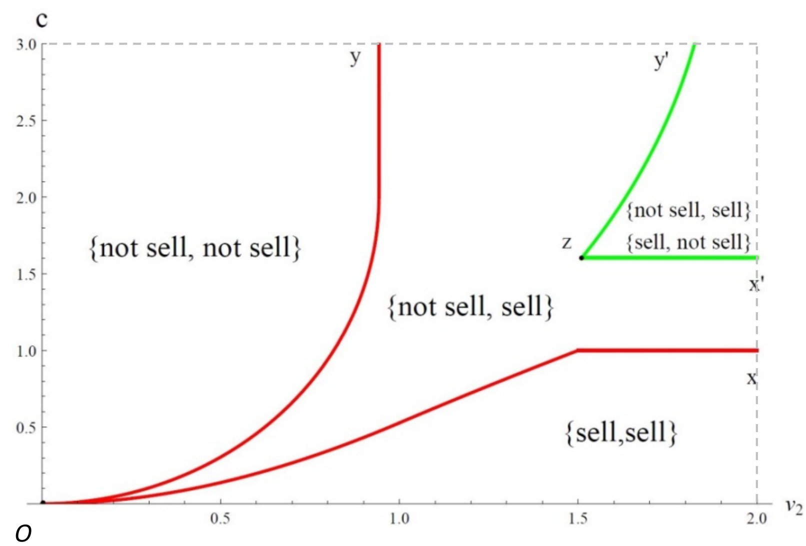
[4] The expressions for c' and v_2' are from Lemma 1. The expressions for c'' and v_2'' are defined in the appendix, where we also prove that $c' < c''$ and $v_2' < v_2''$.

below the Ox curve, both firms sell in the unhealthy good market. The area northeast of xOy, representing high enough market spillovers and reservation values for the unhealthy good, is where the equilibrium with only the inferior firm selling the unhealthy good exists. Finally, in the area northeast of $x'zy'$ there also exists an equilibrium where the superior firm is the only one staying in the unhealthy good market. This last equilibrium is never unique, and is risk-dominated by the equilibrium with the inferior firm staying in the unhealthy good market. Figure 2 is generated for $m=1$, which means the two markets have equal size. As m decreases and the unhealthy good market becomes smaller relative to the primary market, the Ox curve shifts down and the Oy curve shifts to the right, expanding the region where neither firm sells in the unhealthy good market and shrinking the region where both firms sell in the unhealthy good market.

Figure 2. Equilibrium Strategies of {Superior, Inferior} Firms Selling the Unhealthy Good

(WLOG, parameter values $v_A - v_B = 1$, $m = 1$, and $t = 1$ used for generating figure)



As we summarized the firms' equilibrium response to a negative market spillover, our next question is how the negative market spillover will affect firm profitability.

4.2. Firm Profitability under a Negative Market Spillover

In this section we study how the market spillover affects firm profitability. This analysis provides insights on whether or not firms and the industry as a whole are hurt by the emergence of a negative market spillover. We start by comparing equilibrium profits made by the firms under a negative market spillover with the profits they would have made in the absence of any market spillover. In the main text, we focus on the interior solutions in which both firms still sell in the primary market in the {not sell, sell} equilibrium and their profits are represented by equation 5. The conditions for the corner solutions in which the inferior firm exits the primary market in the {not sell, sell} equilibrium, with profits represented by equation 6, provide similar insights and are presented in the appendix.

PROPOSITION 2. *Suppose* $c > c'$ *such that the negative market spillover affects market participation. Defining* $\hat{v}_2 \triangleq Min\{\frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2 - 2c(v_A - v_B)}, t + \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t - c - 2(v_A - v_B))}\}$[5]*, then:,*

(a) *If the consumers' reservation value for the unhealthy good and the size of the unhealthy good market are sufficiently high (i.e.,* $v_2 > \hat{v}_2$ *and* $m > \frac{c(6t - 2(v_A - v_B) - c)}{9t^2}$ *), both firms make more profit in the presence of a market spillover compared to when there is no market spillover.*

(b) *When only the inferior firm participates in the unhealthy good market, if the consumers' reservation value for the unhealthy good or the size of the unhealthy good market is sufficiently low, (i.e.,* $v_2' < v_2 < \hat{v}_2$ *or* $m < \frac{c(6t - 2(v_A - v_B) - c)}{9t^2}$*), the inferior firm makes less profit (and the superior firm makes greater profit) in the presence of a negative market spillover compared to when there is no market spillover.*

(c) *If neither firm participates in the unhealthy good market (i.e.,* $v_2 < v_2'$*), then both firms make less profit in the presence of a negative market spillover compared to when there is no market spillover.*

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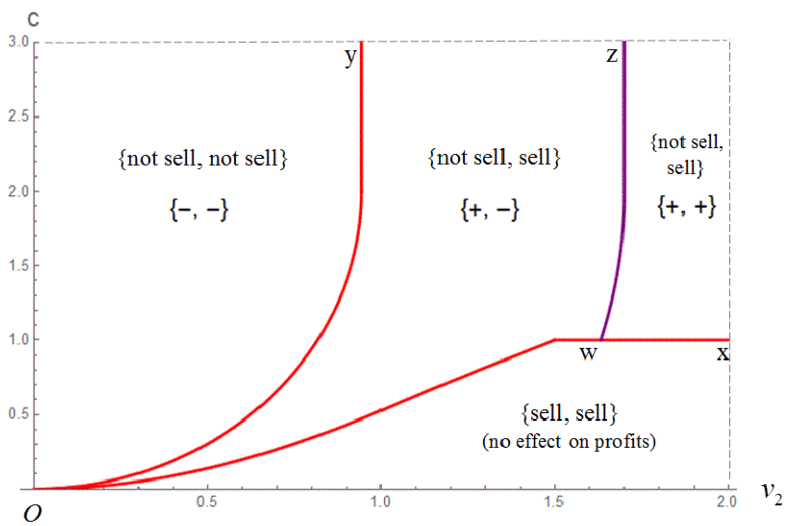
[5] Note that $\hat{v}_2$ always has real values for $c < 3t - (v_A - v_B)$, which is assumed for the interior solution of the {not sell, sell} equilibrium. The conditions on v_2 for the corner solution, where $c > 3t - (v_A - v_B)$, are presented in the appendix.

This proposition shows conditions such that each firm could make more or less profit as a result of the negative market spillover. In fact, consumers' reservation value for the unhealthy good and the size of the unhealthy good market are critical factors in determining how the profits of the firms will be affected by the negative market spillover. Figure 3 demonstrates the findings of proposition 2. The area northeast of the zwx curve shows the region described in proposition 2(a), in which both firms benefit from the emergence of a market spillover. The area bounded by the $yOwz$ curve shows the region for proposition 2(b), in which only the superior firm benefits from a market spillover. Finally, the area northwest of the Oy curve shows the region described in proposition 2(c), in which both firms become worse off with the market spillover.

Figure 3. The Effect of a Negative Market Spillover on Equilibrium Profits
For the {Superior, Inferior} Firms

(WLOG, parameter values $v_A - v_B = 1$, $m = 1$, and $t = 1$ used for generating figure)



Proposition 2 shows the market spillover can function as a competition dampening mechanism, resulting in firms becoming better off as a result of the negative spillover. Interestingly, in the {not sell, sell} equilibrium, the superior firm always earns greater profit than without a market spillover even though it loses sales in the unhealthy good market as it exits from that market. Due to the inferior firm's participation in the unhealthy good market, the inferior firm's value in the primary market lowers and the superior firm gains an even greater advantage in the primary market. Thus, the superior firm gets a bigger portion of the primary market in comparison to when there was no negative market spillover and this increased profit outweighs the loss associated with exiting the unhealthy good market.

Surprisingly, the inferior firm can also earn greater profit than without a market spillover when v_2 and m are high enough, even though it incurs a reservation value reduction in its primary market due to the spillover. The intuition for the market spillover leaving both firms better off is as follows. The inferior firm gets the unhealthy good market to itself due to the competitor choosing to respond to the spillover by exiting the unhealthy good market. Earning monopoly profit in the unhealthy good market can offset the diminished profitability in the primary market, but only if the consumers' reservation value for the unhealthy good and the size of the unhealthy good market are high enough.

Finally, proposition 2 shows when v_2 is low enough such that both firms exit the unhealthy good market, both firms make less profit as a result of the market spillover. This result was expected, as the market spillover causes both firms to lose a profitable unhealthy good market while gaining no additional advantage over the competition in the primary market.

The fact that the negative market spillover can increase the profits of all firms in the industry can be considered the opposite of what would be intuitively expected from a negative spillover effect. Though consumers may avoid buying primary goods from sellers of unhealthy goods with the possible intention of punishing them, this avoidance can have the reverse effect and increase the profit of the unhealthy good seller. On the other hand, the firm that exits the unhealthy good market can get rewarded with more profit despite entirely losing a market. Therefore, industries in which a negative market spillover emerges could become better off as a whole.

Next, we compare the profits of the two firms in the existence of the market spillover to find which of the two firms can benefit more from a negative market spillover.

PROPOSITION 3. *When only the inferior firm stays in the unhealthy good market, for a low negative market spillover (i.e.,* $c < 3mt/2 - (v_A - v_B)$*) and a high reservation value for the unhealthy good (i.e.,* $v_2 > 2\sqrt{2t/(3m)}\sqrt{c + (v_A - v_B)}$ *), the inferior firm's profit is higher than the superior firm's profit.*

This result shows the firm that is inferior in the primary market may actually earn greater profit than the superior firm. Although the market spillover imposes identical penalties on both firms and both firms face the same set of choices, the inferior firm benefits more from the market spillover even in cases where it is the only firm directly penalized by it. This effect takes place in the equilibrium where only the inferior firm stays in the unhealthy good market. This result is especially interesting because it holds for high v_2, meaning even when the unhealthy good market becomes highly lucrative for the inferior firm, the superior firm may still prefer to exit that market, leaving all the profits to the inferior firm. There are two interesting implications of this finding. First, if quality decisions are fixed prior to the emergence of the market spillover, a market spillover can actually reverse the advantage held by the superior firm. Second, if future market spillovers are predicted prior to quality investment decisions, it may cause diminished quality investment in the primary market since a quality advantage will actually reduce profitability by diminishing the marginal incentive to participate in a lucrative unhealthy good market.

To understand this result, first consider the market outcome. In equilibrium, the firm that is inferior in the primary market loses a competitor in the unhealthy good market, while it may or may not stay in the primary market depending on the magnitude of the market spillover. Though this turns out to be quite lucrative for the inferior firm, this strategy cannot be profitably replicated by the superior firm. Foremost, since the superior firm serves a greater number of consumers in the primary market, it has much to lose in the primary market by staying in the unhealthy good market. Secondly, the superior firm, on the margin, has less to gain from staying in the unhealthy good market because it can at best share the market with its competitor, which makes deviation to selling the unhealthy good not profitable for the superior firm even for high v_2. Thus, the superior firm's advantage in the primary market actually serves as a disadvantage with a negative market spillover because, on the margin, it prevents the firm from participating in the profitable unhealthy good market.

The results presented so far have analyzed a vertically differentiated competition with one superior and one inferior firm. Next, we study symmetric firms to see the extent to which our findings rely upon quality asymmetry.

COROLLARY 1. *Suppose the firms are vertically undifferentiated such that* $v_A = v_B$. *For high enough market spillover and consumers' reservation value for the unhealthy good, one firm sells in the unhealthy good market in equilibrium while the other firm exits the market.*

Corollary 1 shows that the existence of asymmetric equilibria, where only one firm exits the unhealthy good market, is not driven by vertical asymmetry between the firms. Instead, the driver of asymmetric strategies by firms is competition among firms which causes staying in the unhealthy good market to be highly profitable when the other firm has exited the market, and also causes exiting the unhealthy good market to be a profitable move for one firm due to the negative market spillover. Therefore, even when both firms have the same quality in both markets, it is possible for the firms to choose different strategies with respect to selling in the unhealthy good market. Either firm may choose to exit the unhealthy good market and thus there exists two asymmetric equilibria for high enough v_2 and c. As quality asymmetry, $v_A - v_B$, decreases, the regions in Figure 2 for both symmetric equilibria, {sell, sell} and {not sell, not sell}, expand and the asymmetric equilibrium region shrinks. However, as Corollary 1 shows, the asymmetric equilibrium region depicted in Figure 2 never disappears even as $v_A - v_B$ approaches zero.

COROLLARY 2. *Suppose the firms are vertically undifferentiated such that* $v_A = v_B$. *In an asymmetric equilibrium, for high enough consumers' reservation value for the unhealthy good and high enough size of the unhealthy good market, both firms make more profit in the presence of a negative market spillover compared to when there is no market spillover.*

With regard to firms' profits, Corollary 2 shows that the findings of Proposition 2, which shows firms can both be better off as a result of a negative market spillover, are preserved with the assumption of symmetric firms. In fact, what drives the increase in both firms' profit is the competition dampening effect of a market spillover, not vertical differentiation among firms. As argued in Corollary 1, even symmetric firms can choose asymmetric strategies in equilibrium. Once this equilibrium occurs, each firm will receive high profits from one market, while allowing the other firm to dominate the other market. This in turn can greatly reduce competition intensity in the primary market for high enough market spillovers and create a lucrative monopoly in the unhealthy good market for high enough v_2 and m, thereby increasing both firms' profits. Thus, while firms may have symmetric quality, they can still gain a competitive advantage in different markets due to the market spillover.

The results summarized in Propositions 1-3 have been established in a parsimonious model in which the primary and unhealthy good markets are independent of one another. Such a model fits well in instances for which the customers in each market are drawn from distinct populations or if the customers make separate purchase decisions across markets. We recognize, however, that certain markets may be complementary in the sense that a consumer can save a store trip by purchasing both a primary and an unhealthy good during a single purchase occasion. The following extension explores such a possibility.

4.3. A Model of Dependency across Primary and Unhealthy Good Markets

In this section, we examine an extension in which we relax the assumption that the primary and unhealthy good markets are independent of one another. We first describe the difference in assumptions. We then outline how the analysis changes with these assumptions and summarize the impact of the assumptions on the results.

In this model, there is a single population of consumers whose locations are uniformly distributed on the unit line. The firms are again located at $L_A = 0$ and $L_B = 1$. A consumer's choice set includes whether or not to buy for each product (i.e., primary and unhealthy) and from which firm to buy each product. Whereas the main model considered the primary market serving different consumers than the unhealthy good market, this extension allows consumers to visit one firm (incurring a single transportation cost) or visit both firms (incurring a transportation cost for each visit).

The utility of the consumer located at x buying the primary good from firm *i* and the unhealthy good from firm k depends on whether firm *i* sells the unhealthy good, as shown below:

$$u_{ik}(x) = v_i - p_{i1} - |x - L_i|t - D_i \times c + v_2 - p_{k2} - Z_{ik}|x - L_k|t \qquad (9)$$

$$\text{where } Z_{ik} = \begin{cases} 1 & if\ i \neq k \\ 0 & if\ i = k \end{cases} \text{ and } D_i = \begin{cases} 1 & if\ \ firm\ i\ stays\ in\ the\ unhealthy\ good\ market \\ 0 & if\ \ firm\ i\ exits\ the\ unhealthy\ good\ market \end{cases}$$

A consumer's outside option of not buying either product is assumed to be zero.

As in the main model, the utility maximizing behavior depends on the participation in the unhealthy good market by the superior and inferior firm. Consider first the case in which the inferior firm stays in the unhealthy good market and the superior firm exits the market. A similar process is followed for the remaining subcases.

Let x' be defined such that the utility of buying the primary good from firm A is equal to the utility of buying the primary good from firm A and the unhealthy good from firm B: $v_A - p_{A1} - x't = v_A - p_{A1} - x't + v_2 - p_{B2} - (1-x')t$. Let x'' be defined such that the utility of buying the primary good from firm A is equal to the utility of buying both the primary and unhealthy goods from firm B: $v_A - p_{A1} - x''t = v_B - p_{B1} + v_2 - p_{B2} - (1-x'')t - c$. Finally, let x''' be defined such that the utility of buying the primary good from firm A and the unhealthy good from firm B is equal to the utility of buying both the primary and unhealthy goods from firm B: $v_A - p_{A1} - x'''t + v_2 - p_{B2} - (1-x''')t$ $= v_B - p_{B1} + v_2 - p_{B2} - (1-x''')t - c$.

Comparing these locations, simple algebra shows that if and only if $c > p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$ then $x' < x'' < x'''$; otherwise $x' > x'' > x'''$. The former implies that there are some customers who buy from both firms and the latter implies all consumers buy from at most one firm. These two possibilities are depicted in Figure 4a and 4b. Letting q_{il} denote the quantity of product l sold by firm i, $c > p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$ implies $q_{A1} = x''' = (c - p_A + p_B + v_A - v_B)/t$, $q_{B1} = 1 - x'''$, and $q_{B2} = (1 - x') = (v_2 - p_{B2})/t$. If $c < p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$, then $q_{A1} = x'' = (c - p_A + p_B + p_{B2} + t - v_2 + v_A - v_B)/(2t)$ and $q_{B1} = q_{B2} = 1 - x''$.

Figure 4a: Depiction of Demand for High Market Spillovers When Only Firm B Sells Unhealthy Good;

$c > p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$

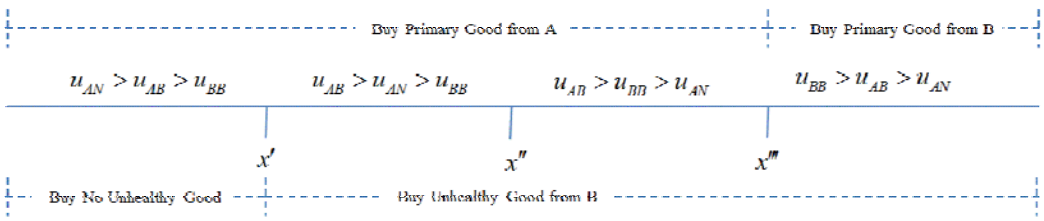
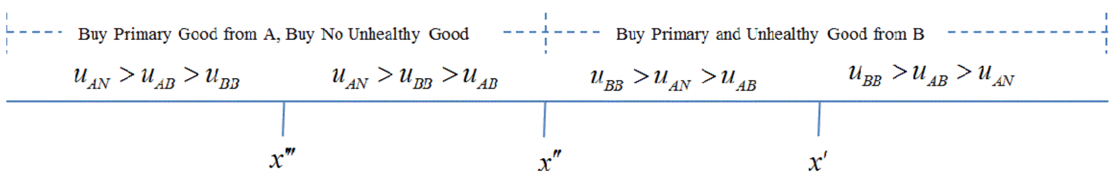


Figure 4b: Depiction of Demand for Low Market Spillovers When Only Firm B Sells Unhealthy Good;

$c < p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$



Demand for each of the remaining subgames is derived in similar fashion. The following table gives demand for each subgame considering interior solutions where one firm alone selling the unhealthy good does not cover the market fully but if both firms sell the good, together they sell to the whole market. It is also assumed that both firms sell the primary good to a non-zero number of consumers.

Table 2. Demand Expressions for Each Subgame

	Inferior Firm Stays in Unhealthy Good Market	Inferior Firm Leaves Unhealthy Good Market
Superior Firm Stays in Unhealthy Good Market	If $t < -p_{A1} + p_{A2} + p_{B1} - p_{B2} + v_A - v_B$: $\begin{cases} q_{A1} = (p_{B1} - p_{A1} + v_A - v_B)/t \\ q_{A2} = (p_{B2} - p_{A2} + t)/t \\ q_{B1} = 1 - q_{A1},\ q_{B2} = 1 - q_{A2} \end{cases}$ If $t > -p_{A1} + p_{A2} + p_{B1} - p_{B2} + v_A - v_B$: $\begin{cases} q_{A1} = q_{A2} = (-p_{A1} - p_{A2} + p_{B1} + p_{B2} + t + v_A - v_B)/2t \\ q_{B1} = q_{B2} = 1 - q_{A1} \end{cases}$	If $c > -p_{A1} + p_{A2} + p_{B1} + t - v_2 + v_A - v_B$: $\begin{cases} q_{A1} = (p_{B1} - p_{A1} - c + t + v_A - v_B)/t \\ q_{A2} = (v_2 - p_{A2})/t \\ q_{B1} = 1 - q_{A1},\ q_{B2} = 0 \end{cases}$ If $c < -p_{A1} + p_{A2} + p_{B1} + t - v_2 + v_A - v_B$: $\begin{cases} q_{A1} = q_{A2} = (p_{B1} - p_{A1} - p_{A2} - c + t + v_2 + v_A - v_B)/2t \\ q_{B1} = 1 - q_{A1},\ q_{B2} = 0 \end{cases}$
Superior Firm Leaves Unhealthy Good Market	If $c > p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$: $\begin{cases} q_{A1} = (c - p_{A1} + p_{B1} + v_A - v_B)/2t,\ q_{A2} = 0 \\ q_{B1} = 1 - q_{A1},\ q_{B2} = (v_2 - p_{B2})/t \end{cases}$ If $c < p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$: $\begin{cases} q_{A1} = (c - p_{A1} + p_B + p_{B2} + t - v_2 + v_A - v_B)/2t \\ q_{A2} = 0 \\ q_{B1} = q_{B2} = 1 - q_{A1} \end{cases}$	$\begin{cases} q_{A1} = (p_{B1} - p_{A1} + t + v_A - v_B)/t,\ q_{A2} = 0 \\ q_{B1} = 1 - q_{A1},\ q_{B2} = 0 \end{cases}$

For each subgame, we solve for the pricing equilibrium using the demand expressions of Table 2. We first suppose a given constraint holds (e.g., $c > p_{A1} - p_{B1} + p_{B2} + t - v_2 - v_A + v_B$) and then check whether the prices derived from the corresponding demand expressions satisfy the constraint. The corresponding conditions such that the equilibrium prices satisfy the constraints under which they are derived are reported along with profits in Table 3.

Note that when consumers purchase from at most one firm, it is the sum of primary and unhealthy goods prices that factors into the decision rather than either price individually. As such, multiple prices can arise in equilibrium and whether consumers purchase from at most one firm (versus some consumers splitting their firm choice across products) depends on the price of the unhealthy good.

Table 3. Subgame Profit Outcomes

	Inferior Firm Stays in Unhealthy Good Market	Inferior Firm Leaves Unhealthy Good Market
Superior Firm Stays in Unhealthy Good Market	If $v_A - v_B > t$: $\begin{cases} \pi_A^{SS} = (5t^2 + 2t(v_A - v_B) + (v_A - v_B)^2)/9\text{t} \\ \pi_B^{SS} = (5t^2 - 4t(v_A - v_B) + (v_A - v_B)^2)/9\text{t} \end{cases}$ If $p_{A2} - p_{B2} < (3t - v_A + v_B)/6$: $\begin{cases} \pi_A^{SS} = (3t + v_A - v_B)^2/18t \\ \pi_B^{SS} = (3t - v_A + v_B)^2/18t \end{cases}$	If $2c - 4t + 3v_2 - 2v_A + 2v_B > 0$: $\begin{cases} \pi_A^{SN} = (c - 2t - v_A + v_B)^2/9t + v_2^2/4t \\ \pi_B^{SN} = (c + t - v_A + v_B)^2/9t \end{cases}$ If $p_{A2} > (c - 3t + 5v_2 - v_A + v_B)/6$: $\begin{cases} \pi_A^{SN} = (-c + 3t + v_2 + v_A - v_B)^2/18t \\ \pi_B^{SN} = (-c - 3t + v_2 + v_A - v_B)^2/18t \end{cases}$
Superior Firm Leaves Unhealthy Good Market	If $2c - 4t + 3v_2 + 2v_A - 2v_B > 0$: $\begin{cases} \pi_A^{NS} = (c + t + v_A - v_B)^2/9t \\ \pi_B^{NS} = (c - 2t + v_A - v_B)^2/9t + v_2^2/4t \end{cases}$ If $p_{B2} > (c - 3t + 5v_2 + v_A - v_B)/6$: $\begin{cases} \pi_A^{NS} = (c + 3t - v_2 + v_A - v_B)^2/18t \\ \pi_B^{NS} = (c - 3t - v_2 + v_A - v_B)^2/18t \end{cases}$	$\begin{cases} \pi_A^{NN} = (3t + v_A - v_B)^2/18t \\ \pi_B^{NN} = (3t - v_A + v_B)^2/18t \end{cases}$

Table 3 includes seven possible profit outcomes. We compare these outcomes and identify the equilibrium unhealthy good market participation by examining whether either firm can unilaterally profitably deviate from each of the candidate equilibria. The results show that similar to our findings from the main model, for high enough values of v_2 and c, there exists an equilibrium where only the inferior firm stays in the unhealthy good market, and this is the only unique asymmetric equilibrium. Profit analysis for this equilibrium shows similar results as those in the main model; for high enough v_2, both firms make more profit in the {not sell, sell} equilibrium compared to when no market spillover exists. Also, for high v_2 and low c, the inferior firm makes higher profit than the superior firm in the {not sell, sell} equilibrium.

In conclusion, this extension demonstrates that the main model's assumption regarding the independence of the primary and unhealthy good market allowed for parsimony without sacrificing robustness.

5. Discussion

In this paper we looked at negative market spillovers that may occur if the firm decides to participate in an unhealthy good market and can lower consumers' willingness to pay for the firm's products in its primary market. Such negative market spillovers, examples of which can be observed in pharmacy and grocery industries, are becoming more prevalent as consumers become more health and socially conscious. As a result, firms active in industries with market spillovers face an interesting dilemma: should they withdraw from their profitable unhealthy good market to avoid lowering their value in the primary market or should they collect profits from the unhealthy good market and let their primary market value decrease? We modeled this phenomenon by considering two competing firms which can decide whether or not to participate in the unhealthy good market at the cost of a negative spillover to their primary market.

Analyzing the equilibrium strategies of competing firms and their profitability under a negative market spillover, we found multiple interesting results from the model. First, we found that for sufficiently large market spillovers and consumers' reservation value for unhealthy goods, there is an equilibrium where the inferior firm stays in the unhealthy good market while the superior firm exits this market. Interestingly, we show that in this equilibrium both the inferior and the superior firm can be better off with the market spillover compared to before its emergence, when the consumers' reservation value for the unhealthy good and the size of the unhealthy good market are high enough. Otherwise, when only the superior firm exits the market and consumers' reservation value for the unhealthy good or the size of the unhealthy good market is not too high, only the superior firm makes more profit with market spillover than without it. Also, when consumers' reservation value for the unhealthy good is low enough such that both firms exit the unhealthy good market, both firms become worse off as a result of the market spillover. Finally, we find that when the inferior firm is the only one selling the unhealthy good, it can even make more profit than the superior firm.

These results show the opposite effect of what may be expected from a negative market spillover; even though firms get penalized through the market spillover, there are conditions for which they can still end up making more profit. The superior firm may exit the unhealthy good market and, in spite of entirely losing one market, become better off since it earns more profit in the primary market as a consequence of negative market spillover for the inferior firm for staying in the unhealthy good market. On the other hand, the inferior firm can also be better off when consumers' reservation value for the unhealthy good and the size of the unhealthy good market are high enough, despite getting penalized in the primary market, because it now has monopoly power in the lucrative unhealthy good market. The market spillover thus can work as a competition dampening mechanism resulting in higher profits for firms. As we mentioned, even more surprisingly the inferior firm can earn higher profit than the superior firm in this equilibrium if the consumers' reservation value for the unhealthy good is high enough. The inferior firm enjoys monopoly power over the unhealthy good market, but the superior firm has no incentive, on the margin, to participate in this market since that market won't be as lucrative with two participants and it would lose its advantage in the primary market.

Our analysis has clear implications for managers involved in industries with market spillovers. Our research shows when a manager for a superior firm should react to a negative market spillover by withdrawing from the unhealthy market. Managers should also consider the effect that the emergence of negative market spillover can have on the firms' profits, by evaluating the critical factors of consumers' reservation value for the unhealthy good, size of the unhealthy good market, and the magnitude of market spillover. Based on our findings, it may actually be counterproductive for managers to try to resist and fight negative market spillovers, as they can increase the profits of all competing firms through lowered competition. We also provide managers insights on which of the high quality or low quality firms receive more profit from a market spillover. This result suggests that when investing in quality, managers should consider whether market spillovers are to be expected and decide accordingly.

The insights from our analysis of negative market spillovers from unhealthy good markets may be considered more broadly when examining how a firm's participation in one market causes the value in other markets to decrease. Another common example of such market spillovers is for online intermediaries and their liability for fighting internet piracy. In the recent years, the entertainment industry has increased its efforts to encourage online intermediaries, such as search engines, to limit consumers' access to pirated content (Kravets 2013). In October 2014, Google announced it has redefined its search algorithm to lower the ranking of those sites with high numbers of copyright removal notices in its search results (Dredge 2014). By avoiding engagement in the pirated market, Google is not only building better partnerships with the entertainment industry, but also providing better value for those consumers who are afraid of falling victim to copyright infringement. As Google mentions in its announcement "Only copyright holders know if something is authorized, and only courts can decide if a copyright has been infringed… This ranking change should help users find legitimate, quality sources of content more easily." Therefore, users looking for pirated content may start looking for search engines that do not lower the rankings of such content, while users looking for legitimate content would welcome Google's move and get more value from this search engine. Again this means that the decision to participate in one market can affect the value offered in another market. Future research can investigate whether the findings of the current model are replicated or moderated when incorporating the complexities of piracy enforcement.

In summary, this paper studied the concept of negative market spillovers. We developed an analytical model that identified when the superior firm or both the superior and inferior firm will exit the unhealthy market. Our comparison between firms' profits before and after the introduction of the market spillover shows that under some conditions both firms can benefit from the market spillover. The results provide implications for managers considering participation in unhealthy good markets as their participation in these markets begins to affect consumer preferences for the company's other lines of business.

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APPENDIX

I) Proof of Lemma 1:

The subgame equilibrium prices for $3t/2 < v_2 < 2t$ are derived in the main text, with profits defined by equations (2)-(8). With these prices, unhealthy good market is fully covered if $v_2 > 3t/2$.

CLAIM: For $t < v_2 < 3t/2$, in the {sell, sell} subgame, each firm charges the highest price possible in the unhealthy good market that will cover half of the market, which is $v_2 - t/2$. PROOF: No firm can deviate to higher or lower prices profitably. The profit of charging $v_2 - t/2$ is $m(v_2 - t/2)/2$ for both firms. If firm A increases its price, demand becomes $m(v_2 - p_{A2})/t$. The profit function becomes $m(v_2 p_{A2} - p_{A2}^2)/\mathrm{t}$, which is decreasing in p_{A2} for $p_{A2} \geq v_2 - t/2$. If firm A decreases its price, the demand will be derived from $v_2 - yt - p_{A2} = v_2 - (1-y)t - (v_2 - t/2)$ and profit would be $m(t/2 + v_2 - p_{A2})p_{A2}/t$, which is diminished by decreasing p_{A2} from $\mathrm{v}_2 - t/2$. Thus, $p_{A2} = v_2 - t/2$ is the equilibrium price. Similar analysis can be used to show $p_{B2} = v_2 - t/2$. □

If $v_2 < t$, both firms are local monopolies and set prices of $v_2/2$, earning profits of $mv_2^2/4t$.

We summarize the payoffs from each possibility in Tables A1, A2, and A3. If $c < 3t - (v_A - v_B)$, then all subgames have interior solutions and the equilibrium is found from Table A1. If $3t - (v_A - v_B) < c < 3t + (v_A - v_B)$, then the {not sell, sell} subgame reaches a corner solution, resulting in Table A2. Finally if $c > 3t + (v_A - v_B)$, then both subgames with asymmetric strategies have corner solutions, shown in Table A3.

Table A1. Profit Outcomes if $c < 3t - (v_A - v_B)$

	B: Sell Unhealthy Good	B: Not Sell Unhealthy Good
A: Sell Unhealthy Good	$if\ \frac{3t}{2} < v_2 < 2t: \begin{cases} \pi_A^{SShighv_2} = ((v_A - v_B)/3 + t)^2/2t + mt/2 \\ \pi_B^{SShighv_2} = ((v_B - v_A)/3 + t)^2/2t + mt/2 \end{cases}$ $if\ t < v_2 < \frac{3t}{2}: \begin{cases} \pi_A^{SSmedv_2} = ((v_A - v_B)/3 + t)^2/2t + m(v_2 - t/2)/2 \\ \pi_B^{SSmedv_2} = ((v_B - v_A)/3 + t)^2/2t + m(v_2 - t/2)/2 \end{cases}$ $if\ 0 < v_2 < t: \begin{cases} \pi_A^{SSlowv_2} = ((v_A - v_B)/3 + t)^2/2t + mv_2^2/4t \\ \pi_B^{SSlowv_2} = ((v_B - v_A)/3 + t)^2/2t + mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{SNlowc} = ((v_B - v_A + c)/3 - t)^2/2t + mv_2^2/4t \\ \pi_B^{SNlowc} = ((v_B - v_A + c)/3 + t)^2/2t \end{cases}$
A: Not Sell Unhealthy Good	$\begin{cases} \pi_A^{NSlowc} = ((v_A - v_B + c)/3 + t)^2/2t \\ \pi_B^{NSlowc} = ((v_A - v_B + c)/3 - t)^2/2t + mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{NN} = ((v_A - v_B)/3 + t)^2/2t \\ \pi_B^{NN} = ((v_B - v_A)/3 + t)^2/2t \end{cases}$

Table A2. Profit Outcomes if $3t - (v_A - v_B) < c < 3t + (v_A - v_B)$

	B: Sell Unhealthy Good	B: Not Sell Unhealthy Good
A: Sell Unhealthy Good	$if\ \frac{3t}{2} < v_2 < 2t: \begin{cases} \pi_A^{SShighv_2} = ((v_A - v_B)/3 + t)^2/2t + mt/2 \\ \pi_B^{SShighv_2} = ((v_B - v_A)/3 + t)^2/2t + mt/2 \end{cases}$ $if\ t < v_2 < \frac{3t}{2}: \begin{cases} \pi_A^{SSmedv_2} = ((v_A - v_B)/3 + t)^2/2t + m(v_2 - t/2)/2 \\ \pi_B^{SSmedv_2} = ((v_B - v_A)/3 + t)^2/2t + m(v_2 - t/2)/2 \end{cases}$ $if\ 0 < v_2 < t: \begin{cases} \pi_A^{SSlowv_2} = ((v_A - v_B)/3 + t)^2/2t + mv_2^2/4t \\ \pi_B^{SSlowv_2} = ((v_B - v_A)/3 + t)^2/2t + mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{SNlowc} = ((v_B - v_A + c)/3 - t)^2/2t + mv_2^2/4t \\ \pi_B^{SNlowc} = ((v_B - v_A + c)/3 + t)^2/2t \end{cases}$
A: Not Sell Unhealthy Good	$\begin{cases} \pi_A^{NShighc} = v_A - v_B + c - t \\ \pi_B^{NShighc} = mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{NN} = ((v_A - v_B)/3 + t)^2/2t \\ \pi_B^{NN} = ((v_B - v_A)/3 + t)^2/2t \end{cases}$

Table A3. Profit Outcomes if $c > 3t + (v_A - v_B)$

	B: Sell Unhealthy Good	B: Not Sell Unhealthy Good
A: Sell Unhealthy Good	$if\ \frac{3t}{2} < v_2 < 2t: \begin{cases} \pi_A^{SShighv_2} = ((v_A - v_B)/3 + t)^2/2t + mt/2 \\ \pi_B^{SShighv_2} = ((v_B - v_A)/3 + t)^2/2t + mt/2 \end{cases}$ $if\ t < v_2 < \frac{3t}{2}: \begin{cases} \pi_A^{SSmedv_2} = ((v_A - v_B)/3 + t)^2/2t + m(v_2 - t/2)/2 \\ \pi_B^{SSmedv_2} = ((v_B - v_A)/3 + t)^2/2t + m(v_2 - t/2)/2 \end{cases}$ $if\ 0 < v_2 < t: \begin{cases} \pi_A^{SSlowv_2} = ((v_A - v_B)/3 + t)^2/2t + mv_2^2/4t \\ \pi_B^{SSlowv_2} = ((v_B - v_A)/3 + t)^2/2t + mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{SNhighc} = mv_2^2/4t \\ \pi_B^{SNhighc} = v_B - v_A + c - t \end{cases}$

A: Not Sell Unhealthy Good	$\begin{cases}\pi_A^{NShighc} = v_A - v_B + c - t \\ \pi_B^{NShighc} = m v_2^2 / 4t\end{cases}$	$\begin{cases}\pi_A^{NN} = ((v_A - v_B)/3 + t)^2 / 2t \\ \pi_B^{NN} = ((v_B - v_A)/3 + t)^2 / 2t\end{cases}$

We start by analyzing the profits in Table A1 when $3t/2 < v_2 < 2t$ (high v_2), denoting $K = v_A - v_B$. Comparing profits, $\pi_A^{SShighv_2} = \pi_A^{NSlowc}$ at $c = -K - 3t + \sqrt{9\ mt^2\ + (K+3t)^2}$ and $c = -K - 3t - \sqrt{9\ mt^2\ + (K+3t)^2}$. The second root is negative and $\pi_A^{NSlowc} - \pi_A^{SShighv_2}$ is increasing in c for all $c > -K - 3t$. Thus, $\pi_A^{SShighv_2} < \pi_A^{NSlowc}$ if $c > c_{NS/SS\sim H} \equiv -K - 3t + \sqrt{9\ mt^2\ + (K+3t)^2}$. Recall our bound on c for Table A1 and note that $c_{NS/SS\sim H} < 3t - K$ iff $K < 3t(\sqrt{4-m} - 1)$. Therefore in Table A1, $\pi_A^{SShighv_2} < \pi_A^{NSlowc}$ if $K < 3t(\sqrt{4-m} - 1)$ and $c > c_{NS/SS\sim H}$; otherwise $\pi_A^{SShighv_2} > \pi_A^{NSlowc}$. Using similar logic we find the cutoffs for each range of v_2, by choosing the profits corresponding to $t < v_2 < 3t/2$ (medium v_2) or $v_2 < t$ (low v_2). Thus we find that for $t < v_2 < 3t/2$, $\pi_A^{SSmedv_2} < \pi_A^{NSlowc}$ if $K < -3t + 3\sqrt{t((8+m)t/2 - mv_2)}$ and $c > c_{NS/SS\sim M} = -3t - K + \sqrt{(9mt(v_2 - t/2) + (3t+K)^2)}$; otherwise $\pi_A^{SSmedv_2} > \pi_A^{NSlowc}$. Similarly for $v_2 < t$, $\pi_A^{SSlowv_2} < \pi_A^{NSlowc}$ if $K < -3t + 3\sqrt{4t^2 - mv_2^2/2}$ and $c > c_{NS/SS\sim L} = -3t - K + \sqrt{9mv_2^2/2 + (3t+K)^2}$; otherwise $\pi_A^{SSlowv_2} > \pi_A^{NSlowc}$.

Also in Table A1, $\pi_B^{SShighv_2} < \pi_B^{SNlowc}$ if $c > c_{SN/SS\sim H} \equiv -3t + K + \sqrt{9\ mt^2\ + (3t-K)^2}$. Note that $c_{SN/SS\sim H} < 3t - K$ iff $K < t(3 - \sqrt{3m})$. Thus in Table A1, $\pi_B^{SNlowc} > \pi_B^{SShighv_2}$ if $K < t(3 - \sqrt{3m})$ and $c > c_{SN/SS\sim H}$; otherwise $\pi_B^{SShighv_2} > \pi_B^{SNlowc}$. Similarly for $t < v_2 < 3t/2$, $\pi_B^{SNlowc} > \pi_B^{SSmedv_2}$ if $K < 3t + \sqrt{3mt(v_2 - t/2)}$ and $c > c_{SN/SS\sim M} = -3t + K + \sqrt{9mt(v_2 - t/2) + (3t-K)^2}$; otherwise $\pi_B^{SSmedv_2} > \pi_B^{SNlowc}$. Similarly for $v_2 < t$, $\pi_B^{SNlowc} > \pi_B^{SSlowv_2}$ if $K < 3t + (\sqrt{3m/2})v_2$ and $c > c_{SN/SS\sim L} = -3t + K + \sqrt{9mv_2^2/2 + (3t-K)^2}$; otherwise $\pi_B^{SSlowv_2} > \pi_B^{SNlowc}$.

Also, in Table A1, $\pi_A^{SNlowc} > \pi_A^{NN}$ for $v_2 > v_{2SN/NN} \equiv \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t+2K-c)}$. Finally, $\pi_B^{NSlowc} > \pi_B^{NN}$ for $v_2 > v_{2NS/NN} \equiv \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t-2K-c)}$. Note that both $v_{2SN/NN}$ and $v_{2NS/NN}$ have real values in Table A1, where $c < 3t - K$.

Next we analyze profits in Table A2, when $3t - K < c < 3t + K$. For high v_2, $\pi_A^{SShighv_2} > \pi_A^{NShighc}$ if $K > 3t(\sqrt{4-m}-1)$ and $3t - K < c < c_{NS/SS2\sim H} = (3+m)t/2 + K(K-12t)/18t$; otherwise $\pi_A^{SShighv_2} < \pi_A^{NShighc}$. For medium v_2, $\pi_A^{SSmedv_2} > \pi_A^{NShighc}$ if $K > -3t + 3\sqrt{t((8+m)t/2 - mv_2)}$ and $3t - K < c < c_{NS/SS2\sim M} = (6-m)t/4 + mv_2/2 + K(K-12t)/18t$; otherwise $\pi_A^{SSmedv_2} < \pi_A^{NShighc}$. Similarly, for low v_2, we have $\pi_A^{SSlowv_2} > \pi_A^{NShighc}$ if $K > -3t + 3\sqrt{4t^2 - mv_2^2/2}$ and $3t - K < c < c_{NS/SS2\sim L} = mv_2^2/4t + (3t-K)(1/2 - K/18t)$; otherwise $\pi_A^{SSlowv_2} < \pi_A^{NShighc}$. The comparison between firm B's profit in the {sell, sell} and {sell, not sell} subgames is the same as the one in Table A1, but with different conditions on K: $3t - K < c_{SN/SS\sim H} < 3t + K$ if $K > t(3 - \sqrt{3m})$, $3t - K < c_{SN/SS\sim M} < 3t + K$ if $K > 3t + \sqrt{3mt(v_2 - t/2)}$, and $3t - K < c_{SN/SS\sim L} < 3t + K$ if $K > 3t + \sqrt{3m/2}\,v_2$. $\pi_A^{SNlowc} > \pi_A^{NN}$ iff $v_2 > v_{2SN/NN} \equiv \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t+2K-c)}$. $\pi_B^{NShighc} > \pi_B^{NN}$ iff $v_2 > \sqrt{2/m}(3t-K)/3$.

Finally, we analyze Table A3 when $c > 3t + K$. For all $0 < K < 3t$, we know that $\pi_B^{SNhighc} > \pi_B^{SNhighc}\big|_{c\to 3t+K} = 2t$ and $\pi_B^{SSlowv_2}, \pi_B^{SSmedv_2}, \pi_B^{SShighv_2} < \pi_B^{SShighv_2}\big|_{K\to 0} = (m+1)t/2 < t$, which means in this Table we always have $\pi_B^{SNhighc} > \pi_B^{SS}$, where π_B^{SS} could be any of the three profits $\pi_B^{SSlowv_2}$, $\pi_B^{SSmedv_2}$, or $\pi_B^{SShighv_2}$. Also for $0 < K < 3t$, we know $c_{NS/SS\sim H}, c_{NS/SS\sim M}, c_{NS/SS\sim L} < 3t + K$, which means in Table 3 we always have $\pi_A^{NShighc} > \pi_A^{SS}$. The inequality $\pi_A^{SNhighc} > \pi_A^{NN}$ holds if $v_2 > \sqrt{2/m}(3t+K)/3$, and $\pi_B^{NShighc} > \pi_B^{NN}$ holds if $v_2 > \sqrt{2/m}(3t-K)/3$.

To find the condition for the {sell, sell} equilibrium, we compare the condition for firm A not deviating from {sell, sell} with the condition for firm B not deviating to see which condition is stricter. Starting with high v_2, we show that for $K > 0$, $c_{NS/SS\sim H} < c_{SN/SS\sim H}$; taking the derivatives of $c_{NS/SS\sim H}$ and $c_{SN/SS\sim H}$ with respect to K, we find

$$\frac{\partial c_{NS/SS\sim H}}{\partial K} = -1 + \frac{K+3t}{\sqrt{(K+3t)^2 + 9mt^2}} < 0$$
$$\frac{\partial c_{SN/SS\sim H}}{\partial K} = 1 - \frac{K-3t}{\sqrt{(K-3t)^2 + 9mt^2}} > 0$$

Also note that $c_{NS/SS\sim H}\Big|_{K\to 0} = c_{SN/SS\sim H}\Big|_{K\to 0}$. Therefore, $c_{NS/SS\sim H}$ and $c_{SN/SS\sim H}$ have the same value at $K = 0$, but $c_{NS/SS\sim H}$ is decreasing in K, while $c_{SN/SS\sim H}$ is increasing. Thus for all $K > 0$, $c_{NS/SS\sim H} < c_{SN/SS\sim H}$. As K becomes bigger than $3t(\sqrt{4-m}-1)$, the condition for $\pi_A^{SShighv_2} > \pi_A^{NShighc}$ becomes $c < c_{NS/SS2\sim H}$. For $K > 3t(\sqrt{4-m}-1)$, we have $c_{NS/SS2\sim H} < c_{NS/SS\sim H}$ which also implies $c_{NS/SS2\sim H} < c_{SN/SS\sim H}$. Using similar logic for other ranges of v_2, we show that $c_{NS/SS\sim M} < c_{SN/SS\sim M}$ since $\frac{\partial c_{NS/SS\sim M}}{\partial K} < \frac{\partial c_{SN/SS\sim M}}{\partial K}$ and $c_{NS/SS\sim M}\Big|_{K\to 0} = c_{SN/SS\sim M}\Big|_{K\to 0}$. Also in this range, for $K > -3t + 3\sqrt{t((8+m)t/2 - mv_2)}$ we have $c_{NS/SS2\sim M} < c_{NS/SS\sim M} < c_{SN/SS\sim M}$. Finally, $c_{NS/SS\sim L} < c_{SN/SS\sim L}$ since $\frac{\partial c_{NS/SS\sim L}}{\partial K} < \frac{\partial c_{SN/SS\sim L}}{\partial K}$ and $c_{NS/SS\sim L}\Big|_{K\to 0} = c_{SN/SS\sim L}\Big|_{K\to 0}$. Also for $K > -3t + 3\sqrt{4t^2 - m{v_2}^2/2}$ we have $c_{NS/SS2\sim L} < c_{NS/SS\sim L} < c_{SN/SS\sim L}$. Thus, if the condition for firm A not switching from {sell, sell} to {not sell, sell} is satisfied, then firm B would also not switch from {sell, sell} to {sell, not sell}.

This proves that the {sell, sell} equilibrium exists only for $c < c'$. Let $r \in \{L, M, H\}$ represent the region to which v_2 belongs, such that $r = L$ requires $0 < v_2 < t$, $r = M$ requires $t < v_2 < 3t/2$, and $r = H$ requires $3t/2 < v_2 < 2t$. The definition of c' is such that for v_2 belonging to the region $r \in \{L, M, H\}$, $c' = c_{NS/SS\sim r}$ if $K < K_r^*$, and $c' = c_{NS/SS2\sim r}$ if $K > K_r^*$, where $K_L^* = -3t + 3\sqrt{4t^2 - mv_2^2/2}$, $K_M^* = -3t + 3\sqrt{t((8+m)t/2 - mv_2)}$, and $K_H^* = 3t(\sqrt{4-m} - 1)$. Thus, proof of Lemma 1(a) is completed.

Similarly, to find the condition for the {not sell, not sell} equilibrium, we compare the conditions for $\pi_A^{NN} > \pi_A^{SN}$ and $\pi_B^{NN} > \pi_B^{NS}$. For $c < 3t - K$, we have $v_{2NS/NN} < v_{2SN/NN}$. For $3t - K < c < 3t + K$, the minimum of $v_{2SN/NN}$ occurs at $c = 3t - K$ and is equal to $\frac{\sqrt{2}}{3\sqrt{m}}\sqrt{(3t-K)(3t+3K)}$ which is greater than $\frac{\sqrt{2}}{3\sqrt{m}}(3t-K)$. Thus, for $3t - K < c < 3t + K$ we have $v_{2SN/NN} > \frac{\sqrt{2}}{3\sqrt{m}}(3t-K)$. Finally, for $c > 3t + K$ we know the threshold for $\pi_B^{NN} > \pi_B^{NS}$, $v_2 = \sqrt{2/m}(3t-K)/3$, is less than the threshold for $\pi_A^{NN} > \pi_A^{SN}$, $v_2 = \sqrt{2/m}(3t+K)/3$.

Thus the upper bound condition on v_2 for $\pi_B^{NN} > \pi_B^{NS}$ is always stricter than that for $\pi_A^{NN} > \pi_A^{SN}$ for the {not sell, not sell} equilibrium. This proves that the {not sell, not sell} equilibrium exists if and if $v_2 < v_2'$, where $v_2' = v_{2NS/NN}$ for $c < 3t - K$ and $v_2' = \sqrt{2/m}(3t-K)/3$ for $c > 3t - K$, proving Lemma 1(b). *Q.E.D.*

II) Proof of Proposition 1:

Putting together the results of the analysis in the proof of Lemma 1, we find the {not sell, sell} equilibrium exists for $c > c'$ and $v_2 > v_2'$. We also find the conditions for the {sell, not sell} equilibrium.

This equilibrium exists for $c > c''$ and $v_2 > v_2''$. Let v_2 belong to the region $r \in \{L, M, H\}$. We define $c'' = c_{SN/SS\sim r}$. We define $v_2'' = v_{2SN/NN}$ for $c < 3t + K$, and $v_2'' = \sqrt{2/m}(3t+K)/3$ for $c > 3t + K$.

In the proof of Lemma 1 we showed that $\pi_B{}^{NN} > \pi_B{}^{NS}$ guarantees $\pi_A{}^{NN} > \pi_A{}^{SN}$. Thus the region for $\pi_A{}^{SN} > \pi_A{}^{NN}$ is a subset of the region for $\pi_B{}^{NS} > \pi_B{}^{NN}$ and $v_2' < v_2''$. We also showed that $\pi_A{}^{SS} > \pi_A{}^{NS}$ guarantees $\pi_B{}^{SS} > \pi_B{}^{SN}$. Thus the region for $\pi_B{}^{SN} > \pi_B{}^{SS}$ is a subset of the region for $\pi_A{}^{NS} > \pi_A{}^{SS}$ and $c' < c''$. This means the region where the {sell, not sell} equilibrium exists is a subset of the region where the {not sell, sell} equilibrium exists, and the {not sell, sell} equilibrium is unique in the region for $c' < c < c''$ and $v_2' < v_2 < v_2''$. This proves Proposition 1(a).

Next we prove the risk-dominance of the {not sell, sell} equilibrium over the {sell, not sell} equilibrium. The condition for the risk-dominance of the {not sell, sell} equilibrium is $RD = (\pi_A{}^{NS} - \pi_A{}^{SS})(\pi_B{}^{NS} - \pi_B{}^{NN}) - (\pi_A{}^{SN} - \pi_A{}^{NN})(\pi_B{}^{SN} - \pi_B{}^{SS}) > 0$. We begin with low v_2, and use similar logic for higher values of v_2.

For low v_2, there are three Tables to consider. For Table A1, $RD = 2c^3K/81t^2 > 0$.

For low v_2 and Table A2, $\partial(RD)/\partial v_2 = mv_2(c - 3t + K)/6t$ is positive for Table A2, meaning RD is minimized with respect to v_2 at $v_2 = 0$. We show that this minimum of RD is positive, thus proving RD is positive. $\partial(RD|_{v_2 \to 0})/\partial K$ is continuous in K and never zero for $0 < K < 3t$, which means $RD|_{v_2 \to 0}$ is monotonic for $0 < K < 3t$. Thus, the minimum of $RD|_{v_2 \to 0}$ with respect to K is at one of the corners of the region $0 \le K \le 3t$. Since $RD|_{v_2 \to 0, K \to 0} > 0$ and $RD|_{v_2 \to 0, K \to 3t} > 0$, the minimum of $RD|_{v_2 \to 0}$ is positive, thus $RD|_{v_2 \to 0} > 0$ and $RD > 0$.

For low v_2 and Table A3, $RD = (6(2c-5t)t + 3mv_2^{\ 2} - 2K^2)K / 18t$, which is positive for $c > (-3mv_2^{\ 2} + 30t^2 + 2K^2)/12t$. Also, $(-3mv_2^{\ 2} + 30t^2 + 2K^2)/12t < 3t + K$ for all $K < 3t$. Thus, in Table A3, $RD > 0$. Using the same logic, it is straight forward to show that for medium and high values of v_2, RD is still positive. *Q.E.D.*

III) Proof of Proposition 2:

If no negative market spillover exists, then the two markets are independent from each other. The firms' profits would be the same as when a negative market spillover existed and both firms stayed in the unhealthy good market. We denote these profits $\pi_A^{\ Z}$ and $\pi_B^{\ Z}$. For instance for $3t/2 < v_2 < 2t$, we have $\pi_A^{\ Zhighv_2} = ((v_A - v_B)/3 + t)^2 / 2t + mt/2$ and $\pi_B^{\ Zhighv_2} = ((v_B - v_A)/3 + t)^2 / 2t + mt/2$. We compare these profits with profits under a market spillover in the {not sell, sell} equilibrium, starting from high v_2. Note that $\pi_A^{\ Zhighv_2} = \pi_A^{\ SShighv_2}$. Therefore, since in the {not sell, sell} equilibrium we must have $\pi_A^{\ SShighv_2} < \pi_A^{\ NS}$, we also know $\pi_A^{\ Zhighv_2} < \pi_A^{\ NS}$.

We start with comparing $\pi_B^{\ Z}$ with $\pi_B^{\ NS}$ in Table A1. For $3t/2 < v_2 < 2t$, we have $\pi_B^{\ Zhighv_2} < \pi_B^{\ NSlowc}$ if $v_2 > \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2 - 2cK}$. For $t < v_2 < 3t/2$, we have $\pi_B^{\ Zmedv_2} < \pi_B^{\ NSlowc}$ if $v_2 > t + \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t - c - 2K)}$. For $0 < v_2 < t$, $\pi_B^{\ Zlowv_2} < \pi_B^{\ NSlowc}$ never holds. Considering these thresholds of v_2, we find $v_2 = \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2 - 2cK} < 2t$ holds only for $m > \frac{c(6t - 2K - c)}{9t^2}$. Also, $v_2 = \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2 - 2cK} > 3t/2$ requires $m < \frac{8c(6t - 2K - c)}{9t^2}$, which results in $\frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2 - 2cK} < t + \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t - c - 2K)}$. Also, $v_2 = t + \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t - c - 2K)} < 3t/2$

requires $m > \dfrac{8c(6t-2K-c)}{9t^2}$, which results in $\dfrac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2+6ct-c^2-2cK} > t + \dfrac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t-c-2K)}$.

Thus, $\pi_B{}^Z < \pi_B{}^{NS}$ requires $v_2 > Min\{\dfrac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2+6ct-c^2-2cK}, t + \dfrac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t-c-2K)}\}$ and $m > \dfrac{c(6t-2K-c)}{9t^2}$.

Using similar logic in Tables A2 and A3 we find in the {not sell, sell} equilibrium, when $c > 3t-K$, $\pi_B{}^Z < \pi_B{}^{NS}$ and $\pi_A{}^Z < \pi_A{}^{NS}$ if $v_2 > Min\{\dfrac{\sqrt{2}}{3\sqrt{m}}\sqrt{9(1+m)t^2-K(6t-K)}, t + \dfrac{\sqrt{2}}{3\sqrt{m}}(3t-K)\}$ and $m > \dfrac{(3t-K)^2}{9t^2}$. *Q.E.D.*

IV) Proof of Proposition 3:

Consider the {not sell, sell} equilibrium in Table A1. The inequality $\pi_A{}^{NS} < \pi_B{}^{NS}$ holds true if $v_2 > 2\sqrt{2/3m}\sqrt{ct+Kt}$. Comparing this condition with $v_2 > v_{2NS/NN}$, required for the {not sell, sell} equilibrium, we find that $v_2 > 2\sqrt{2/3m}\sqrt{ct+Kt}$ guarantees $v_2 > v_{2NS/NN}$ in Table A1 and thus satisfies the equilibrium condition. Considering the condition $v_2 < 2t$, the threshold $2\sqrt{2/3m}\sqrt{ct+Kt}$ is below $v_2 = 2t$ if $c < 3mt/2-K$, which can be satisfied in Table A1, since $3mt/2-K$ is bigger than $c_{NS/SS\sim H}$ for $K < 3(\sqrt{4+m}-1)t$. Thus the region where $\pi_A{}^{NS} < \pi_B{}^{NS}$ can satisfy the conditions $c > c'$ and $v_2 > v_2'$ required for the {not sell, sell} equilibrium in Table A1. Considering Tables A2 and A3, $\pi_A{}^{NS} < \pi_B{}^{NS}$ requires $v_2 > 2\sqrt{t/m}\sqrt{c-t+K}$. The threshold $2\sqrt{t/m}\sqrt{c-t+K}$ is larger than $v_2 = 2t$ for all $c > 3t-K$. Thus, only Table A1 can result in $\pi_A{}^{NS} < \pi_B{}^{NS}$. *Q.E.D.*

V) Proof of Corollary 1:

Similar to our proof for Lemma 1, we analyze firm profits for $K=0$. If $c<3t$, there's an interior solution for the firms' profits when one firm leaves the unhealthy market, and if $c>3t$, we get a corner solution in both asymmetric subgames. The resulting profits are shown in Tables A4 and A5.

Table A4. Profit Outcomes if $K=0$ and $c<3t$

	B: Sell Unhealthy Good	B: Not Sell Unhealthy Good
A: Sell Unhealthy Good	$if\ \frac{3t}{2}<v_2<2t: \begin{cases} \pi_A^{SShighv_2}=t/2+mt/2 \\ \pi_B^{SShighv_2}=t/2+mt/2 \end{cases}$ $if\ t<v_2<\frac{3t}{2}: \begin{cases} \pi_A^{SSmedv_2}=t/2+m(v_2-t/2)/2 \\ \pi_B^{SSmedv_2}=t/2+m(v_2-t/2)/2 \end{cases}$ $if\ 0<v_2<t: \begin{cases} \pi_A^{SSlowv_2}=t/2+mv_2^2/4t \\ \pi_B^{SSlowv_2}=t/2+mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{SNlowc}=(c/3-t)^2/2t+mv_2^2/4t \\ \pi_B^{SNlowc}=(c/3+t)^2/2t \end{cases}$
A: Not Sell Unhealthy Good	$\begin{cases} \pi_A^{NSlowc}=(c/3+t)^2/2t \\ \pi_B^{NSlowc}=(c/3-t)^2/2t+mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{NN}=t/2 \\ \pi_B^{NN}=t/2 \end{cases}$

Table A5. Profit Outcomes if $K=0$ and $c>3t$

	B: Sell Unhealthy Good	B: Not Sell Unhealthy Good
A: Sell Unhealthy Good	$if\ \frac{3t}{2}<v_2<2t: \begin{cases} \pi_A^{SShighv_2}=t/2+mt/2 \\ \pi_B^{SShighv_2}=t/2+mt/2 \end{cases}$ $if\ t<v_2<\frac{3t}{2}: \begin{cases} \pi_A^{SSmedv_2}=t/2+m(v_2-t/2)/2 \\ \pi_B^{SSmedv_2}=t/2+m(v_2-t/2)/2 \end{cases}$ $if\ 0<v_2<t: \begin{cases} \pi_A^{SSlowv_2}=t/2+mv_2^2/4t \\ \pi_B^{SSlowv_2}=t/2+mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{SNhighc}=mv_2^2/4t \\ \pi_B^{SNhighc}=c-t \end{cases}$
A: Not Sell Unhealthy Good	$\begin{cases} \pi_A^{NShighc}=c-t \\ \pi_B^{NShighc}=mv_2^2/4t \end{cases}$	$\begin{cases} \pi_A^{NN}=t/2 \\ \pi_B^{NN}=t/2 \end{cases}$

Using the same steps as in the proofs of Lemma 1 and Proposition 1, we can find the conditions for asymmetric equilibria. When $K=0$, we find that $v_2'\big|_{K\to0}=v_2''\big|_{K\to0}$ and $c'\big|_{K\to0}=c''\big|_{K\to0}$. Thus, {not sell, sell} equilibrium and {sell, not sell} equilibrium both exist for $v_2>v_2'\big|_{K\to0}$ and $c>c'\big|_{K\to0}$. *Q.E.D.*

VI) Proof of Corollary 2:

We use steps similar to those in the proof of proposition 2, but for tables A4 and A5. We assume the {not sell, sell} equilibrium for this proof. The conditions for the other asymmetric equilibrium are derived similarly. In Table A4, we have ${\pi_B}^Z < {\pi_B}^{NS}$ if $v_2 > Min\{\frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2}, t + \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t-c)}\}$ and $m > \frac{c(6t-c)}{9t^2}$. In Table A5, for all $0 < m < 1$ we have ${\pi_B}^Z > {\pi_B}^{NS}$. Also, we know that in the {not sell, sell} equilibrium, we always have ${\pi_A}^Z < {\pi_A}^{NS}$. Thus, both firms make more profit in the {not sell, sell} equilibrium if $v_2 > Min\{\frac{\sqrt{2}}{3\sqrt{m}}\sqrt{9mt^2 + 6ct - c^2}, t + \frac{\sqrt{2}}{3\sqrt{m}}\sqrt{c(6t-c)}\}$ and $m > \frac{c(6t-c)}{9t^2}$. *Q.E.D.*

VII) Proof for the Model of Dependency across the Markets:

We show the proof of analysis for high v_2 such that $v_2 > 3t/2$. The analysis for medium and low values of v_2 follows the same process.

Tables 2 and 3 show the demands and profits for each subgame, assuming both firms sell the primary good to some consumers in asymmetric subgames, $q_{A1} > 0$ and $q_{B1} > 0$, which is satisfied if $c < 2t - K$.

For $c > 2t - K$, if the inferior firm is the only firm selling the unhealthy good, it will not sell the primary good to any consumers. In this case, each firm sells a different product and the markets for the two goods become independent, which means the model is similar to the main model and the profits for the {not sell, sell}subgame are similar to those in Table A2. Similarly for $c > 2t + K$, if only the superior firm is selling the unhealthy good, the markets for the two goods are not dependent, resulting in profits for the {sell, not sell} subgame similar to those in Table A3. We show the analysis for $c < 2t - K$, the proof for other cases follows the same steps.

For {not sell, sell} strategies, when $c < 2t - K$, we find the conditions required for neither firm to unilaterally deviate, considering alternative strategies that result in consumers buying from both firms or only one firm. Comparing subgame profits, we find that for $v_2 > \frac{\sqrt{2}}{3}\sqrt{t^2 + 2tK + 4c(2t-K) - K^2 - 2c^2}$ and $c > Max\{-K - t + \sqrt{K^2 + 2Kt + 5t^2}, -K - t + \sqrt{(K+3t)^2/2}\}$ the {not sell, sell} equilibrium where some consumers buy from both firms exists. A {not sell, sell} equilibrium where consumers buy from at most one firm never exists. Similarly for {sell, not sell} strategies, we find that for $v_2 > \frac{\sqrt{2}}{3}\sqrt{t^2 - 2tK + 4c(2t+K) - K^2 - 2c^2}$ and $c > Max\{K - t + \sqrt{K^2 - 4Kt + 5t^2}, K - t + \sqrt{(K-3t)^2/2}\}$ the {sell, not sell} equilibrium where some consumers buy from both firms exists. A {sell, not sell} equilibrium where consumers buy from at most one firm never exists.

Next we analyze the uniqueness of the two asymmetric equilibria. We find that for $c < 2t - K$, $Max\{-K - t + \sqrt{K^2 + 2Kt + 5t^2}, -K - t + \sqrt{(K+3t)^2/2}\} < Max\{K - t + \sqrt{K^2 - 4Kt + 5t^2}, K - t + \sqrt{(K-3t)^2/2}\}$.

Also we have $\frac{\sqrt{2}}{3}\sqrt{t^2 - 2tK + 4c(2t+K) - K^2 - 2c^2} > \frac{\sqrt{2}}{3}\sqrt{t^2 + 2tK + 4c(2t-K) - K^2 - 2c^2}$ for all $c > Max\{K - t + \sqrt{K^2 - 4Kt + 5t^2}, K - t + \sqrt{(K-3t)^2/2}\}$, where the {sell, not sell} equilibrium is possible. Thus the region for {sell, not sell} is a subset of the region for {not sell, sell}.

Next, we compare the profits from the {not sell, sell} equilibrium with profits when no market spillover exists. To make the comparison for $c < 2t - K$, we compare the profits shown in the {not sell, sell} subgame of Table 3 with $\pi_A{}^Z = (5t^2 + 2tK + K^2)/9t$ and $\pi_B{}^Z = (5t^2 - 4tK + K^2)/9t$. Since $\pi_A{}^Z = \pi_A{}^{SS}$ and $\pi_A{}^{NS} > \pi_A{}^{SS}$ in the {not sell, sell} equilibrium, we know that $\pi_A{}^{NS} > \pi_A{}^Z$ holds. Comparing firm B's profit under the market spillover with $\pi_B{}^Z = (5t^2 - 4tK + K^2)/9t$ shows that if $v_2 > 2\sqrt{t^2 + 4ct - 2cK - c^2}/3$ then $\pi_B{}^{NS} > \pi_B{}^{SS}$.

Finally, we find the condition for the inferior firm making more profit than the superior firm in the {not sell, sell} equilibrium. We compare the profits in the {not sell, sell} subgame of Table 3 and find $\pi_B^{NS} > \pi_A^{NS}$ for $v_2 > 2\sqrt{(2c+2K-t)t/3}$ which is less than $2t$ for all $c < 2t - K$. *Q.E.D.*

VIII) Ratings-Based Conjoint Studies:

We designed two ratings-based conjoint studies (see Schindler (2011), pp. 56-62) where we varied prices and whether the seller also sold unhealthy goods.

In study 1, we studied the effect of a pharmacy selling tobacco on the subjects' willingness to pay for unrelated products from that pharmacy. We recruited 91 participants who were compensated for their participation on Amazon Mechanical Turk. Subjects were told that "Pharmacy A sells cigarettes and other tobacco products in addition to medical drugs" and "Pharmacy B sells medical drugs, but does NOT sell tobacco products." They were then asked to state their likelihood of purchasing travel immunization consulting from each of the pharmacies at the prices of $10 and $12 on a scale of 0 to 10.

We regressed the ratings of likelihood to purchase on price and a dummy variable for the presence of tobacco. The results are presented in Table A6.

Table A6. Regression Results for Study 1

	Coefficients	Standard Error
Price	-0.59*	0.14
Tobacco Sale (dummy)	-2.62*	0.29
Intercept	14.05*	1.59

* *p-value < 0.001*

As described in Schindler (2011), the negative value of selling tobacco can be calculated by $\frac{|\text{coefficient of the dummy variable}|}{|\text{coefficient of price}|}$. This gives the estimate of a negative market spillover of $4.41.

Study 2 analyzed the effect of a grocery store selling confectionery at checkout lines on subjects' willingness to pay for unrelated products at that store. In this study, 101 Amazon Mechanical Turk participants were told that "Grocery store A sells candy, chocolates, and other sugar-filled treats at their checkout lines" and "Grocery store B has removed candy, chocolates, and other sugar-filled treats from their checkout lines, replacing them instead with nuts, dried fruit, trail mixes, water, and other healthy snacks." Then, they were asked to state their likelihood of purchasing a healthy salad from each store's salad bar at the prices of \$3, \$4, and \$5 on a scale of 0 to 10. The results of the regression are shown in Table A7. The estimated negative value of selling confectionery is \$0.61.

Table A7. Regression Results for Study 2

	Coefficients	Standard Error
Price	-1.84*	0.12
Confectionery Sale (dummy)	-1.11*	0.20
Intercept	13.73*	0.51

* *p-value < 0.001*