Strategic Interdependence and Passive Smoking[*]

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Abstract

An ex post *analysis shows that avoidance, as against associating, by smoker and non-smoker when the former smokes is a Nash outcome.* Ex ante*, passive smoking occurs because socio-legal structures allow smokers to take non-smokers for granted. This can be done away with if smoker's cost (material plus non-material) of associating with a non-smoker while smoking is greater than that of avoiding. To ensure this, norms and conventions of avoidance ought to be developed and the health-risk of passive smoking should be made common knowledge. As a special case, a single person's active smoking behaviour has also been analysed.*

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I Introduction

Despite growing evidence on health-risk of smoking, people continue to smoke.[1] Becker and Murphy (1988), Boyer (1978), Chaloupka (1991) and, more recently, articles in Elster and Skog (1999) on addiction, Laux (2000) and Suranovic *et.al.* (1999) have tried to theorise this phenomenon. One, however, gets the feeling that a relatively under-researched area is passive smoking, also referred to as second hand smoking or environmental tobacco smoke (ETS). This paper tries to determine the conditions that could lead to passive smoking in a two person game theoretic framework. Notations are given in section 2. Section 3 takes into consideration the possibilities of association and avoidance by a smoker and non-smoker and analyses *ex post* sharing of expenditure

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(smoking cost plus treatment cost due to an ailment suffered by the non-smoker) in a constant-sum game. In an *ex ante* sense (section 4), association and avoidance have been analysed through cost identified with social norms and expected healthcare cost. In section 5, the above formulation has been used to analyse the health-risk of the smoker, as a special case. Finally, some concluding remarks have been made.

II Notations and Definitions

Notations

Two individuals,

$i=S, T$

Smoker (S) and Non-smoker alias Teetotaller (T) have a strategy combination

$[S_k, T_l]$

for k^{th} strategy of S and l^{th} strategy of T where

$k, l=O, V$

denote associates (O) and avoids (V) such that for every $[S_k, T_l]$ the individuals incur non-negative expenses on two items,

$j=C, D$

Smoker's cost of smoking (C) and cost of treatment on ailment suffered by Teetotaller (D). In an *ex post* analysis, as the act has already taken place, the material costs are given and it is

$0 \leq \alpha_{ij} \leq 1; \sum_i \alpha_{ij}=1$

the proportion share of expenses of the i^{th} individual on the j^{th} item for a given strategy combination (where for each and every item the sum of the shares over individuals add up to unity) would determine

$\sum_j \alpha_{ij} j \; \forall \; i$

the total cost incurred on both the items by the i^{th} individual for that strategy combination. In an *ex ante* sense

$j=C^e, D^e$

the amount of costs on the two items are expected expenditure such that

$C^e=C^m+C^n$

the expected cost of smoking consists of material aspect or price to be paid (C^m) plus non-material or qualitative aspects (C^n) and

D^e

the expected cost of treatment are dependent on $[S_k, T_l]$, and hence, the subscripts in

j_{ikl}

denote that the j^{th} item's expected cost is for the i^{th} individual under $[S_k, T_l]$ where

$\sum_i j_{ikl}=j_{kl}$

denotes the combined expected cost of j for that strategy combination and

$\sum_j j_{kl}$

denotes the total combined expected cost over all items for that strategy combination.

Definitions of Association/Avoidance by Smoker and Teetotaller

S_O: Smoker associates if he lights the cigarette in the presence of Teetotaller or publicly.

S_V: Smoker avoids if he does not light the cigarette in the presence of Teetotaller. He goes to some isolated place to light the cigarette. It is equivalent to Not-S_O.

T_O: Teetotaller associates if she tries to be in the presence of Musher when the latter smokes. She gives him company when the latter smokes in her presence, that is, under S_O – this can be referred to as weak association (Weak-T_O). Or she goes and joins him when the latter is smoking in an isolated place, that is, under S_V – this can be referred to as strong association (Strong-T_O).

T_V: Teetotaller avoids weakly (Weak-T_V) if she does not try to be in the presence of Musher when the latter is smoking in an isolated place. Weak-T_V is equivalent to Not-Strong-T_O. Whereas she avoids strongly (Strong-T_O) when she goes away from the place after he starts smoking. Strong-T_V is equivalent to Not-Weak-T_O.

III *Ex post* Analysis of Association and/or Avoidance

Who is the Free Rider?

As mentioned, Smoker and Teetotaller are two friends. Smoker claimed himself to be civilised and modern because he could do what he wanted, that is, smoke. On the other hand, Teetotaller could not do what she wanted – she was a passive smoker. Teetotaller had no arguments against this. Thus, it was assumed that Teetotaller accepted Smoker's claim, and hence, presumed that Smoker was civilised and advanced or superior to Teetotaller.

There were instances of Smoker saying that Teetotaller has been free riding through passive smoking and that there should be a mechanism to ensure that she pays for it. This argument is based on two implicit assumptions: that passive smoking gives positive utility to Teetotaller and that Teetotaller is the one who has been associating to obtain this.

Alternatively, if Teetotaller suffers from an ailment because of Smoker's smoking then should Smoker pay for Teetotaller's Treatment? Even if one is ambiguous about positive utility from passive smoking to Teetotaller, Smoker ought to pay if he is the one who has been associating. Smoker might ask for exemption on the ground that he was not aware of the health-risk. The argument, of course, sounds superfluous given the statutory warning "CIGARETTE SMOKING IS INJURIOUS TO HEALTH" (as practised in India) in each cigarette, packet and advertisement. Nevertheless, a proper dissemination should emphasise explicitly that smoking tobacco in any form is also injurious for the passive smoker. In simple terms, "YOUR SMOKING IS HEALTH-RISK TO OTHERS" or something similar should be made a part of public information campaign. With the antecedent knowledge on health-risk Smoker's association with Teetotaller while smoking is an act of free riding, as he does not have to pay for Teetotaller's treatment. This calls for a mechanism that does away with the

free rider problem. In other words, the socio-legal structure allows for a payment mechanism that takes care of this problem.

The Possible Outcomes under a Sharing Mechanism

For simplification, this section will analyse the *ex post* sharing of expenses incurred in Smoker's smoking, represented by C and cost of treatment, D, as a result of the ailment being suffered by Teetotaller depending on who free-rides (associates) and who does not (avoids).

Given the definitions of association and/or avoidance we will have four possible scenarios. Note that Smoker takes the first move.

Smoker associates and Teetotaller strongly associates: By definition, it is not possible in a single instance for Smoker to associate and Teetotaller to strongly associate, but for multiple interactions in a period of time, it might be possible for Teetotaller to associate when Smoker has not been associating. Careful attention should be given to find out whether Teetotaller's association was strong or weak. For instance, an employee associating with employer because nature of work demands that then it is a weak association. Further, if Teetotaller had no antecedent knowledge on health-risk then also her association will be a weak association. However, if Smoker associates and Teetotaller strongly associates then both are free riders. Thus, a mechanism where Smoker pays a proportion of Teetotaller's treatment and Teetotaller pays a proportion of Smoker's smoking expenses seems reasonable.

Under [S_O, Strong-T_O]: $0<\alpha_{SC}<1$, $0<\alpha_{SD}<1$, $0<\alpha_{TC}<1$, $0<\alpha_{TD}<1$

Smoker avoids whereas Teetotaller strongly associates: In such situations, the outcome suggests that Teetotaller has been free riding. Thus, it would be reasonable to ask Teetotaller to pay a proportion of Smoker's smoking expense and there is no sharing on her treatment.

Under [S_V, Strong-T_O]: $0<\alpha_{SC}<1$, $\alpha_{SD}=0$, $0<\alpha_{TC}<1$, $\alpha_{TD}=1$

Smoker associates whereas Teetotaller weakly avoids. Strictly speaking, in a single instance, Teetotaller either weakly associates or strongly avoids. This may actually mean that she does not have the option of weak avoidance. However, Teetotaller's avoidance can be gauged from the fact that whenever possible she tried to go away from the place when Smoker smoked in her presence or simply from the fact that she was pre-empted from avoiding. Thus, it would be reasonable to ask Smoker to pay a proportion of Teetotaller's treatment and there is no sharing on his smoking expenses.

Under [S_O, Weak-T_V]: $\alpha_{SC}=1$, $0<\alpha_{SD}<1$, $\alpha_{TC}=0$, $0<\alpha_{TD}<1$

Smoker avoids and Teetotaller weakly avoids. No one is a free rider. Under such a situation, Teetotaller is not suffering from an ailment because of Smoker's smoking - there could be other reasons. It is reasonable if there is no sharing of expenses - Smoker spends for his smoking and Teetotaller for her treatment.

Under [S_V, Weak-T_V]: $\alpha_{SC}=1$, $\alpha_{SD}=0$, $\alpha_{TC}=0$, $\alpha_{TD}=1$

The four scenarios mentioned above can be depicted in a two-person constant-sum game. The constant-sum is on the distribution of expenditure for two things. Cigarettes smoked by Smoker, *C*, and the cost of treatment, *D*, by Teetotaller where the depiction of cost sharing is an *ex post* scenario and $\sum_j \alpha_{ij} j$ is the total cost incurred on both the items by the i^{th} individual.

For simplification, let us assume the following. (1) $C=D=1$ unit of money. (2) If Smoker associates with Teetotaller while smoking he pays 70 per cent of Teetotaller's treatment expenditure $\alpha_{SD}=0.7$ and $\alpha_{TD}=(1-\alpha_{SD})=0.3$. (3) If Teetotaller associates she pays 20 per cent of the expenditure on smoking because of passive smoking $\alpha_{TC}=0.2$ and $\alpha_{SC}=(1-\alpha_{TC})=0.8$. These assumption along with the definite results from the four scenarios that when Smoker avoids $\alpha_{SD}=0$ and $\alpha_{TD}=1$ and when Teetotaller avoids $\alpha_{TC}=0$ and $\alpha_{SC}=1$ are used in Figure 1.

Figure 1

A Numerical Example Depicting Sharing of Expenditure on Smoker's Smoking and Teetotaller's Treatment

		Teetotaller	
		Associates	Avoids
Smoker	Associates	**1.5**=(0.8+0.7) (0.2+0.3)=**0.5**	**1.7**=(1.0+0.7) (0.0+0.3)=**0.3**
	Avoids	**0.8**=(0.8+0.0) (0.2+1.0)=**1.2**	**1.0**=(1.0+0.0) (0.0+1.0)=**1.0**

Notes: (i) For this and the subsequent figures, payoffs (costs) in each cell for Smoker and Teetotaller are given in top-left and bottom-right corner respectively. (ii) Payoffs determined by the explanation given in text.

An Ex post *Result*

By analysing the payoffs of Figure 1 one can state that:

Proposition 1: The situation where both Smoker and Teetotaller avoid, $[S_V, T_V]$, is Nash.[2]

However, it is perplexing to observe that Teetotaller has to incur a cost of treatment *D* even when both avoid. This is so because the analysis started with the fact that an amount *C* on Smoker's smoking and an amount *D* on Teetotaller's treatment has been spent. The analysis only wanted to show how the expenses are to be shared under different conditions. Thus, avoidance by both has to be interpreted as a situation where Smoker incurred his smoking expenses and Teetotaller incurred her treatment expenses.

A related question is that why do people associate when avoidance by both is Nash? This is so because socio-legal structures allow outcome from association as if the individuals were avoiding. In particular, people might give zero value to smoking related cost of treatment for non-smoker, $D=0$, and zero value to sharing of expenses – Smoker

paying for Teetotaller's treatment cost, $\alpha_{SD}=0$, and Teetotaller paying for Smoker's smoking cost, $\alpha_{TC}=0$. More importantly the decision to associate or avoid depends on *ex ante* conditions for each strategy combination.

IV Social Norms and Cost of Association/Avoidance

Ex ante, one refers to the expected (social) cost, C^e_{ikl}, and expected cost of treatment for Teetotaller, D^e_{ikl}, identified with i^{th} individual for the strategy combination $[S_k, T_l]$. The usage of the term social cost is to incorporate non-material aspects, C^n, like the presence/absence of ridicule, shame, and social ostracisation. Even time cost or the fact that one has to go to a different place to avoid is part of social cost – of course, social cost can also include material aspects, C^m. Expected cost of treatment for Teetotaller, D^e_{ikl}, can also be treated as a part of social cost but its separate identity has its own relevance that has been discussed below. Whatever may be the components, analytically one can derive social cost for various strategy combinations from some utility function that also incorporates the benefits, if any, from (passive) smoking but this has not been attempted in the present paper. It would also be interesting to differentiate the various components of social cost, but this has also not been attempted here. Further, it may be noted that costs that are a constant under all possible strategy combinations will not have an impact on the outcome. It is for this that the subsequent analysis does not refer to expenditure on smoking, C^m, which is more often than not, paid by the smoker, and hence, would be a constant under all possible scenarios.

It is the socio-legal structure that will determine the value of C^e_{ikl} and information on health-risk due to passive smoking that will determine D^e_{ikl}. Thus, for $[S_k, T_l]$ an individuals combined cost will be $(\sum_{ij} J_{ikl}=C^e_{ikl}+D^e_{ikl})$. Given the strategy of the other individual an individual will associate (avoid) if the cost of association will be lower (greater) than cost of avoidance. Depending on the outcome for each individual, any $[S_k, T_l]$ can be Nash – either both of them associate or both of them avoid or one of them associates and the other avoids. Three cases – social cost being independent of the other's action, strategic interdependence and expected cost of treatment – are discussed. The first two cases are discussed by assuming that $D^e_{ikl}=0$.

Social Cost is Independent of Other's Action

When social cost is independent of the action of the other individual, $C^e_{SkO}=C^e_{SkV}\ \forall\ k$ and $C^e_{TOl}=C^e_{TVl}\ \forall\ l$. However, the payoffs are dependent on where the action takes place and to some extent, the identity of the other individual (Who is the other individual?). In a crowd or in similar situations where a person's identity is not known – she/he is faceless – environmental tobacco smoke can be curbed by effective legal sanctions, as is the case in aeroplanes, airports or other no-smoking zones. It also explains situations such as a smoker smoking on the pavement or places where socio-legal structures are not effective and not being bothered about another passer-by. Whereas in one's own neighbourhood/locality, where an individual's identity is known it is norms and conventions that define etiquette that can be effective. This may also explain why, in some cases, students/children avoid smoking near the vicinity of teachers/elders.

For simplification, if we assume the following. (1) An individuals action is independent of others action, $C^e_{iOO}=C^e_{iOV}=C^e_{iO\bullet}$ and $C^e_{iOV}=C^e_{iVV}=C^e_{i\bullet V}$. And (2) the social cost of avoidance is a positive value unity, $C^e_{SVO}=C^e_{SVV}=C^e_{TOV}=C^e_{TVV}=1$. It follows that association (avoidance) is the preferred strategy if cost of association is less (greater)

than that positive value unity. In other words, as shown in Figure 2, Smoker associates if $C^e_{SO\bullet}<1$ and avoids if $C^e_{SO\bullet}>1$ whereas Teetotaller associates if $C^e_{T\bullet O}<1$ and avoids if $C^e_{T\bullet O}>1$. Thus, depending upon the values of $C^e_{SO\bullet}$ and $C^e_{T\bullet O}$, any strategy combination $[S_k, T_l]$ can be Nash where an individual's preferred strategy is independent of the strategy chosen by the other individual. Further, by excluding the fact that $C^e_{SO\bullet}=1$ or $C^e_{T\bullet O}=1$ one can state that this Nash is unique. In other words, in the absence of strategic interdependence it is the socio-legal structure influencing $C^e_{SO\bullet}$, $C^e_{SV\bullet}$, $C^e_{T\bullet O}$ and $C^e_{T\bullet V}$ that would determine Nash.

Figure 2

Social Cost Independent of Others' Action

		Teetotaller	
		Associates	Avoids
Smoker	Associates	$C^e_{SO\bullet}$	$C^e_{SO\bullet}$
		$C^e_{T\bullet O}$	1
	Avoids	1	1
		$C^e_{T\bullet O}$	1

Notes: (i) As in Figure 1. (ii) Assumptions, as mentioned in text. From this it can be said that any strategy combination can be Nash.

Social Cost under Strategic Interdependence

In close knit groups such as friends or colleagues the social costs would also be determined by the action of the other individual – this is referred to as strategic interdependence. In some situations, it is quite likely that Teetotaller's cost of avoidance is greater if Smoker associates than when Smoker avoids, $C^e_{TOV}>C^e_{TVV}$. More so, if Teetotaller's avoidance, after Smoker associates, is to be considered as bad or indecent behaviour according to the social parlance – this behaviour by Teetotaller may be referred to as strong avoidance (Strong-T_V). Adherence to strong avoidance may be somewhat closer to Pattanaik (1988), where certain social norms or values have to be given up or redefined to uphold individual rights. However, if Smoker is a senior colleague or the boss and Teetotaller has the possibility of losing his job or promotion then it may be so that $C^e_{TOO}<C^e_{TOV}$. In such situations it can be said that Teetotaller has been pre-empted from avoiding – Teetotaller cannot but associate. Again, in some situations Smoker might avoid smoking near Teetotaller because Smoker feels that passive smoking might cause displeasure to Teetotaller and internalises this as his cost – in a boss-employee relationship this can be possible by reduction in productivity because of adverse work environment that Teetotaller has to work in.

As discussed in the previous case, any strategy combination can be Nash, but it would be interesting to discuss about a co-ordination game.[3] To discuss this we make the following assumptions. (1) The social cost of avoidance is a positive value unity for both when both are avoiding, $C^e_{SVV}=C^e_{TVV}=1$. (2) The social cost of association is zero for both when both are associating, $C^e_{SOO}=C^e_{TOO}=0$. (3) The social cost is greater than unity for an individual when she/he associates when the other individual is avoiding, $C^e_{SOV}>1$ and $C^e_{TVO}>1$, for simplification we consider $C^e_{SOV}=C^e_{TVO}=1.5$. And (4) the social cost is greater than zero for an individual when she/he avoids when the other individual is

associating, $C^e_{SVO}>0$ and $C^e_{TOV}>0$, for simplification we consider $C^e_{SVO}=C^e_{TOV}=0.5$. From these assumptions we have Figure 3 where there are two Nash equilibria – either when both associate or when both avoid.

Figure 3

Social Cost Under Strategic Interdependence Depicting a Co-Ordination Game

		Teetotaller	
		Associates	Avoids
Smoker	Associates	**0**=C^e_{SOO} C^e_{TOO}=**0**	**1.5**=C^e_{SVO} C^e_{TVO}=**0.5**
	Avoids	**0.5**=C^e_{SVO} C^e_{TVO}=**1.5**	**1**=C^e_{SVV} C^e_{TVV}=**1**

Notes: (i) As in Figure 1. (ii) Assumptions, as mentioned in text. It follows that there will be two Nash equilibria – when both associate and when both avoid where the former dominates over the latter.

In Figure 3 both will have a lower cost when both associate making this strategy combination the dominant Nash equilibria. This can explain a scenario where individuals would prefer to co-ordinate by associating because avoidance involves a social cost but there is no such cost while associating. Or, because both individuals have lower social cost when both associate than when both avoid. This is so because of the norms and conventions deciding the social cost. One such aspect can be the exclusion of expected cost of treatment.

Expected Cost of Treatment

As mentioned earlier, while discussing the *ex post* scenario, cost of association will be higher for Teetotaller if one takes the health-risk arising out of passive smoking. Cost of association will also be high for Smoker if he has to pay for Teetotaller's health-risk. Besides legal sanctions, this is quite likely when both are family members – expenditure on smoking as well as expected possible treatment would be met from a common budget. Analytically, D^e_{ikl} can be considered as a part of social cost, C^e_{ikl}, but we retain its separate identity, as we would like to differentiate between the two costs. For instance, given the fact that Smoker associates, Teetotaller's social cost is likely to be higher under avoidance, $C^e_{TOV}>C^e_{TOO}$, whereas expected cost of treatment is likely to be less under avoidance, $D^e_{TOV}<D^e_{TOO}$. Further it would be reasonable to say that when both avoid then the expected cost of treatment will be zero or at least less than the expected cost when either Smoker or Teetotaller associates. This may explain the behaviour of certain smokers who avoid smoking near pregnant women (wife) because of their belief that smoking will have a health-risk on the child and mother. This can be depicted in the co-ordination game discussed in the previous section by adding another assumption. The assumption that an individuals expected cost of treatment is greater than unity when the other individual associates, $D^e_{S\bullet O}>1$ and $D^e_{TO\bullet}>1$, for simplification we consider $D^e_{S\bullet O}=D^e_{TO\bullet}=1.5$ and $D^e_{SVV}=D^e_{TVV}=0$. By adding these D^e_{ikl}

values to the values of C^e_{ikl} of Figure 3 we obtain Figure 4 where both the individuals would co-ordinate to avoid.

Figure 4

Social Cost Plus Expected Cost of Treatment Leading to Co-ordination

		Teetotaller	
		Associates	Avoids
Smoker	Associates	**1.5**=$\sum_i j^e_{SOO}$	**1.5**=$\sum_i j^e_{SOV}$
		$\sum_i j^e_{TOO}$ **=1.5**	$\sum_i j^e_{TOV}$ **=2**
	Avoids	**2**=$\sum_i j^e_{SVO}$	**1**=$\sum_i j^e_{SVV}$
		$\sum_i j^e_{TVO}$ **=1.5**	$\sum_i j^e_{TVV}$**=1**

Notes: (i) As in Figure 1. (ii) Assumptions, as given in Figure 3 plus an additional assumption, as mentioned in text. As in Figure 3 we again arrive at a co-ordination game with two Nash equilibria when both associate and when both avoid. However, in this case both avoiding dominates over both associating.

Another aspect of D^e_{ikl} is that it will vary across individuals for the same situations. There will be differences in the individual estimates of expected cost because of the following reasons. First, there is lot of ambiguity in deciding the risk of disease as a result of (passive) smoking. An example with regard to ambiguity in risk, of course in another context, is the statement that "one prominent British scientist offered the rather imprecise risk judgement that the human form of mad cow disease … would kill from 500 to 500,000 British consumers" (Viscusi *et.al.*, 1999: 250). Second, there could be various reasons that will lead to the occurrence of a particular disease and smoking could be one possible reason. Last, but not the least, different individuals may process the same information differently. For instance, smokers in general give a very low premium to smoking induced health-risk and the cost of curing such diseases (Viscusi *et.al.*, 1999: 264-265) or because of ignorance individuals may consider D^e_{ikl}=0 under all situations. Anyway, this is another matter; it would be pertinent to give some general result in the *ex ante* sense.

An Ex-Ante *Result*

Proposition 2: All possible [S_k, T_l] can be Nash. However, if (i) $j_{SVl}<j_{SOl}$ $\forall$ j,l and $j_{TkV}<j_{TkO}$ $\forall$ j, k then [S_V, T_V] is Nash. Further, if (ii) $j_{SkV}\leq j_{SkO}$ $\forall$ j, k and $j_{TVl}\leq j_{TOl}$ $\forall$ j, l then [S_V, T_V] is a social optimal that is dynamically stable.

Thus, to arrive at a situation that is Nash that does away with passive smoking (i) there has to be (a) introduction of norms and conventions that reduce the social cost of avoidance when compared to association and (b) dissemination of information regarding adverse affects of passive smoking. Further, (ii) Nash is also a social optimal if cost of avoidance when the other person avoids is cheaper than cost of avoidance when the other person associates.

The above proposition 2 also implies that in situations/societies where socio-cultural norms and legal sanctions are not anti-smoking - the smoker need not pay an additional cost for causing displeasure/harm to a non-smoker - there would be no reason for the smoker to avoid smoking near a non-smoker. Such an outcome can also be possible in societies where legal sanctions exist but there are no law enforcing mechanisms. Or because of high transaction cost the sufferer may not move to the court, that is, when the gains from legal sanctions may be lower than the cost involved in the litigation. As a corollary, in situations where socio-cultural norms and/or legal sanctions exist and are well executed and as a result, there is an additional social cost involved in smoking near non-smokers, smokers might not smoke in the vicinity of non-smokers.

Further, proposition 2 also suggests that socio-legal structure that curb passive smoking (reduce displeasure to others) and ensure dissemination of information on adverse-affects of smoking can lead to a shift in Nash from one where one or both associate to one where both avoid. Similarly, a decline in enforcement of civic values that discourage passive smoking and reduction of information campaign on health-risk of tobacco can lead to a shift in Nash from one where both avoid to either one or both of them associating.

One interesting aspect that arises from proposition 2 is if one takes into consideration the overall social costs involved in changing norms and conventions, and in dissemination of information then the claim on avoidance by both being socially optimal may not hold. To be specific, it would restrict the social optimality to those situations where costs on transition and dissemination of information are less than the gains. In the interaction between Smoker and Teetotaller costs of transition and dissemination can be considered as part of social cost of avoidance but even then it may be worthwhile to mention that these costs may not be much in the material sense. For instance, change of norms can mean an attitudinal change where Smoker goes and smokes elsewhere, as his right to smoke should stop when someone else's nose starts. Or, Teetotaller politely asks Smoker not to smoke in her presence. Similarly, dissemination of proper information could mean a change in the current dissemination method to make it more effective without making it more costly in the material sense. More importantly, effective norms and dissemination of information can have a very positive impact on reducing Disability Adjusted Life Years (DALYs) lost due to (passive) smoking.

The discussion so far assumed interaction between Smoker and Teetotaller, a non-smoker. However, to make the analysis on passive smoking applicable to active smoking, one should be able to explain a situation where there is no interaction but there is an expected cost of treatment because Smoker himself has a health-risk, as a result of smoking.

V Smoking Induced Health-Risk for Smoker

Now, one can consider that Smoker has the possibility of suffering from an ailment and the expected cost of treatment is towards this possibility. To analyse this, one has to redefine the meaning of strategies and the relevance of Teetotaller. In case of Smoker, the strategies of associate or avoid can be referred to as the decision to smoke or not to smoke respectively. For a smoker the decision not to smoke would be equivalent to

quitting. One can also use this to explain the possibility of a non-smoker's or a potential smoker's decision to start smoking.[4]

Similarly, Teetotaller's strategies of associate or avoid can refer to the efforts made by Teetotaller for creating conditions that would make Smoker decide whether to smoke or not to smoke. Further, Teetotaller can refer to an individual or to the general state of nature. The differences in the social cost, if available, in a given state of nature can be helpful in devising the future course of action. To be particular, it can suggest to us to devise policies that would reduce the inducement to smoke or increase the possibility of not smoking.

Coming to the costs (payoffs), the expected cost of treatment would be those related to treating ailment whereas all other costs would be considered as social cost. It follows that the cost that would be incurred for treating withdrawal symptoms as a result of quitting can be considered as part of social cost.

Thus, from proposition 2, interpreted for the active smoker, one can state that (i) quitting would be preferred over smoking if it can reduce (a) social cost and (b) expected cost of treatment. Further, (ii) quitting becomes socially optimal if (a) quitting is easier when the state of nature creates a congenial environment and (b) the state of nature is better off when the smoker quits than when smoker continues to smoke.

It follows that at any given time, a smoker will decide whether to continue smoking or quit depending on the social cost of smoking and the estimated cost of treatment. It can explain how under habit formation (Boyer, 1978), rational addiction (Becker and Murphy, 1988), hyperbolic discounting (Ainslie, 1999), weakness of the will (Gjelsvik, 1999), social interaction (Moene, 1999), unstable preferences, (Skog, 1999), adjustment costs (Suranovic *et.al.*, 1999), failure to fully internalise costs (Laux, 2000) the smoker is not able to quit. It can also explain that if expected cost of treatment increases because of some relevant information then, as mentioned by Becker and Murphy (1988), many smokers would go cold turkey as this would increase the 'full price' of smoking.[5] For the same reason many potential consumers may not enter into the participation of smoking.[6] However, younger cohorts may still decide to smoke (Viscusi, 1991) because their perception to smoking is synonymous to enjoying life today without giving much thought for tomorrow – they are myopic (Becker and Murphy, 1988) – or because adolescent experimentation that may lead to addiction has nothing to do with price of cigarettes (Emery *et.al.*, 2001).

VI Some Concluding Remarks

One would not be wrong, if one considers Smoker's decision to associate as one that has a complete disregard for Teetotaller. This is quite true in the *ex post* analysis, which showed that avoidance by both would have been Nash. *Ex ante* analysis tried to identify certain conditions that would lead Smoker/Teetotaller to associate. In crowds where the identity of the other person is not known or in situations where action of the other person does not matter, legal sanctions, as in no-smoking zones, make associating (smoking) costly. Alternatively, areas devoid of smoking restrictions (say, a pavement) may very well lead to a smoker being insensitive to a non-smoking passer-by. Norms and conventions where others matter, as among friends and colleagues or even for a passer-by on the road, may be a way out. However, if smoking is considered as an

acceptable social behaviour (manly/macho) and avoidance by non-smoker is considered as indecent behaviour then these norms and conventions are part of a larger social evil that disregard non-smoker's interest – these should be done away with and replaced with those sensitive towards others. Within the family, cost of association can be really high because association can lead to ailment of the non-smoker that has to be met from a common budget. It is here that information on adverse affects of passive smoking would make a greater impact. Thus, it would be worthwhile to develop norms and conventions that discourage smoking in general and passive smoking in particular and supplement it with public information campaigns to get an outcome that is not only Nash but also socially optimal.

Endnotes

1. One may question the causality with regard to inhaling of smoke causing lung cancer (or other ailments) - one of the greatest sceptics being R. A. Fisher. He proposed that (i) cancer caused smoking or (ii) a third *constitutional* factor, possibly genetic, caused smoking and cancer. Jerome Cornfield and his colleagues, writing in 1959, refuted (i) because median age to begin smoking was 18 whereas lung cancer was diagnosed at 50+ years. On (ii) they argued that it indicated a constitutional change (a) during the first half of twentieth century, more so among males, when cancer related mortality increased, (b) that is similar among rodents, as tobacco smoke cuased cancer when applied to their skin, (c) different among cigarette smokers and cigar/pipe users, as the former is related with lung cancer and the latter with mouth and throat cancer, (d) decreases for those who stop smoking and, (e) increases with amount smoked. (Gail, 1996: 9). Today, health-risk of smoking is no longer a scientific uncertainty (Lopez, 1999: 82) - the affect of tobacco in general and cigarette in particular has been put succinctly in 'tobacco's global death march' (Ravenholt, 1990). In point of fact, smoking causes lung cancer, chronic bronchitis and emphysema, heart disease and stroke, aneurysms, atherosclerotic peripheral vascular disease, oral cavity and laryngeal cancer, intrauterine growth retardation, neonatal deaths (including Sudden Infant Death Syndrome). It is also associated with other additional cancers - bladder, pancreatic, renal, gastric and cervical - vision and hearing problems, slowed healing from injuries and increased susceptibility to certain infections. Passive smoking causes lung cancer and heart disease deaths among non-smokers and leads to diseases and creates functional limitation among children of smokers (Chaloupka and Warner, 2000).

2. Nash denotes the best strategy of each and every individual given the strategy of the other individual(s). In the present case avoidance by Smoker is his best strategy given that Teetotaller also avoids and *vice versa*.

3. Under co-ordination an individual would like to behave similar to that of the other individual. This and other scenarios of interaction for two persons have been discussed in Mishra (1999: Section 2.3).

4. One can also use this to explain the possibility of a non-smoker's or a potential smoker's decision to start smoking.

5. Jones (1989) for the UK and Becker *et.al.* (1994), Chaloupka (1991) and Schneider

et.al. (1981) for the US have empirically shown the positive impact of government regulation or health-scare. Kenkel (1991) and Sander (1995) have shown the impact of schooling on reducing smoking.

6. Jones (1989) has mentioned that cigarette smoker's decision is a combination of a participation decision and a consumption decision.

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