Discussion Papers No. 279, July 2000
Statistics Norway, Research Department

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The Evolution of Considerate Smoking Behavior

Abstract:
This paper studies the formation of social norms for considerate smoking behavior. Being considerate gives smokers a higher social approval from non-smokers, but imposes an inconvenience cost. A non-smoker's disapproval of inconsiderate smoking is assumed to be stronger the less used he is to being exposed to passive smoking. The analysis shows that introduction of a smoking regulation may move the society from an initial no-consideration Nash equilibrium to a Nash equilibrium in which every smoker is considerate, even in the unregulated zone. This crowding in of considerate behavior will prevail even after policy reversal. Empirical evidence confirms that a shift in social norms on considerate smoking has taken place in Norway after the smoking law amendments in 1988, and supports the plausibility of model assumptions.

Keywords: Passive smoking, regulation, social norms, evolutionary game theory.

JEL classification: C72, D11, I18.

Acknowledgement: Thanks to Bente Halvorsen for helpful computer assistance. Funding was provided by the Norwegian Research Council.

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1 Introduction

In recent years, several countries and states have introduced regulations which restrict the right to smoke in public. A major motivation for these regulations has been to protect the interests of those exposed to passive smoking. Of course, the regulations do not apply everywhere. In private homes, for example, the authorities typically cannot regulate individuals' smoking behavior. However, in this paper we show that regulation in some public areas may induce a change in social norms, and in this way indirectly affect behavior in unregulated areas.

One interesting example of the possible interplay between regulation and behavior in unregulated areas is the development following the substantial amendment of the Norwegian smoking law in 1988. The amendment prohibited smoking in 'premises and means of transport to which the public have access', as well as in 'meeting rooms, work premises and institutions where two or more persons are gathered'.[1] A few exceptions applied; for example, rules were somewhat more liberal for restaurants and bars. For most people a major implication was that smoking was no longer permitted in their working environments.

Of course, the regulations did not apply in private homes. Data reported in this paper shows, however, that exposing others to passive smoking in private homes has become considerably less frequent since these regulations were introduced. For example, when visiting a non-smoker's home, it is today most common to go outdoors to smoke.

Below, we propose a model of social norms for considerate smoking behavior. Our starting point is that smokers do care about social acceptance. Inconsiderate smoking is assumed to trigger negative emotions on non-smokers' part, and these reactions are stronger the less used non-smokers are to such inconsiderate behavior. Smokers decide whether to be considerate or not by weighting the inconvenience costs of being considerate against the benefits of social acceptance. This gives rise to a game with several Nash equilibria, including one in which every smoker is considerate and one in which no-one is considerate. An evolutionary analysis shows that the introduction of a smoking regulation may move a society from the no-consideration Nash equilibrium to the equilibrium in which everybody is considerate even in the unregulated zone. Moreover, we demonstrate that if the regulation is subsequently removed, the economy

[1] *The Act Relating to Prevention of the Harmful Effects of Tobacco* can be found at the National Council on Tobacco and Health's homepage: http://www.tobakk.no/statistikk /loven_eng.htm.

will in fact stay in the high consideration equilibrium.

The intuition of the model is very simple and straightforward. Imagine a situation in which all smokers are inconsiderate such that non-smokers are frequently exposed to passive smoking. Then smoking regulations are introduced, forcing smokers to be considerate in certain places or at certain times. This has the effect of making non-smokers somewhat less used to passive smoking. When they do encounter inconsiderate smokers, they will therefore react more negatively than before. This leads to an increased loss of social acceptance for inconsiderate smokers, making considerate behavior relatively more attractive than before. If the decrease in social acceptance is sufficiently large, some smokers will change their behavior. Then non-smokers become even less used to passive smoking and their negative emotions towards non-smokers are further reinforced. Thus, inconsiderate smoking becomes even less attractive. This process continues until the new equilibrium is reached.

The paper is organized as follows: Section 2 presents a simple game analyzing smokers' behavior, while section 3 gives an evolutionary analysis of this game. Section 4 applies the evolutionary analysis in order to analyze the implications of a smoking regulation. Section 5 extends the model to account for heterogenous preferences. Section 6 reports empirical evidence based on interviews with more than one thousand individuals, while some alternative hypotheses are discussed in section 7. Section 8 concludes.

2 The Model

In a society a share $(1-\alpha)$ of the population are smokers. The smokers impose a negative externality on non-smokers when exposing them to passive smoking. This externality is due to the discomfort and negative health effects associated with passive smoking. In order to protect non-smokers from this externality, the government imposes a smoking regulation. The regulation implies that every individual's time is divided between a share $R \in [0,1]$ spent in the regulated zone, where all smoking is prohibited (e.g. public offices), and a share $(1-R)$ spent in the unregulated zone (e.g. private homes). The regulations are strictly enforced such that no violations occur.

To which degree non-smokers are exposed to passive smoking in the unregulated zone depends on how considerately smokers behave to non-smokers in this zone. Let $\gamma_i \in \{0,1\}$ denote smoker i's consideration

level in the smoking zone. Each smoker is faced with a discrete choice: In the smoking zone he can choose either to be considerate, $\gamma_i = 1$, or to be inconsiderate, $\gamma_i = 0$. On the one hand, being considerate will impose an inconvenience cost, $c > 0$. This inconvenience cost might be caused by having to leave good company to smoke outside, or by getting cold from smoking outdoors in bad weather. On the other hand, being inconsiderate will impose a cost in the form of reduced social approval, r, due to the disapproval of non-smokers. Thus, the payoff function of a smoker i is represented by

$$U_i = (r - c)\,\gamma_i \tag{1}$$

Non-smokers' disapproval of smokers is not necessarily backed by a deliberate and conscious choice. The theory of social exchange maintains that sanctions may occur spontaneously and even involuntarily (Blau, 1964; Gächter and Fehr, 1999). Moreover, social sanctions need not involve substantial costs on sanctioners' part; a discrete frown, or simply the suspicion that someone dislikes his behavior, may constitute a significant social cost for a smoker. Reduced social approval of being inconsiderate is given by

$$r = \alpha k h \tag{2}$$

where k denotes the public's belief about adverse health effects and discomfort for those exposed to passive smoking, and h denotes average consideration level in society.

The first factor, α, in (2) reflects that a smoker's decrease in social approval is larger the more non-smokers around who are affected by his inconsiderate behavior. The second factor, k, reflects that non-smokers disapprove more of inconsiderate smokers the worse the health effect and discomfort of passive smoking. This captures the idea that social sanctions enforcing a social norm can arise because of market failure, which has been argued by a number of authors (e.g. Arrow 1971, Ullmann-Margalit 1977, North 1981, Coleman 1990).

The third factor in (2) reflects that a non-smoker disapproves the behavior of an inconsiderate smoker more the less used he is to being a passive smoker. The average consideration level in society is given by

$$h = R + (1 - R)\,\bar{\gamma} \tag{3}$$

where $\bar{\gamma}$ is average consideration level in the unregulated zone[2]. If non-smokers are used to being exposed

[2] In the regulated zone the average consideration level is 1. In this zone all smokers are forced to be considerate.

to passive smoking, they have a higher level of tolerance toward an inconsiderate smoker. This may occur either because breathing tobacco smoke is more uncomfortable for someone who is not used to it, or because the average consideration level determines the behavior non-smokers expect from smokers and thus the degree of disappointment non-smokers exposed to inconsiderate behavior experience. The latter cause is similar to Lindbeck (1997) and Lindbeck et al. (1999), in which it is presupposed that a social norm is felt more strongly the greater the number of people who obey it.

Equation (1), (2) and (3) imply that a smoker's payoff function is given by

$$U_i = U(\gamma_i; \bar{\gamma}) = (k\alpha(R + (1-R)\bar{\gamma}) - c)\gamma_i \tag{4}$$

Thus, $\gamma_i = 1$ for all i is a Nash-equilibrium if $k\alpha > c$, and $\gamma_i = 0$ for all i is a Nash-equilibrium if $k\alpha R < c$. If $k\alpha(R + (1-R)\bar{\gamma}) - c = 0$, smokers are indifferent between being considerate and inconsiderate. This implies that there is also a Nash equilibrium in which a share $(\frac{c}{\alpha k} - R)/(1-R)$ of the smokers are considerate. Thus,

Proposition 1 *Assume that* $1 > \frac{c}{\alpha k} > R$. *Then, the game has three Nash equilibria: One in which every smoker is considerate, one in which no smoker is considerate, and one in which a share* $(\frac{c}{\alpha k} - R)/(1-R)$ *of the smokers are considerate. The Nash equilibrium in which every smoker is considerate exists independently of the smoking regulation* R.

3 Evolutionary Dynamics

Smokers do not at the outset possess all the information needed in order to calculate whether being considerate gives them higher utility than not being considerate. Instead, we assume that smokers learn their optimal strategy through a trial-and-error-process. Börgers and Sarin (1997) have demonstrated that such processes can be represented by the replicator dynamics (Taylor and Jonker 1978) from the field of evolutionary game theory. The replicator dynamics says that the growth rate of the population share using a certain strategy equals the difference between the strategy's current payoff and the current average payoff in the population (Weibull 1995, p. 73).

Let x denote the share of smokers who are considerate. Clearly $\bar{\gamma} = x$. The replicator dynamics is

represented by[3]

$$\dot{x} = x\left(U\left(1;x\right) - \bar{U}\left(x\right)\right) \tag{5}$$

where $\bar{U}\left(l\right)$ denotes average utility level in society, i.e. $\bar{U}\left(x\right) = xU\left(1;x\right) + \left(1-x\right)U\left(0;x\right)$. Substituting for $\bar{U}\left(x\right)$, (5) can be written as

$$\dot{x}\left(x\right) = x\left(1-x\right)\left(U\left(1;x\right) - U\left(0;x\right)\right) \tag{6}$$

Equation (4) and (6) imply that

$$\dot{x}\left(x\right) = x\left(1-x\right)\left(k\alpha\left(R + \left(1-R\right)x\right) - c\right) \tag{7}$$

Figure 1 plots the evolutionary dynamics $\dot{x}\left(x\right)$ in (7) given that $1 > \frac{c}{\alpha k} > R$. This graph illustrates what is proven in Proposition 2.

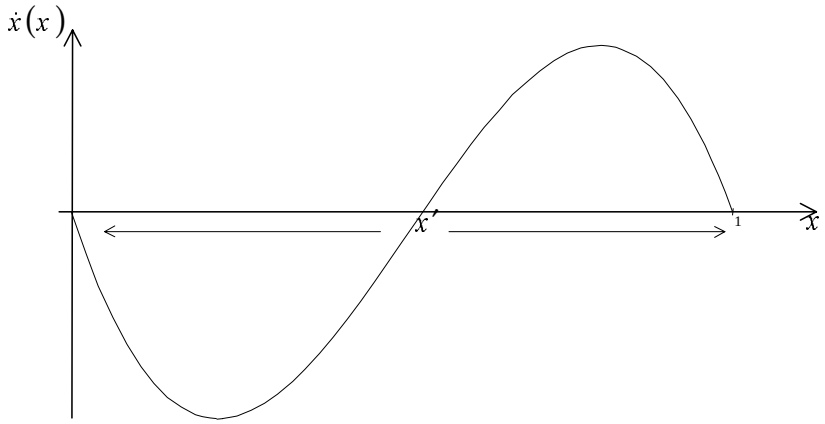

Figure 1 Evolutionary dynamics: Development of the share of considerate smokers.

Proposition 2

- *If* $\frac{c}{\alpha k} < 1$, *then there exists an asymptotically stable state,* $x = 1$, *in which every smoker is considerate. If the share of considerate smokers gets above the unstable stationary state,* $x' = (\frac{c}{\alpha k} - R)/(1-R)$, *then more and more smokers will become considerate. This process will continue until the society reaches the asymptotically stable state,* $x = 1$.

[3]The propositions derived in this paper hold for any payoff monotonic dynamics. The specific replicator dynamics is chosen due to its familiarity to many readers and its simplicity.

- *If $R < \frac{c}{\alpha k}$, then there exists an asymptotically stable state, $x = 0$, in which no smoker is considerate. If the share of non-considerate smokers gets below the unstable stationary state, $x' = (\frac{c}{\alpha k} - R)/(1 - R)$, then more and more smokers will become non-considerate. This process will continue until the society reaches the asymptotically stable state, $x = 0$.*

Proof. Equation (7) implies that the stationary states are determined by $x\,(1-x)\,(k\alpha\,(R+(1-R)\,x)-c) = 0$. Thus there exist three stationary states: $x = 0$, $x = 1$, and $x = (\frac{c}{\alpha k} - R)/(1-R) \equiv x'$. Equation (7) implies that $\dot{x} > 0$ if $(k\alpha\,(R+(1-R)\,x)-c) > 0$, and $\dot{x} < 0$ if $(k\alpha\,(R+(1-R)\,x)-c) < 0$. Thus $\dot{x} > 0$ if $x < x'$ and $\dot{x} < 0$ if $x > x'$. Since $x' \leq 0$ if $R \geq \frac{c}{\alpha k}$ and $x' \geq 1$ if $\frac{c}{\alpha k} \geq 1$. Thus the stationary state $x = 1$ is asymptotically stable if $\frac{c}{\alpha k} < 1$, and the stationary state $x = 0$ is asymptotically stable if $R < \frac{c}{\alpha k}$. ■

The intuition behind the evolutionary dynamics stated in proposition 2 is as follows: For $0 < x < x'$ a smoker's decrease in social approval, r, from being inconsiderate is small. Non-smokers' tolerance for inconsiderate behavior is high because they are used to be passive smokers. Thus, smokers are better off being inconsiderate. Considerate smokers will eventually learn this and change their strategy, i.e. $\dot{x} < 0$. For $x' < x < 1$ a smoker's increase in social approval, r, from being considerate is large. Non-smokers' tolerance for inconsiderate behavior is low because they are not used to being passive smokers. This makes smokers better of by being considerate. Inconsiderate smokers will eventually learn this and change their strategy, i.e. $\dot{x} > 0$.

4 Establishing a Social Norm for Considerate Smoking

This section shows how introducing a smoking regulation can establish a social norm for considerate smoking, which applies even in the unregulated zone. A social norm is a rule of behavior which is enforced by social sanctions. Proposition 2 showed that the game presented in the previous section has two asymptotically stable states if $1 > \frac{c}{\alpha k} > R$: One in which every smoker is considerate, and one in which no smoker is considerate. Only the equilibrium in which every smoker is considerate has an enforced social norm for considerate smoking. The social norm for considerate smoking is self-enforcing: In the norm equilibrium every smoker is considerate because every other smoker is considerate.

Look at a society in which there is no smoking regulation (i.e. $R = 0$), and $1 > \frac{c}{\alpha k} > 0$. The

evolutionary path of the society is given by the lower graph in Figure 2. Assume the society is in the equilibrium with no social norm for considerate smoking, $x = 0$. In order to reduce passive smoking, the government decides to introduce smoking regulations corresponding to $R' > c/\alpha k$. Then Proposition 2 implies that the stationary state $x = 0$ is no longer asymptotically stable. The evolutionary path will shift upwards to the upper graph in figure 2, such that $\dot{x}(x) > 0$ for all x. Smokers will eventually learn that they are better off by being considerate and start changing their behavior. This process will continue until the society reaches the asymptotically stable state, $x = 1$, in which everybody is considerate. Thus, the governmental regulation of smokers will crowd in considerate smokers. Indeed, Proposition 2 implies that this crowding in of considerate smokers will prevail even if the policy change is reversed, provided that x has increased such that $x > x' = c/k\alpha$. To summarize:

Corollary 3 *Look at a society with no smoking regulation in which* $1 > \frac{c}{\alpha k} > 0$. *Assume the society is in the asymptotically stable state,* $x = 0$, *in which no smoker is considerate. Introducing a smoking zone* $R' > c/\alpha k$ *in this society will increase* x *to the asymptotically stable state in which every smoker is considerate. This crowding in of considerate smokers will prevail after the policy change is reversed if* x *has increased such that* $x > c/\alpha k$.

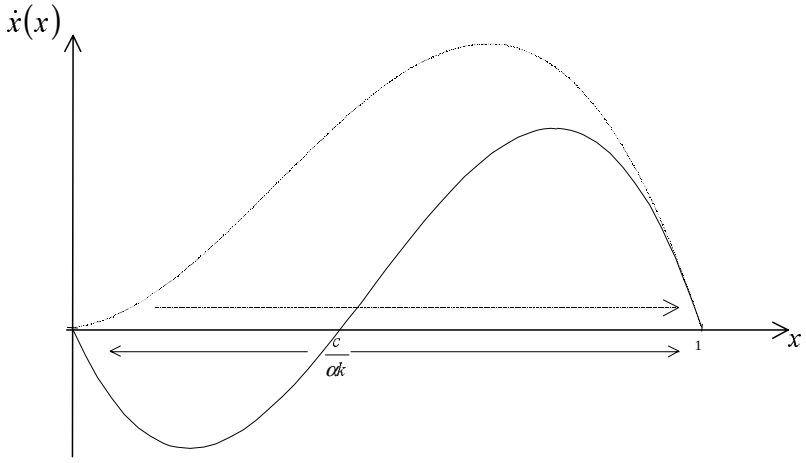

Figure 2 Crowding in of considerate smokers

Non-smokers' tolerance for inconsiderate smoking behavior is lower the less they are used to being passive smokers. When the regulated zone is introduced, non-smokers get less accustomed to being passive

smokers, since they now spend a part of the day in places where smoking never occurs. Thus, as a direct consequence of the smoking regulations, the non-smokers' tolerance for inconsiderate behavior is lowered, implying stronger disapproval of inconsiderate smokers. Since $R' > c/\alpha k$, this increase in disapproval for inconsiderate smoking is sufficient to make smokers become considerate. Thus, the smoking regulation, $R' > c/\alpha k$, has lead to the establishment of a social norm for considerate smoking: This regulation moved the society to the equilibrium in which every smoker is considerate *even in the unregulated zone.*

In order to understand why the society will stay in the equilibrium with a social norm for considerate smoking even after policy reversal, it is important to realize that a smoking regulation $R' > c/\alpha k$ decreases non-smokers' tolerance of inconsiderate behavior in two steps: First, non-smokers' tolerance of inconsiderate behavior decreases because non-smokers spend a part of their day in areas in which smoking never occurs. Then, their tolerance decreases because more and more smokers become considerate. When $x > x'$, non-smokers' tolerance of inconsiderate behavior has become sufficiently low to make all smokers want to become considerate, independently of the smoking regulation. In this way a temporary smoking regulation can move the society to the equilibrium with a social norm for considerate smoking.

5 Heterogeneous preferences

For a smoking regulation to establish a social norm for considerate smoking in the model presented above, the regulation must be sufficiently tight; i.e. $R > c/\alpha k$. Such a policy would immediately make *all* smokers better off by being considerate. This section will show that in a model with heterogenous preferences for social approval, it may suffice with a less extreme regulation which, at the outset, only changes the behavior of the individuals with strongest preferences for social approval.

Assume that there are two types of individuals in society; a share β is of type s with strong preferences for social approval, and a share $1-\beta$ is of type w with weak preferences for social approval. The preferences for an individual i of type j is given by

$$U_{i,j} = (a_j r - c)\,\gamma_i,\ j = s, w$$

where $a_s > a_w$. Like in the previous game each person is learning his optimal strategy in a process which

is represented by the replicator dynamics. Thus,

$$\dot{x}_s(x_s) = x_s(1-x_s)(a_s k\alpha(R+(1-R)(\beta x_s+(1-\beta)x_w))-c) \quad (8)$$

$$\dot{x}_w(x_w) = x_w(1-x_w)(a_w k\alpha(R+(1-R)(\beta x_w+(1-\beta)x_s))-c) \quad (9)$$

This yields the following:

Proposition 4

- *If* $\frac{c}{a_s\alpha k} < (1-R)\beta + R$ *and* $\frac{c}{a_w\alpha k} < 1$ *then there exists an asymptotically stable state,* $x_s = x_w = 1$, *in which every smoker is considerate. If the share of considerate smokers gets above the state such that* $\beta x_s + (1-\beta)x_w = (\frac{c}{a_j\alpha k} - R)\frac{1}{(1-R)}$, *then more and more smokers of type* j *will become considerate. This process will continue until the society reaches the asymptotically stable state in which* $x_j = 1$.

- *If* $R < \frac{c}{a_s\alpha k} < \frac{c}{a_s\alpha k}$, *then there exists an asymptotically stable state,* $x_s = x_w = 1$, *in which no smoker is considerate. If the share of non-considerate smokers gets below the state such that* $\beta x_s + (1-\beta)x_w = (\frac{c}{a_j\alpha k} - R)\frac{1}{(1-R)}$, *then more and more smokers of type* j *will become inconsiderate. This process will continue until the society reaches the asymptotically stable state in which* $x_j = 0$.

Corollary 5 *Look at a society with no smoking regulation in which* $\frac{c}{a_s\alpha k} < \frac{c}{a_w\alpha k} < \beta$. *Assume the society is in the asymptotically stable state,* $x_s = x_w = 0$, *in which no smoker is considerate. Introducing a smoking zone* $R' > \frac{c}{a_s\alpha k}$ *in this society will increase* x_s *and* x_w *to the asymptotically stable state in which every smoker is considerate. First, smokers with strong preferences for social approval will become considerate. Then, as soon as* $\beta x_s > (\frac{c}{a_w\alpha k} - R)\frac{1}{(1-R)}$, *smokers with weak preferences for social approval will also become considerate. This crowding in of considerate smokers will prevail after the policy change is reversed if* x_s *has increased such that* $\beta x_s > \frac{c}{a_s\alpha k}$.

The proofs of Proposition 4 and Corollary 5 are similar to that of Proposition 2.

6 Empirical evidence

As explained in the introduction, a major tightening of the Norwegian smoking law was implemented in 1988. The model presented above predicts that a such change in regulation may be followed by a substantial shift in smokers' behavior in the unregulated zone. Further, if a shift of social norms has taken place, smokers would expect more negative reactions than before if they actually do expose others to passive smoking.

To compare these predictions to the actual development in Norway, we needed data on smoking behavior and reactions in the unregulated zone, but such data were not readily available. We have thus collected new data, using Statistics Norway's "Omnibus" survey, which is a interview survey carried out 4 times a year. Questions on background information such as income, education, gender, family situation, and political party preference are asked routinely in these surveys; while additional questions can be included on a payment per minute basis. The survey we used was conducted by Statistics Norway's interviewers in November and December 1999, with a representative gross sample of 2000 individuals of age 16-79. The response rate was 58.6 percent, yielding a net sample of 1162 individuals.[4] Since time series data was not available, we asked respondents above the age of 30 to report information both on current smoking behavior and/or reactions, and on their behavior or reactions 10-15 years ago. This is clearly less satisfactory than ordinary time series data, but presumably better than no data at all.

Smokers and non-smokers were asked a different set of questions (occasional smokers were classified as non-smokers). Smokers were first faced with the following question:

Assume that you are visiting non-smoking friends, and you wish to smoke. There are no children present. What would you do most often?

1. *I would smoke indoors*
2. *I would ask first, and smoke if the hosts said it was OK*
3. *I would not smoke indoors*

Those who were older than 30 years also received the following question with the same response alterna-

[4] Since the sample is split in smokers and non-smokers, and respondents of age 30 or below are excluded for some questions, sample sizes are sometimes considerably smaller than the entire net sample. 76 percent of the interviews were in-person, while 24 percent were conducted by telephone.

tives as above:

What would you most often have done in a similar situation 10- 15 years ago?

In Table 1 below, responses to the first question ("now", i.e. reported behavior in 1999) are given both for the total sample of smokers and for those over 30.

Table 1. Smokers' responses, percent. n = number of respondents.

	Now	Now, age >30	10-15 years ago[5]
n	366	268	268
I would smoke indoors	1.6	1.5	36.9
I would ask first	47.3	43.3	41.8
I would not smoke indoors	50.8	54.9	16.0
Don't know	0.3	0.4	1.1

The first two columns draw a picture of a very considerate population of smokers (or at least, smokers who think of themselves as very considerate): Hardly anyone (6 and 4 individuals, respectively) reported that they would most often smoke indoors without first asking for the hosts' permission. Moreover, more than 50 percent would simply not smoke indoors. However, 10-15 years ago, 37 percent would most often have smoked indoors without asking, and only 16 percent would most often not have smoked indoors at all. The reported changes in behavior are thus quite dramatic.

To further illustrate this, let us rank "I would not smoke indoors" as indicating the most considerate behavior, followed by "I would ask first", and then "I would smoke indoors". Then, only 2.2 percent of the smokers of age over 30 reported that they had changed their behavior in a less considerate direction. On the other hand, 56.3 percent reported a change in a more considerate direction.

Non-smokers were faced with a corresponding question:

When you have guests who are smokers, what do you experience most often? Assume that there are no children present.

[5] The numbers below do not add up to 100 because current smokers over thirty who did not smoke 10-15 years ago are not included in the table (4.1 percent).

For those over 30, the following question was also asked:

What did you most often experience in similar situations 10- 15 years ago?

Responses are given in percentages in Table 2 below:

Table 2. Non-smokers' responses, percent. n = number of respondents.

	Now	Now, age > 30	10-15 years ago
n	795	563	563
Guests smoke indoors	10.4	11.7	73.7
Guests ask first	45.2	44.4	15.5
Guests do not smoke indoors	44.0	43.5	9.6
Don't know	0.4	0.4	1.2

As one may expect, non-smokers are less convinced about smokers' consideration level than smokers are themselves. However, the numbers are still striking: While only about 10 percent of non-smokers report that guests would most often smoke indoors without asking in 1999, as much as 73.7 percent report that this was the most common behavior experienced from smoking guests 10 -15 years before. Moreover, while about 44 percent of the non-smokers report that most often, guests currently do not smoke indoors in their home at all, only about 10 percent (of exactly the same respondents) believe that this was true 10 - 15 years ago.

When ranking response alternatives as above, micro data reveals that only 0.9 percent of all non-smoking respondents above 30 find that smokers' behavior has changed in a less considerate direction. However, as much as 70.5 percent report that smokers have become more considerate.

These results strongly indicate that a shift of social norms has taken place. We should then also expect that the negative reactions from non-smokers exposed to passive smoking have become stronger; or, at least, that smokers think they will be faced with more negative reactions than before. The next question is concerned with this issue. For smokers, the question was formulated as follows:

Imagine that you smoked indoors in friends' homes. Do you think it would be very likely, rather likely, rather unlikely or very unlikely that present non-smokers would dislike it?

Those above thirty also received the following question:

What do you think you would have replied to this question 10- 15 years ago?

Responses are given in percentages in Table 3 below.

Table 3. Smokers' responses, percent. n = number of respondents.

	Now	Now, age >30	10-15 years ago
n	365	256	256
Very likely	39.2	43.0	19.1
Rather likely	30.7	28.5	20.7
Rather unlikely	15.9	13.7	30.1
Very unlikely	8.8	9. 4	25.8
Don't know	5.5	5. 5	4.3

About 70 percent of the smokers found it very likely or rather likely that non-smokers would dislike their indoors smoking in 1999, while about 40 percent thought this likely 10 - 15 years earlier. Note also the large change in the percentage who would find non-smokers' dislike "very unlikely"; for those over 30 years, less than 10 percent chose this response alternative for the current situation, versus 25.8 percent 10 - 15 years ago. Only 3.5 percent of the smokers above 30 found it less likely that non-smokers would react negatively in 1999 than 10-15 years earlier, while 45.3 percent believed that this had become more likely.

The corresponding question to non-smokers was the following:

If someone smokes indoors while you are visiting others, is it very likely, rather likely, rather unlikely or very unlikely that you would dislike it?

Those over 30 were also asked as follows:

What do you think you would have replied to this question 10- 15 years ago?

Responses are reported as percentages in Table 4 below.

Table 4. Non-smokers' responses, percent. n = number of respondents.

	Now	Now, age >30	10-15 years ago
n	795	563	563
Very likely	19.5	20.6	11.7
Rather likely	23.8	23.1	16.5
Rather unlikely	20.9	21.7	23.4
Very unlikely	35.3	34.3	46.9
Don't know	0.5	0.4	1.4

The changes are in the expected direction here as well. Of non-smoking respondents over 30 years, 27.9 percent found it more likely that they would dislike others' smoking now than 10-15 years ago, while only 4.4 found it less likely that they would react negatively now.

The changes in attitudes reported in Table 3 and 4 are significant , but less dramatic than those concerning behavior reported in Table 1 and 2. Note, however, that while the theoretical model predicts dramatic changes in behavior when a shift to another equilibrium occurs, the predicted change of attitudes (negative reactions) need not necessarily be correspondingly dramatic, according to the model.

Those who chose different response alternatives to the questions of Tables 3 and 4 for the current and the past situation, respectively, also received a follow-up question. For smokers the question was:

What is the reason that non-smokers have changed their reaction to indoors smoking? Say if you agree completely, agree partially, disagree partially of disagree completely to the following response alternatives:

a) Beliefs about negative health effects due to passive smoking have changed

b) Non-smokers are less used to be exposed to passive smoking than before

c) Social attitudes have changed.

Smokers' responses are reported as percentages in Table 5:

[5] Applying Pearson's Chi-square test to the data reported in Table 3 shows a significant change in smokers' perception of non-smokers' attitudes, irrespective of whether we compare column 3 to column 1 or to column 2 ($p < 0.00000001$). Furthermore, applying Pearson's Chi-square test, the data reported in Table 4 shows a significant change in non-smokers' attitudes irrespective of whether we compare column 3 to column 1 or to column 2 ($p < 0.00000001$).

Table 5. Smokers' responses, percent. n = 129.

	Health effects	Less used to	Social attitudes
Agree completely	79.8	58.9	80.6
Agree partially	14.7	26.4	15.5
Disagree partially	1.6	4.7	2.3
Disagree completely	2.3	8.5	0.8
Don't know	1.6	1.6	0.8

The corresponding question to non-smokers was:

What is the reason that you have changed your reaction to indoors smoking? Say if you agree completely, agree partially, disagree partially or disagree completely to the following response alternatives:

a) I have changed my beliefs about health damages due to passive smoking

b) I am less used to be exposed to passive smoking than before

c) I am more used to be exposed to passive smoking than before[6]

d) Changed social attitudes have influenced my reaction.

Non-smokers' responses are reported as percentages in Table 6:

Table 6. Non-smokers' responses, percent. n = 182[7]

	Health eff.	Less used	More used	Social attit.
Agree compl.	64.8	72.0	2.8	46.2
Agree part.	21.4	15.9	1.7	31.3
Disagree part.	4.4	4.4	9.4	6.6
Disagree compl.	8.8	7.1	85.6	14.8
Don't know	0.5	0.5	0.6	1.1

[6] This was not provided as a response alternative in smokers' parallell question. While clearly be relevant for some individual non-smokers who have, for example, changed their family situation, this response alternative provoked such disbelief and confusion when included in smokers' questionnaires in test rounds that we found it best to omit it.

[7] n =181 for the alternative "more used to".

An overwhelming majority of both smokers (85 percent of those receiving this question) and non-smokers (88 percent) agree completely or partially that non-smokers are today less used to be exposed to passive smoking than before. Similarly, most smokers (96 percent) and non-smokers (78 percent) agree partially or completely that non-smokers' changed reaction may be explained by changed social attitudes. Very few non-smokers report that they have changed their reactions because they are exposed more to passive smoking than before. The responses regarding health effects are discussed below.

A crucial assumption in the above model is that smokers feel uncomfortable knowing or believing that someone dislike their smoking behavior. Some may object that this assumption is somewhat *ad hoc*. Thus, we added one final question to the smokers in our sample. The question was as follows:

If you believe that someone who is present dislike that you smoke, would this bother you a lot, bother you a little, or would it not bother you?

The responses to this question are reported in Table 7 below.

Table 7. Smokers' responses. n = 365.

	Percent
It would bother me a lot	48.5
It would bother me a little	33.4
It would not bother me	16.4
Don't know	1.6

Almost half of the smokers report that others' negative reactions would bother them a lot, while only 16 percent report that it would not bother them at all. Note that our question did not indicate active sanctioning from others: We asked merely if it would bother them if they *believed* that someone disliked their smoking.

The presence of the 16 percent who do not care about others' dislike will modify the extreme equilibria of our theoretical model: The full consideration equilibrium will in this situation be changed into a high consideration equilibrium, since these people will not change their behavior even if everybody else does.

7 Discussion

A change in beliefs about negative health effects can be an alternative explanation of the crowding in of social norms for considerate smoking behavior. It follows directly from Proposition 2 that an exogenous increase in the perceived health effects of passive smoking (k) may cause a move towards the high consideration equilibrium, even in the absence of changes in the smoking regulations. According to Table 5 and 6, both smokers and non-smokers support the suggestion that beliefs about health effects have changed. Furthermore, time series data presented in Lund (1996) shows that from 1975 to 1995, a steadily increasing share of the Norwegian population believed that cigarette smoking caused negative health effects.

A change in the share of the population who are non-smokers, α, has the same effects on smokers' behavior as a change in the beliefs about health effects (see Proposition 2). Both the share of smokers in the Norwegian population and the cigarette consumption per smoker has declined, although only slightly, in the period from 1988 to 1998 (National Council of Tobacco and Health, 2000).

Change in beliefs about negative health effects, decline in the share of smokers, and the new smoking regulations may have reinforced each others' effects. Look, for example, at a society which is initially in the low consideration equilibrium. Then, perceived health effects of passive smoking increases. This change in beliefs will have an effect even if the change is insufficient to move the society to the low consideration equilibrium: A smaller change in smoking regulations is now sufficient to change the norm.

In our model, the share of smokers, α, is exogenous. One might assume, instead, that α is endogenously related to smoking regulations, because forcing smokers to be considerate in the regulated zone may make it easier to quit smoking (Evans et al., 1999). This would reinforce the mechanisms of our model, since a stricter regulation would then lead to stronger social sanctions both through h and α in equation (2).[8]

Further, we have implicitly assumed that the tobacco consumption per smoker is constant. An alternative assumption is that smokers reduce their tobacco consumption when a regulation is introduced,

[8] A similar effect would occur if introduction of a smoking regulation was interpreted as a change in property rights: Before the regulation, smokers had the right to smoke, while after the regulation, non-smokers have a right to clean air. One way to capture this in the model is to accompany the introduction of a smoking regulation by an increase in k. This would reinforce the mechanisms of the model.

because it forces them to bear the inconvenience cost of being considerate in the regulated zone (going outdoors to smoke when at work). This would not change the main mechanisms of the model: Smokers are by assumption considerate in the regulated zone, so changed consumption in this zone does not change non-smokers' exposure to passive smoking. If the reduced tobacco consumption in turn makes it easier to quit and thus leads to a decrease in α, this reinforces the model mechanisms as described above.

Finally, the smoking regulation may itself be endogenous: If the population's beliefs about health effects change, introduction of strict smoking regulations may become politically more acceptable. This would not change the basic mechanism of the model, except that the change in social norms would then be initially set off by changed beliefs, not by the policy change.

8 Conclusions

In this paper, we have demonstrated that introduction of smoking regulations can induce dramatic changes in smokers' consideration levels. Starting from a situation in which no-one is considerate, new regulations may move the economy to an equilibrium in which every smoker is considerate, *even in the unregulated zone*. Further, once such a new norm is established, the regulations may in fact become superfluous, since social sanctions may then be sufficient to sustain the high consideration equilibrium. Such dramatic shifts from low to high consideration equilibria require, however, that the tightness of new restrictions exceeds a critical level. This critical level depends, among other things, on the size of smokers' costs of being considerate.

Our empirical evidence confirms that social norms on considerate smoking behavior have shifted quite dramatically in Norway. In 1999, only 10 percent of non-smokers reported that smoking guests would usually smoke indoors in their home without asking for permission. As much as 74 percent reported that this was the most common behavior among smoking guests 10 -15 years earlier. Since a major smoking law amendment was implemented in 1988, this is consistent with the predictions of our theoretical model. On the basis of our data we can, however, not conclude on whether the shift in social norms was triggered by the new smoking regulation or by a change in beliefs about negative health effects. Nevertheless, the sum of these changes, possibly reinforcing each other, has apparently been sufficient to move the economy

to a high consideration equilibrium.

References

[1] Arrow, Kenneth J., 1971, "Political and Economic Evaluation of Social Effects and Externalities", in Intrilligator, M. (ed.), Frontiers of Quantitative Economics, Amsterdam: North-Holland Publishing.

[2] Blau, P., 1964, *Exchange and Power in Social Life.* Transaction Publishers, New Brunswick.

[3] Börgers, T., and R. Sarin, 1997, Learning through Reinforcement and Replicator Dynamics. *Journal of Economic Theory* Vol. 77 (1), p 1-14.

[4] Coleman, James, 1990, *Foundations of social theory*, Cambridge, MA: Harvard University Press.

[5] Elster, Jon, 1989, "Social Norms and Economic Theory", *Journal of Economic Perspectives,* 3(4), pp. 99-117.

[6] Evans, William N., Matthew C. Farrelly, and Edward Montgomery, 1999, "Do Workplace Smoking Bans Reduce Smoking?" *The American Economic Review*, 89 (4), 728-747.

[7] Gächter, Simon, and Ernst Fehr, 1999, "Collective Action as a Social Exchange", *Journal of Economic Behavior and Organization*, 39(4), pp. 341-69.

[8] Lindbeck, Assar, 1997, "Incentives and Social Norms in Household Behavior", *American Economic Review*, 87(2), pp. 370-377.

[9] Lindbeck, Assar, Sten Nyberg, and Jörgen Weibull, 1999, "Social Norms and Economic Incentives in the Welfare State", *The Quarterly Journal of Economics*, 114(1), pp. 1-35.

[10] Lund, Karl Erik, 1996, *Samfunnsskapte endringer i tobakksbruk i Norge i det 20. århundre*, doctoral dissertation, University of Oslo (in Norwegian).

[11] National Council of Tobacco and Health (2000): Homepage at http://www.tobakk.no

[12] North, Douglass, 1981, *Structure and Change in Economic History,* New York.

[13] Taylor, Peter and Leo Jonker, 1978, "Evolutionarily Stable Strategie and Game Dynamics", *Mathematical Biosciences*, 40(2), pp. 145-56.

[14] Ullmann-Margalit, E., 1977, *The Emergence of Norms*, Oxford: Oxford University Press.

[15] Weibull, Jörgen W., 1995, *Evolutionary Game Theory*, Massachusetts: MIT Press.