ICSDS 2011 Submission #1285 – Please do not quote or cite without permission from the authors (SAND 2011-2287 C)

Developing a theory of the societal lifecycle of cigarette smoking: Explaining and anticipating trends using information feedback

Aldo A. Zagonel, Mohammad Mojtahedzadeh, George P. Richardson, Nancy S. Brodsky, Theresa J. Brown, Stephen H. Conrad, and Robert J. Glass

DRAFT
6/7/2011

Developing a theory of the societal lifecycle of cigarette smoking: Explaining and anticipating trends using information feedback

Abstract

Cigarette smoking presented the most significant public health challenge in the United States in the 20th Century and remains the single most preventable cause of morbidity and mortality in this country. A number of System Dynamics models exist that inform tobacco control policies. We reviewed them and discuss their contributions. We developed a theory of the societal lifecycle of smoking, using a parsimonious set of feedback loops to capture historical trends and explore future scenarios. Previous work did not explain the long-term historical patterns of smoking behaviors. Much of it used stock-and-flow to represent the decline in prevalence in the recent past. With noted exceptions, information feedbacks were not embedded in these models. We present and discuss our feedback-rich conceptual model and illustrate the results of a series of simulations. A formal analysis shows phenomena composed of different phases of behavior with specific dominant feedbacks associated with each phase. We discuss the implications of our society's current phase, and conclude with simulations of what-if scenarios. Because System Dynamics models must contain information feedback to be able to anticipate tipping points and to help identify policies that exploit leverage in a complex system, we expanded this body of work to provide an endogenous representation of the century-long societal lifecycle of smoking.

Introduction

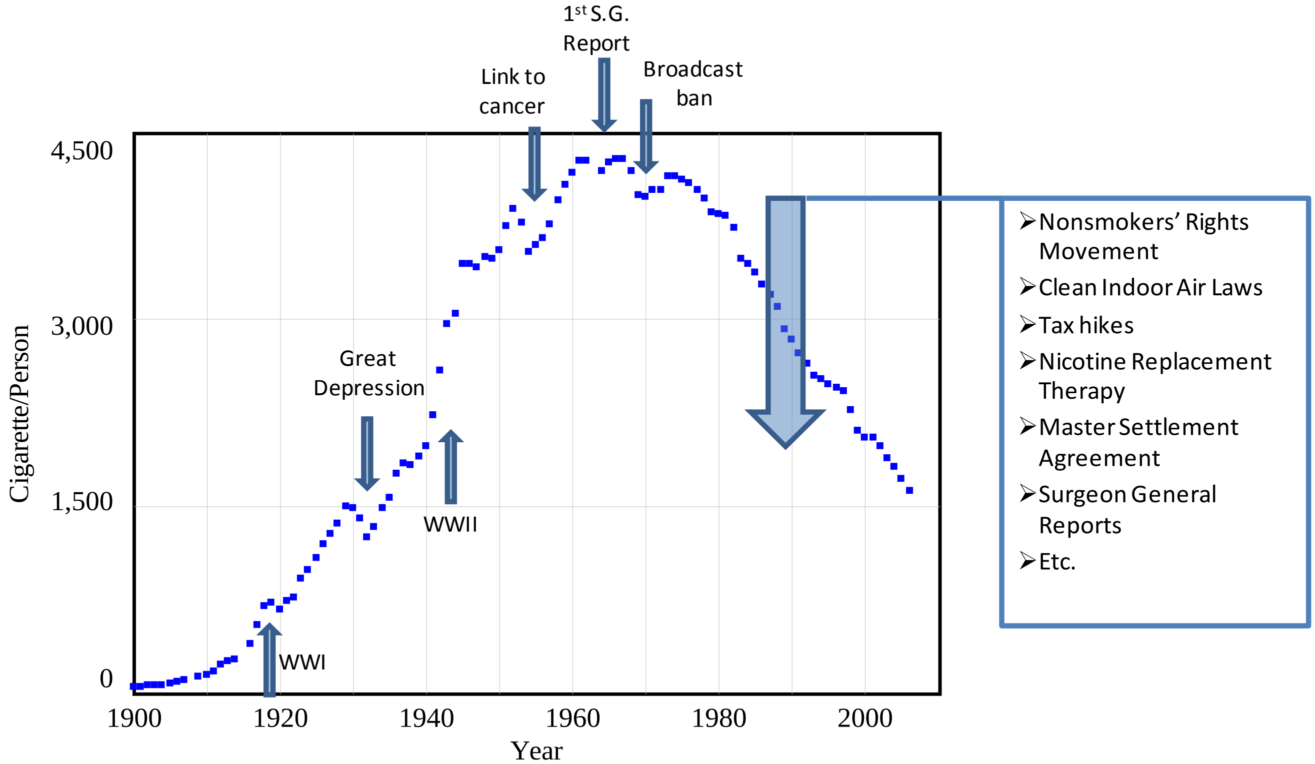
Cigarette smoking presented the most significant public health challenge in the United States in the 20th Century and remains the single most preventable cause of morbidity and mortality in this country. According to a recent study by the Centers for Disease Control and Prevention (CDC), more than 400 thousand premature deaths attributable to smoking occur annually (years of potential life lost were estimated at approximately 5.1 million and productivity losses at $96.8 billion annually).[1] One in every five U.S. adults is still smoking.[2] While we continue to struggle with this problem, other progressive countries are not faring much better and cigarette smoking is actually on the rise in some places.[3]

The pattern for consumption of manufactured cigarettes per capita in the United States, between 1900 and 2006, is depicted in Figure 1. The peak in smoking occurred in the 1960s, and dropped sharply since, presumably due to increased awareness of the harmful effects of smoking and successful tobacco control initiatives.

The purpose of this research is to explain this historical pattern of behavior using a parsimonious feedback-rich model, and to be able to anticipate future trends that take into account the system structure underlying this pattern. Our effort is focused on conceiving the structure needed to explain historical smoking behaviors at the population level and, thus, to develop a theory of the societal lifecycle of cigarette smoking that is generic and generally applicable.

[1] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5745a3.htm
[2] http://www.infoplease.com/ipa/A0762370.html
[3] http://www.wpro.who.int/media_centre/fact_sheets/fs_20020528.htm

Figure 1. Manufactured cigarette consumption per capita (United States, 1900-2006)



Source: http://www.cdc.gov/tobacco/data_statistics/tables/economics/consumption/

Working with a structural theory, we should be able to anticipate future trends. Will cigarette smoking continue to drop significantly, steadily decline, level off, or actually rise again? With a model depicting an appropriate "governing structure" of cigarette consumption and the tobacco control system, we can realistically analyze plausible future scenarios, and evaluate strategies that can effectively influence system behavior with greater confidence.

We explore the population responses to changes in the system, as well as the time frame for the changing patterns of behavior resulting from policy implementation and social adaptation to these policies. Our population of interest is the USA; however, a general theory should have applicability to other settings if it adequately depicts the social phenomenon of cigarette smoking.

Review of previous SD studies

Because we are interested in capturing the structure of the cigarette smoking and tobacco control system that incorporates a feedback-rich perspective, existing System Dynamics models were an obvious point of departure for our study. An initial broad search of the literature led us to select the following five models, listed here in chronological order, for deeper investigation:

- The MIT model (Roberts *et al.*, 1982)
  - 1 publication; model not available
- The Tobacco Policy Model – TPM (Tengs, Ahmad, *et al.*, 2001-2005)

  - 7 publications; model not available
- The Initiative on the Study and Implementation of Systems – ISIS Model (Richardson, 2007)
  - 1 publication; model available
- The New Zealand TPM (Cavana, Tobias, Bloomfield, 2008 & 2010)
  - 2 publications; model available
- The Prevention Impacts Simulation Model – PRISM (Homer, Milstein, Hirsch, *et al.*, 2008-2010)
  - 3 publications; model and reference manual available

We reviewed this work primarily based upon publications in peer-reviewed journals and, in one case, a monograph (ISIS). We were able to obtain and look into some of the models (ISIS, NZ-TPM, and PRISM) with the intent of understanding the structure behind these models to incorporate key features into our work.

<u>MIT model</u>:

The MIT model was set up using U.S. smoking population data between 1965 and 1974. For the purpose of analysis, the simulations started in 1970 and ran for a period of 40 years, until 2010. The results show declining prevalence. Some forms of feedback were incorporated into the model, such as reinforcing feedback due to peer pressure and balancing feedback due to perception of hazards associated with smoking. The authors used the model to examine strategies such as anti-smoking campaigns, increased prices of cigarettes, reduction in contaminants, and advertising bans (both marketing and education). They found model behavior to be very sensitive to model assumptions, considered at the time highly uncertain.

The authors did not look far enough into the past to capture and explain the historical behavior leading to the peak in smoking prevalence or cigarette consumption. They only examined the period of decline starting in the mid 1960s.[4]

<u>Tobacco Policy Model (TPM)</u>:

The Tobacco Policy Model was calibrated using U.S. smoking population data from 1995 to 2003. For the purpose of analysis, the simulations started in 2001 or 2003 and ran for a period of 50 years or more. (In some publications the unit of analysis was not the U.S. population, but that of the state of California.) No form of information feedback was incorporated in the model except for first-order controls for the population stocks. However, the model has a very elaborate stock-and-flow structure, capturing six age groups per gender and distinguishes three categories: never smokers, smokers, and former smokers. The model contained physical feedback, in the form of “relapse” from former to current smokers, to supplement the initiation and cessation flows.

The authors used the model to contrast the impacts of changes in initiation, cessation and relapse, and to examine strategies such as education, reduced harm (both toxicity and nicotine level), reduced

[4] Even though this Dynamo model is dated, it would be interesting to have access to it since the publication itself does not fully document model diagrams and equations.

access to cigarettes, and increased prices due to higher taxes. Their analyses showed steady declines in prevalence, and great effort was directed to estimating the decline that could be achieved with each strategy examined, as well as to measuring costs. An interesting aspect of this work is the measurement of Quality-Adjusted Life Years (QALYs) to establish cost-effectiveness of policy options.

The authors did not explain the long-term historical behavior. They looked only at the very recent period of declining consumption. While the model provides useful forecasts based upon the ongoing behavioral trend, without information feedback it cannot endogenously capture changes in behavioral trends.[5]

ISIS model:

The ISIS Model was calibrated using U.S. smoking population data from 1965 to 2000. For the purpose of analysis, the simulations ran for a period of 55 years, until 2020, contrasting model behavior with historical data for selected variables between 1965 and 2000. In general, the simulations suggested a further decline in prevalence. This model was built with emphasis on information feedback. Similar to the MIT model, it contains a reinforcing feedback of smoking as a social norm (aka, peer pressure), and a balancing feedback due to public awareness of tobacco health risk (aka, perceived hazards of smoking).

This effort did not include explanation of the historical behavior leading to the peak and decline in prevalence or cigarette consumption per capita. Instead, the model was used to illustrate the use of System Dynamics for tackling a complex problem embedded in a feedback-rich system. Less emphasis was placed on examining tobacco control strategies and scenarios.

New Zealand TPM:

The New Zealand Tobacco Policy Model was calibrated using New Zealand smoking population data from 2001 to 2004. For the purpose of analysis, the simulations started in 2001 and ran for a period of 30 to 50 years. The only form of information feedback incorporated in the model was a reinforcing effect involving role modeling, similar to the notion of peer pressure or social-norm formation. (Instead of first-order control on population stocks, this model used a conveyor-belt or material-delay formulation.) This model is very similar in scope to the U.S. TPM model, relying on an elaborate stock-and-flow structure. It includes the additional effects of second-hand smoking. Similar to the TPM approach, the authors examined strategies involving harm reduction (both toxicity and nicotine level), and increased prices. The analyses suggested a further decline in prevalence (without measuring QALYs or attempting to do a cost-benefit analysis). It is important to note that these analyses had an impact on resource allocation, leading to a governmental decision to invest US$32 million in cessation services.

The authors did not explain the historical behavior, calibrating to what we presume to be the period of decline in smoking prevalence in New Zealand. Without emphasis on information feedback, the model

[5] Given the level of effort that was placed in this research, and the number of peer-reviewed publications resulting from it, it would be invaluable to make it publicly accessible.

cannot endogenously capture changes in behavioral trends. Thus, the simulations showed continued decline in prevalence.

PRISM:

The Prevention Impacts Simulation Model (denoted PRISM) was calibrated using U.S. population data from 1990 to 2004. For the purpose of analysis, the simulations ran for a period of 50 years, until 2040. (There are also instantiations of this model for specific counties in the states of Texas and Colorado.) This model focuses on the contributions of cigarette consumption to cardiovascular disease. Therefore, it includes smoking as one important factor. No form of information feedback was incorporated in the smoking sector of the model (except for first-order controls on the population stocks). However, the model accounts for long-term ex-smokers, who have a reduced relative-risk of morbidity and mortality, and includes second-hand smoking. Great care was directed towards estimating morbidity and mortality, and to assessing health care capacity needed to meet increased demand for public health services. Their analyses suggested a further decline in smoking prevalence, particularly with the implementation of policies that promote healthy lifestyles and environmental changes.

The authors did not explain the long-term historical behavior in smoking prevalence. They looked at the very recent period of decline. Without information feedback, the model will not endogenously capture changes in the current trend.

In summary:

Table 1 illustrates the choice of time horizon of interest for each of these studies, as well as for this study. The existing SD work did not examine the historical growth and decline of cigarette consumption, but was informative in:

1. Providing a foundation upon which to identify system structures, determine morbidity and mortality, assess potential impacts of interventions and measure their cost effectiveness;
2. Demonstrating impact and influencing public health policy and decision making; and
3. Providing insight on key information feedbacks:
   - Reinforcing feedback between prevalence and initiation rate
   - Balancing feedback due to awareness of health consequences of smoking

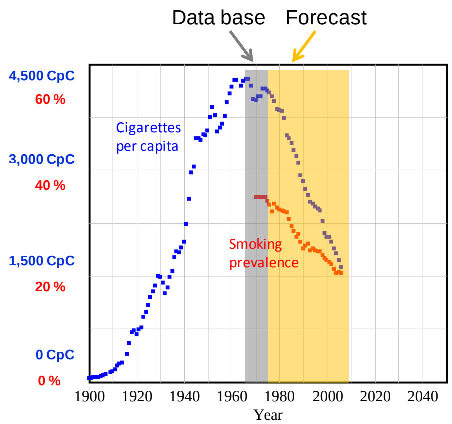
All of the models looked at a relatively short historical period of reference, and none of the models looked at the possibility of a “rebound” in smoking, which is one of the important scenarios for our explorations.

Therefore, we saw a path open to expand this body of knowledge that involved looking at the long-term history of cigarette smoking behavior. Our research effort is focused on developing the structure needed to account for the societal lifecycle of cigarette smoking, with emphasis on information feedback and using an Occam’s razor approach.[6]

[6] http://en.wikipedia.org/wiki/Occam%27s_razor

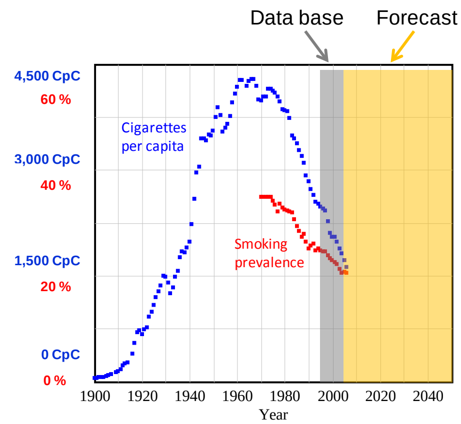
Table 1. Choice of time horizon for SD studies of cigarette smoking and tobacco control

MIT model



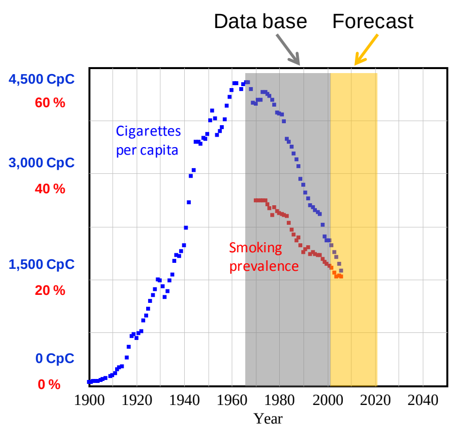
Hindsight (1965-1974); foresight (until 2010)

Tobacco Policy Model



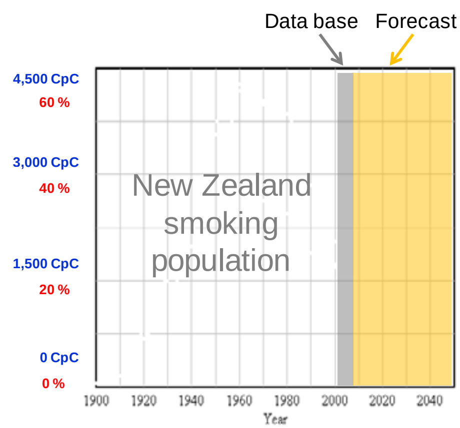
Hindsight (1995-2003); foresight (until 2051+)

ISIS model



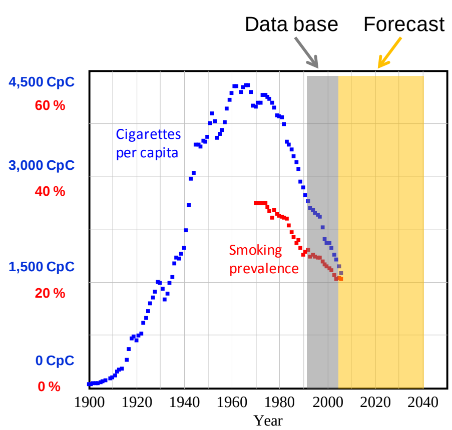
Hindsight (1965-2000); foresight (until 2020)

New Zealand TPM



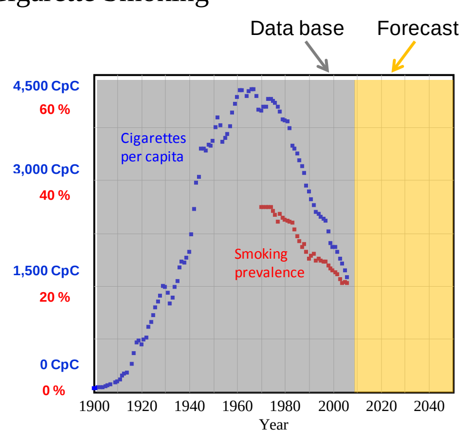
Hindsight (2001-2004); foresight (until 2051+)

PRISM



Hindsight (1995-2003); foresight (until 2040)

Societal Lifecycle of Cigarette Smoking

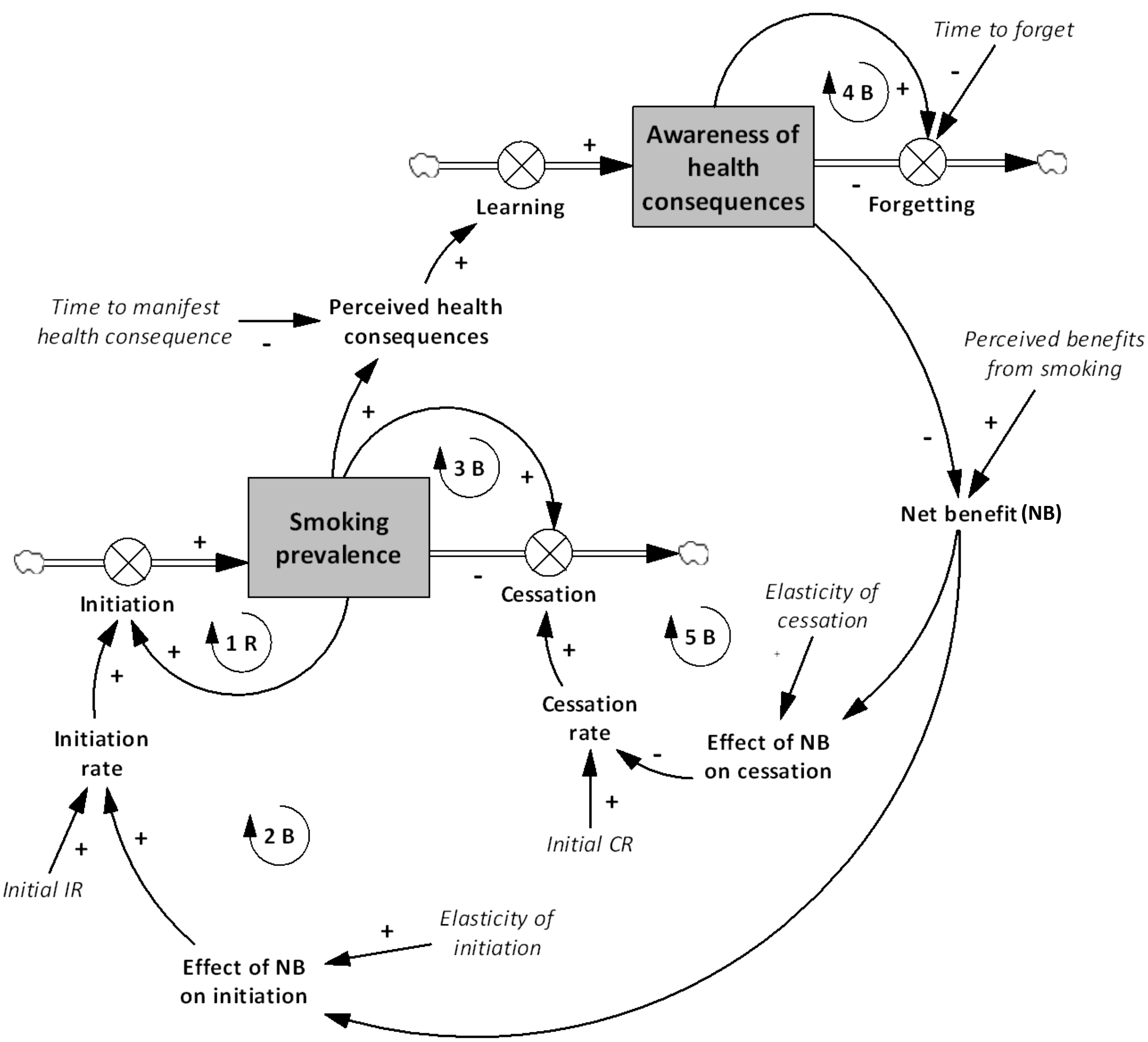


Hindsight (1900-2010); foresight (until 2051+)

Dynamic hypothesis

We propose a conceptual model, which represents our initial effort to develop a parsimonious, feedback-rich theory of the societal lifecycle of smoking. Illustrated in Figure 2,this is a prototype or proof-of-concept model.

Figure 2. Our feedback-rich concept model of the societal lifecycle of cigarette smoking



Feedback loops:

1. Reinforcing “initiation” loop
2. Balancing “awareness curbs initiation” loop
3. Balancing “cessation” loop
4. Balancing “losing awareness” loop
5. Balancing “awareness boosts cessation” loop

We incorporated the major feedbacks used in the existing studies:

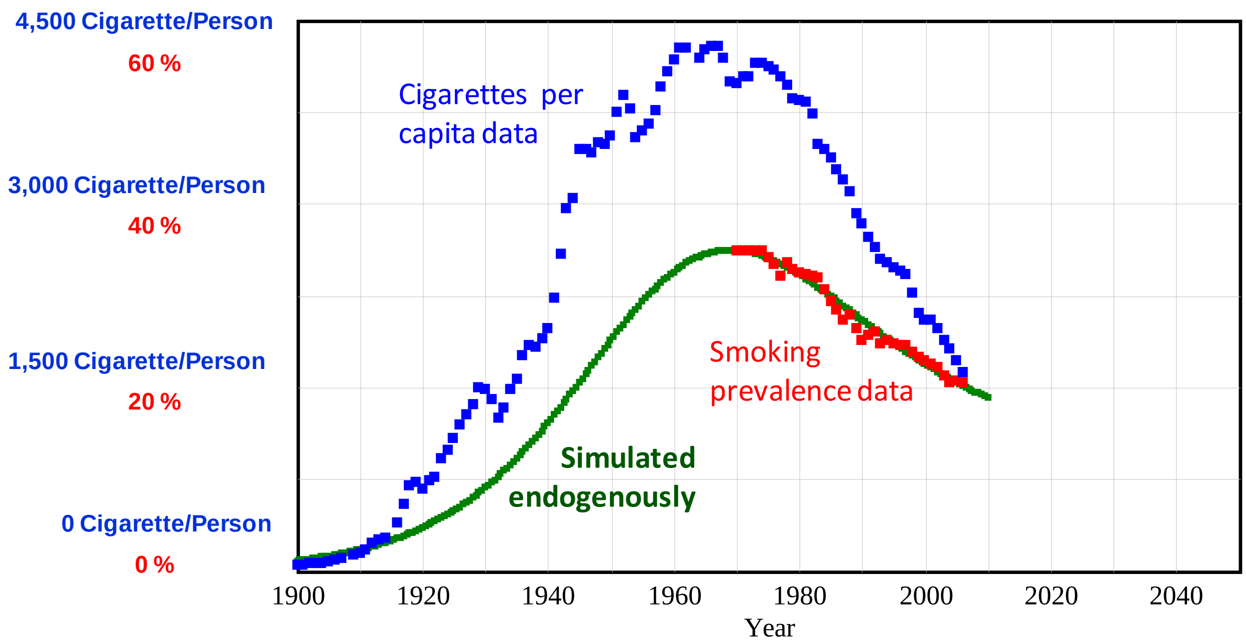
- Loop #1 is a reinforcing loop that represents peer pressure, social norm formation, or role modeling. We call it the initiation loop.
- Loops #2 and #5 are balancing loops that represent the perceived hazards of smoking or awareness of tobacco health risks. They act to influence initiation and cessation, respectively.
- Loop #3 is present in the stock-and-flow structure of all of the models examined. We call it the cessation loop, and it captures the balancing effect of changes in prevalence due to cessation.
- We included a novel loop #4 in our conceptual model, which we define as a losing-awareness loop.

In our model, awareness of health consequences does not represent cumulative scientific knowledge, but rather awareness that is current in the mindset of the population of interest.

Parameterization and calibration

Appendix 1 provides the model equations. Using notional parameters that were sensible, we calibrated the model to roughly replicate the shape of the cigarette per capita curve while overlapping as closely as possible the data for smoking prevalence. Both sets of data and the model simulated behavior are shown in Figure 3.

Figure 3. Base run (historical)



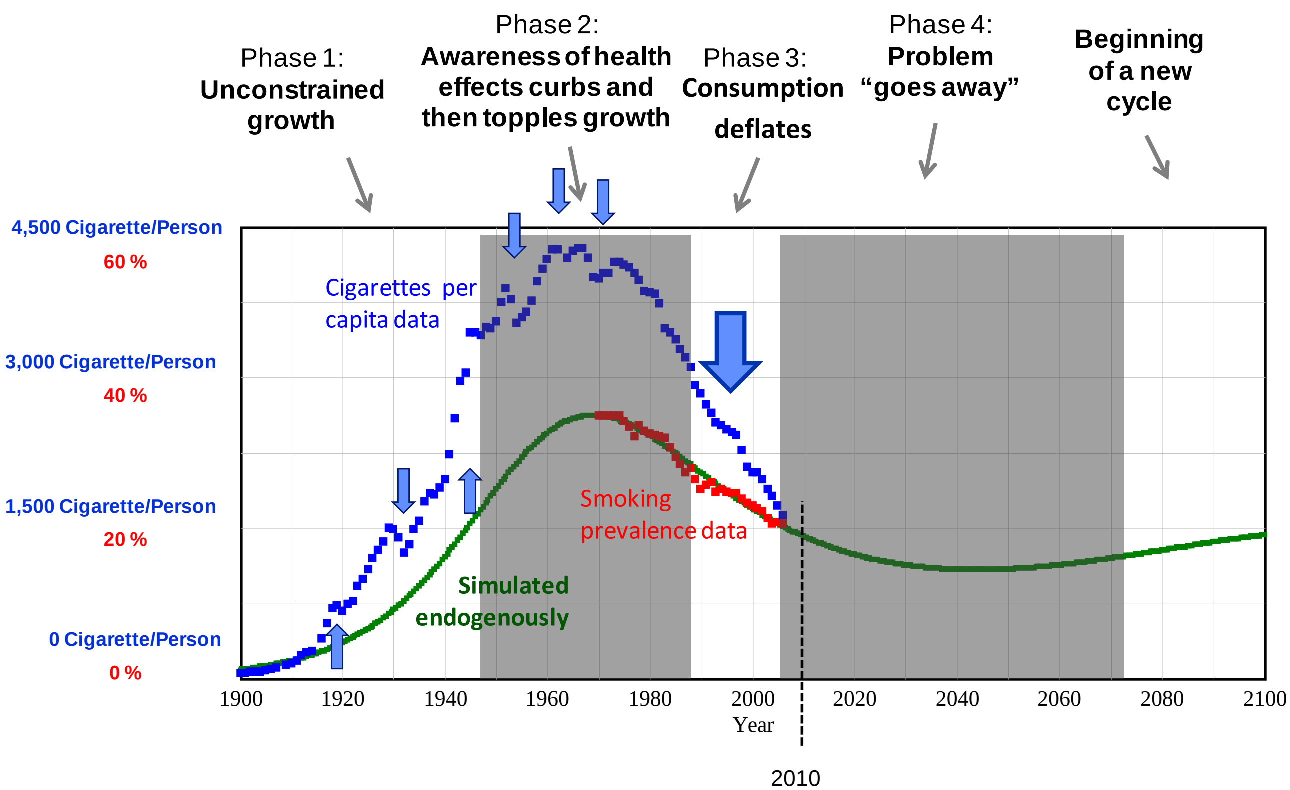
Our time series data for cigarette smoking prevalence is incomplete, going back to 1970 only. (Note that there are now two scales in the Y axis.) We observe that a greater percentage of the population smoked in the past and, also, those who smoked consumed more cigarettes per year.

Our goal here was not to have a perfect model or simulation, but to underscore the role of the time horizon of interest and information feedback in explaining the historical smoking behavior in the population and in capturing tipping points endogenously.

Formal analysis

We used Pathway Participation Metrics[7] to conduct formal model analysis and trace model behavior to model structure. We identified four phases of behavior, each dominated by a different feedback loop, as illustrated in Figure 4:

Figure 4. Societal lifecycle of smoking



Phase 1, unconstrained growth, is dominated by the reinforcing "initiation" loop. The Great Wars and the Great Depression are noise in an otherwise smooth exponential growth pattern of behavior. Since these influences are not in the model, the simulated behavior does not capture those fluctuations. The transition to the next phase occurs in the mid- to late-1940s.

---

[7] Mojtahedzadeh M., Andersen D., Richardson G.P., 2004, Using Digest to implement the pathway participation method for detecting influential system structure. *System Dynamics Review* 20(1): pp 1-20; Mojtahedzadeh, M., 1997, "A Path Taken: Computer Assisted Heuristics for Understanding Dynamic Systems," Ph.D. Dissertation (University at Albany, SUNY: Albany, NY).

In **phase 2**, awareness of health effects from smoking curbs and reverses the initial growth trend. This phase is dominated by the balancing "awareness curbs initiation" loop. Note that the specific events are not exogenously captured in the model; rather, the model endogenously simulates the awareness process. In this light, the Surgeon General's Report, for example, can be seen as a manifestation of the state of awareness in society, as well as an element of the structural drive for behavioral change. Coincidently or not, the report publication coincides exactly with the tipping point of cigarette consumption behavior, preceded by the overwhelming scientific evidence of the link between smoking and cancer, consolidating and boosting public awareness, and followed by the first significant tobacco control initiative, the broadcast ban on cigarette advertisements.

The next phase begins in the mid- to- late-1980s. During **phase 3**, cigarette consumption deflates significantly. The dominant loop here is the balancing "cessation" loop. Awareness has an impact on cessation but, because cigarette smoking is addictive; the boost effect of awareness on cessation has limited impact. (The latter is the only feedback loop that is never dominant.) Additional tobacco control measures maintained the spotlight on cigarette smoking consequences. However, initiation had already declined drastically in the previous phase, and nicotine addiction prevents a significant increase in cessation in this one. Still, cessation is greater than initiation and prevalence continues to fall, even if more slowly.

According to this analysis, we recently entered **Phase 4**, which is dominated by the balancing loop of loosing awareness. We appear to be in the beginning of a very long phase that could last almost 70 years. During this time, scientific knowledge is not lost, but smoking as a health problem loses the spotlight because prevalence is relatively low and continues to decline for another 30 years or more. Naturally, over this time period other health issues, such as obesity for example, will gain prominence, visibility and resources. Eventually, initiation will become greater than cessation again, perhaps around 2050. The analysis indicates the beginning of a new cycle, two decades later, when exponential growth resumes.

The exact transition dates should not be given too much consideration, because they are subject to change if the model is re-calibrated to better data, or data that incorporate additional forms of tobacco use. However, it is interesting to note the possibility of a new lifecycle, albeit one that will not begin for several decades. This phased cigarette consumption pattern is characterized by damped oscillations; therefore, the next peak should be much lower, and the behavior tends toward stability when awareness is institutionalized at some level.

What-if scenarios

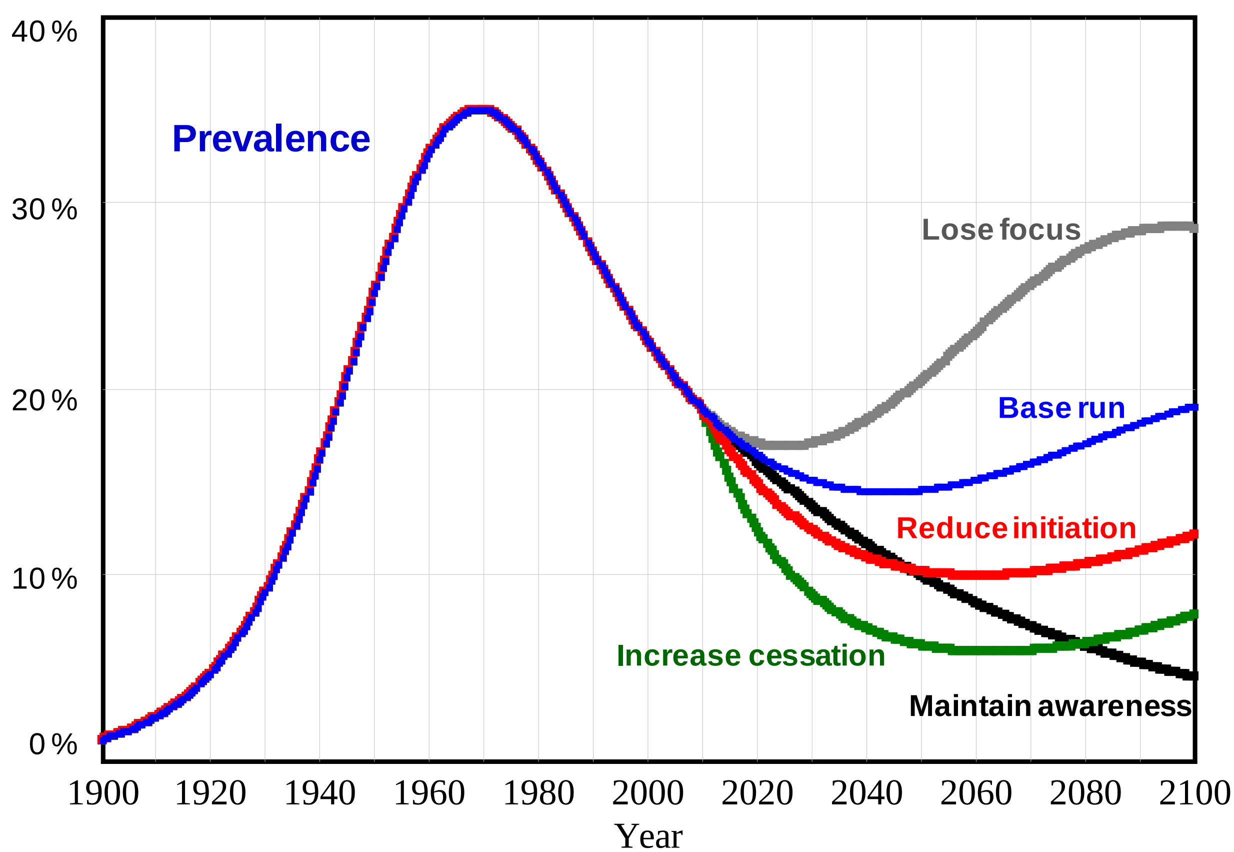
We examined human interventions to this system using four what-if scenarios:

1. What happens if we reduce initiation?
2. What happens if we increase cessation?
3. What if we lose focus?
4. What if we maintain awareness?

A reduction in initiation could be implemented by restricting access to cigarettes for those aged 21 and younger. An increase in cessation could be implemented by providing free nicotine replacement therapy (NRT) and behavioral counseling. Time to forget the health consequences of cigarette consumption might decrease if the issue of the health consequences loses the spotlight; conversely, permanent measures may be taken to maintain awareness –even if prevalence were to become negligible and other health issues much more prominent.[8]

Predicated on all of these changes being implemented in 2011, the results of these simulations are shown in Figure 5:

Figure 5. Four what-if scenarios



In the short term, further reductions in cigarette consumption can be achieved by emphasizing programs that reduce initiation and/or increase cessation. However, the balancing feedback loops that go through awareness of health consequences counteract such efforts. To the extent that we are successful in reducing prevalence, awareness falls and this causes initiation to rise and cessation to fall.

The quantity, time to forget the health consequences of cigarette consumption, has an important role in determining the dampening property of the oscillation. If we lose focus (shorten the time to forget), the

[8] We can also test the effects of strategies that impact the initiation and cessation elasticities. Reducing addictiveness, for example, should increase the elasticity of the effect of awareness on cessation. It will be easier to quit, if cigarettes are less addictive.

new cycle begins sooner and the rise in prevalence is more pronounced. Therefore, maintaining a high level of awareness is critical to keeping prevalence low in the population. This awareness must be maintained despite success in reducing smoking prevalence. In fact, the more successful the reduction of smoking prevalence, the greater the effort must be in maintaining awareness; otherwise, the importance of non-smoking will fade from public consciousness.

The ability to keep prevalence in decline depends upon the net difference between initiation and cessation rates. So long as cessation is greater than initiation, prevalence will continue to decline. This can be achieved by multiple means. Closely monitoring these rates of change, as opposed to simply tracking prevalence, can provide an early warning signal of a reversal in the prevalence trend.

Summary

Previous studies de-emphasized feedback and/or looked at a limited time frame, perhaps because information feedback is less tangible and more subjective. Therefore, their analyses are more open to question and less typical of evidence-based empirical analyses. Our feedback-rich conceptual model proposes a theory of the societal lifecycle of cigarette smoking and fits the data well. Our goal was not to produce a perfect model or simulation, but to underscore the role of the time horizon and feedback in explaining historical smoking behavior in the population and in capturing tipping points endogenously.

A formal analysis shows phenomena composed of different phases of behavior (patterns) with differing feedback loops dominant in each phase. The analysis indicates that the society is now in the beginning of a very long and gradual phase of losing awareness, transitioning from a period in which cessation is greater than initiation to a period in which initiation will be greater than cessation, even though smoking prevalence itself remains roughly stable. Prevalence could resurge if people “forget” or resources are placed elsewhere.

We simulated four what if questions about cigarette access, cessation services, and social awareness of the health consequences of smoking cigarettes. Focusing on initiation and cessation produces results in the short term, but those results are not sustainable unless social awareness of the health consequences of smoking is institutionalized over time and across generations.

Why is a feedback-rich model/theory useful?

In this as in many other cases, a feedback-rich model/theory helps us understand and explain historical behavior, particularly when there are tipping points. This perspective provides the ability to predict changes in patterns, and it helps to identify leverage points, i.e., locations for the most effective strategic interventions in a system. If the model is kept sufficiently parsimonious, it helps reveal fundamental structure via “looking at the forest as opposed to focusing on the trees.” This particular model is so general that it could be applied to other problem areas where a behavior has a tendency to grow until it is perceived as unhealthy and, once corrected, the problem is forgotten and resurfaces again over a long time period or across intergenerational gaps. For example, this phenomenon may be taking place today with respect to the resurgence of HIV/AIDS.[9]

[9] http://www.seattlepi.com/local/132645_aids28.html

References for previous SD studies reviewed

MIT model:

Roberts, E., Homer, J., Kasabian, A., and Varrell M. 1982. A Systems View of the Smoking Problem: Perspective and Limitations of the Role of Science in Decision-Making. *Int. J. Bio-Medical Computing* (13):69-86.

Tobacco Policy Model:

Ahmad S. 2005. The Cost-Effectiveness of Raising the Legal Smoking Age in California, *Medical Decision Making* 25(3) 330-340.

Ahmad S. 2005. Increasing excise taxes on cigarettes in California: a dynamic simulation of health and economic impacts, *Preventive Medicine* 41(1): 276-283.

Ahmad S and John Billimek. 2005. Estimating the Health Impacts of Tobacco Harm Reduction: A Simulation modeling Approach, *Risk Analysis* 25(4): 1-12.

Tengs, T., Ahmad, S, Moore, R., and Gage, E. 2004. Federal Policy Mandating Safer Cigarettes: A Simulation of the Anticipated Population Health Gains or Losses, *Journal of Policy Analysis and Management* 23(4): 857-872.

Tengs, T., Ahmad, S, Savage, J, Moore, R., and Gage, E. 2005. The AMA Proposal to Mandate Nicotine Reduction in Cigarettes: A Simulation of the Population Health Impacts, *Preventive Medicine* 40(2): 170-180.

Tengs TO, Osgood ND, Chen LL. December 2001. The cost-effectiveness of intensive national school-based anti-tobacco education: results from the tobacco policy model. *Preventive Medicine* 33(6): 558– 70.

Tengs TO, Osgood ND, Lin TH. October 2001. The public health impact of changes in smoking behavior: results from the tobacco policy model. *Medical Care* 39(10): 1131– 41.

The Initiative on the Study and Implementation of Systems (ISIS) model:

Richardson GP. 2007. How to Anticipate Changes in Tobacco Control Systems. NCI Tobacco Control Monograph Series 18. *Greater Than the Sum of Parts: Systems Thinking in Tobacco Control*: 109-146 (Edited by Best et al). US Department of Health and Human Services.

New Zealand Tobacco Policy Model:

Cavana RY, Tobias M. 2008. Integrative System Dynamics: Analysis of Policy Options for Tobacco Control in New Zealand. *Systems Research and Behavioral Science* 25: 675-694.

Tobias MI, Cavana RY, Bloomfield A. July 2010. Application of a System Dynamics Model to Inform Investment in Smoking Cessation Services in New Zealand. *American Journal of Public Health* 100(7): 1274-1281.

Prevention Impacts Simulation Model (PRISM):

Hirsch GB, Homer JB, Evans E, Zielinski A. April 2010. A System Dynamics Model for Planning Cardiovascular Disease Interventions. *American Journal of Public Health* 100(4): 616-622.

Homer JB. June 2010. PRISM: The Prevention Impacts Simulation Model; Reference Guide for Model Version 09v2q: 100p.

Homer JB, Milstein B, Wile K, Pratibhu P, Farris R, Orenstein D. January 2010. Modeling the Local Dynamics of Cardiovascular Health: Risk Factors, Context, and Capacity. *Preventing Chronic Disease* 7(1): 1-6.

Homer JB, Milstein B, Wile K, Trogdon J, Huang P, Labarthe D, Orenstein D. April 2008. Simulating and Evaluating Local Interventions to Improve Cardiovascular Health. *Preventing Chronic Disease* 5(2): 1-11.

Appendix 1 – Model equations

Awareness of health consequences = INTEG (Learning-Forgetting, Initial K); Units: Dmnl
Cessation = Smoking prevalence*Cessation rate; Units: 1/Year
Cessation rate = Initial CR*Effect of NB on cessation; Units: 1/Year
Effect of NB on cessation = Net benefit^(-Elasticity of cessation); Units: Dmnl
Effect of NB on initiation = Net benefit^Elasticity of initiation; Units: Dmnl
Elasticity of cessation = 0.3; Units: Dmnl
Elasticity of initiation = 2.4; Units: Dmnl
FINAL TIME = 2100; Units: Year
Forgetting = Awareness of health consequences/Time to forget; Units: 1/Year
Initial CR = 0.06; Units: 1/Year
Initial IR = 0.135; Units: 1/Year
Initial K = 0; Units: Dmnl
Initial P = 0.011; Units: Dmnl
INITIAL TIME = 1900; Units: Year
Initiation = Smoking prevalence*Initiation rate; Units: 1/Year
Initiation rate = Initial IR*Effect of NB on initiation; Units: 1/Year
Learning = Perceived health consequences; Units: 1/Year
Net benefit = Perceived benefits from smoking-Awareness of health consequences; Units: Dmnl
Perceived benefits from smoking = 1; Units: Dmnl
Perceived health consequences = Smoking prevalence/Time to manifest health consequence; Units: 1/Year
SAVEPER = 0.5; Units: Year
Smoking prevalence = INTEG (Initiation-Cessation, Initial P); Units: Dmnl
TIME STEP = 0.25; Units: Year
Time to forget = 35; Units: Year
Time to manifest health consequence = 25; Units: Year