What is an effective, reasonable way to reduce smoking in the US?

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May 7, 2009

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Introduction

During America's colonial stage, John Rolfe introduced a new type of tobacco to Virginia, setting the stage for drastic social, political, and economic changes in the years to follow. In the early 20th century, smoking became more popular, and in the 20s and 50s, the number of smokers jumped incredibly high. In the later part of the century, it was discovered that smoking causes cancer and other health problems, so the number of smokers began to wane. The US government began to regulate the smoking industry, and education about its true effects spread rapidly. Nowadays, we have two major choices: pressure the government to raise taxes and increase their money spent on anti-smoking education, resulting in less smokers, or do nothing, letting the number of smokers stay about the same, killings hundreds of thousands annually.

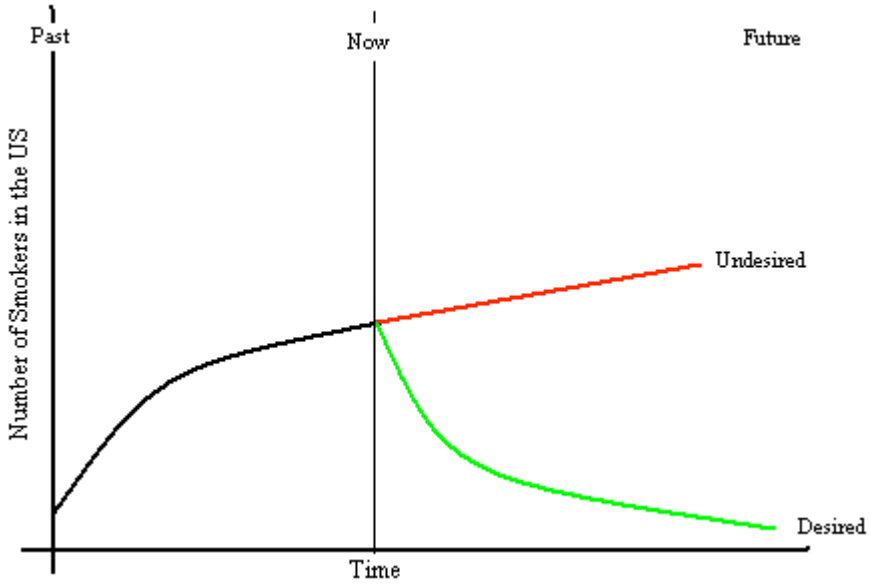

Figure 1: Reference Behavior over Time Graph

Though there already is a tax on smoking, I believe it is not enough, for the signs of damage from smoking are apparent in my everyday life. Furthermore, I wanted to be able to observe a possible scenario where the government regulated tobacco industries more and redistributed the money from taxes earned. Through the STELLA model that I hoped to build, I would have a clearer understanding of the impact that government could, and possible should have on these malicious businesses.

The Process of Model Building

When creating my very first, most basic model, I broke the system into three stocks: the non-smokers, the smokers, and the ex-smokers, where various effects (tax included) would alter the values. In the end, however, the difficulty designating numbers to the various effects and the ex-smoker stock resulted in a model that, even if mildly functional, would not be realistic. For this reason, I scrapped this scenario within a few days of testing.

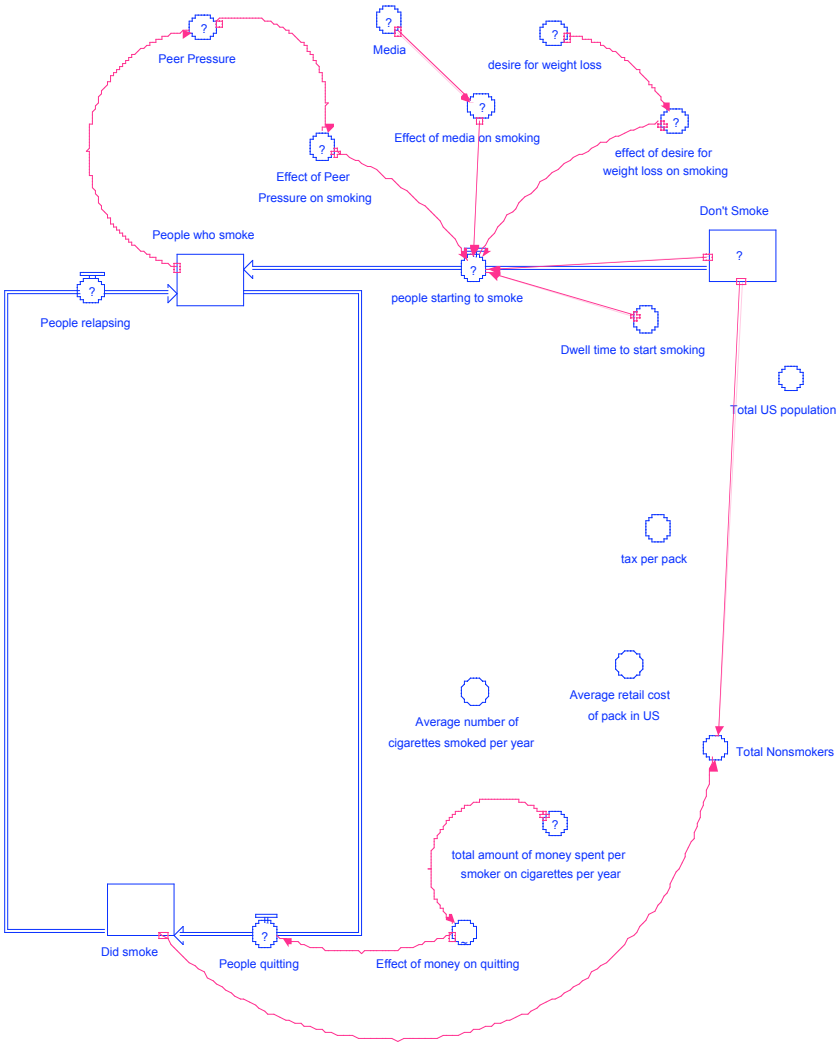

Figure 2: Smoking Model, 1st Version

When creating a new, more realistic version of the model, I based the new version off of a previous supply and demand scenario, which is able to contain the general trend of a product's price and total number. I was able to (somewhat) show a tax on the cigarette price here, though the tax/cigarette company's profit didn't go anywhere in this early version of the model. On the upper half of the diagram, a population aging chain is shown, which allows me to calculate the total number of smokers based on a normal smoking rate. This model is obviously incomplete, however, because the smoking rate is a constant that is changed by nothing. This is fixed in the final model.

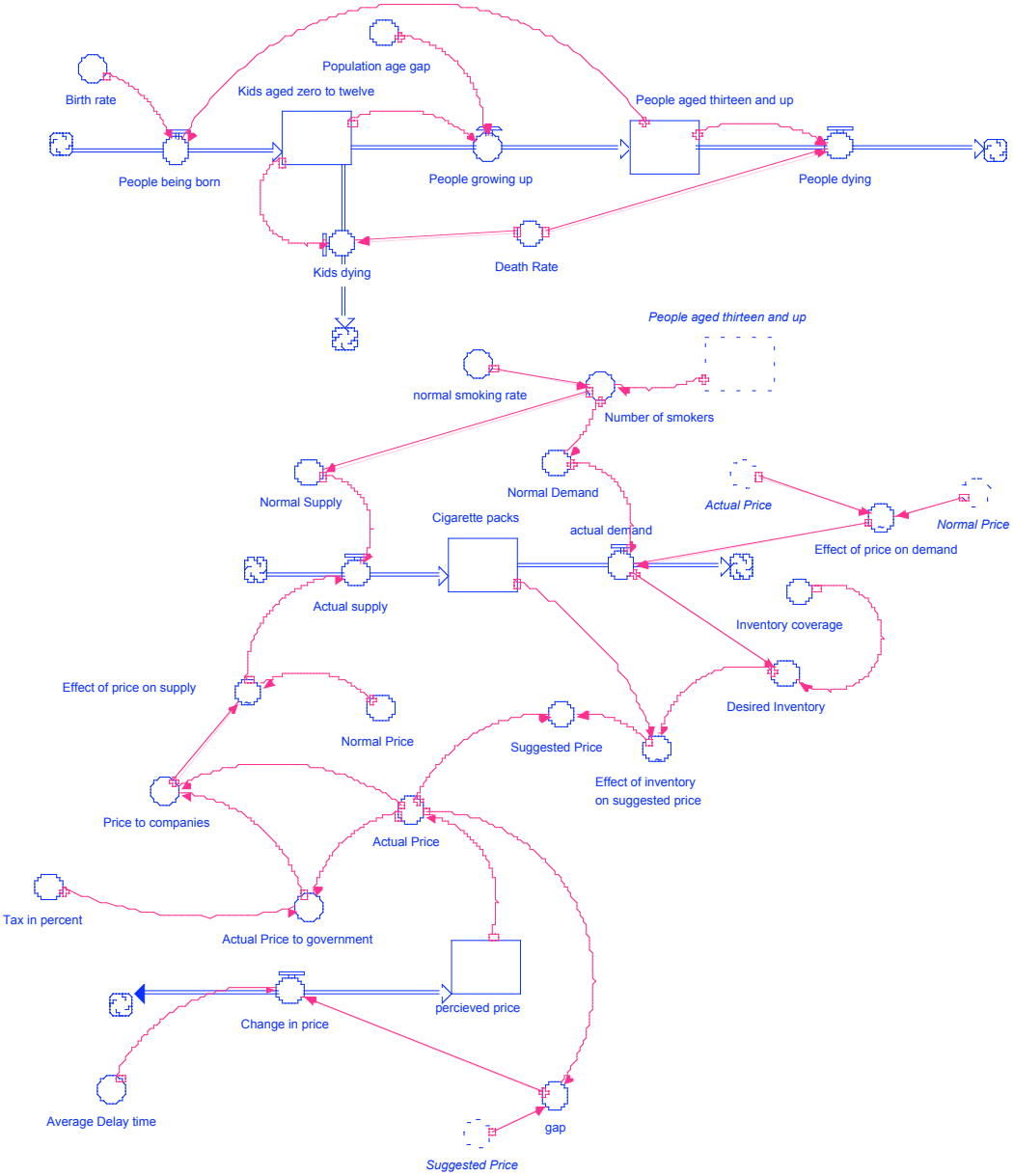

Figure 3: Smoking Model, 2nd Version

In the final version of the model, the flow of money earned from cigarette sales is broken into two parts based on the tax: "total price to companies" and "total price to the government." From here, these two converters counteract each other in the "effect of

advertising and education on the smoking rate," which changes the actual smoking rate accordingly. In addition, in the final version, the death rate is fixed to become more realistic.

The Finished Model and How It Works

In the final model, there are three basic parts: a supply and demand section, an advertising versus education section, and a population section.

The Population Section

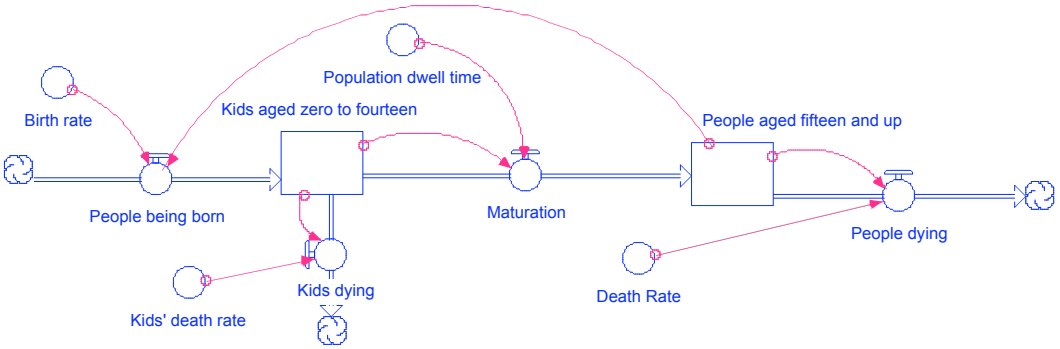

Figure 4: The Population Section

In the Population section of the model, a very basic scenario can be seen. Kids are born into the stock "kids aged zero to fourteen", and after 15 years, they mature into the "people aged fifteen and up" stock. There are separate death rates for both adults and kids, and the "people aged fifteen and up stock is used to calculate the number of smokers in the supply and demand section.

The Supply and Demand Section

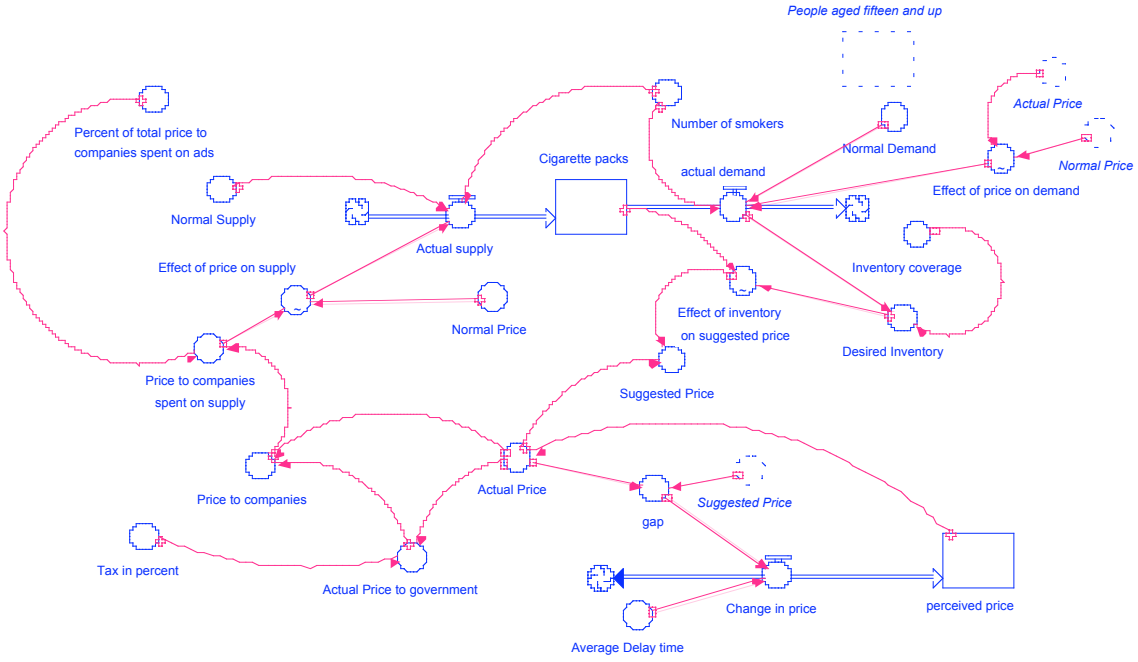

Figure 4: The Supply and Demand Section

In this section of the model, the total number of cigarette packs produced per year is calculated, along with the price of each pack and the amount of that price that goes to companies and the government. The number of smokers is calculated based on the "people aged fifteen and up" and the smoking rate. The "number of smokers" flows into the supply and demand sections of the model, where they are multiplied by the average number of cigarette packs smoked per year. In this part of the model, there are many things that affect the price, supply and demand. The ratio of cigarette packs and desired inventory creates an optimal price to satisfy the conditions, which is called the suggested price. After a delay in time, going through the "Perceived price" section, the suggested actual price is figured out and broken into two parts: the "price to government" and the "price to companies," which is altered based on a tax. The values for "price to companies" and "price to government" are used in the education versus advertisement section of the model. With this in mind, a section of the money that is spent on advertising could not be used to pay for more of the supply, so it is subtracted here, creating the converter called "price to companies spent on supply." It is then used to figure out the "effect of price on supply" (which basically dictates that if the companies earn more money than usual, they can sell more cigarette packs), which flows back into the actual supply.

The Advertising versus Education Section

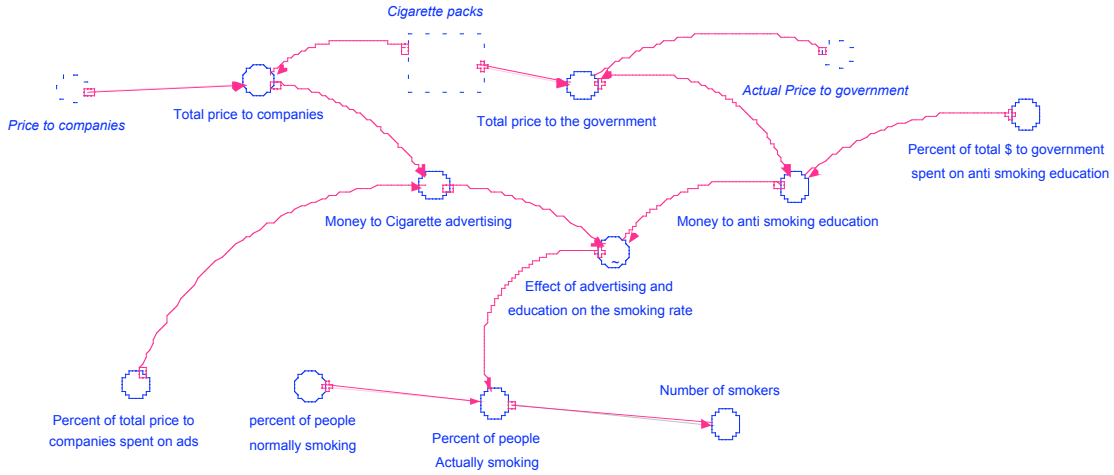

Figure 5: The Advertising versus Education Section

In the final section of the model, the total amount of money earned by the companies and the government is calculated, and a portion of that goes to advertising and education. These converters then fight against each other in the "effect of advertising and education on the smoking rate," which is used to calculate a new smoking rate, either increased by advertising, or lessened by government-sponsored education.

The Final Model

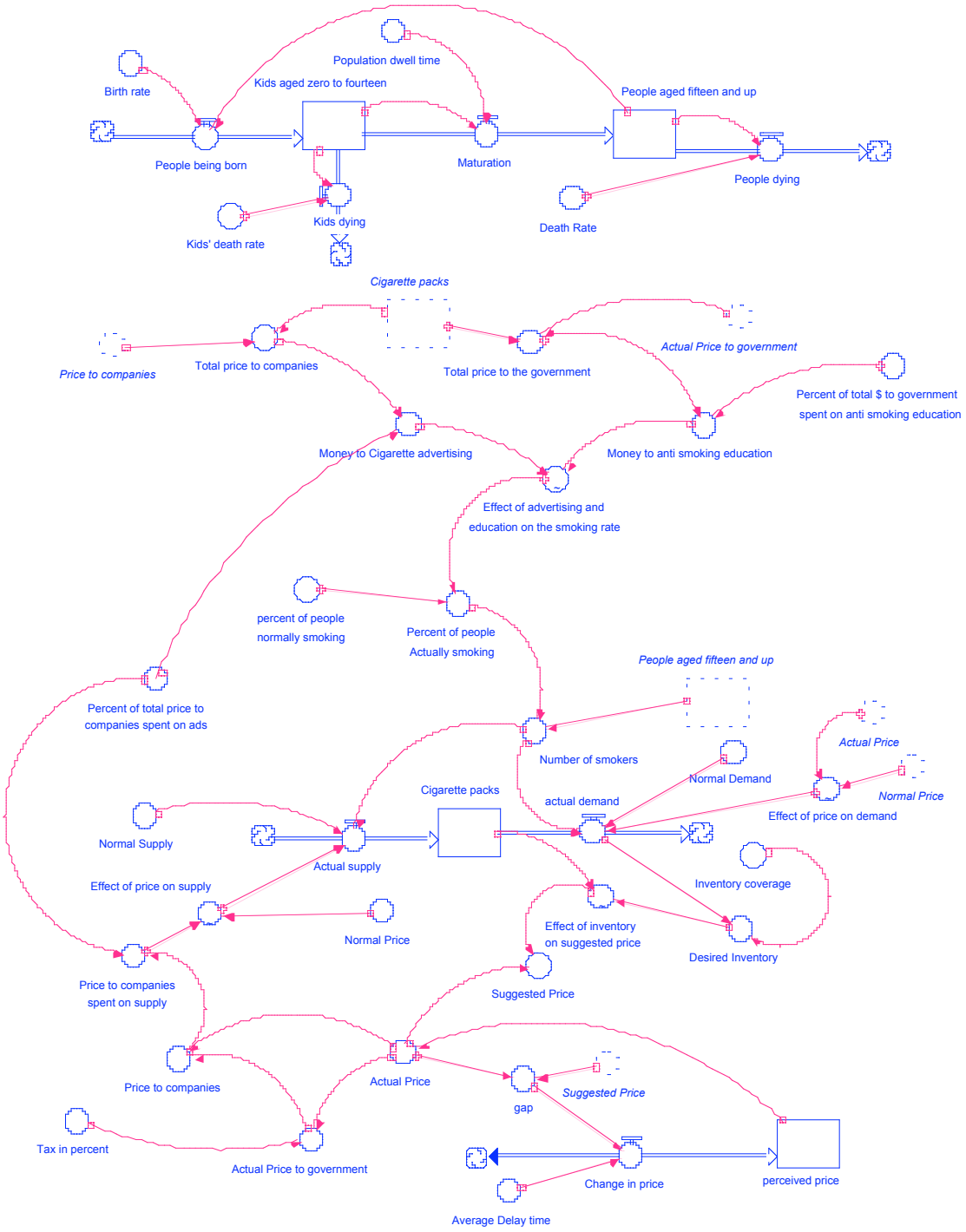

Figure 6: Smoking Model, Final Version

The Model Feedback & Loop Story

The essence of my model is to explain that the number of smokers will go up or down depending on who has control of regulating the cigarette industry: the companies, or the government. To give the government this advantage, it will need to be reasonably aggressive with taxes to be able to spend more money on anti-smoking education than the companies can spend on advertising. These two different interests, from the government and from companies, can be seen in the feedback loops below.

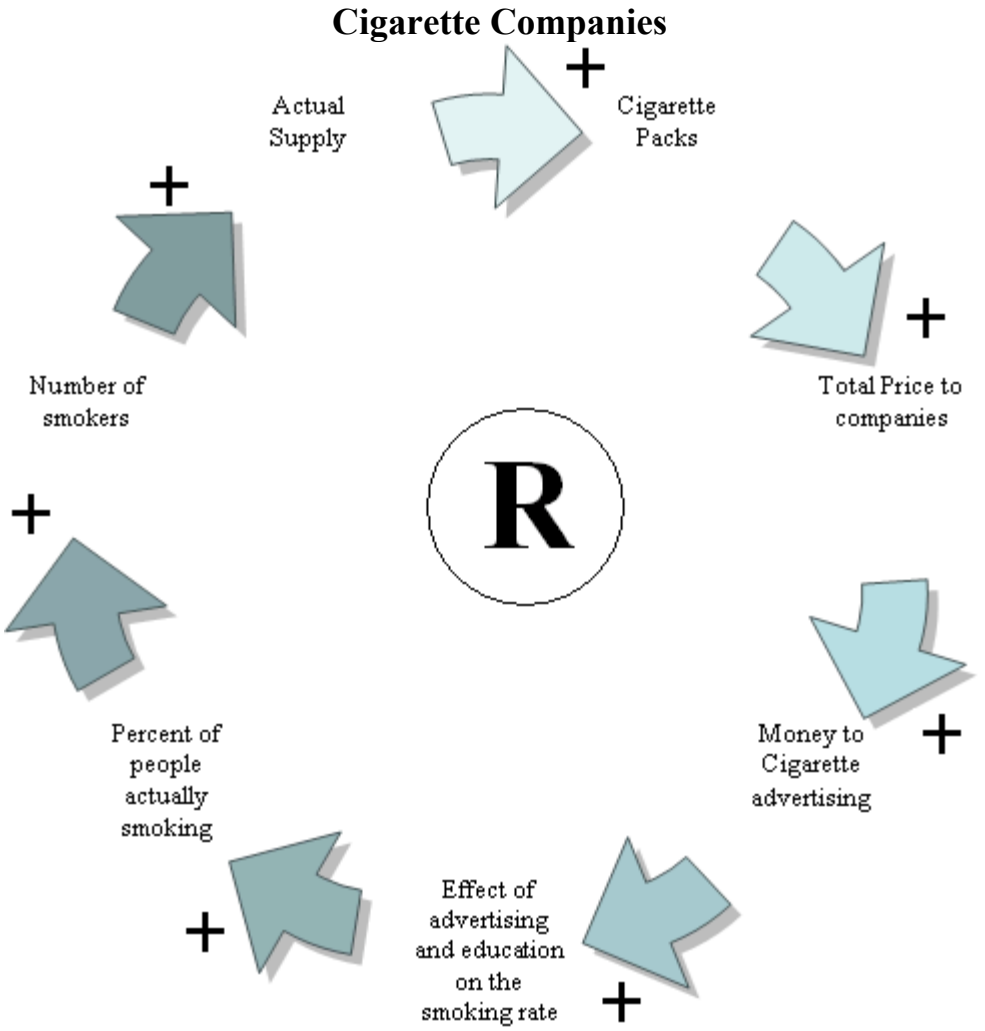

Figure 7: Cigarette Companies feedback loop

In the loop above, if the number of "cigarette packs" sold per year increases, it increases the "total price to companies", which increases the "money to cigarette advertising", which increases the "effect of advertising and education on the smoking rate", which increases the "percent of people actually smoking", which increases the "number of smokers", which increases the "actual supply", which increases the "cigarette packs." This increasing behavior can easily be identified as reinforcing, and if the government did little to intervene, the number of smokers would increase itself drastically. This would

increase both the supply and demand for cigarettes, making the selling of cigarettes a much bigger industry.

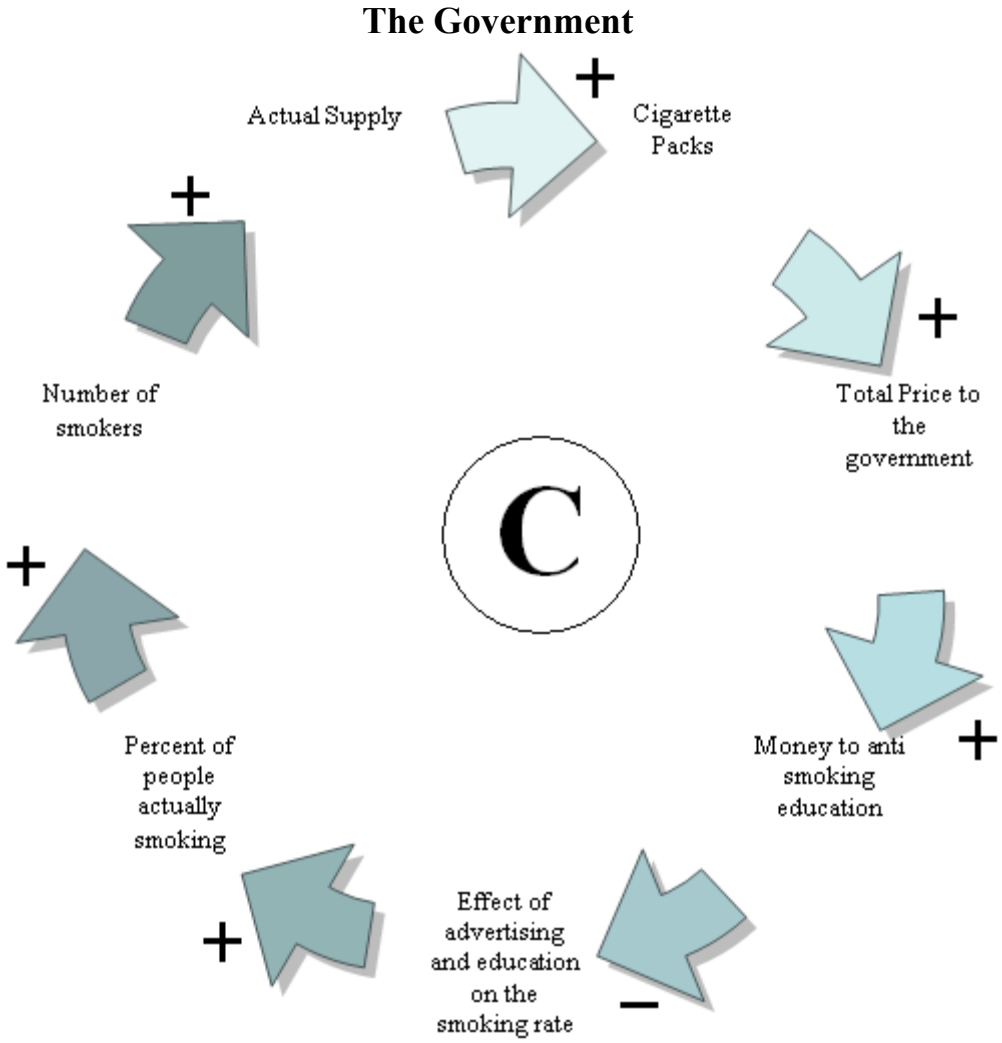

Figure 8: The Government feedback loop

In the loop above, if the number of cigarette packs sold per year increases, it increases the "total price to the government", which increases the "money to anti-smoking education", which decreases the "effect of advertising and education on the smoking rate", which decreases the "percent of people actually smoking", which decreases the "number of smokers", which decreases the "actual supply", which decreases the "cigarette packs." This behavior can be identified as counteracting, for as the "cigarette packs" increases, it actually decreases itself through the loop. This loop symbolizes that the government can fight off the negative effects of cigarette advertising, and more importantly, the government will have more money to fight off the smoking problem as it increases. This beneficial endogenous behavior can only happen with the assistance of an exogenous input, like an act that would increase the taxes on cigarettes. With a high enough tax lowering the smoking rate, the supply and demand for cigarettes would lower as well.

The Model Boundaries

The most important factors left out of the model were the other "effects" that could increase or decrease the "percent of people actually smoking." Peer pressure, medical discoveries, and social/cultural traditions cannot be modeled easily, and because of this the trend of the model may be slightly unrealistic. The model still serves its main purpose, however: it shows that the government must tax and educate to effectively reduce the smoking rate in a "companies versus government" scenario. A few other factors were left out as well, such as the increased death rate for smokers, due to time restraints.

I decided to run the model for about 20 years, starting from now (2009) and ending around 2030. This time spec was set for two major reasons: first, the majority of the data about smoking is accurate for today, so starting it now would be most realistic, and secondly, 20 years seemed like a controllable section of time where few exogenous entities could alter the model considerably.

Model Testing

While testing the model, I often altered exogenous factors, such as the "tax in percent", the "percent of total price to companies spent on ads", and the "percent of total $ to government spent on anti-smoking education." When these values were changed, the graphs altered correctly according to the trends described in the feedback loops above. In the end, the model agreed (more or less) with the behavior over time graph, but only if the government used a major increase to taxes and percent spent on education.

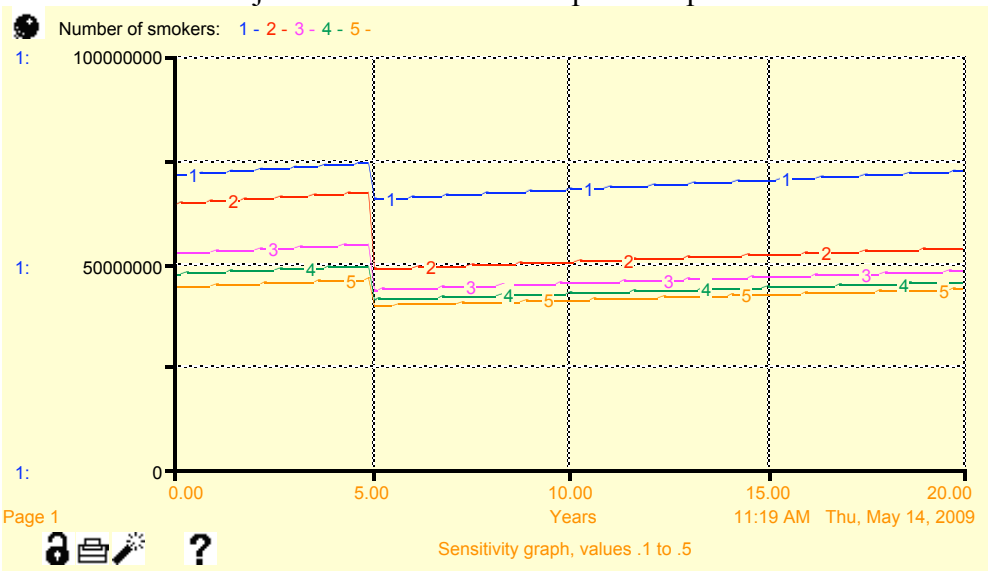

Figure 9: Graph of the number of smokers reducing with more government money spent on education

In the sensitivity analysis above, the "percent of total money to government spent on anti-smoking education" was altered from .1 to .5 (where .1=1, .2=2, etc) for a comparative analysis to see what happens with different money distribution. As it can be seen, a realistic change in behavior in the number of smokers occurs: though the number will

continually increase due to a population increase, as the government spends more on education, the number of smokers drops more and more.

The Results of Modeling and Thinking

One final graph, seen below, has two major exogenous actions that need to be noted. After 5 years, the tax is increased from 24% to 40%, and after 10 years, the "percent of total money to government spent on anti-smoking education" increases from 10% to 20%. As you can see, each of these causes the smoking rate to drop significantly.

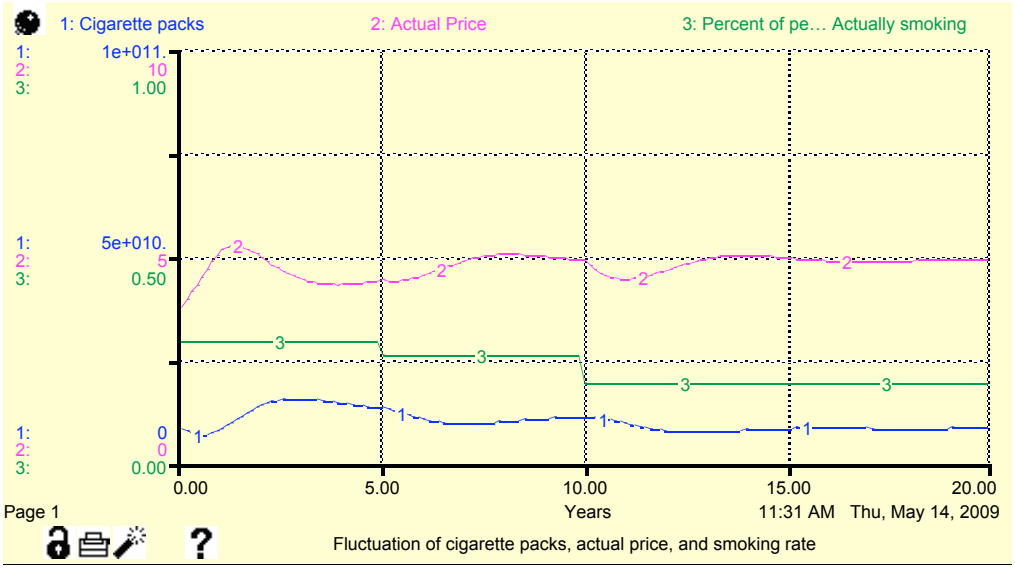

Figure 10: Graph of the fluctuation of cigarette packs, actual price, and smoking rate

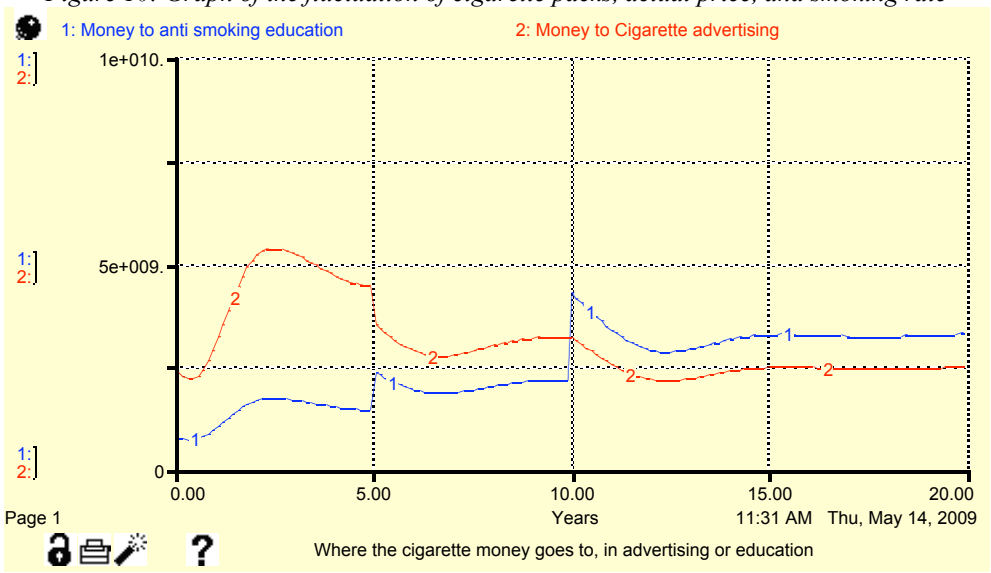

Figure 11: Graph of where the money goes to, in advertising or education

In the graph above, the desired result has been somewhat achieved: with government intervention, the percent of people actually smoking dropped from 29% to 19% after 20 years. In addition, the cost of cigarette packs (for consumers) has been kept fairly constant, avoiding public opposition to the new measures, and the flow of money (seen in

the graph in figure 11) has been completely altered, as more money was spent on education than advertising after about 10 years.

The Key Learning from the Modeling Process

Here is a list of statements about what I learned from the model:

- An increase in taxes, as well as increased spending towards education, greatly reduces the smoking rate.
- An increased tax would make the problem self-solving: as more people buy cigarettes, the government would have more money to spend towards anti-smoking education.
- An increased tax, though hurting the tobacco companies, would cause little change in the actual price, resulting in a less vocal public disapproval of taxes on the companies.
- Following my plan for increasing taxes and government spending towards education, the smoking rate could be greatly reduced in less than 20 years.
- Through the process of modeling, I feel much more comfortable with understanding how to analyze and solve realistic problems.

In conclusion, raising taxes from 24% to 40% in five years, as well as increasing the amount of government money spent on anti-smoking education by 10% would greatly reduce the smoking rate while gaining the approval from the public. In addition, this solution would help protect against future increases in smoking rates, for the taxes would increase education spending, make the system self-solving.

This model could be amended to solve other ideas easily: if other, malicious products (such as alcohol, or possibly marijuana (if it became legal)) were becoming a major problem, the same system could be used. The only differences would be in the titling and values of a few parts (such as the "cigarettes packs" stock being changed to "gallons of alcohol," or something similar), and the taxes might be different depending on the scenario.

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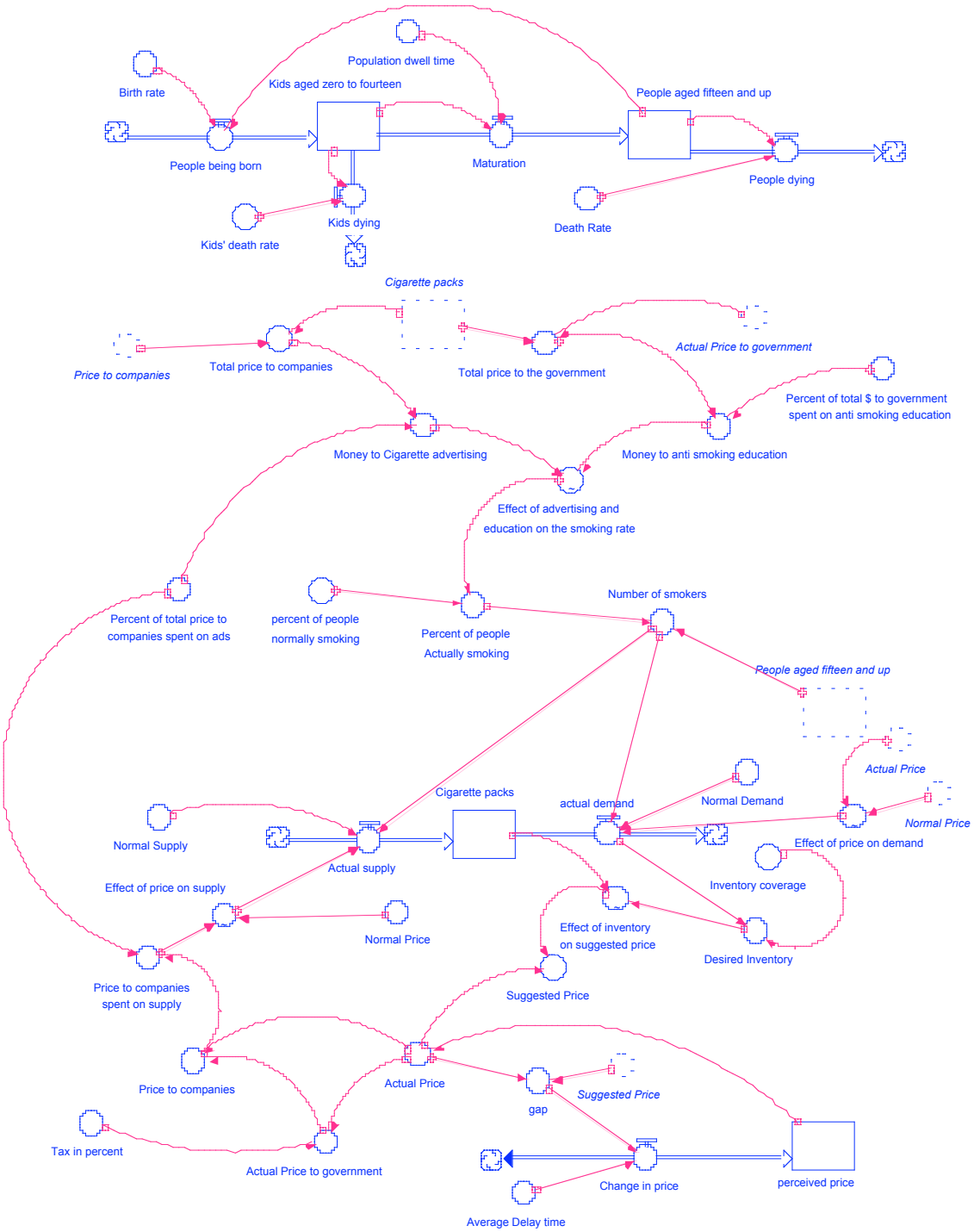
Appendix

EQUATIONS - Omitted

FULL MODEL DIAGRAM



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