



# *The SimSmoke* Model of Tobacco Control Policies

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**Pacific Institute for Research and  
Evaluation**

**Presentation to Health Economics  
Workshop**

## ***SimSmoke* History**

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Originally, computer simulation model of tobacco control policies for the US started in 1998

Models developed for Arizona, California, KY, MASS, and NY, and for Albania, Argentina, China, France, Japan, Korea, Malaysia, Poland, Taiwan, Thailand, Vietnam and 15 others related to FCTC.

# **What is SimSmoke?**

**SimSmoke simulates the dynamics of smoking use and smoking-attributed deaths in a State or Nation, and the effects of policies on those outcomes.**

**Compartmental (macro) model with smokers, ex-smokers and never smokers through time**

**Focus on policies**

**Effects vary depending on the way the policy is implemented and on demographics**

**Dynamic, nonlinear and interactive effects**

**Deterministic uni-casual model with sensitivity analysis**

# Basic Approach



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**Policy  
Changes**



**Cigarette  
Use**



**Smoking-  
Attributable  
Deaths**

**Norms,  
Attitudes,  
Opportunities**

***Ex- and current  
Smokers,  
relative risks***



# Overview of Literature and System-wide Approach

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**Relationship between policies based on:**

- **Evidence from tobacco and other literatures,**
- **Theories (Economics, Sociology, Psych, Epidemiology, etc), and**
- **Advise by a multidisciplinary expert panel**

*Need to understand the variation in results across studies*



# Basic Structure of Model

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- Population model begins with initial year population (by age and gender) and moves through time (by year) with births and deaths (1<sup>st</sup> order discrete Markov process)
- Smoking model distinguishes population in never smokers, smokers, and ex-smokers and moves through time with initiation, cessation and relapse (Markov)
- Smoking-attributable deaths depend on smoking rates and RRs
- Policy modules- one for each policy with interdependent effects on smoking rates



# Population Model: Evolution of Population

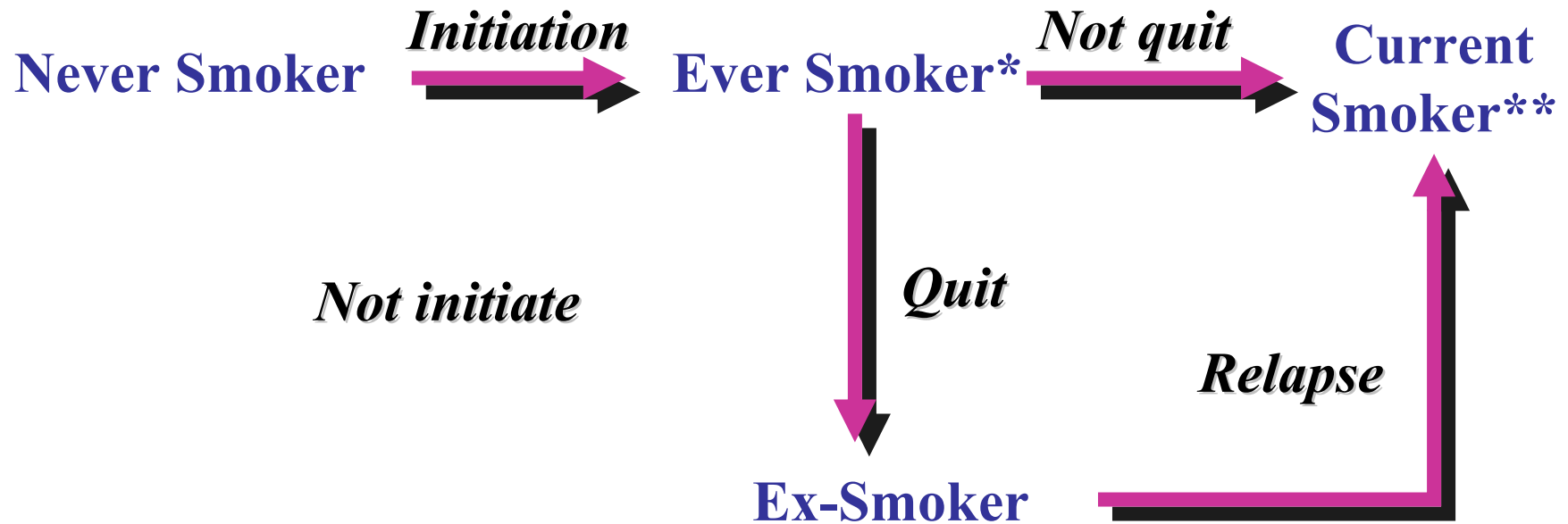
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- Start with the Population in the *base year*, first year of the model
- Distinguished by age and gender
- Evolves through time:



Some models incorporate migration, immigration

# Smoking Model: Evolution of Smokers





# Smoking model (structure)

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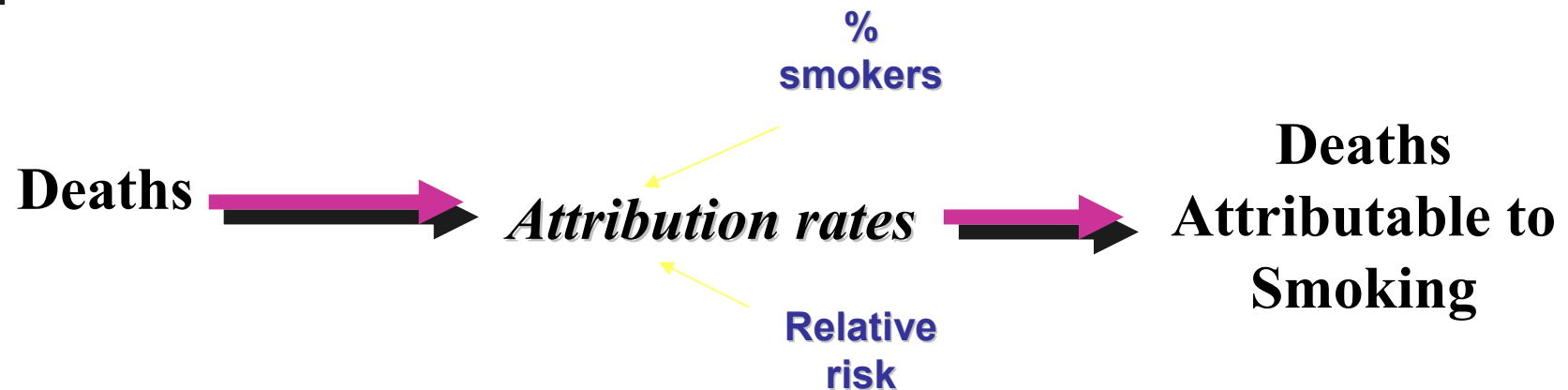
- Basic Model
  - Stocks: never smokers, smokers, ex-smokers (by year since quit)
  - Flows: initiation, cessation, relapse
  - Populations: by age and gender
- Data
  - The US and state models use smoking data for 1993 based on large scale (100,000 obs) survey (TUS-CPS).

# Smoking Model :Definitions of Variables



- Established smokers- *Smoked 100 cigarettes lifetime, smoked some or all days (distinguish quantity and some/every day smokers in some models)*
- *Initiation- change in smoking prevalence through age 24 generally*
- *Cessation- Quit in the last years, but not last 3 months, distinguish quit attempts, treatment use and treatment success in some models*
- *Relapse- various sources*

# Smoking-Attributable Deaths



- ***Examines total deaths and by type (lung, COPD, heart and stroke)***
- ***Other work examining role of quantity and duration***



# Two approaches: total vs. parts

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- **Total = use overall morality and corresponding relative risks**
  
- **Parts:**
  - Lung cancer
  - COPD (emphysema, bronchitis)
  - Heart disease
  - Stroke
  - Other cancers (mouth, stomach)



# Magnitude of relative risks in model

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- **Total: US RR= 2, varies by age, gender and years quit, based on CPS-2 and other studies.**
- **Lung cancer: US RR= 20-30, varies by age, gender and years quit, based on CPS-2 and other studies**



# Policy Modules

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- **Cigarette taxes**
- **Clean air laws**
- **Mass media/tobacco programs**
- **Youth access policies**
- **Education programs**
- **Cessation treatment**

**We also include warning labels and advertising bans for other nations**



# Policy Effects

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- In percentage terms relative to smoking rate ( $1+PR$ ),  $PR =$  percent reduction
- Initial impact on cessation through prevalence ( $1+PR$ ).  
*Based on studies*
- Maintained through initiation rates ( $1+PR$ ) and increased through cessation rates ( $1-PR$ )  
*Less known about these effects*
- Effects may differ by age and gender
- Effects depend on the way in which policy is implemented: level, degree of enforcement, publicity, other policies in effect, etc.

# TAXES



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**Substantial literature on the effects of taxes and price on smoking rates, with relatively consistent results. Larger effects on youth and for those with low incomes**

## **Prevalence elasticities vary by age:**

<b>Age 15–17</b>	<b>-0.6</b>
<b>Age 18–24</b>	<b>-0.3</b>
<b>Age 18–24</b>	<b>-0.2</b>
<b>Age &gt; 35</b>	<b>-0.1</b>



# Predictions

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- Policy effects depend on the size of the price increase relative to the initial price, and increase over time through the larger impact on youth as they disseminate through to adult population
- Issues:
  - Dynamic effects
    - Poor knowledge of direct effects on initiation, cessation and relapse
    - Prevalence seems to depend on quantity effects
  - Role of untaxed cigarettes, especially internet



# CLEAN INDOOR AIR LAWS

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- Work site: many studies on private restrictions that are somewhat consistent, but do not consider other policies. Less research on clean air laws, with less clear effects. Effects depend on restrictiveness of the policy
- Public places: weak evidence, limited ability to distinguish the effects
  - Restaurants and bars
  - Schools
  - Other places— public transit, shopping areas, enclosed arenas

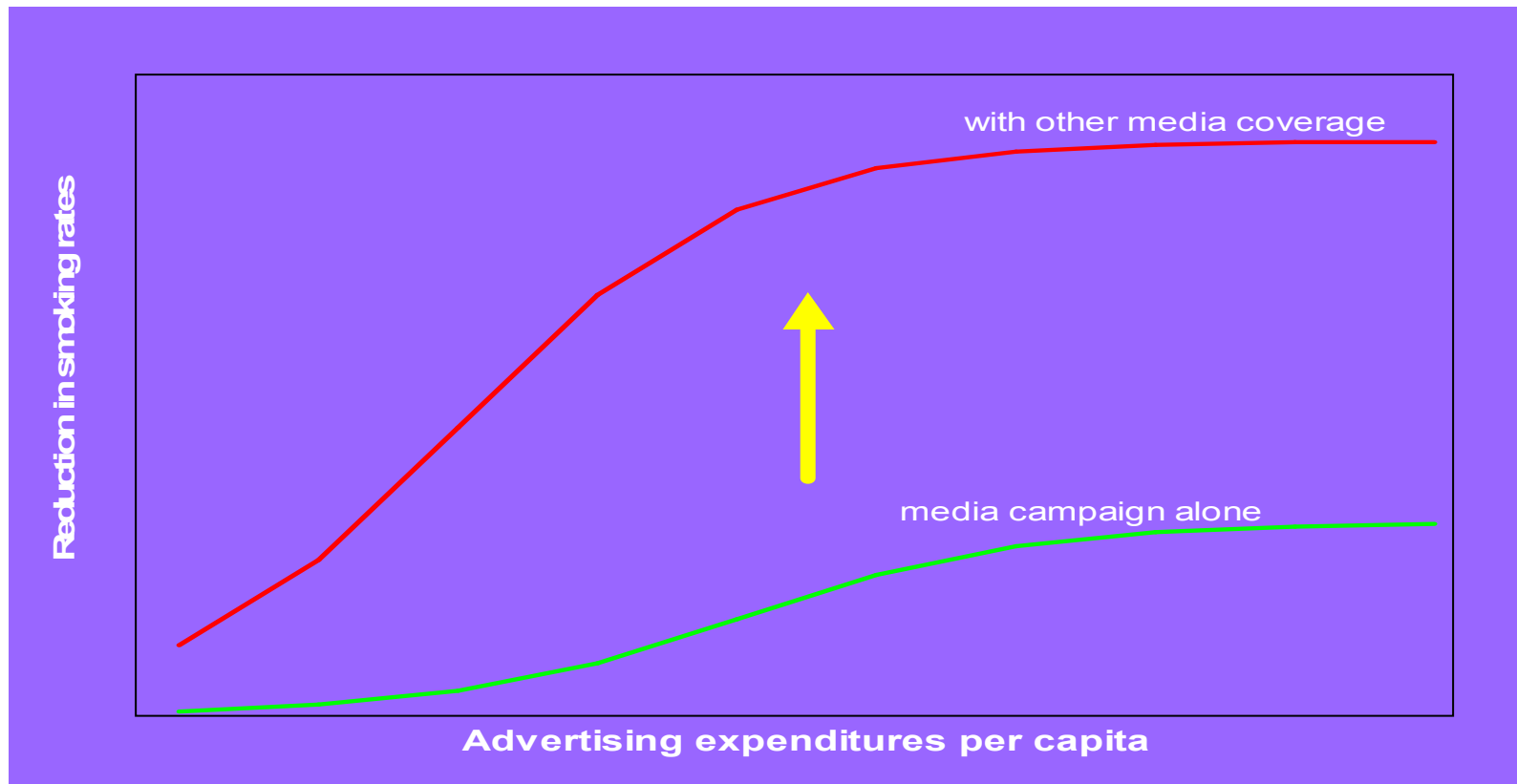


# Effects of Clean Air Laws

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- Effects on quantity at first and then cessation, through
  - opportunities to smoke
  - Social norms
- Depends on age and gender for worksite laws (labor participation, indoors vs outdoors)
- Depends on the extent of laws and loopholes (partial, total, ventilation, excluded businesses)
- Depends on private work restrictions already in place
- Depends on enforcement and publicity

# Effect of Media / Campaigns





# **YOUTH ACCESS POLICY**

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- **Enforcement of laws that affect retail sales to youth**
- **Past literature suggests youth access policies lead to increased retail compliance.**
- **Effects on actual smoking rates are at best unclear. Two potential reasons:**
  - **Role of non-retail sources of cigarettes (parents, older friends, theft)**
  - **Level and types of policies used to affect sales**



# Sources of Cigarettes for Youth in the US

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- Retail sales: in store (49%)
  - Behind-the-Counter (40%)
  - Self-Service (60%)
- Vending machine sales (3%)
- Theft (5%)
  - Only through self-service in the model
- Other sources (non-retail, including parents and older peers) (49%)

Suggests importance of substitution to non-retail sources if retail sales cut off.



# Model's Youth Access Policies

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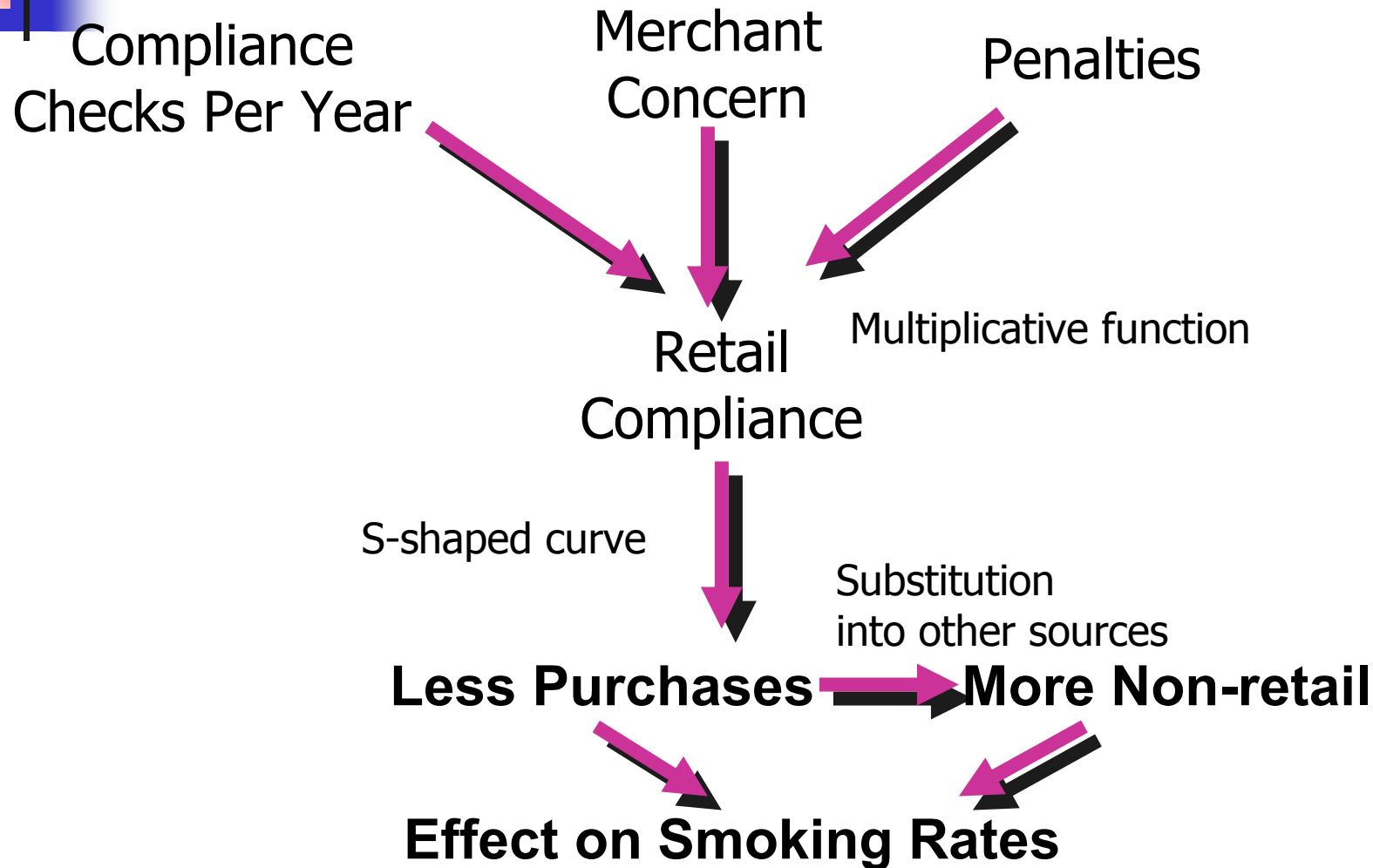
## Retail Compliance Policies:

- Compliance checks with repeat checks
- Significant penalties that are enforced
- Merchant Concern: merchant awareness and community mobilization

*Policy effectiveness depends upon extent of checks, penalties, and merchant concern*

Vending Machine and Self-Service Bans  
(reduces advertising and theft)

# Policies Affecting Retail Compliance



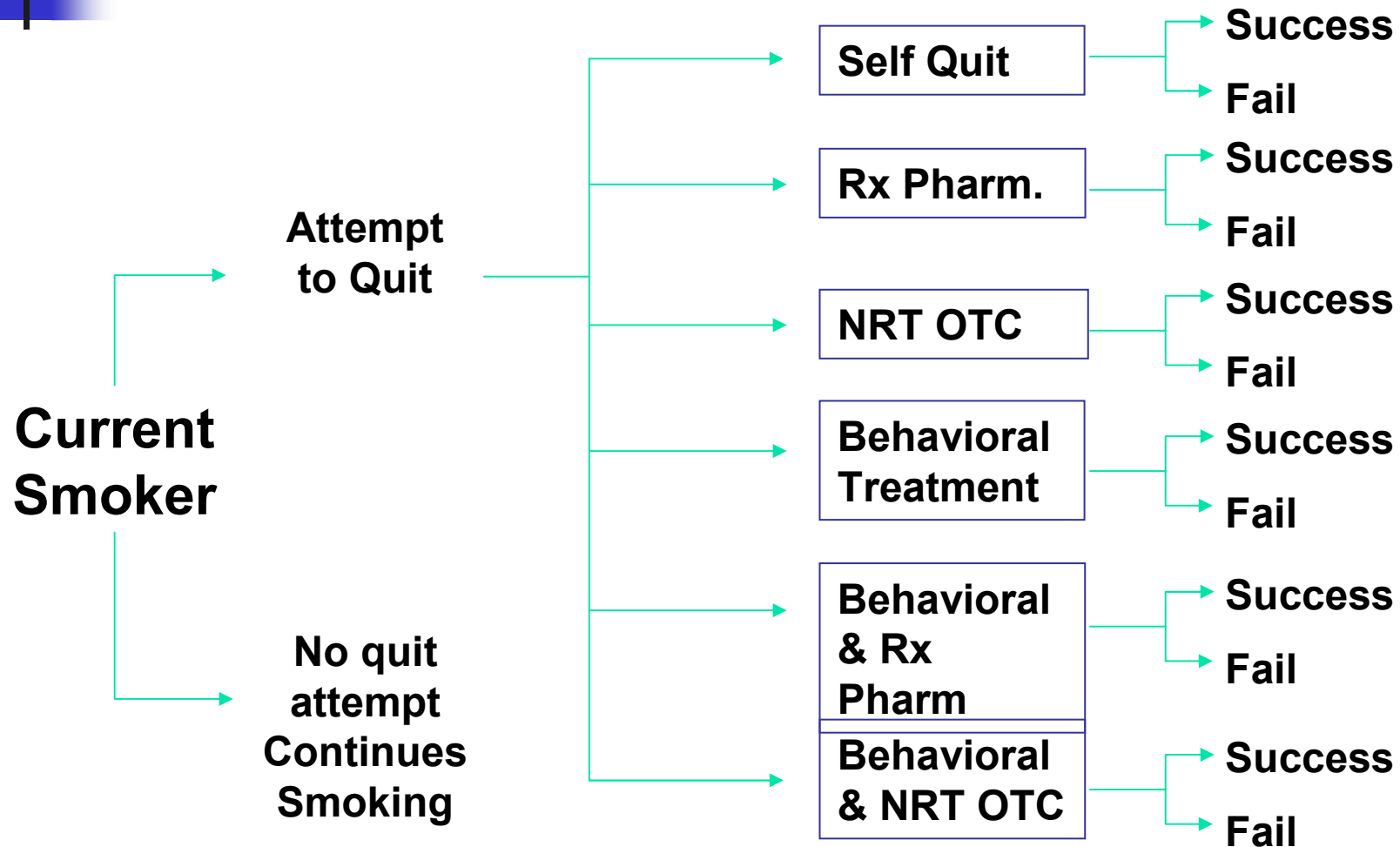
# Cessation Treatment Policies



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- **TREATMENT COVERAGE:** payment or mandatory coverage for cessation treatments
  - Prescription or OTC pharmacotherapies alone
  - Behavioral treatment alone
  - Pharmacotherapies and/or behavioral
- **QUITLINES:** delivered by government and coordinated through health care system
- **BRIEF INTERVENTIONS:** delivered by health care provider, focuses on decision to quit, but could aid in choice of treatment, recently extended to consider systems integration, tailored treatments, web-based treatments, etc.

# Cessation Module Structure: Quit Decision



# Model of Cessation Treatment Policies



- **Begins with the decision theoretic model of quit attempt and quit success (which depends on treatment use)**
- **Policies may affect quit attempts or quit success**
- Interdependence of policies: Some policies may encourage others, e.g., brief interventions or quitlines may encourage more effective treatment use, e.g. quitlines with free NRT
- Substitution: Policies are assumed to about double use, but some new users of a treatment or combination of treatments formerly use a different treatment or combination of treatments
- Diminishing returns: New users who pay a lower price or previous users may have a lower likelihood of successful treatment (lower inclination to quit, less suited to the treatment, More hard core or failed in past)



# Past vs. Future

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- **Tracking Period-** starts from year where requisite data available = 1993, and continues to most recent year = 2008
  - Can be use to calibrate (adjust parameters) the model
  - Can be used to validate (test) the model
  - Examine the role of past policies
- **Future Projection-** examine the effect of policies from current year forward, starts from 2009

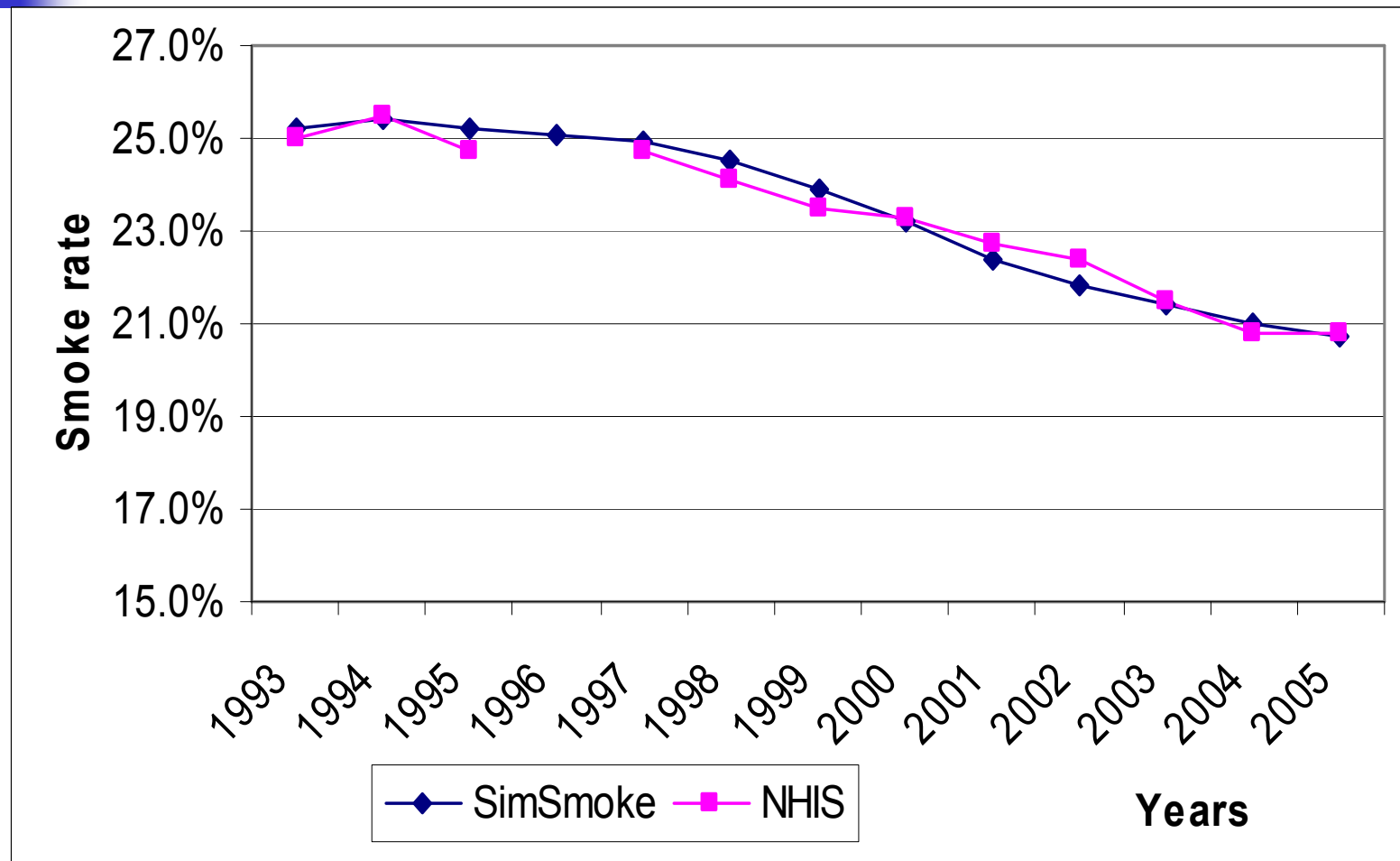


# **Justification for the Model**

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- **Based on past studies and expert panel, and publication of the model in peer reviewed journals.**
- **Benchmarked policy modules to studies of policies trying to explain variation in results**
- **VALIDATION OF THE MODEL**

# U.S. Model Validation: Smoking Prevalence





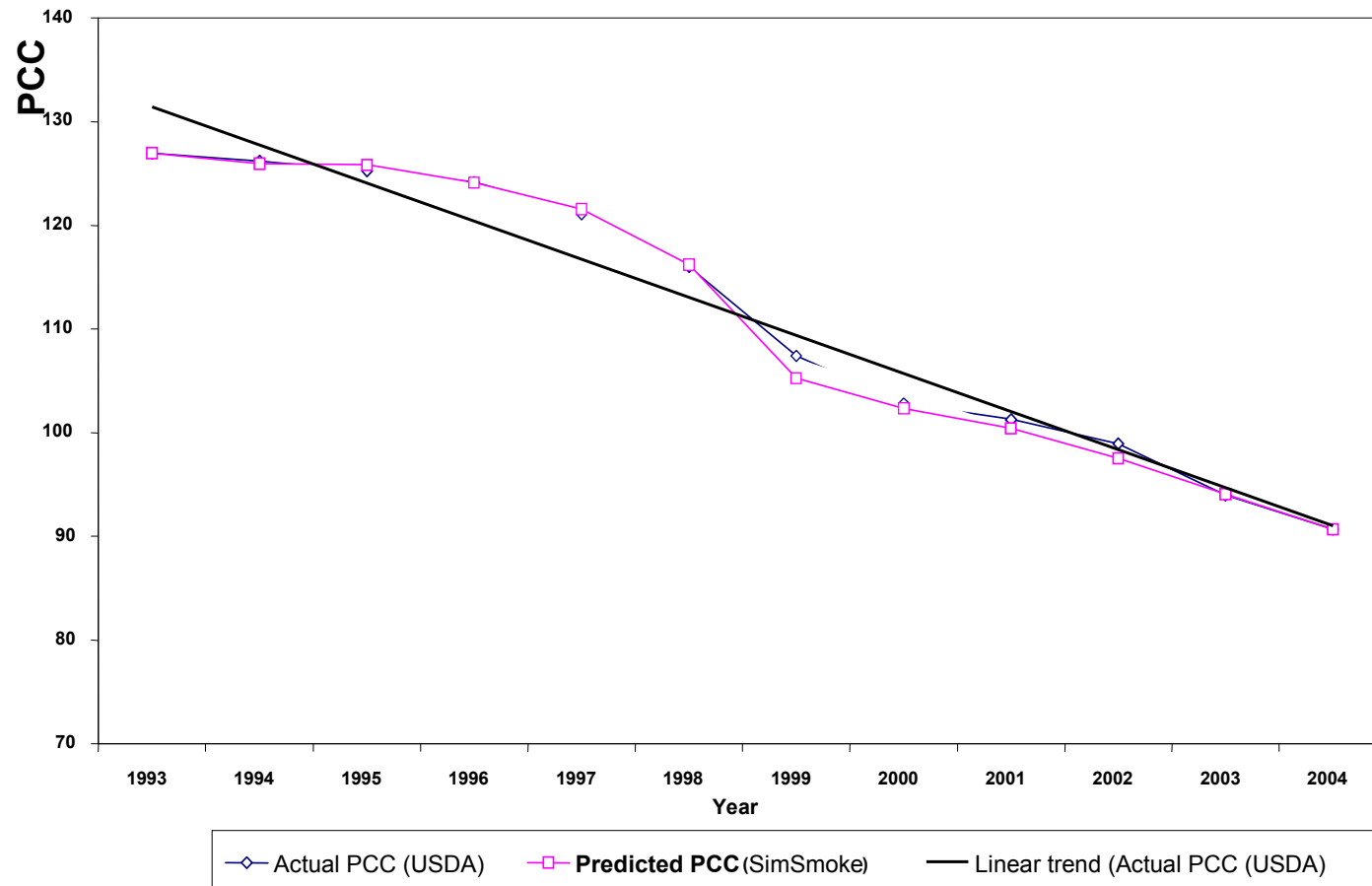
# Model Validation

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- **For overall adult smoking prevalence, predicts long term downward trend (in absolute and relative terms) and changes in trend well, although with deviations around the large price changes in 1998-9**
- **Does less well for some age groups, especially 18-24 year olds and seniors, under-predicts increase in youth smoking rates (1993-97) and decline since 1997**

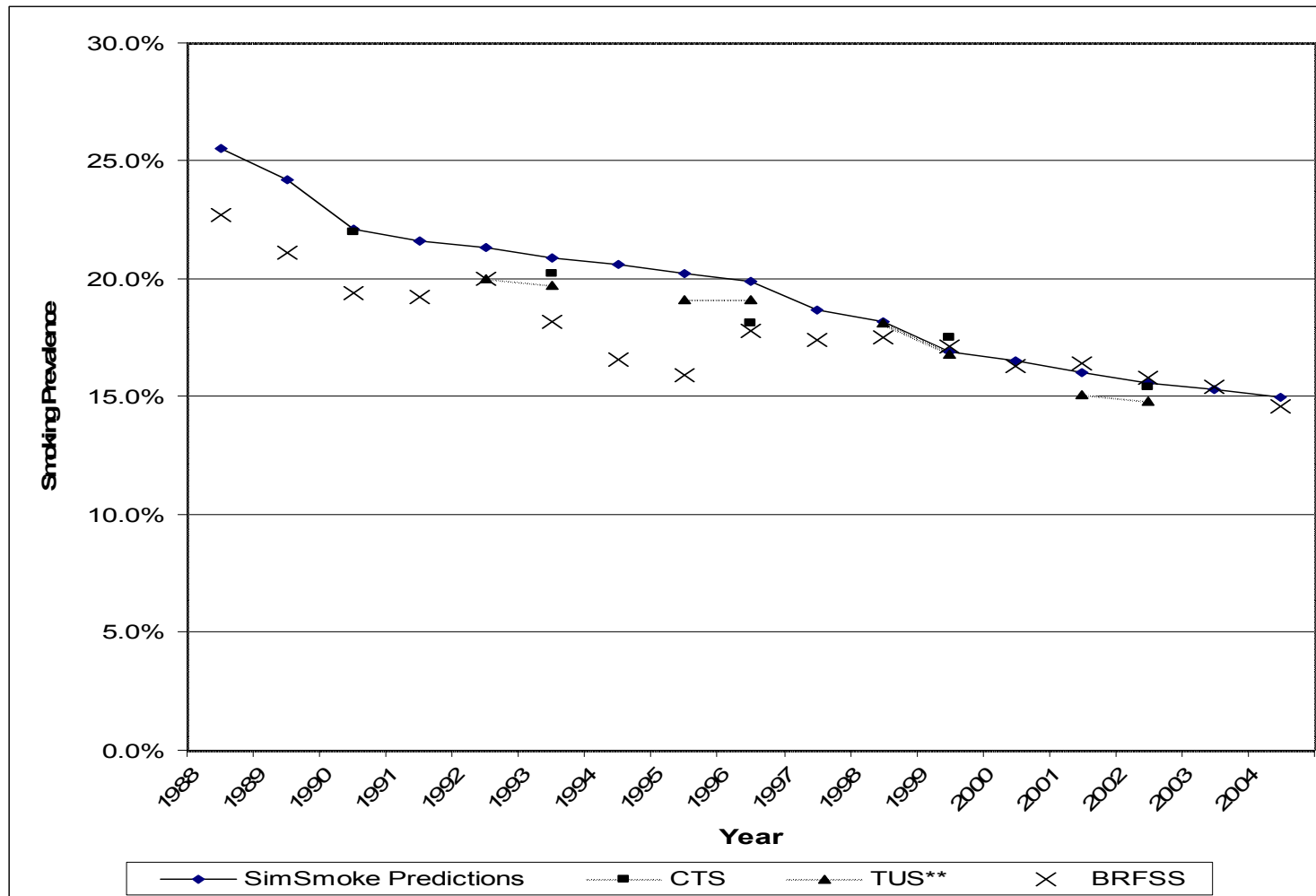
*Potentially important is the role of reductions in quantity smoked per smoker*

# Actual and Predicted Per Capita Consumption (PCC) with Trend Line

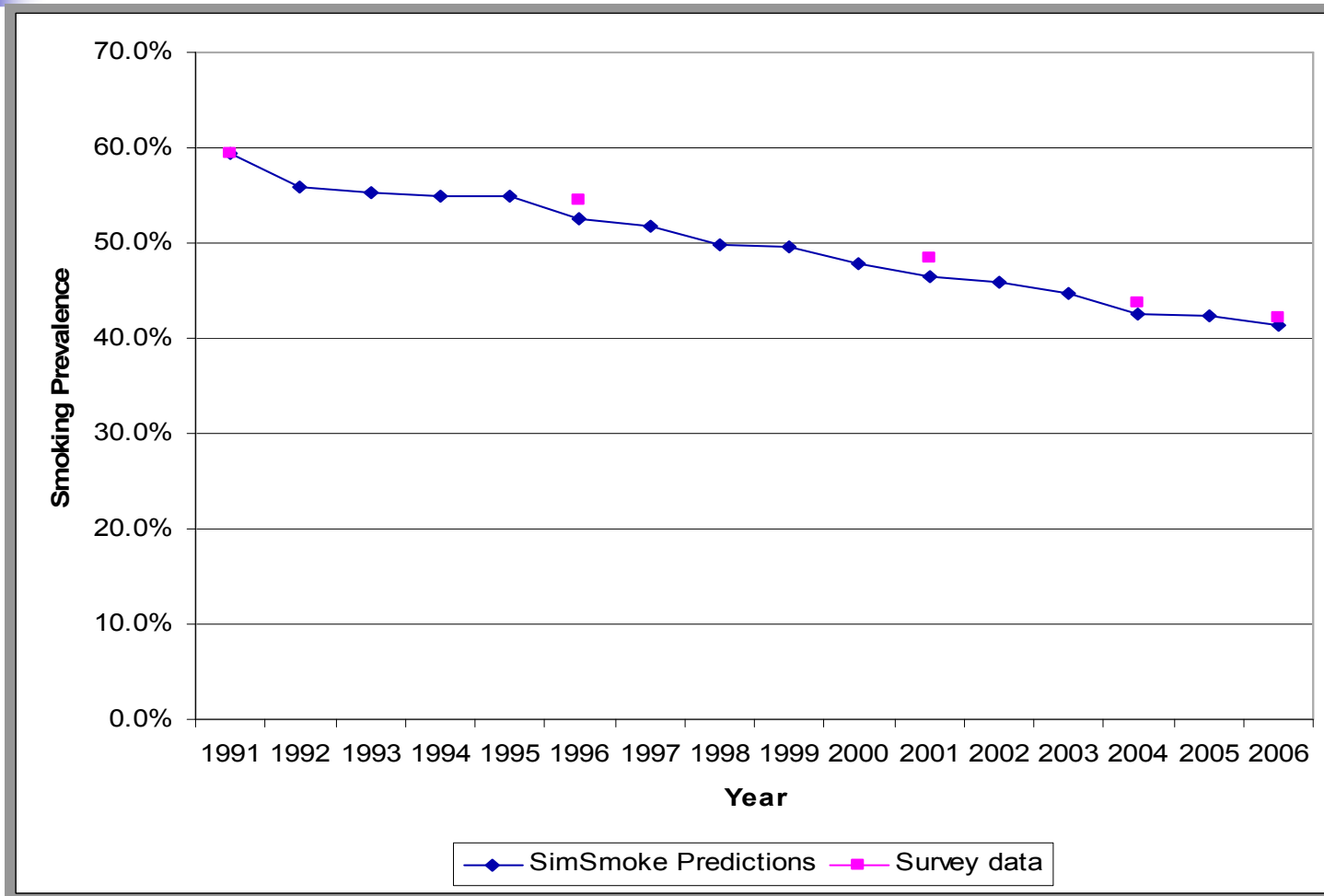


# California SimSmoke Predictions and Data Estimates of Adult (age 18+) Smoking Prevalence, 1988-2004.

## Smoking Prevalence, 1988-2004.



# Model Validation: Thailand Male Smoking Prevalence





# Validation for Thailand

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- **OVERALL: Predicts well**
- **BY SUB-PERIODS: The model over-predicts the relative decline during the 1991-1996 for males (may be due to industry price and non-price promotions). The model predicts well for 1996-2001, but under-predicts the decline for 2001-2003 (may be due to the Thai Health Foundation which acted as a watch guard for the enforcement of policies).**



# **Purposes of Model 1: Justification of Policies**

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- **Shows smoking rate and health impact in the absence of policy\_ the growth in smoking as younger people age, and the deaths caused.**
- **The potential effect of tobacco control policies**
  - **past**
  - **and future**

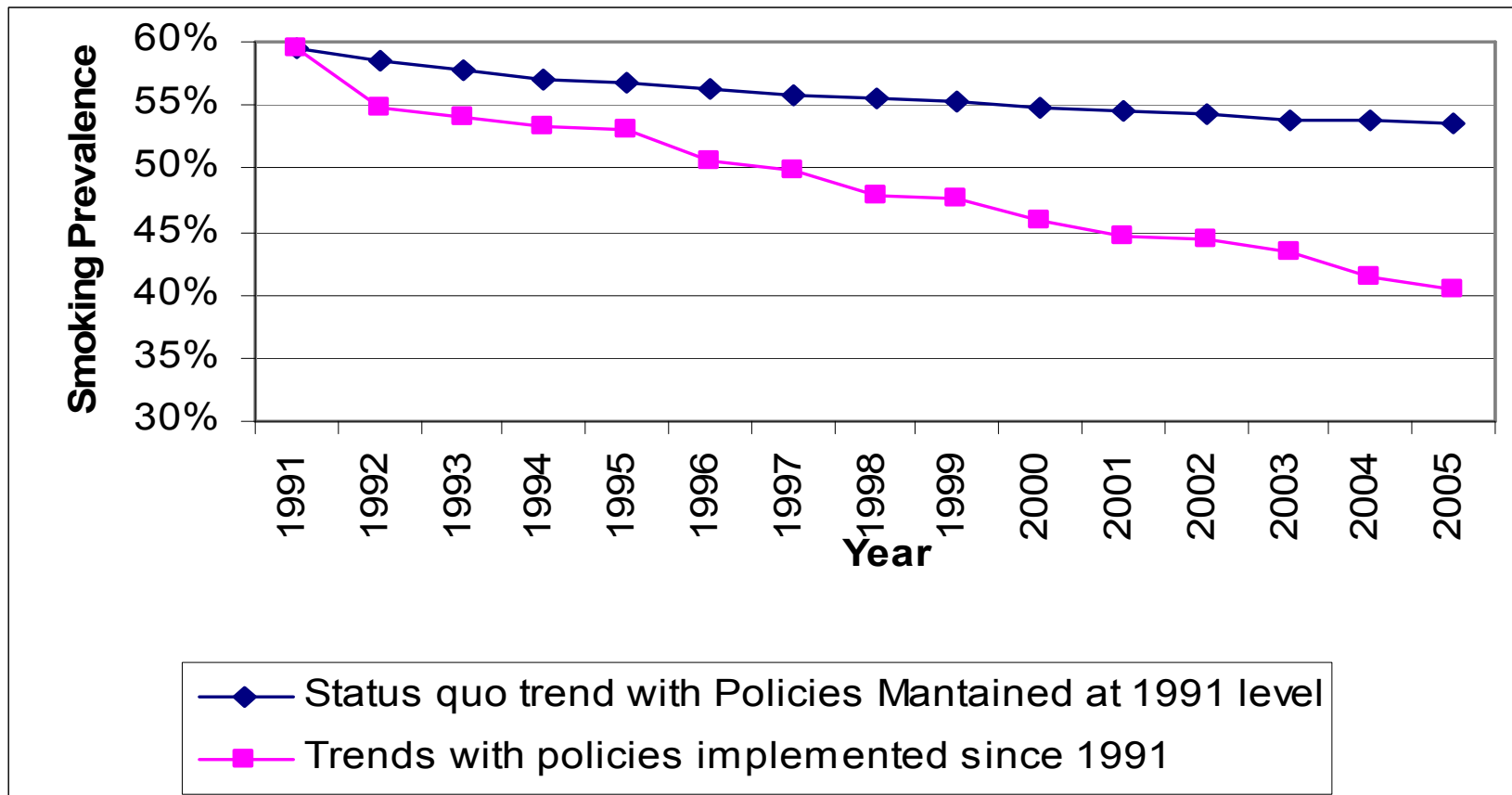


# Impact of past policies

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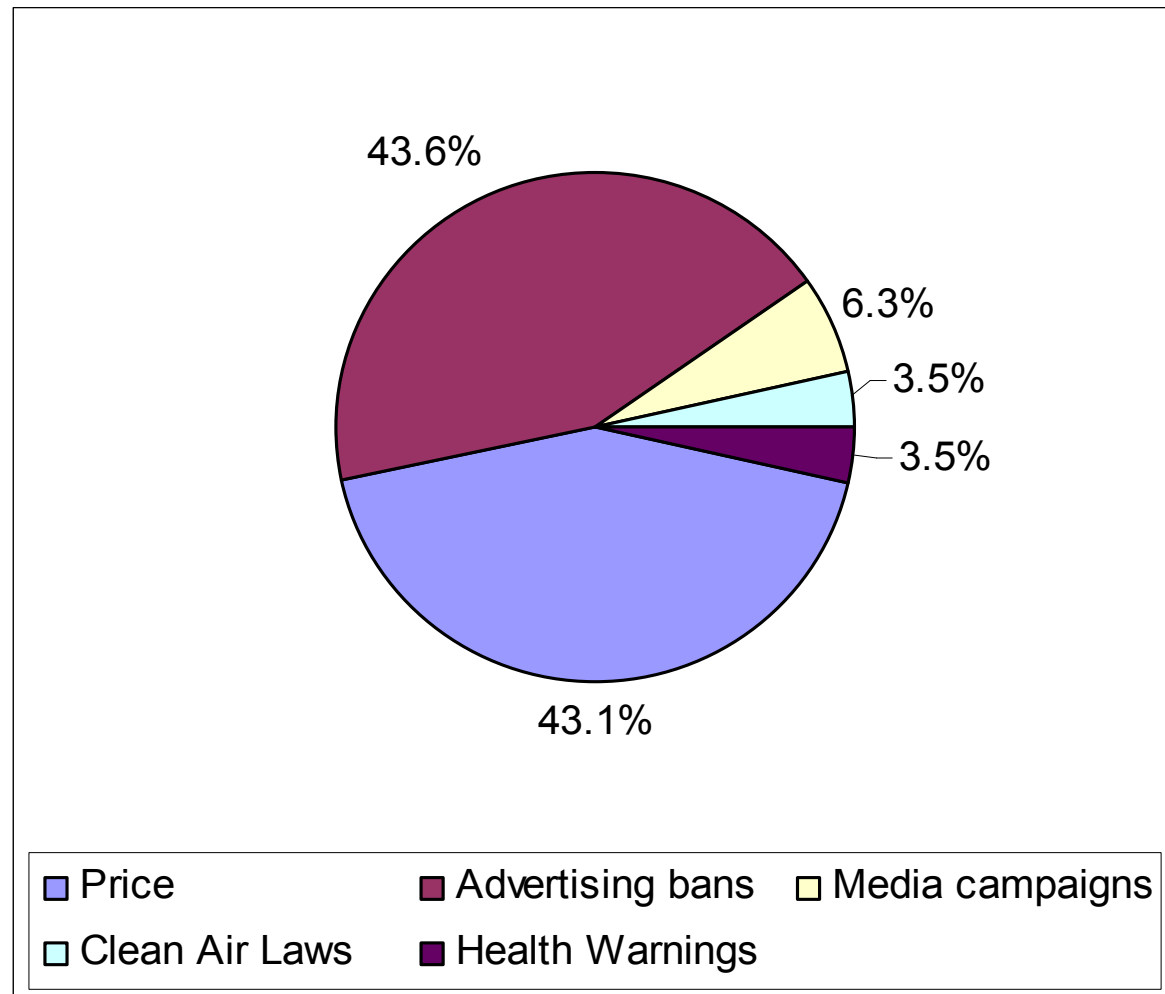
- Once policies are used and model is validated, can distinguish the role of tobacco control policies by setting policies to their pre-control levels
- In California and Arizona, we were able to show the effect of state tax hikes and comprehensive campaigns.

# Impact of Past Policies: Example Thailand Males

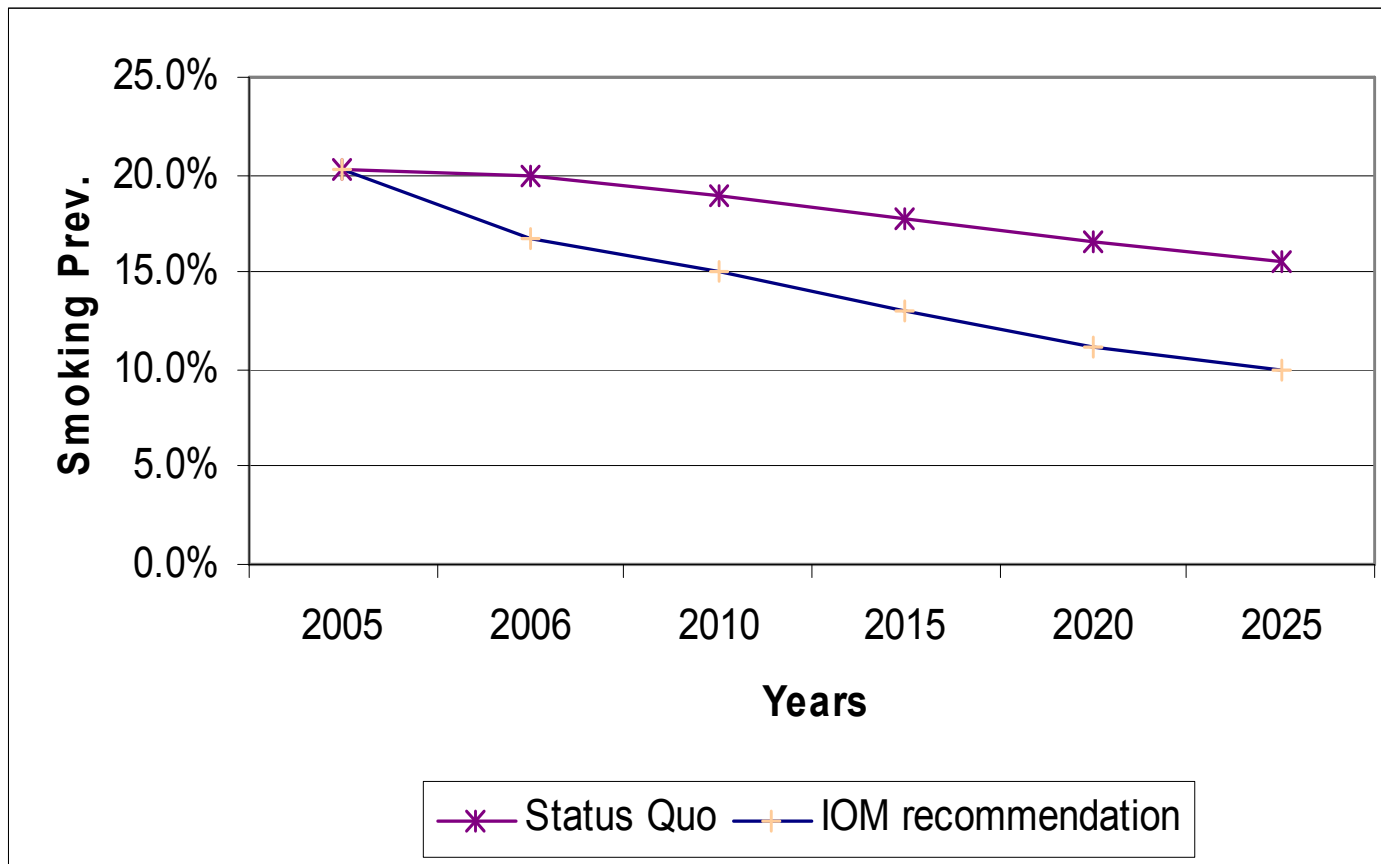


**Smoking prevalence was 25% less as a result of policies!**

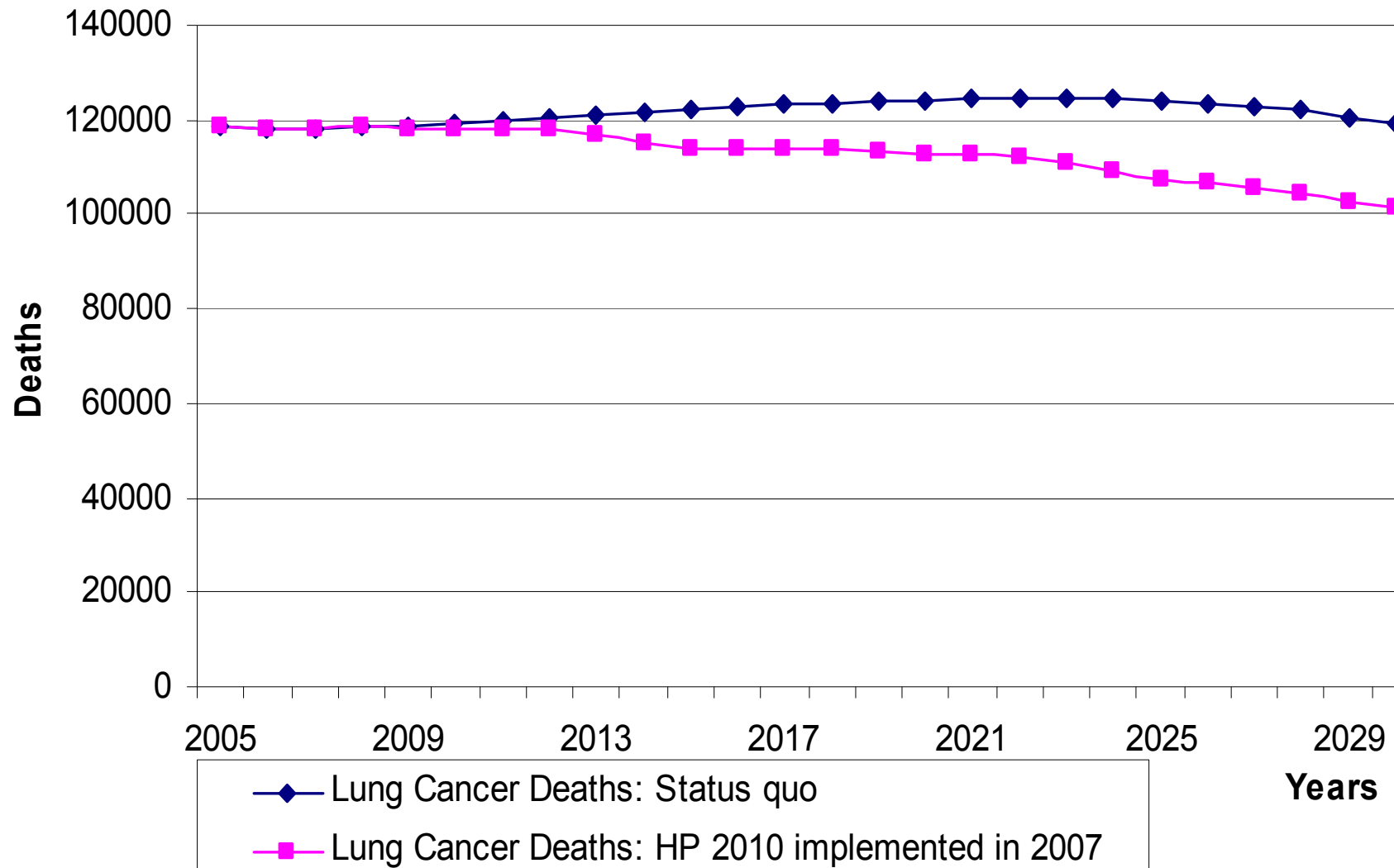
# The Impact of Specific Policies: Thailand Males by 2006



# Effects of Implementing IOM Recommendations on Smoking Prevalence



### Smoking-Attributable Lung Cancer Deaths: Status Quo vs. Health People 2010 Goals as Projected by SimSmoke





# Healthy People 2010 goals

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- Focusing on states with high smoking rates, such as KY
  - Currently involved in dissemination project
- Special populations
  - Low SES
  - “Hard core” smokers



# Other nations

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- FCTC policies
  - Individually and combined
  - Not clearly defined
- MPOWER policies
  - Similar to FCTC
  - We have modeled about 75% of world pop covered

# Purpose 2: Prediction and Planning



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- **Demographics groups affected**
- **Individual policies**
- **How effects depend on implementation**
- **Combinations of policies**



# Model Use

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- Excel model: Easily modifiable and transferable. Based on previously developed C++ model.
- Transparent and easily adaptable by user, with constantly improving interface
- Easily Downloaded

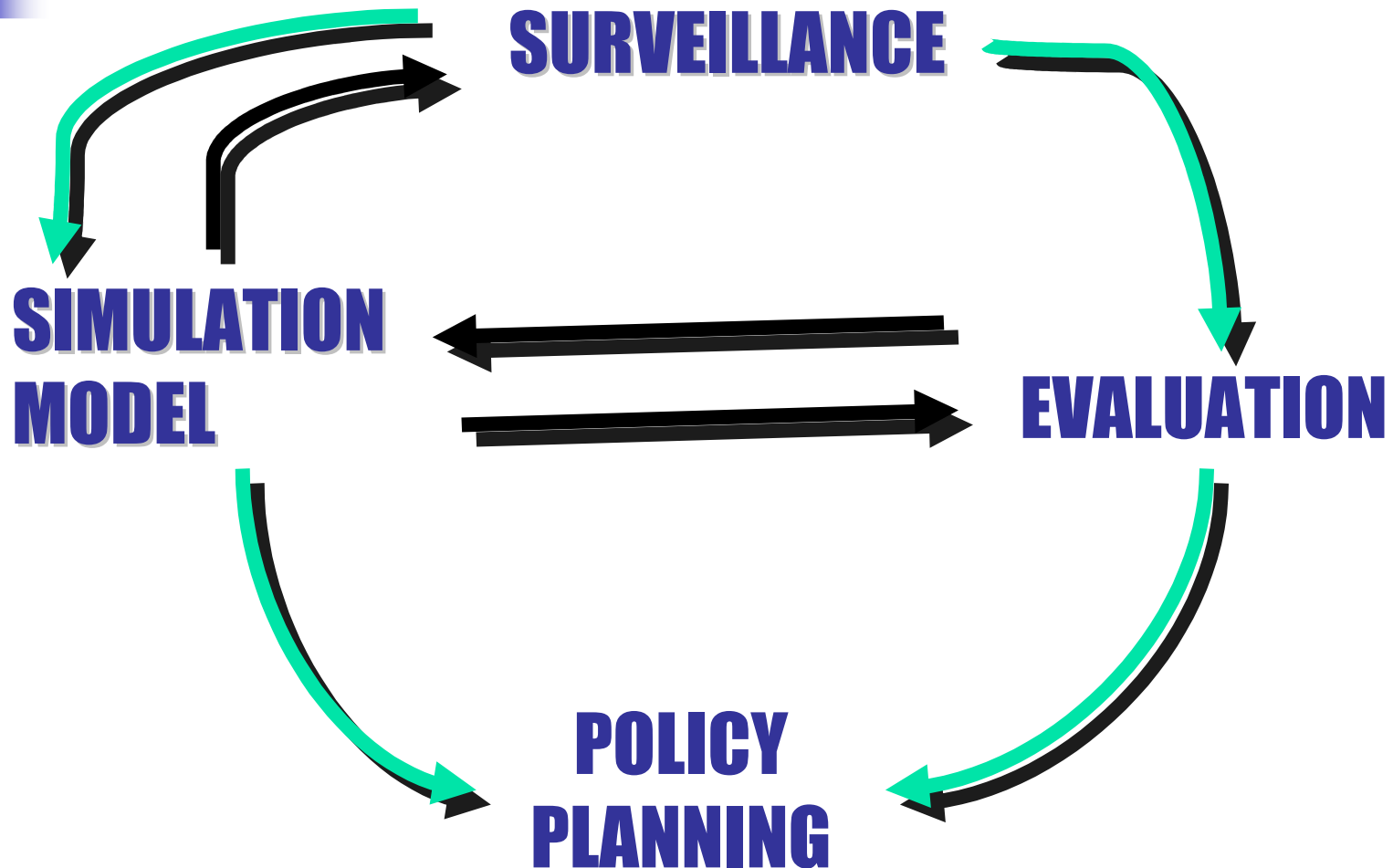


# Part of Surveillance/ Evaluation System

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- **Helps determine the data to be collected**
- **Design of evaluation methodology**
- **Evaluation of evaluation outcome**
- **Revision of parameter estimates in planning system**
- **Development of new policies**

# Dynamic Process





# Purpose 3: Heuristic

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**Understanding policies and their effects as part of a larger dynamic, system:**

- **Academic: helps guide research**
  - Variation in effects over time
  - Nonlinearities
  - Interactive effects, and
  - Varying demographic effects (especially age)
- **Applied: helps understand and evaluate successful policies (format made transparent)**