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Population Impact Model

Population Model to Estimate Health Effects of Launching a NGP in a Market
Illustrated with e-cigarettes and all-cause mortality rates in the UK

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Population Impact Model



- Introduction
- System Dynamics
- Population Impact Model structure and inputs
- Case study: e-cigarettes in the UK



Population Modeling

Introduction



FDA Modified Risk Tobacco Product Application

- › The relative health risks the modified risk tobacco product present to individuals
- › The **increase or decrease likelihood** that existing tobacco product users who would stop otherwise stop using tobacco products **will switch to using the modified risk tobacco product**
- › The increase or decrease likelihood that **persons who do not use tobacco products will start using the modified risk tobacco product**

EU Tobacco Products Directive (TPD2)

- › Tobacco products: “member states should require manufacturers and importers to submit internal and external studies available to them on market research and **preferences of various consumer groups**, including young people and current smokers, relating to ingredients and emissions, as well as executive summaries of any market surveys they carry out when launching new products.”
- › Novel tobacco products: Above + “other available and relevant information, **including risk/benefit analysis** of the product, its expected effects on cessation of tobacco consumption and predicted consumer perception.”



Regulation

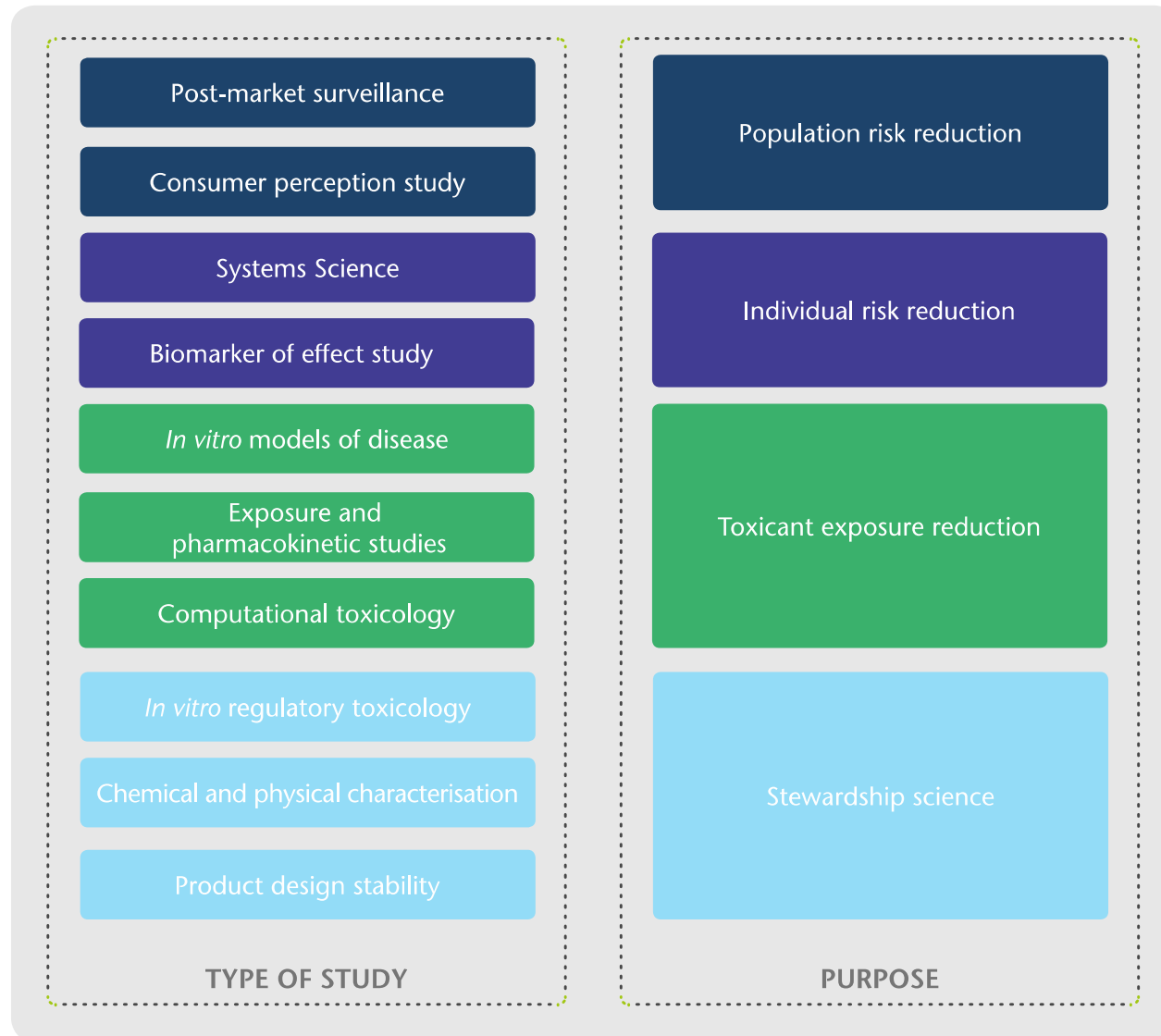
Introduction



- The “FDA encourages the development and application of innovative analytical methods to make preliminary estimates of the potential effects of some change in the marketplace
- To conduct analyses of various scenarios, including worst-case scenarios”



Framework to assess the risk reduction potential of tobacco & nicotine products





Tobacco Control and Product Assessment Models

Introduction



Two main groups of models :

- Aggregate (also called compartmental models)
- Microsimulations (which model at the individual level)



SYSTEM DYNAMICS



Use of System Dynamics Methodology For Tobacco Policy Assessment

System Dynamics



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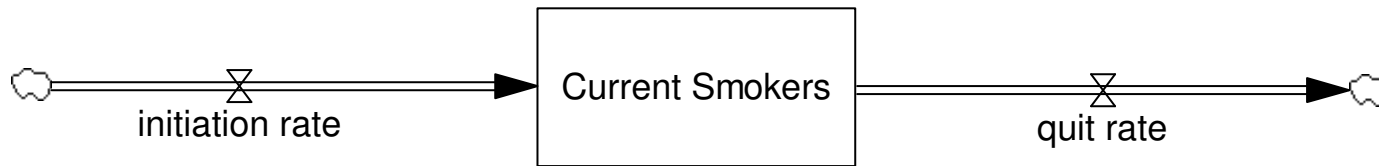
Previous System Dynamic models include:

- MIT Model (1982)
- Tobacco Policy Model (2005)
- SimSmoke (2006)
- ISIS Model (2007)
- New Zealand Tobacco Policy Model (2008)
- Preventions Impact Study Model (2008)



Stock and Flow Mathematics

System Dynamics



- Current Smokers is the '**stock**'
- Initiation and Quit Rate are the '**flows**'
- Flows change over time
- Rate of change

$$\frac{d(\text{Smokers})}{dt} = \text{initiation rate} - \text{quit rate}$$

- Accumulation of changes

$$\text{Smokers}(t) = \text{Smokers}(t - dt) + dt(\text{initiation rate} - \text{quit rate})$$



Why System Dynamics

System Dynamics



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- Widely used determining the long-term dynamics of population-level tobacco rates
- Provide a foundation upon which to identify system structures to determine mortality and assess potential impacts.
- Provide insight on key information feedbacks:
 - Reinforcing feedback between prevalence and initiation rate
 - Balancing feedback due to awareness of health consequences of smoking



POPULATION IMPACT MODEL



Qualitative Design

Population Impact Model

Specification to include

- Sub-Populations by Age and Gender
- Initiation Rates
- Quit Rates
- Relapse Rates
- Mortality Rates Never Smokers
- Smoking Relative Risks
- Net Migration

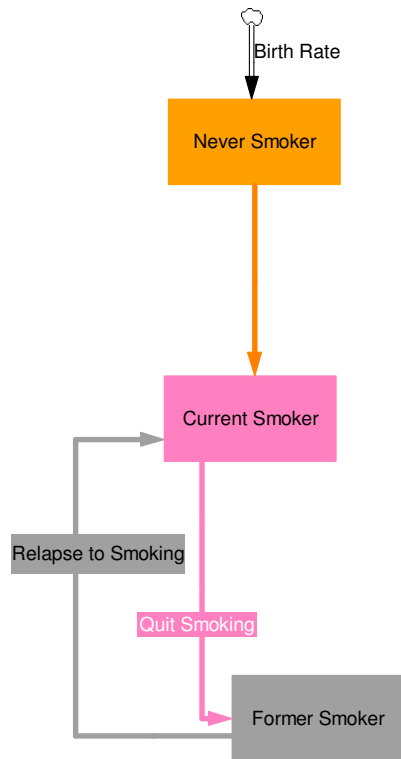


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Traditional Smoking Model

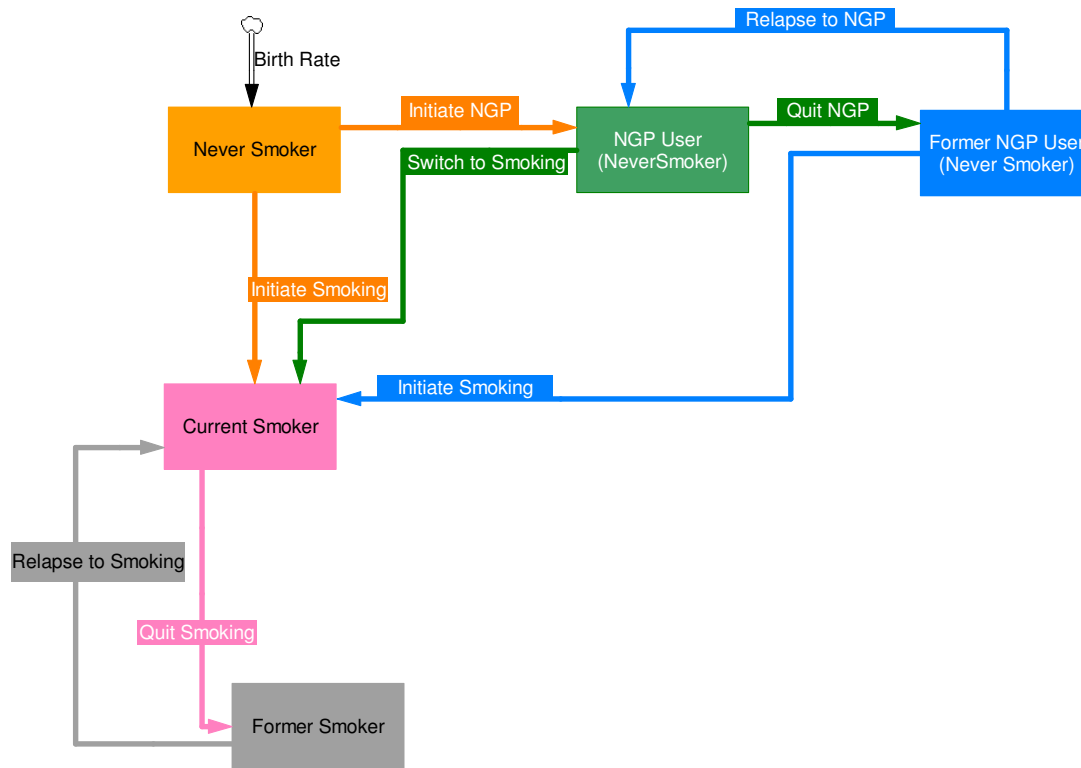
Population Impact Model





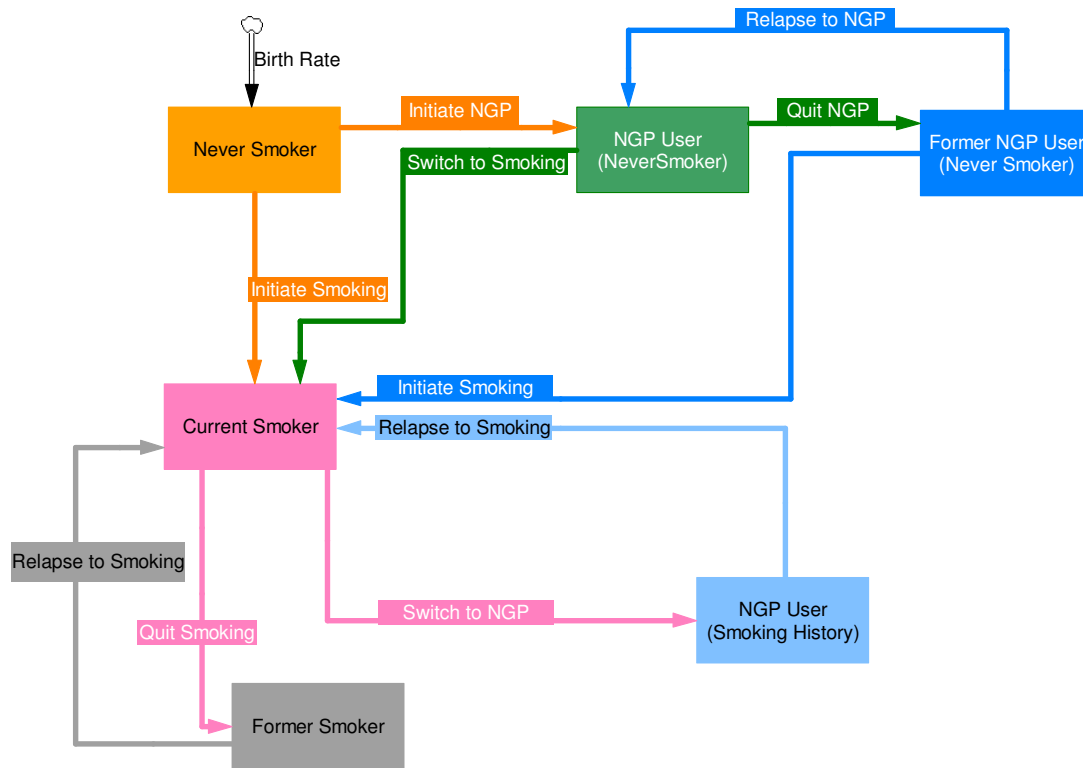
NGP Use by Never Smokers

Population Impact Model





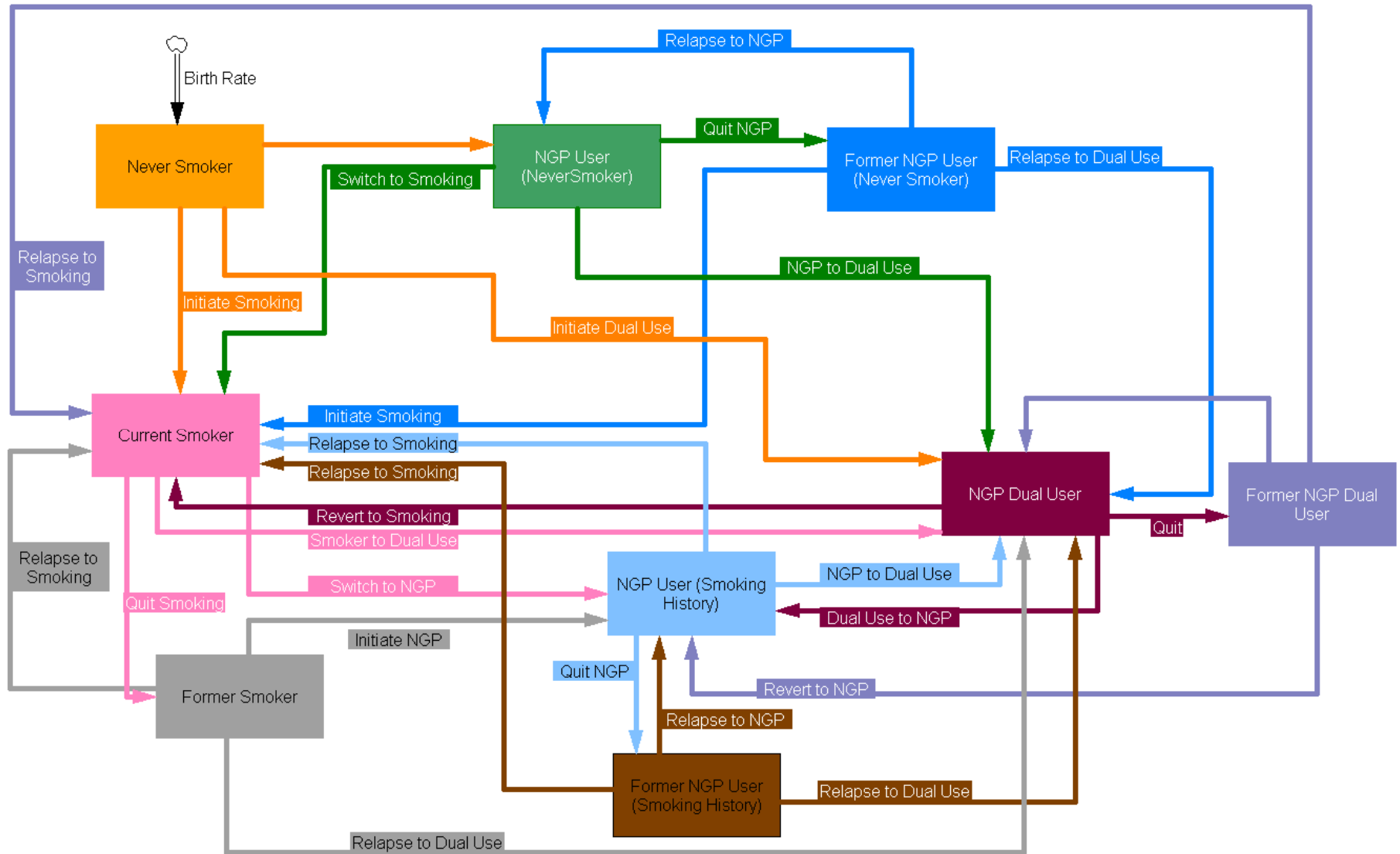
Current Smokers Switching to NGP





Complete Conceptual Model

Population Impact Model





Viable Transitions

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	Never Smokers	Current Smokers	Former Smokers	NGP User (Never Smoker)	NGP User (Smoking History)	Dual User	Former NGP User (Never Smoker)	Former NGP User (Smoking History)	Former Dual User
Never Smokers	Grey	Green	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow
Current Smokers	Yellow	Grey	Green	Yellow	Green	Green	Yellow	Yellow	Yellow
Former Smokers	Yellow	Green	Grey	Yellow	Green	Green	Yellow	Yellow	Yellow
NGP User (Never Smoker)	Yellow	Green	Yellow	Grey	Yellow	Green	Green	Yellow	Yellow
NGP User (Smoking History)	Yellow	Green	Yellow	Yellow	Grey	Green	Yellow	Green	Yellow
Dual User	Yellow	Green	Yellow	Yellow	Green	Grey	Yellow	Yellow	Green
Former NGP User (Never Smoker)	Yellow	Green	Yellow	Green	Yellow	Green	Grey	Yellow	Yellow
Former NGP User (Smoking History)	Yellow	Green	Yellow	Yellow	Green	Green	Yellow	Grey	Yellow
Former Dual User	Yellow	Green	Yellow	Yellow	Green	Green	Yellow	Yellow	Grey



Age Cohorts

Population Impact Model



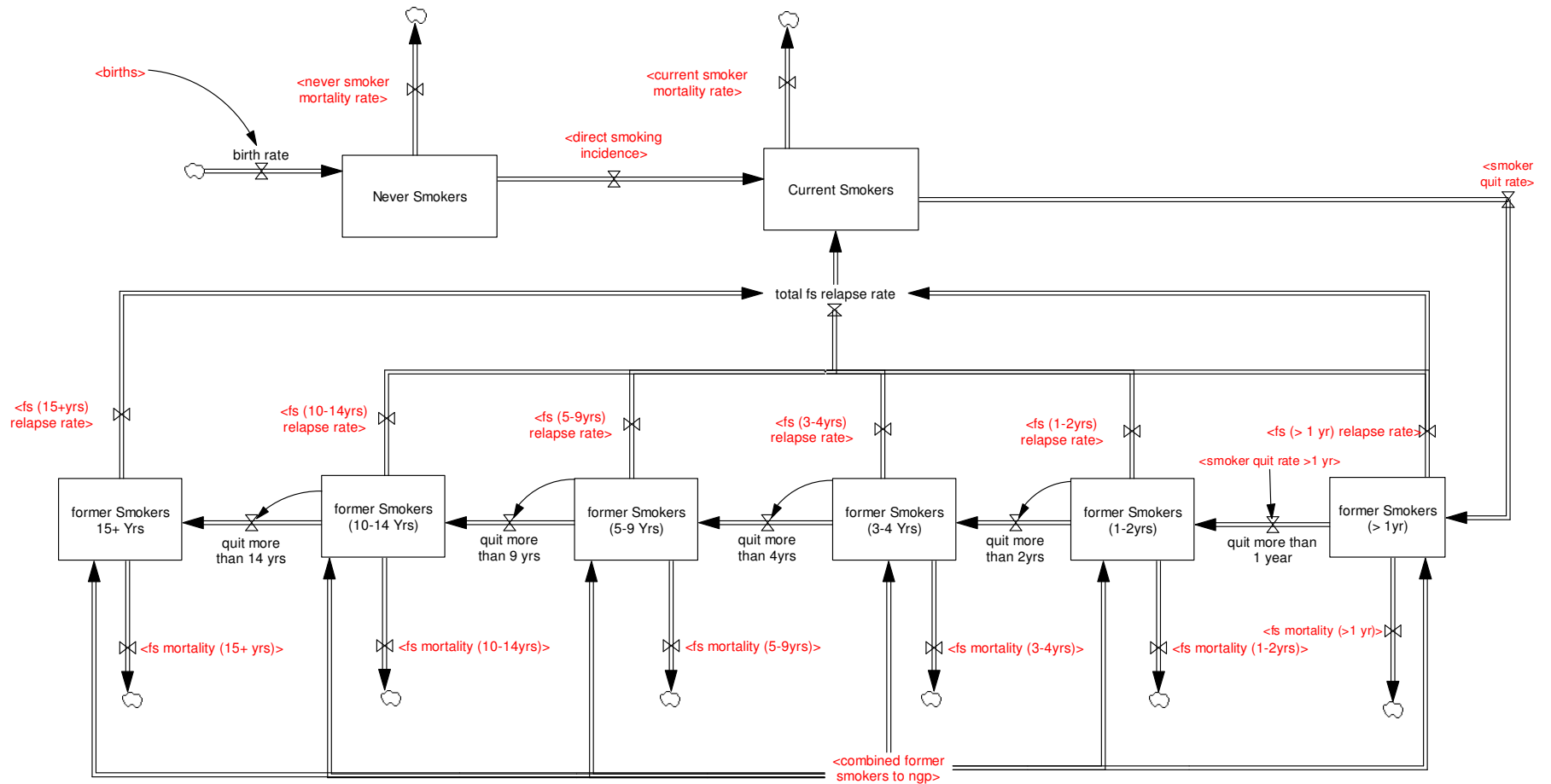
- A realistic representation of the population is achieved by inclusion of demographics for the whole population (gender specific birth rates, migration rates and mortality rates)
- Single year age cohorts the preferred level of detail
- Lack of data capture and availability at this level, cohorts covering multiple ages were necessary
- Age cohorts chosen to match those used in available data

Under 10	11 -15	16 -19	20 -24	25-34
35 - 49	50 - 59	60 - 64	65 - 74	75+



Actual Model Structure

Population Impact Model





CASE STUDY: E-CIGARETTES IN THE UK



Main Data Sources Identified

Case study: e-cigarettes in the UK



- Office for National Statistics
 - *Population Estimates for UK*
 - *National Population Projections*
 - *General Household Survey / General Lifestyle Survey*
 - *Smoking-related Behaviour and Attitudes*

- Health and Social Care Information Centre
 - *Health Survey for England*
 - *Smoking, drinking and drug use among young people in England*
 - *Statistics on Smoking*

- University of Bristol
 - *Long-Term Smoking Relapse: A Study Using the British Household Panel Survey*



Data Gap Solutions/Assumptions

Case study: e-cigarettes in the UK



- Gaps in UK Data for :
 - Quit Rates: *Estimated by model calibration*
 - Relapse rates: *Assumed age/gender independent*
 - Relative Risks by Age: *Age standardised rates applied*
- Other Assumptions
 - Where UK data not available, data available for England assumed to apply to UK



E-Cigarette Parameters

Case study: e-cigarettes in the UK



- 28 parameter inputs
- All independent of age/gender
- Restricted E-Cigarette data currently available
- Many inputs scaled versions of Cigarette data

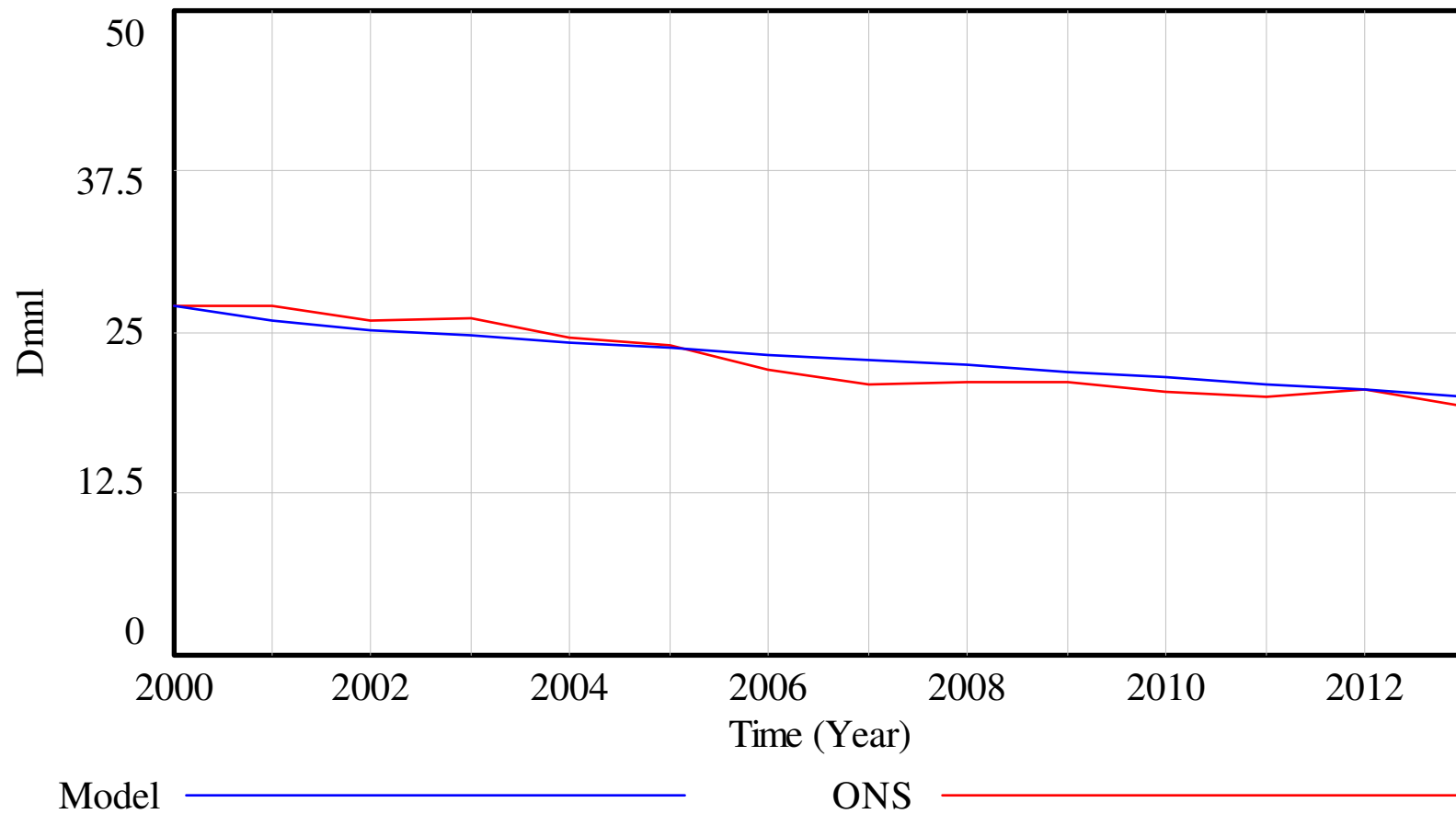


Calibrated Model Estimates

Case study: e-cigarettes in the UK



Adult Smoking Prevalence





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