



Population Health Impact Modelling – A calibration approach to address data gaps

A UK vaping example

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Agenda

- 1** Modelling & System Dynamics
- 2** Data Requirements
- 3** Calibration Approach
- 4** Calibration Results
- 5** Next Steps & Conclusions

What is modelling....?



**Mathematical
Models**



**Used in
various fields**



**Project
outcomes of
interest over
time**



**Alternative
approach for
evaluating
long term
effects**

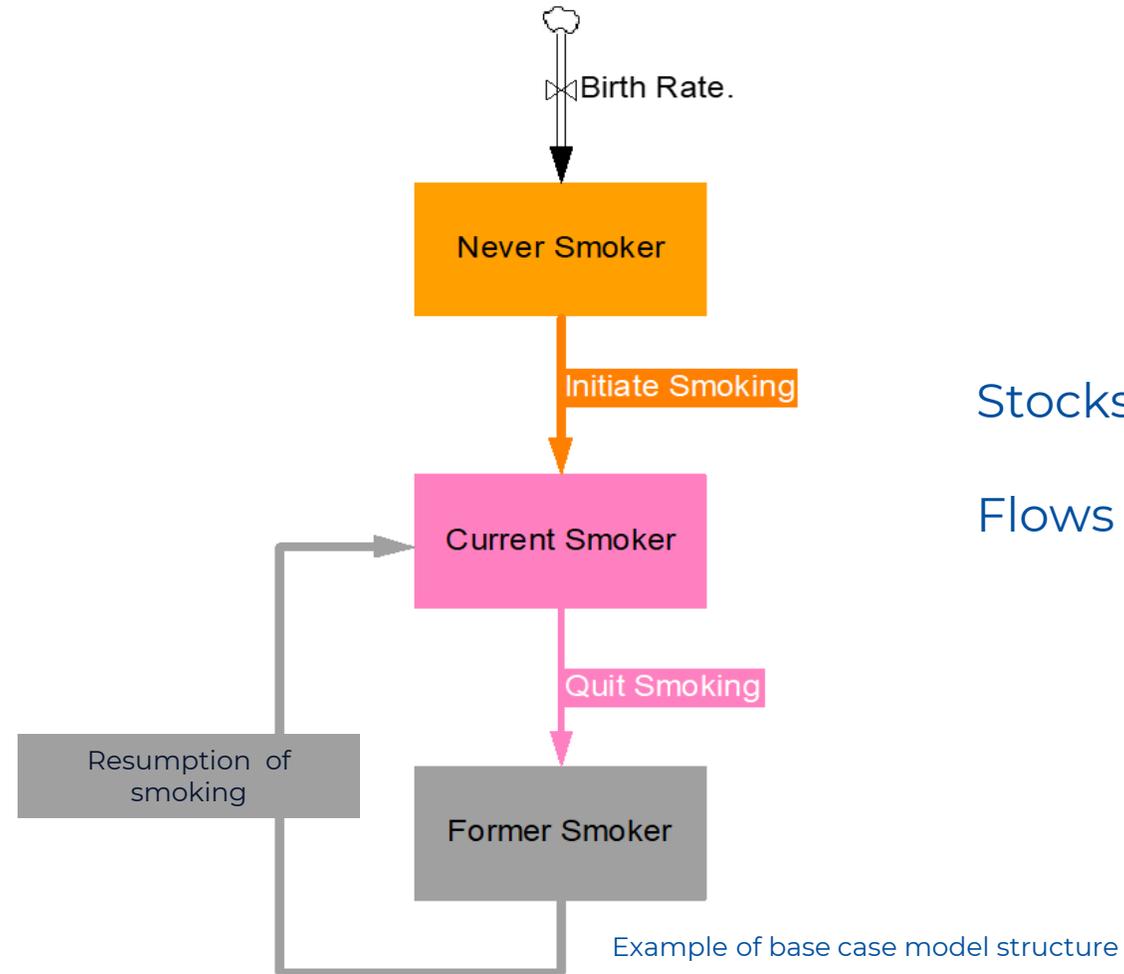


**New
smokeless
products are
launched in a
market**

**Goal: To estimate the population health impact
of a new product launched**

System Dynamics Approach

System Dynamics



Stocks – Product use states

Flows - Transitions

Data Inputs

Requirements

Demographic

Mortality rates/Life Tables

Relative risk for smoking

Estimated reduced relative risk for alternative product

Transitions

Challenges

Data availability

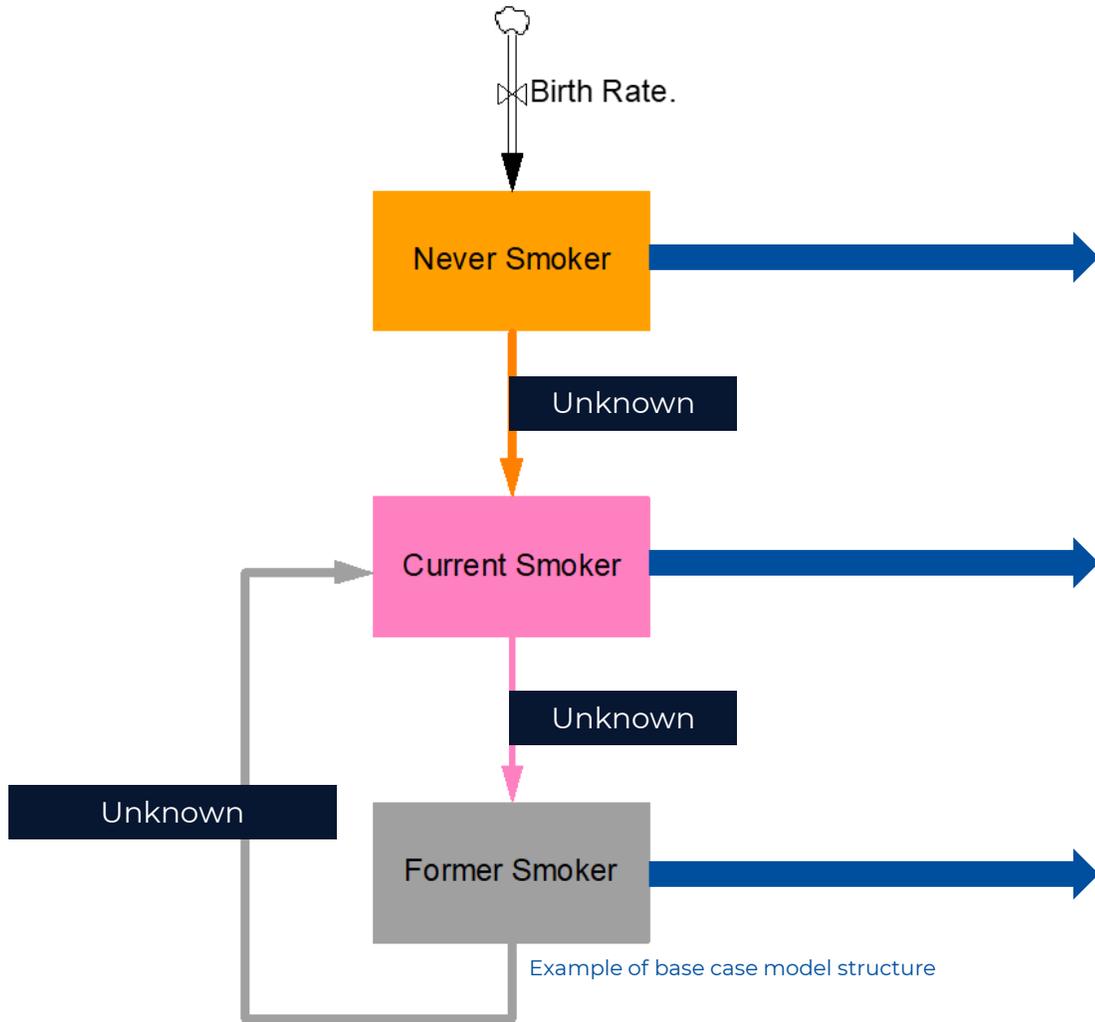
Definitions

Different data collection methods

Limited survey research

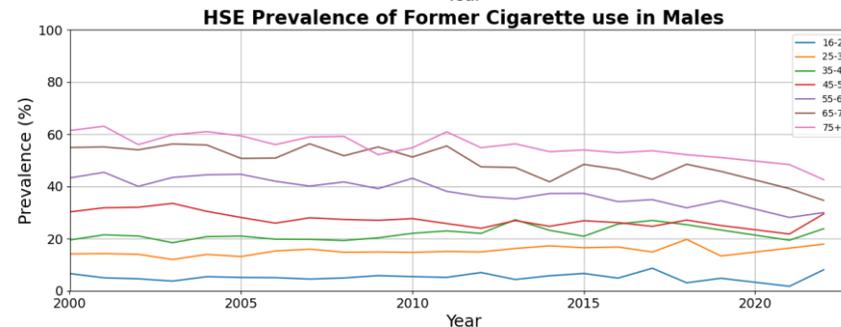
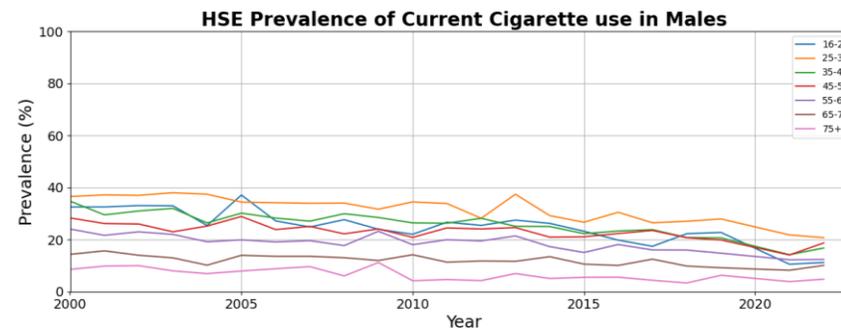
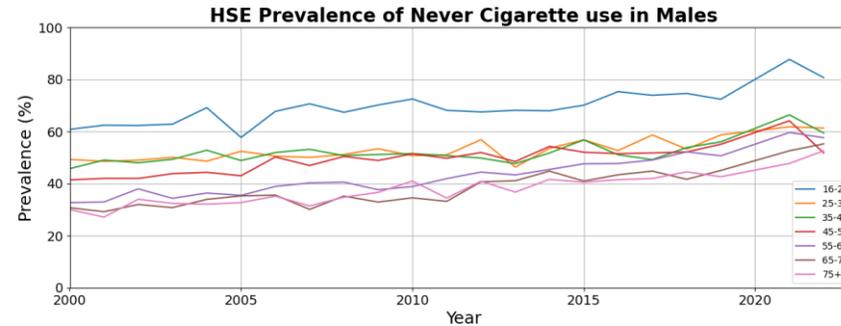
Lack of data for transitions

Post Market Modelling – UK example



Published data from external sources

Prevalence data from Health Survey for England (HSE)



Contains information from NHS England, licenced under the current version of the Open Government Licence

Source: NHS England, Health Survey for England, 2022 Part 1, 2024

The legal age for buying tobacco in England changed to 18 years of age in October 2007. Prior to this it was 16, which is why the starting age range of HSE's prevalence data is 16-24.

Can we use the data we do have to inform model transitions?

Estimate model transitions by calibrating to observed publicly available prevalence data

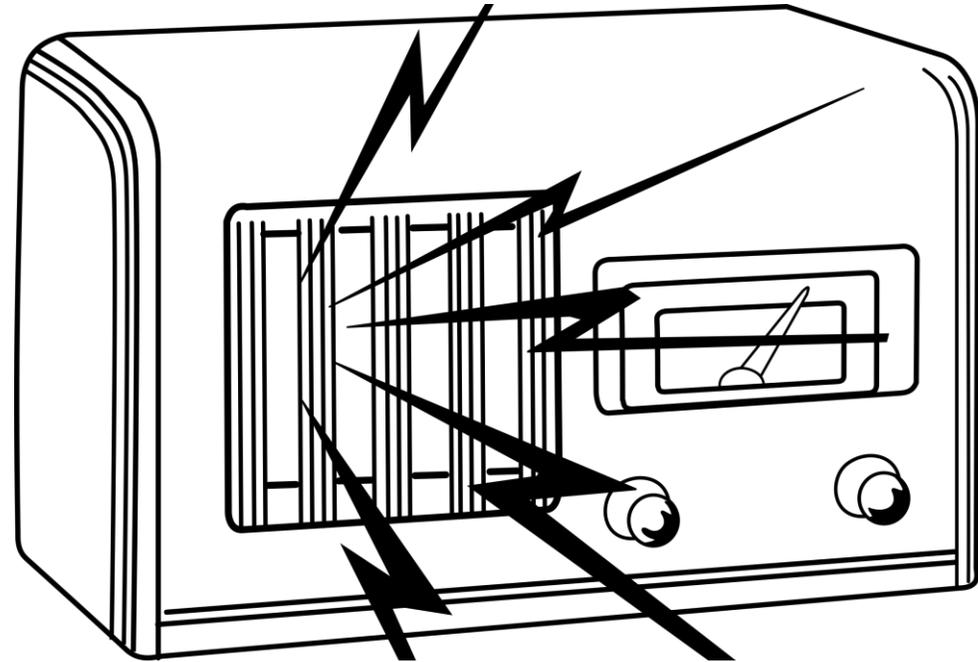
- 1) Select model parameters for estimation
- 2) Define target data



Powell optimisation method



Minimize difference between projected and observed prevalence



Step-wise Approach

Base Case  2 Product Model



* In 2007, the legal age to purchase cigarettes was raised from 16 to 18 years of age. Inclusion of a 16-24 age cohort aligns to the age range as presented by Health Survey for England (HSE) 2000-2012 data

Step 1 – Smoking Initiation

Calibration Parameters



Model Parameters

- Initial Annual Smoking Initiation Probability (2000)
- Average Annual Decline in Smoking Initiation

Calibration data (public data sources)

- Ever Smoker Prevalence
- Health Survey for England (HSE) 2000-2012
- By age/gender

Assumption

All smoking initiation occurs before age 25

Source: Department of Health and Social Care. 2013. Chief Medical Officer annual report 2012: Children and young people's health. Available from: [GOV.UK](http://gov.uk)

Calibrated Parameters

Initiation rates calibrated to observed publicly available prevalence data

Gender	Age Cohort	Probability in 2000	Annual Decay
Male	*16-24	3.2%	8.82%
Female	*16-24	1.7%	

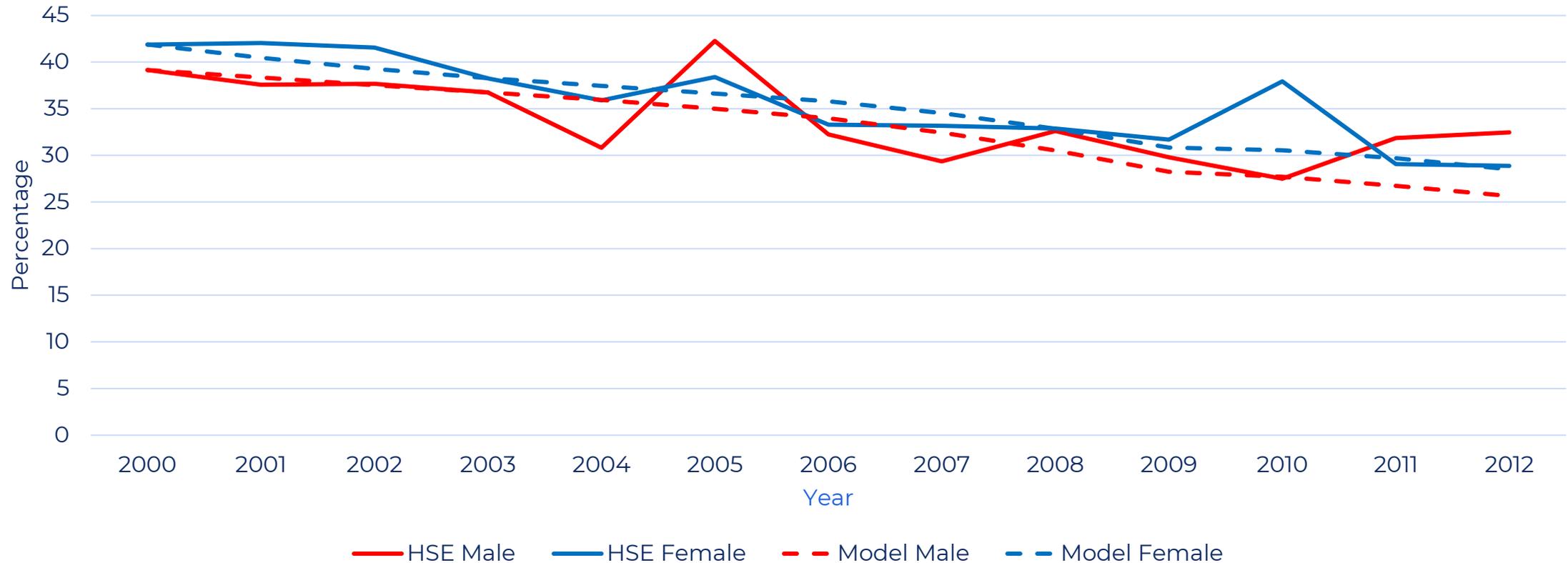
*In 2007, the legal age to purchase cigarettes was raised from 16 to 18 years of age. Inclusion of a 16-24 age cohort aligns to the age range as presented by Health Survey for England (HSE) 2000-2012 data.

Step 1 – Smoking Initiation

Calibration Results



Ever Smoking Prevalence *16 -24



Ever smoking prevalence driven by initiation rates.

Model projections generally align with observed ever smoking prevalence data across most years.

Observed Data Source: NHS England, Health Survey for England, 2022 Part 1, 2024, licenced under the current version of the Open Government Licence.

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Step 2 - Smoking Cessation

Calibration Parameters



Model parameters

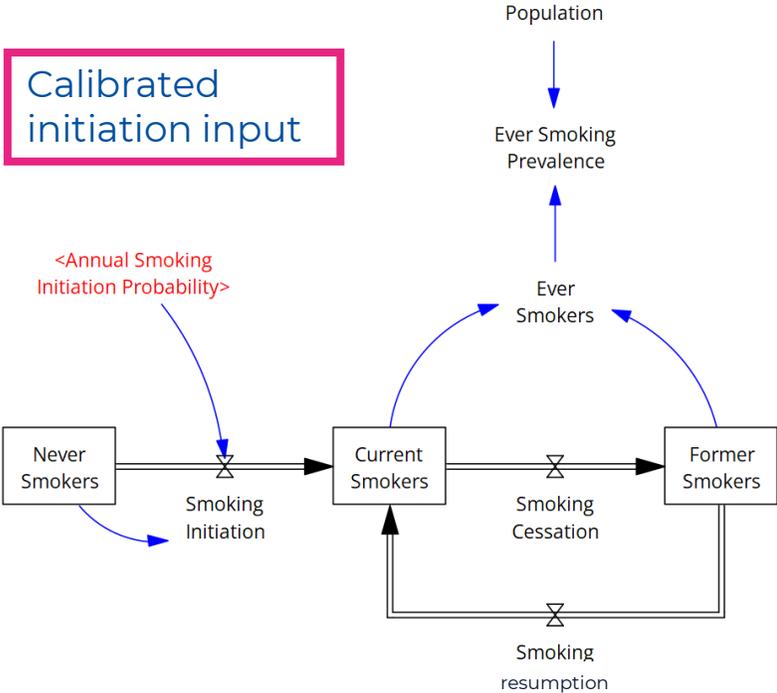
- Smoking Cessation Rate

Calibration Data (public data sources)

- Current & Former Smoking prevalence
- Health Survey for England (HSE) 2000-2012
- By age and gender

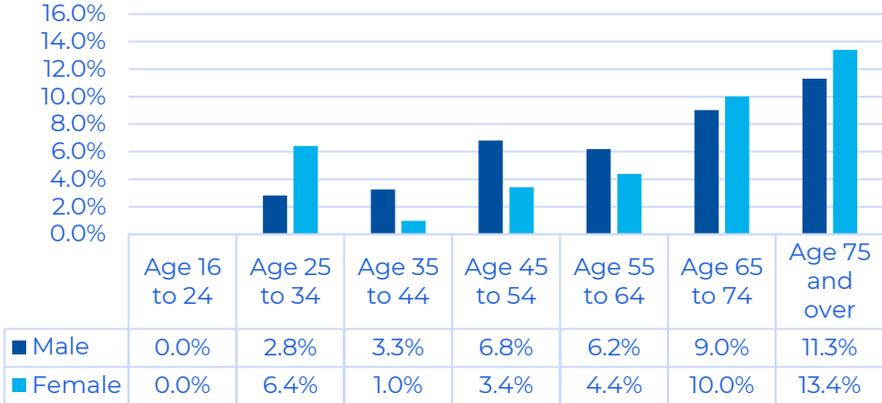
Assumption
Smoking resumption included for year following cessation only

Calibrated initiation input



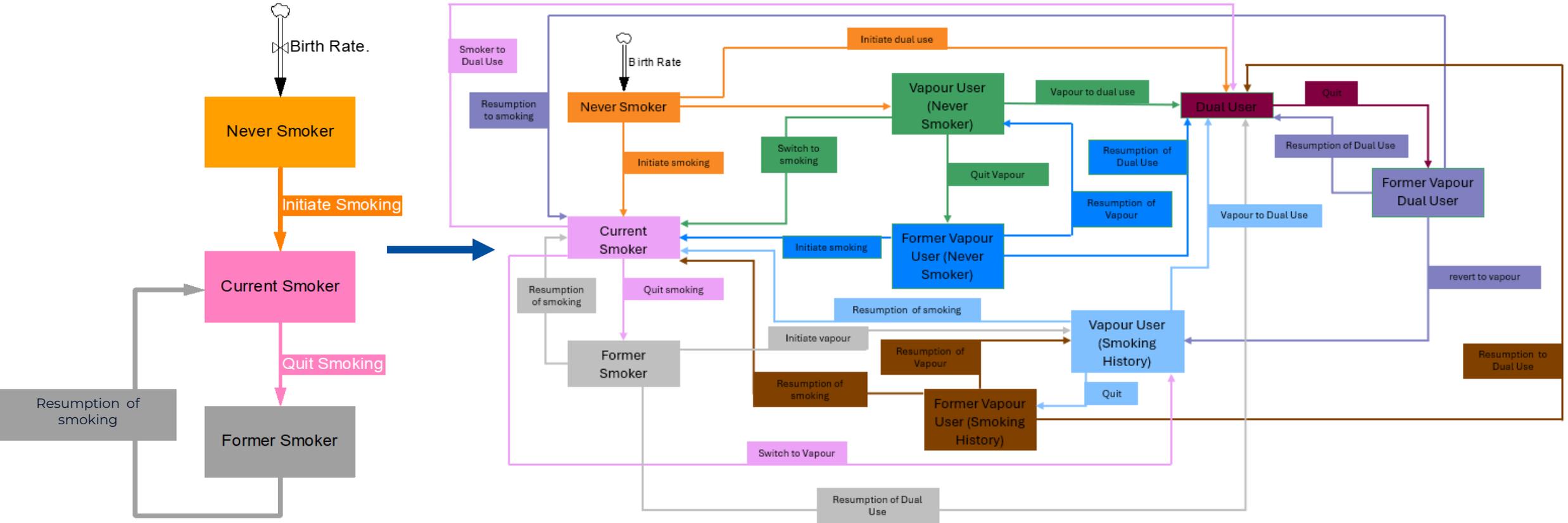
Smoking resumption set at 37% (Hawkins et al 2010)

Calibrated Quit Probability



■ Male ■ Female

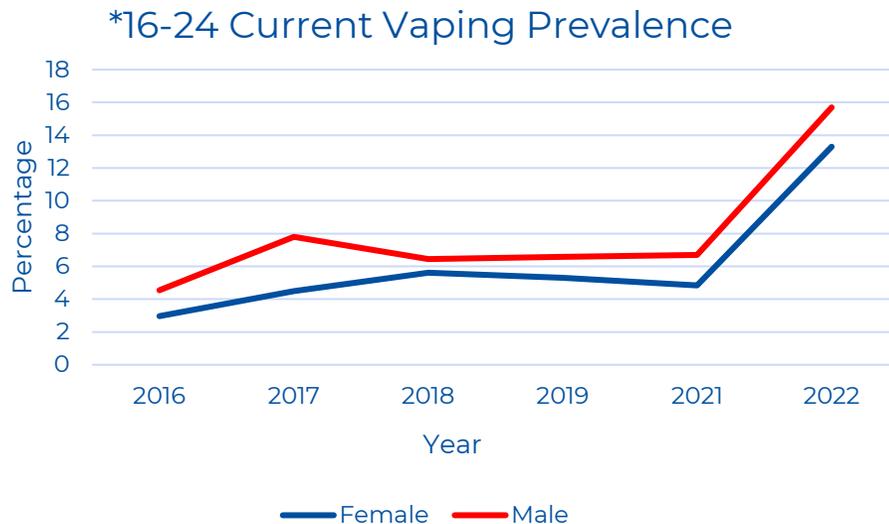
2 Product Model



Step 3 – Fixed Inputs and Assumptions

Vaping Initiation

- Non-calibrated data input
- Data from HSE (2016-2021)
- Applied at beginning of age category



Source: NHS England, Health Survey for England, 2022 Part 1, 2024, licenced under the current version of the Open Government Licence.

*In 2007, the legal age to purchase cigarettes was raised from 16 to 18 years of age. Inclusion of a 16-24 age cohort aligns to the age range as presented by Health Survey for England (HSE) 2000-2012 data.

Assumptions*

Initiation occurs before age 25

Vaping Quit Probabilities = Smoking Quit Probability

Dual Quit Probability = Smoking Quit Probability

Vaping Resumption Probabilities = Smoking Resumption Probabilities

No initiation to dual use

*These assumptions have been made by extrapolation due to absence of comprehensive real-world data and will be re-evaluated as data becomes available.

Step 4 – Simplified Transition Model

Model parameters

- 6 transitions to model switching behaviour

Calibration Data (public data sources)

- Smoking and vaping prevalence data
- Years 2014-2021

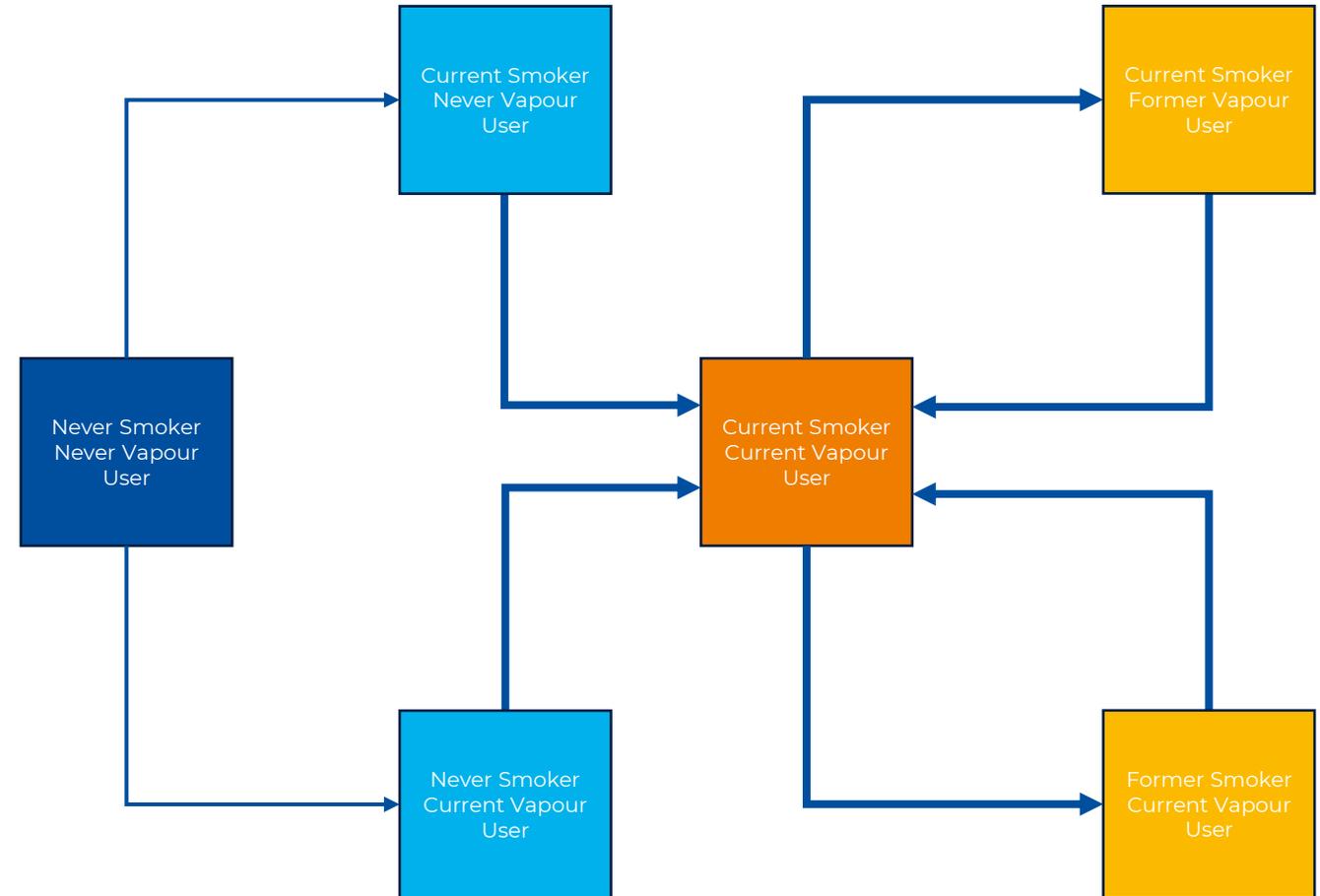
Assumptions

FMC Dual Use* as a transitional state

Former smokers more likely to transition to FMC Dual Use than never users

Sequential calibration (by age categories)

Simplified Switching Diagram



*FMC Dual Use refers to the use by an adult** consumer of both FMC products and potentially reduced risk tobacco and nicotine products which for many smokers is part of a transitional period where those consumers move towards a complete switch to potentially reduced-risk products by reducing the consumption of combustible tobacco products and replacing them with one or more potentially reduced-risk products.

** As defined by the relevant local law but shall in no circumstance refer to any person under the age of 18; and shall in no circumstance refer to any person under the age of 21 in the US.

†BAT is clear that smokers should not delay making a complete switch.

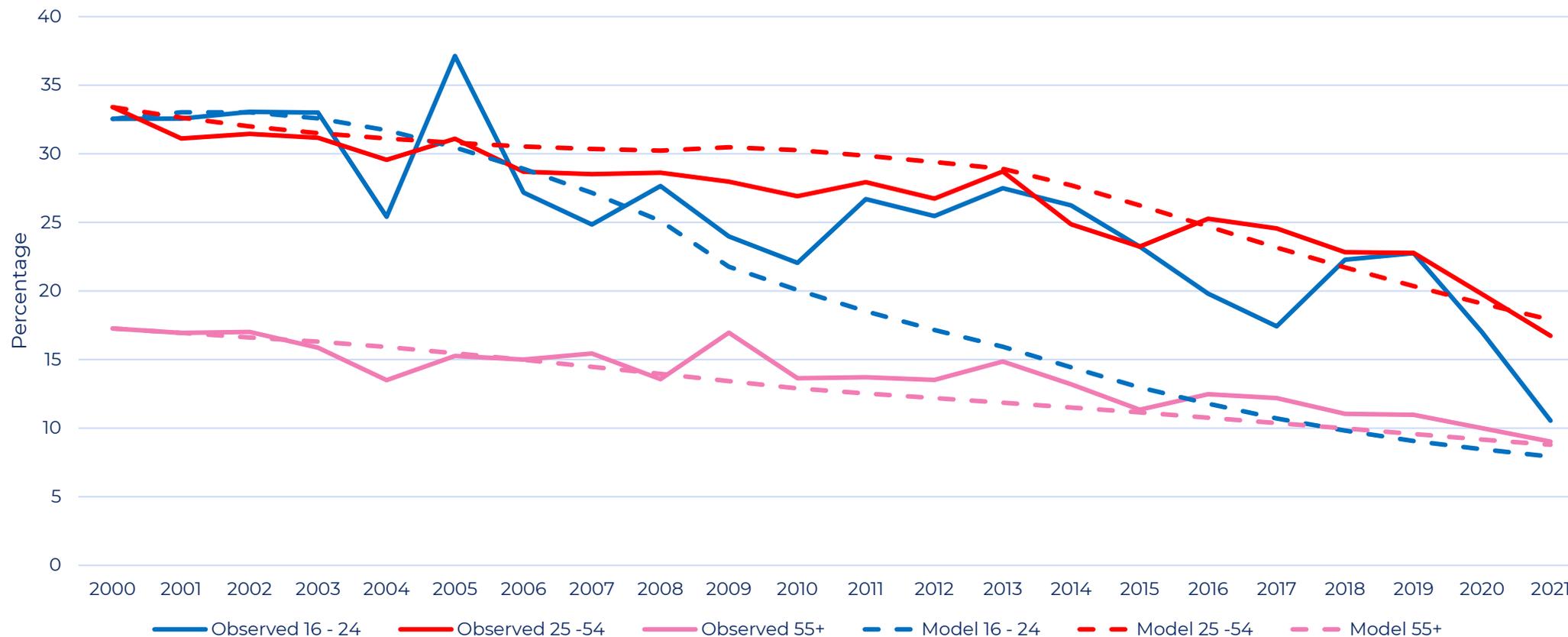
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Calibration Results - Smoking Prevalence

Comparison of model projections to publicly available data



Male Smoking Prevalence



Model projections consistent with observed male and female current smoking prevalence for ages >25

Observed Data Source: NHS England, Health Survey for England, 2022 Part 1, 2024, licenced under the current version of the Open Government Licence.

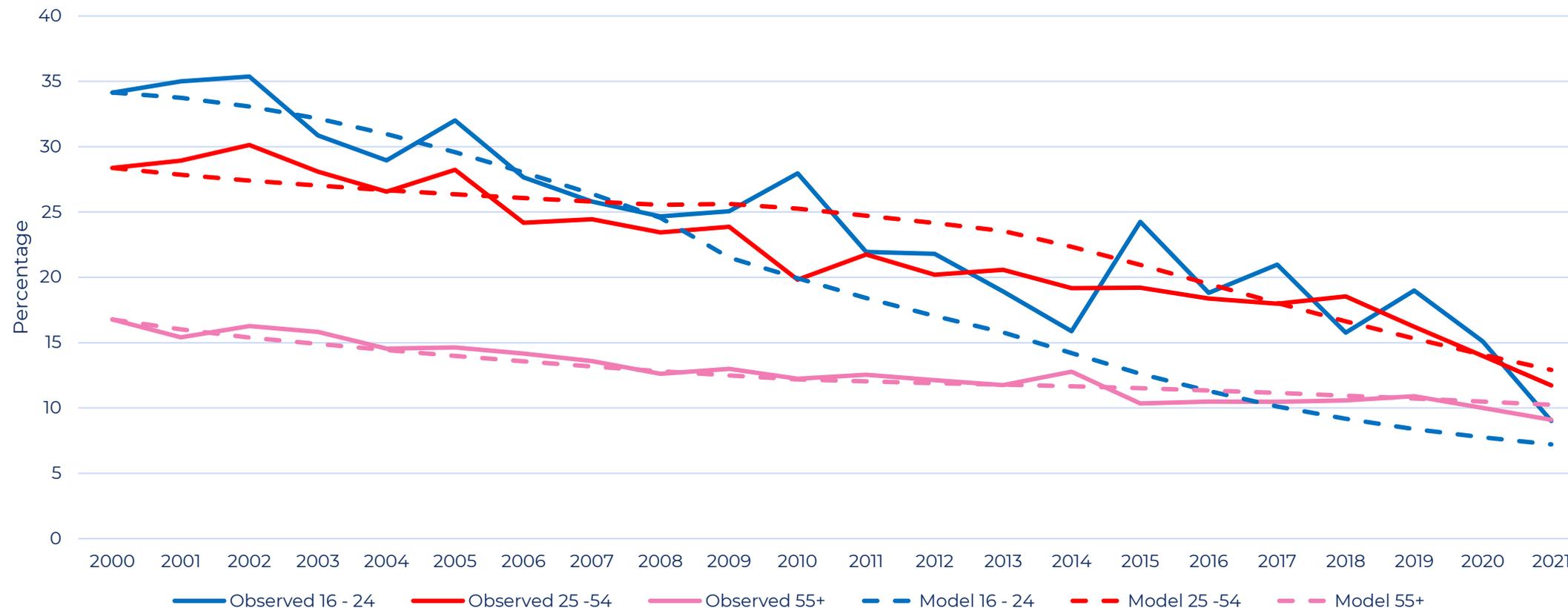
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Calibration Results - Smoking Prevalence

Comparison of model projections to publicly available data



Female Smoking Prevalence



Model projections consistent with observed male and female current smoking prevalence for ages >25

Observed Data Source: NHS England, Health Survey for England, 2022 Part 1, 2024, licenced under the current version of the Open Government Licence.

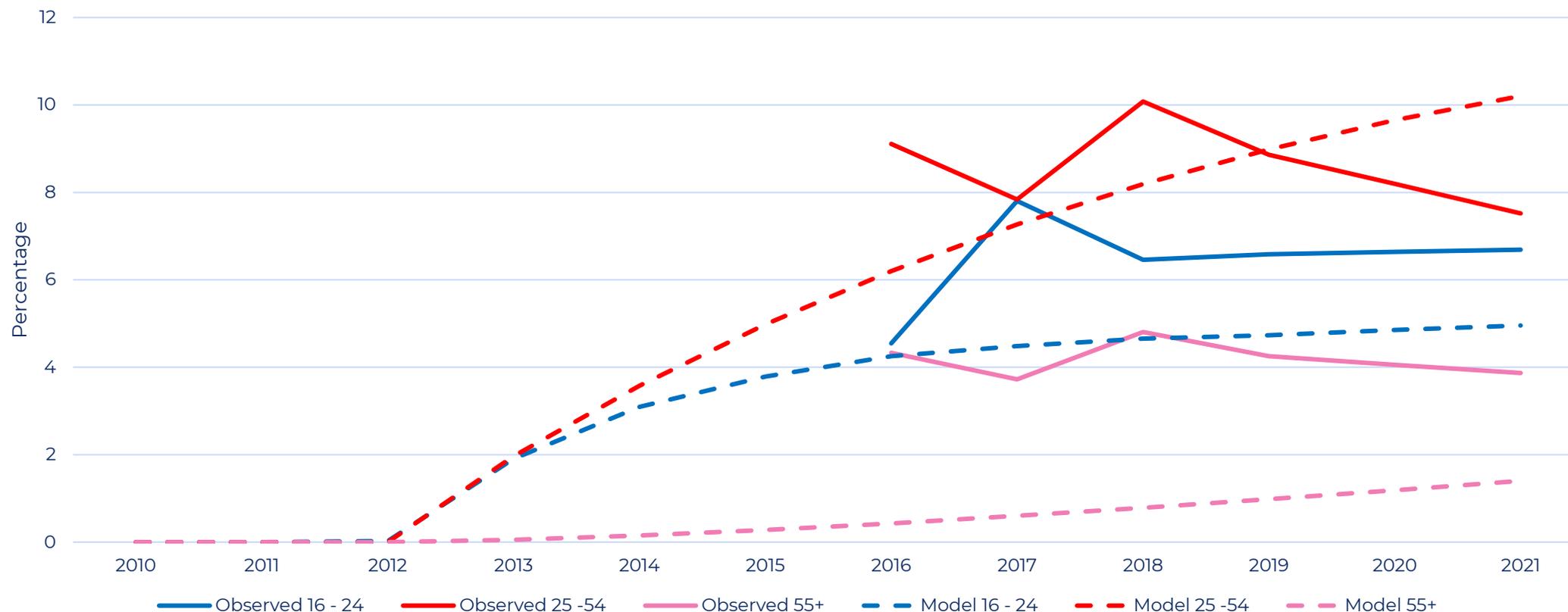
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Calibration Results - Vaping Prevalence

Comparison of model projections to publicly available data



Male Vaping Prevalence



Model projections tend to over-estimate the 25-54 age category and under-estimate >55 for both males and females, but are generally in a similar range to observed data

Observed Data Source: NHS England, Health Survey for England, 2022 Part 1, 2024, licenced under the current version of the Open Government Licence.

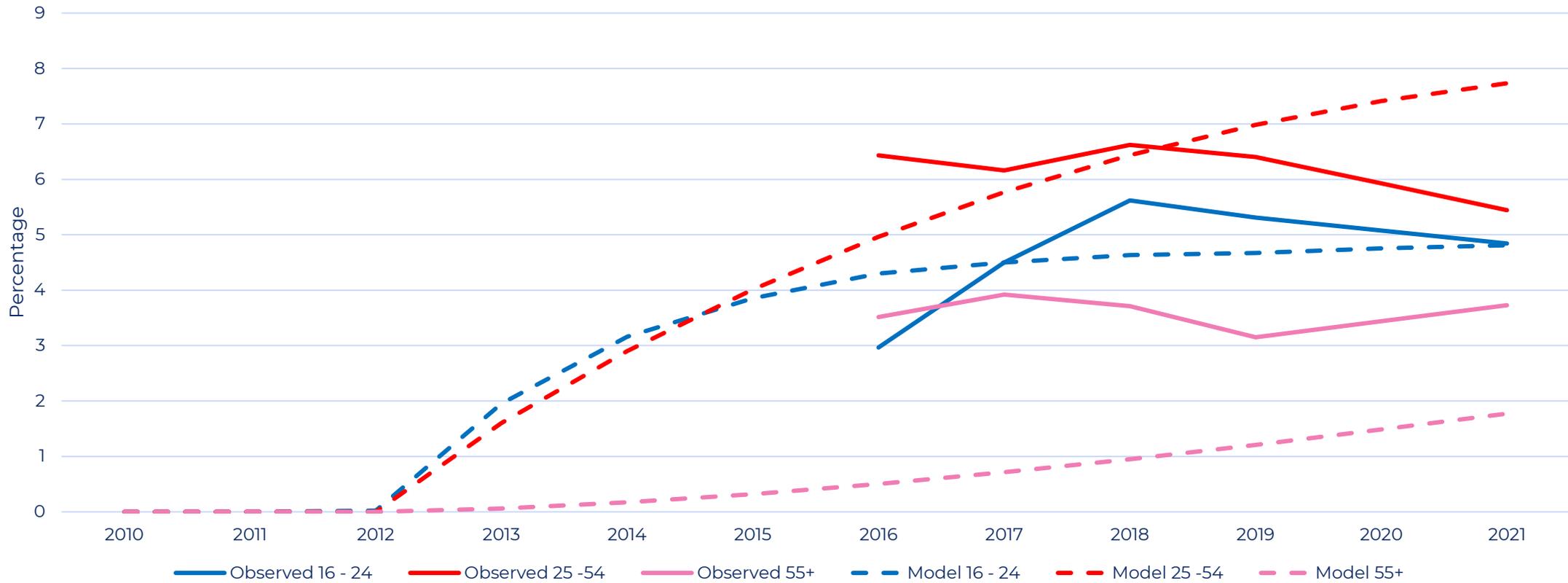
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Calibration Results - Vaping Prevalence

Comparison of model projections to publicly available data



Female Vaping Prevalence

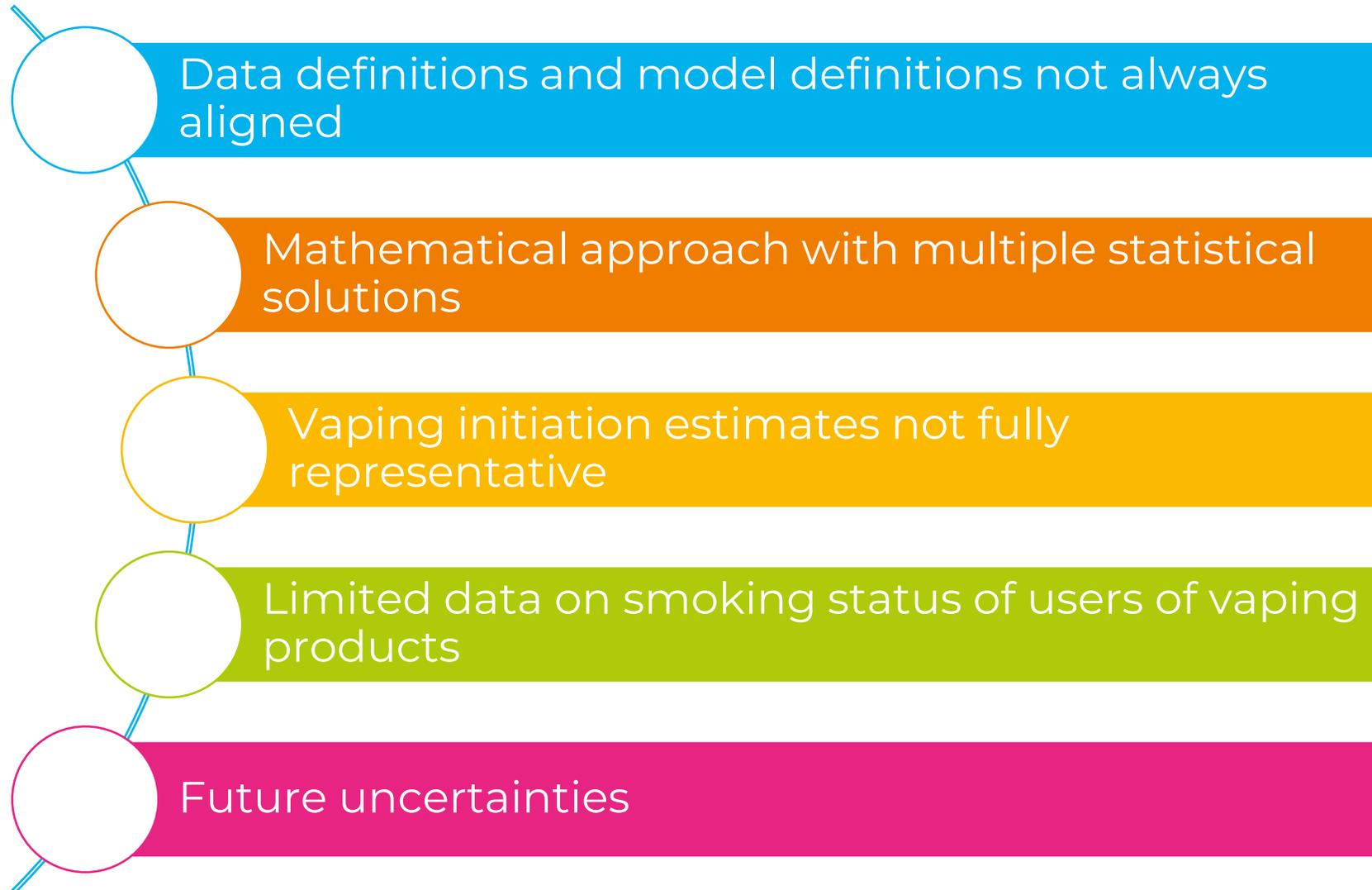


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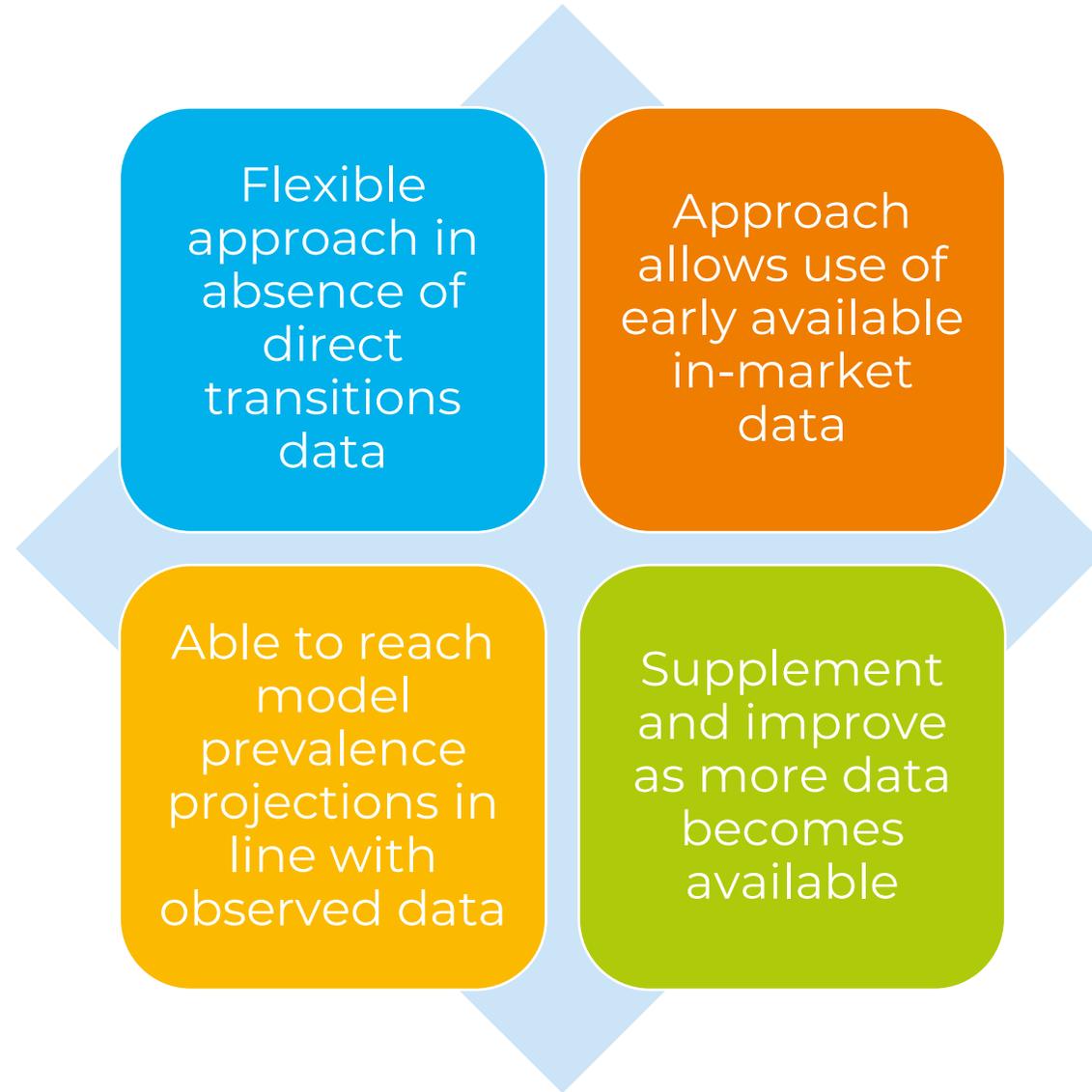
Observed Data Source: NHS England, Health Survey for England, 2022 Part 1, 2024, licenced under the current version of the Open Government Licence.



Limitations



Conclusion



References

- Health Survey for England, 2022 Part 1: Adults' Health-Related Behaviours, NHS England (2024)
- Department of Health and Social Care. 2013. Chief Medical Officer annual report 2012: Children and young people's health. Available from: GOV.UK
- Office for National Statistics (ONS), released 1 October 2024, ONS website, Adult smoking habits in the UK: 2023
- Hawkins, J., Hollingworth, W. and Campbell, R., 2010. Long-term smoking relapse: A study using the British Household Panel Survey. *Nicotine & Tobacco Research*, 12(12), pp.1228–1235.

Acknowledgement:

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