Potential impacts of tobacco tax on health, health inequalities, and health system costs?

Epidemiological and economic modelling in NZ

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Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme

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Context

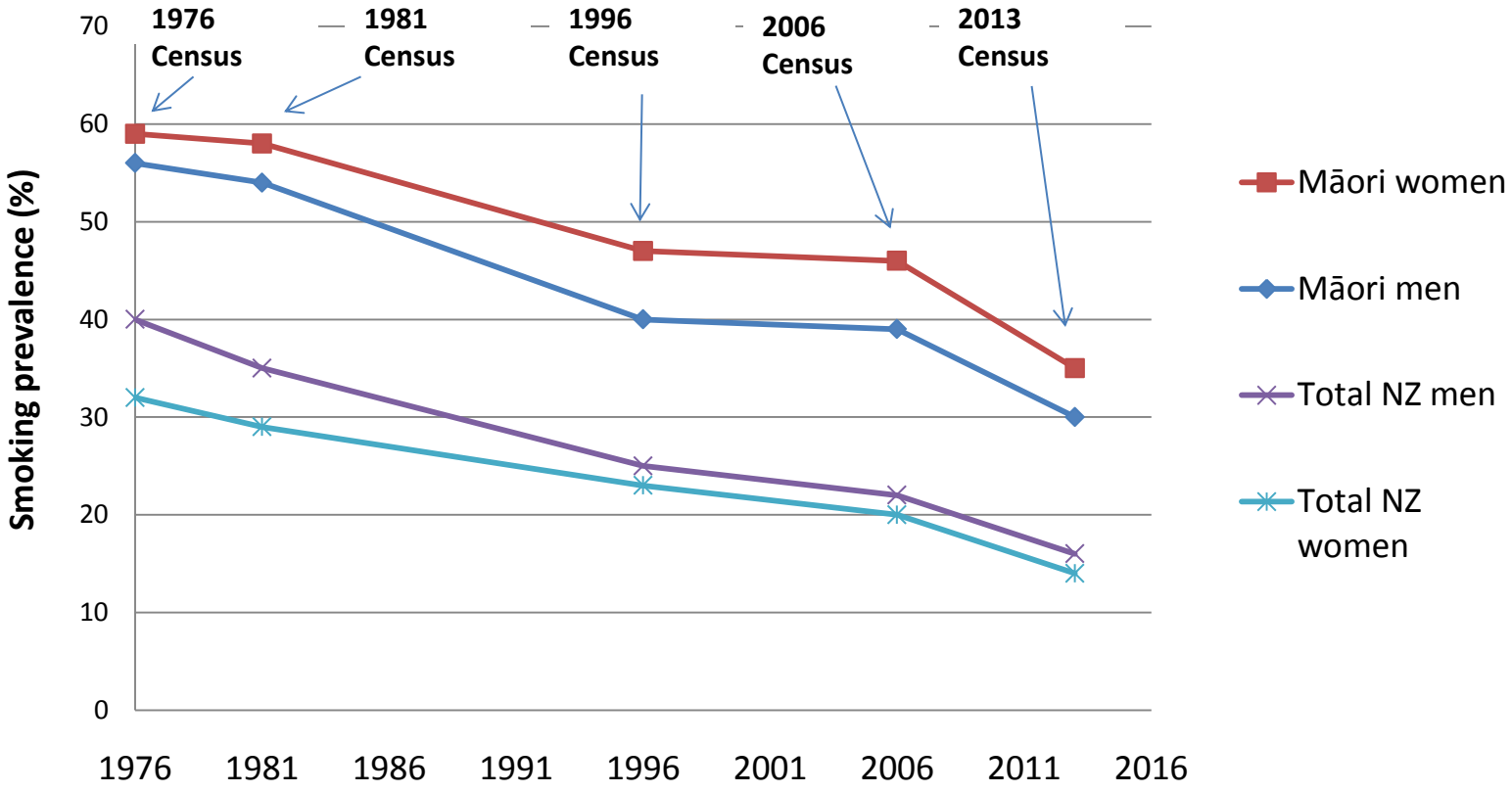
Tobacco-free world 1

A tobacco-free world: a call to action to phase out the sale of tobacco products by 2040

Robert Beaglehole, Ruth Bonita, Derek Yach, Judith Mackay, K Srinath Reddy

- NZ goal of being tobacco-free by 2025, generally interpreted as a smoking prevalence of <5% by 2025
- In this presentation – NZ as a case example for the impact of tobacco tax

NZ Census smoking prevalence by ethnicity and sex, 1976-2013



Which begs all these questions….

- Will NZ achieve the smokefree goal (5%) by 2025 with ongoing 10% per annum increases in excise tax?
- And what will be the impact, and timing, of such ongoing tobacco tax increases on:
  - Health gains in QALYs?
  - Mortality inequalities?
  - Health system costs?

BAU smoking prevalence projections to 2025 and beyond in NZ

Ikeda T, Cobiac L, Wilson N, Carter K, Blakely T. What will it take to get to under 5% smoking prevalence by 2025? *Tob Control* 2013 (online 26 September 2013).

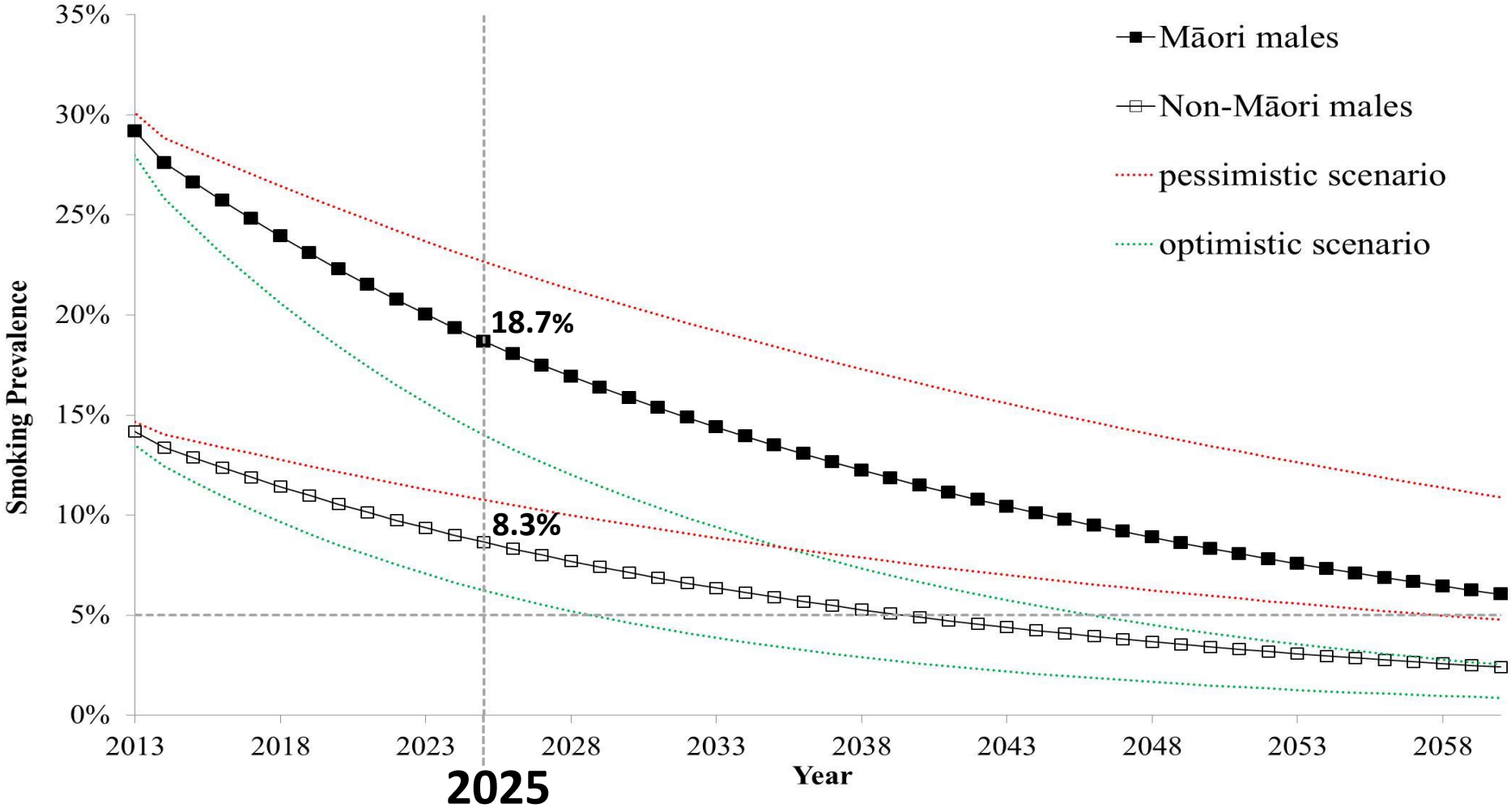
Now updated with smoking prevalence data from the 2013 Census in:
van der Deen FS, Ikeda T, Cobiac L, Wilson N, Blakely T. Projecting future smoking prevalence to 2025 and beyond in New Zealand using smoking prevalence data from the 2013 Census. *N Z Med J* 2014;127(1406):71-79.

Methods

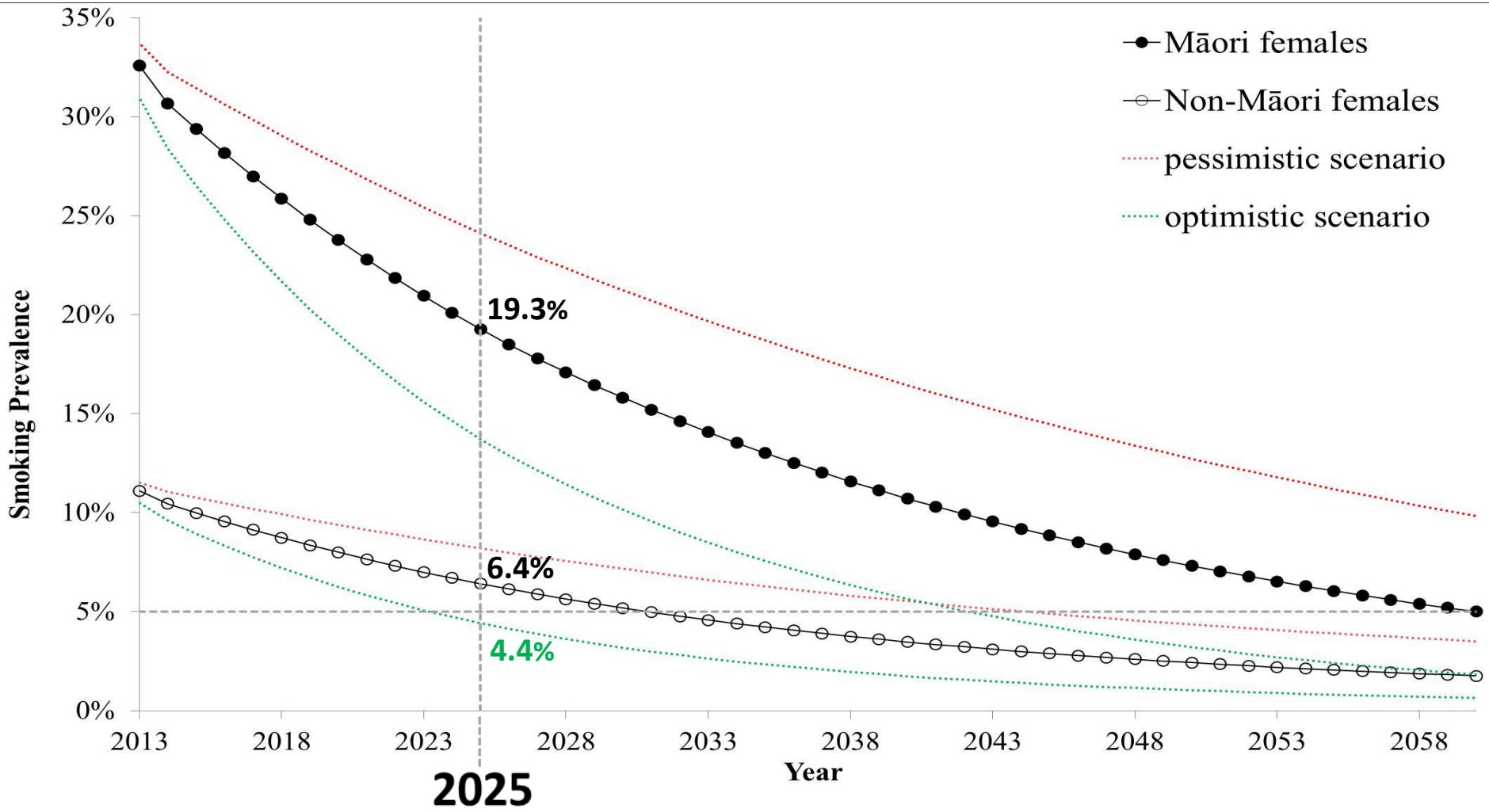
- A dynamic forecasting tobacco model previously built for Australia[1] was adapted for NZ[2,3]
- A Markov model designed in MS Excel
  - Input data (by age, sex, and ethnicity)
    - Smoking prevalence data from the 2006 and 2013 NZ Census[3]
    - Annual birth projections, and annual trends in mortality rates
    - Relative risks of mortality for current & former smokers from NZCMS[4]
  - Outputs are annual cessation rates, and reduction in initiation, that are used to forecast future tobacco smoking prevalence

1. Gartner et al. *Tob Control* 2009;18:183-9.
2. Ikeda et al. *Tob Control* 2015;24:139–145
3. Van der Deen et al. *NZMJ* 2014; 127(1406): 1-9
4. Blakely et al. *N Z Med* J 2010;123(1320):26-36

Smoking prevalence projections – men



Smoking prevalence projections – women



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Intermediate conclusion

- The 2025 goal is not achieved by any group of Māori or non-Māori under the projected annual trends in initiation and cessation (assuming no further tax rises after 2014)
- Therefore, time to explore scenarios that go beyond business-as-usual:
  - Eg, Ongoing 10% (and more) per annum increases in tax

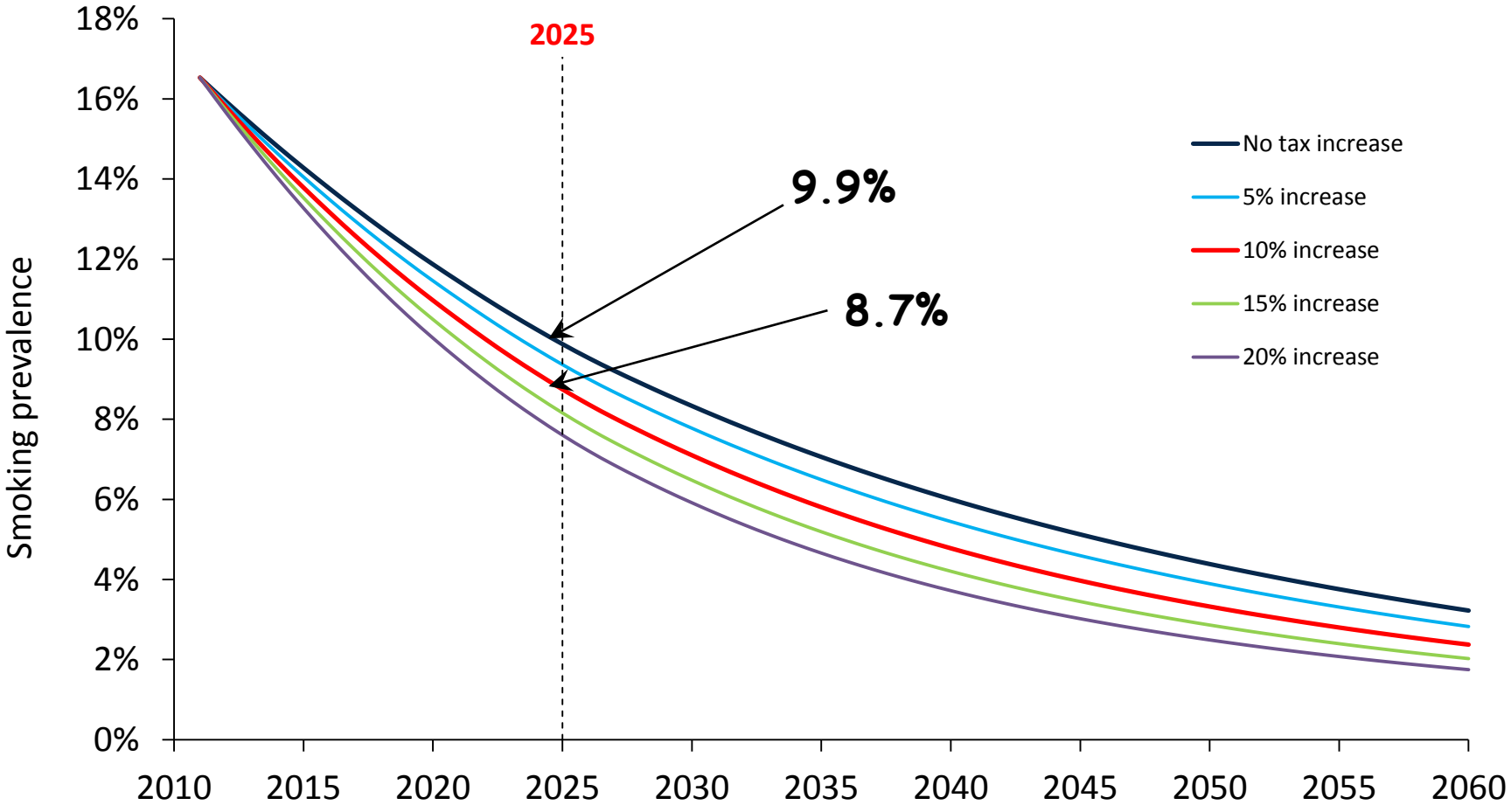
Tobacco taxes and smoking prevalence

Cobiac L, Ikeda T, Nghiem N, Blakely T, Wilson N. "Modelling the implications of regular increases in tobacco taxes as a tobacco endgame strategy." *Tobacco Control* 2015;24:3154-60.

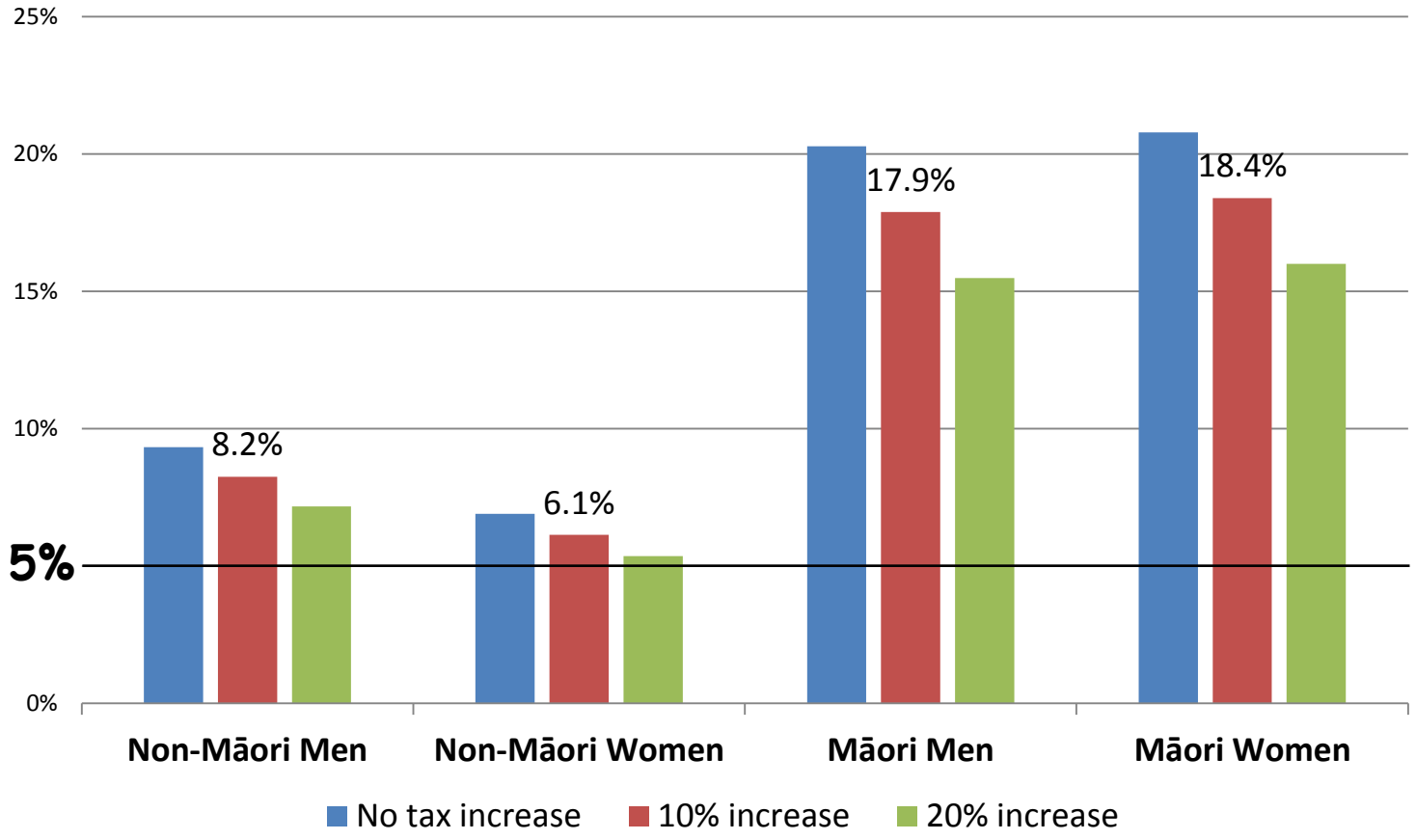
Responses to tobacco prices

- More smokers quit (or fewer young people start)
- Smokers cut-down on number of cigarettes smoked
- Price elasticity data:
  - NZ study (Tait et al 2013): -0.47
  - International data by age-groups (eg, IARC 2011)
  - Some evidence that Māori are more price sensitive (Grace et al 2014 – tobacco, Ni Mhurchu et al 2013 – food)

Smoking prevalence projections



Smoking prevalence in 2025



Pause, reflect – what did we assume?

- That PEs apply for future higher prices:
  - **But** one might expect response to price increases to steepen, as smoker still has other fixed costs (housing, food, etc) and a limited income
  - **But** might change with competing products (e-cigarettes)
- That tax affects cessation rates only in the year of the tax rise:
  - Which is what other models do
  - And accords with short- and long-run price elasticities being similar
- BAU continues as usual …

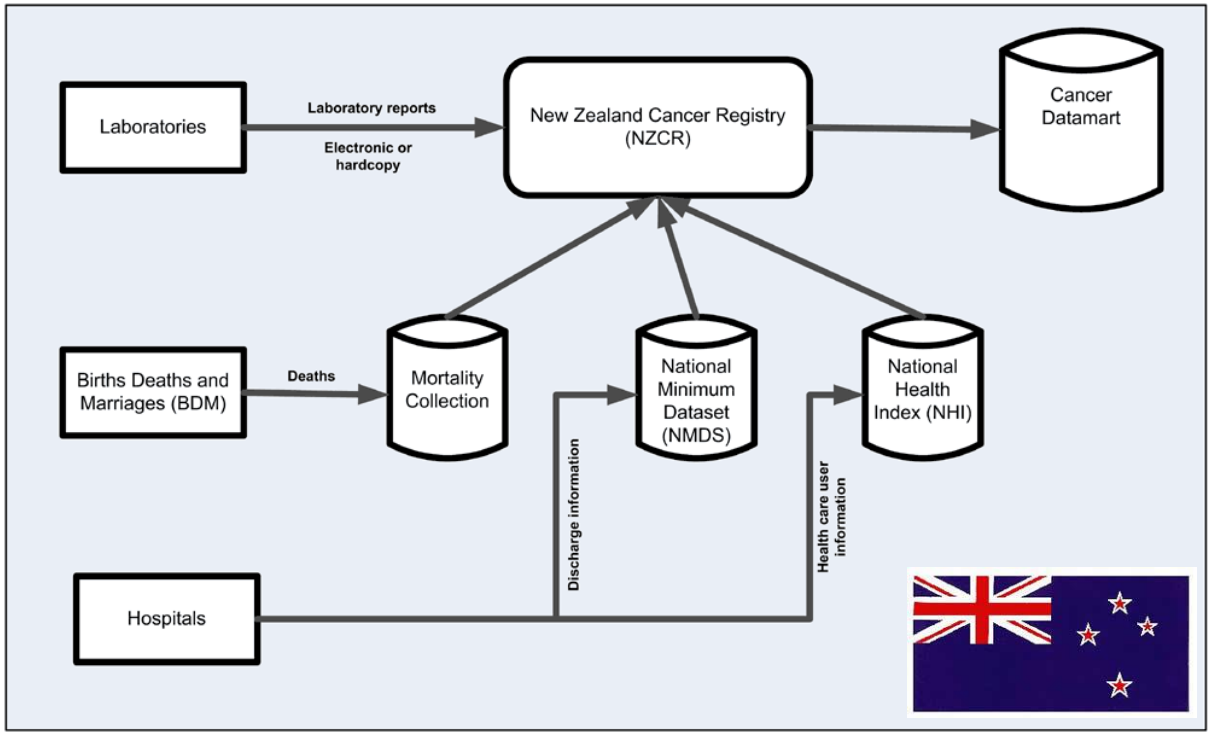
Which begs all these questions….

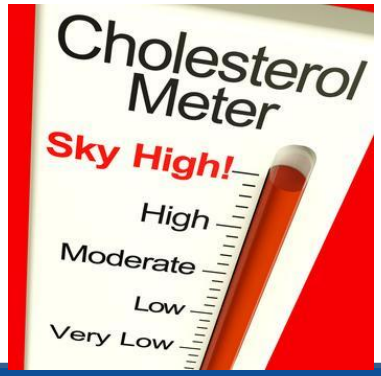
- Will NZ achieve the smokefree goal (5%) by 2025 with ongoing 10% per annum increases in excise tax?
- **And what will be the impact, and timing, of such ongoing tobacco tax increases on:**
  - **Health gains in QALYs?**
  - **Mortality inequalities?**
  - **Health system costs?**

Methods – baseline data

- Including the following diseases:
  - Ischaemic heart disease (IHD) and stroke; respiratory disease (COPD & LRTI)
  - Cancers: bladder, cervical, endometrial, head & neck, kidney, liver, lung, melanoma, oesophageal, pancreas, stomach, thyroid.
- All-cause mortality from SNZ lifetables with 1.75% (non-Māori) and 2.25% (Māori) p.a. ↓ mortality rates to 2026, then constant.
- Disease-specific incidence, case fatality, prevalence from range of sources, brought together with DISMOD to ensure consistency:
  - cancer registry, mortality data, HealthTracker, NZ Burden of Disease Study (NZBDS), NZCMS, CancerTrends
- Morbidity incorporated using years of life lost (YLDs) from NZBDS
- Costs in each state from HealthTracker, 2011 $

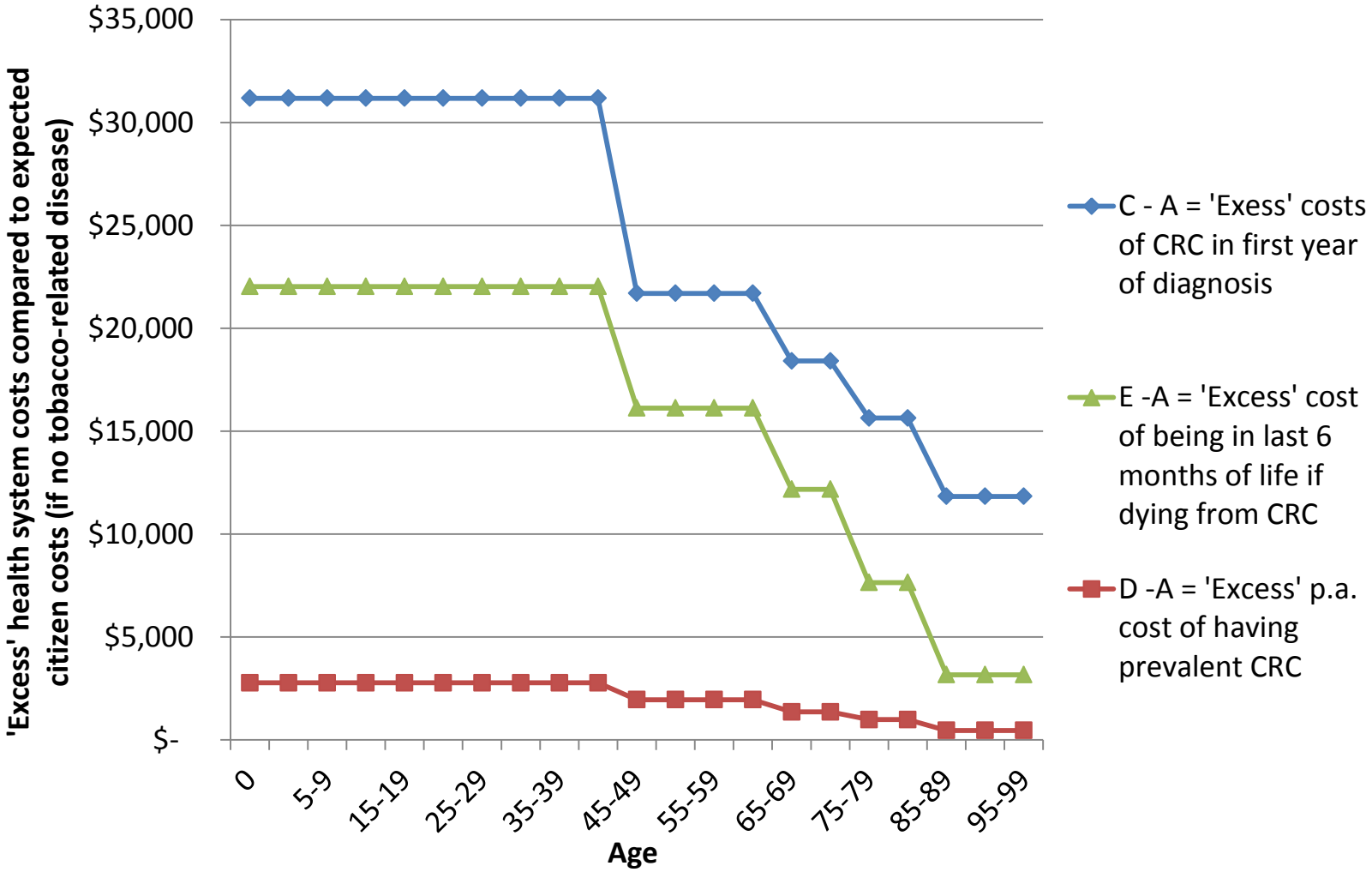
INPUTS (Ministry of Health and other sources)





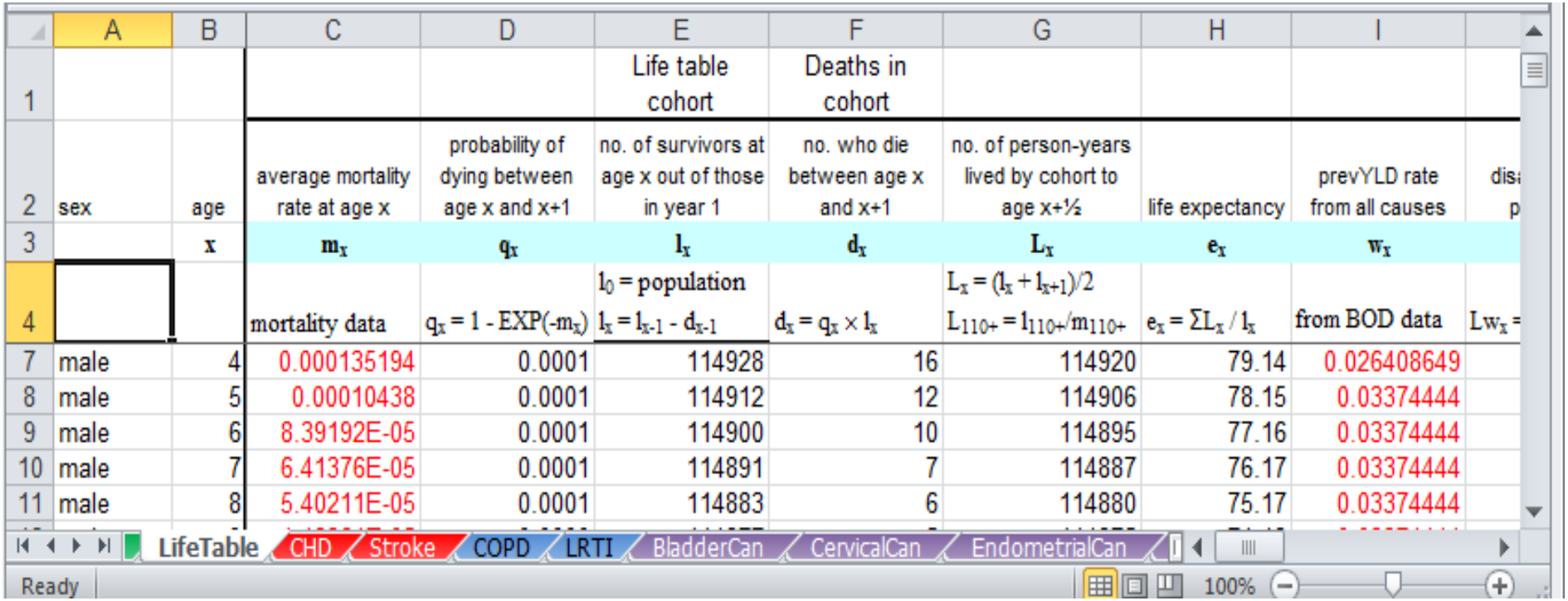
also HealthTracker

Example: Cancer costs (CRC; female) excess health system costs



Methods: multi-state lifetable

- A multi-state lifetable is literally that – a lifetable in which subjects (proportions of a cohort) can be in multiple states simultaneously



	A	B	C	D	E	F	G	H	I
1					Life table cohort	Deaths in cohort			
2	sex	age	average mortality rate at age x	probability of dying between age x and x+1	no. of survivors at age x out of those in year 1	no. who die between age x and x+1	no. of person-years lived by cohort to age x+½	life expectancy	prevYLD rate from all causes
3		x	m_x	q_x	l_x	d_x	L_x	e_x	w_x
4			mortality data	$q_x = 1 - EXP(-m_x)$	l_0 = population $l_x = l_{x-1} - d_{x-1}$	$d_x = q_x \times l_x$	$L_x = (l_x + l_{x+1})/2$ $L_{110+} = l_{110+}/m_{110+}$	$e_x = \Sigma L_x / l_x$	from BOD data
7	male	4	0.000135194	0.0001	114928	16	114920	79.14	0.026408649
8	male	5	0.00010438	0.0001	114912	12	114906	78.15	0.03374444
9	male	6	8.39192E-05	0.0001	114900	10	114895	77.16	0.03374444
10	male	7	6.41376E-05	0.0001	114891	7	114887	76.17	0.03374444
11	male	8	5.40211E-05	0.0001	114883	6	114880	75.17	0.03374444

LifeTable | CHD | Stroke | COPD | LRTI | BladderCan | CervicalCan | EndometrialCan

Ready 100%

Methods – intervention parameterisation

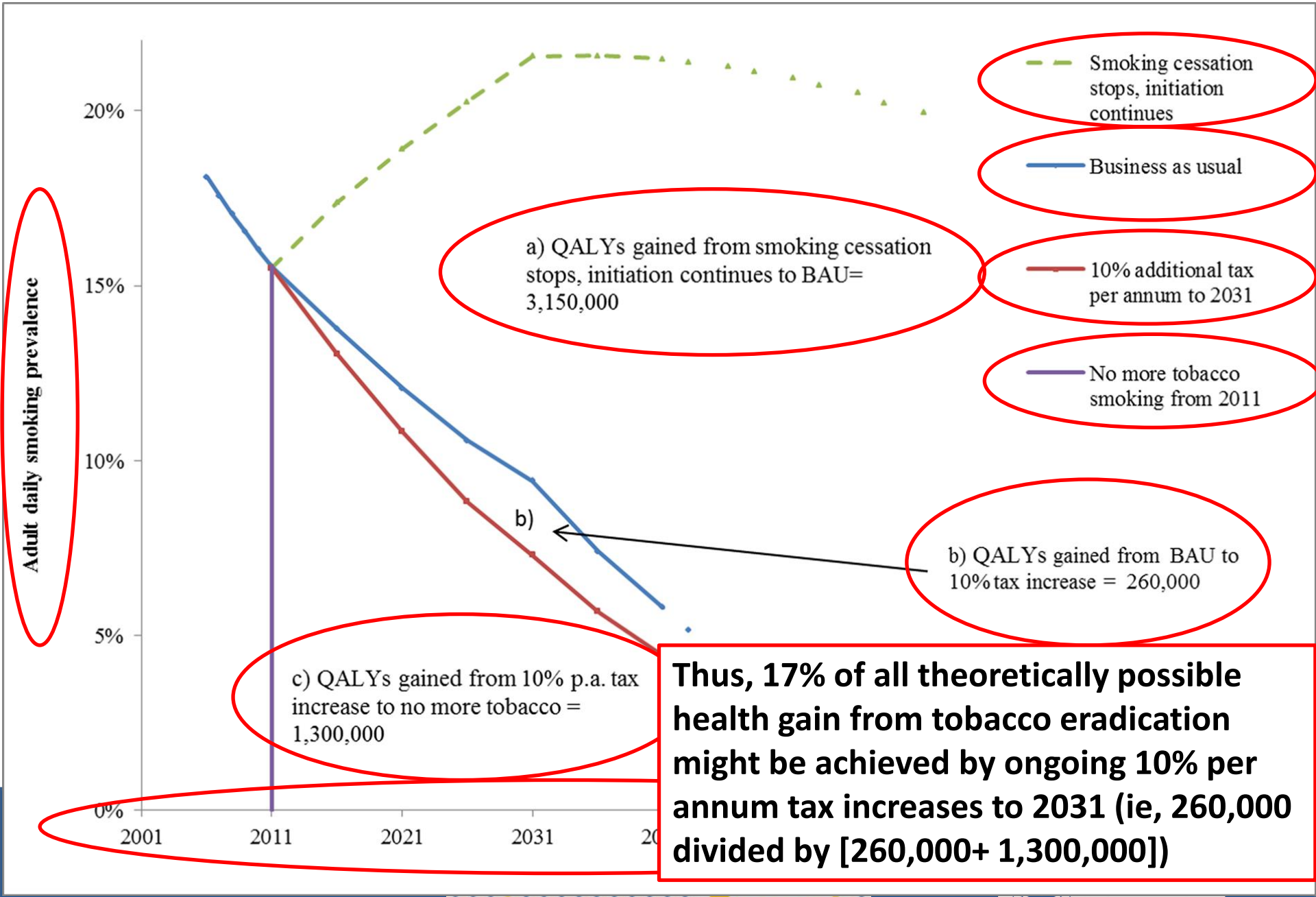
- ↑Tax → ↑price → ↓prevalence and cigs/day:
  - Using price elasticities applied in year of increase only (and in subsequent year in scenario analyses = 'persistence' scenario).
- Relative risks for smoking (NZCMS, other) applied to changing prevalence and cigs/day to calculate population impact fractions (PIFs; aka PAR%), that are then 'fed into' the lifetables to de(in)crease disease incidence.
- Difference in QALYs and cost for 2011 population between comparator and intervention tallied up for rest of their life (max 110 years). 0% discount rate (3% scenario).

What about uncertainty?

- Model structure – what we are assuming:
  - As per tobacco prevalence estimation (eg, PEs into future)
  - Diseases selected, future projections, etc.
- Parameter uncertainty is addressed by running the model 4000 times, each time drawing from probabilistic distributions about parameters, eg:
  - +/- 5% SD for 'accurate' parameters (eg, incidence in 2011)
  - +/- 10% for moderately uncertain parameters (eg, morbidity)
  - +/- 20% for uncertain parameters (eg, price elasticities)
  - … and then scenario analyses about these % SDs themselves

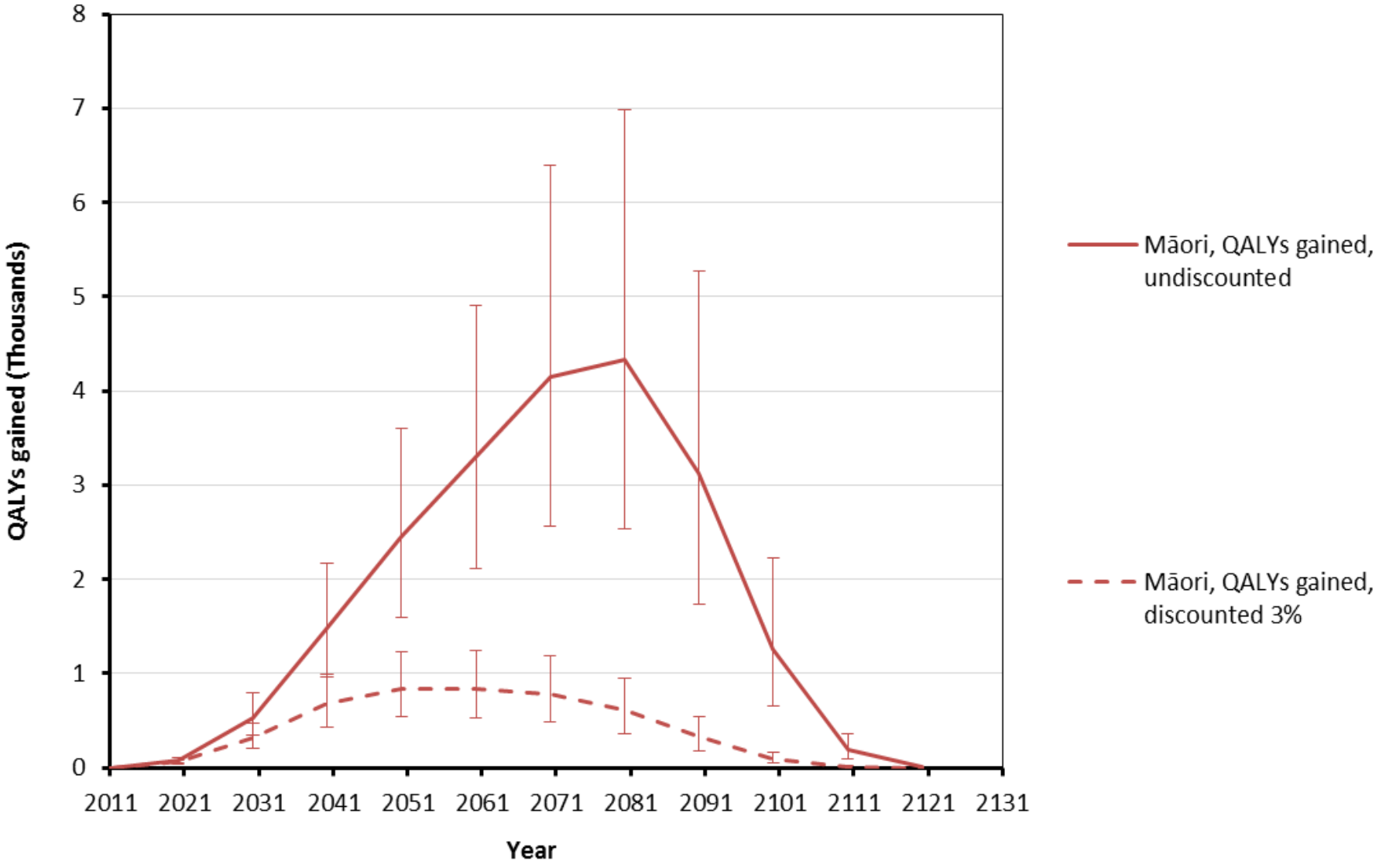
Results: Modelling health gain using quality-adjusted life years [QALYs] from 10% annual tax increases 2011 to 2031

Non-Māori		Māori			Total	
Health gain	**Net cost savings**	**Health gain**	**Health Gain – Equity**	**Net cost savings**	**Health gain**	**Net cost savings**
QALYs	Millions	QALYs		Millions	QALYs	Millions
156,000 (90,300 to 254,000)	**$2550** ($1460 to $4060)	**105,000** (64,100 to 163,000)	**156,000** (91,300 to 247,000)	**$1220** ($738 to $1880)	**260,000** (155,000 to 419,000)	**$3770** ($2200 to $5950)



Thus, 17% of all theoretically possible health gain from tobacco eradication might be achieved by ongoing 10% per annum tax increases to 2031 (ie, 260,000 divided by [260,000+ 1,300,000])

Timing of health gains



Timing of cost savings

Which begs all these questions….

- Will NZ achieve the smokefree goal (5%) by 2025 with ongoing 10% per annum increases in excise tax?
- And what will be the impact, and timing, of such ongoing tobacco tax increases on:
  - Health gains in QALYs?
  - Health system costs?
  - **Mortality inequalities?**

(Should be generalizable qualitatively at least to other countries, with health inequalities in due to tobacco.)

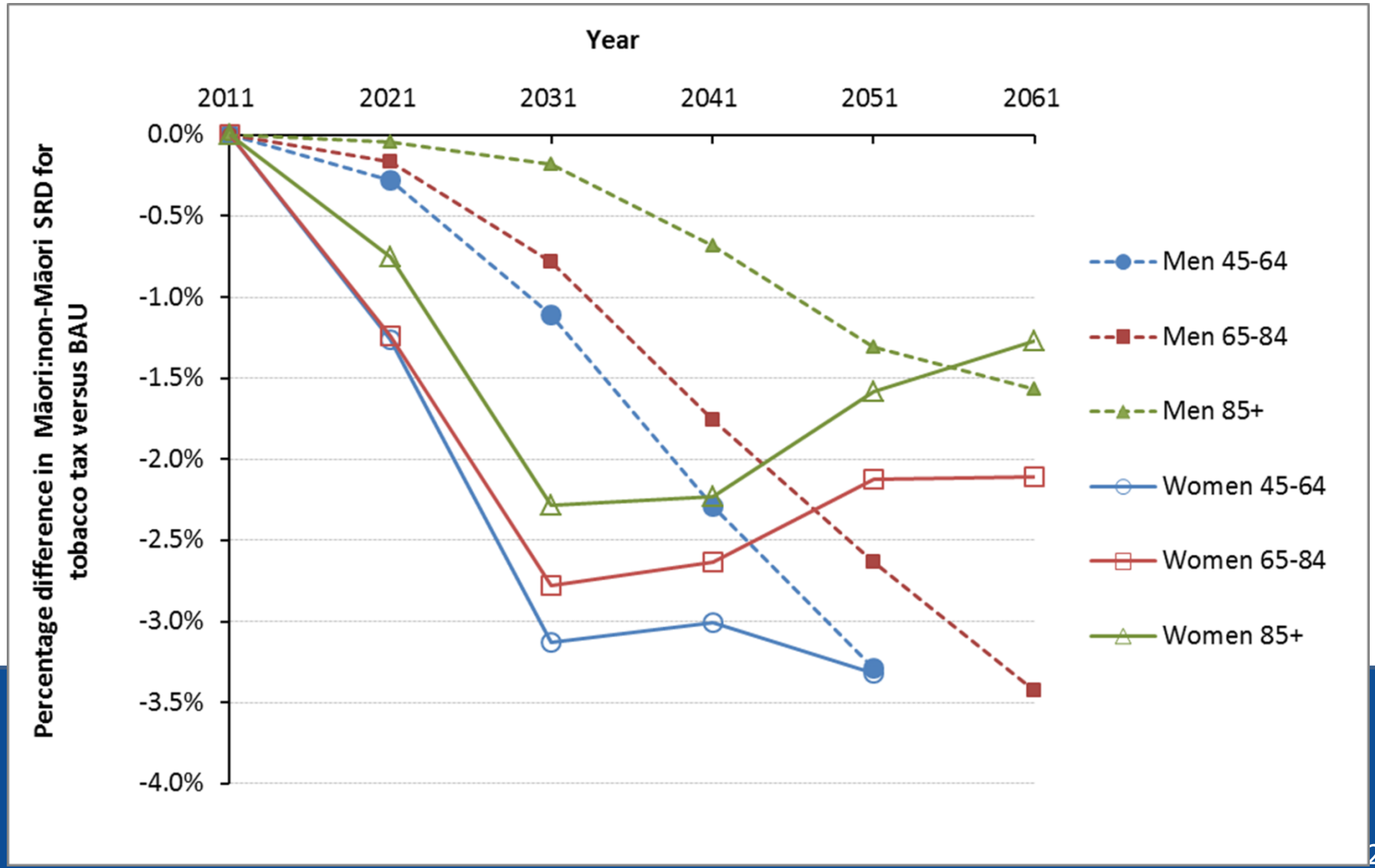
QALYs (undiscounted) gained per capita for 10% tax

	Māori	Non-Māori	RR
'Standard'	0.155	0.042	3.7
Equity analysis *	0.232	0.042	5.5

* Māori have higher mortality and morbidity rates, meaning that a Māori life saved is valued less than a non-Māori life saved. We therefore assign non-Māori mortality and morbidity rates to Māori.

- Strongly pro-equity in relative terms
  - in absolute terms as about 2-3 months extra of life obtained per person for Māori (given starting population structure 2011)

Reduction in Māori:non-Māori mortality inequalities for 10% p.a. tax increases



What are the caveats?

- This modelling – decades into the future (a scenario).
- Assumptions as in previous slides, but to emphasise:
  - 0% discount rate
  - Epidemiological trends projected to 2026, then constant
  - Tobacco tax elasticities constant into the future, and price increase impact on cessation only in year of tax increase
  - All the 'other' model structure assumptions…
  - … but parameter uncertainty captured

Full details & extra results in: Blakely et al *PLoS Medicine* 2015;12(7): e1001856

Extra context (I)

- Impact of increased financial hardship on low-income smokers who don't quit after tax increases:
  - Will probably occur for some
  - But some will cut down and:
    - smoke more intensely (closer to butt, more puffs etc)
    - supplement with low-cost nicotine patches/gum
    - self-import (legal) e-cigarettes
- But adverse impact of increased financial hardship on health for those who don't quit is small compared to direct health impacts of smoking: 42 – 257 times less (Wilson et al *JECH* 2004;58:451-4)
- But other taxes/welfare payments probably impact more than tobacco tax increases & can reduce risks by increased quitting support

Extra context (II)

- QALY gains by age-group (relevant to productivity gains): Only 7% in <65y or 10% in <70y age-groups (DR=3%).
- Growth in illicit trade – included in *Cobiac et al 2015*: small impact as illegal prices assumed to rise with legal prices.
- Tax revenue increases to $3.5 billion in 2025 (base case) (*Cobiac et al 2015*).
- New NZ data on supplementary measures eg, standardised plain packaging equivalent to ~5% tobacco price increase (*Gendall et al 2015 Tobacco Control*).
- We are currently working on estimating more plausible PEs for very high tobacco prices (using budget constraint data).

Conclusions (I)

- 10% (or even 20%) p.a. tax increases will not achieve 2025 goal:
  - Other interventions would also be needed eg, de-nicotinisation
- For a scenario of 10% tax increases p.a. from 2011-2031: Health gains large (260,000 QALYs), and achieves 17% of all possible health gain from getting rid of tobacco
- Will health inequalities between Māori and non-Māori decrease?
  - Yes – modestly by 2-3% (mortality rates).
- Will there be cost savings to the health system?
  - Yes. About NZ$3.8 billion (95% UI: $2.2 to $6.0 billion).
- Timing of health gains and cost savings?
  - Start immediately but 50 years or so to peak, due to tax effecting younger people more, who are still decades away from their NCDs.

Conclusions (II)

- For more rapid health gains (and cost savings, and inequality reduction), more would need to be done for enhancing smoking cessation among middle-age to older smokers (eg, mass media campaigns).
- Future versions of this modelling could be further improved with better estimates of PEs at high tobacco prices (likely to result in increased QALYs gained & increased cost savings) & cross PEs for competing products (e-cigarettes).