

# **Modeling of E-cigarette Use**

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# No Conflicts of Interest

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# Purposes of Modeling

- Examining Past Behavior:  
Past Policies-> Smoking Behaviors ->  
Health Outcomes
- Potential Future Public Health Impacts:  
Potential Future Policies (given current policies) ->  
E-Cigarette and Cigarette Use Patterns ->  
Health Outcomes
- Heuristic: Understanding system aspects,  
helping to determine the information needed  
to evaluate public health impacts\*\*\*

# Models needed, but

*It's tough to make predictions, especially about the future.*

*Yogi Berra*

*In theory, there is no difference between theory and practice. In practice, there is.*

*Yogi Berra*

*If you don't know where you are going, you will wind up somewhere else!*

*Yogi Berra*

# Previous Models: All cohort-based\*

- ❖ Modified Risk Product:
  - Scandia model (Vugrin et al)\*
  - Industry model (Bachand and Sulsky; Bachand, Sulsky, Curtin, Risk Anal; Poland B, Teischinger, NTR; Weitkunat et al. , Reg Tox)\*
- ❖ E-cigarettes: Kalkhoran and Glantz (2016)\*
- ❖ E-cigarettes: Cobb et al. (2015) \*
- ❖ E-cigarettes: Cherng et al (2016)
- ❖ E-cigarettes: Levy et al (2016, 2017)
- ❖ Warner & Mendez\*

*\* While these models follow cohorts, they focus on age => problematic results. The projections are dependent on constant initiation rates and cessation rates by age based on data for a specific time period*

# Reasons to Focus on Cohort

- ❖ Use rates highly dependent on age and surrounding circumstances for a given cohort
  - Awareness and perceived risk
  - Available products with differing appeal, ability to satisfy cravings
  - Differing policies, especially price of e-cigs relative to cigarettes
- ❖ Circumstances at early ages affect later ages (potential to try and progress, past experiences)

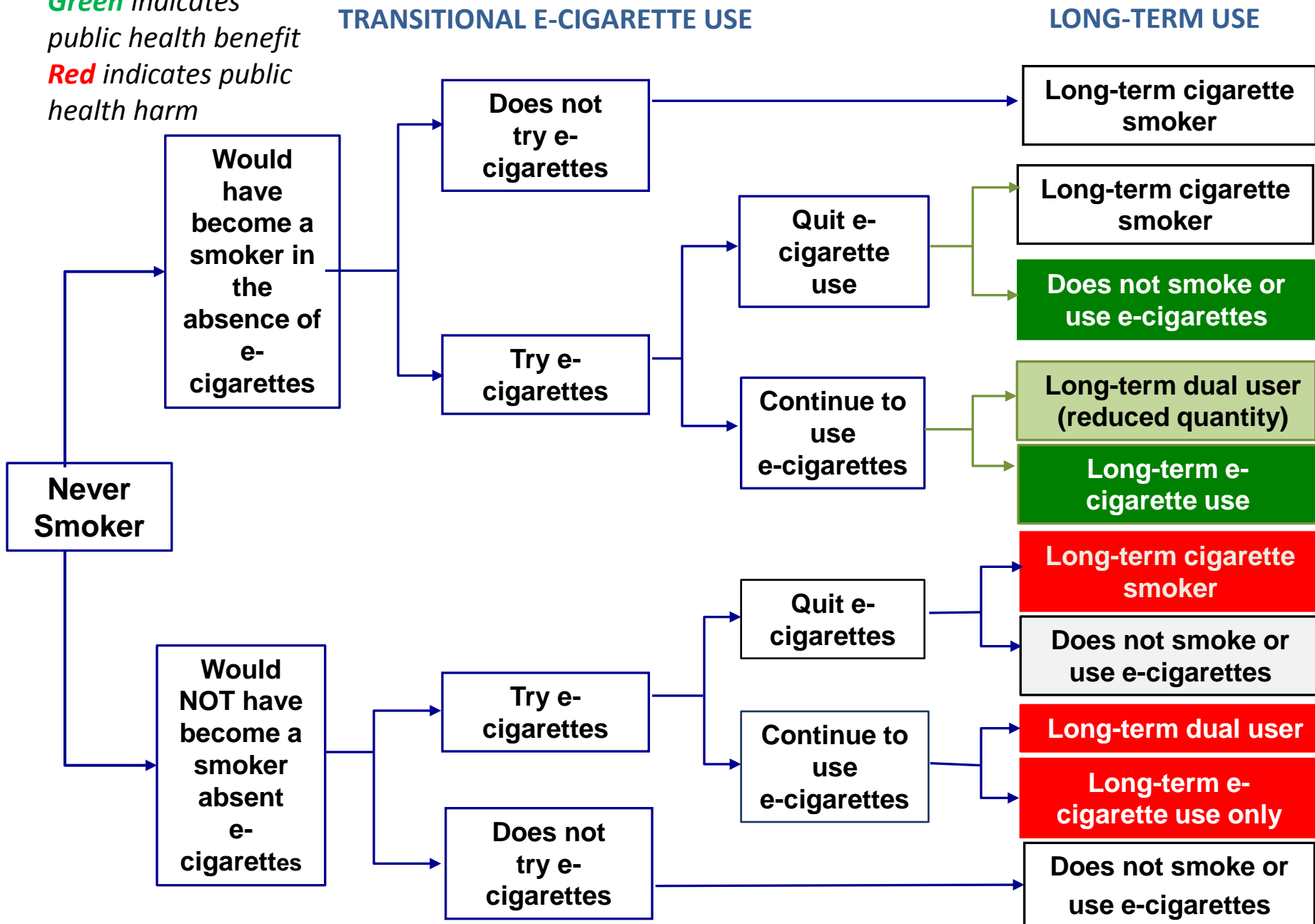
*Evidence that e-cigarette use rates changing considerably by age group over time is suggestive of important cohort effects*

# Levy et al. model (2016, NTR)

- ❖ Unlike earlier models, focuses on a representative single cohort: age 15 in 2012
- ❖ Applies a decision-theoretic framework (Levy et al. 2017, Addiction) grounded in a public health approach to examine the effect of transitions to final states of established use.
- ❖ Public health implications depend on the counterfactual of what would have happened in the absence of e-cigarette use
- ❖ Distinguishes trial use from established e-cigarette use
- ❖ With trial use, individuals may transition to: 1) exclusive e-cigarette use, 2) dual (cig and e-cig) use, 3) exclusive cigarette use, or 4) no use (e-cigarettes as transition to quitting both).

# THE PUBLIC HEALTH IMPACT OF E-CIGARETTE USE AMONG NEVER SMOKERS

**Green** indicates public health benefit  
**Red** indicates public health harm





# Status Quo (smoking only)

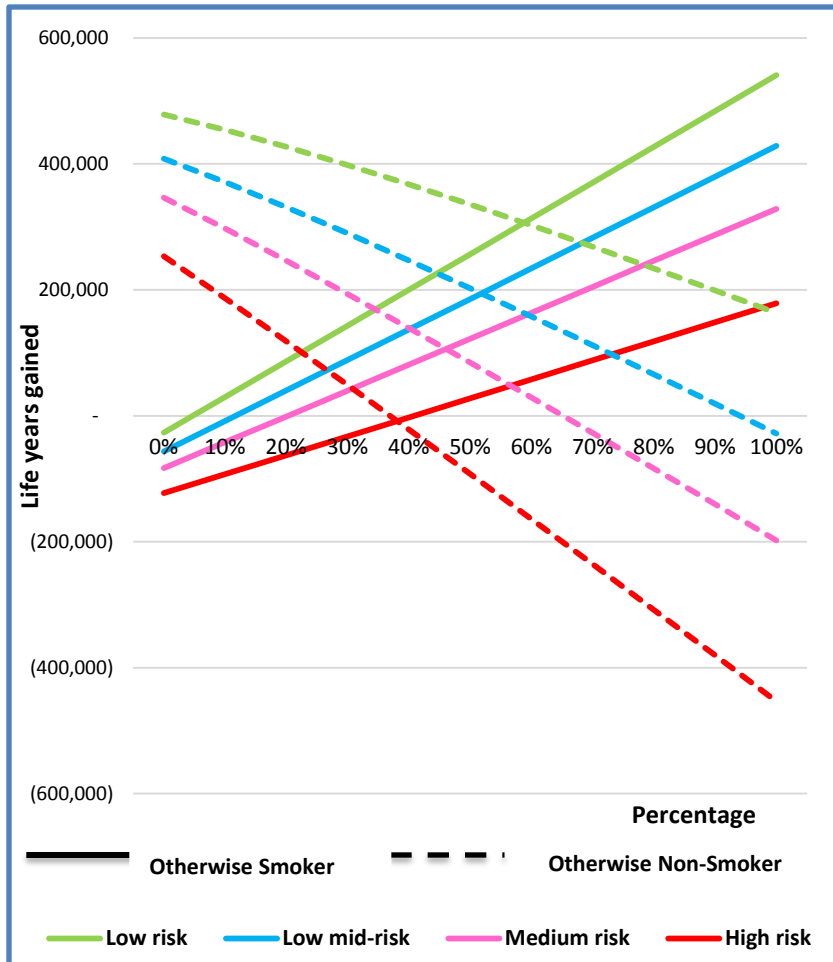
## Counterfactual

- Prevalence by current, former and never smoker using NHIS data through 2010 (Holford et al. AJPM, 2013) updated to 2012 (Holford et al, JAMA 2014). CISNET data developed using age-period-cohort model correcting for differential mortality
- Projections based on NHIS data through 2012 based on initiation and cessation rates (measured as 2 year quit = cessation net of relapse) ***before significant e-cigarette use***
- Death rates based on CPS-I and CPS-II data (recent data suggests higher risks) vary by age and gender and by current, former (reflecting years quit) and never smokers

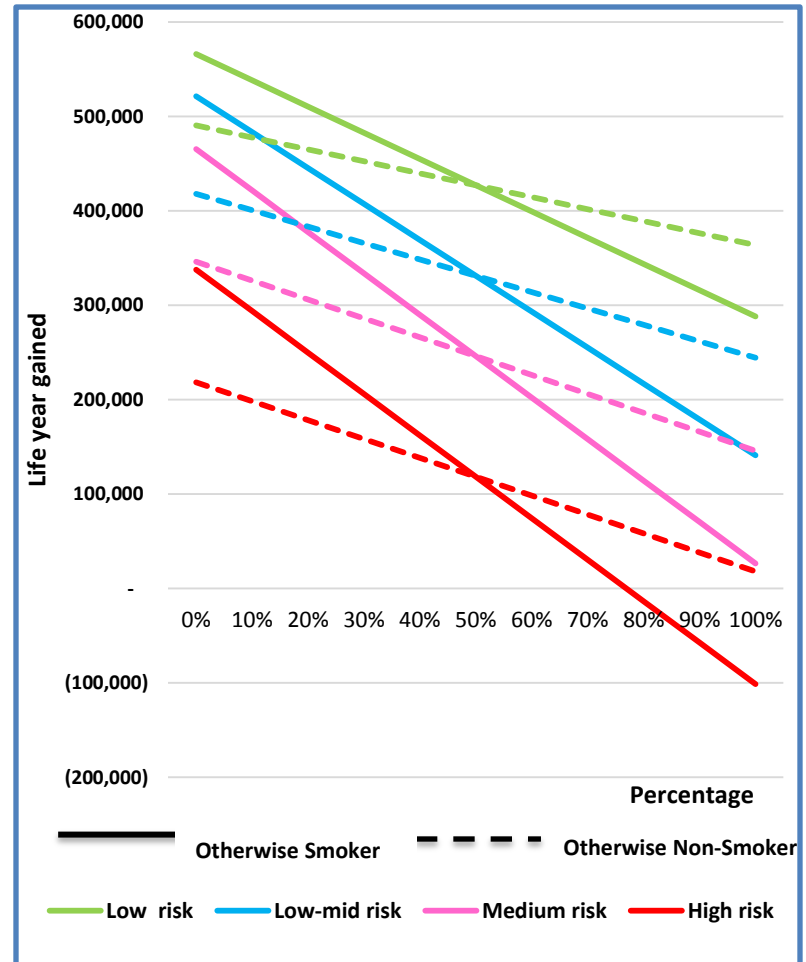
# Results: US Males for 1997 cohort

Scenario	Measure	Age	15	25	45	65	85	Cumulative Ages 15-85	Difference from Status Quo
Status quo	Prevalence	Smoker	4.6%	20.4%	12.7%	5.6%	1.1%		
	SADs		-	-	581	2,116	2,816	79,322	
	LYL		-	-	23,573	46,335	16,706	1,539,242	
Best	Prevalence	Smoker	2.8%	12.4%	7.7%	3.4%	0.6%		
		E- cigarette	1.3%	5.9%	3.7%	1.6%	0.3%		
		Dual	1.3%	5.9%	3.7%	1.6%	0.3%		
Low Risk	SADs		-	-	442	1,522	1,879	56,213	23,109
	LYL		-	-	17,921	33,313	11,147	1,112,151	427,091
Low-mid Estimate	SADs		-	-	480	1,653	2,041	61,058	18,264
	LYL		-	-	19,465	36,184	12,108	1,208,000	331,242
Medium Risk	SADs		-	-	514	1,769	2,185	65,365	13,958
	LYL		-	-	20,838	38,736	12,962	1,293,200	246,042
High risk	SADs		-	-	565	1,944	2,401	71,824	7,498
	LYL		-	-	22,898	42,564	14,243	1,421,000	118,242

# Male Regular Use Sensitivity Analysis



# Male Dual Use Sensitivity Analysis



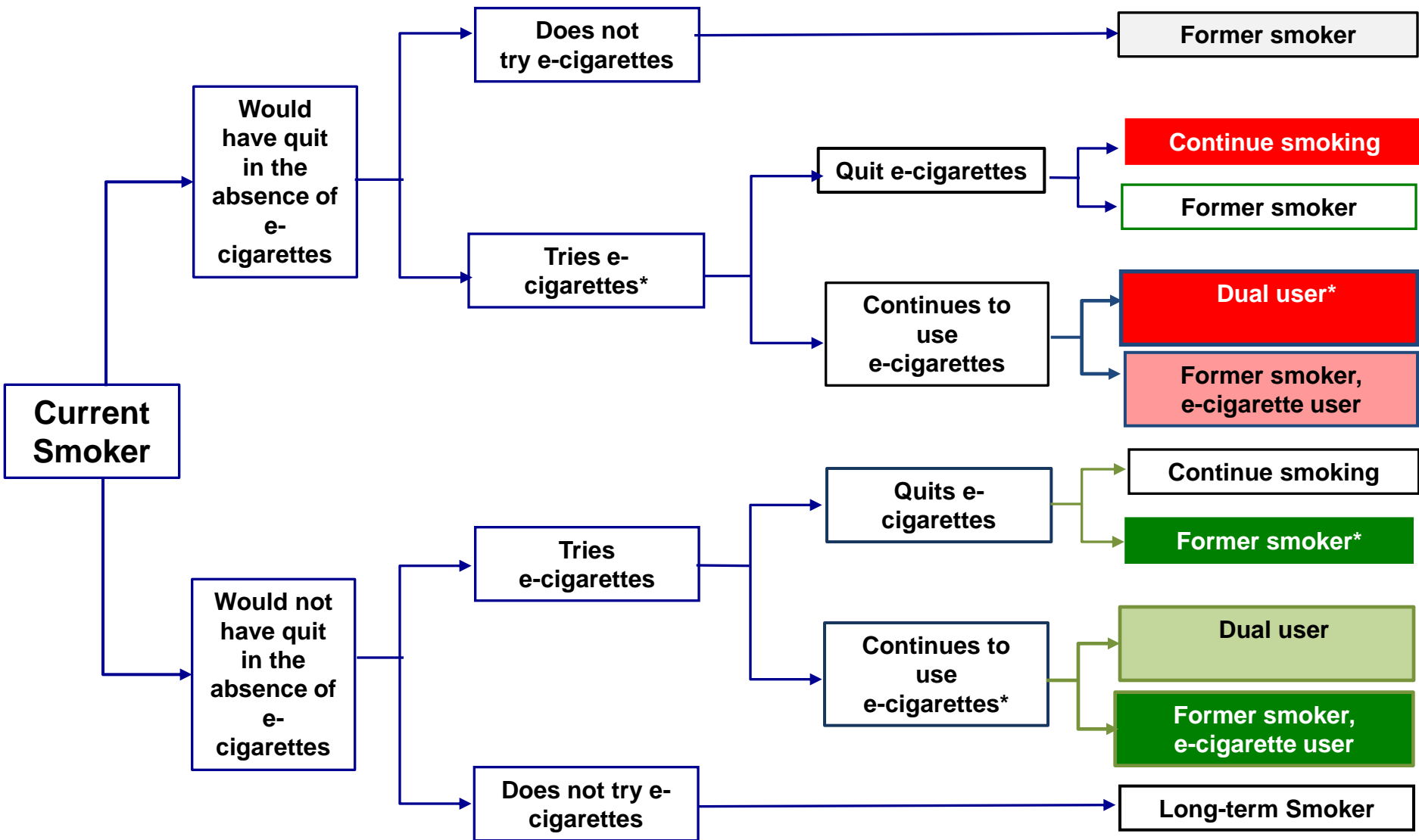
# Implications

- Public health benefits are projected over a wide range of parameters
- Results insensitive to future cessation (not shown)
- Results sensitive to use rates of otherwise smokers vs otherwise non-smokers especially at low risk-> need to continue making cigarettes less appealing (cig taxes, etc), but adopt policies that discourage use by otherwise never smokers (raised MLPA, taxes?)
- Results depend on toxicity-> may reduce harms to users and encourage exclusive rather than dual use
- **Results are highly sensitive to initial use and transition measures**

# THE PUBLIC HEALTH IMPACT OF E-CIGARETTE USE AMONG CURRENT SMOKERS

## TRANSITIONAL E-CIGARETTE USE

## LONG-TERM use



# What could be?

- Previous work projected potential effects, but limited by data, particularly the ability to distinguish cohort effects
- Most recent paper (Tobacco control) looks at the potential impact of e-cigarettes on public health => way to get to the cigarette “endgame”
- Two scenarios: optimistic and pessimistic

# THE TWO SCENARIOS

## ASSUMPTIONS

### OPTIMISTIC

1. Excess mortality risk of e-cigarettes at 5% that of cigarettes
2. Cessation from cigarettes and e-cigarettes at the 100% the rate of cigarette cessation pre-strategy
3. Initiation at the 100% the rate of cigarette initiation pre-strategy
4. Residual cigarette prevalence of 5% after 10 years

### PESSIMISTIC

1. Excess mortality risk of e-cigarettes at 40% that of cigarettes
2. Cessation from cigarettes and e-cigarettes at the 50% the rate cigarette cessation pre-strategy
3. Initiation at the 150% the rate of cigarette initiation pre-strategy
4. Residual cigarette prevalence of 10% after 10 years

## STRUCTURE

- Both scenarios involve switching from cigarettes to e-cigarettes over a ten year period to the residual cigarette prevalence
- Project from 2016 to 2100 by age and gender for US
- Model includes current and former cigarette and e-cigarette prevalence
- Model calculates cigarette and e-cigarette attributable deaths and life year lost



## Status Quo and E-Cigarette Substitution, Premature Deaths and Life Years Lost For All US Cohorts, Males and Females Combined

<b>OUTCOME</b>	Year 2016	2026	2060	2080	2100	Cumulative (2016-2100)	Deaths Prevented/ Life Years Gained**	% Change relative to status quo
<b>Status Quo Scenario*</b>								
<b>Premature Deaths</b>	461,588	470,743	316,556	167,037	2,905	26,065,448		
<b>Life Years Lost</b>	5,689,458	5,625,286	2,626,503	685,593	1,852	248,639,532		
<b>Optimistic Scenario</b>								
<b>Premature Deaths</b>	461,588	380,832	233,243	56,399	459	19,484,289	<b>6,581,159</b>	<b>-25.2%</b>
<b>Life Years Lost</b>	5,689,458	3,839,765	1,345,385	183,297	294	161,905,579	<b>86,733,953</b>	<b>-34.9%</b>
<b>Pessimistic Scenario</b>								
<b>Premature Deaths</b>	461,588	456,297	298,689	127,706	2,188	24,432,065	<b>1,633,383</b>	<b>-6.3%</b>
<b>Life Years Lost</b>	5,689,458	5,261,398	2,319,388	528,926	1,396	227,835,203	<b>20,804,329</b>	<b>-8.4%</b>
* Status Quo Scenario: Smoking Rates evolve from initial 2016 levels based on age, gender and cohort-specific smoking initiation and cessation rates in the absence of e-cigarette use								
** Life Years gained = Life years lost in Status Quo - Life years lost in E-cigarette Substitution Scenario								

# Results and Implications

- Even under pessimistic (worst case scenario), there are gains from a strategy of encouraging switching from cigarettes to e-cigarettes
- Next step to model policies to encourage reduced smoking: two pronged approach
- Stronger policies against cigarettes (now better justified):
  - Traditional Policies- increase cigarette taxes, extend smoke-free air laws, greater retail compliance with minimum purchase
  - New policies- implement strong graphic warnings, raise minimum purchase age, ban retail displays (ban slotting allowances?). Nicotine reduction?
- Policies encouraging switching to e-cigarettes

# Policies to Encourage E-cigarettes

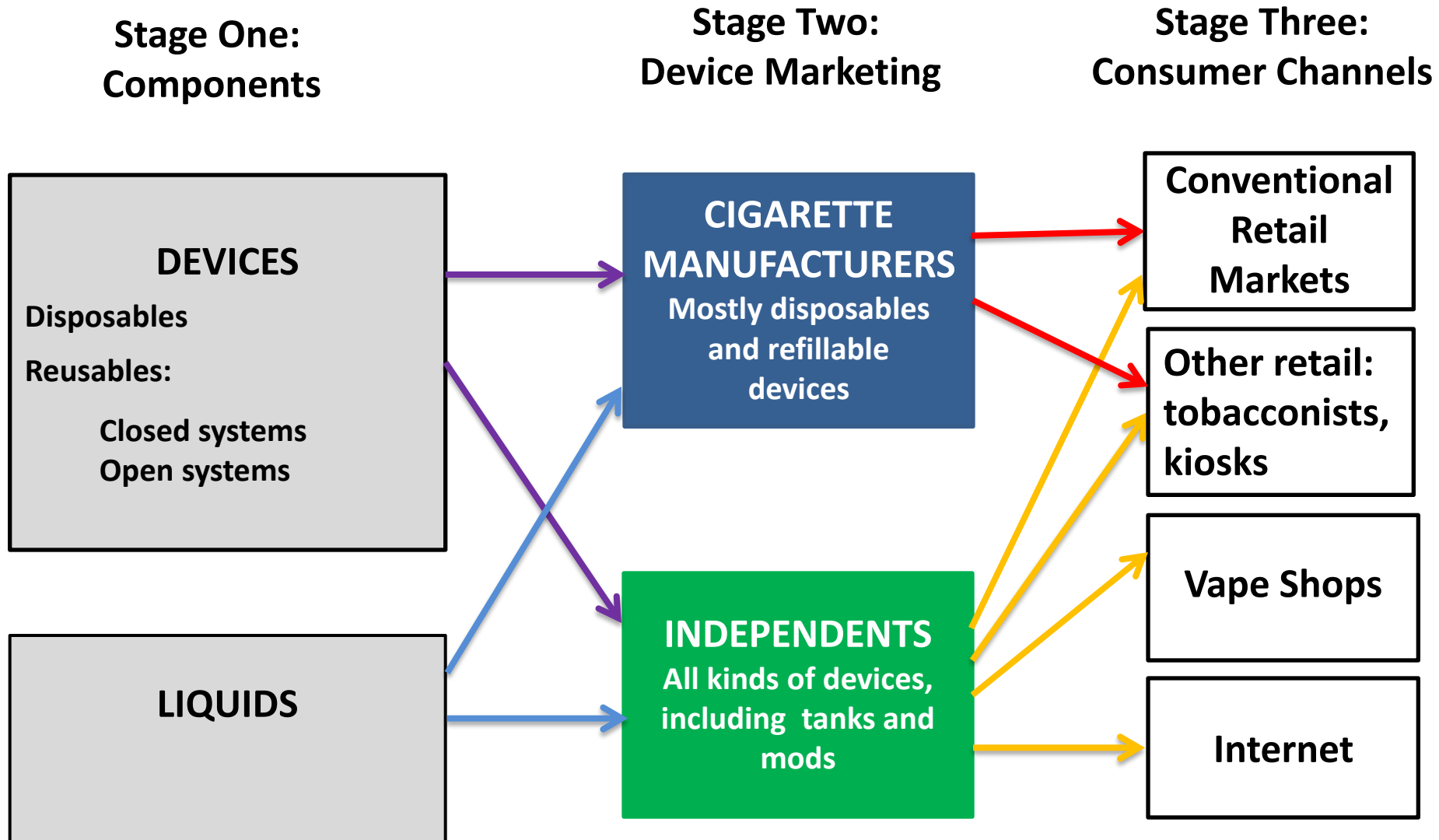
- Policies

- Content unrestricted: toxicity, flavors
- Marketing restrictions, incl. retail point of sale
- Taxes: e-cigarette & cigarette
- Smoke-free air laws
- Messaging regarding risks: media, packaging, news and websites

- Impacts

- Direct on product toxicity, flavorings, types, costs, where used and consumer knowledge
- Indirect through market structure: Independents have different incentives than cigarette firm (protecting profitability of cigarettes)

# Structure of VNP Industry



# Conclusions

- E-cigarette use has beneficial public health impact over a wide range of plausible values
- Cohort analysis is central, will need to examine age patterns over time by cohort
- Will need better measures of use, especially established use (exclusive and dual)
- Much will depend on products available (esp HNB)
- Government regulation and industry structure are likely to play an important role

*Now working on model for England, hope to have results soon*

You can observe a lot by just watching. Yogi Berra

Yogi Berra's wife recently asked, "Yogi, when you die, where do you want to be buried, in Montclair, New York or in St. Louis?"

Yogi: "I don't know, Carmen, why don't you surprise me?"