

Modeling of E-cigarette Use

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Purposes of Modeling

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

Previous Models:

- ❖ Modified Risk Products:
 - FTC model: Scandia (Vugrin et al)*
 - Industry models: Bachand and Sulsky; Bachand, Sulsky, Curtin, Risk Anal; Poland B, Teischinger, NTR; Weitkunat et al., Reg Tox
- ❖ E-cigarettes: Kalkhoran and Glantz (2016),* Cobb et al. (2015),* Cherng et al (2016),* Levy et al (2016, 2017), Soneji et al. (2018)

** Most e-cigarette models meant to be predictive rather than hypothetical*

Hypothetical Impacts: Two Scenarios

STRUCTURE

- Both scenarios involve hypothetical rates of 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

Levy et al. 2017, Tobacco Control

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 of 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

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

OUTCOME	Year 2016	2026	2060	2080	2100	Cumulative (2016-2100)	Deaths Prevented/ Life Years Gained*	% Change relative to status quo
Status Quo Scenario								
Premature Deaths	461,588	470,743	316,556	167,037	2,905	26,065,448		
Life Years Lost	5,689,458	5,625,286	2,626,503	685,593	1,852	248,639,532		
Optimistic Scenario								
Premature Deaths	461,588	380,832	233,243	56,399	459	19,484,289	6,581,159	-25.2%
Life Years Lost	5,689,458	3,839,765	1,345,385	183,297	294	161,905,579	86,733,953	-34.9%
Pessimistic Scenario								
Premature Deaths	461,588	456,297	298,689	127,706	2,188	24,432,065	1,633,383	-6.3%
Life Years Lost	5,689,458	5,261,398	2,319,388	528,926	1,396	227,835,203	20,804,329	-8.4%
* 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
- Potential for major gains in optimistic scenario

Predictive: Levy et al. Initiation Model (2017, Nic Tob Res)

- ❖ Unlike other 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.
- ❖ 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).
- ❖ Public health implications depend on the counterfactual of what would have happened in the absence of e-cigarette use

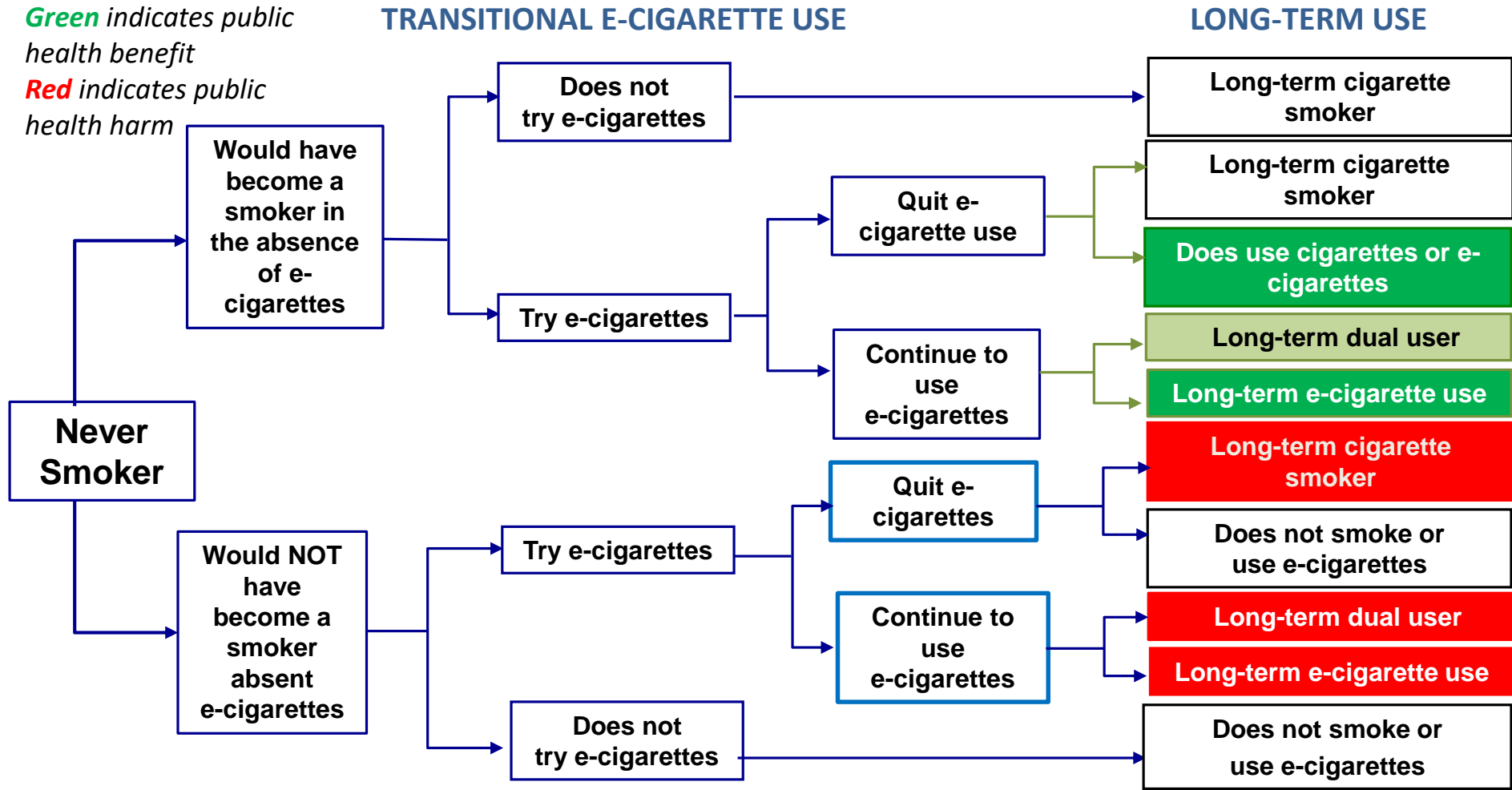
Results: US Males for 1997 cohort

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

Predictive, But Heuristic: The Public Health Impact of E-cigarette Use Among Never Smokers

Green indicates public health benefit

Red indicates public health harm



In Examining Past Behavior, Need to Focus on Useful Measures

- ❖ **Need to determine useful measures of experimental and long-term use**
- ❖ **Measures may need to vary by cohort as well as age**, i.e., Circumstances at early ages affect later ages (past experiences)
 - Awareness and perceived risk
 - Previous experience: Available products with differing appeal, ability to satisfy cravings
 - Differing policies, especially price of e-cigs relative to cigarettes

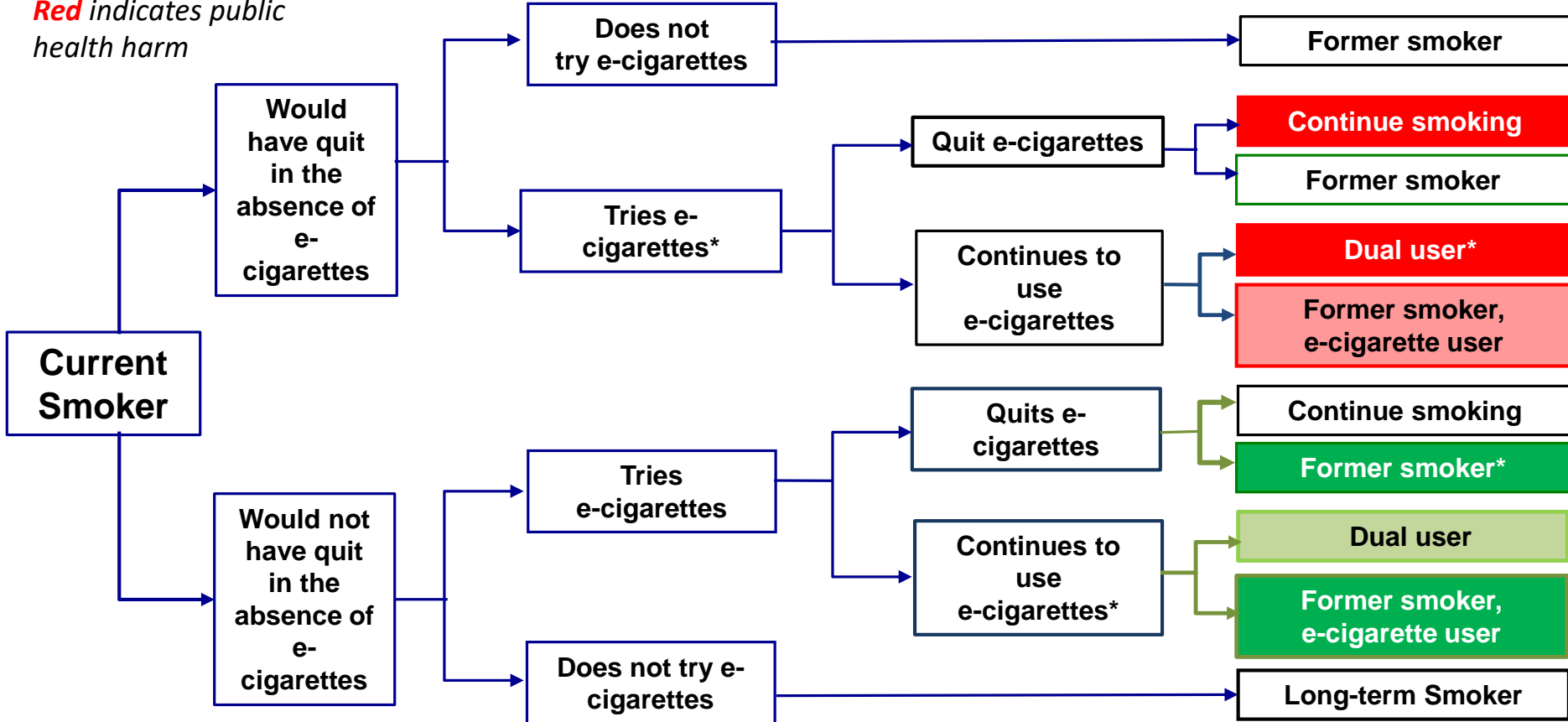
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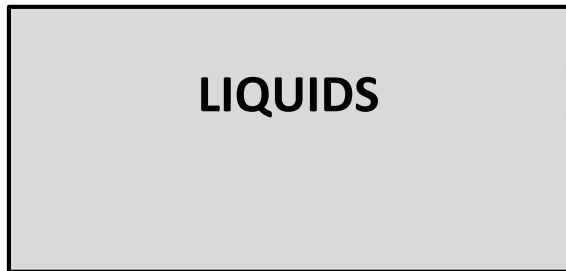
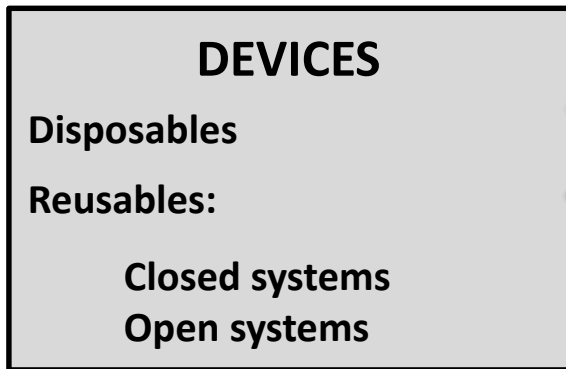
TRANSITIONAL E-CIGARETTE USE

LONG-TERM use



Heuristic: Need to Consider the Structure of the E-Cigarette Industry

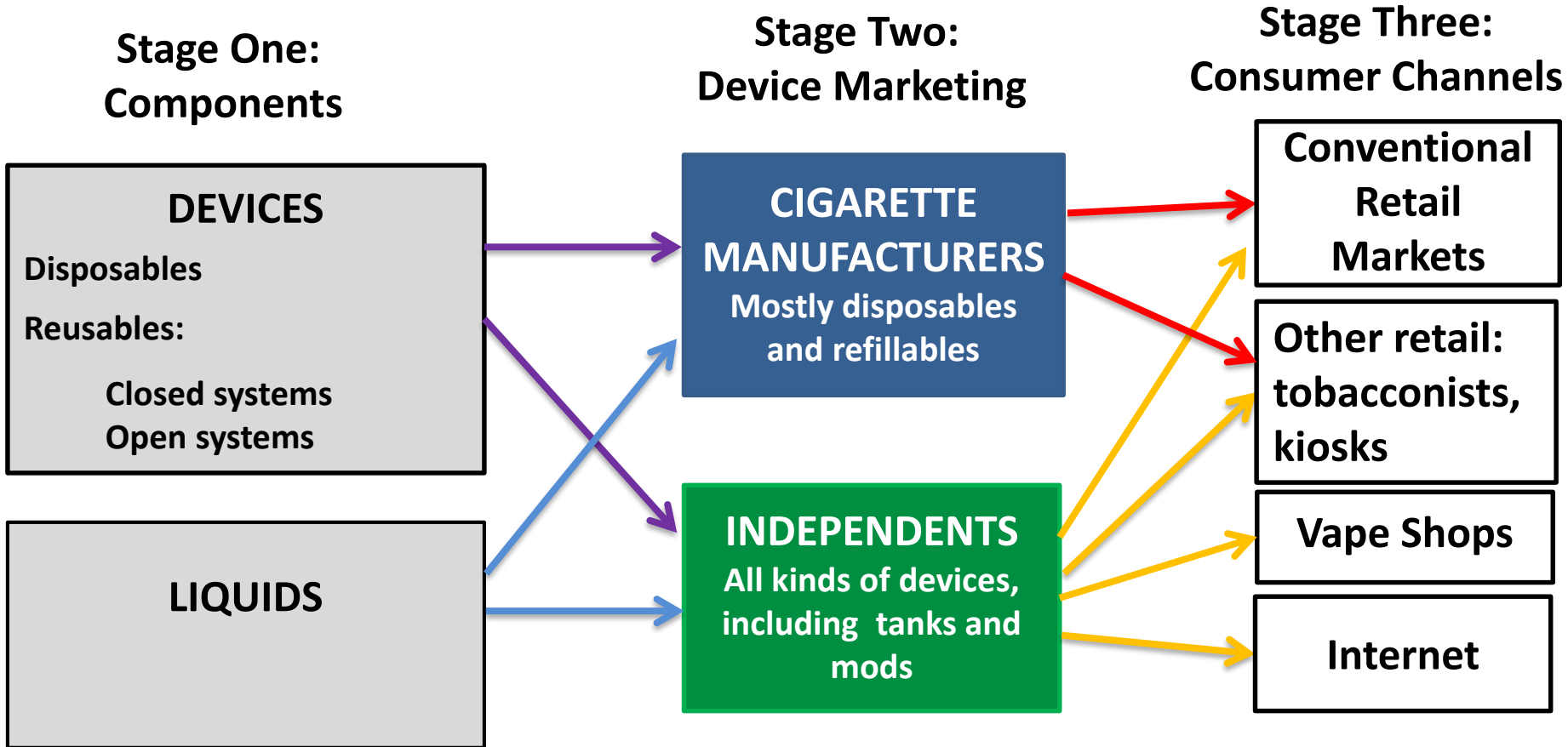
Stage One: Components



Stage Two: Device Marketing



Stage Three: Consumer Channels



Market Structure (Based on Antitrust Guidelines)

Horizontal (competition at product level):

- **E-cigarettes- many different types and more product variety than cigarettes (disposables and close and open system reusables) with much innovation**
- **Markets less distinct- increasingly closer substitute to cigarettes.**
- **New products which are potential close substitutes, e.g. heat-not-burn**

Vertical (different stages of production):

- **Manufacture of devices and liquids- much produced in China**
- **Sellers of devices, mostly US: responsible for pricing and marketing of products**
- **Distribution channels: retail stores (mass market and kiosks), vape shops, internet**

Conglomeration (firms producing different final products)

- **Cigarette manufacturers producing e-cigarettes (also smokeless and cigars**
- **Independents = largely independent firms, many technology-oriented**

US Market Consumer Channels and Industry Shares

	2014	2015	2016	2017	MARKET SHARES
E-cigarettes (Disposables and Closed system)	1,000	1,400	1,600	1,400	31.8%
Mass Market (Retail convenience store, Food, Drug stores)	600	600	700	700	15.9%
Online	200	400	500	400	9.1%
Other Retail (including kiosks)	200	400	400	300	6.8%
Vapors/Tanks/Mods & Personal Vaporizers (Open System)	1,500	1,900	2,500	3,000	68.2%
Convenience Store, Food, Drug and Mass Retail	300	300	500	500	11.4%
Online and other retail outlets	300	400	600	700	15.9%
Vape Shops	900	1,200	1,400	1,800	40.9%
Total	2,500	3,300	4,100	4,400	100.0%

Market shares:

Source: Wells Fargo Securities

Type: Open Systems 68%, Closed Systems and Disposables 32%

**Consumer sectors: Mass market retail 27%, Other retail 7%-20%, Online 15-20%,
Vape shops 41%**

**Cigarette Manufacturers: mostly mass market retail (27%) where they are 65%
(Vuse, MarkTen, Blu and Logic) =>
total market share of approximately 18%-25%**

Economic Framework: Entry Barriers

Horizontal:

Production- appears to be minimal economies of scale and can purchase from other China, vape shops appear to require minimal investment (and franchised)

Marketing- internet and word of mouth are important, does not appear to be require large expenditures for mass media

Vertical:

Entry barriers foreclosures of market downstream, e.g., through retail shelf-space

Limit supplies of essential inputs upstream- not likely for e-cigarettes, unless proprietary or patents or regulatory hurdles to product devices or e-liquids (can be produced in China)

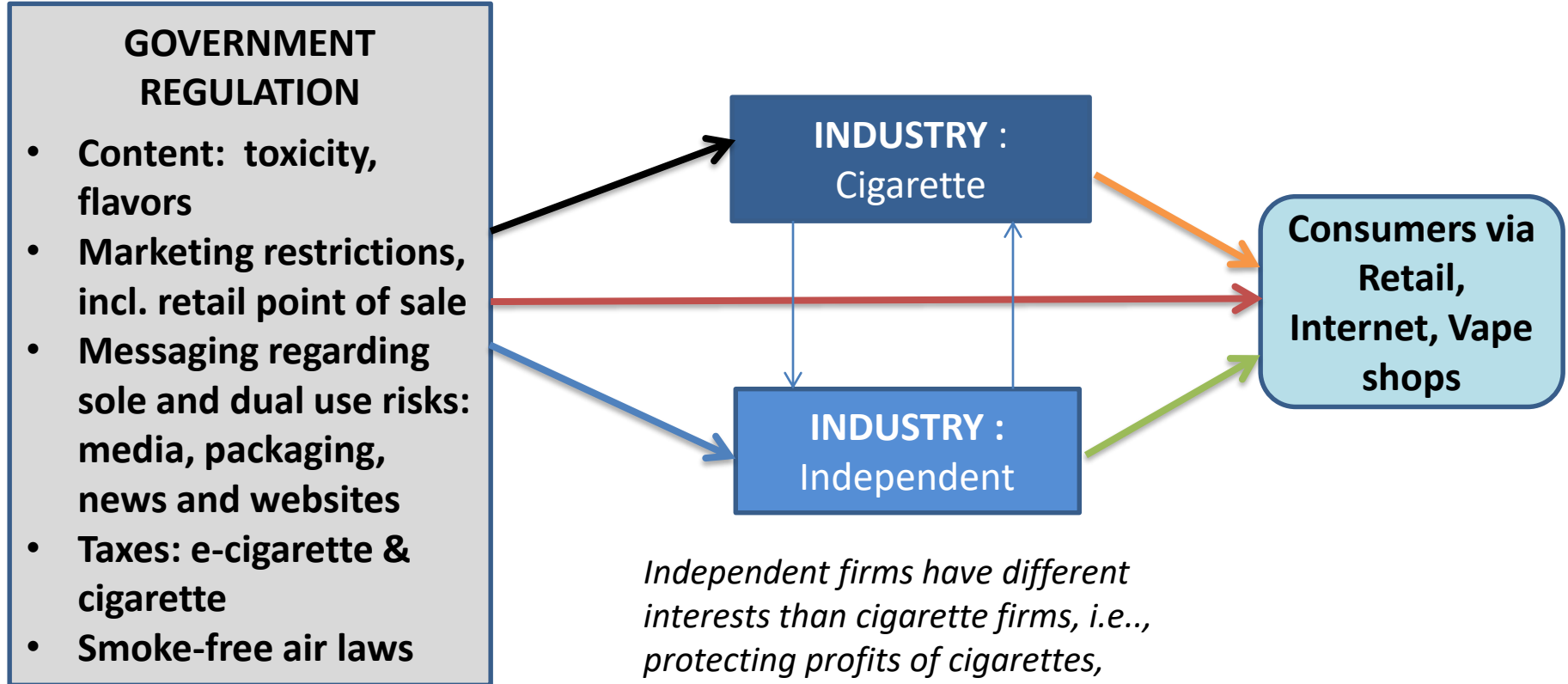
Government regulations: before deeming was small, but now unclear, some at state level

US Market Conduct

- Competitive: With minimal concentration and low entry barriers (subject to government regulation)
- Prices of specific products have been falling over time
- New products through innovation: recent growth in sales of Juul
- Demand may to have flattened for some products, but growth in others (e.g., Juul)
- Future growth likely to depend on regulations, information dissemination about risks and new products, smoke-free air laws and taxes

The market structure and conduct of firms in this industry is very different from the prior (pre-2005) experience in the cigarette market

Heuristic: Government Regulation and Market Structure: Further complexity



Independent firms have different interests than cigarette firms, i.e., protecting profits of cigarettes, but compete with each other

Modeling policies to encourage switching

Two pronged approach being considered in the US

- **Stronger policies discouraging cigarettes:**
 - 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:**
 - Content unrestricted: toxicity, flavors
 - Marketing restrictions, incl. retail point of sale, but geared toward youth
 - Taxes: e-cigarette low relative to cigarettes
 - Smoke-free air laws
 - Messaging regarding risks: media, packaging, news and websites

Modeling the Impact of Policies

- Policies: need to distinguish the effects of cigarette-oriented and e-cigarette oriented policies
- Impacts
 - Direct on product toxicity, flavorings, types, costs, where used and consumer knowledge
 - Interactive effects, i.e., cigarette policies may have greater effects with non-restrictive e-cigarette policies
 - Indirect through market structure: Independents have different incentives than cigarette firms (protecting profitability of cigarettes)

Conclusions

- E-cigarette use has beneficial public health impact over a wide range of plausible values
- To model actual trends:
 - 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

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

Yogi Berra's wife 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?"