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The impact of e-cigarette and cigarette prices on e-cigarette and cigarette sales in California

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ABSTRACT

Although numerous studies have examined the impact of cigarette prices on cigarette demand, research examining the impact of e-cigarette and cigarette prices on e-cigarette demand is relatively limited. This study estimated the impact of e-cigarette and cigarette prices on e-cigarette and cigarette sales in California.

Using the 2012–2017 Nielsen Retail Scanner Data, we constructed e-cigarette prices, cigarette prices, and per capita e-cigarette and cigarette sales by year, quarter, and Nielsen scantrack market in California. E-cigarettes were categorized as disposable or reusable. Separate fixed-effects models estimated the impact of e-cigarette and cigarette prices on per capita disposable e-cigarette, reusable e-cigarette, and cigarette sales controlling for year, quarter, market, and smoke-free air law coverage.

Average prices were $5.86 per pack of 20 cigarettes, $9.80 per disposable e-cigarette, and $19.11 per reusable e-cigarette. When prices of disposable e-cigarettes, reusable e-cigarettes, and cigarettes increased by 1%, per capita sales of the products decreased by 0.37%, 0.20%, and 0.21% respectively. Cigarette prices were positively associated with per capita sales of reusable e-cigarettes, indicating reusable e-cigarettes are substitutes for cigarettes. Reusable e-cigarette prices were positively associated with per capita sales of disposable e-cigarettes, indicating disposable e-cigarettes are substitutes for reusable e-cigarettes. No statistically significant association was found between disposable/reusable e-cigarette prices and cigarette sales.

Our results suggest that raising prices of disposable e-cigarettes, reusable e-cigarettes, and cigarettes such as via tobacco excise tax increases would result in reduced sales for the products. Policymakers should consider the substitution between e-cigarettes and cigarettes when designing tobacco control policies.

1. Introduction

Electronic cigarette (e-cigarette) use has increased among adults and youth in the U.S. in recent years. In the U.S., 3.2% of adults aged 18 and older currently used e-cigarettes every day or some days in 2018 (Creamer et al., 2019). The prevalence of young adults (aged 18–24 year old) who currently used e-cigarettes every day or some days increased from 5.2% in 2017 to 7.6% in 2018 (Wang et al., 2018; Dai and Leventhal, 2019). E-cigarette use increased by 32.2% (from 20.8% in 2018 to 27.5% in 2019) among high school students and increased by 114.3% (from 4.9% in 2018 to 10.5% in 2019) among middle school students (Gentzke et al., 2019; Wang et al., 2019). In California, 3.0% of adults used e-cigarettes every day or some days (Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance System, State Tobacco Activities Tracking and Evaluation System, 2017) and 17.3% of high school students used e-cigarettes on at least one day in the past 30 days in 2017 (Centers for Disease Control and Prevention, Youth Risk Behavior Surveillance System, 2017).

While a large number of studies have examined the impact of conventional cigarette prices on the demand for conventional cigarettes,

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research examining the impact of e-cigarette/cigarette prices on the demand for e-cigarettes is limited. A few studies have estimated own-price elasticity (i.e. the percentage change in quantity demanded in response to a percentage change in price) for e-cigarettes using retail store scanner data. Separating disposable e-cigarettes from reusable e-cigarettes, Huang and colleagues (Huang et al., 2014) used the 2009–2012 Nielsen Retail Scanner data for all U.S. markets and estimated that the own-price elasticities for disposable and reusable e-cigarette sales were −1.2 and −1.9, respectively, indicating that a 1% increase in disposable e-cigarette prices would reduce disposable e-cigarette sales by 1.2% and a 1% increase in reusable e-cigarette prices would reduce reusable e-cigarette sales by 1.9%. In a later study using the 2007–2014 Nielsen Retail Scanner data for all U.S markets, Huang and colleagues (Huang et al., 2018) estimated the own-price elasticity for disposable and reusable e-cigarettes as −1.6 and −1.4 respectively. Combining all types of e-cigarettes together, Zheng et al. (2017) used the 2009–2013 Nielsen Retail Scanner data for U.S. convenience stores only and estimated that own-price elasticity of e-cigarettes sales was −2.1. Another study that used the 2011–2017 Nielsen Retail Scanner data for all U.S. market, a working paper by Cotti and colleagues, estimated that own-price elasticity of e-cigarettes was −1.5 (Cotti et al., 2020). Several data sources including the 2013–2017 Nielsen Retail Scanner data were used in another working paper conducted by Allcott and colleagues estimated an e-cigarette own-price elasticity of −1.3 (Allcott and Rafkin, 2020).

Studies have reported mixed results for cross-price elasticity (i.e. the percentage change in quantity demanded for one product in response to a percentage change in price of another product) of e-cigarette sales in response to cigarette prices. Zheng et al. (2017), and Cotti et al. (2020) found statistically significantly positive cross-price elasticities of e-cigarettes sales in response to cigarettes prices by lumping all types of e-cigarettes together. However, analyzing disposable and reusable e-cigarettes separately Huang et al. (2014), did not find a statistically significant relationship between cigarette prices and either disposable or reusable e-cigarette sales for all store types while another study conducted by Huang et al. (2018) found a significantly positive relationship between cigarette prices and disposable e-cigarette sales with a cross-price elasticity of 3.15 when focusing on convenience stores only.

Very few studies estimated the cross-price elasticity between disposable and reusable e-cigarettes. Using the 2009–2012 Nielsen Retail Scanner data Huang et al. (2014), found that increasing reusable e-cigarette prices would increase disposable sales. Similarly, increasing disposable e-cigarette prices would increase reusable e-cigarette sales. However, neither of them was statistically significant.

California has developed a world-renowned comprehensive tobacco control program and is nationally and internationally recognized for its success in tobacco control (Roeseler and Burns, 2010). In 2017, California voters approved an increase in the cigarette excise tax of $2.00 per pack, with equivalent increases on other tobacco products including e-cigarettes implemented a few months later (California Department of Health Care Services, 2020). These tax increases resulted in price increases for tobacco products and offer a unique opportunity to analyze how the tax increases on cigarettes and e-cigarettes may affect the demand for e-cigarettes and cigarettes in California. This study estimates the own-price elasticity of demand for disposable and reusable e-cigarettes (the two major types of e-cigarette products available during the time period of this study), and the impact of changes in cigarette prices on the demand for these e-cigarette products in California. We also estimate the impact of prices for one type of e-cigarette on the demand for another type of e-cigarettes. In addition, in order to examine if the cross-price effects are symmetric and if tax increases on e-cigarettes will have any unintended effects of increasing cigarette sales, we estimate the impact of e-cigarette prices on the demand for cigarettes. Our estimates of cross-price elasticity will provide policymakers information about whether e-cigarettes and cigarettes are substitutes or complements which will inform the design of tobacco control policies.

2. Materials and methods

2.1. Data source

We analyzed data from the 2012–2017 Nielsen Retail Scanner (NRS) dataset. The NRS dataset is one of the few datasets that contains data on sales and prices for both cigarettes and e-cigarettes. It contains detailed information on weekly pricing, sales in dollars, and volume of sales by product (including e-cigarettes and conventional cigarettes) generated from point-of-sale systems from more than 35,000 participating retail stores across all U.S. markets beginning in 2006. Participating retailers include food stores (such as Safeway and Whole Foods), drug stores (such as CVS and Walgreens), mass merchandisers (such as Target and Costco), and convenience stores. The data cover more than half the total sales volume of grocery and drug stores and more than 30% of all mass merchandiser sales volume in the U.S. (The Kilts Center for Marketing, University of Chicago Booth School of Business, 2020) The NRS dataset includes geographic information such as zip code and Federal Information Processing Standard (FIPS) state and county codes, so we can identify California-specific data. There are four scantrack markets in California in the NRS data: Los Angeles, Sacramento, San Diego, and San Francisco.

2.2. Identifying different types of e-cigarettes

We categorized e-cigarette products into 2 mutually exclusive types: disposable and reusable. Disposable e-cigarettes are those no longer useable once the battery is drained or e-liquid is exhausted (Huang et al., 2014). Reusable e-cigarettes (or refillable/rechargeable e-cigarettes) are those that use rechargeable or replaceable batteries and refillable cartridges, and can be used many times (Huang et al., 2014). Disposable and reusable e-cigarettes are significantly different from each other in terms of product characteristics and prices (Huang et al., 2014). We identified e-cigarette products using UPC (Universal Product Code) information contained in the NRS data. UPC code descriptions were obtained using data from the GS1 US (https://www.gs1us.org/), an organization that provides detailed product identification data for UPCs and barcodes. Finally, we used the company/brand websites to verify our product categorization.

2.3. Dependent variables

2.3.1. Per capita sales volume of e-cigarettes

The NRS Data provides the weekly dollar value and quantity (in terms of number of units) of e-cigarette sales. First, we aggregated the weekly dollar value and quantity of e-cigarette sales by year, quarter, and scantrack market for each type of e-cigarette. Second, the total sales volume (i.e, pieces) of e-cigarette sales in a given year/quarter/market was calculated by multiplying the total quantity (i.e, total number of units) of sales in that year/quarter/market by the number of e-cigarettes contained in each individual unit (because one unit of e-cigarettes may contain more than one e-cigarette). Lastly, the per capita sales volume of e-cigarettes was derived by dividing the total sales volume in a year/quarter/market by the total population for persons aged 0 + in that year/quarter/market for each type of e-cigarettes (Huang et al., 2014, 2018).

2.3.2. Per capita sales volume of cigarettes

The per capita sales volume (packs) of cigarettes was constructed using the same method as used for constructing per capita sales volume of e-cigarettes.

2.4. Independent variables

2.4.1. E-cigarette prices

For each type of e-cigarette in each year/quarter/market, the price per piece was calculated by dividing total dollar sales by total sales volume. These nominal prices were then adjusted for inflation to 2017 dollars using the 2012–2017 Consumer Price Index obtained from the Bureau of Labor Statistics to generate a real price series for each type of e-cigarettes.

2.4.2. Cigarette prices

The average inflation-adjusted cigarette price per pack in a given year/quarter/market for all brands was constructed using the same method as described for e-cigarettes.

2.4.3. Year dummies

Five dichotomous variables representing years 2013–2017 (2012 was omitted as the reference group) were created to capture time-varying influences on e-cigarette sales.

2.4.4. Quarter dummies

Three dichotomous variables representing quarters 2–4 (the first quarter was omitted as the reference group) were created to capture seasonality in e-cigarette sales.

2.4.5. Market dummies

Three dichotomous variables representing scantrack markets in Sacramento, San Francisco, and San Diego (Los Angeles was omitted as the reference group) were created to capture the influence of market level characteristics on e-cigarette sales.

2.4.6. Percent of population covered by 100% smoke-free air laws (SFAL) in California

We controlled for the percent of the California population covered by 100% smoke-free air laws in each year/quarter using data from the American Nonsmokers' Rights Foundation (US tobacco control laws database, 2020). A yearly average SFAL coverage index was calculated by taking the mean of the three weighted percentages for workplaces, restaurants, and bars in the state. Because the SFAL in California banning smoking in most bars, restaurants and workplaces are state laws, there was little change in the SFAL index across four quarters within a single year (the average annual increase rate was about 4.5% per year) in California. Thus, we used the annual index as a proxy for the index in each year/quarter. We merged this index with the NRS data by year, and quarter.

2.5. Study sample

California sales information for cigarettes and both types of e-cigarettes is available in the NRS data since 2012, so we included 2012–2017 NRS data in our analysis. After separately aggregating sales data (sales volume and inflation-adjusted price of e-cigarettes and cigarettes) by year, quarter, and market, a total of 96 (=4 quarters × 6 years × 4 markets) observations were obtained for cigarettes and each type of e-cigarettes.

2.6. Statistical analysis

We used fixed-effects models to estimate the impact of e-cigarette and cigarette prices on e-cigarette sales separately for each type of e-cigarettes controlling for year, quarter, scantrack market, and California SFAL coverage. The demand model for disposable e-cigarettes was specified as:

$$Ln\ Q_{e-cigarette\_d} = f\ \left(Ln\ P_{e-cigarette\_d},\ Ln\ P_{e-cigarette\_r,}\ Ln\ P_{cigarette},\ y,\ q,\ m,\ s\right) \quad (1)$$

where $Q_{e\text{-}cigarette\_d}$ represents the average per capita disposable e-cigarette sales volume in a given year/quarter/market; $P_{e\text{-}cigarette\_d}$ is the inflation-adjusted average disposable e-cigarette price per piece in a given year/quarter/market; $P_{e\text{-}cigarette\_r}$ is the inflation-adjusted average reusable e-cigarette price per piece in a given year/quarter/market; $P_{cigarette}$ is the inflation-adjusted average cigarette price per pack in a given year/quarter/market; y represents the dummy variables for year; q represents the dummy variables for quarter; m represents the dummy variables for market; and s represents the average SFAL coverage index in a given year/quarter.

The $Q_{e\text{-}cigarette\_d}$, $P_{e\text{-}cigarette\_d}$, $P_{e\text{-}cigarette\_r}$, and $P_{cigarette}$ were logarithmically transformed so that the own-price elasticity of demand for disposable e-cigarettes was simply equal to the estimated coefficient for the disposable e-cigarette price variable ($P_{e\text{-}cigarette\_d}$), the cross-price elasticity of demand for disposable e-cigarettes in response to reusable e-cigarette prices was equal to the estimated coefficient for the reusable e-cigarette price variable ($P_{e\text{-}cigarette\_r}$), and the cross-price elasticity of demand for disposable e-cigarettes in response to cigarette prices was equal to the estimated coefficient for the cigarette price variable ($P_{cigarette}$).

The demand model for reusable e-cigarette sales was specified as:

$$Ln\ Q_{e-cigarette\_r} = f\ \left(Ln\ P_{e-cigarette\_r},\ Ln\ P_{e-cigarette\_d,}\ Ln\ P_{cigarette},\ y,\ q,\ m,\ s\right) \quad (2)$$

where the notation for $Q_{e\text{-}cigarette\_r}$, $P_{e\text{-}cigarette\_r}$, $P_{e\text{-}cigarette\_d}$, $P_{cigarette,}$ y, q, m, and s is the same as described in Eq. (1)

Similarly, the dependent variable ($Q_{e\text{-}cigarette\_r}$) and price variables ($P_{e\text{-}cigarette\_r}$, $P_{e\text{-}cigarette\_r}$, and $P_{cigarette}$) were in natural log form. Therefore, the estimated coefficients of $P_{e\text{-}cigarette\_r}$, $P_{e\text{-}cigarette\_r}$, and $P_{cigarette}$ give the own-price elasticity of demand for reusable e-cigarettes, the cross-price elasticity of demand for reusable e-cigarettes sales in response to disposable e-cigarette prices, and the cross-price elasticity of demand for reusable e-cigarette sales in response to cigarette prices.

In addition, we estimated the impact of e-cigarette prices on cigarette sales. The model was specified as:

$$Ln\ Q_{cigarette} = f\ \left(Ln\ P_{cigarette},\ Ln\ P_{e-cigarette\_d,}Ln\ P_{e-cigarette\_r},\ y,\ q,\ m,\ s\right) \quad (3)$$

where the notation for $Q_{cigarette}$, $P_{e\text{-}cigarette\_r}$, $P_{e\text{-}cigarette\_d}$, $P_{cigarette,}$ y, q, m, and s is the same as described in Eq. (1). Similarly, the coefficient of $P_{cigarette}$ gives the own-price elasticity of demand for cigarettes and coefficients of $P_{e\text{-}cigarette\_d}$ and $P_{e\text{-}cigarette\_r}$ give the cross-price elasticity of demand for cigarettes in response to disposable and reusable e-cigarette prices, respectively.

All analyses were carried out using SAS 9.4 (SAS Institute Inc, Cary, NC). A two-tailed p-value < 0.05 was considered to be statistically significant.

3. Results

Table 1 summarizes the descriptive statistics for the key variables in our analysis. The average quarterly sales volume in a Nielsen market in California from 2012 to 2017 was 2,936,063 packs for cigarettes, 14,155 pieces for disposable e-cigarettes, and 3831 pieces for reusable e-cigarettes. The average price was $5.86 per pack of cigarettes, $9.80 per disposable e-cigarette, and $19.11 per reusable e-cigarette. Average quarterly prices of cigarettes and e-cigarettes over time in California are shown in Fig. 1. As expected, we found that cigarette prices did not increase until the second quarter of 2017 when California increased cigarette taxes by $2 per pack. The prices for both disposable and reusable e-cigarettes increased in the third quarter of 2017 when Proposition 56 also levied a comparable tax rate (65.08% of wholesale cost) on e-cigarettes on July 1, 2017.

3.1. Own-price elasticities

We estimated that own-price elasticity was −0.37 for disposable e-

Table 1
Descriptive statistics, 2012–2017 Nielsen Retail Scanner data in California.

Variables	N	Mean	Std Dev	Minimum	Maximum
Total quarterly sales volume					
Cigarette sales (packs)	96	2,936,063	1,837,736	842,176	6,345,432
Disposable e-cigarette sales (pieces)	96	14,155	11,005	2,549	47,728
Reusable e-cigarette sales (pieces)	96	3,831	3,159	960	17,210
Per capita quarterly sales volume					
Cigarette sales (packs)	96	0.3768	0.0835	0.2578	0.6146
Disposable e-cigarette sales (pieces)	96	0.0017	0.0005	0.0008	0.0028
Reusable e-cigarette sales (pieces)	96	0.0005	0.0002	0.0002	0.0013
Price					
Cigarette price ($ per pack)	96	5.86	0.81	5.29	8.29
Disposable e-cigarette price ($ per piece)	96	9.80	1.19	6.15	11.99
Reusable e-cigarette price ($ per piece)	96	19.11	15.72	7.78	64.92

cigarettes, −0.20 for reusable e-cigarettes, and −0.21 for cigarettes, which indicates that when price increases by 1%, per capita sales would decrease by 0.37% for disposable e-cigarettes, 0.20% for reusable e-cigarettes, and 0.21% for cigarettes (Table 2).

3.2. *Cross-price elasticities*

We found that the cross-price elasticity of disposable e-cigarettes sales with respect to cigarette prices was positive at 0.50 but not statistically significant (Table 2). The cross-price elasticity of reusable e-cigarettes sales with respect to cigarette prices was statistically significant at 1.74, indicating that a 1% increase in cigarette prices leads to an increase in the quantity demanded for reusable e-cigarettes by 1.74%.

Table 2 also shows the cross-price elasticity of demand for one type of e-cigarettes in response to the changes in the price of the other. The cross-price elasticity of disposable e-cigarette sales in response to reusable e-cigarette prices was positive and statistically significant at 0.14, indicating that disposable e-cigarettes are substitutes for reusable cigarettes. Although reusable e-cigarette sales were negatively associated with disposable e-cigarette prices, this association was not statistically significant.

No statistically significant associations were found between cigarette sales and disposable or reusable e-cigarette prices in the cigarette demand model.

Compared to the Los Angeles market, the Sacramento market had higher sales for reusable e-cigarettes and cigarettes; the San Diego market had lower sales for disposable e-cigarettes and cigarettes; and the San Francisco market had higher sales for disposable e-cigarettes and cigarettes (Table 2). No statistically significant association was found between SFAL and either type of e-cigarette or cigarette sales.

4. Discussion

This study contributes to the literature on price-responsiveness of demand for different types of e-cigarettes by providing evidence for California. Our results indicate that even after accounting for time fixed-effects, market fixed-effects, and smoke-free air laws, there is a significant and negative relationship between e-cigarette demand and e-cigarette prices for both disposable and reusable e-cigarettes. We also found evidence that reusable e-cigarettes are substitutes for cigarettes and that disposable e-cigarettes are substitutes for reusable e-cigarettes.

Our estimates of own-price elasticity of demand for disposable (−0.4) and reusable (−0.2) e-cigarettes are lower than the estimates in the previous studies (−1.20 or −1.56 for disposable e-cigarettes, and −1.90 or −1.36 for reusable e-cigarettes), which used the NRS data on all U.S. markets (Huang et al., 2014, 2018). NRS data does not capture e-cigarettes sales that occurred in non-participating retail outlets, vape shops, tobacco stores, and online. If e-cigarettes in those channels represented a smaller proportion of total e-cigarette sales in California than in other states/markets, changes in sales of tracked e-cigarette products would be smaller in California in response to the same price increase compared with those in other states/markets. Another possible reason could be the different study periods between this study (2012–2017) and previous studies (2009–2012 (Huang et al., 2014) or 2007–2014 (Huang et al., 2018). E-cigarettes could be an elastic product in early years, but over time, they have become less elastic particularly when users

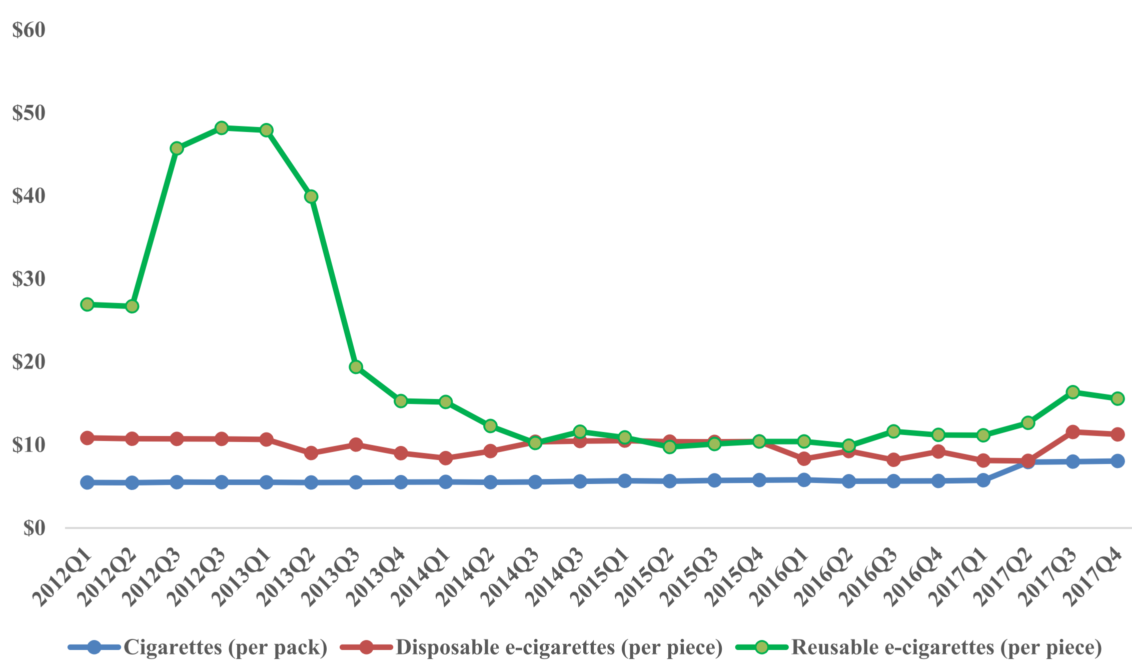

Fig. 1. Average quarterly cigarette and e-cigarette prices, California, 2012–2017.

Table 2
Own-and cross-price elasticity of demand for e-cigarettes and cigarettes, 2012–2017 Nielsen Retail Scanner data in California.

	Disposable e-cigarette sales Eq. (1)		Reusable e-cigarette sales Eq. (2)		Cigarette sales Eq. (3)	
	Coefficient	P	Coefficient	P	Coefficient	P
Own price elasticity	−0.37	0.04	−0.20	0.00	−0.21	0.04
Cross-price elasticity						
Cigarette price (log)	0.50	0.11	1.74	0.00		
Disposable e-cigarette price (log)			−0.21	0.42	0.01	0.84
Reusable e-cigarette price (log)	0.14	0.00			−0.01	0.61
Year						
2012 (reference)						
2013	0.34	<0.0001	0.76	<0.0001	−0.05	0.05
2014	0.16	0.24	0.50	0.02	−0.13	0.01
2015	−0.09	0.70	0.56	0.12	−0.10	0.21
2016	0.20	0.63	0.74	0.22	−0.11	0.42
2017	0.48	0.34	1.33	0.08	−0.01	0.95
Quarter						
1 (reference)						
2	0.03	0.53	−0.09	0.26	0.04	0.02
3	−0.02	0.72	−0.02	0.83	0.05	0.03
4	−0.05	0.54	0.12	0.36	0.01	0.64
Market						
Los Angeles (reference)						
Sacramento	−0.01	0.75	0.21	0.00	0.40	<0.0001
San Diego	−0.24	<0.0001	−0.08	0.27	−0.08	<0.0001
San Francisco	0.12	0.02	−0.05	0.51	0.14	<0.0001
SFAL index	−0.03	0.76	−0.23	0.09	−0.03	0.33

developed nicotine dependency.

We found a positive value of cross-price elasticity for reusable e-cigarettes sales with respect to cigarette prices, indicating that reusable e-cigarettes are substitutes for cigarettes.

Consistent with the study conducted by Huang and colleagues (Huang et al., 2014) which examined cross-price effects between disposable and reusable e-cigarettes, our study did not find statistically significant relationship between disposable e-cigarette prices and sales of reusable e-cigarettes. However, we found that an increase of reusable e-cigarette prices would increase sales of disposable e-cigarettes, implying that disposable e-cigarettes are substitutes for reusable e-cigarettes.

Although we found reusable e-cigarettes to be substitutes for cigarettes, the cigarette demand model showed that cigarettes are not substitutes for reusable e-cigarettes.

As tobacco product prices increased as a result of the California tobacco tax increase, we would expect to see a decrease in e-cigarette retail sales because of the negative own-price elasticity of demand for both disposable and reusable e-cigarettes. However, because taxes were increased not only on e-cigarettes but also on cigarettes, an unintended consequence is an increase in reusable e-cigarette sales because of the positive cross-price elasticity between cigarette prices and reusable e-cigarette sales. In addition, because cigarette demand is not responsive to disposable or reusable e-cigarette price, imposing e-cigarette taxes is not likely to change cigarette sales.

This study has some limitations. First, because JUUL e-cigarette sales data in California only became available in the 4th quarter of 2016 in the NRS dataset, we were not able to include JUUL products in our analysis because there would be too few observations. JUUL has become the most popular e-cigarette brand in the U.S. since 2017 (Richard, 2018; King et al., 2018; LaVito, 2018). It occupied a large share of the electronic cigarette market (72% as of September 2018 (Richard, 2018; King et al., 2018; LaVito, 2018) until September 2019 when the U.S. Food and Drug Administration warned JUUL Labs about illegally marketing its product as a safer alternative to cigarettes (The U.S. Food and Drug Administration, 2019). Future studies which examine the impact of e-cigarette prices on the demand for JUUL and cross-price effects between JUUL and other e-cigarettes are needed. Second, the NRS data only captures sales in Nielsen participating retail stores and does not include online retailers or vape shops. Wells Fargo analysts estimated that online and vape shop sales accounted for 30% and 23%, respectively, of the total e-cigarette market in 2014 (Wells Fargo Securities, 2014). Therefore, future studies which include online sales and vape store sales are needed. Despite these limitations, the NRS data have been used to analyze demand for cigarettes (Huang et al., 2018; Tauras et al., 2006; Chaloupka and Tauras, 2004; Wang et al., 2015), e-cigarettes (Huang et al., 2014, 2018; Zheng et al., 2017), and nicotine replacement therapy (Huang et al., 2018; Tauras et al., 2005), and are widely regarded as one of the best sources for retail sales data available.

5. Conclusion

In conclusion, we found that e-cigarette and cigarette sales are responsive to own price changes, which suggests that raising prices, such as increasing the tobacco excise tax, can help reduce sales of the products. However, the magnitude of the effects would differ by e-cigarette product type. Reusable e-cigarettes are substitutes for cigarettes and disposable e-cigarettes are substitutes for reusable e-cigarettes. Policymakers should take into account the substitution between e-cigarettes and cigarettes when designing tobacco control policies.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Researchers own analyses were calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researcher(s) and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

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