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Research on the factors influencing new tobacco consumption behavior

Yuqing WEN
Singapore Management University, yuqing.wen.2017@ckdba.smu.edu.sg

RESEARCH ON FACTORS INFLUENCING NEW TOBACCO CONSUMPTION BEHAVIOR

WEN YUQING

SINGAPORE MANAGEMENT UNIVERSITY

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Research on the Factors Influencing New Tobacco Consumption Behavior

Wen Yuqing

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Dissertation Committee:

Fu Fangjian (Supervisor/Chair)
Associate Professor of Finance
Singapore Management University

Wang Yijiang (Co-Supervisor)
Professor of Economics and Human Resources
Cheung Kong Graduate School of Business

Dan Ma
Associate Professor of Information Management
Singapore Management University

SINGAPORE MANAGEMENT UNIVERSITY

2023

I hereby declare that this DBA dissertation is my original work, and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in this DBA dissertation.

This DBA dissertation has also not been submitted for any degree in any university previously.

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Wen Yuqing

Jan, 11, 2023

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Abstract

In the global environment of tobacco control, along with the increasing concern for health, electronic companies around the world have focused on the research and production of "non-combustible alternatives to cigarettes" to meet the psychology of consumers to quit smoking and the pursuit of fashion, and the most popular products are E-cig and its similar products. Domestic E-cig-related products have gradually known by the public, with increasing exposure in the news media and rapid growth in sales. Because E-cig and HnB Tobacco Products have stylish designs, low harm to humans, and numerous product flavors, they have quickly dominated the market among alternatives of traditional cigarettes.

Using least square method and instrumental variables, this dissertation investigates the impact of changes in consumer cognitive ability, attention paid to health, and external factors on the consumption of new e-cigarettes in the E-cig industry to explore the impact of new product changes on changes in Consumer Behavior. By studying this issue, we can effectively get to know the current hotspots and consumption trends in domestic tobacco market, help E-cig companies in developing, designing, and optimizing E-cig products, and facilitate the E-cig players to be more adaptable to the rapidly changing external environment of the industry and promote the healthy development of the E-cig industry.

The first part makes an introduction. It contains the background, the research content, the framework structure of the research, and the innovation of the dissertation. The second part is mainly divided into two aspects: defining concepts and analyzing the current situation. On the one hand, it is to explain the key terms and concepts. On the other hand, it is to make a systematic analysis of the current development status of China's E-cig industry to highlight the importance of this dissertation's research. The third part lists literature review and research hypotheses: firstly, age, income and education are closely related to E-cig consumption behavior. Secondly, lower health risks are an important reason for consumers to choose E-cig over traditional cigarettes. Thirdly, external factors are a key reason for E-cig consumption. The fourth part reveals data, variables, and identification strategies. It mainly introduces the data used, the variables set, and the identification strategy used herein, while also gives the descriptive statistics of the data in this dissertation. The fifth part describes the basic measurement results. This part focuses on the validation of the proposed hypotheses using the data in this dissertation through various methods such as least square regression model, Instrumental Variables Method, principal component analysis, and Shapley decomposition. The sixth part conducts robustness test, specifically by further controlling for county-level fixed effects to demonstrate the robustness of the results of this dissertation. The seventh part gives the research conclusions and policy recommendations.

Keywords: New E-cig; Consumer Behavior.

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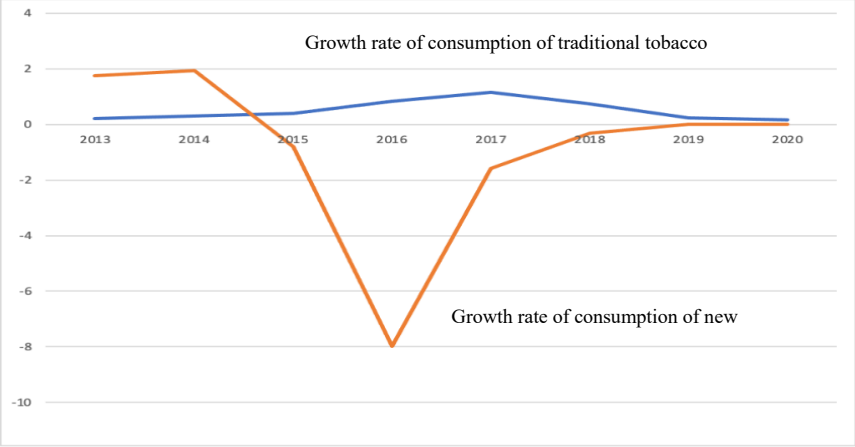
As a microcosm of millions of Chinese private family businesses, the case in my thesis has witnessed the booming growth of China's economy and society and benefited from the dividends of the development. Hopefully, this thesis can offer useful lessons for the entrepreneurship and sustainable growth of local businesses in China.

Chapter 1 Introduction

1.1 Research motivation

Under the background of global tobacco control and consumers' health awareness improvement, studying tobacco consumer behavior changes is an important research topic in current consumer behavior. In recent years, the rise of new tobacco has changed the pattern of the tobacco consumption market. As shown in Figure 1.1, taking China's tobacco market as an example, the growth rate of consumption in China's traditional tobacco market has slowed down significantly since 2013, and sharply declined around 2016. At the same time, the growth rate of consumption in the new tobacco market has maintained an upward momentum, in sharp contrast to traditional tobacco consumption. The rapid rise of the new tobacco market is not only a hot spot for new consumer products, but also shows a change in consumers' preferences for traditional consumer products. Therefore, studying the factors that affect new tobacco consumption behavior is a subject of academic and practical value.

Figure1.1 Growth Rate of Consumption of New Tobacco and Traditional Tobacco



Previous studies have conducted in-depth research on the factors affecting tobacco consumption, which provides important reference value for this study. For example, a large number of literatures have explored the important impact of consumers' personal characteristics on tobacco consumption (Wang et al., 2018), and some scholars have explained the impact of consumers' health awareness improvement on the decline of tobacco consumption (Li, 2015). Classic literature shows that external factors such as tobacco control policy may have a greater impact on tobacco consumption than personal characteristics and health awareness (Alesci et al., 2003; Glantz, 2006). Although the above studies have analyzed the factors that impact tobacco consumption, less attention has been paid to the factors that affect new tobacco consumption. Why do many tobacco consumers choose new tobacco? Is this related to their personal traits, health awareness, or external factors? Based on the author’s experience in the new tobacco industry, the reasons why many traditional tobacco consumers began to choose new tobacco reflect the new characteristics of current consumer preferences. Therefore, this dissertation will focus on the reasons why consumers choose new tobacco, which will help us grasp the reasons of market changes in and the development direction and policy orientation of the tobacco industry.

1.1 Background and significance

1.1.1 Background

China is a country with a large population, and a large tobacco country. China has about 300 million smokers, accounting for about 25% of the world's smoker population, while China also produces 35% of the world's tobacco and

sells 32% of the world's tobacco. Since the reform and opening, China's planting area, production and growth rate of roasted tobacco, production and sales and growth rate of tobacco products, the number and growth of the number of smokers and tobacco tax growth rate has led other players in the world. It can be said that China has been a veritable world's first major tobacco country. However, with the advancement of the times, the structure of domestic tobacco product consumers is gradually changing. Consumers of tobacco market at the beginning of the 21st century has gradually aged, while the young consumers who continue to enter the tobacco market not only have an age advantage, but their value concept, consumption ability and purchasing preference are significantly different from those of previous customers. Many tobacco companies have clearly recognized the changing pattern of the domestic tobacco consumption market. In recent years, they have made innovations in the specifications, materials and packaging of tobacco products and have developed new products to meet the diversified needs of the market, including medium-fine cigarettes, exploding cigarettes and short cigarettes. In this wave of innovation in the tobacco industry, the E-cig segment has grown rapidly in the last 10 years and has gained widespread popularity, especially among young and middle-aged consumers.

Tobacco products have enormous damages to human health. In the context of increasingly stringent global tobacco control policies, the status of the traditional tobacco market has been declining, with Philip Morris International, British American Tobacco and other multinational tobacco companies having shifted their strategic focus to new tobacco areas, represented by the Electronic Cigarette (“E-cig”) and Heat-not-Burn Tobacco Product (“HnB”). An E-cig is

an Electronic Nicotine Delivery Systems (or “ENDS”) that consists of three main components: the battery stem, the atomizer, and the cartridge. As the E-cig will not burn and the main chemical components of the smoke liquid in the cartridge are glycerol, propylene glycol, water, and low concentrations of nicotine, no harmful substances such as tar and carbon monoxide will be produced during the smoking and the release of harmful substances is also extremely low (Jin et al., 2016). In contrast, HnB tobacco products are closer to traditional ones. They are filled with tobacco flakes and the front-end heating device consists of a battery and a heating core. The tobacco will be heated the electric heating core through the temperature-controlled technology, so that tobacco just releases aromatic substances and nicotine and therefore smoke forms (Liu et al., 2018). Therefore, the absence of combustion process and low temperature heating of tobacco products can significantly reduce the release of harmful substances, thus achieving the dual purpose of providing smoking satisfaction while reducing coke and harm. Because E-cig and HnB Tobacco Products have stylish designs, low harm to humans, and numerous product flavors, they have quickly dominated the market among alternatives of traditional cigarettes.

Figure 1.2 shows the changes in the global and Chinese E-cig scale from 2013 to 2020. From 2013 to 2020, the global E-cig market size rose from USD 4.3 billion to USD16.8 billion, nearly four times, while the Chinese E-cig market started late with a market size in 2013 of only RMB 550 million, but in 2020 reached RMB 8.33 billion, a growth rate of 15 times in 8 years, implying an average annual growth rate of a staggering 189%. This shows the very rapid development of China's E-cig market. Figure 1.3 shows the proportion of the

world's E-cig market share by region in the country. The United States is undoubtedly the largest E-cig market, accounting for 66% of the global E-cig market in 2019, while China's share is also on the rise, rising from 7% in 2014 to 9% in 2019. Considering the huge number of smokers in China, it also signals the huge potential of new tobacco products such as E-cig in the Chinese consumer market.

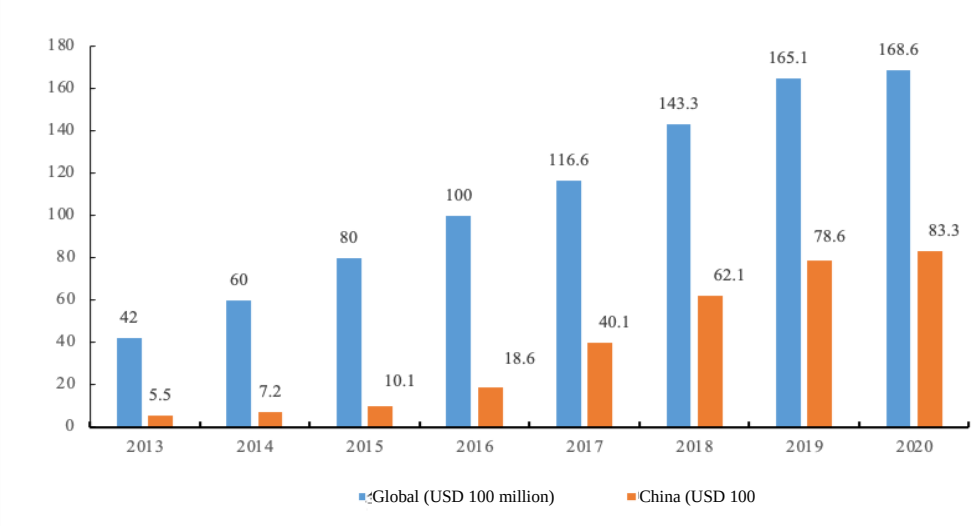


Figure 1.2 E-cig Market Size

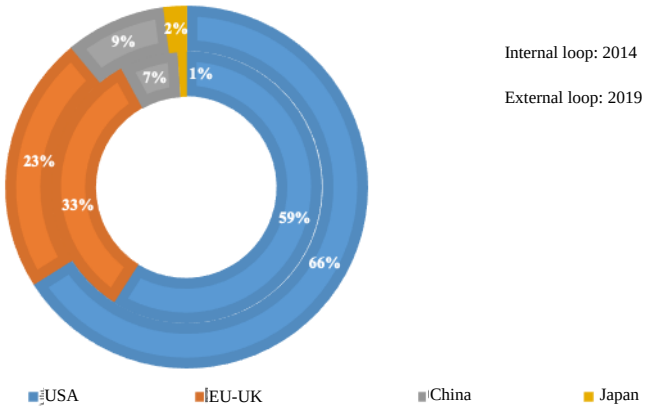


Figure 1.3 Global E-cig Market Share by Region

Tobacco harms are becoming one of the most serious public health problems in the world today, and the biggest risk factor for human health. It is well documented that about half of all smokers will eventually die from

tobacco-related diseases. At the same time, smoking can cause serious pollution to the environment. According to studies, a cigarette can degrade air quality within minutes. The World Health Organization Framework Convention on Tobacco Control (WHO FCTC) has been implemented in China since 2006. It means that China must realize a total ban on smoking in indoor workplaces and public transportation, which is bound to deal a serious blow to the tobacco industry and have a huge impact on the sales and demand of tobacco products. In 2015, the new Advertising Law also came into effect, prohibiting the placement of tobacco advertisements in mass media or public places, and prohibiting tobacco product manufacturers or sellers from including the names, trademarks, packaging, decorations, and similar content in announcements of relocation, name change, recruitment, etc. of tobacco products. The introduction of these policies and decrees is unprecedentedly severe for the tobacco industry, and the impact on the consumption of tobacco products is becoming increasingly evident. In terms of national policy, the "Health China 2030" Outline, which was adopted by the Political Bureau of the CPC Central Committee in 2016, clearly requires that "by 2030, the smoking rate of people over 15 years of age must be reduced to 20%." The "Health China Action (2019-2030)" issued by the State Council in 2019 clearly states that "tobacco products are serious hazards to people's health. The impact of the institutional environment is huge, and the impact on the cultural environment is also far-reaching. With the acceptance and recognition of the consensus that "smoking is harmful to health" and the importance attached to one's own health, the traditional practice is considered old-fashioned and outdated, and people's attitude towards smoking has become more cautious.

Traditional tobacco products have been a customary product for centuries and have been integrated into the lives of most smokers. In recent years, however, the disadvantages associated with these traditional tobacco products have become more prominent as people have rethought the issues of smoking and health and secondhand smoke. At the same time, as tobacco control has intensified around the world, countries have issued a range of tobacco control laws and policies. These laws and policies bring about significant and profound changes on the development environment for tobacco products and the structure of tobacco products is being adjusted to diversified and smoke-free development at an accelerated pace. In addition, at present, the composition of Chinese smokers is gradually changing, and the most important feature is that the smokers tend to be younger. According to the statistics of the Chinese Ministry of Health, the age of first-time smokers in China dropped from 22.4 years old in 2000 to 19.7 years old in 2018. The younger generation of smokers clearly prefer new and trendy cigarettes in the market, and their interest in full traditional cigarettes is decreasing. Therefore, China's E-cig market will usher in a new opportunity for vigorous development in the coming years thanks to the rapid increase in market demand for E-cig and the vast space for supply. However, amid the rapidly developing market environment, the characteristics of E-cig consumer groups are not well portrayed, including the process of preference shift for tobacco consumer products. The use of emerging technologies in the E-cig market and the impact on consumer preferences are important but under-researched issues for the E-cig industry.

1.1.2 Significance

1.1.2.1 Theoretical implications

Although many studies have examined the impact of technological advances on Consumer Behavior, there is still relatively little coverage on the emerging industry of E-cig. The theoretical significance of the research on technological advances in the E-cig industry is reflected in three main points:

First, the use of new technologies in the E-cig industry has completely overturned the traditional consumption and inhalation practice of tobacco products, which is a huge change that no other industry, especially the consumer goods industry, has ever seen. Therefore, research on the E-cig industry can help more fully understand the impact of technological advances on consumer preferences.

Second, as a kind of "addictive" consumer product, consumers' preference for this kind of consumer product has a certain degree of consumer stickiness. Research on the E-cig industry is useful in understanding the impact of technological advances on consumer preferences in the remaining addictive consumer product industries. We provide evidence from China on this issue, which enriches and complements Consumer Behavior research.

Third, because of the potential health risks, the tobacco industry is a strictly controlled industry in all countries around the world. Understanding the impact of technological advances on consumer preferences for E-cig and studying the changes in Consumer Behavior brought about by the new tobacco products is conducive to a deep understanding of consumer needs and has implications for regulating the development of the industry.

1.1.2.2 Relevance

First, the research in this dissertation is conducive to regulating the E-cig market and providing E-cig enterprises with the necessary information from the

consumer's perspective, which in turn will promote the development of the E-cig industry toward low harm and improve the current disordered trend of the E-cig industry, thus contributing to the reduction of health costs for the whole society.

Second, the research in this dissertation is helpful to get more effectively to know the current domestic tobacco market hotspots and consumption trends, and to help E-cig companies in developing, designing, and optimizing E-cig products. China is the most promising market for E-cig in the world, and the hot spots of concern for new tobacco products, differences in purchase preferences, and the attribute characteristics of different types of tobacco products can have an impact on Consumer Decision Making. In this dissertation, we analyze the information on consumer hotspots, factors influencing Consumer Decision Making and potential Consumer Behavior in the E-cig market through a large sample of research data, which significantly reduces the cost of market research for enterprises and makes the research findings more representative and objective. At the same time, the R&D investment expenditure of E-cig companies is rising year after year. By studying the potential consequences of product changes due to technological advances, this dissertation is conducive to further providing guidance for the direction of R&D in the E-cig industry and improving the effectiveness and success rate of innovation.

Third, the research in this dissertation has the benefit of making players in the E-cig industry more adaptable to the rapidly changing external environment. In the context of increasingly stringent global tobacco control policies in recent years, the status of the traditional tobacco market has been declining, with

Philip Morris International, British American Tobacco and other multinational tobacco companies having shifted their strategic focus to new tobacco areas, especially the HnB Tobacco Products. New tobacco products and E-cig are growing rapidly, and the market has far exceeded expectations. The main feature of the development of new tobacco products is the rapid development of technology, rapid product renewal and greatly increased production capacity. As for the E-cig in new tobacco products, the product has developed a variety of atomization technologies from the original single electric wire atomization, such as ultrasonic atomization and ceramic heating atomization. At the same time, temperature control, power regulation and other technologies have also been widely used in E-cig, greatly improving product performance. However, the new tobacco industry is still in its infancy. Due to market structure, consumer preferences, and different regulatory policies, there are many uncertainties in the iterative technologies of the new tobacco industry, and the research in this dissertation will help companies improve their understanding of the market to better overcome such uncertainties.

1.2 Research content and methodology

1.2.1 Research content

This dissertation is to study the impact of new product changes on changing Tobacco Consumption Behavior preferences in the E-cig industry. It is arranged from the following issues:

(1) What are the characteristic profiles of potential E-cig consumers?

(2) What are the reasons why E-cig consumers consuming E-cig instead of traditional tobacco?

(3) What are the preferences of E-cig consumers for E-cig consumption?

(4) Does E-cig technology make a difference to consumers' inhalation experience?

(5) How well the current E-cig technology matches consumer needs and the room for future improvement

This dissertation is arranged as follows:

The first part makes an introduction. It contains the background and significance of the topic selected, the research content, the research method, the framework structure of the research, and the innovation of the dissertation.

The second part is mainly divided into two aspects: defining concepts and analyzing the current situation. On the one hand, it is to explain the key terms and concepts, and at the same time systematically compare the advantages and disadvantages of new tobacco and traditional cigarette, to highlight the new product change. On the other hand, it is to make a systematic analysis of the current development status of China's E-cig industry to highlight the importance of this dissertation's research.

The third part lists literature review and research hypotheses. This part mainly presents an analysis of three significant factors affecting tobacco, especially E-cig consumption: personal factors such as gender, age and income, health factor and the external factors, such as the cohort effect. Three research hypotheses are proposed based on literature review: 1. Younger, better educated, and higher income level consumers have a better understanding of new tobacco technologies and are more inclined to E-cig consumption. 2. Lower health risks are an important reason for consumers to choose E-cig over traditional cigarettes. 3. External factors are a key reason for E-cig consumption.

The fourth part reveals data, variables, and identification strategies. It mainly introduces the data used, the variables set, and the identification strategy used herein, while also gives the descriptive statistics of the data in this dissertation.

The fifth part describes the basic measurement results. This part focuses on testing the proposed hypotheses using data from this dissertation through various methods such as least square regression model, Instrumental Variables Method, and others.

The sixth part is the robustness test. The findings of this dissertation are verified from multiple perspectives by varying multiple regression strategies and constructing different indicator systems to prove the robustness of the results.

The seventh part gives the research conclusions and policy recommendations. This part summarizes the research of this dissertation, provides policy recommendations on how to further regulate the E-cig industry using changes in Consumer Behavior, and presents the shortcomings of this dissertation and prospects for further research.The research framework of this dissertation is shown in the following figure.

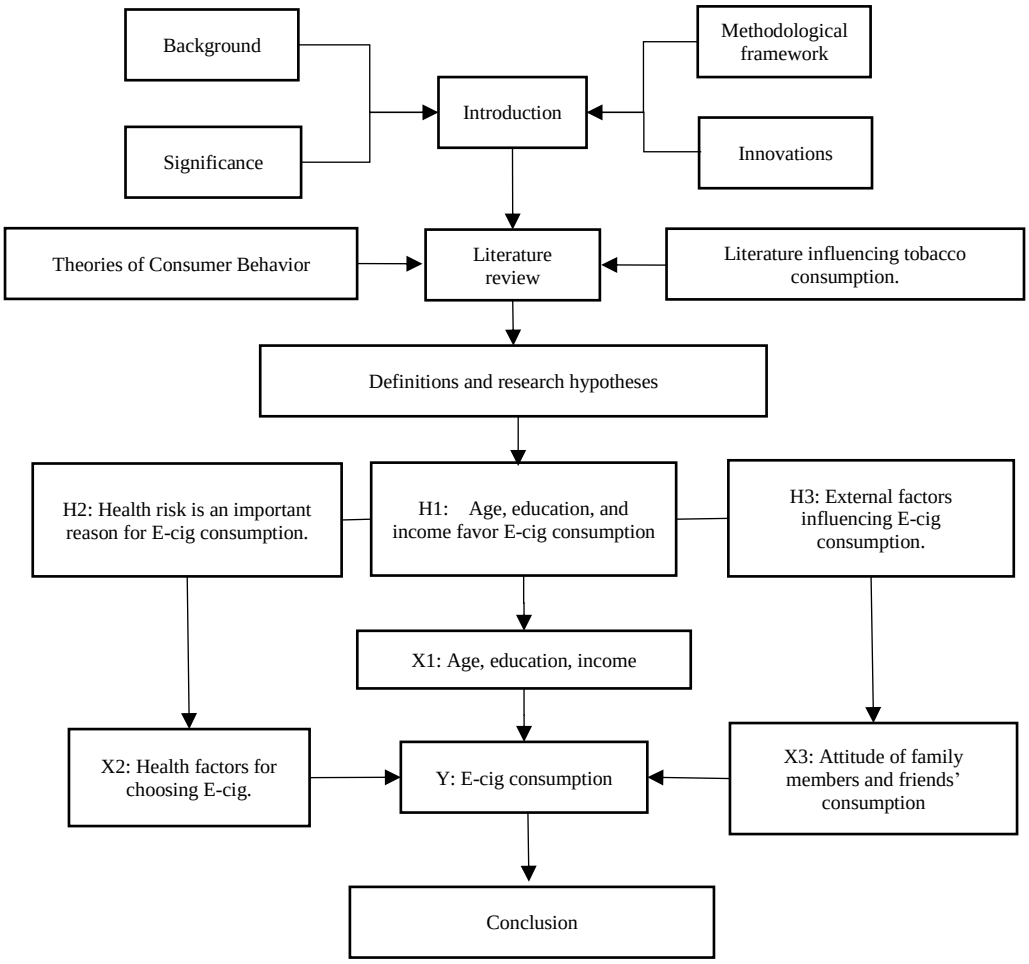


Figure 1.4 Schematic Diagram of the Framework of this Dissertation

1.2.2 Research method

This dissertation combines theoretical and applied analysis, qualitative and quantitative analysis, and normative and empirical analysis to analyze the relationship between new product changes and consumer preferences based on reference to a large amount of relevant literature and research results. This dissertation is based on a large amount of literature and focuses on the mechanism of the effect of new product changes on consumer preferences using the relevant theories and methods from econometrics, medicine, statistics, marketing, and other disciplines.

1.2.2.1 Inductive Reasoning Method

Many studies have been conducted to evaluate the relationship between new product changes and consumer preferences using qualitative and quantitative research methods such as cases and research, while there have been more and more studies and reports on the E-cig industry in recent years, and the relevant contents and reports are relatively abundant. On this basis, this dissertation summarizes the mechanism of the effect of product change on consumer preference from the actual experience and related reports carried out in various places, thus forming the theoretical framework and research hypotheses of this dissertation.

1.2.2.2 Regression Analysis and Instrumental Variables Method

In statistics, Regression Analysis refers to a statistical analysis method to determine the quantitative relationship between two or more variables that are dependent on each other. Regression Analysis is divided into univariate regression and multiple Regression Analysis according to the number of variables involved; Simple Regression Analysis and Multiple Regression Analysis according to the number of dependent variables; and Linear Regression Analysis and Nonlinear Regression Analysis according to the type of relationship between the independent and dependent variables. This dissertation mainly uses Multiple Linear Regression Analysis and intends to use the Instrumental Variables Method to overcome the endogeneity issue in this dissertation's research. The Instrumental Variables Method is mainly used to solve the endogeneity issues of the model. When the explanatory variables in the model are correlated with the error term, the model has the endogeneity

issue, which will lead to inconsistent estimation results. At this point, we need to select a proxy variable that is correlated with the endogenous explanatory variables and uncorrelated with the error term to replace the endogenous explanatory variables in the model and select a two-stage least squares regression model to obtain consistent estimates of the original model. This proxy variable is the instrumental variable.

1.2.2.3 Documentary Analysis

By searching, reading, and summarizing the research results of domestic and foreign scholars, it helps to have a comprehensive understanding of the existing research results on technological progress and Consumer Behavior preferences, to better grasp the theoretical knowledge and research methods related to Consumer Behavior theory and marketing theory, and to form specific research ideas and technical lines based on them.

1.2.2.4 Comparative Study Method

The Comparative Study Method is a method to study and judge the degree of similarity or dissimilarity between things and people. The Comparative Study Method can be understood as a method of examining two or more things that are related according to certain criteria, looking for their similarities and differences, and exploring universal and special laws. As discussed in this dissertation, as the E-cig industry is in the early stages of development, many studies have not been conducted for the E-cig field, but there is more research on traditional tobacco products. Because of the high degree of homogeneity between tobacco products and E-cig, conclusions can be drawn through a comparative study approach.

1.2.2.5 Questionnaire Method

The Questionnaire Method is one of the more widely used methods in social surveys at home and abroad. A questionnaire is a form used for statistical and survey purposes that formulates questions in the form of set questions. The Questionnaire Method is a method in which the researcher uses this controlled measurement to measure the problem under study and thus collect reliable information. The main advantages of the Questionnaire Method are standardization and low cost. Because the Questionnaire Method is conducted with a designed questionnaire, the questionnaire must be designed on a standardized and measurable basis.

Chapter 2 Definitions and Current Situation Analysis

2.1 Definitions

New tobacco products can reduce harms and are the future trend. Because the traditional way of smoking can lead to lung disease and cardiovascular disease, it is easy to produce "smoking addiction", threatening the physical and mental health of human beings. The new tobacco came into being in recent years. New tobacco products mainly refer to the tobacco products that are different from the traditional way of burning and vaporing cigarettes. Their main common feature is that they do not need to burn, basically generate no tar and other harmful ingredients, and at the same time can meet the human body's need to ingest a certain amount of nicotine. According to the use of the form, new tobacco products can be divided into smokeless and smoky ones. The former type mainly includes oral, chewing tobacco, and mouth-dissolving tobacco products, etc., while smoky products are HnB tobacco products and E-cig. Among them, HnB tobacco products are divided into two types: electrically heated and carbon heated. Electrically HnB tobacco products are usually defined as E-cig because of the use of electronic devices.

2.1.1 ECs

Electronic Cigarette (“EC”), also known as Electronic Nicotine Delivery Systems (ENDS), is a new type of tobacco product that produces gas by atomizing tobacco tar for human consumption. ECs are small devices used to simulate or replace cigarette smoking. The basic principle is to use heat and ultrasound to atomize a solution of glycerin or propylene glycol containing nicotine and flavor ingredients to produce a mist like the burning of a cigarette

for people to smoke. Most E-cigs have a similar look, smoke, taste and feel to cigarettes, and the way they are smoked is basically the same as cigarettes. At the same time, because it uses the method of heating the tobacco liquid instead of the burning tobacco process of cigarettes, the release of tar, carbon monoxide, nitrite and other harmful components compared to traditional cigarettes is significantly reduced while releasing aroma and nicotine at the same time, which is not easy to produce second-hand smoke pollution. Moreover, they are applicable to a wider range of places, and have smaller impact on the surrounding population. Therefore, they are widely accepted by consumers in recent years.

ECs have gone through three generations of development stages. First-generation E-cig: designed in white color and with a shape the same as the real cigarette and with a yellow cartridge. The First-generation E-cig is easy to be accepted by customers in terms of sensory, the disadvantage mainly lies in the atomizer performance, E-cig atomizer is easy to be burned off. Second-generation E-cig: slightly longer in appearance than the first-generation E-cig and equipped with improved atomizers with a protective cover; the use of the cartridge inserted into the atomizer. Compared with the first-generation E-cig, the most significant feature of the second-generation E-cig is the merging of the cartridge with the atomizer. Third-generation E-cig: thanks to the greatly improved atomizer performance, the smoke effect has been very close to the real cigarette and a variety of tastes are available. In addition to relatively remarkable updates in the appearance of the atomizer and raw materials, personalization and customization are valued. Vaporization equipment began to have some additional features, such as digital display, temperature control,

higher power, etc., while achieving the repeated fueling and battery reuse. ECs are now mainly divided into closed ECs and open ECs.

Closed electronic atomizers are easy to use, as their shape is usually like a pen or USB memory stick, which is also easy to carry around. Closed electronic atomizers generally last about 3 to 12 days. Closed ECs are ECs with prefilled cartridges that are similar in shape to cigarettes, smaller in size, and easy to carry, so they are also known as small cigarettes. They can be divided into disposable E-cig and Pod Mod based on the number of uses. First entered the market in 2003, disposable E-cigs are very close to the traditional cigarette in shape. They do not need to charge and replace the cartridge, so it is easier to use compared to other E-cig products. Moreover, completely closed design also makes their failure rate greatly reduced. Different from the traditional cigarette, the Pod Mod has more beautiful shape. In addition to replaceable cartridge, it can be recharged repeatedly, so the cost is relatively low. Currently, the more famous brands of closed E-cig include JUUL, Vype, RELX, etc.

Open e-atomizers provide users with a more personalized user experience, and various types of heating oil tank and battery modules can be matched to meet a variety of individual needs. In terms of the choice of e-atomization fluid, open e-atomizers are more flexible. Changing consumer needs, such as higher smoke volume and higher power, have contributed to the development of open e-atomizers. As the market for packaged coil tank and components such as e-atomizer kits become more mature, open e-atomizer will become more accessible to consumers who lack knowledge of e-atomizers. Open ECs allow users to replace the coil tank and battery module, and buy different tar, so it is more flexible and can meet a variety of personalized needs. Compared to the

closed E-cig, open ECs have greater power and strong endurance capacity; however, it is also more complex to operate, and their size is also relatively large; therefore, open ECs are known as big cigarettes. In recent years, foreign E-cig groups began to use "Vape" to describe the behavior of smoking E-cig. E-cig gradually become a trendy culture and open E-cig is more popular among the VAPE group because of its gameplay characteristics. The more famous brands of open E-cig are SMOK, Vaporesso, IJoy, etc.

2.1.2 HnB tobacco products

HnB Tobacco Product (HnB), also known as Heated Tobacco Product (HTP), produces gas by heating tobacco, which is closer to real smoke. HnB tobacco products, also known as new cigarettes or low-temperature cigarettes, are primarily characterized using an external heat source to heat the tobacco rather than igniting it to produce tobacco-flavored smoke. Compared with burning tobacco, heating tobacco produces less harmful substances.

HnB tobacco products are heated at low temperatures to reduce the release of harmful substances. According to research results, nicotine, and most of the flavor components in tobacco can be released from tobacco at 300-600°C and transferred to the smoke, too high a temperature will instead lead to the pyrolysis of tobacco flavor components into harmful components. Therefore, lowering the temperature of the cigarette not only significantly reduces the harmful components of the smoke, but at the same time the impact on a variety of flavor components is relatively small (and may even increase). If the heating temperature of cigarettes is controlled below 600°C, so that the tobacco is heated but not burned, the harmful components in the smoke will be expected to be significantly reduced, which provides a theoretical basis for the

development of low-hazard cigarettes. HnB tobacco products are thus born.

The research and development of HnB E-cig has only made substantial progress in recent years. Since 1988, the major tobacco giants have spent nearly USD10 billion to explore a variety of HnB methods such as carbon heating, electric heating, and customized cigarettes, and launched a variety of brands including Premier, Eclipse. But due to the complex characteristics of the cigarette itself and the discerning taste of smokers, these products have never been recognized by consumers. In 2014, Philip Morris International officially launched IQOS, a HnB E-cig, in Japan, and in 2016 the product was introduced on a famous entertainment show, and then was able to grow rapidly. IQOS is now available in 28 countries worldwide. At present, in addition to IQOS under Philip Morris International, brands such as Glo from British American Tobacco, Ploom from Japanese Tobacco and LIL from KT&G in Korea also have many followers.

Table 2.1 Comparison of Harmful Substances after Combustion between ECs and Cigarettes

Harmful components	Unit	Atomized E-cig production	Multiplier	Tobacco production
NNAL (carcinogenic substances)	pg/mg	3.8-6.3	60	181.7-227.9
Cadmium (respiratory system)	ng/mg	0.16-0.23	2	0.26-0.30
Naphthalene (blood system)	ng/mg	4.7-5.9	3	13.2-14.6
Pyrene (carcinogenic substance)	ng/mg	0.14-0.18	2	0.29-0.32
Acrolein (induces inflammation of the respiratory tract)	ng/mg	95.9-121.6	2.5	255.1-289.0
Acrylonitrile	ng/mg	3.0-5.2	36	109.9-139.7
Acrylamide (neurological and reproductive toxicity)	ng/mg	51.1-61.5	2.5	129.3-143.8
Nicotine (stimulates the cardiovascular system)	nmol/mg	1.1-3.5	20	23.8-32.7

Table 2.2 Comparison of Emerging Tobacco Products with Traditional Tobacco Products

	Closed ECs	Open ECs	HnB E-cig	Traditional tobacco products

Working principle	Atomized tobacco tar		Heats specialty tobacco but does not burn	Direct burning of tobacco by open fire
Temperature	170℃-200℃		350℃-600℃	800℃-1000℃
Ingredients	Tobacco tar, propylene glycol, nicotine, flavors and fragrances		Re-cured tobacco, glycerin, propylene glycol, flavors and fragrances	Tobacco, cigarette dissertation, combustion aid
Times of use	One or multiple times, can replace the cartridge or be repeatedly filled	Multiple times, can be repeatedly filled	Multiple times, need to replace the cigarette cartridges	Once
Portability	More portable	Large size, less portable	Average	More portable
Taste	The difference between the taste of ordinary tobacco tar and real cigarette is large. After using nicotine salt, it is closer to the taste of real cigarettes		Closer to the taste of real cigarettes than ECs	-
Release	8% of traditional tobacco		5% of traditional tobacco	-
Carcinogenic content	Lower	Lower	Lower	Higher
Nicotine content	Determined by tobacco tar		Lower	High
Tar content	None		Lower	High
Effect on others (second-hand cigarette)	Lower	Average	Lower	Lower
Price	Lower	Low	Higher	Lower

Table 2.3 Comparison of Harmful Substances after Combustion of HNB and Cigarettes

Harmful components	Unit	Average value of HNB production	Multiplier	Tobacco production average
Nicotine (stimulates the cardiovascular system)	mg /stk	1.1	2	1.9

Formaldehyde (respiratory system, nervous system damage)	μg/ stk	8.0	10	85.2
NNN (strong carcinogen)	ng/ stk	10.2	28	283
Acetaldehyde (strong carcinogen)	ng/ stk	217	7.5	1641
Acrolein (induces inflammation of the respiratory tract)	μg/ stk	9.6	16	156
NNK (strong carcinogen)	μg/ stk	6.8	40	264
Carbon monoxide (blood, neurotoxin)	mg / stk	0.44	68	30.2

2.2 Current situation analysis

2.2.1 Global perspective

Tobacco products mainly include cigarettes, E-cig, and others (e.g., pipe tobacco, chewing tobacco, cigars, and snuff). The current tobacco market is dominated by cigarettes. Cigarettes are made by rolling or packing shredded tobacco leaves and tobacco flakes into a cylindrical cigarette dissertation. E-cig products include electronic atomizers (VAPE) and HnB devices (HNB).

Currently, the global tobacco market is still dominated by traditional cigarettes, and the market size thereof increased from USD715.7 billion in 2014 to USD 865.4 billion in 2019, with a compound annual growth rate of 3.9%. Figure 2.1 shows that in 2014, cigarettes accounted for 91% of the global tobacco market, but in 2019 this share fell to 88%, while at the same time the market share of E-cig rose 7% to 8%. Although the cigarettes still dominate, but if we look at the compound annual growth rate of segmented tobacco products, we find that from 2014 to 2019, the compound annual growth rate of E-cig products is as high as 24.2%, compared with only 3.2% for cigarettes. The growth rate of E-cig products reached nearly 8 times that of traditional cigarettes. Another noteworthy phenomenon is that, among all tobacco products, the compound annual growth rate of cigarettes is the slowest, which indicates

that with the development of the tobacco market and changes in the consumer base, traditional cigarettes have gradually declined. On May 1, 2013, Citigroup released a report listing the top 10 disruptive technologies that are about to change the world as we know it. Those technologies involve from 3D printing to personalized medicine and even solar energy, and E-cig is listed at number two on this list.

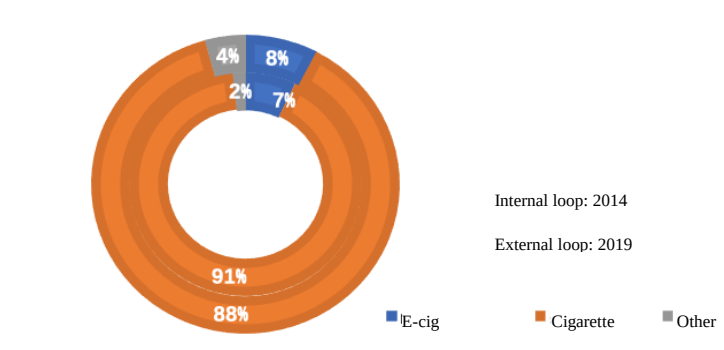


Figure 2.1 Change in Global Market Share of Tobacco Products by Type in 2014-2019

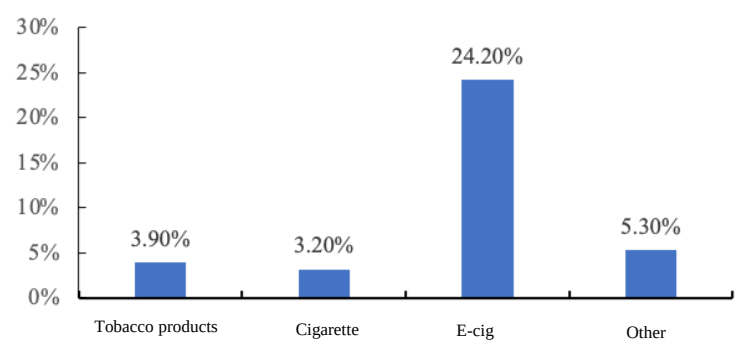


Figure 2.2 Compound Annual Growth Rate of Global Tobacco Products by Type in 2014-2019

If we focus our attention to segments of the E-cig industry, one topic of interest is the development of different types of E-cig products. Figure 2.3 illustrates the change in market size of the global E-cig device industry from 2013-2020, with open e-atomizers rising from USD5.3 billion in 2013 to USD 19.9 billion in 2020, a 3.75-fold increase; closed e-atomizers rising from USD 4.3 billion in 2013 to USD 33 billion in 2020, a 7.67-fold increase, and HnB

devices from USD 4 million in 2013 to USD 13.5 billion, an astounding 3,375-fold increase. This indicates that HnB tobacco products within E-cig sector maintain a very rapid growth momentum, especially after 2016 began to occupy an increasingly important market share in the overall E-cig device market, and by 2020, the proportion of HnB tobacco products in the overall E-cig device sector has reached 20%.

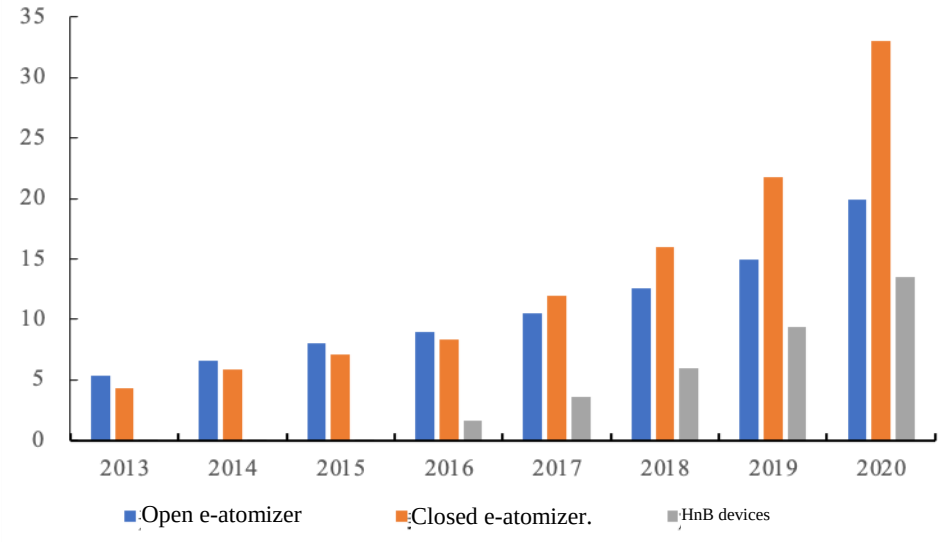


Figure 2.3 Market Size of Global E-cig Devices Industry in 2013-2020 (USD billion)

In the last two years, the development of E-cig around the globe has slowed down significantly, which is partly due to the economic recession and shrinking consumption caused by the pandemic and the gradually strengthened control of new tobacco products such as E-cig practiced by countries. According to the 2020 World Tobacco Development Report released by the Economic Research Institute of the China Tobacco Monopoly Bureau, the rapid expansion of E-cig slowed down in 2020 due to the pandemic. The sales on the global market except China totaled USD 19.62 billion, an increase of 4.3% over the previous year, with growth falling back 24.4 percentage points year-on-year. The United States, the United Kingdom and Canada are three countries selling

more than USD1 billion E-cigs around the globe. The combined sales accounted for 68.2% of the total market sales outside of China. In the United States, the first major market for E-cig, the federal and state governments strengthened control from the age of the purchaser, the product taste, and other aspects due to the negative impact of E-cig-related lung disease, resulting in rapid decline in the U.S. market after rapid growth. The annual sales were USD 9.5 billion, down 1.6% from the previous year, while the growth rate was up to 41.2% in 2019. In the United Kingdom, E-cig sales growth continued to slow, achieving sales of USD3.04 billion for the year, up 12.3% from the previous year, a 3.7 percentage point drop in growth. Canada sold USD1.21 billion, up 17.5% over the previous year, a significant drop of 88.4 percentage points in growth. However, there is no doubt that the E-cig industry will continue to be in the windfall position in the tobacco market, and the future development will still be promising.

2.2.2 China

China's E-cig industry began in 2003, when Han Li, a Chinese pharmacist, applied for the first patent for a modern E-cig, opening the era of modern E-cig in China. China's E-cig industry has experienced three stages of initial development, rapid expansion, and industry reshuffling. In these three periods China's E-cig industry continues to grow and develop. As the state gradually makes clear its regulation of E-cig, the E-cig industry entered the reshuffling stage, and the future industry will be more orderly. Therefore, this part will analyze the development status of China's E-cig industry from three perspectives: the demand side, the supply side, and the regulatory side.

2.2.2.1 Demand side

The market demand for E-cig in China has expanded rapidly over the past decade, but there is still much room for development. The market size of China's E-cig market was RMB 550 million in 2013, increased to RMB 8.38 billion in 2020, and is expected to exceed RMB 10 billion in 2021, with a dramatic expansion of China's E-cig market. In 2019, the number of smokers in China was 316 million, ranking first in the world; however, the proportion of E-cig consumers in China to the number of smokers is only 0.6%. In terms of other major countries in the world, the United States, the United Kingdom and France respectively have only 71 million, 11 million and 13 million, only 22.4%, 3.5% and 4.1% of the number of smokers in China, but the E-cig penetration rates of these three developed countries, that is, the proportion of E-cig consumers to the total number of smokers, were 13%, 4.2% and 3.1%, 21.7 times, 7 times and 5.1 times China. If compared with the world's largest E-cig using country - the United States, there is a very huge gap between the E-cig penetration rates between China and the United States and in the future, as the E-cig market penetration rate increases, China's E-cig market size is expected to increase significantly.

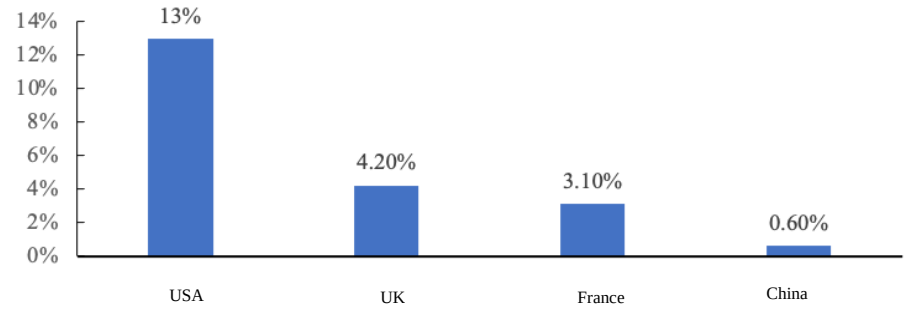


Figure 2.4 E-Cig Penetration Rate

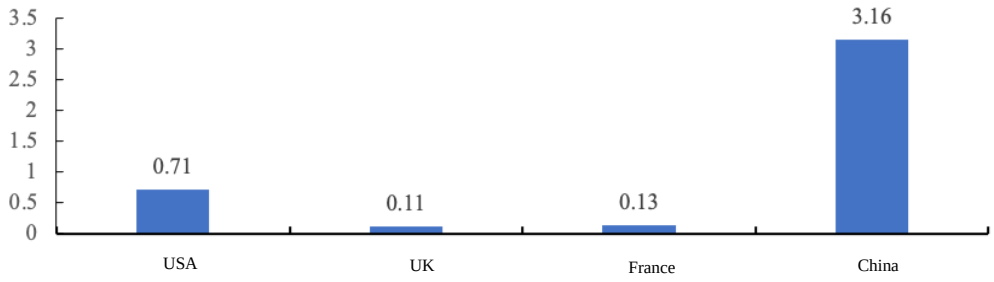


Figure 2.5 Total Number of Smokers by Country (billion people)

2.2.2.2 Supply side

China is the world's largest E-cig production base, accounting for about 95% of global production, of which more than 90% is supplied for export, with domestic sales of about 5%, and the domestic consumer market is still relatively small. In 2019, a total of 218 countries and regions around the world procured E-cigs from China, with a total procurement amount of RMB 76.585 billion. The United States, Hong Kong, China, and Japan ranked top three by the import amounts, purchasing RMB 19.614 billion, RMB 16.412 billion and RMB 8.225 billion, or 25.48%, 21.4% and 10.7% respectively. In 2020, the E-cig industry ushered in the second reshuffle due to the outbreak of the pandemic, the stagnation of logistics, the failure of factories to resume production and other factors. As domestic enterprises start to resume work and production, China becomes a global "production center" for the entire world, which will further drive the export growth of China's E-cig market.

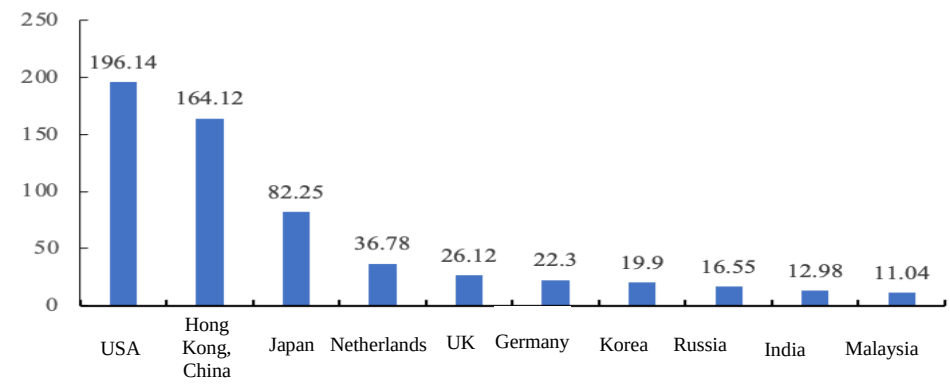


Figure 2.6 China's Top Ten E-cig Exporters (100 million)

The vast market development space of E-cig attracts many enterprises. Data show that China's E-cig enterprises grew rapidly from 45,457 in 2013 to 168,452 in 2020, and as of February 4,2021, China's surviving E-cig enterprises totaled 174,399. In terms of growth rate, the number of E-cig enterprises in China is growing at a faster pace, with a high growth rate of 30.28% in 2020. It is foreseeable that the number of enterprises in the industry will continue to soar in the future, and the industry track will become more crowded.

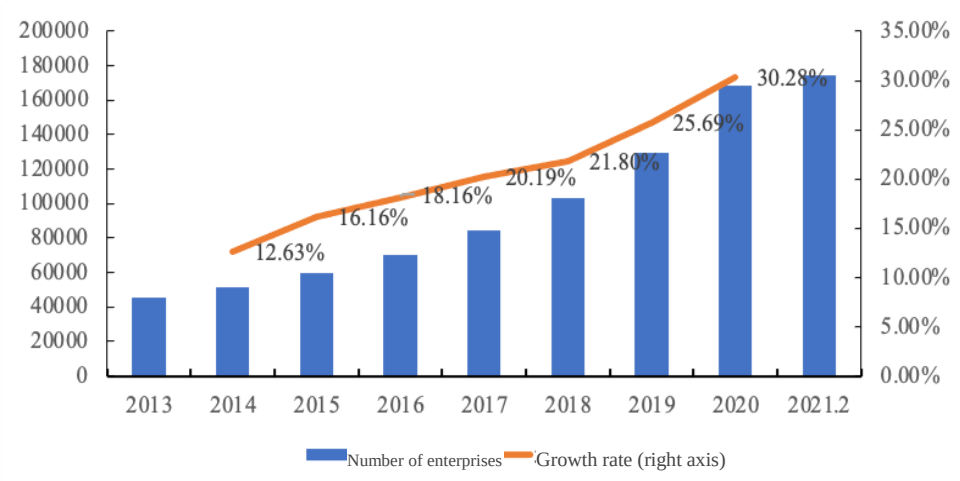


Figure 2.7 Number of Enterprises in China's E-cig Industry

Nowadays, E-cig has become a development trend that cannot be underestimated, and enterprises in China's E-cig industry are gradually improving their R&D capabilities. Data show that from 2010 to 2019, the number of E-cig-related patents in China has grown from 84 to 5385. Among

them, HnB technology, low-temperature ceramic atomization technology, and salt and alkali technology as the current research and development of key technology areas will lead the change of the E-cig industry, to achieve innovative breakthroughs and development of E-cig technology. With more stringent testing and certification of E-cig import and export and sales in recent years, domestic enterprises have invested more energy in product development and innovation, and the rapid development of technological change is expected to lead the further development of this industry.

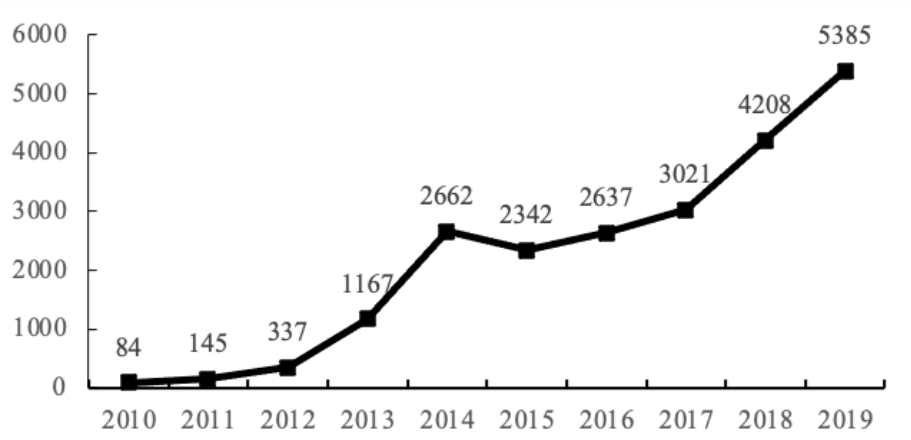


Figure 2.8 Patent Applications for E-Cigs in China

2.2.2.3 Regulatory side

Currently, one person dies from a smoking-related disease every six seconds on average around the globe. The number of smokers in China accounts for about one-third of the global population, with more than 1 million deaths due to smoking each year and about 100,000 deaths due to passive smoking related diseases. Overall, the main future trends in tobacco control and cessation. And the WHO Global Tobacco Epidemic Report 2019 points out that E-cig has not only nicotine, but also some other harmful substances. It is not clear about the long-term impact on health and there is not enough evidence that E-cig helps

to quit smoking, so the control of the tobacco market continues all the time and is a common practice in countries around the world. In addition to our serious rectification with respect to the E-cig market from last year, countries have implemented relevant control policies on E-cig. Since 2018, Portugal has banned the use of e-atomizers in enclosed spaces; in September 2019, several U.S. states began to ban the sale of various forms of non-tobacco flavored E-cig, and the U.S. Food and Drug Administration has also required the submission of a listing application before the listing of E-cig; otherwise the sale will be prohibited; in July 2020, the U.S. Senate passed another bill banning the sale of E-cig to minors on e-commerce platforms.

In November 2019, relevant state departments began tightening control over E-cig. Major e-commerce platforms took down E-cig products overnight due to the introduction of the ban on the online sale of E-cig. Before the online sales channel was cut off, E-cig players sold products online, which could avoid stores and distributors from sharing profits and reduce product costs. Thus, due to the ban, E-cig companies can no longer market through online, and the publicity effect has been greatly reduced, while standards around the world have been introduced one after another, so that E-cig ushered in a violent reshuffle. However, although countries have adopted one policy after another, they have not completely banned the sale and import and export of E-cigs, but have strengthened the testing and certification of import, export, and sales of E-cigs. The future of the E-cig market will exist for a long time, but regulators will continue to put forward higher requirements for the E-cig products, companies need to continue to strengthen the production and development of compliant and reliable products, to survive and develop under the policy

regulation.

Regulatory policy is the key to industry development. Regulatory policy plays an extremely critical role in the development of E-cigs as a new industry. At present, there is a lack of domestic regulatory policies on E-cigs, and most E-cigs are still developed under no product standards, no quality control and no safety evaluation. There are no regulations on E-cig. But the State is speeding up the development of regulatory policies and regulations. On July 17, the China Tobacco Monopoly Bureau said in the Circular of the China Tobacco Monopoly Bureau on Issuing Main Points of the Comprehensive Deepening Reform in 2018 to promote research on the regulation of new tobacco products. In terms of policies and regulations, it will strengthen research on the classification and management measures of new tobacco products, actively promote the inclusion of new tobacco products such as E-cig in regulation, further strengthen market analysis and regulatory model research on E-cig and coordinate with legislative departments to develop effective regulatory policies and feasible measures. The regulatory policy to release at home will be the key to the development of the E-cig industry in the future.

Table 2.4 Overview of China's Policies Related to the Sale and Production of E-cigs.

Time	Policy	Main content
August 2018	Notice on the Prohibition of Sale of E-Cigs to Minors	The State Administration for Market Regulation and the China Tobacco Monopoly Bureau require domestic market entities not to sell E-cigs to minors

November 2019	Circular on Further Protection of Minors from E-cigs	All types of market entities shall not sell E-cig to minors; E-cig production and sales enterprises or individuals are urged to promptly close websites or clients making available E-cigs; e-commerce platforms shall promptly close E-cig stores and take E-cig-related products off the shelves in a timely manner, urge the E-cig enterprises and individuals to withdraw E-cig advertisements published via the Internet
July 2020	Notice on Releasing a Special Inspection Action Plan for the E-cig Market	Carry out a comprehensive cleanup of Internet E-cig information, a comprehensive inspection of physical E-cig stores, and of emerging channels such as E-cig vending machines.
October 2020	Law on the Protection of Minors	Parents or other guardians of minors shall not indulge or instigate minors to smoke (including E-cig), drink alcohol, gambling, beg, or bully others. The sale of tobacco products (including E-cig) to minors is also prohibited.

Note: Compiled by the author.

Chapter 3 Literature Review and Research Hypotheses

3.1 Consumer Behavior Theory

3.1.1 Consumer Behavior

Consumer Behavior is an emerging field of research, and since its introduction in the mid- to late-1960s, there are several definitions of “Consumer Behavior” in academic circles, and these definitions have been continuously developed and refined(Si, 2001). For example, according to Woods (1981), Consumer Behavior in a narrow sense refers to the activities that people do when they get what they need, including shopping, comparing, buying, and using products and services. Loudon and Bitta (1984) define "Consumer Behavior" as the decision-making processes and physical activities that people engage in when evaluating, acquiring, using, and disposing of products or services. Schiffman and Kanuk (1987) consider Consumer Behavior as "the behavior of consumers in finding, buying, using, evaluating, and disposing of products, services, and ideas that they want to satisfy their needs. Engell (1996) defines Consumer Behavior as "the various actions taken to acquire, use, and dispose of consumer goods and the decision-making processes that are limited to and determine these actions". Domestic scholars also have specific definitions. For example, Dong (2012) considers Consumer Behavior as the consumer's consumption behavior, the decision-making process that consumers make when acquiring, evaluating, using, and disposing of products and services, and the various actions that they take as a result. It can be found that some parts of the definition of Consumer Behavior by various scholars have similarities and differences. The difference may be related to the

fact that researchers adopt different research paradigms and differ in their judgment perspectives.

Early studies on Consumer Behavior were based on the theory of economics that consumers are rational decision makers and that consumers purchase products or services based on the basic principle of maximizing benefits. Subsequent studies found that consumers often make impulsive purchases, and they are influenced by their personal perceptions, emotions, families, reference groups, advertisers, and roles in the purchase decision process. Different scholars have explained Consumer Behavior starting from the relevant theories from each school of thought. Economists believe that individuals derive satisfaction from the consumption of products and are assumed to consider their level of income and the price of the product to obtain the maximum benefit and satisfaction. In addition, individuals can rationally judge their tastes and preferences to make rational purchase actions.

3.1.2 Consumer Buying Behavior

Consumer Decision Making is the process by which a consumer carefully evaluates the attributes of a product, brand or service and makes a choice to purchase a product that satisfies a particular need. Broadly speaking, Consumer Decision Making refers to the process of analyzing, evaluating, selecting, and implementing the best purchase option among two or more options available to consumers to satisfy a certain need, and post-purchase evaluation, under the domination of certain purchase motives. It is a systematic process of decision-making activities, including the determination of needs, the formation of purchase motives, the choice and implementation of purchase options, post-purchase evaluation and other links. The Consumer Decision Making process

consists of five stages: need, information collection, evaluation, decision to purchase and post-purchase behavior.

To decide, consumers must plan, select and arrange around the goal, stimulated by internal and external factors, generate demand, form purchase motivation, choose and implement purchase options, and post-purchase experience will influence the next Consumer Decision Making, thus forming a complete cycle. As the purchase behavior is the external manifestation of the subjective needs and wishes of consumers and influenced by many objective factors, in making decisions consumers will not only carry out a series of sensory, perceptual, attention, memory and other mental activities, but also must carry out a series of analysis, reasoning, judgment and other thinking activities, and calculate the cost of expenditure and a variety of benefits that may bring.

Consumers are influenced and constrained by various factors when making decisions, including their personalities, temperaments, interests, habits, and income levels; the spatial, socio-cultural, and economic environments in which they live and other stimuli, such as product attributes, prices, corporate reputation, and service levels, as well as various forms of promotion. There are complex interactions among these factors, which have uncertain effects on the content, manner, and outcome of consumers' decisions. Specifically, personal factors, such as age, gender, race, ethnicity, income, family life cycle, and occupation. These factors can influence not only the participation in household decision making, but also the speed of people's decision-making process.

Psychological factors, including feelings, motivations, experiences, attitudes, and consumer personality.

Social factors, including role and family, relevant groups, social class, and culture.

Since the various factors that influence decision making are not static, but constantly change with time, place, and environment, the consumption decision for the same consumer is distinctly situational, and the specific way it is made varies depending on the context in which it is made. Because of the differences in income levels, purchasing traditions, consumer psychology, family environment, and other influencing factors, different consumers may also have different purchasing decisions for the same product.

3.2 Consumer characteristics and tobacco consumption

According to the hypothesis of rational man in economics, smoking cigarettes is not good for health, so why would consumers consume a good that is harmful to their health. In this regard Becker and Murphy developed a rational addiction model to explain this. Becker and Murphy (1988) state that "addictive behaviors such as smoking, although distinct from the consumption of other goods, can also be explained in economics, i.e., the smoker feels pleasure in the process of smoking, and even if he is aware of the long-term health risks, he will weigh the pros and cons between the present pleasure and the long-term health risks to make the optimal choice that maximizes his utility, which is the famous rational addiction theory. Therefore, from the perspective of neoclassical economics, addiction is also a rational economic behavior that is consistent with maximizing the decision maker's utility, even if it may end up costing a heavy price in life. Chaloupka (1991) found that smoking is an addictive behavior and that smokers are not short-sighted or lacking in foresight. The empirical results show that when consumers' age and education are at the

same level, those with low or young education are more prone to addiction, while the lower the education background, the more price sensitive they are, with long-run price elasticities roughly between -0.57 and -0.62; while the higher the education background, the more retarded they are to price changes. Orphanides and Zervos (1995) argue that people's addictive behavior is mainly due to information asymmetry, i.e., consumers' judgments about addictive products come from external perceptions and their own perceptions, but in fact the harm of addictive products themselves is underestimated, so they fall into addictive behavior and find it difficult to extricate themselves.

Meanwhile, as the development of mass media in recent years has profoundly influenced Consumer Behavior. For example, Henriksen et al. (2010) showed that exposure to cigarette sales advertising is a risk factor for individuals to start smoking, i.e., exposure to tobacco advertising increases the likelihood of individuals to smoke. The results of the 2015 China Adult Tobacco Survey Report are consistent with this finding that a higher proportion of smokers aged 15, 22, 24 years and older saw cigarette advertisements and promotional messages in the past 30 days (7.9%) than non-smokers (5.7%) (Chinese Center for Disease Control and Prevention, 2016).

Therefore, we will probe into three aspects of consumers' personal characteristics, the importance consumers place on health, and the external environment consumers face based on the research focus of the existing literature. In the next part, we will present the corresponding research hypotheses based on the findings of these three broad directions.

3.2.1 Personal characteristics of consumers

According to Consumer Behavior theory, many studies have explored

consumers' purchasing behavior from their personal characteristics.

First, gender and age are important factors that influence individual smoking behavior (Higgins et al., 2015). Significant gender and age differences do exist in smoking behavior among Chinese adults (15 years and older): smoking prevalence is 50.5% for men compared to 2.1% for women. Among the male smokers, the current smoking prevalence is highest in the 45-64 age group at 57.1% and lowest in the 15-24 age group at 34.0%. The current smoking prevalence increases with age for women, with the highest level in the 65+ age group at 4.1% and the lowest in the 15-24 age group at 0.9%. In addition, smoking cessation rates increase with age: the lowest rate is 1.3% in the 15-24 age group; the highest rate is 34.5% in the 65+ age group (Chinese Center for Disease Control and Prevention, 2019). Similarly, Lv et al. (2019) found that the likelihood of quitting smoking increases with age.

Second, race/ethnicity may influence individual smoking behavior. Studies have found that racial discrimination is associated with an increased risk of smoking (Borrell et al., 2007; Landrine and Klonoff, 2000). Meanwhile, Brook et al. (2007) and Wills et al. (2007) suggest that racial pride or identity may reduce the risk of tobacco use. Wang et al. (2019) and Zhang et al. (2019) found that smoking prevalence did differ between Han and ethnic minorities in China. However, Li et al. (2015) concluded that smoking risk among ethnic minorities is like that of Han Chinese, which may be due to genetic inheritance and environmental sharing, so further research is still needed.

Third, family structure and size may influence individual smoking behavior. Marital status has been shown to influence individuals' smoking behavior (Cho et al., 2008; Lindström, 2010; Ramsey et al., 2019), but the effect

of family size on individual smoking is inconclusive. Some studies have shown that large family size is associated with lower levels of smoking (Jarvis, 1996), but there are some studies that have found the opposite (Block and Webb, 2009; Isohanni et al., 1991; Johansson et al., 2003). Inconsistencies in the findings may result from difference in other control factors or the omission of relevant and important factors. For example, the results of Arouri et al. (2017) demonstrated a correlation between parental smoking and the number of children in the family, but most studies ignored this factor.

Some other studies have examined the influence of family factors on adolescent smoking behavior. The influence of family on adolescent smoking behavior includes the smoking behavior and attitudes of parents, the smoking behavior and attitudes of other family members, and the influence of family relationships on individuals. Numerous studies have shown that parental smoking behavior significantly increases an individual's risk of smoking (Thorlindsson and Vilhjalmsson, 1991) and that there is a dose-response to parental smoking behavior, meaning that smoking by both parents has a greater negative impact on the individual (Ogawa et al., 1988; Shibata et al. 1990). The importance of this intergenerational transmission of smoking behavior was also demonstrated in a study by Tang et al. (2014). In addition, parental attitudes toward smoking can also influence individual smoking behavior, and if parents have uncertain attitudes, their children will be more likely to smoke (Lin et al., 2008; Newman and Ward, 1989). Similarly, the smoking behavior of siblings also increases the risk of smoking in individuals (Leonardi-Bee et al., 2011). In addition, family closeness, education style, etc. can also influence individual smoking behavior to varying degrees.

This has been demonstrated in some domestic studies. For example, Fang et al. (2001) chose the smoking survey project of the National Institute on Drug Abuse and selected 319 middle school students from 22 families to conduct a randomized survey towards them and their families and found that family factors were significantly correlated with adolescent smoking behavior. Family communication, cohesion, parental monitoring, maternal emotional care and punitive severity, and paternal emotional care were negatively associated with adolescent smoking behavior; family conflict, maternal punitive severity, denial of denial, and excessive interference were positively associated with adolescent smoking behavior. In addition, those adolescents living alone and in single-parent families were more likely to smoke.

Fourth, socioeconomic status was also an important factor in determining smoking behavior. Studies have found that groups with low socioeconomic status are more likely to be smokers (Hiscock et al., 2012) and they are less likely to quit (Osler and Prescott, 1998). There are different measures of socioeconomic status, where smoking-related influences include education background, income level, and type of occupation (Li et al., 2016; Zhang et al., 2014). The level of education is a protective factor, i.e., the higher the level of education, the lower the likelihood of smoking (Wang et al., 2018) and the higher the likelihood of quitting (Lv et al., 2019). This finding is consistent with the actual situation in China, where the lowest smoking rates were found in the group with college and higher education (Chinese Center for Disease Control and Prevention, 2016). Yang et al. (2008) showed that higher income groups were more likely to smoke compared to lower income groups; however, Wang et al. (2018) concluded that in middle-aged and older age groups, the effect of

income factors on the smoking behavior of individuals was minimal. In addition, the risk of smoking varies among individuals with different types of occupations. Li et al. (2015) found that manual workers have a higher risk of smoking compared to mental workers or retirees.

Fifth, differences in residence may have an impact on individual smoking behavior (Doogan et al., 2017; Taype et al., 2017). Astell-Burt et al. (2015) found significant geographical differences in smoking behavior among Chinese residents. As shown by the 2018 China Adult Tobacco Survey Report, the prevalence of smoking among adults in rural China (28.9%) was higher than that in urban areas (25.1%). The results of Chen et al. (2018) proved that the smoking behavior of individuals was indeed significantly associated with the characteristics of their regions.

3.2.2 Consumers' perceptions of the health risks of smoking behavior

To explore the influence of consumers on the health behavior of smoking behavior, it is first necessary to clarify the hazards of smoking behavior, and the current literature mainly studies the health risks of smoking behavior from two aspects: active smoking and passive smoking.

3.2.2.1 Health risks of active smoking

First, smoking can lead to malignant tumors. Tobacco smoke contains at least 69 carcinogens that can cause cellular carcinogenesis and malignancy. There is strong evidence that smoking can cause oropharyngeal, laryngeal, esophageal, tracheal, and bronchial tumors, lung, acute myelogenous leukemia, stomach, liver, pancreatic, kidney, cervical, bladder, and colorectal cancers. In addition, evidence suggests that smoking may cause breast cancer; smokers

have a higher risk of dying from prostate cancer compared to non-smokers (U.S. Department of Health and Human Services, 2014). In most developed countries, 16% of cancers are caused by smoking. To be specific, about 25% of cancers in the male population and 4% in the female population; while in less developed countries, about 10% of cancers are caused by smoking (Sasco et al., 2004). Chen et al. (2019b) revealed that smoking was the leading carcinogenic factor for men in 31 provinces and autonomous regions in China, and about 25% of cancer deaths in men were caused by smoking and in addition, more than half of lung cancer deaths were caused by smoking. The results of a prospective study in China showed that smokers had a higher risk of lung cancer death than non-smokers. Specifically, among urban men, the risk of lung cancer death was 3.78 times higher among smokers whose initial smoking age was less than 20 years old than nonsmokers, among smokers whose initial smoking age was 20-24 years old 3.17 times higher than nonsmokers, and 2.23 times higher among smokers whose initial smoking age was 25 years old or older than nonsmokers. Among rural men, the corresponding risk of lung cancer death risk for smokers in each initial age group was 2.91, 2.45 and 1.63 times that of nonsmokers, respectively (Chen et al., 2015). Currently, lung cancer ranks first in incidence and death from malignant tumors in China (Zheng et al., 2019), and Zou et al. (2017) suggest that this is closely related to smoking and exposure to secondhand smoke.

Second, smoking can cause a variety of respiratory diseases. Inhalation of tobacco smoke can adversely affect respiratory immune function, lung structure and lung function. Studies have demonstrated that smoking can cause chronic obstructive pulmonary disease and asthma in adolescents and increase the risk

of developing tuberculosis and other respiratory infections (U.S. Department of Healthand Human Services, 2014). Findings show that the emergency room and hospitalization rates for non-smoking asthma patients in China are significantly lower than those for asthma patients with a history of smoking (Su et al., 2014). A prospective study of chronic disease found that among urban men in China, the risk of death from COPD was 2.94 times higher among smokers with less than 15 cigarettes per day than among nonsmokers, 5.40 times higher among smokers with 15-24 cigarettes per day, and 7.26 times higher among smokers with 25 cigarettes per day or more than among nonsmokers; among rural men, the risk of death from COPD corresponding to each smoking subgroup was 1.52, 1.32 and 1.34 times higher than that of nonsmokers, respectively (Chen et al., 2015). In addition, adult smokers in China, especially those who quit due to disease, have significantly higher rates of chronic respiratory disease (Kurmi et al., 2015).

Third, smoking impairs vascular endothelial function and triggers a variety of cardiovascular and cerebrovascular diseases. There is ample evidence that smoking can lead to cardiovascular diseases such as coronary heart disease, stroke, and peripheral arterial disease. In addition, smoking cessation significantly reduces the risk of morbidity and mortality from cardiovascular disease. Studies have shown that smokers have two to four times the risk of coronary heart disease and stroke as non-smokers, and that smokers have a significantly higher risk of coronary heart disease even when they smoke less than five cigarettes per day (U.S. Department of Health and Human Services, 2014). In addition, 19.9% of acute coronary events and 11.0% of acute ischemic stroke events in Chinese people aged 35-64 years can be attributed to smoking.

The risk of acute coronary disease in smokers is 1.75 times higher than in nonsmokers; the risk of ischemic stroke in smokers is 1.37 times higher than in nonsmokers; and the risk of hemorrhagic stroke in smokers is 1.21 times higher than in nonsmokers (Wang et al. 2006).

Fourth, tobacco smoke contains a variety of harmful substances that can affect human reproductive and developmental functions, and smoking can lead to reproductive and developmental abnormalities. Studies have shown that smoking can adversely affect the endocrine system, fallopian tube function, placental function, and immune function in women. There is ample evidence that smoking reduces the women's chances of pregnancy; for men, smoking affects sperm quality, thereby reducing fertility and increasing the risk of birth defects and miscarriage in pregnant women. In addition, maternal smoking can damage genetic material and cause fetal cardiovascular system, tissue and organ failure, and can even cause placenta previa, placental abruption, fetal growth restriction, low birth weight of the newborn, and sudden infant death syndrome. In addition, evidence suggests that smoking can also cause erectile dysfunction in men, ectopic pregnancy and spontaneous abortion in women (U.S. Department of Health and Human Services, 2014).

Fifth, smoking can lead to other diseases and health problems. Studies have shown that smoking can lead to periodontitis, cataracts, hip fractures, and skin aging. For the postoperative population, smoking can lead to poor wound healing and even postoperative respiratory complications. For people with H. pylori infection, smoking can cause them to have peptic ulcers. In addition, smoking may lead to type 2 diabetes according to Liu et al. (2018), which found that long-term smokers have a 15% to 30% higher risk of developing type 2

diabetes than nonsmokers. For diabetic patients, smoking not only increases their risk of macrovascular and microvascular complications, but also affects disease prognosis. In addition to causing these diseases, smoking can have many other adverse effects on the body, such as causing inflammation and weakening immune function. In addition, there is evidence that smoking may also cause dementia.

3.2.2.2 Health risks of passive smoking

The current literature on the harms of secondhand smoke focuses on the effects on adolescents as well as children. Exposure to secondhand smoke has been shown to cause illness and early death in children and adult nonsmokers.

First, exposure to secondhand smoke can be harmful to adult health. There is conclusive evidence that passive smoking directly and adversely affects the cardiovascular system in adults and increases the risk of lung cancer and coronary heart disease in adults. Studies have found that exposure to secondhand smoke during living with smokers increases the risk of coronary heart disease in nonsmokers by 25% to 30%; it also increases the risk of lung cancer in nonsmokers by 20% to 30%. In addition, evidence suggests that exposure to secondhand smoke may contribute to sinus cancer, atherosclerosis, acute or chronic respiratory symptoms, decreased lung function, asthma, stroke, and breast cancer in women (U.S. Department of Health and Human Services, 2006). The increased prevalence of COPD and respiratory symptoms in China is indeed associated with passive smoking. The risk of developing COPD among nonsmokers is strongly associated with self-reported exposure to secondhand smoke in the home or workplace. Among others, the risk of COPD among nonsmokers with high long-term exposure levels (40 hours per week for

more than 5 years) is 1.48 times higher than that of those with high short-term exposure (40 hours per week but less than 2 years) (Yin et al., 2007). Exposure of Chinese nonsmoking women to tobacco smoke when their husbands smoke increases their risk of all-cause mortality by 15%, including a 37% increase in the risk of death from cardiovascular disease; exposure to secondhand smoke at an early age increases the risk of cardiovascular death by 26% (Wen et al., 2006).

Second, exposure to secondhand smoke poses more serious health risks to children. Ample evidence supports that exposure to secondhand smoke increases the risk of sudden infant death syndrome, acute respiratory infections, ear disease, and severe asthma in children. In addition, exposure to secondhand smoke in pregnant women leads to lower birth weight in newborns. Maternal smoking increases the risk of lower respiratory disease in infants and children, and parental smoking affects lung development and leads to middle ear disease (acute otitis media, recurrent otitis media, and chronic middle ear effusion) in children. Evidence suggests that exposure to secondhand smoke in pregnant women may lead to preterm birth, and exposure to secondhand smoke both before and after birth can lead to cancer, leukemia, lymphoma, and brain tumors in children (U.S. Department of Health and Human Services, 2006).

3.2.2.3 Consumers' perceptions of health risks of smoking behaviors and tobacco consumption

Numerous studies have shown that individuals' perceptions and attitudes toward smoking and tobacco control will also influence their own smoking behavior, and the more consumers are aware of the health risks of smoking, the less they will consume cigarettes. Zhou et al. (2019) concluded that people with

low levels of smoking hazard perceptions are more likely to smoke, while those with higher levels of smoking hazard perceptions are more likely to quit. This is consistent with the actual situation in China: according to the 2015 China Adult Tobacco Survey Report, the proportion of current smokers aged 15 years and older who believed that smoking causes stroke, myocardial infarction, lung cancer, and erectile dysfunction was 26.1%, significantly lower than 32.8% of nonsmokers (Chinese Center for Disease Control and Prevention, 2016). In addition, Feng et al. (2016) concluded that the knowledge of tobacco control affects individuals' psychology of smoking, which in turn affects their smoking behavior. However, some studies have also concluded that attitudes and perceptions are not a significant predictor of individual smoking behavior when other factors are considered (Mc Neill et al., 1989).

There are likewise studies that have examined their effect on smoking cessation behavior in terms of perceptions of health risks, which could argue the other way. It has been found in the literature that many factors are now significantly associated with the success of smoking cessation, including reasons for active smoking cessation, self-efficacy to refuse smoking, level of nicotine dependence, level of perception of anticipated difficulties, and so on. Overall, the factors that motivate smokers to quit are summarized in two main areas: the motivation that drives them to quit and their level of nicotine dependence. Of course, the motivation of tobacco users to quit is a key factor in determining their success in smoking cessation. In contrast, tobacco users' perceptions of the harms associated with smoking behavior determine their motivation to quit. Leventhal et al.'s (1998) Self-Regulation Common Sense Model (CSM) of health and disease suggests that individuals who are exposed

to a disease threat or health risk first form an initial cognitive representation and then take measures to control and cope with it (Marteau and Weinman 2006). Many studies have also shown that people's understanding of perceived harm from smoking significantly influences their cessation behavior, with people with higher understanding levels being more likely to quit (Williams et al., 2011; Sansone, 2012) and more likely to quit successfully (Feng et al., 2010; Yang et al., 2010). In an investigation of risk factors influencing smoking cessation behavior in adults, Kaleta et al. (2012) found that among men who smoked, those with higher awareness of smoking-related diseases had more than eight times the smoking cessation rate than those with lower awareness.

3.2.3 Literature on external environment and tobacco consumption

3.2.3.1 Cohort effects

Numerous studies have shown that peer smoking behavior and attitudes are effective predictors of adolescent smoking behavior (Tyas and Pederson, 1998). As the influence of family members such as parents and siblings on individuals diminishes with age, the influence of peers becomes more important in predicting individual smoking behavior (Vink et al., 2003). Among others, spouse is an important peer, and spouse smoking increases the likelihood of an individual smoking by 40% (Margolis and Wright, 2016). In addition, Chu et al. (2010) argued that adult smoking initiation is also influenced by social peers, which is consistent with the findings of Dai et al. (2014).

For the same reason, some studies have found that the school environment is an important influence on adolescent smoking behavior, and some have shown that the school's attitude towards smoking has significant relationship

with adolescent smoking behavior (Gong et al., 2004). When schools have a relatively tolerant attitude towards smoking, their students' smoking rates are significantly higher. Also, the number of male teachers in the school who smoked is significantly and positively associated with adolescent smoking behavior, and the more male students perceived as smoking, the more students smoke.

Some studies have explained this in terms of sociological theories. Sociological theory suggests that adolescents' smoking behaviors are acquired through observation and imitation of others' smoking behaviors. Parents and teachers are the objects that adolescents often come into contact within their lives, and movie stars are those that are often observed on the screen. Their behaviors can have a great influence on adolescents. They serve as role models and objects to be imitated, and whether they smoke can have a significant impact on adolescents' smoking behaviors. Adolescents anticipate the consequences of smoking by observing whether their real-life role models smoke or not, and by personal experience and by observing what people around them say about their smoking. If adolescents receive positive conclusions, they tend to be more likely to smoke because they believe that smoking has a positive effect on them and that smoking is socially desirable. This is especially true for adolescents who lack confidence in their social competence (Bandura, 1986). Peer smoking is an important influence on adolescent smoking behavior, as peer smoking increases the probability that adolescents will be exposed to the smoking environment on the one hand and persuaded to smoke on the other. Different levels of smoking among adolescents were significantly associated with peers' smoking behaviors and attitudes, direct and regular peer pressure

(Fang et al., 2001). Adolescence is a critical period of development, when adolescents have strong rebellious mentality, a desire for independence, a high sense of community, a strong curiosity, and a strong ability to imitate, but do not have sufficient judgment (Fang et al., 2001). Adolescents are at the age when they are blindly following the crowd and following the trend, and peer smoking tends to interest them; therefore, peer smoking behavior tends to make the adolescent smoking group grow rapidly.

3.2.3.2 Influence of the external environment

The current literature on the influence of the external environment on individual smoking behavior has two main mainstream theories, one is the Social Norm Theory and the other is the Behavior Availability Theory, both of which elaborate on how the external environment affects individual tobacco consumption from different perspectives.

The first is the Social Norm Theory. According to Social Norm Theory, smoking behavior is associated with individuals' misperceptions of relevant social norms and misinformation about social norms. When individuals believe that smoking behavior is group acceptable behavior in social norms, that it is acceptable for them to smoke, and that it is correct for others to smoke, they begin smoking to be consistent with others. Conversely, when individuals realize that smoking is not only unhealthy, uncivilized, and unwelcome, but also disliked and rejected by the group, and may even be punished and discriminated, through correct information and various environmental restrictions, individuals are likely to correct their personal perceptions, form a negative attitude towards smoking and form behaviors of not smoking, quitting smoking, or even restricting others from smoking, and a social norm of not smoking will

gradually be reinforced and even institutionalized (Opp, 2002). This is supported by studies that have found that tobacco control policies (Alesci et al., 2003), social norms, and other factors are associated with smoking behavior, and Siegal et al. (2004) demonstrated that laws reduce youth smoking by changing smoking-related social norms (Glantz, 2006). As described by Siegel et al. (2004), "the introduction of laws can change norms from an incomplete and temporarily institutionalized social norm to an authoritative and deeply institutionalized social norm." Social norms in social organizations should rightfully be led by the organization's leaders. A smoke-free environment policy is not only the organization's regulation of indoor smoking bans, but more importantly, it also indicates the organization’s and its leaders' attitudes toward tobacco control and facilitates the formation of social norms for tobacco control.

The second is Behavior Availability Theory. Behavior Availability Theory clarifies the relationship between the conditions of behavior implementation and behavior. The easier the behavior is to implement, the more likely it is to occur, and conversely, when it is inconvenient to implement, the occurrence of that behavior is inhibited (Carnell and Wardle, 2008). This theory has been successfully tried in numerous behavior changes (Yang, 2007). Exploring the relationship between behavioral availability and smoking behavior has important implications for tobacco control. The occurrence of smoking behavior is related to environmental conditions, such that if a certain environment is unfavorable to smoking behavior, smoking may subsequently decrease. In other words, by imposing restrictions on smoking in public places, workplaces, and homes through rules or regulations that create inconveniences for smoking behavior, smoking behavior will be less likely to occur because it

is discouraged.

This has been demonstrated in many studies. Environmental restrictions, by directly reducing the opportunity to smoke, reduce the amount of tobacco use in restricted areas and may increase the chance of quitting (Levy and Friend, 2003). Restrictions on smoking in public places (e.g., theaters, movie theaters, shopping malls), workplaces, and public transportation make people cannot smoke for an extended period, which is likely to motivate some of them to try to quit, thus contributing to higher quit rates (Wilson et al., 2007). In a survey covering students, the accessibility of smoking behavior was found to contribute to its behavioral availability (Alesci et al., 2003). After the introduction of smoking ban regulations in public places, fewer adolescent smokers were saw in public places (Siegel et al., 2004), and the disappearance of smoking sent a powerful message to adolescents about what is appropriate desirable behavior (Eisenberg and Forster, 2003). When anti-smoking regulations restricted smoking to designated areas, the accessibility of indoor smoking, the availability of behaviors declined and adolescents smoked less (Alesci et al., 2003), starting cessation efforts on the one hand and being able to increase cessation success because of reduced smoking opportunities on the other. More quit attempts and higher quit success rates mean more successful quitters and fewer people continuing to smoke.

3.3 Hypothesis

This dissertation lists and summarizes the research results of cigarettes and E-cig consumption in detail above. The said literature provides a solid theoretical and literature basis for this research, but it is not difficult to find that

such literature still has the following deficiencies which can be supplemented and advanced in this dissertation:

First, a large amount of current research on cigarette consumption is still concentrated in the traditional tobacco field. Since E-cig is an emerging industry in recent years, the theoretical research seriously lags behind the development of the E-cig industry due to the lack of relevant data. In particular, although a small number of literatures conducted preliminary research on E-cig consumption, most of which were foreign empirical evidence. However, it is unknown whether these empirical evidence is applicable to domestic consumers. Particularly, though China is a big country of cigarette consumption and one of the largest markets for E-cig, there is still a lack of empirical research using Chinese consumers as samples.

Second, from the perspective of existing literature, most of the literature focuses a certain factor and studies its impact on E-cig consumption. However, there are many factors that affect E-cig consumption to varying degrees. No matter for theoretical research or guiding the industry development, it is of great significance to correctly identify what is the main factor affecting E-cig consumption. This dissertation attempts to divide all factors that affect E-cig consumption into three perspectives: personal characteristics, health risk perception and external factors, and find the main factor that has the greatest impact.

Third, from the perspective of empirical analysis, most existing studies have serious endogeneity problems, so their results are of questionable credibility. Most of the studies are merely relatively simple descriptive statistics and correlation analysis, but this dissertation can well deal with the endogenous

problems in the studies through instrumental variables, which makes the research conclusions hereof more credible. To sum up, on the basis of existing literature, this dissertation attempts to conduct empirical tests based on the following three hypotheses:

Hypothesis 1: Consumer characteristics are highly correlated with E-cig consumption.

Hypothesis 2: Low health risk is an important reason why consumers choose E-cig instead of traditional cigarettes.

Hypothesis 3: The probability of consumers consuming E-cig increases when family members are more averse to the act of smoking.

Chapter 4 Data, Variables, and Descriptive Statistics

4.1 Empirical model setting

4.1.1 Empirical model

The baseline regression model used in this dissertation is:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \gamma_i + \tau_i + \varepsilon_i \quad (4\text{-}1)$$

$$Y_i = \beta_0 + \beta_2 X_{2i} + \gamma_i + \tau_i + \varepsilon_i \quad (4\text{-}2)$$

$$Y_i = \beta_0 + \beta_3 X_{3i} + \gamma_i + \tau_i + \varepsilon_i \quad (4\text{-}3)$$

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \gamma_i + \tau_i + \varepsilon_i \quad (4\text{-}4)$$

where X_{1i}, X_{2i} and X_{3i} are a series of explanatory variables; Y_i is the predicted variable; subscript i represents the individual, and τ_i is the controlled variables such as gender, age, smoking age, height-to-weight ratio, and ethnicity. To exclude the interference of factors such as consumers' location, this dissertation uses γ_i as province-level fixed effects. Specifically, Formula (4-1) is the regression model of the impact of consumers' individual characteristics on E-cig consumption, Formula (4-2) is the regression model of the impact of consumers' health concerns on E-cig consumption, and Formula (4-3) is the regression model of the impact of external factors on E-cigconsumption. Formula (4-4) is the result of multivariate regression. As shown in Figure 4.1, in formulas 4-1, 4-2 and 4-3, X_{ki} is the core explanatory variables. This dissertation focuses on the sign and significance of the coefficient β_1, which represent the effect of new E-cig use on Consumer

Behavior change. Since our predicted variable is whether consumers consume E-cig, which is a binary variable, we use the Probit model for regression.

4.1.1.1 Predicted variable

This dissertation explores the effect of new E-cig use on changes in Consumer Behavior. Existing literature generally take whether one has used E-cig as the predicted variable Y_i. In the sample of questionnaires in this dissertation, the consumer is assigned a value of 1 if he or she has used E-cig and 0 otherwise.

4.1.1.2 Core explanatory variables

To measure the impact of new E-cig use on Consumer Behavior change, the core explanatory variables include the following three main aspects.

i. Personal characteristics of consumers. According to Wang (2003), income and price are the most important factors in determining consumption, and consumers' perceptions of product safety are related to consumers' gender, age, education background, and household income (Luo and Li, 2010). Therefore, based on the questionnaire data, this dissertation selects the consumer's living environment (cultural and social factors) and consumer characteristics as important factors affecting individual consumption, specifically including individual i's demographic characteristics, such as education background and age, and including individual i's economic and social variables, such as income, as core explanatory variables.

ii. Consumer cognitive variables. The factors that affect consumers' ability to perceive products are mainly consumers' purchasing experience and the level of consumers' concern about product safety (Ma and Qin, 2009; Liu and Qiao,

2010). Therefore, this dissertation selects consumer perception variables, such as why consumers believe that new E-cigs are healthier than traditional cigarettes, whether consumers have chosen to quit smoking and whether consumers understand the hazards of reducing smoking as core explanatory variables to investigate whether lower health risks are important reasons for consumers to choose E-cig over traditional cigarettes.

iii. External factors. A study by Yu and Su (2013) found that consumer motivation, consumption perceptions, and purchase behavior of the product were related to family, couple emotional commitment (Lin, 2018), and number of children (Ma and Qin, 2009). Therefore, in this dissertation, external factors affecting consumption, such as whether they are married, whether the spouse smokes, and the spouse's attitude towards smoking, are selected as core explanatory variables to explore whether external factors are the key reasons affecting E-cig consumption.

4.1.1.3 Controlled variables

To control the interference of other factors on the use of new E-cig on the change of Consumer Behavior, based on the existing literature and reality, this dissertation uses basic characteristics of consumers such as gender, age, smoking age, height-to-weight ratio, ethnicity, and others as controlled variables.

4.2 Data, variable selection, and descriptive statistics

4.2.1 Data sources and survey methods

The survey referred to the Global Youth Tobacco Survey (GTYS) unified standard questionnaire and set questions according to the actual situation in

China and the focuses of this dissertation. The survey objects of the questionnaire are smokers, including traditional tobacco consumers and E-cig consumers, some of whom are both traditional tobacco consumers and E-cig users. We set the survey objects of the questionnaire as smokers mainly for two purposes. First, this dissertation focuses on research of E-cig consumption choice behavior of smokers. Second, we consider market trends and tobacco control policy. Because research on smokers' reduced consumption of traditional tobacco and increased consumption of E-cig without negative impact on external environment is helpful for the formulation of tobacco control policy and provides a certain reference for the E-cig industry. The questionnaire included gender, age, location, tobacco use, tobacco dependence and cessation, exposure to secondhand smoke, new electronic tobacco access and price, new electronic tobacco advertising and promotion, and knowledge and attitude towards new electronic tobacco. The purpose and main content of the survey are presented to the respondents before the survey begins, highlighting that the survey is anonymous, there are no right or wrong answers, the survey results are confidential, and participation is voluntary.

From August to December 2021, I conducted the questionnaire survey by randomly distributing 1,069 electronic questionnaires. After all data collection was completed, the data were cleaned. Firstly, samples whose format could not be matched were deleted; secondly, samples whose age was greater than 100 years were deleted; finally, samples whose smoking age was greater than or equal to age were deleted. After processing, a total of 1059 valid questionnaires were collected, and the response rate of all of them was 99%. The variable assignments are shown in Table 4.1, and descriptive statistics are shown in

Table 4.2.

It should be noted that, considering the impact of COVID-19, the questionnaire in this dissertation is distributed online, which can ensure the efficiency. However, we must omit information about consumers who are not accustomed to using the Internet, resulting in a certain bias in sample selection. Judging from the current survey data, the oldest sample is 66 years old, and the average age is 28 years old, indicating that the middle-aged and elderly consumers account for a relatively small proportion. Will this cause serious sample selection bias in this study? Based on the previous analysis of the basic principles and facts of E-cig, we believe that the basic portraits of E-cig consumer groups are young and middle-aged people with certain educational level and consumption ability. The consumption of electronic products such as E-cig features technology and health, making it more acceptable to young people, especially those with certain scientific and cultural knowledge, and the price of E-cig also requires certain income threshold for consumers. This shows that, E-cig consumers highly overlap with Internet users. Therefore, we believe that though the adoption of online questionnaire herein ignores a small number of E-cig consumers who are not Internet users, most E-cig users can still be randomly investigated, so the data is still highly valid and credible.

Table 4.1 Assignment of Variables for Regression Analysis

Variables	Variable	Assignment
gender	gender	1=male, 2=female
Use_ele_cig_before	Use E-cig before	1=yes, 0=no
marriageornot	Marriage or not	1=single or regular partner, 2=married
Spousesmokingornot	Whether the spouse is smoking	1=yes, 0=no
Spouse_att_smoking	Spouse's attitude towards smoking	1=support, 0=oppose
Stop_smoking	Whether to try to quit smoking	1=yes, 0=no
Try_Elcigarettes_be	Whether or not tried new E-cig	1=yes, 0=no
reduce_harm_smoking	How to reduce the harm of smoking	1=know, 0=not sure
index_smoking_care	What index do you care about when you smoke?	1=tar or nicotine, 2=not sure
Channel_for_ecigar	Channels to learn about E-cig	1=spouse or friend, 2=other

Table 4.2 Descriptive Statistics

Variables	Variable	Obs	Mean	Std. Dev.	Min	Max
gender	gender	1059	0.819	0.385	1	2
Smoking age	Smoking age	1059	7.670	6.520	0	45
Use_ele_cig_before	Use E-cig before	1059	0.315	0.465	0	1
Age	Age	1059	27.86	8.243	19	66
marriageornot	Marriage or not	1059	1.332	0.471	1	2
Number of Child	Number of Child	1059	0.420	0.703	0	4
Spousesmokingornot	Whether the spouse is smoking	1059	0.270	0.444	0	1
Spouse_att_smoking	Spouse's attitude towards smoking	1059	1.228	0.420	1	2
Income	Annual income	1059	181035	520696	0	9996666
Stop_smoking	Whether to try to quit smoking	1059	1.641	0.480	1	2
Try_Elcigarettes_be	Whether or not tried new E-cig	1059	0.623	0.485	0	1
Spouse_att_smoking	Spouse's attitude towards smoking	1059	1.349	0.477	1	2
Channel_for_ecigar	Channels to learn about E-cig	1059	1.552	0.497	1	2
reduce_harm_smoke	How to reduce the harm of smoking	1059	1.392	0.488	1	2

4.2.2 Analysis of the general results and measurement results of the questionnaire

(1) Analysis of general results

The survey sample consisted of 1059 consumers, 868 (82%) male consumers and 191 (18%) female ones. Among them, 273 male consumers (31%) had tried traditional E-cig; 539 male consumers (62%) had used new E-cig, while the proportion of female consumers trying traditional E-cig and using new E-cig was basically the same as male consumers, 32% (61) and 63.1% (121), respectively.

The ages of individuals subject to the survey range mainly from 19 to 45 years old; the oldest consumer is 66 years old, and the youngest consumer is 19 years old. In further analysis of the age data in Figure 4.1, it was found that 61%, 67%, and 68% of the 19-29, 30-39, and 40-49 years old used new E-cig, respectively, with their proportions exceeding 60%, and the number of people consuming new E-cig declined as their age increased.

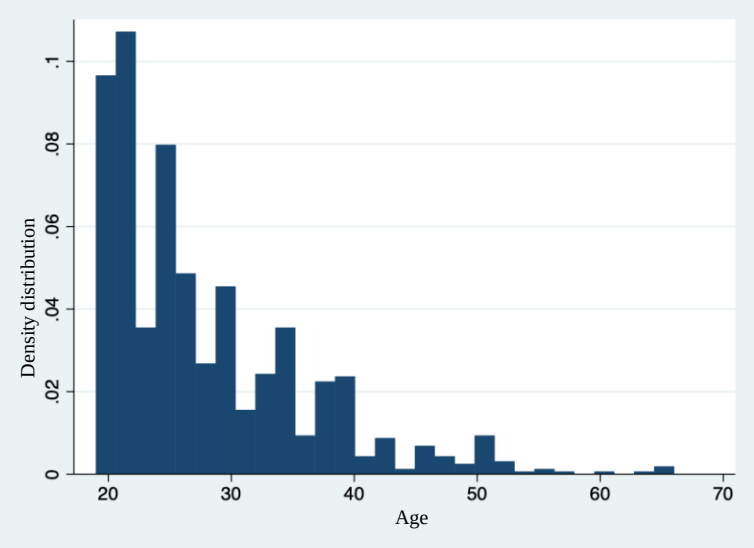


Figure 4.1 Age Distribution

Figure 4.2 shows the annual income distribution of consumers in the survey questionnaire. More intuitively show the density distribution of consumers' annual income, this dissertation only intercepted consumers with annual income of RMB0 - RMB100,0000. The figure below shows that consumers with annual income distribution around zero occupy a larger group, which indicates that the new E-cig consumers are partly students, which is close to the results in Figure 4.3. From the descriptive row statistics in Table 4.3, we find that the average annual income of the survey questionnaire is RMB 181,035, which is higher than the annual per capita disposable income of RMB 76,401 for the high-income group announced by the National Bureau of Statistics in 2020, which reflects that the high-income group is the main force consuming new E-cig.

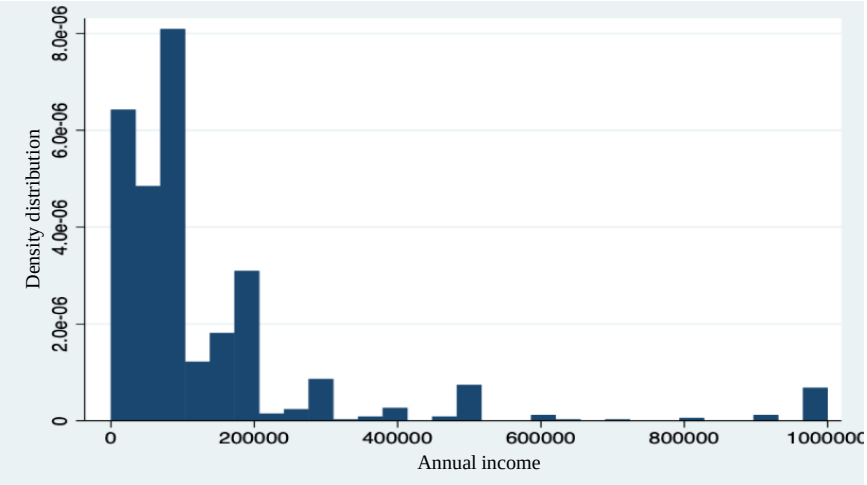


Figure 4.2 Annual Income Distribution

Figure 4.3 shows the education background of the respondents and we found that the survey questionnaire basically covered groups with different education backgrounds. In the comparison of different education background groups in Table 4.3, we found that a total of 801 individuals (75.6%) with

bachelor's degree or above had tried new E-cig, while a total of 258 (24.4%) with college degree or below had tried new E-cig.

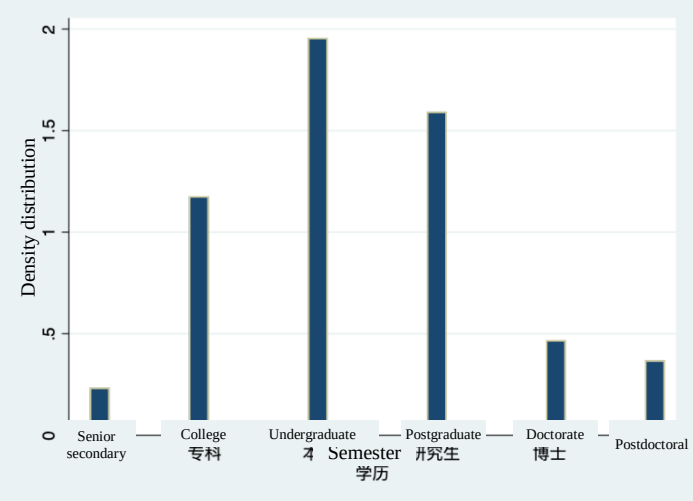


Figure 4.3 Education Background Distribution

Figure 4.4 visually reflects that consumers care more about the presence of harmful substances in cigarettes, with almost half of them caring more about the presence of tar in cigarettes, and almost 30% about nicotine and carbon monoxide in cigarettes, while others are not concerned about the contents in cigarettes. In terms of knowledge about cigarettes, a total of 563 people (53.1%) were more concerned about tar and nicotine content when smoking, while 496 (46.9%) were not concerned about specific indicators. Among those who tried to quit smoking, a total of 411 people (60%) tried to gradually get rid of their dependence on cigarettes through new E-cig, while 264 (66%) used new E-cig instead of cigarettes, as detailed in Table 4.3.

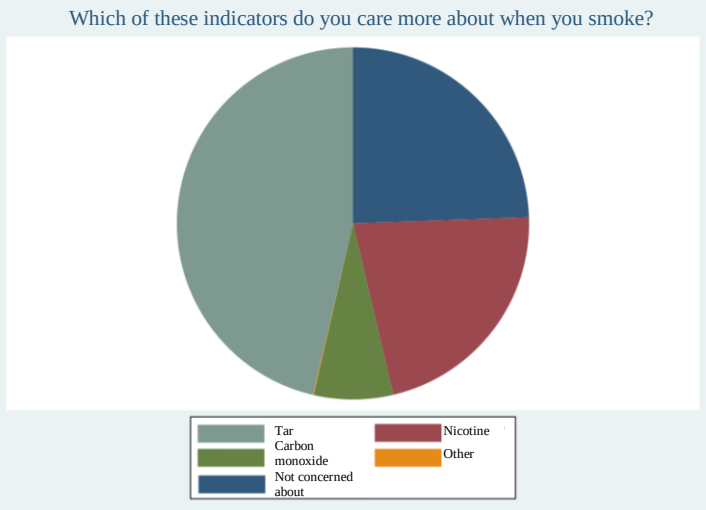


Figure 4.4 Which indicator will be more important when smoking.

Figure 4.5 shows whether spouses' attitudes toward smoking improve after consumers choose the new E-cig, and it is clear that spouses will prefer the new E-cig. As for spouse's attitude towards smoking, a total of 817 (77%) disagreed with their spouse's smoking, but more than 242 (67%) supported their spouse's use of the new E-cig to replace traditional cigarettes, as detailed in Table 4.3.

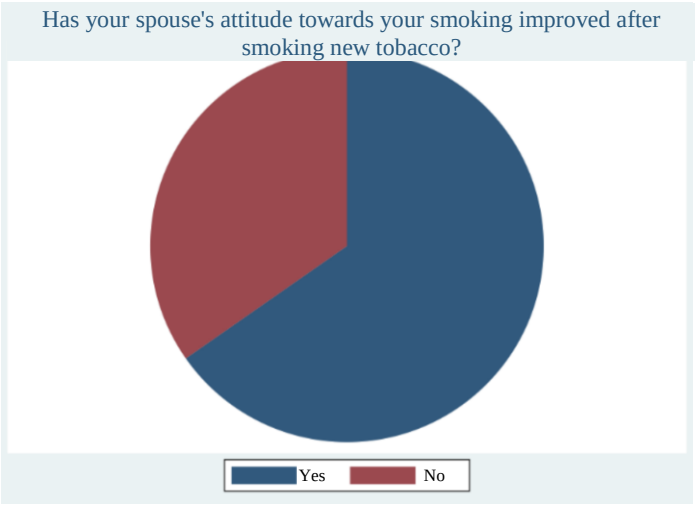


Figure 4.5 Whether your spouse's attitude towards smoking has improved after choosing new E-cig

Table 4.3 E-cig Use among People with Different Characteristics

Characteristics	Number of people	Number of people using traditional E-cigs	Use of new E-cig Number of people
gender			

Male	868	273	539
Female	191	61	121
19-29 years old	706	198	431
30-39 years old	246	102	164
40-49 years old	76	26	51
50-59 years old	26	6	13
60 years old and above	5	0	1
Senior secondary	43	12	22
Junior college	215	59	126
Undergraduate	357	113	217
Postgraduate	291	97	196
Doctorate	86	29	50
Postdoctoral	67	24	48
Yes	679	219	411
No	380	121	264
Tar, nicotine	563	-	-
Don't care much about indicators	496	-	-
Yes	242	-	-
No	817	-	-
Yes	689	-	-
No	370	-	-

Chapter 5 Empirical Analysis

5.1 Basic results

5.1.1 Univariate analysis

This dissertation first analyzes the relationship between consumers' personal characteristics and E-cig consumption. Q5 of the questionnaire, "Have you ever used iQos?" summarizes each individual i's use of E-cig and sets as the predicted variable; through Q6: "What is your height, weight, age, ethnicity, and education", we summarize each individual i's age and education and set as the core explanatory variable; Q11 "What is your annual income?" summarizes the income of each individual i and sets it as the core explanatory variable. After obtaining the core explanatory variables and core expected variables, we apply a least squares regression model to control province-level fixed effects and explore the factors influencing consumers' personal characteristics on the consumption of new E-cig. Specific results of the regression are shown in Table 5.1. From the results in columns (1) and (2) of Table 5.1, after controlling province-level fixed effects, the coefficients of the effects of education background and income are both significant at the 10% level. It indicates that groups with higher education background and higher income have a fuller understanding of E-cig and tend to consume it. In column (3) of Table 5.1, the effect coefficient of age is significantly positive at the 1% level, while the squared term of age is significantly negative at the 1% level, indicating that there is an "inverted U-shaped relationship" between age and E-cig consumption. It reveals that the probability of E-cig consumption increases with age but decreases after a certain age. This suggests that older smokers are less

likely to consume E-cig, which is consistent with the findings of Tyas and Pederson (1998) and John et al (2005). The results in column (4) of Table 5.1 show that the coefficients and significance of income and age remain largely unchanged after considering personal characteristics such as consumer education background, income, and age, indicating that among the personal characteristics of consumers, age and income are determinants of E-cig consumption, a result that tentatively supports the first hypothesis of this dissertation. Therefore, this dissertation further investigates whether consumers' perceptions of health affect the consumption of E-cigs.

Table 5.1 Factors Influencing Consumers' Personal Characteristics on the Consumption of New E-cig.

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not	(4) Use E-cig before or not
Education	0.024*			-0.013
background	(1.696)			(-0.783)
Income		0.000**		0.000*
		(2.471)		(-1.828)
Age			-0.021***	0.018***
			(-3.452)	(-3.135)
Age squared			0.000***	-0.000***
			(3.309)	(3.066)
gender	0.012	0.021	0.022	0.026
	(0.280)	(0.518)	(0.539)	(0.613)
Smoking age	-0.001	-0.001	-0.002	-0.001
	(-0.765)	(-0.636)	(-0.723)	(-0.639)
Height-to-	0.028	0.033	0.026	0.029
weight ratio	(0.462)	(0.542)	(0.425)	(0.468)
Ethnicity	-0.001	0.001	0.001	0.001
	(-0.051)	(0.053)	(0.025)	(0.034)
_cons	1.440***	1.374***	1.649***	1.680***
	(7.039)	(6.946)	(7.590)	(7.583)
Province-level fixed effects	Control	Control	Control	Control
N	1059	1059	1059	1059
r2	0.047	0.050	0.055	0.060
F	0.787	1.434	2.167	2.280

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

After the initial testing of the first hypothesis, the second hypothesis of lower health risk as an important reason for consumers to choose E-cig over

traditional cigarettes was tested by using an inductive questionnaire, while retaining the core predicted variable of the first hypothesis "whether or not to use E-cig", as follows. First, Q24: "Do you know the difference between vape E-cig and HnB HDB in new tobacco?", is designed to check whether consumers believe that E-cig are healthier and was set as the core explanatory variable. Then, Q20: " Do you know of any ways to reduce the harm of smoking?" is designed to represent whether consumers knew of ways to reduce the harm of smoking and was set as the core explanatory variable. Finally, Q21, "Have you ever tried to quit smoking?" is designed to check out whether consumers have ever tried to quit smoking and was set as the core explanatory variable. Based on this, a least squares regression model was used, controlling province-level fixed effects, and exploring whether lower health risks were an important reason for consumers to choose E-cig over traditional cigarettes, as shown in Table 5.2. The results in column (1) of Table 5.2 show that the coefficient of the effect of perceiving E-cig as healthier on E-cig consumption is significantly positive at the 1% level, indicating that a one standard deviation increase in consumer understanding after perceiving E-cig as healthier increases the probability of using new E-cig by 3.3%. In column (2) of Table 5.2, the coefficient of influence for the understanding of reduced harm from smoking is significant at the 1% level, indicating that consumers would choose to consume healthier E-cig to reduce the harm associated with cigarette smoking. The results in column (3) of Table 5.2 show that the coefficient of influence for whether to quit smoking is significant at the 10% level, indicating that consumers would like to quit smoking by replacing cigarettes with E-cig. Column (4) of Table 5.2 shows that after combining the three core explanatory

variables mentioned above, the coefficients for consumers' perception of E-cig as healthier, desire to learn about ways to reduce the harms of smoking, and whether they have quit smoking are all significant at the 10% level, indicating that lower health risks are important reasons for consumers to choose E-cig over traditional cigarettes, which is in line with the results of Williams et al. (2011) and Sansone (2012), justifying hypothesis 2 of this dissertation.

Table 5.2 Factors Influencing Health Risks on the Consumption of New E-cig.

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not	(4) Use E-cig before or not
Believe that E-cig are healthier	0.035***			0.036***
	(2.961)			(2.663)
Desire to learn about ways to reduce the harm of smoking		0.027***		0.028***
		(3.149)		(2.792)
Whether or not they have quit smoking			0.044*	0.047*
			(1.738)	(1.905)
gender	0.008	0.012	-0.003	-0.001
	(0.160)	(0.282)	(-0.064)	(-0.022)
Smoking age	-0.002	-0.001	-0.002	-0.001
	(-0.377)	(-0.813)	(-1.116)	(-0.714)
Height-to-weight ratio	0.017	0.029	0.036	0.017
	(0.320)	(0.497)	(0.604)	(0.262)
Ethnicity	-0.002	-0.001	0.002	0.001
	(-0.099)	(-0.033)	(0.085)	(0.034)
_cons	1.278***	1.302***	1.255***	1.139***
	(6.422)	(6.579)	(6.071)	(5.535)
Province-level fixed effects	Control	Control	Control	Control
N	1059	1059	1059	1059
r2	0.052	0.053	0.047	0.063
F	1.967	2.193	0.688	3.039

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

After verifying the plausibility of hypotheses 1 and 2, I selected Q7, 9 and 10 to summarize the external factors that affect consumer consumption and to investigate the plausibility of hypotheses 3 that external factors are the key reason for E-cig consumption, as follows. First, Q7, "Are you married?" was

summarized as whether or not you are married and set as the core predicted variable; second, Q9, "Does your spouse smoke?" was summarized as whether or not your spouse smokes, and set as the core explanatory variable; finally, Q10, "What is your spouse's attitude towards your smoking?" was summarized as spouse's attitude towards smoking, and set as the core explanatory variable. The least squares regression model was used to control province-level fixed effects and analyze whether external factors were the key reason for E-cig consumption, as detailed in Table 5.7. The results from column (1) of Table 5.3 show that the coefficient of effect of whether to get married is significantly positive at the 10% level after controlling regional fixed effects, which indicates that when consumers get married up by one standard deviation, it increases E-cig consumption by 3.2%. The results in column (2) of Table 5.3 show that the coefficient on whether the spouse smokes is not significant. In contrast, the results in column (3) of Table 5.3 indicate that the coefficient on the effect of spouse's attitude towards smoking is significantly negative at the 1% level, suggesting that households whose spouses oppose smoking choose to consume more E-cig, which is close to the findings of Carnell and Wardle (2008).

The results in column (4) of Table 5.3 show that the coefficients of the effects of marriage and spouse on smoking attitudes are significant at the 1% level when the three core explanatory variables are considered together, suggesting that spouses influence consumer choice of new E-cig. However, the coefficient of the effect of whether the spouse smokes or not is not significant at the 10% level, but the coefficient is significantly positive, indicating that spouse smoking will make consumers choose to consume more E-cig, thus reducing the health risks of cigarette smoking. This shows that external factors

are also one of the key reasons affecting E-cig consumption (Opp, 2002; Levy and Friend, 2003).

Table 5.3 Influence of External Factors on the Consumption of New E-cig

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not	(4) Use E-cig before or not
Whether married or not	0.029*			0.056***
	(1.695)			(3.041)
Whether spouse smokes		-0.007		0.051
		(-0.165)		(1.319)
Spouse's attitude towards smoking			-0.106***	-0.129***
			(-4.291)	(-5.007)
Number of child				0.014***
				(3.085)
gender	0.007	0.013	-0.003	-0.001
	(0.160)	(0.282)	(-0.065)	(-0.023)
Smoking age	-0.001	-0.002	-0.002	-0.001
	(-0.373)	(-0.814)	(-1.126)	(-0.707)
Height-to-weight ratio	0.019	0.030	0.037	0.016
	(0.314)	(0.494)	(0.605)	(0.261)
Ethnicity	-0.000	0.000	0.001	-0.003
	(-0.014)	(0.004)	(0.024)	(-0.148)
_cons	1.431***	1.356***	1.135***	1.229***
	(7.042)	(6.802)	(5.599)	(5.952)
Province-level fixed effects	Control	Control	Control	Control
N	1059	1059	1059	1059
r2	0.047	0.044	0.061	0.077
F	0.798	0.220	3.921	4.644

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

5.1.2 Multivariate analysis

In the previous part, we used univariate analysis to test each of the three hypotheses proposed herein and the results initially supported the hypotheses

hereof. But it is possible that the three hypotheses are influenced by each other, and we also selected multiple variables as proxy variables in each hypothesis, and these variables may be interrelated with each other. To further analyze which specific hypothesis and which key indicator plays a dominant role in consumers' E-cig consumption behavior, we next tested it further using multivariate analysis. According to the Formula 4-4, in Table 5.4, all the variables involved in hypothesis 1 through hypothesis 3 were gradually included in the regression, with column 1 including only the variables associated with hypothesis 1, which is consistent with column 4 in Table 5.1, and columns 2 and 3 including the variables associated with hypothesis 2 and hypothesis 3, respectively, based on column 1. The goodness-of-fit of the regression is gradually increasing from column 1 to column 3, indicating that the explanatory power of the regression equation is gradually increasing. When only considering the coefficients in column 3, we find that among the consumer characteristics variables in hypothesis 1, only the coefficient for age remains significant at the 1% level; in hypothesis 2, the two variables of whether consumers think E-cig are healthier and want to learn about ways to reduce the harm of smoking remain significantly positive; and in hypothesis 3, marital status, spouse's smoking status, and number of child remain highly significant. This indicates that the three hypotheses still have sufficient explanatory power for Consumer Behavior after considering all three hypotheses that affect E-cig consumption. By comparing the magnitude of the coefficients, we can see that the magnitude of the coefficients for each of the variables in hypothesis 3 is larger, so it can be conjectured that hypothesis 3 has the greatest effect on Consumer Behavior. In conclusion, after the multivariate analysis, we further

validate the hypotheses proposed in the theoretical part of this dissertation.

Table 5.4 Factors Influencing Consumers' Personal Characteristics on the Consumption of New E-cig.

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not
Education background	-0.011	-0.012	-0.009
	(-0.783)	(-0.892)	(-0.659)
Income	0.000*	0.000*	-0.000
	(1.828)	(1.695)	(-1.480)
Age	0.019***	0.019***	0.017***
	(-3.142)	(3.210)	(2.910)
Age squared	-0.000***	-0.000***	-0.000***
	(-3.066)	(3.156)	(-3.025)
Believe that E-cig are healthier		0.032***	0.030***
		(2.801)	(2.632)
Desire to learn about ways to reduce the harm of smoking		0.020***	0.018**
		(2.737)	(2.459)
Whether or not they have quit smoking		0.044*	0.029
		(1.784)	(1.172)
Whether married or not			-0.042**
			(-1.983)
Whether spouse smokes			0.009***
			(2.945)
Spouse's attitude towards smoking			0.044
			(1.146)
Number of child			0.114***
			(4.422)
gender	0.026	0.024	0.014
	(0.613)	(0.575)	(0.313)
Smoking age	-0.001	-0.002	-0.002
	(-0.639)	(-0.738)	(-0.971)
Height-to-weight ratio	0.029	0.030	0.022
	(0.468)	(0.493)	(0.358)
Ethnicity	0.001	-0.000	-0.004
	(0.034)	(-0.020)	(-0.178)
_cons	1.680***	1.478***	1.342***
	(7.583)	(6.463)	(5.800)
Province-level fixed effects	Control	Control	Control
N	1059	1059	1059
r2	0.060	0.079	0.103
F	2.280	3.544	4.493

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

5.2 Principal component analysis method

In the previous part of the regression, we have conducted a preliminary

test of the 3 hypotheses using the original questions in the questionnaire, and the basic results tentatively prove the hypotheses of this dissertation. In order to discuss the above 3 hypotheses more conveniently, this part uses principal component analysis to generate three proxy variables, which denote consumers' technological comprehension, the importance of health risks, and external factors, for the next analysis. To facilitate the discussion, we will use the results of the principal component analysis method in all the regressions that follow.

Principal component analysis is a multivariate statistical method that examines the correlation between multiple variables to reveal the internal structure of multiple variables through a few principal components, i.e., deriving a few principal components from the original variables so that they retain as much information as possible about the original variables and are uncorrelated with each other. The usual mathematical treatment is to make a linear combination of the original P indicators as a new composite indicator. In essence, as a means of dimensionality reduction data processing, it transforms the original random vector whose components are correlated into a new random vector whose components are uncorrelated by means of an orthogonal transformation, which is expressed algebraically as transforming the covariance array of the original random vector into a diagonal array, and geometrically as transforming the original coordinate system into a new orthogonal coordinate system, so that it points to the P most widely scattered orthogonal directions of the sample points Then, the multidimensional variable system is downscaled so that it can be converted into a low-dimensional variable system with a higher accuracy, and then the low-dimensional system is further converted into a one-dimensional system by constructing an appropriate value function.

For hypothesis 1, in the basic regression, we treat the three indicators of consumer's education, age, age-squared term and income as proxy variables for consumer's understanding of technology, so based on these four variables, we use the principal component analysis method after the corresponding calculation results are shown in Table 5.5 below. As can be seen, after the calculation, two of the four variables have eigenvalues greater than 1, and at the same time these two eigenvalues have 81% explanatory power, so we generate the eigenvalues f11 and f12 of these two principal components based on this result, and according to the respective explanatory strength we can calculate the principal component scores for hypothesis 1.

$$H_1 = f11 * \frac{0.5007}{0.8158} + f12 * \frac{0.3150}{0.8158} \tag{5.4}$$

Table 5.5 Results of Principal Component Analysis for Hypothesis 1

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.00297	0.742916	0.5007	0.5007
Comp2	1.26006	0.561405	0.3150	0.8158
Comp3	0.698651	0.66033	0.1747	0.9904
Comp4	0.038321	.	0.0096	1.0000

For hypothesis 2, in the basic regression, we used the three indicators of whether consumers think E-cig are healthier, whether they are willing to learn about health, and whether they have quit smoking as proxy variables for the importance consumers attach to health risks. So based on these three variables, the corresponding calculated results after we used principal component analysis are shown in Table 5.6 below. After the operation, only the eigenvalue of 1 principal component among the 3 variables is greater than 1, but the eigenvalue of Comp2 is very close to 1. Meanwhile, comp1 has only 42.67% of the explanatory power, while comp1 and comp2 together explain 75% of it. So, we generate the eigenvalues f21 and f22 of these two principal components based

on this result, and according to the respective explanatory strength, the principal component scores for hypothesis 2 can be calculated as follows:

$$H_2 = f21 * \frac{0.4267}{0.7575} + f22 * \frac{0.3308}{0.7575} \quad (5.5)$$

Table 5.6 Results of Principal Component Analysis for Hypothesis 2

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.2801	0.287704	0.4267	0.4267
Comp2	0.992397	0.264896	0.3308	0.7575
Comp3	0.727502	.	0.2425	1.0000

For hypothesis 3, in the basic regression, we treat the four indicators of whether consumers are married, the number of children they have, whether their wives smoke, and their wives' attitudes towards smoking as proxy variables for external factors. So, on the basis of these four variables, we use principal component analysis and the corresponding calculated results are shown in Table 5.7. It can be seen that after the calculation, two of the three variables have eigenvalues greater than 1, but the eigenvalue of comp3 is very close to 1. Meanwhile, comp1 and comp2 have only 61.22% of the explanatory power, which is less than the rule of thumb of 75%, while comp1+comp2+comp3 explains 85.5% of them, so we generate, based on this result eigenvalues f31, f32 and f33 for these two principal components. Based on the respective explanatory strengths the principal component scores for hypothesis 3 can be calculated as:

$$H_3 = f31 * \frac{0.3080}{0.8550} + f32 * \frac{0.3042}{0.8550} + f33 * \frac{0.2428}{0.8550} \quad (5.6)$$

Table 5.7 Results of Principal Component Analysis for Hypothesis 3

Component	Eigenvalue	Difference	Proportion	Cumulative

Comp1	1.23202	0.015206	0.3080	0.3080
Comp2	1.21682	0.245688	0.3042	0.6122
Comp3	0.971131	0.391105	0.2428	0.8550
Comp4	0.580026	.	0.1450	1.0000

After the above operation, we have obtained the corresponding principal component scores for the three hypotheses. After bringing the three principal component scores into the regression equation, we can use a comprehensive index to test the hypotheses in this dissertation, and the corresponding results are shown in Table 5.8. Column 1 of Table 5.8 reveals that the principal component score H1 for hypothesis 1 is positive at the 5% significance level, and the stronger the consumer's awareness of technology, the more likely they are to consume E-cig. Column 2 of Table 5.8 makes clear that the more consumers value health, the more they tend to consume E-cig, and although the significance of the coefficient of the principal component score H2 for hypotheses 2 decreases, it is still positive at the 10% level of significance. Column 3 of Table 5.8 presents that the stronger the external factors of consumers, the more consumers tend to consume E-cig, and the coefficient of the principal component score H3 for hypothesis 3 is positive at the 1% level of significance. The results of the principal component analysis remain consistent with the basic results of this dissertation, which further demonstrates the robustness of the results hereof. Also, we find that the coefficients after using principal component analysis are very close in magnitude to the regression coefficients obtained using the specific questions in Table 5.4-Table 5.6, which indicates that the three proxy variables obtained after using principal component analysis in this dissertation are reliable. In column 4, we also performed a multiple linear regression, and the results remained the same.

Table 5.8 Principal Component Analysis Regression

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not	(4) Use E-cig before or not
H1	0.037**			0.021**
	(2.073)			(2.420)
H2		0.025*		0.006**
		(1.881)		(1.921)
H3			0.044***	0.045***
			(3.097)	(3.452)
gender	0.008	0.012	-0.011	-0.014
	(0.195)	(0.299)	(-0.258)	(-0.255)
Smoking age	0.000	-0.001	-0.002	-0.002
	(0.098)	(-0.803)	(-1.212)	(-1.208)
Height-to-weight ratio	0.022	0.030	0.041	0.038
	(0.362)	(0.483)	(0.672)	(0.645)
Ethnicity	0.000	-0.000	0.000	0.000
	(0.005)	(-0.007)	(0.002)	(0.003)
_cons	1.355***	1.357***	1.366***	1.367***
	(6.849)	(6.859)	(6.921)	(6.9996)
Province-level fixed effects	Control	Control	Control	Control
N	1059	1059	1059	1059
r2	0.048	0.048	0.053	0.062
F	1.075	0.923	2.135	2.951

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

5.3 Shapley Decomposition

Based on the principal component analysis method, this dissertation uses the Shapley Decomposition method to decompose the factors that influence the differences in E-cig consumption. First, the basic principles of the Shapley Decomposition are briefly outlined.

5.3.1 Basic principle of Shapley

The basic idea of the Shapley Decomposition method is that, assuming that the variance of an indicator is the result of the combined influence of multiple factors, and that the removal of any factor produces a marginal contribution to the variance of the indicator, then the average value of the

marginal benefit from the removal of the factor in all possible orders is its contribution to the variance of the indicator. The sum of the contributions of all influencing factors together constitutes the variance of that indicator (Shorrocks, 2013). Specifically, E-cig purchase decisions are influenced by a range of factors in this dissertation, including an individual's ability to understand the technology, attention paid to health and external factors. At this point, we hypothesize that when a factor X is fixed, an estimate of the degree of environmental improvement excluding the effect of X can be derived, and thus the marginal contribution of X to the purchase decision can be calculated accordingly. The marginal contribution of X to the purchase decision can be obtained by combining the above marginal contributions for all possible elimination paths of X.

In other words, if the relationship between the level of improvement of the purchase decision and the determinants can be:

$$G = g(Y) = g(f(x)) \tag{5.6}$$

Suppose $G = g(Y) = g(f(x))$, then X_k the Shapley value for the purchase decision can be:

$$SV_k = \sum_{x \in X} \varphi_k(x)[g(f(x) - g(x|X_k))] \tag{5.7}$$

In the above equation, k is the number of influencing factors and $g(f(x) - g(x|X_k))$ is the marginal contribution of X_k to G. $\varphi_k(x) = \frac{(k'-1)!(k-k')!}{k!}$ represents the weighting factor of the game set x. X_k The relative contribution of each influence factor is:

$$\text{Contribution} = SV_k / \sum_k^K SV_k \tag{5.8}$$

5.3.2 Results of Shapley Decomposition

The results of the Shapley decomposition show the ranking of the contribution of consumer personal characteristics factors, health risk perceptions, and external factors to differences in E-cig consumption.

From the decomposition results of the E-cig consumption differences in Table 5.9, the external factor is the most important reason for influencing Consumer Behavior, which is also consistent with the previous analysis that the occurrence of smoking behavior is related to environmental conditions. For an example, if a certain environment is unfavorable for the implementation of smoking behavior, smoking may subsequently decrease. In other words, by imposing restrictions on smoking in public places, workplaces, and homes through rules or regulations that create inconveniences for smoking behavior, smoking behavior will be less likely to occur because it is discouraged. Consumers' personal characteristics are also one of the most important factors influencing the consumption of new tobacco, which is close to the results of Orphanides and Zervos (1995), when consumers are more aware of the health risks of smoking, the less they consume cigarettes and switch to consuming new E-cig that are less harmful to their health.

Table 5.9 Results of the Shapley Decomposition of Differences in E-cig consumption

Factor	Shapley value	Percent
Pac1	0.00668	33.58 %
Pac2	0.00313	15.72 %
Pac3	0.01009	50.70 %
Total	0.01990	100.00 %

5.4 Endogeneity test

In analyzing whether changes in Consumer Behavior affect E-cig consumption, I argue that consumers choose to consume new E-cig based on their personal characteristics, their level of health awareness, and external factors. Although I have controlled most of the important influencing factors, there are still missing, or unquantifiable factors present. That is, consumers may not or may only choose to consume E-cig based on consumers' personal characteristics, their level of health awareness, and external factors. Therefore, drawing on Fisman and Svensson (2007), I construct the province average iv through the previous principal component analysis, as shown in equation (5.9):

$$\overline{x_i} = \sum_k x_{i,k} \tag{5.9}$$

where i denotes the individual and k denotes the province in which individual i is located.

The rationales are that (1) consumers in the same province face the same living environment and regulations, and therefore, the characteristics of consumer i, $x_{i,k}$ in the province are influenced by other individuals in the province, i.e., the correlation condition of the instrumental variable is satisfied. (2) The living environment and regulations within the province do not directly affect whether consumers purchase E-cig, and therefore the exogeneity condition of the instrumental variable is satisfied.

Therefore, the data for the provincial average in this dissertation were obtained from the national survey data of the China Household Tracking Survey (CFPS) for a total of five rounds (2010, 2012, 2014, 2016, and 2018) from

2010-2018. Since each year of data in this database is cross-sectional, we first intercept all the required variables from these 5 rounds of cross-sectional data and merge them vertically into unbalanced panel data; then, we remove the data of households that have moved across regions since the migration of households across geographic regions would make the research findings more biased; finally, we remove the sample of households that have been surveyed for less than 5 rounds to form a balanced panel data, and the average value after principal component analysis of each province was calculated and set as the instrumental variable. In this part, samples cover a total of 23 provinces, 92 counties, 1333 rural villages and 3 urban communities and 6148 households.

As can be seen from the results in Table 5.9, in column (1) of Table 5.10, this dissertation finds that the instrumental variable IV1 of hypothesis 1 is positive at the 5% level of significance, indicating that consumers' propensity to consume E-cig increases with their knowledge of the technology. In addition, IV2 in column (2) and IV3 in column (3) of Table 5.9 are both positive at the 1% significance level, indicating that health importance and external factors are reasons for consumers to consume E-cig. Meanwhile, this dissertation found that the results of the Instrumental Variables Method were consistent with those of the main regression and principal component analysis with no significant change in magnitude, which proves that the basic results of this dissertation remain robust.

Table 5.10 Endogeneity Test

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not
IV1	0.161** (2.060)		
IV2		0.188*** (2.816)	

IV3			0.115***
			(3.095)
gender	0.046	-0.006	-0.052
	(1.018)	(-0.146)	(-1.123)
Smoking age	-0.009**	-0.001	-0.003*
	(-2.191)	(-0.632)	(-1.763)
Height-to-weight	0.064	0.026	0.058
ratio	(0.978)	(0.404)	(0.951)
Ethnicity	-0.000	-0.002	-0.000
	(-0.000)	(-0.075)	(-0.002)
F	12.94	25.36	14.53
_cons	1.221***	1.328***	1.391***
	(4.614)	(5.003)	(5.523)
Province-level fixed effects	Control	Control	Control
N	1059	1059	1059

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

5.5 Robustness test

In the underlying regression, this dissertation controls province-level fixed effects. However, it is not enough to control for the effect of some policies or other regulatory documents in each district or county. Because of the control smoking policies that will be introduced in each region and these policies will affect the sales of new E-cig. Therefore, this dissertation includes county-level fixed effects in the regressions, as detailed in Table 5.11. County-level economic data were obtained from the 2010-2018 China County (City) Social and Economic Statistical Yearbook. To control for the impact of regional economy on households (Liu, 2013; Liu et al., 2015), this dissertation selected county population density (10,000 people/100 km2), the share of secondary industry in GDP, the share of fiscal expenditure in GDP, and per capita GDP as controlled variables at the county level. The results in Table 5.11 show that the econometric results are not significantly different from those of the principal component analysis method after controlling for unobservable county-level fixed effects, which proves that the basic results of this dissertation remain

robust.

Table 5.11 Robustness Test

	(1) Use E-cig before or not	(2) Use E-cig before or not	(3) Use E-cig before or not
Pac1	0.039*		
	(1.851)		
Pac2		0.035**	
		(2.106)	
Pac3			0.050***
			(2.905)
gender	-0.003	0.001	-0.030
	(-0.070)	(0.018)	(-0.626)
Smoking age	-0.001	-0.002	-0.003
	(-0.380)	(-1.071)	(-1.461)
Height-to-weight ratio	-0.040	-0.035	-0.034
	(-0.554)	(-0.481)	(-0.465)
Ethnicity	-0.004	-0.005	-0.005
	(-0.154)	(-0.197)	(-0.181)
_cons	1.488***	1.498***	1.525***
	(6.432)	(6.478)	(6.601)
County-level fixed effects	Control	Control	Control
County-level economic fixed effects	Control	Control	Control
N	1059	1059	1059
r2	0.329	0.330	0.333
F	0.960	1.162	1.965

Note: (1) t-values of estimated coefficients are in parentheses, and standard errors are adjusted for clustering at the province level; (2) *, **, and *** denote the 10%, 5%, and 1% statistical significance levels, respectively.

Chapter 6 Conclusion and Prospect

6.1 Conclusion

Based on the questionnaire data, this dissertation explored the changes in Consumer Behavior brought about by changes in the E-cig industry. This dissertation attempts to examine the changes in Consumer Behavior brought about by new tobacco products in the context of tightening global smoking controls from three perspectives: consumer personal characteristics, consumer perceptions of health, and external factors. The relevant results are summarized as follows: First, in terms of consumers' personal characteristics, after considering personal characteristics such as consumers' education background, income and age, income has a positive effect on new E-cig, while the relationship between age and E-cig consumption is presented. Second, consumers' health perceptions have positive effects when consumers believe that E-cig are healthier, wish to learn about ways to reduce the harm of smoking and whether they have quit smoking, indicating that lower health risks are important reasons for consumers to choose E-cig instead of traditional cigarettes. Third, in terms of external factors, marriage and spouses' attitudes towards smoking have a positive effect, suggesting that spouse influences consumers' choice of new E-cig. However, whether the spouse smokes or not is not significant, but the coefficient is significantly positive, which indicates that spouse smoking will make consumers choose to consume more E-cig, thus reducing the health risk of cigarette smoking.

Based on these key findings, this dissertation can draw several policy recommendations as follows:

First, the higher the income, the more people prefer to consume E-cig. This

is mainly because E-cigs are still more expensive than traditional cigarettes, so on the one hand, taxes on traditional cigarettes can be increased to raise the cost of smoking traditional cigarettes, so those who consume low-priced cigarettes and are price sensitive will correspondingly reduce more tobacco consumption, and on the other hand, technological innovation in the field of E-cig can be increased to reduce production costs and thus lower the price of E-cig, so that more low-income consumers can use E-cig to replace traditional cigarettes, thereby reducing the health costs of society as a whole. At the same time, there is a need for diversified innovation in the production process of E-cig and based on creating more smoking flavors, there is also a need to selectively simulate the smoking taste of traditional cigarettes, so that consumers who originally smoked traditional cigarettes can easily accept the consumption experience of E-cig. At the same time, because E-cigs are popular among young people, it is also necessary to strengthen the supervision of the sales side to prevent the large-scale popularity of E-cig in the underage group.

Second, an important reason why people choose to consume E-cig is the lower health risks associated with E-cig. This indicates that the continued healthier development model of E-cig is the future development direction of the E-cig industry. With the improvement of residents' health awareness, the consumption of the tobacco industry will become more and more rational, and the traditional tobacco products market will continue to be challenged by the shrinking size of consumers. Therefore, that E-cig companies increase the research and development of science and technology to reduce the health risks of tobacco tar and cartridge is the core factor leading the development of the E-cig industry. At the same time, the government and regulatory authorities should

introduce industry-wide quality standards as soon as possible, strengthen supervision, and regulate the future development of the E-cig industry through the dual role of the government and the market.

Third, because the external environment is an important factor affecting the consumption of E-cig, we need to control tobacco and encourage tobacco cessation and reduce the rate of tobacco exposure in the whole society. Specifically, it is important to strengthen tobacco control health education, especially for young people; on the one hand, schools strengthen education on the dangers of tobacco and on the other hand, they should create a smoke-free external environment, including measures to ban tobacco advertising, building smoke-free schools, and banning smoking in public places. In addition, legislation can also be passed to explicitly prohibit the sale of tobacco to minors. These measures can be made in place to build awareness of the health hazards of smoking from an early age and help them master the skills to refuse to become a smoker. Smoking is not only affected by age, education, occupation, and alcohol consumption are also important factors. The provision of targeted tobacco control measures according to the affecting factors will achieve twice the result with half the effort. For people with low education, having a warning picture exhibition in the promotion of knowledge of the dangers of tobacco will be more effective. Second, to provide technical services and support to help smokers quit. Hospitals open smoking cessation clinics and hotline, provide smokers with inexpensive and safe smoking cessation medications when conditions permit, follow up on the effects of smoking cessation by phone, and provide quality cessation services to increase the success rate of smoking cessation. Promote tobacco control legislation. Along with the dissemination of

knowledge about the hazards of tobacco, we should promote tobacco control legislation and regulations, promote smoking bans in public places, and well enforce the regulations. Third, it is also vital to raise awareness of the dangers of passive smoking, especially for protection of women and children from the dangers of passive smoking, so that smokers realize that smoking is not only harmful to themselves, but also to their families and friends, and thus take the initiative to reduce smoking in the home and public places. For non-smokers, we can raise their awareness of the dangers of passive smoking, cause them to discourage family members from smoking, and promote family members' awareness of the dangers of passive smoking through activities to further reduce passive smoking in the family.

For the operation of E-cig companies, the conclusions of this dissertation also have strong guiding significance. First, the conclusions of this dissertation show the target customers of E-cig companies are mainly young people who are well educated and have high level of income. They have strong purchasing power and are more concerned about the impact of their behavior on others, and thus have great consumption stickiness and are the target group to be mainly maintained by companies. Second, with the gradual expansion of the E-cig market, both the consumer group and scale are expanding. Many potential smokers will choose E-cig as their main smoking products. Therefore, E-cig companies should pay attention to not only consumers changing from traditional smokers, but also potential first-time cigarette consumers. Third, with the development of the E-cig industry, it is a fact that E-cig consumers are gradually younger and younger. This is worthy of vigilance for E-cig companies. They should indicate E-cig's harm to the body on the casing and packaging and

strictly prohibit the sales of E-cigs to minors at retail terminals to strictly fulfill their social responsibilities.

6.2 Research Outlook

Due to the realistic constraints of data and methods, this study still has many deficiencies, which are mainly reflected in the data used herein. Since the questionnaire used herein is collected through the Internet platform and whether to use the Internet is inherently selective, it means that some older and less educated people, who are usually traditional cigarette consumers, were not surveyed due to their non-use of Internet. Therefore, there is inevitably some selection bias in this dissertation, the solution of which will depend on follow-up research.

In addition, the substitutional relation that traditional tobacco consumers turning to consume E-cigs and E-cig consumers turning to consume traditional tobacco is an important research issue. And we hope to conduct more research on this issue in the future by collecting more consumer data.

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Appendices

Questionnaire

Q1: ID (Variable name: id) - Data ID, 1169 samples.

Q2: gender (Variable name: gender)

- Male-1
- Female-0

Q3: age of smoking (Variable name: age of smoking).

Q4: province city district (Variable name: province city district)

Q5: Have you ever used iQos? (Variable name: use_ele_cig_before)

- Yes-1
- No-0

Q6: height, weight, age, ethnicity (Variable name: height, weight, age, ethnicity)

Q7: are you married? (Variable name: Marriageorno)

- Single-1,
- Regular partner 2,
- Married-3

Q8: How many children do you have? (Variable name number of children)

Q9: Does your spouse smoke? (Variable name: spouse_smokingornot)

- Yes-1.
- No-0

Q10: What is your spouse's attitude towards your smoking? (Variable name: support_spouse_smokingornot)

- Support-3
- Don't care-2
- Oppose-1

Q11: What is your approximate annual income? (Variable name: Annual income)

Q12: Year of smoking (smoking traditional cigarettes) (Variable name: year_of_smoking)

- 1 for 1-3 years
- 4 for 2-10 years
- 10 for 3-20 years
- 4 for 20 years or more

Q13: How long do you smoke a pack of cigarettes? (Variable name: smoke_packs_of_cigarettes)

- 1 for half a day or less
- 2 for half a day to 1 day
- 3 for 2-3 days
- 4 for 4-7 days
- 5 for 7 days and above

Q14 Price per pace of daily smoked cigarettes? (Variable name: price_of_cigarettes)

- 1 for RMB 10 or less
- 2 for RMB 10-15
- 3 for RMB 15-20
- 4 for RMB 20-30
- 5 for RMB 30-40
- 6 for RMB 40 or more

Q15 What is your usual habit of buying cigarettes? (Variable name: habits_of_smoking)

- 1 for buy in carton
- 2 for buy one pack after smoking
- 3 for buy packs in normal times and in carton on holidays or for guests
- 4 if basically from friends

Q16 "The 3 most commonly smoked brands in order are:" skip to the next question if there is no way to measure and it is similar to Q15

Q17 (Multiple choice, more than one answer is possible) What is the primary consideration for choosing a cigarette brand?

(Variable name primary_choosing_cigarette)

- 1 for good taste
- 2 for consistent quality
- 3 for affordable price
- 4 for high reputation
- 5 for high class
- 6 for availability
- 7 for the same as the ones smoked by your friends.

Q18 How much will you choose another brand of cigarettes if the price of the brand you are smoking increases?

(Variable name effect_of_cigarette_prices)

- 1 for RMB 1
- 2 for RMB 2-3
- 3 for RMB 3-5
- 4 for RMB 5 or more
- 5 if it doesn't matter

Q19 Which index content do you care more about when you smoke? (Variable name index_smoking_care)

- 1 for tar
- 2 for nicotine
- 3 for carbon monoxide
- 4 for other
- 5 if it doesn't matter

Q20 Do you know of any ways to reduce the harm of smoking?

(Variable names reduce_the_harm_of_smoking)

- 6 Yes, food therapy, exercise, etc.;if you usually do it
- 5 Yes, food therapy, exercise, etc.; if you don't care about it.
- 4 No; if you know you will do it
- 3 No; if you know you can do it
- 2 No; even if you know, you can't stick
- 1 No; if you don't want to know.

Q21 Have you ever tried to quit smoking? (Variable names stop_smoking)

- 1 if you have not tried
- 2 if you tried but failed
- 3 if you tried and succeed

Q22 If you have tried to quit smoking, what do you think is more effective? (Variable name quit_smoking)

- 1 for relying on others' supervision
- 2 for diverting your attention
- 3 for throwing away things related to cigarettes
- 4 for substitute something else

- 5 for other

Q23 Have you tried new types of tobacco (E-cig or HDB)?

(Variable name whether or not you use E-cig)

- 0 if you have not tried
- 1 if you have tried

Q24: Do you know the difference between vape E-cig and HnB HDB in new tobacco?

(Variable namedifference_between_e_cigarettes)

- 1 E-cig atomizes tobacco tar and HnB atomizes through the heating of tobacco or plant particles
- 2 E-cig tar tastes richer and more diverse and HnB HDB tastes more like the real cigarette
- 3 HnB contains real tobacco, and does not contain tobacco, made of pure plant particles
- 4 if you do not know above differences and information

Q25: Has your spouse's attitude towards your smoking improved after smoking new types of tobacco (E-cig or HnB HDB)?

(Variable name spouse_attitude_toward_smoking)

- 1 for yes
- 2 for No

Q26 What are the types of HnB that you know of? (Variable name types_of_e_cigarettes)

- 1 for overseas brands such as IQOS (USA) and PLOOM HnB (Japan)
- 2 for the tobacco HnB products under China Tobacco
- 3 for ZERO + and other domestic non-tobacco HnB HDB products

- 4 if you don't know

Q27: How long have you been using the new HnB tobacco products (years)?

(Variable name using_e_cigarettes)

- 1 if you never used
- 2 for less than half a year
- 3 for half a year - 1 year
- 4 for 1-2 years
- 5 for 2 years or more

Q28 Do you know the way to heat HnB products? (Variable name channel_for_e_cigarettes)

- 1 for face-to-face recommendation among friends
- 2 for WeChat, Taobao, Douyin, Weibo and other online channels
- 3 for tasting events and media publicity
- 4 for offline stores
- 5 for other

Q29 to Q32 are sorted, list the brand name title or taste and other topics and cannot be measured by numbers.

Q33: How does the frequency of smoking traditional cigarettes change after exposure to HnB cigarettes?

(Variable name frequency_of_smoking)

- 1 if nothing changed
- 2 if addiction (to traditional cigarettes) became greater
- 3 if less addicted to smoking (traditional cigarettes)
- 4 if hardly smoked (traditional cigarettes)

Q34 (multiple choice, more than one answer is possible) ZERO + and other domestic HnB products are abbreviated in HDB, do you know its meaning?

(Variable name meanings_of_HDB)

- 1 for HEAT DOESN'T BURN
- 2 if it is a registered trademark of the HnB brand ZERO+
- 3 indicates all HnB products and brands of the new tobacco field
- 4 if all of the above is true
- 5 if you do not know

Q35 HnB HDB is healthier than traditional cigarettes, and why?

(Variable name reasons_of_HDB_morehealthy)

- 1 as the temperature of HnB HDB products is controlled at about 350°C, effectively reducing the number of carcinogens produced by open fire combustion
- 2 as HDB products reduce tar by 68%, nicotine by 97%, and carbon monoxide by 99% compared to traditional cigarettes
- 3 as HDB products help smokers reduce the frequency of using traditional cigarettes
- 4 as all the above

Q 36: Do you think that the taste of HnB HDB is more like real tobacco than that of oil-based E-cig?

(Variable name reason_HDB_like_cigarettes)

- 1 as compared to E-cig tobacco tar, HnB tobacco products are made from natural plant pellets
- 2 as HDB products use pure electric heating, there is no open fire burning packet material generated by the interference of odor

- 3 as particle materials of HDB products are porous, more evenly heated, to achieve a more efficient volatile atomization effect
- 4 as all the above

Q37 Main advantages for ZERO + zero and other non-smoking HDB brands can achieve industry-leading product experience and stable quality? (Variable name advantages_0f_HDB)

- 1 the summary of overseas first brand experience and optimization program
- 2 the technology research and development of Shennong Tobacco and other core professional team and dozens of famous universities and research institutes at home and abroad
- 3 the successful application of several achievements with independent intellectual property rights, such as " grassland liquid extraction" and "biological harm reduction technology"
- 4 the data support of large consumer groups under the domestic demographic dividend
- 5 Don't know the above advantages and think foreign products are better

Q38 In addition to the original cartridge flavor closer to the real cigarette, why do you think non-tobacco HDB brand taste more diverse? (Variable name variety_0f_HDB)

- 1 Overseas HDB products use homogenized flake technology, which is difficult to group processing subject to the characteristics of the process
- 2 Domestic ZERO + and other manufacturers use granular load material fragrance, to mix and fill different flavors in batches
- 3 Domestic spice procurement cost is cheaper
- 4 Don't know

Q39 What do you know about the differences in core ingredients of ZERO + and other non-smoking HDB brands compared to overseas IQOS?

(Variable name core_material_difference)

- 1 IQOS use homogenized flake with main ingredient of tobacco shredded materials
- 2 HDB adopts herbal technology granules as raw material granules with natural plants as the main ingredient
- 3 Do not know any of the above information

Q40 What do you know about the characteristics of HDB's cartridge? (Variable name characteristics_of_HDB)

- 1 IQOS uses a patchwork composite filter stick like traditional cigarettes, with a homogenized flake form that is compact, resulting in a higher heating temperature, and the cartridge contains a cooling section
- 2 HDB uses an integrated seal filling the cartridge; the particle gap is larger; the smoke temperature is lower, can be smoked naturally without cooling section design and suitable for most of the HnB smoking equipment
- 3 Do not know any of the above information

Q41: Different HnB brands are complete sets of smoking equipment, cigarette peripheral equipment, you prefer to choose the case of adaptation is? (Variable name Adaptation_situation_of_HDB)

- 1 Highly adaptable; for example, ZERO + brand smoke cartridges can be used in IQOS smokers, saving repeat purchase
- 2 Mutually incompatible; brand accessories are different, and you can compare a variety of different use experience
- 3 Does not matter