Empirical study of protective products in an emerging market

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Received 29 July 2021
Revised 4 August 2021
Accepted 4 August 2021

Abstract

Purpose – This paper aims to study the motivations for purchasing protective products.
Design/methodology/approach – Empirical microeconomic research.
Findings – The results show that comparing with ordinary families, families vulnerable to environmental conditions, including prepregnant, pregnant and postpartum families, are not intended to consume more protective products. Among the above three types of families, postpartum families consume the most, followed by pregnant families, and prepregnancy families consume the least. The results also showed that a higher level of economic development, more prevalent Internet access and higher levels of education also increase the consumption of protective products.
Originality/value – New dataset and new empirical results.

Keywords Protective products, Environmental products consumption, Niche market, Marketing mix, Segmenting, Targeting, Positioning
Paper type Research paper

1. Introduction

The emerging economies have experienced fast growth in the last few decades. However, high economic growth came at a price. Most emerging economies rely heavily on mass production and energy consumption, which have led to all kinds of environmental issues such as air pollution and water pollution. As a result, health issues have become increasingly prominent in these emerging economies such as China and India [1]. According to the 2017 China State of the Environment Bulletin, among the 338 cities across the nation, over 70% of air sources were seriously polluted. Pollution in the environment has seriously threatened consumer health. The diseases driven by air pollution became the fourth leading factor of death in China.

In recent years, with increased consumer awareness of environmental issues, markets for protective products against environmental pollution in China have expanded rapidly. In 2017, the air purification market volume in China was about $2.5 billion US dollars, a 20% increase since 2016 [2]. The protective product market maintained a steady growth and gradually expanded its market capacity.

In this study, we attempt to address the following questions: What factors affect the purchase of productive products? Specifically, will vulnerable consumers behave the same

Funding: The authors gratefully acknowledge financial support from the Beijing Municipal Natural Science Foundation (Grant No. 9212018), the 2020 Emergency Project "China Financial Security under the Impact of the COVID-19" of the Beijing's advanced "Financial Security Engineering", the Program for Innovation Research in Central University of Finance and Economics. In addition, Dongmei Guo gratefully acknowledges financial support from the sixth phase of the Ali Living Water Project organized by Ali Research Institute. Dongmei Guo is corresponding author.

Journal of Internet and Digital Economics
Vol. 1 No. 1, 2021
pp. 36-46
Emerald Publishing Limited
e-ISSN: 2752-6364
p-ISSN: 2752-6356
DOI 10.1108/JIDE-07-2021-0002

as the non-vulnerable groups? And will consumers within the vulnerable groups behave the same?

To disentangle these questions and identify factors that influence consumers' purchase of protective products, this paper takes a quantitative approach by analyzing the actual purchase data instead of self-report consumers' purchase intentions. We acquired purchasing data from one of the largest online retailers in China, Taobao.com, and combine them with survey data on environmental pollution from China's national statistical agency and provincial-level demographic data from October 2014 to April 2016 of 31 provinces to empirically study household motivation for purchasing protective products.

Given that the protective product is a relatively new category in an emerging market, this paper aims to extend existing theories to better understand the consumer purchase in this product category. Furthermore, our research also offers insights into the consumption of an understudied niche market, vulnerable groups that include consumers that are preparing for pregnancy, enduring pregnancy and at the postpartum stage. These unique consumer groups in this research allow us to answer important research questions about the choices of health-related products among vulnerable consumers. The purpose of our study includes providing a better understanding of market segmentation, targeting and positioning strategies for the protective products, as well as the differences between vulnerable verse non-vulnerable consumer groups.

Through analyzing the protective product purchases, we aim to reveal the risk perception and behavioral patterns among different consumer groups under the same level of pollution. Specifically, we investigate the impact of consumer structure and demographics on consumption decisions of protective products; whether their risk tolerance differs, which can reflect in their purchasing behavior. Our study is also among the first to reveal the consumption patterns among the vulnerable consumer groups on protective products.

The rest of the paper is structured as follows: We first present the process of developing a conceptual framework based on the review of consumer decision theories followed by the hypotheses derived from it. Then we describe the research methodology used to empirically test the framework followed by the results. This paper concludes with a discussion of the implications of research findings for academia and industry practitioners, as well as suggestions for future research.

2. Literature and theoretical background

In this research, protective products are defined as products that can alleviate damage to health caused by hazards in the environment, such as masks and air filters.

Previous studies focus on the relationship between household expenditure on protective products and air pollution. Usually, households invest more in masks and air filter products when ambient pollution levels exceed key alert thresholds (Escofet and Bravo-Peña, 2007; Russu, 2009; Zhang and Mu, 2018; Sun *et al.*, 2017; Deschenes *et al.*, 2017). But the defensive expenditure has no effect on the consumption behavior in Italy (Tiezzi, 2005). Another study investigates the effects of air pollution on late fetal and birth size, reduced fetal growth late in pregnancy (Malmqvist *et al.*, 2017), lower birth weight (Chen *et al.*, 2018) and preterm birth (Han *et al.*, 2018).

To summarize, severe air pollution may lead to fertility disorders and carcinogenic, teratogenic, mutagenic effect on the embryo along with other chronic symptoms. Vulnerable consumer groups that are preparing for, enduring or have just completed the pregnancy stage are likely to have higher protective needs than those without. However, this niche market has not been researched. We expect these vulnerable consumer groups to purchase more protective products than the other non-vulnerable groups due to their need for protecting the mother/mother-to-be and the unborn/born baby. Therefore, we propose the following five hypotheses:

H1. Consumption of protective products is higher in the vulnerable group than in the non-vulnerable group.

With the raised awareness of antenatal, perinatal and postpartum care and increasing public knowledge of environmental issues, consumption of protective products will significantly increase along with the stage of the families: the prepregnancy, pregnancy and postpartum stage. There are two reasons for the differences in household protective products consumption. First, with the birth of the baby, the awareness of protection becomes more salient. To ensure a healthy environment for the baby's growth, parents tend to buy more protective products. Second, the high level of consumption of air protection products by postpartum families may also be due to the vulnerability of the mothers who need to protect themselves from pollution, especially if they are nursing. However, these two motives were not investigated in H1. Thus, we add a comparative commodity to the basic model to control all these three factors. Thus we propose

H2. Within the vulnerable group, consumer's purchase of protective products is higher in postpartum families than in pregnant and prepregnancy families.

We also examine whether people who live in more developed regions are more protective of themselves than those who are in less developed regions after controlling for the regional pollution level. Thus, based on the budget constraint, when facing the same level of pollution, consumers from the more developed regions have more financial resources to purchase more protective products than those in the less developed regions even after we control for the income level. Second, based on the information asymmetry, consumers who live in more developed regions tend to have more health information and resources available, such as more medical experts, high-quality hospitals and health promotion agencies. Thus, we propose

H3. Consumers in developed regions purchase more protective products than those in less developed regions due to a higher awareness of the risk.

Consumers with a higher level of education may have more opportunities to acquire new information and knowledge about pollution and are more conscious about health-related issues than those with lower education. They are able to acquire more knowledge about environmental issues and are more likely to comprehend the negative consequences of pollution on health. Thus, they may purchase more protective products than those with a lower education level.

H4. Consumers in provinces with a higher education level purchase more protective products than those in provinces with lower education.

The Internet plays an important role in disseminating information and public education. Access to the Internet allows consumers to obtain a substantial amount of information on environmental pollution and protective products. Being able to access more information further promotes consumers' purchase of protective products. According to the above, we propose the following hypothesis:

H5. Consumers in provinces with a high level of Internet access purchase more protective products than those in provinces with a lower level of Internet access.

3. Methodology and results

3.1 Data and variables

We obtained the purchase data of protective products and contract products from Taobao, one of the largest e-commerce platforms in China. In 2018, the total online retail sale in China

is 1.36 trillion US dollars, and Taobao accounts for 27.2% of the total amount. Our data span across 16 months from October 2014 to April 2016. The data covers 31 provinces in China. Air pollution protective products include various types of air purifiers, purifying accessories, air fresheners and masks etc, which are listed in Table 1.

Depending on the products purchased by consumers, we divided consumers into four categories: (1) pre-pregnant group; (2) pregnant group; (3) postpartum group and (4) regular group. Pre-pregnant consumers are those who buy folic acid; pregnant consumers are those who purchase radiation protection suits or for-the-go or monthly suits; postpartum consumers are those who purchase infant formula, baby diapers, baby clothes and toys; other consumers are those who do not purchase the above items. We also define the pre-pregnant, pregnant and postpartum consumers as vulnerable consumers and other consumers as non-vulnerable consumers.

We collected data from multiple sources to capture the pollution level in the air. Specifically, the air quality data was collected from *China Environmental Protection Administration (EPA)*. We collected daily air quality index data from different provinces and classified different air quality indexes according to the national air quality grading standards, which measure atmospheric pollution at specific times in this region.

We collected additional data from the Chinese National Bureau of Statistics. These province-level data include the population, Internet access, and the proportion of the population with different education levels. They are monthly data at the provincial level.

Variable descriptions and data sources are listed in Table 2.

Descriptive statistics of air pollution protection products can be found in Table 3.

Table 3 shows that among the three types of vulnerable consumers, the average consumption of protective products is the highest among postnatal consumers, followed by pregnant families and pre-pregnant families. From the perspective of regional differences, the average consumption in the eastern region is higher than in the central and western regions. From the perspective of different ages, the average consumption of protective products is highest among consumers aged 31–40, followed by consumers aged 20–30 years old and those aged under 20 and above 40 years old. From the perspective of education, the higher the education level, the higher the protective products expenditure across all three consumer groups.

3.2 Model specification

We list the explanation of all variables and parameters in Table 4:

To test Hypothesis 1, we estimate a model as presented in Equation (1)

$$C_{it} = \alpha_0 + \alpha_1 Consumer\_type_{it} + \alpha_2 Age_{it} + \alpha_3 Tshirt_{it} + \alpha_4 X_{it} + T_t + \varepsilon_{it} \quad (1)$$

The dependent variable in Equation (1) is the consumption level of air protective products (monthly data collected from the Taobao platform) [3]. The independent variables included in the analysis are consumer type (1 = vulnerable consumer and 0 = non-vulnerable consumer), consumer's age range (1 = 31–40 years old and 0 = 20–30 years old). We focus on these two groups as optimal conception age considering that the probability of successful conception

Pollution category	Protective goods
Air pollution	Air purifier/oxygen bar/indoor fresh air system
	Purifying/humidifying dehumidifier accessories
	Air freshener/formaldehyde scavenger
	Wind, dust, moth, goggles and anti-fog mask
	Green plant/nasal eyewash solution

Table 1. Environmental protective consumption category

Category	Conceptual variable	Measured variable	Data description
Dependent variables	Consumption amount	Consumption amount of air pollution protection product	Continuous variable (count)
Independent variables	Consumer type	1 = vulnerable consumer (prepregnant, pregnant and postpartum consumer) and 0 = non-vulnerable consumer (others) in Equation (1) 2 = postpartum consumer, 1 = pre-pregnant consumer and 0 = pregnant consumer in Equation (2–5)	Categorical variable
Control variables	Age range	1 = 31–40 years old and 0 = 20–30 years old in Equation (1) 2 = 31–40 years old, 1 = 20–30 years old and 0 = below 20 and above 40 years old in Equation (2–5)	Categorical variable
	T-shirt consumption amount	Consumption amount of T-shirt	Continuous variable (count)
	Pollution level	Air pollution level of each province	Categorical variable
	Region	Reflect development level based on regional classification 0 =central; 1 = west; 2 = east	Categorical variable
	Education level	Education level = proportion of the population without education*1+ proportion of the population with primary school education *2+ proportion of the population with junior high school education*3+ proportion of the population with high school education *4+ proportion of the population with college graduates or above education*5	Categorical variable
	Internet access level	Internet access per capita of each province	Continuous variable (count)
	Lnpopulation	The logarithm of the population of each province each year	Continuous variable (count)
	Lngdppc	The logarithm of GDP per capita	Continuous variable (count)
	Rprw	Rural population share	Continuous variable (count)

Table 2.
Variable description and data sources

Grouping criteria	Pre-pregnant	Pregnant	Postpartum
East region	7.990	11.099	13.451
Central region	6.947	10.365	12.697
West region	6.557	8.888	11.401
20–30 years old	7.377	10.692	13.073
31–40 years old	7.725	10.743	13.388
Below 20 or above 40	6.154	9.237	10.920
Low education level	6.608	9.852	12.415
Medium education level	6.913	10.735	13.177
High education level	8.347	11.701	14.028

Note(s): Education level above is separated by tertile

Table 3.
Logarithm of the average amount of air pollution protective consumption (yuan)

Variable	Explanation
C_{it}	The amount of consumption of protective products in province i at time t (Equation 1–5)
$Consumer\_type_{it}$	Types of consumers (i.e. prepregnancy, pregnancy, postpartum and others) in province i at time t (Equation 1–5)
Age_{it}	Age groups (i.e. 20–30, 31–40, under 20 or over 40) (Equation 1–5)
$Tshirt_{it}$	T-shirt consumption in province i at time t. T-shirts were selected as comparative goods to control the impact of changes in household size and consumption habits (Equation 1–5)
$Pollution_{it}$	Air pollution level in province i at time t (Equation 1–5)
$Region_{it}$	Regions (i.e. east, central and west) according to its level of economic development. The region of the province in time t (Equation 3)
$Education_{it}$	Education level of province i at time t. Education level = proportion of the population without education*1+ proportion of the population with primary school education *2+ proportion of the population with junior high school education*3+ proportion of the population with a high school education*4+ proportion of the population with college graduates or above education*5 (Equation 4)
$Internet\_access_{it}$	Internet access per capita in province i at time t (Equation 5)
X_{it}	Variables that control regional heterogeneity, including logarithm of population, the logarithm of GDP per capita and rural population share, etc.
T_t	Time fixed effect
ε_{it}	Residual item

Table 4.
Description of the main variables and parameters

after the age of 40 is significantly reduced, and the income level after the age of 40 is significantly increased, leading to estimation errors, and the situation of aging between 20 and 40 in China is non-marital pregnancy, the situation is more complicated, so the exclusion of observations younger than 20 and older than 40 is reasonable.

By comparing online product category according to Taobao data, we find that T-shirt is a typical product, which was characterized by low prices, large consumption and diversified consumer types, and is, therefore, often chosen as comparative products in consumption analysis to control the impact of household member increase and offline consumption time decrease. Naturally, the consumption of T-shirts can be used to explain the local online consumption habits and a number of consumers per household. Controlling the amount of T-shirt consumption ensures that the obvious difference among the three household types comes from the difference in household self-protection consciousness.

To test Hypothesis 2, we estimate a model as presented in Equation (2)

$$C_{it} = \alpha_0 + \alpha_1 Consumer\_type_{it} + \alpha_2 Age_{it} + \alpha_3 Tshirt_{it} + \alpha_4 X_{it} + T_t + \varepsilon_{it} \quad (2)$$

Different from Equation (1), in Equation (2), consumer type is classified in vulnerable consumers and three types of consumers are defined (2 = postpartum consumer, 1 = pre-pregnant consumer and 0 = pregnant consumer). And consumers' age range is larger (2 = 31–40 years old, 1 = 20–30 years old and 0 = below 20 years old and above 40 years old). Other variables are defined the same as those in Equation (1).

To test Hypothesis 3, we estimate a model as presented in Equation (3)

$$C_{it} = \alpha_0 + \alpha_1 Consumer\_type_{it} + \alpha_2 Age_{it} + \alpha_3 Tshirt_{it} + \alpha_4 Pollution_{it} + \alpha_5 Region_{it} + \alpha_6 X_{it} + T_t + \varepsilon_{it} \quad (3)$$

Based on Equation (2), we add following control variables: the air pollution level and geographical regions (0 = central region, 1 = west region and 2 = east region). Other variables are defined the same as those in Equation (2).

To test Hypothesis 4, we estimate a model as presented in Equation (4)

$$C_{it} = \alpha_0 + \alpha_1 Consumer\_type_{it} + \alpha_2 Age_{it} + \alpha_3 Tshirt_{it} + \alpha_4 Pollution_{it} + \alpha_5 Education_{it} + \alpha_6 X_{it} + T_t + \varepsilon_{it} \quad (4)$$

To test Hypothesis 5, we estimate a model as presented in Equation (5)

$$C_{it} = \alpha_0 + \alpha_1 Consumer\_type_{it} + \alpha_2 Age_{it} + \alpha_3 Tshirt_{it} + \alpha_4 Pollution_{it} + \alpha_5 Internet\_access_{it} + \alpha_6 X_{it} + T_t + \varepsilon_{it} \quad (5)$$

In Equation (4) and (5), we respectively replace the development level in Equation (3) with the education level and Internet access level. Education level is measured by the weighted sum of the proportion of the population with different education level, and the Internet access level is measured by Internet access per capita.

3.3 Results

We use the ordinary least sSquares (*OLS*) regression to empirically test our hypotheses H1 to H5. We first report the difference in terms of protective product consumption between vulnerable and non-vulnerable consumers. Using non-vulnerable consumers as the benchmark, the coefficient of vulnerable households is negative ($\beta = -0.557$), which is statistically different from zero at the 1% level, indicating that vulnerable consumers tend to consume less protective products than the non-vulnerable consumers. This result is surprisingly opposite to our first hypothesis. Based on the products purchased by consumers, we divided consumers into vulnerable consumer groups and non-vulnerable consumer groups. In China, folic acid can be freely provided by the community health center. Radiation protection suits are shown useless by some doctors. Naturally, there is a measurement error in this classification method. But we have not found better classification products. Therefore, vulnerable consumers possibly tend to consume less protective products than non-vulnerable consumers or indifferent between two groups. Model 1 is the result of our basic regression, which is reported in Table 5.

To further explore how consumer characteristics and consumption motives of different groups within vulnerable consumers, we then analyze how different types of vulnerable consumers differ in their consumption behavior of protective products. We apply the *OLS*

Vulnerable consumer vs non-vulnerable consumer Consumption amount	Model 1 Add T-shirt
Vulnerable consumer	−0.557*** [0.102]
31–40 years old	0.138** [0.053]
T-shirt	0.715*** [0.024]
Lnpopulation	0.473*** [0.069]
Lngdppc	−2.100** [0.881]
Rprw	0.632** [0.276]
Time	Yes
Constant	−7.858** [3.441]
Sample number	4,128
R^2	0.804

Note(s): **$p < 0.05$; ***$p < 0.01$

Table 5.
Basic regression

regression method to test H2 using Equation (2). The emergence of a pregnancy situation and children's birth will obviously lead to the increase of people's awareness of self-protection against air pollution, which further leads to an increase in people's consumption of air protection products. Based on the pregnancy household, the regression results of model (2) show that among the three types of vulnerable consumers, the coefficient of postpartum households is positive ($\beta = 1.962$) and significant at the 1% level. On the contrary, the coefficient of pre-pregnant consumers is negative ($\beta = -3.422$) and is significant at one%, indicating that postnatal household consumption is the most, followed by pregnant families, and pre-pregnant families have the least household consumption. The results of the regression are shown in Table 6.

3.4 Robustness test

In this section, different explained variables and explanatory variables are added to the fundamental regression to test the robustness of our model.

We test each factor that may affect the consumption of protective products, respectively. Consumers' consumption behavior is mainly affected by their income and demand. Due to the different levels of development in various provinces, there is a significant difference in consumer income in different provinces. The level of education and the level of Internet access will affect the ability of consumers to understand information and receive information, which, in turn, affects the level of consumer demand.

Hypotheses 3 to 5 are to examine the impact of regional development level, education level and Internet access level on the consumption of protective products. Table 7 shows the regression results of Equations (3) to (5). Variables of the regional development level, education level and Internet access level are added to Model 3, respectively.

Considering the classification criteria of China's eastern, central and western regions, the development level of the eastern region is higher than that of the central region, and the development level of the western region is the lowest. The negative coefficient of the west region indicates that the average household purchase of air protective products is significantly lower in the west than in the central region. While the positive coefficient in the east region indicates that the purchase of air productive products is significantly higher in the east than in the central region, lending support of H3. Therefore, the regression results show that the higher the level of development in the region, the more air protective products are consumed. Similarly, observe the regression results of model (2) and model (3), and find

Consumption amount	Model 2 Add T-shirt
Pre-pregnant	−3.422*** [0.168]
Postpartum	1.962*** [0.114]
20–30 years old	2.290*** [0.087]
31–40 years old	2.301*** [0.109]
T-shirt	0.132*** [0.037]
Lnpopulation	1.279*** [0.092]
Lngdppc	0.759* [0.446]
Rprw	−5.027*** [1.278]
Time	Yes
Constant	−9.872* [5.087]
Sample number	4,364
R^2	0.789

Note(s): *$p < 0.1$; ***$p < 0.01$

Table 6.
Pre-pregnant, pregnant and postpartum consumer

Consumption amount	Model 3 Region	Model 4 Education	Model 5 Media
Pre-pregnant	−3.411*** [0.074]	−3.373*** [0.154]	−3.331*** [0.148]
Postpartum	1.954*** [0.060]	1.928*** [0.107]	1.901*** [0.103]
20–30 years old	2.291*** [0.058]	2.267*** [0.082]	2.246*** [0.077]
31–40 years old	2.272*** [0.056]	2.251*** [0.101]	2.232*** [0.096]
Pollution level	0.345*** [0.067]	0.140 [0.156]	0.386 [0.259]
West area	−0.315*** [0.052]		
East area	0.197*** [0.063]		
Education		0.767* [0.416]	
Media			1.240*** [0.126]
T-shirt	0.122*** [0.014]	0.131*** [0.035]	0.139*** [0.033]
Lnpopulation	1.167*** [0.030]	0.625* [0.354]	
Lngdppc	−4.518*** [0.336]	−4.190*** [1.138]	−4.040*** [1.154]
Rprw	0.476*** [0.108]	0.629 [0.385]	0.372 [0.411]
Time	Yes	Yes	Yes
Constant	−7.379*** [1.259]	−7.271 [4.727]	−6.567 [4.707]
Sample number	4,364	4,364	4,364
R^2	0.837	0.835	0.831

Note(s): *$p < 0.1$; ***$p < 0.01$

Table 7.
Analysis of influencing factors

that the higher the education and Internet access level in the region, the more consumption of air protective products. Besides, the coefficient of pollution level remains significantly positive, indicating that increased air pollution will increase household consumption of air protection products.

4. Conclusion

Although the impact of air pollution on human health has been intensively studied, there is limited research on the purchase pattern of consumers from vulnerable groups. Based on real consumption data, we are able to study consumer behaviors for the benefits of their next genera nation.

This paper focuses on the influence of consumer types on the consumption behavior and characteristic of protective products. We examine the purchase pattern of different consumer groups: pre-pregnant consumer, pregnant consumer and postpartum consumer. The hypothesis that vulnerable consumer tends to consume more protective products than non-vulnerable consumer is denied. But among vulnerable consumer types (pre-pregnant, pregnant and postpartum consumer), postpartum household consumes the least amount, followed by pregnant household, and prepregnancy household consumes the most. The different consumption behaviors between different consumer types can help suppliers to target consumers more precisely. Besides, the higher the level of development, the education and Internet access in the region, the more air protective products the consumers purchase.

Even though we can draw a conclusion about how different household types affect their pollution protective consumption, there are still some disadvantages in our research. The quantitative method we used to estimate coefficients is relatively simple. And due to the difficulties in data acquisition, the conclusion only applies at provincial levels, lacking evidence about the true situation at the city level.

This paper finds that an effective measure of residential protective expenditure is also proved as an important indicator to estimate the effectiveness of governmental environment policies and a valid component for the construction of governmental comprehensive development indicators such as green GDP and livable cities.

Firstly, this paper offers an effective measure of the consumption situation of local residents' defensive products and provides support to the government to construct comprehensive economic indicators such as green GDP and livable cities. The inclusion of defensive product expenditure into the green GDP system can present the effects of current environmental governance policies from the perspective of household consumption, especially the residents' satisfaction with the current environmental governance effects and also effectively measure the protective costs of environmental pollution. It can also effectively reflect the residents' awareness of environmental protection and risk protection in the area, and provide strong support for measuring the sustainable development of the regional economy and the state of environmental governance.

Secondly, this paper provides a basis for the government's policy formulation by measuring the expenditure of defensive products. By analyzing consumer expenditures on defensive products in different regions, different categories and different household types, it is possible to effectively deduce the areas where the current pollution is more serious and their pollution types, thus instructing corresponding policies for pollution control. The effectiveness of environmental protection and pollution prevention policies can also be improved.

Notes

1. UNEP Report, 2017, "Toward a Pollution-free Planet": https://www.unenvironment.org/resources/report/towards-pollution-free-planet-background-report
2. China Industry Information Network, 2017, "The water purification industry data": http://www.chyxx.com/industry/201811/692334.html
3. The consumption data here is the sum of monthly protective products consumption of different types and different age ranges collected from the Taobao platform.

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