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Abstract:

Canada is a country that has legalized marijuana nationwide. The relative market grew large and quickly, resulting in tremendous opportunities within the industry. A recreational cannabis retailer decided to sell marijuana edibles and is interested in what sales methods will be the most profitable. This research design focuses on exploring the performance of different sales methods of this product, explicitly comparing the buying rate of online and in-store methods using a proportion test.

Online and offline shopping pros and cons are reviewed in this design, along with the background of channel choice, the impact of consumer and retailer factors. Such literature review serves as a foundation of the proposed research plan. Eighteen years old or older adults from Ontario Province with no specific gender, education levels, or occupation characteristics are chosen as the population of interest. In-store and online groups are the primary treatment group where each will be equally split into city and rural subgroups for stratification. Power is set at 0.99, and the sample size is 8000 subjects.

One of two types of coupons will be sent out to each subject according to their belonging group: in-store and online. Two months period will be reserved to observe and collect data on whether subjects use the coupon to purchase the product through the intended channel. All data will be gathered at the end of the two-month period and used to calculate the buying rates for the proportion test.

The Statistical analysis plan is intended to determine whether the two buying rates are significantly different. However, certain limitations and uncertainties still exist with such a design. Location, age group, and gender could all result in biases in the result or could be confounding variables.

Two scenarios are conducted in the simulation, one with no effect and one with an expected effect. The first scenario failed to reject the null hypothesis with a conclusion of not enough statistical evidence showing the two buying rates are not the same. The second scenario rejects the null hypothesis with a conclusion of enough statistical evidence showing the two buying rates are different.

1. Statement of the problem

Canada is the first G20 country that has legalized marijuana nationwide. The act aimed to keep marijuana out of youth usage and keep profit out of the pockets of criminals. The business market quickly sought after the rising opportunities within this industry. From raw to pre-rolled weed, from medical to recreational purposes, the use of cannabis has evolved extremely fast. Since the legalization of marijuana gradually covers more and more cities and countries globally, the cannabis business went from a rarely discussed topic to one of the hottest trends. For instance, the market for smoked cannabis is gradually reaching an equilibrium. A recreational cannabis retailer realized that selling solely smoked marijuana would not make them survive in this market in the long run. Like any company in any industry, one has to be prepared to adapt to any situational/policy changes to maintain competency in the market. So the retailer decided to consider selling marijuana edibles as well. As their consulting team, we will help them determine the best sales strategy for its new product, "Marijuana Gummies."

"Marijuana Gummies" is an edible cannabis product launch that the retailer expects to increase revenue. However, given the nature of marijuana, many consumer restrictions need to be considered when designing sales methods. For example, alcohol and tobacco are substances that are restricted to be sold in certain types of stores. Such situations resulted in the explorations of alternative sales methods such as online and e-commerce. However, such restricted products require a tighter purchasing eligibility screening process, causing the purchasing process to be more complicated and need a longer arrival time. People would prefer online purchasing if access to physical cannabis stores is not convenient. In contrast, some would choose physical stores due to the urgent consumption needs according to the current mood. Therefore, this research is designed to focus on exploring the performance of different sales methods of this product, specifically targeting the comparison between city and rural population preferences.

2. Research Questions and Hypotheses

It is designed that there are two ways of selling the newly launched "Marijuana Gummies": online and in-store. Two months' sales data will be examined. The research question is whether online and in-store sales methods have different buying rates:

$$H_0: p1 = p2$$

$$H_a: p1 < p2$$

Where p1 = in-store buying rate

p2 = online buying rate

3. Literature Review

A list of published journal articles have provided relevant background information about the sales model of Marijuana Gummies.

3.1 Online vs. Offline Shopping

Online and offline sales are the most common sales methods in this society. Both of the sales methods have their own benefits and limitations. It is hard to say that one of the methods is better than the other one.

E-commerce means that people can transact, promote and distribute products and services via some online platforms. From the late 1970s, innovations in information technology started spreading on a large scale. It has a crucial effect on the development of business. IT improved the efficiency of communication, which also promoted the birth of e-commerce. In the late 1990s, E-commerce came into existence, which greatly changed shopping styles. (Reibstein, David J. 2002). Offline sales means the traditional sales method, which has existed since the existence of mankind(Gupta, 2015). Therefore, compared with offline sales, e-commerce has a very short history. However, e-commerce has had a highly rapid development in recent years. The number of customers shopping online is still on the rise.
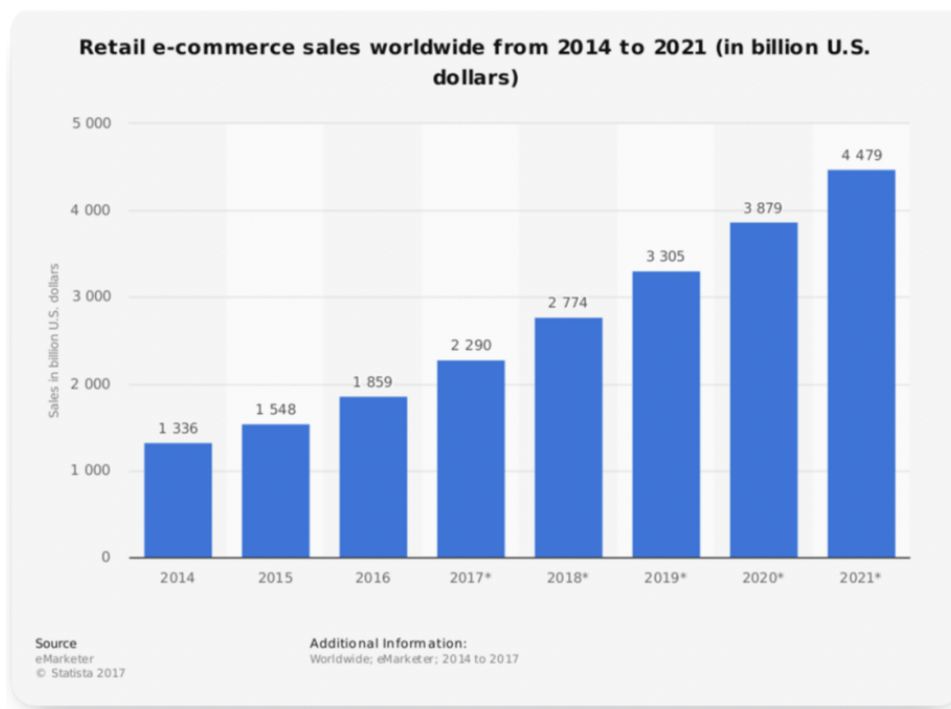
The above figure highlights the development of the global retail e-commerce sales between 2014 and 2021. In 2017, the retail e-commerce sales worldwide is 2290 billion dollars. In 2018, the global sales increased to 2774 billion dollars rapidly. There was a 21% growth in only one year (Dobreva, K. 2018). In 2019, the globally retail e-commerce sales increased to an amount of 3305 billion dollars, representing a 19% increase from 2018. In the following year, 2020, the

retail e-commerce sales worldwide increased to 3879. Compared to 2019, the percentage of increase was 17%. Therefore, the retail e-commerce sales worldwide increased 69% in the four years. Until 2021, the retail e-commerce sales worldwide still keeps increasing. And there are no signs of reduction (Dobreva, K. 2018).
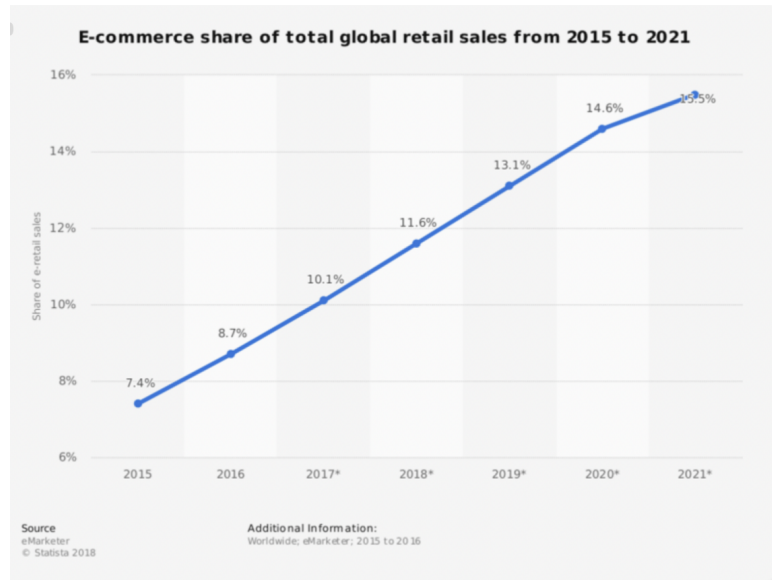
From this figure, e-commerce share of total global retail sales steadily grew from 7.4% in 2015 to 15.5% in 2021(Dobreva, K. 2018).

Although e-commerce is developing at an unprecedented rate, there are still a lot of people preferring to shop in physical stores. According to Rekuc's study, in the United States, 92% of retail sales are still finished offline. Even if e-commerce is growing at an extremely fast speed, it only represents 8% of the retail market in the United States (Rekuc, David.2018). Due to the COVID-19 pandemic, people have to reduce the time of going to the people-intensive places, such as some offline retail stores, super markets, etc.. According to the study, 40% of the participants reduce the frequency of visiting the physical stores during COVID-19 pandemic. But many of them still like offline shopping. Compared to 2020, there is a 9% reduction in the percentage of participants who prefer offline shopping (Aviso, Agatha. 2021).

3.2 Background of Channel Choice

In the article "Marijuana Edibles and 'Gummy Bears'", Larkin discusses the safety issues that come with the sale of marijuana edibles on-line and in-store. In the US, the legalization of marijuana edibles seems to be a matter of less concern since various states have begun legalizing the sale of marijuana edibles for recreational means (Cording, 2021).

When people need to make decisions about the channels of buying a product, it is insufficient to only consider the products and the stores (Black, Lockett, Ennew, Winklhofer, McKechinie.

2002). There are some factors that would influence the decision, including product factors, consumer factors, retailer factors, channel factors and situational factors (Black, Lockett, Ennew, Winklhofer, McKechinie. 2002). The research question is if the online and offline sales methods have different preferences for the population in city and rural areas. The product is Marijuana Gummies, which is a kind of edible marijuana product. Since Canada has already legalized marijuana nationwide, the product can be transacted as normal products. So the factors that would highly affect the channel choice are consumer factors, retailer factors.

3.2.1 The Impact of Consumer Factors

There are a lot of reasons that people enjoy online shopping, including the convenience and accessibility, the wider selection, the informativeness and the lack of sociality (Wolfinbarger, 2001).

First, convenience is academically defined as saving time and effort. The accessibility is also included in the concept of convenience (Wolfinbarger, 2001). The consumers can work or study a whole day at home. When they feel tired, they can easily buy some marijuana gummies with their phones or laptops. They do not need to leave their house, wait at red lights and go several different places to find the gummies produced by the company(Wolfinbarger, 2001). Although it is very late at night and the physical stores are closed, the customers can also get the gummies online. Even if the customers are not in Canada, they also have access to buy the gummies (Ritu, 2018).

Second, the consumers can have wider selection online(Wolfinbarger, 2001). For example, in physical stores, when the marijuana gummies were sold out, the consumers had few selections. They tend to not get the products they want. However, if they shop online, even if they cannot find the marijuana gummies in one store, they can immediately switch to another store to buy the gummies. The world's stores are online(Wolfinbarger, 2001). Besides this, if the consumers feel the marijuana gummies are pretty good and want to learn more about the products in the company, they can go to online stores of the company to find the products they want.

Third, the information is a very important reason for consumers shopping online(Wolfinbarger, 2001). Recently, with the improvement of food safety awareness, the increasing number of people pay much attention to the ingredients when they buy edible products. They can easily compare several similar products to see which one contains the ingredients they are looking for, which would be very effortful or impossible to do in physical stores. Except this, the appropriate graphics of products would be provided along with text. According to a survey from BizRate.com, consumers select the product representation as the most important factor when they make a purchasing decision (Wolfinbarger, 2001).

Fourth, when consumers shop online, they have a relationship with a platform instead of a seller (Wolfinbarger, 2001). The online buyers prefer the shopping way because of the lack of social interaction because of two reasons (Wolfinbarger, 2001). First, they can get rid of some unhelpful salespeople. Second, they can get more freedom and control. They will not be interfered with by their spouse or children when they make a transaction (Wolfinbarger, 2001).

Although there are plenty of advantages for online channels, there are still a lot of advantages for offline channels. According to a study of Raydiant, people prefer offline channels mainly because of the authenticity, the overall experience of shopping and the immediacy of getting the products in physical stores (Raydiant, 2021).

First, offline shopping has higher authenticity than online shopping. People can touch the actual texture of the products in physical stores (Gupta, 2015). Though there are graphics for online products, the products the consumers received are not always the same with the products they saw online (Gupta, 2015).

Then, sometimes, shopping is not only for making transactions. It is an enjoyable process. People can spend some great time with their families and friends. However, online shopping cannot provide such experiences (Sarkar, Sabyasachi. 2017). Although people can buy products much more quickly and easily, it cannot offer valuable experiences with your family and friends (Sarkar, Sabyasachi. 2017).

Next, when the consumers purchase a product online, they cannot get the product immediately. Sometimes, they need to wait for several weeks to get the product (Sarkar, Sabyasachi. 2017). So if the products are buying for immediate use, then do not buy them online (Sarkar, Sabyasachi. 2017).

Considering marijuana gummies, physical stores may be a safer platform to sell it. In the article "Marijuana Edibles and 'Gummy Bears'", based on the online platform, children may have easy access to the drug since they may use stolen identifications to purchase the drugs and have them delivered to addresses where they can pick them easily. Hence, online sale of marijuana may pose a challenge of drug use by the underage population. The article therefore discusses how selling marijuana in-store may be safer since the seller can ask for credentials and identification from and ensure that they are not purchasing on behalf of underage users (Cording, 2021).

3.2.2 The Impact of Retailer Factors

Consumer factors are not the only factor to affect the channel choice. The retailer factors are also an important part.

According to *"E-Commerce Emergence and Development"*, for the retailer, first, they can get income every time in a day. They do not need to close their door at night. Second, the retailers can sell their products to any country in the world. Third, since the retailer can put related graphics online, they can show the products to many consumers at the same time. Fourth, an online store only needs a few employees, which can help the retailer reduce the employee cost. Fifth, it would be much easier to gather consumer data for online stores, which would be helpful for the retailer to make the following strategies. However, for initial start-up, the cost would be higher than the offline stores. And most of the costs are fixed. On the other hand, for some villages and backward areas, the Internet is too expensive to afford. For these areas, they need some physical stores to buy marijuana gummies (Ritu. 2018).

4. Research Plan

Population of Interest

The population of interest is adults who reside in Canada where cannabis has been legalized[1] nationwide. They must be 18 years old or older in order to legally purchase cannabis products. Since the product we want to conduct the experiment on is edible cannabis gummies, unlike smoking cannabis products, it has potential to reach out to more broad-based customers and is also easier to market at the mass level. Thus, no specific genders, education levels, occupations will be excluded. Likewise, the history of tobacco or cannabis smoking is not required.

Sample Selection

In order to limit the cost associated with the experiment, we will conduct the experiment in only one province of Canada, which is Ontario . The primary treatment groups are *the in-store group* and *the online group*, which we want to measure the effect size. However, to prevent a confounding problem that may emerge from different preferences of purchase modality caused by varied distances from subjects' residences to physical stores. Each treatment group will be equally split to *the city subgroup* where subjects live in urban areas and able to access physical stores easily and *the rural subgroup* where physical stores are located afar from subjects' residence for the purpose of stratification. Thus, there will be four subgroups in total: (1) city & in-store (2) city & online (3) rural & in-store and (4) rural & online.

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[1] "Legalization of cannabis is the process of removing all legal prohibitions against it. Cannabis would then be available to the adult general population for purchase and use at will, similar to tobacco and alcohol." (Svrakic, D. M., Lustman, P. J., Mallya, A., Lynn, T. A., Finney, R., & Svrakic, N. M. (2012). Legalization, decriminalization & medicinal use of cannabis: a scientific and public health perspective. *Missouri medicine*, *109*(2), 90–98.)

Subjects must have an active email address to receive a coupon and also a mobile phone to complete a purchase using a coupon. Subjects will be selected from eligible adults who live in Ontario on a randomized basis to minimize remaining biases and enhance capabilities of generalization. The randomized selection process will be repeated four times to evenly allocate subjects into four subgroups.

Sample Size

We are looking for at least a concrete 10% difference in buying rates between two channels, in order to confidently determine which channel will be our selected channel for the real product launch. In addition, we set our power at 0.99. This is because we need to make sure that if our proportion test suggests we can reject the null hypothesis, the possibility that the outcome will be false negative is minimal. In light of the power analysis with aforementioned parameters factored in, the test suggested we should have at least 3,155 subjects included in each primary treatment group for the proportion test and hence, at least 6,310 subjects in total. Thus, since the cost of sending out emails is somewhat negligible, we will set our sample size to 8,000 subjects in total (4,000 subjects in each primary treatment group / 2,000 in each subgroup).

Operational Procedures

To obtain basic data for the experiment, we will buy a customer contact database from an online marketing company who collected and compiled customer profiles from surveys and profiling softwares. The database we bought will exclusively cover only adult customers living in Ontario. The characteristics included in the database are names, genders, ages, broad location of residence (city/rural), and active emails. Subjects will be drawn from this database using the aforementioned method. Emails with a coupon to buy a bag of cannabis gummies at a promotional price will be sent to 8,000 subjects. In order to control the channel which a subject is intended to buy from, there will be 2 types of coupon: (1) in-store coupon which can only be used to purchase the product in-person at our partnered stores (2) online coupon which can only be used to purchase the product on our partnered e-commerce platforms. Each subject will receive only 1 coupon, regarding which primary treatment group they belong to. That is, subjects in the in-store group will receive an in-store coupon while those in the online group will receive an online coupon. The subjects will then be observed whether they use the coupons to purchase the product through the intended channel or not. The time frame for observation will be 2 months after the emails with coupons are sent to subjects.

Brief Schedule

The experiment can be started immediately. As our edible cannabis product was already prototyped and the production line is ready, we estimate our products can be manufactured, shipped, and available on shelfs of our partnered stores as well as warehouses of our partnered e-commerce platforms within 2 weeks. In the meantime, we can randomize and allocate our subjects from the purchased database to the four subgroups as well as prepare coupon codes and notify our partners. After the observation period, it will take approximately 1 week to gather and map data from all stores and platforms and conduct the analysis. Hence, the whole process of study will take approximately 3 months.

Data Collection
For in-store subjects, checkout staff at our partnered stores will be instructed to sell the products to customers with in-store coupons only. When checking out, the staff must scan the in-store coupon to be able to complete the purchase and the coupon will then be recorded as used in the stores' database. For online subjects, the subjects must apply the online coupon code at the checkout page to be able to purchase. The data of used online coupons will then be stored in our partnered e-commerce platforms database. After the 2-months period, we will gather all the data of used coupons recorded from all partnered stores and e-commerce platforms. The data of used coupons will be mapped to its corresponding subjects and calculated as buying rates for the proportion test.

Data Security
The data collected from our partners' points of sale will be sent to us in a form of encrypted files using corporate emails. The gathered data will then be stored and analyzed on a separate database in our Apache Hadoop. The database will only be accessible to a very few personnel involved in this study in order to limit the risk of data leakage.

Variables:
The outcomes or the dependent variable is the purchase number. The variable will record whether the customers purchase with the coupon or not. Since the two kinds of coupons are the factor which will lead to the corresponding purchase methods: in-store and online. Therefore, the only dependent variable will be the actual purchase record. The treatment or the independent variables are the coupon types that the customers will receive in the emails, age, gender and location. The main independent variable will lead to the outcomes. As mentioned in the previous section, there will be two kinds of coupons sent to the potential customers, and the dependent variable, the actual purchase, is the result of the effect. The location will also be recorded as marijuana buyers in different locations may have different buying habits. For example, customers in the city are likely to purchase in-store because there are more smoke shops in the city. On the contrary, buyers in the rural area may choose to use the online method more since

they have less physical stores around. Age and gender are the general information that will be recorded for further studies.

Statistical Analysis Plan

The intention for engaging this experiment is to compare two selling methods: In-store or Online. In previous sections, the data was collected by sending emails with two different coupons and collecting the coupon use rate. In the statistical analysis plan, it is important to see whether two turnover rates are significantly different. For comparing two proportions, a two proportion z test will be appropriate. The conversion rate for In-store will be p_1 and the proportion for online will be p_2. Therefore, the null hypothesis will be $p_1 = p_2$. The alternative hypothesis will be $p_1 \neq p_2$. If the null hypothesis is not rejected, then the two proportions are not significantly different and two selling modes have the same effect. If the null hypothesis is rejected, then the two proportions are significantly different and the company should use a method with higher turnover rate to sell the new edible product.

Limitations and Uncertainties

Despite the important role the research will play in developing a view of the performance of marijuana products in the market, various limitations may hinder the effective development of the study. The first limitation of this research is that since the experiment would only be conducted in a single location, Ontario, which would probably bring out problems when trying to generalize and apply the results to the whole country in the later stages of the study. The section of one province may have a certain type of population that would either entirely accept marijuana edibles and other products or entirely reject it. Also, the population of the selected province may be majorly composed of people of a certain age group or gender, which may yield biased results. In order to address this limitation, the study location can be expanded to more provinces to capture a more significant sample that will effectively represent the entire population. Through this modification, diverse age sets and genders will be efficiently represented, to collect adequate data that will produce convincing statistics regarding the reception rate of marijuana products in the market, and the preferences people have while selecting marijuana edibles. Hence, basing the research on one province may limit the proper representation of the population, and affect the results.

Another significant limitation to the study is with reference to the biases that will be formed as a result of age. The younger generation has more knowledge and awareness of the online market compared to the older generation. Therefore, while developing the market for marijuana edibles on the online market and in-store market, there would be biased purchase since the younger population would buy the edible on the online stores compared to the older generation. This aspect would contribute to a huge limitation in the study since the results would automatically

indicate a separation in the results where the younger sample population prefers the online market whereas the older sample population favors the in-store purchases.

Research Question 1:

Scenario 1: No Effect

Simulation

```{r q1_scenario1_simulation}
```

  To imitate the structure of collected data if the study is really conducted, we created a DataFrame with the 5 columns: treatment, location, gender, age, and buy. String values of the treatment ("online"/"in-store") and the location ("city"/"rural") column were added to the DataFrame in an equally-structured manner that resembled our attempt to stratify the sample in city and rural areas to reduce confounding problems as well as balance the numbers of sample in primary treatment groups. The table below shows how 6,000 samples were equally allocated into each subgroup.

```{r sample_dist, echo =F}
```

  As we hypothetically bought the data from a marketing company, the gender and age characteristics were included in the data. We used an R function "sample( )" to create the gender column ("Male"/"Female") to echo our randomized sampling method. String values "Male" and "Female" had an equal chance to be inserted in each row. For the age column, we used an R function called "rtruncnorm( )". It gave us the liberty to set lower and upper values when generating numbers randomly. We set the lower value at 18, the minimum level age that can buy cannabis products, and the upper value at 65. The ceiling age of 65 was from our intention to limit the samples to people who have the fairly fluency of using the internet. We also set the mean value of 22 and the standard deviation of 15 due to the nature of the hypothetical marketing company that we bought data from tracked customers' profile from the internet and hence, those customers tend to be relatively young. This age data generation method gave us a satisfactory and realistic result. As the graph below shows, the majority of our sample are young adults with the age between 20-35 years old.

```{r age_dist, echo =F}
```

We have an assumption that people in rural areas have higher preference towards cannabis products. Thus, in the "no effect" scenario, we generate the buy column (contains logical values True/False, indicating whether the samples decide to buy our products or not) according to such an assumption. We generated the buying data with the 5% probability to buy for those who live in city areas and 8% for those who live in the rural areas. However, the likelihoods of buying between 2 channels were intended to be indistinguishable, as show in the table below:

```{r effect_size_no_effect, echo =F}
```

Analysis
```{r q1_scenario2_analysis}
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With the Data Frame that simulated in the previous section, we decided to conduct a proportion test to compare the conversion rate between in-store and online. The reason why we chose the proportion test is that the in-store and online group will only generate binary variables (buy or not buy). Dividing the buy numbers by the total coupon number sent will receive the conversion rate of each promotion. The conversion rate is the key indicator of sales number and power. The proportion test can tell if there is a significant difference between two conversion rates, and therefore, engaged in this research. By simulating the data, the total sample size equals 8,000, the number of in-store coupons sent is 4000 , and the total number of online coupons sent is also 4000. After conducting the proportion test a thousand times, the final mean p-value is larger than 0.05 in general. Therefore, we cannot reject the null hypothesis and the two conversion rates between two buying methods are not significantly different. Therefore, without the effect, the company can choose either methods for selling the new product. Besides the final p-value, we also calculated the false positive, the true negative numbers, and the mean effect among the tests. In scenario 1, the number of true negatives is 954, and 46 for false positives, which shows a 95.4 percent true negative rate and 4.6% false positive rate. The mean effect is -0.0014 which indicates that the difference between the predicted mean and true mean is -0.0014. The 95 percent interval is between -1.00000000 and 0.006325199.

Scenario 2: An Expected Effect
Simulation

```{r q1_scenario2_simulation}
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In the "with effect" scenario, apart from buying data, we still used the same data generated in the no effect scenario. This is because the samples were supposed to be the same group of people, but with different preference over buying channels. For samples who live in the city areas, we still maintain the assumption that they tend to use cannabis comparatively less than

people in rural areas. We set their probability of buying from the in-store and the online channels at 3% and 6%, respectively. With approximately 5% average buying rate of both channels, it intentionally resembled the data we generated in no effect scenario. For samples in the rural areas, we set their probability of buying from the in-store and the online channels at 2% and 10%, respectively. The result from data that was created using the aforementioned method are as follows:

```{r effect_size_with_effect, echo =F}
```

      In the second scenario, the analytics process will also use the proportion test. After conducting the proportion test a thousand times, the final mean p-value is less than 0.05. Therefore, we reject the null hypothesis and the two conversion rates between two buying methods are significantly different. Therefore, with the effect, the company can choose the method that has a higher buying rate for selling the new product in the future. In this scenario, we also calculated the true positive, the false negative numbers, and the mean effect among the tests. In scenario 2, the number of true positives is 1000, and 0 for false negatives, which leads to a 100 percent true positive rate and 0 percent false negative rate. The mean effect is -5.5059 which indicates that the difference between the predicted mean and true mean is -5.5059. The 95 percent interval is between -1.00000000 to -0.05142623.

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