

MA415/MA615 EDA Project Report

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Introduction

The goal of the project is to provide insights on planning and marketing refrigerators in the US. Our group has decided to visualize and analyze how income levels, house types, and climate regions affect people's choice of refrigerators. The idea behind this project is to determine how these factors are correlated with refrigerator types.

The data we used comes from U. S. Energy Information Administration, and most of the data sets used were from 2015. However, we did pull data across different years when analyzing over growth of the refrigerator market. When importing data, we omitted two types of statistics that were marked missing as either 'Q'¹ or 'N.'² by reporters.

Growth of the Refrigerator Market

1. Overall Growth of the Market

Table 1: U.S. Families with Refrigerators 1994-2015 (millions)

Year Period	Frequency (million)	Frequency Change	Percentage Change	Yearly Percentage Change
2010 - 2015	117	4.0	3.5	0.59
2006 - 2009	113	2.4	2.2	0.54
2002 - 2005	111	4.2	3.9	0.98
1998 - 2001	107	7.0	7.0	1.75
1994 - 1997	100	3.3	3.4	0.85

In this section, we will look at the growth of the refrigerator market from 1994 to 2015. Looking at the table that was derived from the data, we can observe that the overall growth of the market has been relatively slow but steady over the past 20 years. The annual growth rate of US families with refrigerators ranges between 0.5 - 1.8%. For any new investor to the refrigerator market, it is important to understand growth in sales can be achieved by growth in the market share, not by the growth of the refrigerator market itself. This is mostly because refrigerators tend to have long lifetime, and consumers do not purchase a new refrigerator very often.

2. U.S. Families with one Refrigerator

Table 2: U.S. Families with one Refrigerator 1994-2015 (millions)

Year Period	Frequency (million)	Frequency Change	Percentage Change	Yearly Percentage Change
2010 - 2015	82	-5.4	-6.2	-1.03
2006 - 2009	87	1.1	1.3	0.32
2002 - 2005	86	-2.4	-2.7	-0.68
1998 - 2001	89	4.0	4.7	1.18
1994 - 1997	85	2.6	3.2	0.79

¹Data withheld because either the Relative Standard Error (RSE) was greater than 50% or fewer than 10 cases responded.

²No cases responded.

In the data compiled for the purchase of one fridge, we can see that the volatility of the market has been higher over the years than that of the overall market. This should not be very concerning as we can see that the range is between -1% and 1.2% and numbers are not very extreme.

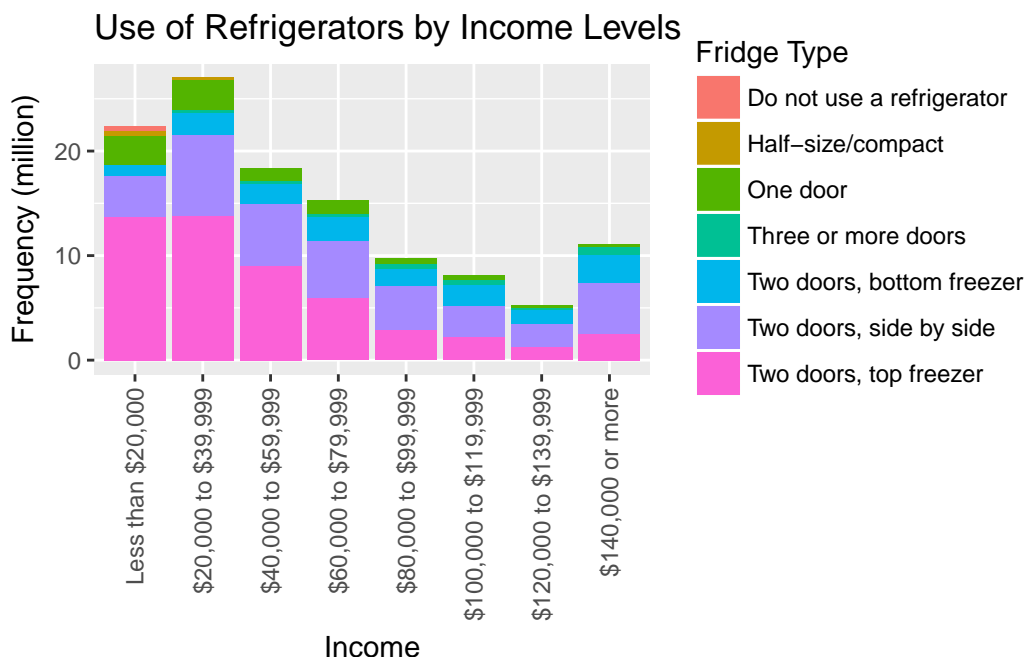
3. U.S. Families with two or more Refrigerators

Table 3: U.S. Families with two or more Refrigerator 1994-2015 (millions)

Year Period	Frequency (million)	Frequency Change	Percentage Change	Yearly Percentage Change
2010 - 2015	35	9.4	36.1	6.0
2006 - 2009	26	1.4	5.7	1.4
2002 - 2005	25	6.5	35.9	9.0
1998 - 2001	18	2.9	19.1	4.8
1994 - 1997	15	0.8	5.6	1.4

If our investor is interested in a faster-growing market, probably market for the second or more fridges is a hot market to enter. Over the past 20 years, the number of people who own two or more fridges has been constantly growing. Indeed its growth has been higher than that of both overall, and single-use fridge market between 1-8% per year.

Income Level Analysis



As we can see from the plot, popularity of each type of refrigerators varies greatly among people with different income levels. It seems that people with different levels of income do not favor the same type of refrigerators.

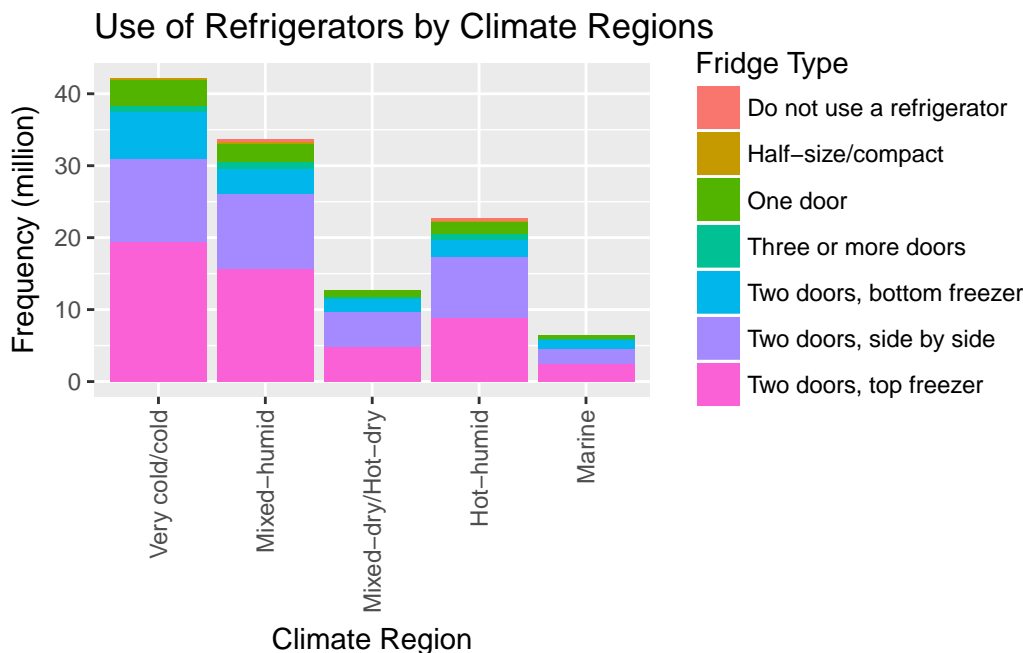
It is worth noticing that two-door refrigerators are used over 80% of the US families in the sample. Moreover, the two-door refrigerators are welcomed by almost all people across different income levels. In the two-door refrigerator family, the one with top freezer is more popular among low income level people, while its brother, the two-door refrigerator with side-by-side freezer, is usually seen in families with high income. A possible explanation is that a refrigerator with top freezer is usually priced lower than one with side-by-side freezer, making the latter less affordable than the former.

On the contrary, one-door refrigerators are the minorities in the fridge family. The reason could be that a one-door refrigerator has smaller capacity and fewer functions compared to other refrigerators. However, such characteristic also makes one-door refrigerators more economical to purchase and own - they are relatively popular among people with less than 40,000 dollars income. Three-or-more-door refrigerators, by contrast, are desired by families with income over 100,000 dollars, as three-or-more-door refrigerators usually provide more functions and are more expensive than other types of refrigerators.

To wrap up our discussion on income levels, we suggest investors to 1) focus on marketing and selling two-door refrigerators, as they are the major refrigerators used by people across all the income levels; 2) Target potential clients with income over 100,000 dollars to sell three-or-more-door refrigerators. 3) Promote two-door refrigerators with bottom freezer among people with income over 100,000 dollars.

Climate Region Analysis

In this part, we will be looking at the sales of refrigerator across climate regions in the United States. There are two figures that reveal interesting sales information.

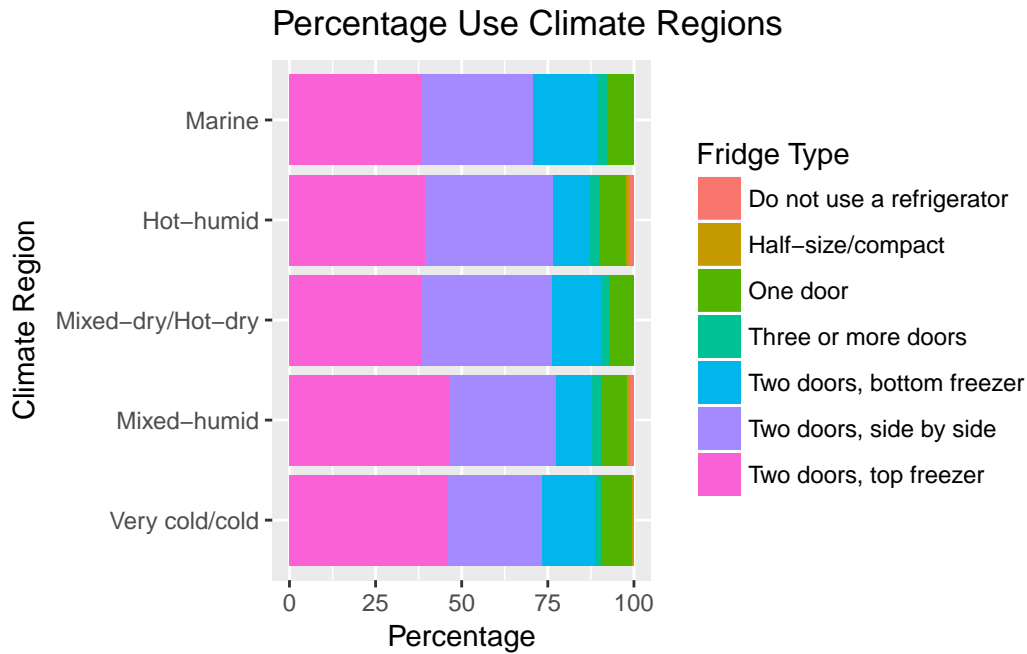


From the figure above, it is quite surprising that the sales of refrigerators in cold/very cold region is about twice of that in the hot region, regardless of refrigerator types. Also, in humid regions, quite a number of households do not use a refrigerator, while in cold/very cold regions, 99.99% of households own at least one refrigerator. It is important to explore the reason behind this phenomenon as we will better understand how climate affects people's preference of refrigerators. A possible explanation is as follows:

- 1) In very cold regions, temperature in refrigerators is even higher than the temperature outside, so households may find it necessary to store their food supply in refrigerators.
- 2) In general, high-GDP states usually are located in cold regions, such as MA, IL, NY, while the lower-GDP ones are usually in the hot, southern part of the United States. If we look at local purchasing power by states, most of the upper states tend to have higher buying power, thereby increasing sales of the refrigerators.

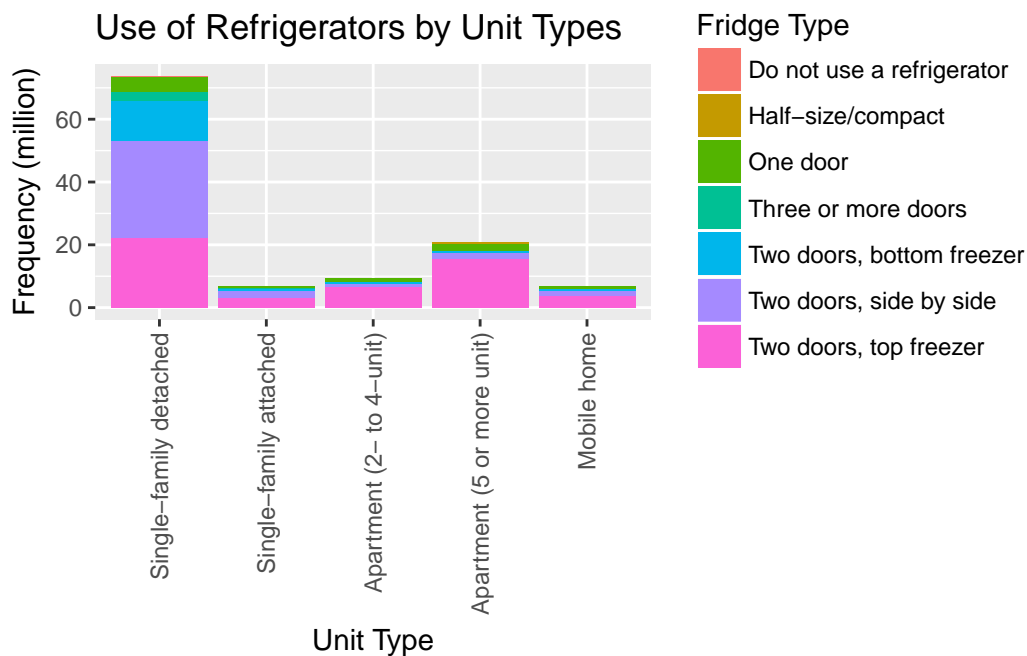
The second figure below compares percentage of refrigerators used across different climate types. It is evident that the two-door refrigerator with top freezer is the most popular, as it appears in about half of the families in all climate regions. The second most popular one is the two-door refrigerator, with side-by-side

freezer, followed by the two-door refrigerator with bottom freezer. This two-door refrigerator family, again, takes over 80% of refrigerator market, for reasons we have elaborated in the previous section.



Unit Type Analysis

According to the visualization, people with different housing unit types prefer different types of refrigerators.



Of all versions of refrigerators, two-door refrigerator with top freezer, two-door refrigerator with side-by-side freezer, and one-door refrigerator are widely used by US families with all housing types.

It can be seen that two-door refrigerators with top freezer are relatively popular among all the housing

types, since this style of refrigerators take up less space and offer sufficient volume to households. On the other side, the two-door refrigerators with side-by-side freezers is popular among families with detached single houses, which is typically more expensive than attached house and apartments. Therefore, we infer that people who own a detached single house are wealthier and have more budget to buy a two-door refrigerator with side-by-side freezer.

Two-door refrigerators with bottom freezer are also mostly used by families with single, detached houses. Compared to other types of refrigerators, two-door refrigerators with bottom freezer are more recent designs - which means they work with higher efficiency than others. Also, two-door refrigerators with bottom freezer are expensive compared to others, so the majority of the buyers of the two-door, bottom-freezer refrigerator are people with more budget, which in our study are the families with single, detached houses. Following the same logic, we can immediately see why refrigerators with three or more doors are mainly only used by the same group of people.

The one-door refrigerator is typical among people with single, detached houses and apartments with 5 or more units. People with single, detached houses might be using a one-door refrigerator as their second refrigerator. People who own apartments with 5 or more units could be landlords and they purchase one-door refrigerator as a standard appliance for their tenants.

From a marketing perspective, two-door refrigerators are what investors want to massively produce. Investors should generally target the two-door refrigerator with top freezer to all customers, regardless of their housing types. Another possible advice is to sell two-door refrigerators with side-by-side freezer or with bottom freezer to customers living in single, detached houses. Three-door refrigerators can be offered as a customized choice, because only a small portion of families tend to purchase them. Last, although relatively small, the market for one-door refrigerators still exists. Investors can promote one-door refrigerators to landlords or people who are looking for a second freezer.