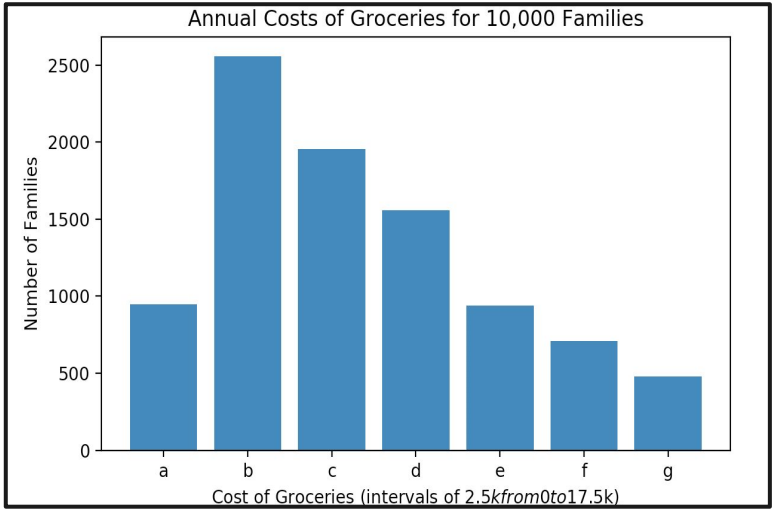
Monte Carlo Simulation: On average, how much money does an American household spend on groceries in a given year?

By: Peter DiNatale

Introduction & Process

To simulate the total amount spent on groceries by an average American household, I took into account 5 factors, each of which were calculated through weighted randomness algorithms that were accurately representative of the chosen statistics: number of members; average cost of a meal; how often a family consumes a commercially-produced meal (I called this “takeout” for simplicity’s sake); and two multipliers (one representative of socioeconomic class, and the other that takes into account the age of the consumer(s).)

In terms of the actual calculation, I ran the program 10,000 times, and each “run” represented the annual cost of groceries for one family. In doing this, I took into account 4 factors as parameters of the class “Family” and then the fifth factor (age) in one of the functions as a multiplier.



Results from running the simulation 10,000 times. A,b,c and so on are consistent intervals starting with $0-$2.5K, and ending with $17.5K. As seen above, the graph centers in on group B ($2.5k to $7.0K), consisting of nearly 4,500 of the 10,000 families. The y axis is the number of families that fell into each category.

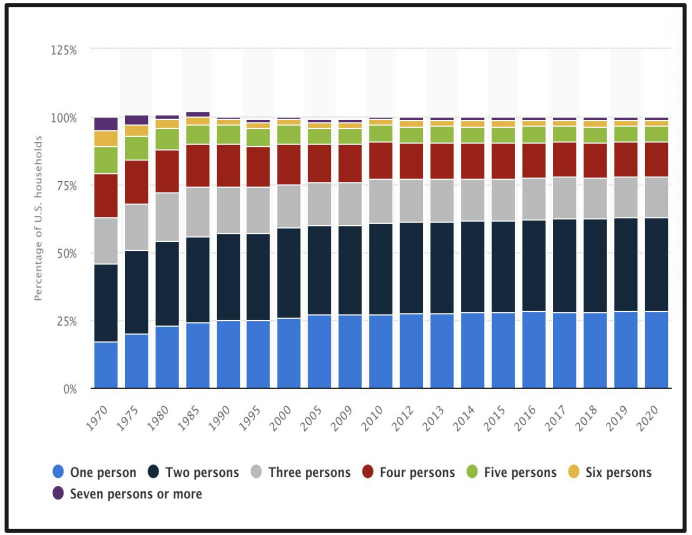
Household Members

List of possible number of members in a given family: [1,2, 3, 4, 5, 6, 7]

Explanation: The program uses weighted randomness to randomly select a number in this list. The weights I chose to determine the likelihood of a given household size being selected corresponds with the breakdown of the graph. As seen in the figure, the most common/probable household sizes are one and two people.

Breakdown of U.S. Household Sizes by Year

2020	
One person	28.18%
Two persons	34.83%
Three persons	15.05%
Four persons	12.66%
Five persons	5.8%
Six persons	2.27%
Seven persons or more	1.2%



This graph shows the breakdown of household size in a given year. I chose to have my program's data correspond with the year 2020, though all of the years tend to show similar percentages. **Source: Statista**

Meal Cost

Instead of doing research for the average cost of an individual meal, I went to the grocery and bought a cart full of food that lasted me approximately a week.

I tried to choose groceries that would most represent which foods people most typically consume. For the last item, I added a cost of miscellaneous items/snack. This is supposed to account for items such as spices for a pasta, fruit for cereal, snacks throughout the day, etc.

Additionally, to acknowledge that the cost of meals is likely to vary a based on a person's food preferences, I added values both lower and higher to the list of meal costs my program can choose from. "3.5" was weighed slightly higher, as this was the price I arrived at.

Possible meal costs = [2.5, 3.0, 3.5, 4.0, 4.5]

My List of Groceries (One Week)

- Box of cereal - $7.00
- Box of waffles - $3.00
- Milk - $4.00
- Loaf of bread - $4.00
- ¾ pound of ham - $7.50
- Meunster Cheese - $4.50
- Mayonnaise - $3.00
- Box of Pasta (5) - $8.00
- Sauce (2) - $5.50
- Orange/Apple Juice - $5.00
- Miscellaneous/snacks - $22.00

- Cost of average meal: $3.50

Commercially-Produced Meal

Average price of a commercially-produced meal: $12.75
Average delivery Fee: $2.00*

To account for the number of times that households will eat commercially-produced food i.e. dine in, takeout, fast food, etc., I factored in the average cost of a restaurant meal. The range of possible costs was $5 to 25$, as the price can definitely range depending on the business.

I also wanted to account for the fact that delivery fees differ by location and that some households prefer takeout, which obviously results in no delivery fee. To do this, I added a wider range of potential “takeout prices” that the program could choose from.

***Price from my experience; varies by location.**

Age group - (Multiplier)

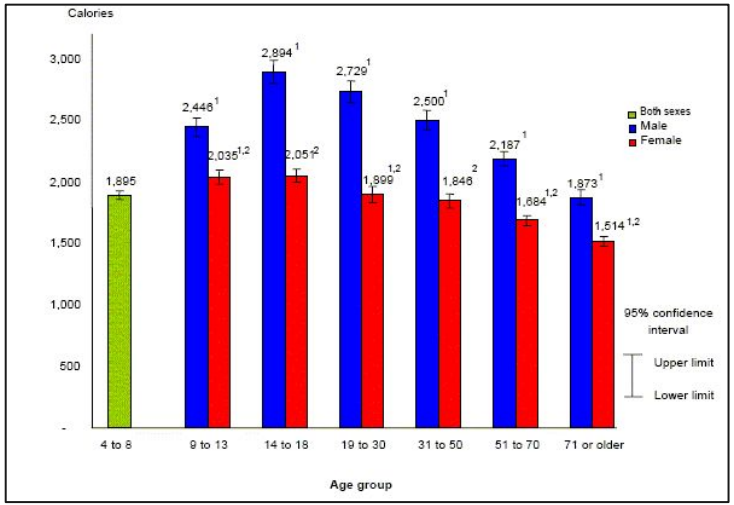
For the following age groups, I either scaled the meal price up or down. I made this decision because the size of a meal is different across a range of age groups - i.e. a baby will not consume nearly as much as a hungry teenager will! To scale up the price, I created a list of the family members ages and a list of the meal costs. (Both lists were of the same length, and therefore their values corresponded.) If the age[x] fell within a certain range, it's corresponding meal price (meal[x]) would be scaled up/down a certain amount.

I also created different household arrangements (randomly). (I did this to avoid unlikely family groupings; i.e. two 5-year-olds would likely not be living alone without an adult.) Some possible groupings include: single parent of one kid, single parent, household with 2 adults and a certain number of children, etc.

My program's Age Groups:

- 0-4 years old
- 5-8 years old
- 9-15 years old
- 16-24 years old
- 25-64 years old
- 65-over years old

Caloric Consumption According to Age Group



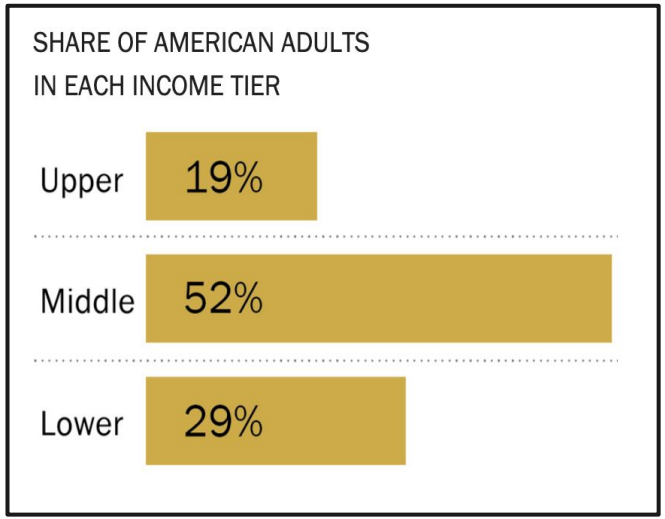
While I did not take into account gender, I figured that the caloric consumptions were close enough that they didn't noticeably impact the results , so when deciding how much to scale up the price of a meal, I (approximately) worked with the averages between the two sexes. **Source: Statcan**

Class - (Multiplier)

Weighted Randomness for breakdown of status identifiers:

- "Share of American Adults in Each Income Tier"
    - Upper-Class: 19%
    - Middle-Class: 52%
    - Lower-Class: 29%

I wanted to also recognize that some families tend to buy more expensive name brands, while others choose the more common and affordable ones. I figured the best way to represent this was with a breakdown of classes. However, I realized that the brands of groceries people buy do not always correspond with the the status/ income range they fall into, so I did not make the effect of this multiplier too significant. However, I still wanted to account for *some* brand-based pricing.



Source: Pew Research

Results Explained

Each of these graphs presents a set of prices ranges for annual grocery cost, and the number of the y-axis represents how many (of the random 10,000 families) fell into each of the categories.

After running the simulation over the $0-$17.5K range, I noticed that set “b” and “c” were the most heavily concentrated with families. (This set of letters represents the range $2.5K to $7.5K.) To zoom in on this data, I created a second graph with the range 1k to 7k. The results (of the lower graph to the right) showed that the number of families that fell into each cost range (on a smaller scale) was pretty evenly distributed.

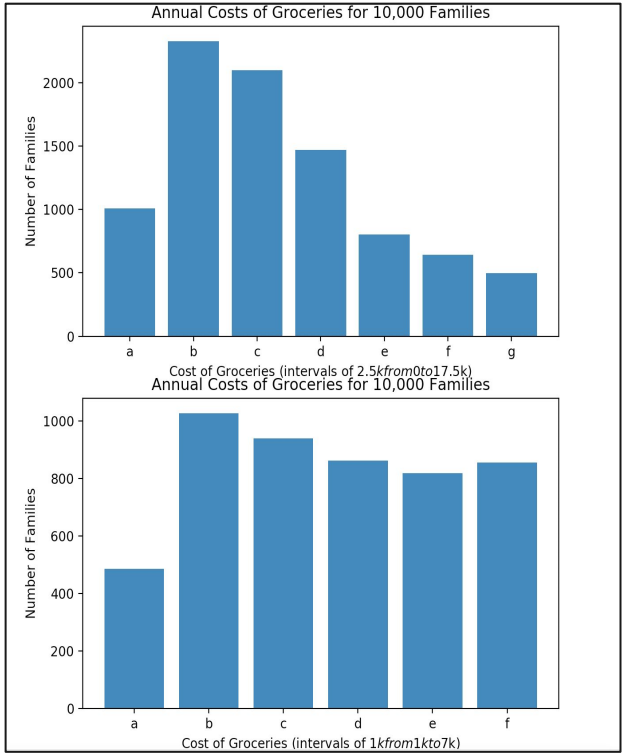
To sum it up, most of the average annual costs for households’ grocery spendings fell pretty evenly throughout the 2.5k to 7.5K range, but leaned slightly more towards “b” (2.5k to 5K). When I took the average of all the values of the 10,000 families, (sum of annual costs/10,000 families) the price fell around $8,400 (After running the program several times.)

Legend:

- A: $0.00 - $2,499.99
- B: $2,500 - $4,999.99
- C: $5,000 - $7,499.99
- D: $7,500 - $9,999.99
- E: $10,000 - $12,499.99
- F: $12,500 - $14,999.99
- G: $15,000 - $17,499.99

Legend:

- A: $1,000 - $1,999.99
- B: $2,000 - $2,999.99
- C: $3,000 - $3,999.99
- D: $4,000 - $4,999.99
- E: $5,000 - $5,999.99
- F: $6,000 - $6,999.99



Reflection/Potential Errors

While I did try to represent the situation in the most accurate way possible by considering and taking into account a range of different factors, I acknowledge that there is definitely still room for error. Some of the possible areas where these may have occurred are below: (The list is not exhaustive, just a few examples)

Class multiplier: As I mentioned earlier, the brand of food one buy's does not always correspond with the class they identify with.
Gender: Initially, I tried testing a gender factor, but I did not think it would end up resulting in any noticeable differences. So, in an attempt avoid any unnecessary complications, I scratched the idea.
Meal Cost: This was probably most difficult area to cover, considering that everyone has different meal preferences, and the cost of these meals can vary drastically. I consulted some family members to get some better insight into what an average day's meals looked like, and for the most part I arrived around the average I got for myself. Thus, I included a range of different possible costs to try and better account for this disparity.