HW 9 SDS

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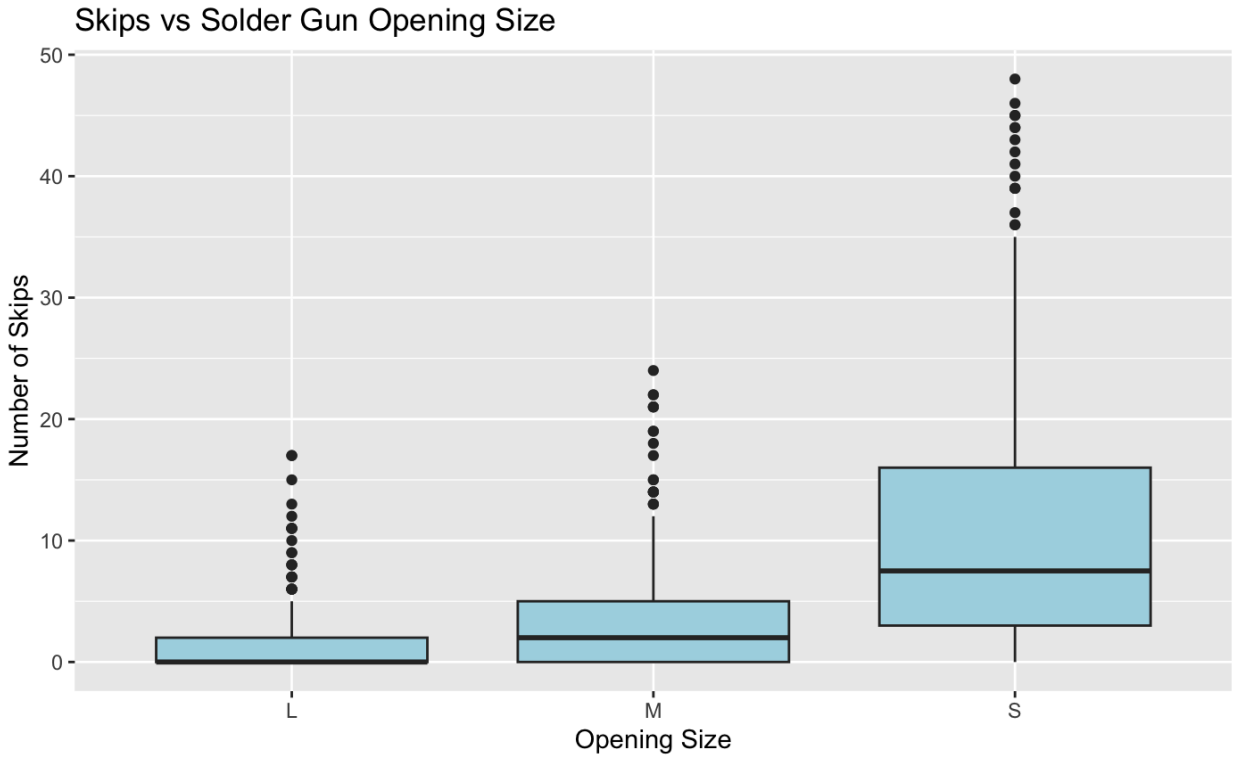
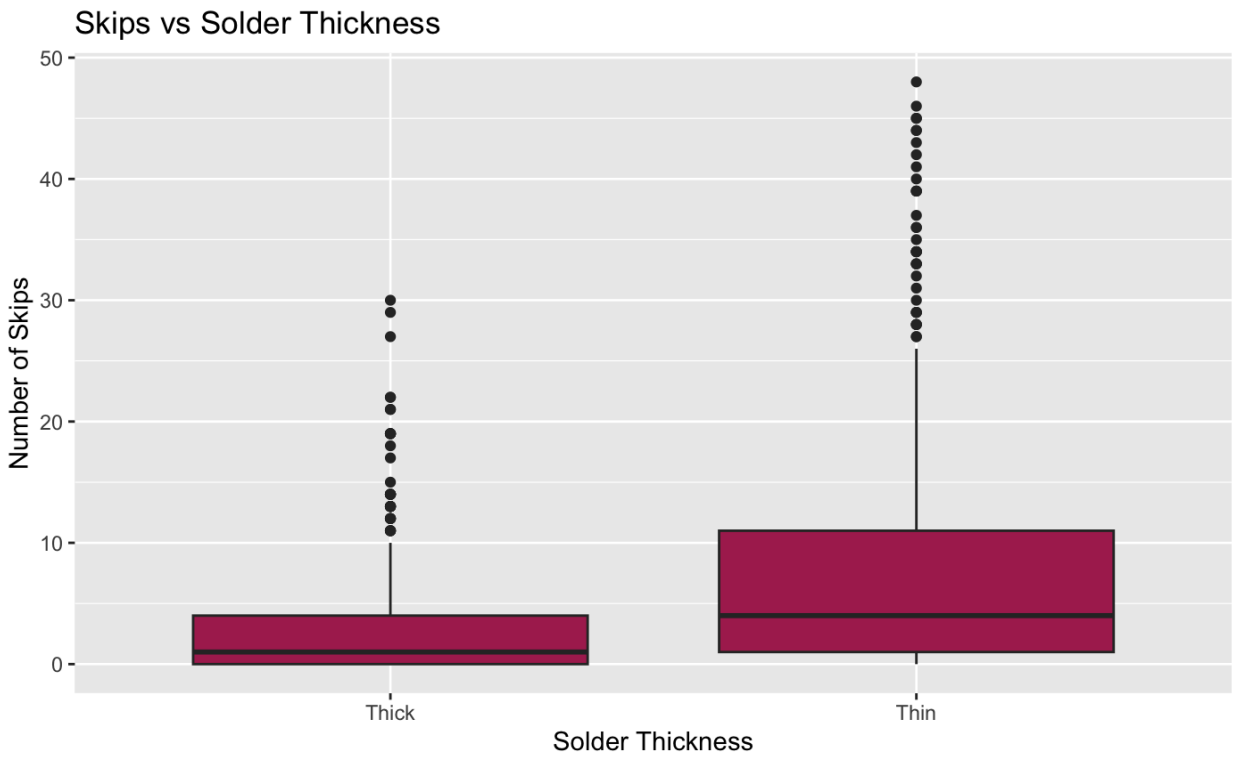
Github: https://github.com/Soumil-A/HW9SDS.git

Problem 1

Part A





- **Plot 1**: This boxplot shows that smaller openings on the solder gun tend to have higher median skip counts, suggesting that there is a relationship between opening size and number of skips.
- **Plot 2**: This plot shows that thick solder has more skips than the thin solder, showing a connection between solder thickness and defects. Boards using thin solder have fewer skips, showing a benefit in using thinner solder to improve quality.

Part B

A tibble: 6 × 7

term <chr>	estimate <dbl>	std_error <dbl>	statistic <dbl>	p_value <dbl>	lower_ci <dbl>	upper_ci <dbl>
intercept	0.39	0.52	0.76	0.45	−0.63	1.41
Opening: M	2.41	0.74	3.27	0.00	0.96	3.85
Opening: S	5.13	0.74	6.97	0.00	3.68	6.57
Solder: Thin	2.28	0.74	3.10	0.00	0.84	3.72
Opening: M:SolderThin	−0.74	1.04	−0.71	0.48	−2.78	1.30
Opening: S:SolderThin	9.65	1.04	9.28	0.00	7.61	11.70

6 rows

Part C

```
(Intercept)            OpeningM            OpeningS           SolderThin
OpeningM:SolderThin OpeningS:SolderThin
               0.39                2.41                5.13                2.28
-0.74                9.65
```

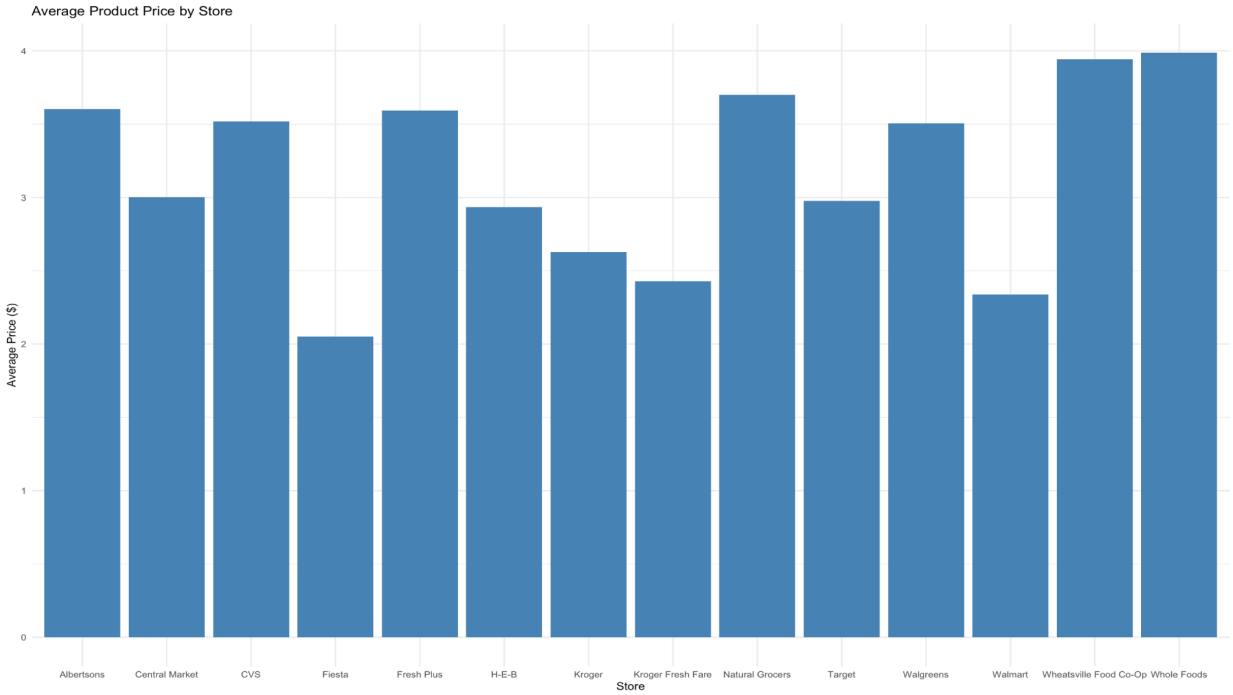
- The baseline skip count for boards using a large opening (L) and thick solder is 0.39 skips.
- The main effect of Opening = M is +2.41 skips, meaning medium openings have 2.41 more skips on average, when the solder is thick.
- The main effect of Opening = S is +5.13 skips, meaning small openings lead to 5.13 more skips than large ones, again while we have thick solder.
- The main effect of using Thin solder vs Thick solder, both with large opening, is that it increases skips by 2.28 on average.
- The interaction between medium opening and thin solder is −0.74, showing that the combined effect is slightly less than expected by simply adding the individual effects (though this interaction is not statistically significant).
- The interaction between small opening and thin solder is +9.65, which means that when both a small opening and thin solder are used, the skip count is 9.65 skips higher than you'd expect by adding their separate effects.

Part D

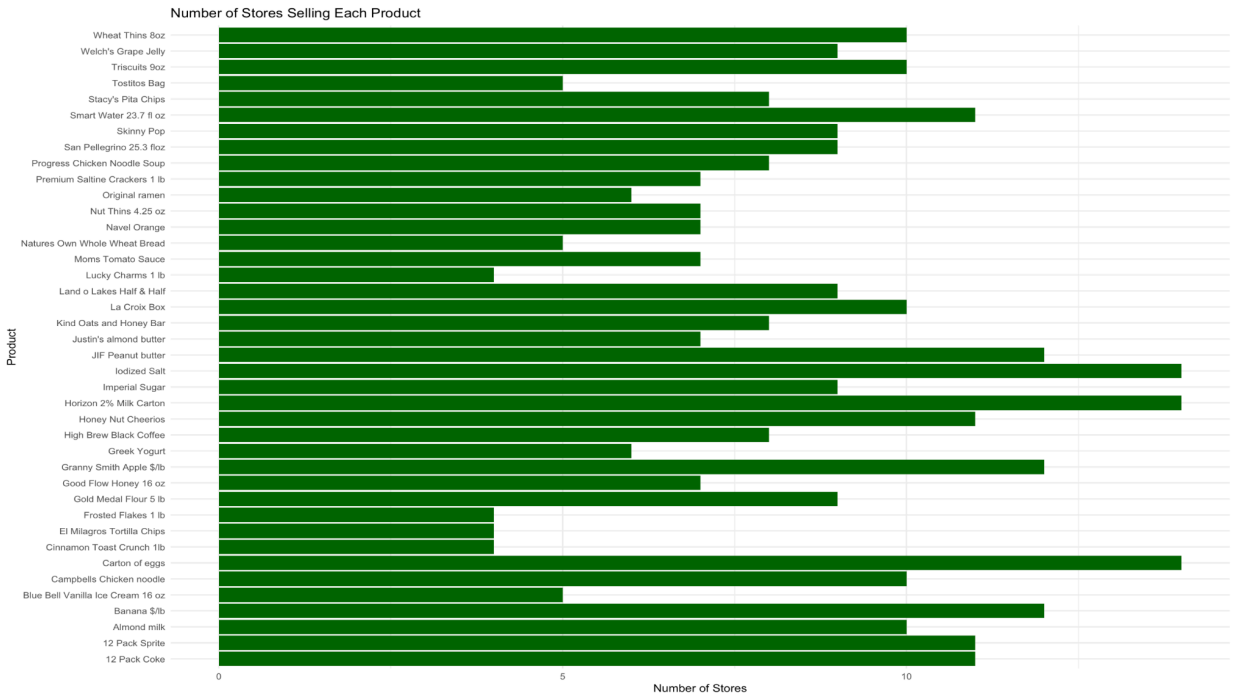
The lowest predicted skip count occurs when using a large opening and thick solder, with an expected value of 0.39 skips. So, AT&T should use a large solder gun opening and thick solder alloy. This combination has the least manufacturing flaws and avoids the strong negative interaction when you have small openings and thin solder.

Problem 2

Part A



Part B



Part C

	2.5 %	97.5 %
(Intercept)	5.4461802	6.4011154524
Product12 Pack Sprite	-0.6340950	0.5974283379
ProductAlmond milk	-2.8525515	-1.5573896506
ProductBanana $/lb	-5.4799319	-4.2894146000
ProductBlue Bell Vanilla Ice Cream 16 oz	-3.7520923	-2.1421358570
ProductCampbells Chicken noodle	-4.1115515	-2.8163896506
ProductCarton of eggs	-3.5774725	-2.4241176770
ProductCinnamon Toast Crunch 11b	-1.8696613	-0.1241717453
ProductEl Milagros Tortilla Chips	-2.9129671	-1.1651607441
ProductFrosted Flakes 1 lb	-2.1246613	-0.3791717453
ProductGold Medal Flour 5 lb	-2.8372300	-1.5046125814
ProductGood Flow Honey 16 oz	0.2808176	1.7240341201
ProductGranny Smith Apple $/lb	-4.3199319	-3.1294146000
ProductGreek Yogurt	-4.6079636	-3.0970491791
ProductHigh Brew Black Coffee	-3.6121524	-2.2295143472
ProductHoney Nut Cheerios	-2.3416352	-1.1094592274
ProductHorizon 2% Milk Carton	-1.6774725	-0.5241176770
ProductImperial Sugar	-3.1483411	-1.8157236926
ProductIodized Salt	-4.4512391	-3.2812048876
ProductJIF Peanut butter	-3.3245622	-2.1168826179
ProductJustin's almond butter	6.0836747	7.5268912630
ProductKind Oats and Honey Bar	-2.5550655	-1.1701652933
ProductLa Croix Box	-1.7195515	-0.4243896506
ProductLand o Lakes Half & Half	-3.9644300	-2.6289732430
ProductLucky Charms 1 lb	-2.3746613	-0.6291717453
ProductMoms Tomato Sauce	0.7236747	2.1668912630
ProductNatures Own Whole Wheat Bread	-3.2238381	-1.6152736311
ProductNavel Orange	-4.6806110	-3.2373944513
ProductNut Thins 4.25 oz	-3.1963253	-1.7531087370
ProductOriginal ramen	-5.8118874	-4.3004408731
ProductPremium Saltine Crackers 1 lb	-3.0518795	-1.6146755310
ProductProgress Chicken Noodle Soup	-3.7593438	-2.3812397045
ProductSan Pellegrino 25.3 floz	-4.3177633	-2.9823065764
ProductSkinny Pop	-2.7046528	-1.3717357209
ProductSmart Water 23.7 fl oz	-4.3084790	-3.0761838276
ProductStacy's Pita Chips	-2.4986751	-1.1174141159
ProductTostitos Bag	-2.4860923	-0.8761358570
ProductTriscuits 9oz	-2.8861621	-1.6263080570
ProductWelch's Grape Jelly	-3.5819230	-2.2890645533
ProductWheat Thins 8oz	-2.8952530	-1.6353989661
TypeGrocery	-0.9154098	-0.4131031458
TypeHigh-end Grocery	-0.5944834	-0.0008968566
TypeNatural	-0.4037250	0.2192581912
TypeSmall Format	-0.7454724	-0.1428388392

Compared with ordinary grocery stores (like Albertsons, H-E-B, or Kroger), convenience stores charge somewhere between $0.41 and $0.92 more for the same product.

Part D

term <chr>	estimate <dbl>	std_error <dbl>	statistic <dbl>	p_value <dbl>	lower_ci <dbl>	upper_ci <dbl>
intercept	5.75	0.23	24.62	0.00	5.29	6.21
Product: 12 Pack Sprite	−0.02	0.29	−0.06	0.95	−0.58	0.55
Product: Almond milk	−2.29	0.30	−7.56	0.00	−2.89	−1.70
Product: Banana $/lb	−4.86	0.28	−17.47	0.00	−5.40	−4.31
Product: Blue Bell Vanilla Ice Cream 16 oz	−3.08	0.38	−8.17	0.00	−3.82	−2.34
Product: Campbells Chicken noodle	−3.55	0.30	−11.71	0.00	−4.15	−2.96
Product: Carton of eggs	−2.98	0.27	−11.07	0.00	−3.51	−2.45
Product: Cinnamon Toast Crunch 1lb	−1.17	0.41	−2.87	0.00	−1.98	−0.37
Product: El Milagros Tortilla Chips	−1.91	0.41	−4.64	0.00	−2.72	−1.10
Product: Frosted Flakes 1 lb	−1.43	0.41	−3.49	0.00	−2.23	−0.62
Product: Gold Medal Flour 5 lb	−2.24	0.31	−7.18	0.00	−2.86	−1.63
Product: Good Flow Honey 16 oz	0.90	0.34	2.67	0.01	0.24	1.57
Product: Granny Smith Apple $/lb	−3.70	0.28	−13.30	0.00	−4.24	−3.15
Product: Greek Yogurt	−3.93	0.35	−11.09	0.00	−4.63	−3.23
Product: High Brew Black Coffee	−3.01	0.32	−9.30	0.00	−3.65	−2.37
Product: Honey Nut Cheerios	−1.68	0.29	−5.84	0.00	−2.24	−1.11
Product: Horizon 2% Milk Carton	−1.08	0.27	−4.01	0.00	−1.61	−0.55
Product: Imperial Sugar	−2.60	0.31	−8.33	0.00	−3.21	−1.98
Product: Iodized Salt	−3.86	0.27	−14.11	0.00	−4.39	−3.32
Product: JIF Peanut butter	−2.63	0.28	−9.33	0.00	−3.19	−2.08
Product: Justin's almond butter	6.71	0.34	19.84	0.00	6.04	7.37
Product: Kind Oats and Honey Bar	−1.90	0.32	−5.85	0.00	−2.53	−1.26
Product: La Croix Box	−1.16	0.30	−3.82	0.00	−1.76	−0.56
Product: Land o Lakes Half & Half	−3.38	0.31	−10.81	0.00	−4.00	−2.77
Product: Lucky Charms 1 lb	−1.68	0.41	−4.10	0.00	−2.48	−0.87
Product: Moms Tomato Sauce	1.35	0.34	3.98	0.00	0.68	2.01
Product: Natures Own Whole Wheat Bread	−2.43	0.38	−6.43	0.00	−3.17	−1.69
Product: Navel Orange	−4.06	0.34	−12.00	0.00	−4.72	−3.39
Product: Nut Thins 4.25 oz	−2.57	0.34	−7.61	0.00	−3.24	−1.91
Product: Original ramen	−5.20	0.35	−14.70	0.00	−5.90	−4.50
Product: Premium Saltine Crackers 1 lb	−2.39	0.34	−7.10	0.00	−3.06	−1.73
Product: Progress Chicken Noodle Soup	−3.14	0.32	−9.71	0.00	−3.77	−2.50
Product: San Pellegrino 25.3 floz	−3.73	0.31	−11.94	0.00	−4.35	−3.12
Product: Skinny Pop	−2.19	0.31	−7.00	0.00	−2.80	−1.57
Product: Smart Water 23.7 fl oz	−3.66	0.29	−12.71	0.00	−4.22	−3.09
Product: Stacy's Pita Chips	−1.91	0.32	−5.91	0.00	−2.55	−1.28
Product: Tostitos Bag	−1.81	0.38	−4.81	0.00	−2.55	−1.07
Product: Triscuits 9oz	−2.12	0.30	−7.19	0.00	−2.70	−1.54
Product: Welch's Grape Jelly	−2.82	0.30	−9.34	0.00	−3.41	−2.22
Product: Wheat Thins 8oz	−2.13	0.30	−7.22	0.00	−2.71	−1.55
Store: Central Market	−0.57	0.18	−3.24	0.00	−0.92	−0.23
Store: CVS	0.19	0.18	1.06	0.29	−0.17	0.55
Store: Fiesta	−0.70	0.27	−2.61	0.01	−1.23	−0.17
Store: Fresh Plus	−0.04	0.16	−0.22	0.82	−0.35	0.28
Store: H-E-B	−0.65	0.15	−4.25	0.00	−0.95	−0.35

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term <chr>	estimate <dbl>	std_error <dbl>	statistic <dbl>	p_value <dbl>	lower_ci <dbl>	upper_ci <dbl>
Store: Kroger	−0.70	0.23	−3.01	0.00	−1.16	−0.24
Store: Kroger Fresh Fare	−0.90	0.23	−3.87	0.00	−1.36	−0.44
Store: Natural Grocers	−0.08	0.20	−0.41	0.68	−0.47	0.31
Store: Target	−0.37	0.19	−1.97	0.05	−0.75	0.00
Store: Walgreens	0.22	0.18	1.19	0.23	−0.14	0.57
Store: Walmart	−0.99	0.23	−4.25	0.00	−1.45	−0.53
Store: Wheatsville Food Co-Op	0.29	0.18	1.62	0.11	−0.06	0.64
Store: Whole Foods	0.36	0.18	2.06	0.04	0.02	0.71

Walmart and Kroger Fresh Fare charge the lowest prices since their coefficients are most negative. The negative values indicate they consistently price below average for the same items.

Wheatsville and Whole Foods have the highest positive coefficients, meaning they charge more than the baseline store.

Part E

The model suggests that Central Market and H-E-B charge similar prices for the same products. Confidence intervals overlap, and the difference between the two is not statistically significant. Central Market is estimated to charge about $0.07 more on average, but this difference is too

small and not statistically significant. So overall, because the difference is small and the intervals overlap, the evidence does not support a price gap between the two stores and shows that the second possibility is correct.

Part F

Consumers in poorer ZIP codes do pay slightly more, but the relationship is not statistically significant because the Income10K coefficient is too small, and the confidence interval also contains 0.
A one-standard deviation increase in the income of a ZIP code seems to be associated with a −0.05 standard-deviation change in the price that consumers in that ZIP code expect to pay for the same product

A tibble: 41 × 7

term <chr>	estimate <dbl>	std_error <dbl>	statistic <dbl>	p_value <dbl>	lower_ci <dbl>	upper_ci <dbl>
intercept	5.616	0.249	22.573	0.000	5.127	6.106
Product: 12 Pack Sprite	−0.018	0.328	−0.056	0.955	−0.664	0.627
Product: Almond milk	−2.114	0.345	−6.133	0.000	−2.792	−1.436
Product: Banana $/lb	−4.908	0.316	−15.514	0.000	−5.531	−4.286
Product: Blue Bell Vanilla Ice Cream 16 oz	−2.908	0.429	−6.777	0.000	−3.752	−2.064
Product: Campbells Chicken noodle	−3.373	0.345	−9.785	0.000	−4.051	−2.695
Product: Carton of eggs	−2.974	0.307	−9.685	0.000	−3.578	−2.370
Product: Cinnamon Toast Crunch 1lb	−1.195	0.465	−2.573	0.011	−2.109	−0.281
Product: El Milagros Tortilla Chips	−2.000	0.464	−4.306	0.000	−2.914	−1.086
Product: Frosted Flakes 1 lb	−1.450	0.465	−3.122	0.002	−2.364	−0.536
Product: Gold Medal Flour 5 lb	−2.099	0.355	−5.917	0.000	−2.797	−1.401
Product: Good Flow Honey 16 oz	1.056	0.383	2.761	0.006	0.303	1.809
Product: Granny Smith Apple $/lb	−3.748	0.316	−11.847	0.000	−4.371	−3.126
Product: Greek Yogurt	−3.917	0.403	−9.730	0.000	−4.709	−3.125
Product: High Brew Black Coffee	−2.823	0.367	−7.687	0.000	−3.546	−2.101
Product: Honey Nut Cheerios	−1.695	0.328	−5.163	0.000	−2.340	−1.049
Product: Horizon 2% Milk Carton	−1.074	0.307	−3.497	0.001	−1.678	−0.470
Product: Imperial Sugar	−2.416	0.355	−6.806	0.000	−3.114	−1.717
Product: Iodized Salt	−3.838	0.312	−12.320	0.000	−4.451	−3.225
Product: JIF Peanut butter	−2.748	0.322	−8.537	0.000	−3.382	−2.115
Product: Justin's almond butter	6.859	0.383	17.927	0.000	6.106	7.612
Product: Kind Oats and Honey Bar	−1.687	0.367	−4.591	0.000	−2.410	−0.964
Product: La Croix Box	−0.981	0.345	−2.846	0.005	−1.659	−0.303
Product: Land o Lakes Half & Half	−3.170	0.355	−8.929	0.000	−3.869	−2.472
Product: Lucky Charms 1 lb	−1.700	0.465	−3.660	0.000	−2.614	−0.786
Product: Moms Tomato Sauce	1.499	0.383	3.918	0.000	0.746	2.252
Product: Natures Own Whole Wheat Bread	−2.471	0.428	−5.766	0.000	−3.314	−1.628
Product: Navel Orange	−3.905	0.383	−10.207	0.000	−4.658	−3.152
Product: Nut Thins 4.25 oz	−2.421	0.383	−6.327	0.000	−3.174	−1.668
Product: Original ramen	−4.979	0.403	−12.341	0.000	−5.773	−4.185
Product: Premium Saltine Crackers 1 lb	−2.247	0.384	−5.859	0.000	−3.002	−1.493
Product: Progress Chicken Noodle Soup	−3.024	0.368	−8.218	0.000	−3.747	−2.300
Product: San Pellegrino 25.3 floz	−3.524	0.355	−9.924	0.000	−4.222	−2.825
Product: Skinny Pop	−1.953	0.355	−5.500	0.000	−2.651	−1.254
Product: Smart Water 23.7 fl oz	−3.735	0.328	−11.378	0.000	−4.380	−3.089
Product: Stacy's Pita Chips	−1.679	0.367	−4.569	0.000	−2.402	−0.956
Product: Tostitos Bag	−1.642	0.429	−3.827	0.000	−2.486	−0.798
Product: Triscuits 9oz	−2.292	0.336	−6.830	0.000	−2.952	−1.632
Product: Welch's Grape Jelly	−3.009	0.344	−8.741	0.000	−3.686	−2.332
Product: Wheat Thins 8oz	−2.301	0.336	−6.857	0.000	−2.962	−1.641
Income10K	−0.014	0.010	−1.464	0.144	−0.033	0.005

1–41 of 41 rows

Problem 3

A: ZIP codes with a higher percentage of minority residents tend to have more FAIR policies per 100 housing units.

True. This is shown by Figure A1, which shows a strong positive trend. The Model A regression also supports this with a positive coefficient on minority percentage showing that the more, minority residents, the bigger the usage rate of FAIR insurance.

B: The evidence suggests an interaction effect between minority percentage and the age of the housing stock in the way that these two variables are related to the number of FAIR policies in a ZIP code.

False. Model B shows a weak relationship between housing age and minority percentage, becasue the confidence interval includes 0, so it is not statistically significant. So the claim isn't supported by the analysis.

C: The relationship between minority percentage and number of FAIR policies per 100 housing units is stronger in high-fire-risk ZIP codes than in low-fire-risk ZIP codes.

True. The relationship between minority percentage and FAIR policies looks stronger in high-fire-risk areas. Figure C1 shows a steeper slope for high-risk ZIP codes, and even though the interaction in Model C is not statistically significant, the difference shows that the association is stronger in those areas.

D: Even without controlling for any other variables, income "explains away" all the association between minority percentage and FAIR policy uptake.

False. Income does not explain away the association. In model D1, the coefficient is 0.014 and in model D2, which does include income, the coefficient is 0.01. Both confidence intervals do not contain 0 even after adding income, showing that income doesn't fully explain the association with FAIR policy use.

E: Minority percentage and number of FAIR policies are still associated at the ZIP code level, even after controlling for income, fire risk, and housing age.

True. Even after controlling for income, fire risk, and housing age, minority percentage still has a positive relationship with FAIR policy. Model E shows that this association is consistent (coefficient = 0.008, p = 0.006), showing that race-related factors could still be influencing access to private insurance.