What Makes Us Happy?

A Look into Adult Happiness Nationally and Globally

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Honors Prob. + Stats

Abstract

Happiness is an elusive emotion that we all want. But what exactly makes us happy? I sought to answer this question through mining data from the following sources serving as my sample population: the General Social Survey, the Gallup World Poll, and the Corruption Perceptions Index. They provided data on happiness and well-being for adults on both a domestic and global scale. These sources minimized bias in ways including random sampling whenever possible, remaining nonpartisan, and synthesizing results from multiple surveys of reliable institutions.

I conducted random samples of the domestic population sources on job satisfaction and # of close friends as tests of population representativeness. Domestic factors in which I actually analyzed their association to happiness were annual family income and birth month. From the global population sources, I looked into religiosity, corruption perceptions, and the world's change in happiness in most of all countries.

From my investigation, the most notable parts were the birth month, religiosity, and corruption perceptions factors. These tests all resulted in very small p-values of nearly 0, allowing me to confidently reject their null hypotheses of (1) no association between corruption perceptions and happiness, (2) no difference in happiness based on how serious a country treats religion, and (3) even distribution of very happy people in each birth month. In summary of all my findings, I conclude that one is happiest when the following are true:

1. Born in February or March
2. Has an annual family income ≥ $60,000
3. Has around six to nine close friends
4. Resident's country regards religion as less important
5. Resident's country is clean

Introduction

We all want to strive for happiness, the elusive state where we have "the experience of joy, contentment, or positive well-being, combined with a sense that one's life is good, meaningful, and worthwhile" (Lyubomirsky 52). In the digital age, happiness is becoming ever more precious, and we need to look after ourselves before we disconnect ourselves from this cherishable emotion. According to Tal Ben-Shahar, a lecturer at Harvard, "in our time, depression is on the rise. More and more students experience stress, anxiety, unhappiness. Students work longer hours and are having to build up their résumés to levels that, 20 years ago, were not expected of young people. Students today are looking for ideas that will help them to lead better lives" (Lambert). His points completely resonated with me.

From the start, I had an interest to do my statistics project on something to do with positive psychology. The last time I had a related food-for-thought was on a Yale college tour when the guide mentioned its renowned "Science of Well-Being" course that attracted more than 1,000 students into the lecture hall. Spurred by this interest to learn more myself, I was inspired to choose data sets on happiness because I thought it may shed light on how I could think about my life and the world differently. In addition, because happiness is such a universal topic and easily comparable, it would not only make data mining less burdensome but would also open up many possibilities for interesting conclusions.

Thus, my focus question soon became, "What makes us happy?". Initially, I wanted to look into what influences happiness in adolescents. Through my extensive searching, I found more accessible data focused around happiness in adults (18+) and on a global scale, so my investigation went in that direction. Thinking about it, I might find it more useful to get a big picture of how adults are happy in a global context since many of these factors may affect our generation's future happiness.

Survey & Sampling Methods

Hypothetical survey questions

Job Satisfaction (1-Prop)

How satisfied are you with your job?

a. Very satisfied
b. Somewhat satisfied
c. Not very satisfied
d. Not at all satisfied

Friends and happiness, part 1 (1-Mean)

1. Would you consider yourself moderately to very happy?

a. Yes
b. No

2. How many close friends do you have?

Response: ____

Friends and happiness, part 2 (ANOVA)

1. How would you rate your current state of happiness?

a. Very happy
b. Moderately happy
c. Not happy

2. How many close friends do you have?

Response: ____

Income and happiness, part 1 (Chi-Square Test for Independence)

1. What is your annual family income bracket?

A. < $10,000	G. $25,000 to 29,999	M. $75,000 to 89,999
B. $12,500 to 14,999	H. $30,000 to 34,999	N. $90,000 to 109,999
C. $15,000 to 17,499	I. $35,000 to 39,999	O. $110,000 to 129,999
D. $17,500 to 19,999	J. $40,000 to 49,999	P. $130,000 to 149,999
E. $20,000 to 22,499	K. $50,000 to 59,999	Q. > $150,000
F. $22,500 to 24,999	L. $60,000 to 74,999	R. Don't know

2. How would you rate your current state of happiness?

a. Very happy
b. Moderately happy
c. Not happy

Income and happiness, part 2 (2-Prop)

1. Is your annual family income over $60,000 but under $75,999?

a. Yes
b. No

2. If you answered b. in question 1, is your annual family income over $170,000?

a. Yes
b. No

3. How would you rate your current state of happiness?

a. Yes
b. No

Religiosity and happiness (2-Mean)

1. How would you rate your current state of happiness, on a scale of 0-10?

0 1 2 3 4 5 6 7 8 9 10

Not happy at all Completely happy

2. Is religion important in your daily life?

a. Yes
b. No

World happiness in 2008-2010 vs. 2015-2017 (Paired Data)

How would you rate your current state of happiness, on a scale of 0-10? (2008-2010)

0 1 2 3 4 5 6 7 8 9 10

Not happy at all Completely happy

How would you rate your current state of happiness, on a scale of 0-10? (2015-2017)

0 1 2 3 4 5 6 7 8 9 10

Not happy at all Completely happy

Birth month and happiness (Chi-Square Goodness-of-Fit)

1. What month were you born in?

A. January	D. April	G. July	J. October
B. February	E. May	H. August	K. November
C. March	F. June	I. September	L. December

2. Would you rate your current state of happiness as very happy, moderately happy, or not happy?

d. Very happy
e. Moderately happy
f. Not happy

Perceived corruption and happiness (Linear Regression)

1. Is corruption widespread within businesses located in your country or not?

a. Yes
b. No

2. Is corruption widespread throughout the government in your country or not?

a. Yes
b. No

3. On a scale of 0-10, how would you rate your happiness living in this country?

0 1 2 3 4 5 6 7 8 9 10

Not happy at all Completely happy

Sample Population(s)

1-Prop: Gallup "Work and Workplace" respondents from 2001 to 2018

1-Mean, ANOVA: Adults (18+) living in households in the U.S. who responded to both the # of close friends and general happiness questions of the 1986 General Social Survey

2-Prop, Chi-Square Test for Independence: Adults 18+ living in households in the U.S. who responded to both the income and general happiness question of the 2016 and 2018 GSSs

2-Mean: Residents in the 144 Countries included in the 2008-2009 Gallup Poll on Religiosity

Chi-Square GOF: Adults (18+) living in households in the U.S.

Paired Data: Residents in all the 141 countries included in the 2008-2010 and 2015-2017 World Happiness Report.

Linear Regression: Residents + business executives/analysts in the 152 countries covered in the 2018 World Happiness Report and the 2018 Corruption Perceptions Index, respectively

Sampling methods

1. General Social Survey (GSS): Randomly-selected households from across the U.S. ensure that all households from across the country had an equal chance of being selected. Within each household, an adult member is randomly-selected to complete the interview.

GSS Samples:

- **1-Prop:** 2018 Job Satisfaction with n = 140
- **2-Prop:** 2016 + 2018 Annual Family Income and General Happiness with $n_1 = n_2 = 45$
- **Chi-Square Test for Independence:** 2016 + 2018 Annual Family Income and General Happiness with n = 2078
- **Chi-Square GOF:** 1976-1998 Birth Month and General Happiness with n = 10476
- **1-Mean:** 1986 # of close friends and General Happiness with n = 140

- **ANOVA:** Same survey as 1-Mean but with $n_1 = 462$, $n_2 = 811$, $n_3 = 165$

2. Gallup World Poll: Gallup is a nonpartisan institution. They typically survey a randomly-selected, nationally representative sample of 1,000 individuals in each of more than 150 countries. People receive a 30-minute telephone interview in countries that have a coverage representing at least 80% of the population. Otherwise, a 1-hour face-to-face interview is conducted.

Gallup Samples

- **2-Mean:** Respondents in the 2008-2009 Religiosity Survey and 2018 World Happiness Report with $n \approx 144{,}000$ (144 countries x ~1,000 samples in each country)
- **Paired Data:** 2008-2010 World Happiness Report with $n = 141{,}000$

  (141 countries x ~1,000 samples in each country)

3. Corruption Perceptions Index (CPI): CPI is calculated for 180 countries around the world, and it is based on 13 sources that collect the assessment of experts/analysts and business executives on some specific corrupt behaviour in the public sector. A country is included in the CPI if it is evaluated by at least 3 of these 13 sources below:

- African Development Bank (based in Ivory Coast)
- Bertelsmann Foundation (based in Germany)
- Economist Intelligence Unit (based in UK)
- Freedom House (based in US)
- Global Insight (based in US)
- International Institute for Management Development (based in Switzerland)
- Political and Economic Risk Consultancy (based in Hong Kong)
- The PRS Group, Inc., (based in US)

- World Economic Forum
- World Bank
- World Justice Project (based in US)

Gallup and CPI Sample

- **Linear Regression:** 2018 Corruption Perceptions Index and 2018 Happiness Score with n ≈ 152,000

  (152 countries x ~1,000 samples in each country)

How the surveys minimized bias

- The GSS selected both the households and the adult within the household randomly.
- Gallup conducts randomly-selected samples of about 1,000 people in all the countries. It remains nonpartisan to ensure it does not misrepresent the opinions and aspirations of people around the globe.
- CPI calculates each country's score in the CPI based on the results of at least 3 of the following 13 surveys below:

  There are numerous reliable and renowned sources above. Also, by aggregating multiple surveys' results, it minimizes the bias of one survey skewing an opinion.

Potential biases/concerns

1. χ^2 Test for Independence

- I am particularly concerned about nonresponse bias in the survey questions that ask about income. Personal finances is a sensitive issue and is often seen as an aspect that defines one's standing in life. Possibly, poor people are less willing to participate in this survey because they feel uncomfortable and insecure about reporting their

lower incomes. On the contrary, wealthier people may be more willing to participate because they are not self-conscious on financial matters.

2. All survey questions with “not happy”, “moderately happy”, and “very happy” as choices.

- I am concerned about response bias in these questions as some people do not feel comfortable admitting that they are not happy. Instead, they may be more inclined to respond what they think is more socially desirable. There may be a bias of more answers being skewed from “not happy” to “moderately happy” when people consider their situation as borderline.

3. Linear Regression

- The perception of corruption is complex and may be hard to capture in a single score representing a whole country.
- Having business executives as a part of judging corruption in businesses seems biased because they have their own business interests.

4. 1 Mean

- Close friends is a subjective thing to gauge.

Assumptions & Conditions

Independence

Each sample in a survey must be independent of other observations for statistical tests to be meaningful. Whenever we sample without replacement, individual observations aren't technically independent since removing each observation changes the population. We check the independence condition by determining if the sample is no more than 10% of the population, because at this point, removing each observation doesn't change the population all that much. The only exceptions are paired data where the treatment and the two observations on one sample must be dependent and the chi-square tests.

< 10% Population Check	**n < 10% population ?**
1-Prop	n = 140 < 141.4
2-Prop	n_1 : 45 < 46.8, n_2 : 45 < 47.3
1-Mean	n = 140 < 144.7
2-Mean	n ≈ 144000 < 10% of population of all 144 countries
Linear Regression	n ≈ 152000 < 10% population of all 152 countries

Means C.I.s & H-Tests including histograms of data and/or Normal Probability Plots (refer to page 126) to check for normal enough

All the surveys satisfy the 10% condition for independence, which is a good sign. Even then, there still might be some slight bias introduced that may not make a factor 100% independent.

- **1 Prop:** One's job satisfaction is probably not affected by another's job satisfaction because we each have a different experience when working a certain job.

- **2-Prop, χ^2 Test for Independence:** One person's income won't affect another person's income.
- **1-Mean and ANOVA:** The number of close friends one has will not affect another's number of close friends
- **2-Mean:** Religiosity in a country may not be completely independent because what region it is located can have an effect.
- χ^2 **GOF:** Birth month is always independent because it is inherent.
- **Linear Regression:** How one perceives corruption may be the influence of negativity spread from others reinforcing the notion. Think of it as being similar to stress culture at HHS. When one student emphasizes how stressful HHS is, others are inclined to think worse about it too.

Normality

Prop. Big enough? - For all proportion hypothesis tests and confidence intervals, the sample is approximately normal if both we can expect at least 10 successes and 10 failures.

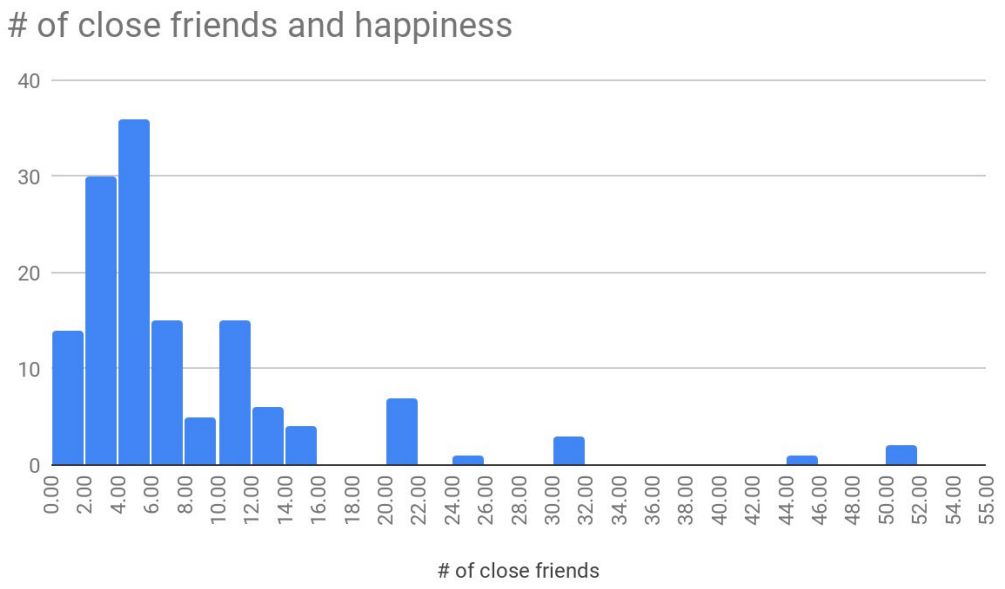
Test/Interval	Successes	Failures	Condition met?
1-PropZTest	np = 122.7	nq = 127.3	Yes
1-PropZInt	x = 117	n-x = 133	Yes
2-PropZTest	$n_1\hat{p}_{pool} = 17.5$ $n_2\hat{p}_{pool} = 17.5$	$n_1\hat{q}_{pool} = 27.5$ $n_2\hat{q}_{pool} = 27.5$	Yes
2-PropZInt	$x_1 = 17$ $x_2 = 18$	$n_1-x_1 = 28$ $n_2-x_2 = 27$	Yes

Means Big enough? - For all mean hypothesis tests and confidence intervals, the sample is approximately normal if it meets the Central Limit Theorem with a reasonably large sample size of $n \geq 30$ and has a population or sample histogram is normal.

Test/Interval	n	Condition met?
1-MeanTTest + Int	1299	Yes
2-MeanTTest + Int	n_1 : 464 n_2 : 176	Yes
Paired	141	Yes

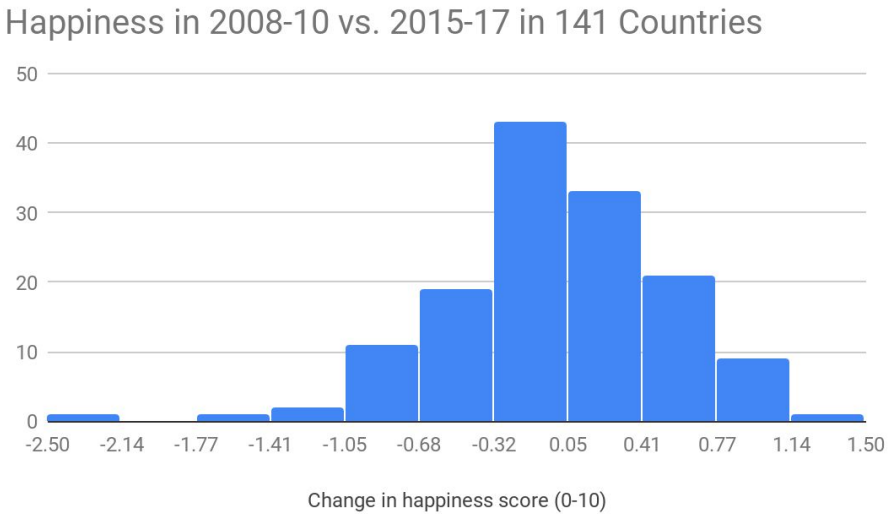
Means Histograms

1-Mean - This histogram of the sample distribution looks skewed to the right. However, without outliers and a greater sample size, we could reasonably expect the distribution to become more normal.



2-Mean - For the histograms, please refer them on page 23. The two groups of samples both look approximately normal, so the normality condition is met.

Paired - We can observe that the histogram of the sample difference is approximately normally-distributed



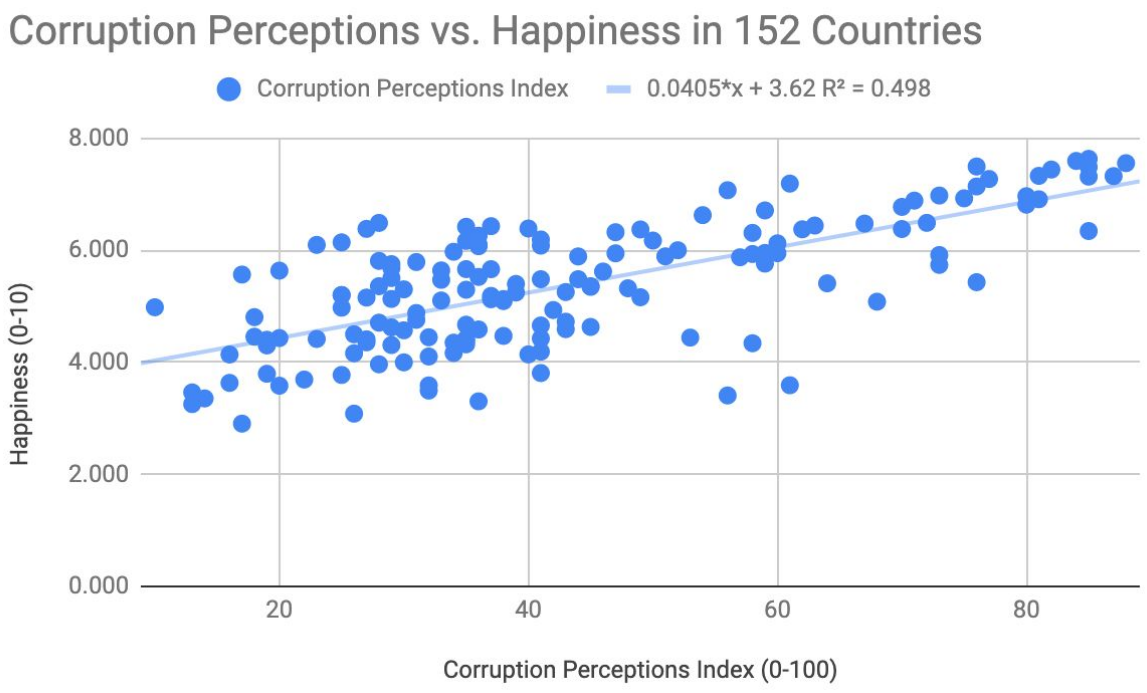
Large Sample Size

In the χ^2 GOF and Test for Independence, the expected counts in each cell should be at least 5.

<table>
<tr><th>χ^2 Test</th><th>Condition met?</th></tr>
<tr><td>GOF</td><td>Yes
<table>
<tr><th>Birth Month</th><th>Expected Counts</th></tr>
<tr><td>January</td><td>872.996508</td></tr>
<tr><td>February</td><td>872.996508</td></tr>
<tr><td>March</td><td>872.996508</td></tr>
<tr><td>April</td><td>872.996508</td></tr>
<tr><td>May</td><td>872.996508</td></tr>
<tr><td>June</td><td>872.996508</td></tr>
<tr><td>July</td><td>872.996508</td></tr>
<tr><td>August</td><td>872.996508</td></tr>
<tr><td>September</td><td>872.996508</td></tr>
<tr><td>October</td><td>872.996508</td></tr>
<tr><td>November</td><td>872.996508</td></tr>
<tr><td>December</td><td>872.996508</td></tr>
</table></td></tr>
<tr><td>Independence</td><td>Yes*
<table>
<tr><th>Income</th><th>Happy</th><th>Not Happy</th></tr>
<tr><td>< $10000</td><td>123.2868142</td><td>63.71318576</td></tr>
<tr><td>$10000 to 12499</td><td>54.06159769</td><td>27.93840231</td></tr>
<tr><td>$12500 to 14999</td><td>34.94225217</td><td>18.05774783</td></tr>
<tr><td>$15000 to 17499</td><td>37.57940327</td><td>19.42059673</td></tr>
<tr><td>$17500 to 19999</td><td>29.66794995</td><td>15.33205005</td></tr>
<tr><td>$20000 to 22499</td><td>46.15014437</td><td>23.84985563</td></tr>
<tr><td>$22500 to 24999</td><td>42.85370549</td><td>22.14629451</td></tr>
<tr><td>$25000 to 29999</td><td>52.74302214</td><td>27.25697786</td></tr>
<tr><td>$30000 to 34999</td><td>75.15880654</td><td>38.84119346</td></tr>
<tr><td>$35000 to 39999</td><td>67.906641</td><td>35.093359</td></tr>
<tr><td>$40000 to 49999</td><td>94.93743985</td><td>49.06256015</td></tr>
<tr><td>$50000 to 59999</td><td>98.89316651</td><td>51.10683349</td></tr>
<tr><td>$60000 to 74999</td><td>135.1539942</td><td>69.84600577</td></tr>
<tr><td>$75000 to 89999</td><td>115.3753609</td><td>59.62463908</td></tr>
<tr><td>$90000 to 109999</td><td>89.00384986</td><td>45.99615014</td></tr>
<tr><td>$110000 to 129999</td><td>79.11453321</td><td>40.88546679</td></tr>
<tr><td>$130000 to 149999</td><td>46.15014437</td><td>23.84985563</td></tr>
<tr><td>>$150000</td><td>147.0211742</td><td>75.97882579</td></tr>
</table></td></tr>
</table>

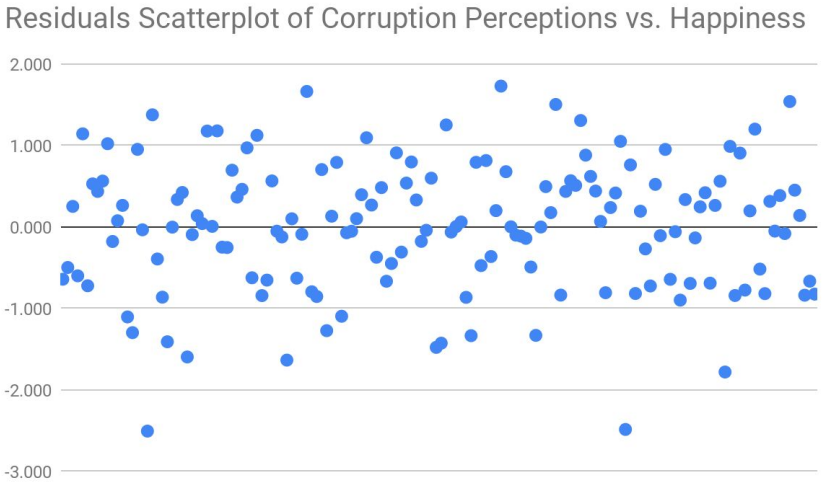
* Originally, the income brackets were split as $150,000-$169,000 and > $170,000, but since the $150,000-$169,000 row had an expected count less than 5, I combined the two categories to fix this issue.

Linear Regression Conditions



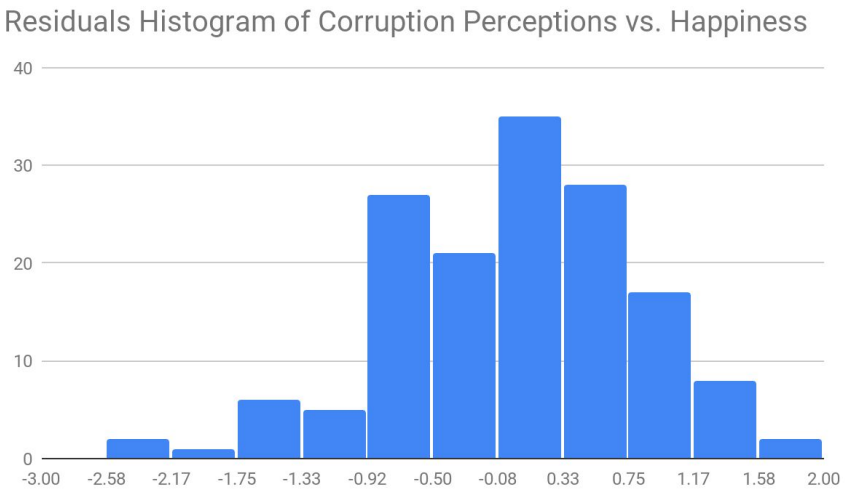
Note: The corruption scale on the Corruption Perceptions Index goes from 0 (completely corrupt) to 100 (no corruption).

1. Linearity - At first glance, the scatterplot looks reasonably straight, meaning our analysis should be worthwhile. In addition, there is a moderately strong $(r^2 = 0.498)$, positive $(r = 0.706 > 0)$, linear correlation between perceived corruption and happiness on the scatterplot.



2. Independence - The residuals scatterplot shows no evidence of patterns.

3. Equal Variance - The residuals plot shows roughly equal variance for all values of perceived corruption.



4. Normality - The histogram of the residuals looks approximately normal.

Analysis & Conclusions

I used α = 0.05 as my alpha-level for all the inference procedures.

Job Satisfaction (1-Prop Hypothesis Test and Confidence Interval)

Hypothesis Test

Purpose: I am testing to see if my 2018 sample proportion of U.S. workers who are very satisfied with their jobs is representative of the population proportion established by the Gallup "Work and Workplace" poll from 2001 to 2018.

Hypotheses

- H_0 : The 2018 sample proportion is representative of the 2001-2018 population proportion $\rightarrow p = 0.4672$
- H_A : The 2018 sample proportion is not representative of the 2001-2018 population proportion $\rightarrow p \neq 0.4672$

Results: $z = -0.4079$, $p \approx 0.3417$
Since the p-value of about 0.3417 is greater than the significance level of 0.05, we fail to reject the null hypothesis. The 2018 sample proportion is representative of the 2001-2018 population proportion.

Confidence Interval

Purpose: To estimate the true proportion of workers who are very satisfied with their jobs.

95% Confidence Interval: (0.368, 0.532)
I am 95% confident that the true proportion of workers who are very satisfied with their jobs is between 36.8% and 53.2%.

Money buys happiness, P1 (χ^2 Test for Independence)

The purpose of this test is to determine whether there is an association between family income bracket and happiness.

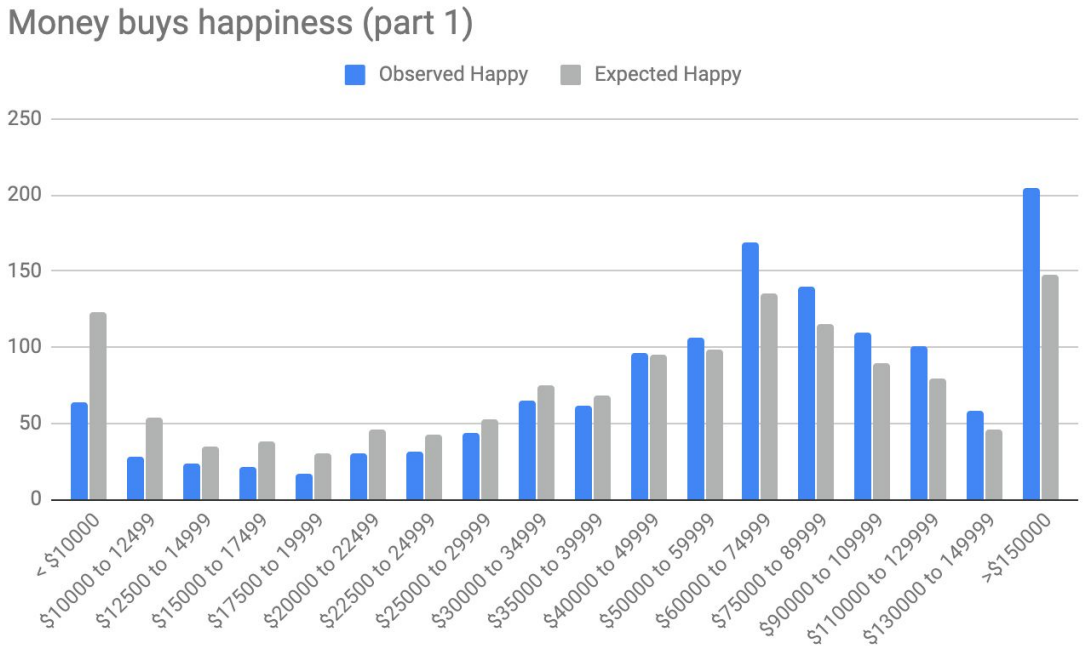
H_0 : There is no association between family income bracket and happiness.
H_A : There is an association between family income bracket and happiness.

Results: $\chi^2 = 287.584,\ df = 17,\ p \approx 0$

Because the p-value of about 0 is less than the significance level of 0.05, we can reject the null hypothesis. There is an association between family income bracket and happiness.

The table below shows the standardized residuals for my χ^2 Test of Independence. We can observe that people in an income bracket below $12,499 had the greatest negative deviation from the expected count in the happiness residuals. On the contrary, people in an income bracket of $60,000-$74,999 or > $150,000 had the greatest positive deviation from the expected count in the happiness residuals. This corroborates our conclusion for this test.

Income Bracket	Happy Stand. Residuals	Not Happy Stand. Residuals
< $10000	-5.339	7.428
$10000 to 12499	-3.545	4.931
$12500 to 14999	-1.851	2.575
$15000 to 17499	-2.705	3.762
$17500 to 19999	-2.326	3.235
$20000 to 22499	-2.377	3.307
$22500 to 24999	-1.811	2.519
$25000 to 29999	-1.204	1.675
$30000 to 34999	-1.172	1.630
$35000 to 39999	-0.838	1.166
$40000 to 49999	0.109	-0.152
$50000 to 59999	0.715	-0.994
$60000 to 74999	2.911	-4.050
$75000 to 89999	2.293	-3.189
$90000 to 109999	2.226	-3.096
$110000 to 129999	2.461	-3.423
$130000 to 149999	1.744	-2.426
>$150000	4.782	-6.652



Money buys happiness, P2 (2-Prop Hyp. Test and CI)

Hypothesis Test

Purpose: I will test whether there is a difference in being very happy among families in an annual income bracket between $60,000-$74,999 and above $150,000.

Hypotheses (p_1 = above $150,000, p_2 = $60,000-$74,999)

- H_0 : There is no difference in the proportion of very happy people in a family annual income bracket between $60,000-$74,999 and above $150,000. ($p_1 - p_2 = 0$)
- H_A : There is a difference in the proportion of very happy people in a family annual income bracket between $60,000-$74,999 and above $150,000. ($p_1 - p_2 > 0$)

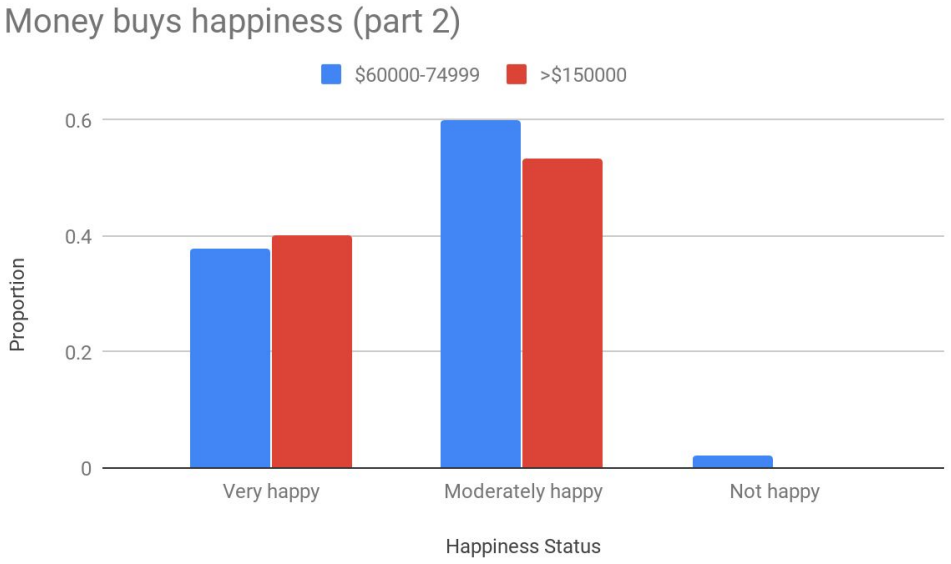
Results: $z = 0.2162$, $p \approx 0.4144$

Since the p-value of 0.4144 is greater than the significance level of 0.05, we fail to reject the null hypothesis. There is no difference in the proportion of very happy people in a family annual income bracket between $60,000-$74,999 and above $150,000. Basically, when a family earns enough to enjoy some luxuries in life, the prospects of achieving happiness are not increased significantly even if it is wealthier. Money buys happiness, but only up to a certain point.

Confidence Interval

Purpose: To estimate the true difference between the proportion of families in an annual income bracket between $60,000-$74,999 and above $150,000 who consider themselves very happy.

95% Confidence Interval: (-0.179 , 0.224)
We are 95% confident that the proportion of very happy people in a family annual income bracket above $150,000 is between 17.9% lower and 22.4% higher than the proportion of very happy people in a family annual income bracket between $60,000-$74,999.



Friends and happiness, P1 (1-Mean Hyp. Test and CI)

Hypothesis Test

Purpose: I am testing to see whether the mean number of close friends that very happy people have in my sample is representative of the 1986 sample population.

Hypotheses

- H_0 : The mean number of close friends that very happy people have in my sample is representative of the true mean in the 1986 sample population. ($\mu = 6.8565$)
- H_A : The mean number of close friends that very happy people have in my sample is not representative of the true mean in the 1986 sample population. ($\mu \neq 6.8565$)

Results: $t \approx 1.054,\ df = 139,\ p \approx 0.2938$
Since the p-value of about 0.2938 is higher than the significance level of 0.05, we fail to reject the null hypothesis. The mean number of close friends that happy people have in my sample is representative of the true mean in the 1986 sample population.

Confidence Interval

Purpose: To estimate the true mean number of close friends that happy people have.

95% Confidence Interval: (6.214 , 8.966)
We are 95% confident that the true mean number of close friends happy people have is between 6.214 and 8.966 close friends (or around 6 to 9 close friends).

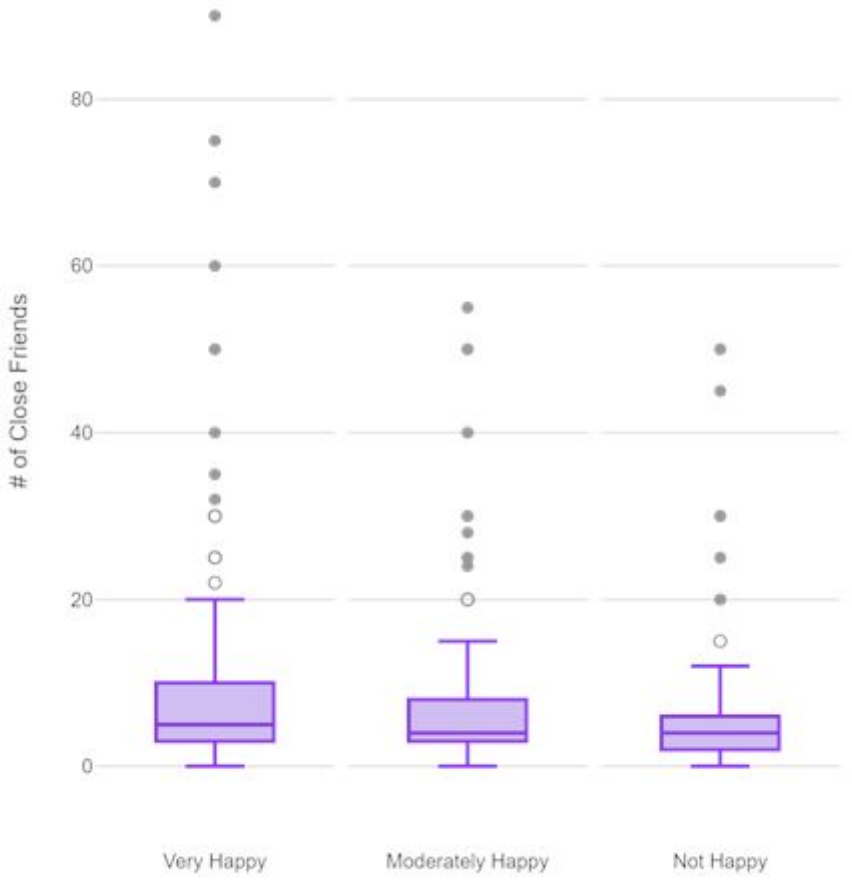
Friends and happiness, P2 (Analysis of Variance)

Purpose: I will test whether there is a difference between the mean number of close friends and one's state of happiness (very happy, moderately happy, or not happy)

Hypotheses

- H_0 : The three means do not differ from each other → $\mu_1 = \mu_2 = \mu_3$
- H_A : The three means are not all equal

Below is a box plot illustrating the three groups' data:



ANOVA Table	
MSTR (between)	494.5441058
MSE (within)	67.8614138
F-statistic	7.2875597
df1	2
df2	1435
P-Value	**0.0007096**

Since the p-value of about 0.0007096 is less than the significance level of 0.05, we can reject the null hypothesis. There is a difference in one's status of happiness and the mean number of close friends. This was expected because happier people tend to be more willing to go out and interact with others.

Religiosity and happiness (2-Mean Hyp. Test and CI)

2-Mean Hypothesis Test

Purpose: To determine whether or not there is a difference in the mean happiness scores between countries that see religion as highly important or less important.

Hypotheses (μ_1 = less important, μ_2 = highly important)

- H_0 : There is no difference in the mean happiness scores between countries that see religion as highly important or less important $\rightarrow \mu_1 - \mu_2 = 0$.
- H_A : There is a difference in the mean happiness scores between countries that see religion as highly important or less important $\rightarrow \mu_1 - \mu_2 \neq 0$

Results: $t \approx 6.989,\ df \approx 141.67,\ p \approx 0$

Since the p-value of about 0 is less than the significance level of 0.05, we reject the null hypothesis. There is a difference in the mean happiness scores between countries that regard religion as highly important or less important. Had I picked a one-tailed test, we would conclude that the mean happiness scores in countries that regard religion as less important is significantly higher.

2-Mean Confidence Interval

Purpose: To estimate the true mean difference of the happiness score between countries that see religion as highly important and countries that see religion as less important.

95% Confidence Interval: (0.815, 1.457)
We are 95% confident that the true mean difference of the happiness score between the two groups of countries is between 0.815 and 1.457 points greater in countries that see religion as less important.

Please refer to page 14 for the graphs of the two groups' histograms

World happiness in 2008-2010 vs. 2015-2017 (Paired Data Hyp. Test and CI)

Paired Data Hypothesis Test

Purpose: I will test whether there is a statistically significant mean difference between the world's overall happiness in 2008-2010 vs. in 2015-2017.

Hypotheses

- H_0 : The world's happiness overall happiness score in 2015-2017 has not changed from that of 2008-2010. ($\mu_{diff} = 0$)
- H_A : The world's happiness overall happiness score in 2015-2017 has changed from that of 2008-2010. ($\mu_{diff} \neq 0$)

Results: $t \approx -0.174,\ df = 140,\ p \approx 0.8621$
Since the p-value of about 0.8621 is greater than the significance level of 0.05, we fail to reject the null hypothesis.

Paired Data Confidence Interval

The purpose of this confidence interval is to estimate the true mean difference in the world's happiness between the two time frames.

95% Confidence Interval: (-0.1 , 0.084)
We are 95% confident that the world's happiness is between 0.1 points less and 0.084 greater in 2015-2017.

Please refer to page 13 for the graph of the paired data.

Birth month and happiness (χ^2 Goodness-of-Fit Test)

Purpose: To determine whether the number of very happy people is distributed evenly in each birth month.

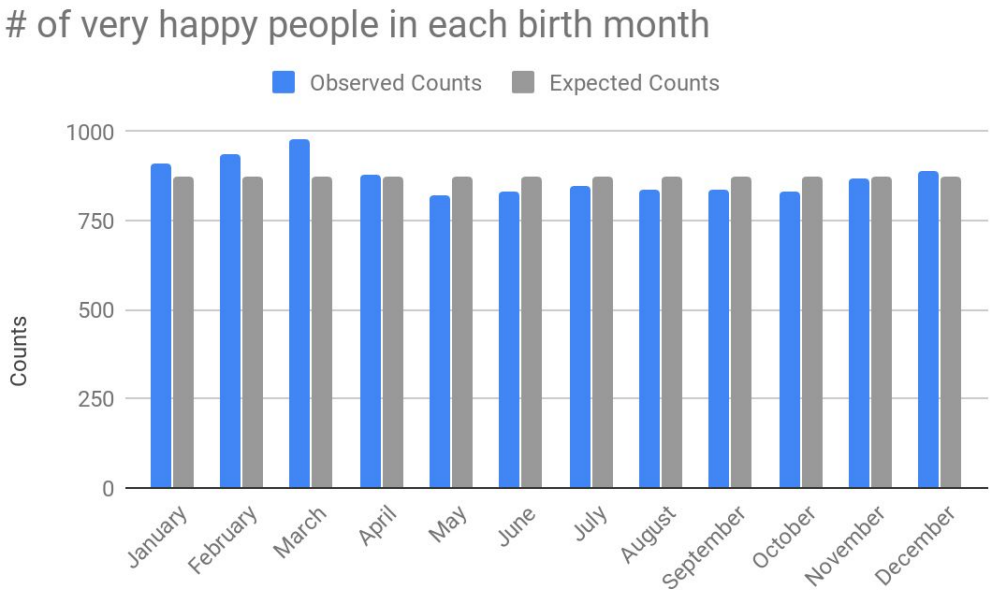
Hypotheses

- H_0 : The number of very happy people is distributed evenly in each birth month.
- H_A : The number of very happy people is not distributed evenly in each birth month.

Results: $\chi^2 = 30.074,\ df = 11,\ p \approx 0.0015425$
Because the p-value of about 0.0015425 is less than the significance level of 0.05, we can reject the null hypothesis. The number of very happy people is not distributed evenly in each birth month.

The table below shows the standardized residuals for my χ^2 GOF test. We can observe that people born in February/March had the greatest positive deviation from the expected count whereas people born in May/June had the greatest negative deviation from the expected count. Therefore, people born in February/March are more likely to be happier and people born in May/June are less likely to be happier.

Birth month	Standardized residuals
January	1.307
February	2.176
March	3.618
April	0.175
May	-1.731
June	-1.387
July	-0.815
August	-1.171
September	-1.174
October	-1.358
November	-0.183
December	0.544



Corruption perceptions and happiness (LinReg Hyp. Test and CI)

The linear model of corruption perceptions and happiness had an $r^2 = 0.498$. This means 49.8% of the variation in happiness (y-axis) is explained by the variation in the perceptions of corruption (x-axis).

Linear Model: $\widehat{Happiness} = 3.62 + 0.0405(Corruption\ Perceptions\ Score)$

LinReg Hypothesis Test

Purpose: I will determine whether there is a linear association between perceived corruption and general happiness in a country. A one-sided test seems more appropriate because I would expect an unfavorable perception of corruption to have a detrimental impact on people's well-being in their country.

Hypotheses

- H_0 : The null hypothesis is that there is no linear association between perceived corruption and general happiness in a country. ($\beta_1 = 0$)
- H_A : The alternative hypothesis is that there is a positive, linear association between perceived corruption and general happiness in a country. ($\beta_1 > 0$)

P-Value: $t \approx 1.976,\ df = 150,\ p \approx 0$

Because the p-value of about 0 is less than the significance level of 0.05, we can reject the null hypothesis. There is a positive, linear association between perceived corruption and general happiness. This means that the more positively people perceive their country's corruption, the estimated happiness goes up, on average.

LinReg Confidence Interval

Purpose: To estimate how much happiness increases for every point increase of perceived corruption.

95% Confidence Interval: (0.034, 0.047)
We are 95% confident that the true slope of the association between corruption and happiness in a country is between 0.034 and 0.047. For every 10 point increase on the corruption index, the happiness score in a country increases by between 0.34 and 0.47 points, on average.

Please refer to page 15 for the scatterplot.

Problems & Bias

Problems

- Looking back on my religiosity and happiness investigation (2-Mean), I realized I should have used data from a different year. The religiosity data came from 2008-2009, while the happiness data came from 2018. In this time, these factors can fluctuate a lot. If I had more time, I would have re-ran the test with the 2010-2012 World Happiness Report, which was the closest data I could find. It is harder to use the data though because it is in text form and Gallup did not provide the raw data spreadsheets back then.

Type I and II Errors in Context

Type I Errors *occur when one falsely rejects a true null hypothesis, equal to* α *(False positive)*

Type II Errors *occur when one fails to reject a false null hypothesis, equal to* β *(False negative)*

My alpha level is $\alpha = 0.05$.

1 Prop - Failed to reject

- **(II) -** I conclude the sample proportion of people very satisfied with their jobs is representative of the population proportion when in fact it is not.

2 Prop - Failed to reject

- **(II) -** I conclude that there is not a difference in the proportion of very happy people between the two annual family income brackets when there really is.

χ^2 **Test for Independence -** Rejected

- **(I) -** There is a 5% chance that I conclude that there is an association between annual family income bracket and happiness when there really is not.

1-Mean - Failed to reject

- **(II) -** I conclude that there is no difference in the sample mean # of close friends and the population mean # of close friends when there really is.

ANOVA - Rejected

- **(I) -** There is a 5% chance that I conclude that very happy, moderately happy, and not happy people do not have an equal mean # of close friends when their means really do not differ.

2-Mean - Rejected

- **(I) -** There is a 5% chance that I conclude that the mean happiness scores in high religiosity and low religiosity countries does differ when in fact it does not.

χ^2 **GOF -** Rejected

- **(I) -** There is a 5% chance that I conclude that very happy people are not evenly-distributed in each birth month when in fact they are evenly-distributed.

Paired - Rejected

- **(I) -** There is a 5% chance that I conclude that there is a difference in the world's happiness in 2008-2010 vs. 2015-2017 when in fact there is no such difference.

Linear Regression - Rejected

- **(I) -** There is a 5% chance that I conclude that there is a positive, linear association between perceptions of corruption and a country's happiness where there is no such association.

Were my initial concerns valid?

My first initial concern was the possibility of nonresponse bias among poorer people in the χ^2 Test for Independence which asks for one's income. To test this concern, I decided to do a χ^2 GOF Test to see if the total responses are distributed according to the 2018 percentile distribution of household income. Below you can see the spreadsheet display of the total counts in each income bracket that responded compared to the expected. The standard residuals show that my initial concern was not valid. Both the larger positive and negative deviations from the expected counts lie in wealthier and poorer income bracket alike.

Income Bracket	Observed Counts	Expected %s	Expected Counts	Stand. Res.
< $10000	380	0.06	284.52	5.661
$10000 to 12499	158	0.02	94.84	6.486
$12500 to 14999	141	0.03	142.26	-0.106
$15000 to 17499	109	0.03	142.26	-2.789
$17500 to 19999	102	0.03	142.26	-3.375
$20000 to 22499	160	0.02	94.84	6.691
$22500 to 24999	178	0.03	142.26	2.996
$25000 to 29999	195	0.06	284.52	-5.307
$30000 to 34999	246	0.04	189.68	4.089
$35000 to 39999	227	0.05	237.1	-0.656
$40000 to 49999	377	0.08	379.36	-0.121
$50000 to 59999	394	0.08	379.36	0.752
$60000 to 74999	473	0.10	474.2	-0.055
$75000 to 89999	381	0.08	379.36	0.084
$90000 to 109999	324	0.08	379.36	-2.842
$110000 to 129999	254	0.06	284.52	-1.809
$130000 to 149999	175	0.04	189.68	-1.066
$150000 to 169999	133	0.02	94.84	3.918
> $170000	335	0.09	426.78	-4.443

2018 Household Income Percentiles: https://money.cnn.com/calculator/pf/income-rank/index.html

Second, another initial concern I had was about the borderline response bias of 'moderately happy' and 'not happy' based on social desirability. In general, I thought this was less of a concern, but maybe adding an additional category could have distinguished

people better on the bar charts on page 20. For example, I would have four categories for happiness: very happy, moderately happy, less happy, not happy at all. In the end though, I think it usually didn't affect my results because I often looked at only the 'very happy' responses, which are not applicable to this concern.

Third, I thought there may have been some undercoverage bias about the CPI in the Linear Regression because the question about business corruption received only input from business executives and none from the general public. However, the linear fit came out really nice and I say that it the theory of corrupt executives being dishonest and inflating their corruption score while clean countries being truthful and having a relatively-deflated corruption score in comparison. I wonder if adding the general public would actually add more bias to the CPI since they tend to be less informed and jump to conclusions more easily. In fact, the CPI used to have such questions but suspended them in recent surveys.

Finally, the concern I had about the subjectivity of close friends in 1-Mean was somewhat valid. Referring to the graph of its distribution on page 13, you can see many outliers. People have their own different conceptions of what classifies as a close friend. What may have happened is that some people put their whole social circles into consideration, which makes it harder to analyze the data meaningfully.

Conclusion

One is most likely to be happy if they were born in February or March, has an annual family income of at least $60,000, lives in a clean country that regards religion as less important, and has around six to nine close friends.

Reference

Lambert, Craig. "The Science of Happiness." Harvard Magazine, Feb. 2007, harvardmagazine.com/2007/01/the-science-of-happiness.html. Accessed 4 June 2019.

Lyubomirsky, Sonja. *The How of Happiness*. New York, Penguin Group, 2007.

My spreadsheet (Data is nested in the 'Happiness' and 'Raw Data' tabs): https://docs.google.com/spreadsheets/d/11fjX6MXPWaAlOQndadRuQnlxtsEChk-7fiw1NJZJh_c/edit?usp=sharing