Exploring Gender Inequality in Hollywood: A Correlational Analysis on the Impact of Female Representation on Film Prosperity in the Movie Industry

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Introduction and Research Question

Gender disparity is defined as unequal treatment and perception based on gender; a notion that has long persisted in society. This project focuses on the gender disparity present in the Hollywood film industry. In our research, we discovered that various filmmakers in Hollywood claim that the inclusion of female characters leads to unprofitable films. This generates the following research question: *Is there a relationship between female representation in Hollywood films and how successful will those films become in the future?* In this paper, success will be gauged based on the budget, domestic gross, and international gross of films, which all contribute to the profitability of films.

Background and Significance

The Bechdel test measures female inclusion in films, and consists of three conditions: (1) film must include 2+ women, (2) women must communicate, and (3) conversations must not be about men. "Bechdel Test: Why It's Important" portrays how media underrepresentation fosters false impressions about minorities. Thus, we believe it is significant to identify whether Hollywood actually underrepresents females in order for society to promptly take action if necessary. Moreover the article "How Exactly Do Movies Make Money?" reads that monetary success is an unpredictable factor in Hollywood. High and rapidly increasing input cost of film production as well as variability in consumer preference both result in filmmakers continuously producing films with great financial loss. Hence, this research aims to help filmmakers decide whether or not they should continue minimizing female inclusion to secure profit by educating them on any true effects that female inclusion might have on film profits.

Methods

We will first conduct a correlational study and 2-Var EDAs on 1,794 films from 1970 to 2013 using data from fivethirtyeight. Data explores a film's (1) pass/fail of Bechdel (from BechdelTest.com) and (2) budget and profit (from The-Numbers.com). Then we will perform multiple EDAs to visually consider our data. Finally, we will perform multiple hypothesis tests and a confidence interval for difference in means to analyze any differences between the average profits of films that pass vs. fail the Bechdel test.

Results and Analysis

***Figure 1 (right)*: Bar plot of counts of movies that pass vs. fail the Bechdel test -** More movies fail the Bechdel test than pass it by a sizable amount. The total count of failures is about 1000, but the total count of passes is about 810. This shows how women are likely being underrepresented in the film industry; more than half of the films in this dataset do not sufficiently feature women.

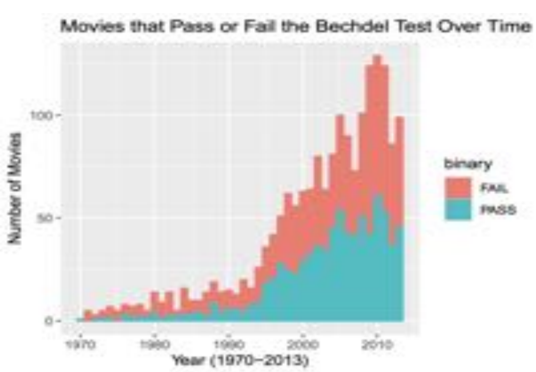
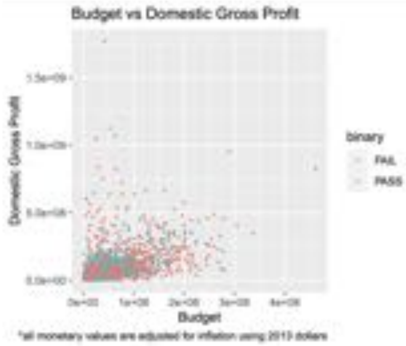


***Figure 2 (left)*: The count of movies that pass or fail the Bechdel test over time.**

There is a clear upward trend in the number of movies that pass the Bechdel test as time goes on. The increase in the amount of movies that pass the test might just be a result of increased movie production with emerging technology rather than an increase in female representation in film. This idea is further justified by the fact that the number of movies that fail the Bechdel test is also increasing over time, and is consistently higher than the number of movies that pass the Bechdel test.



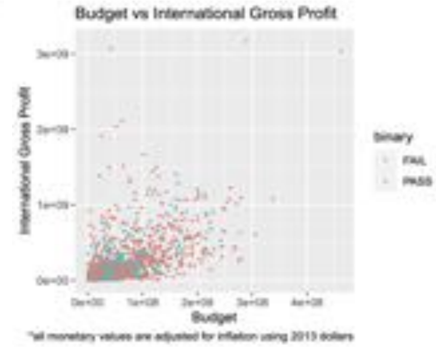
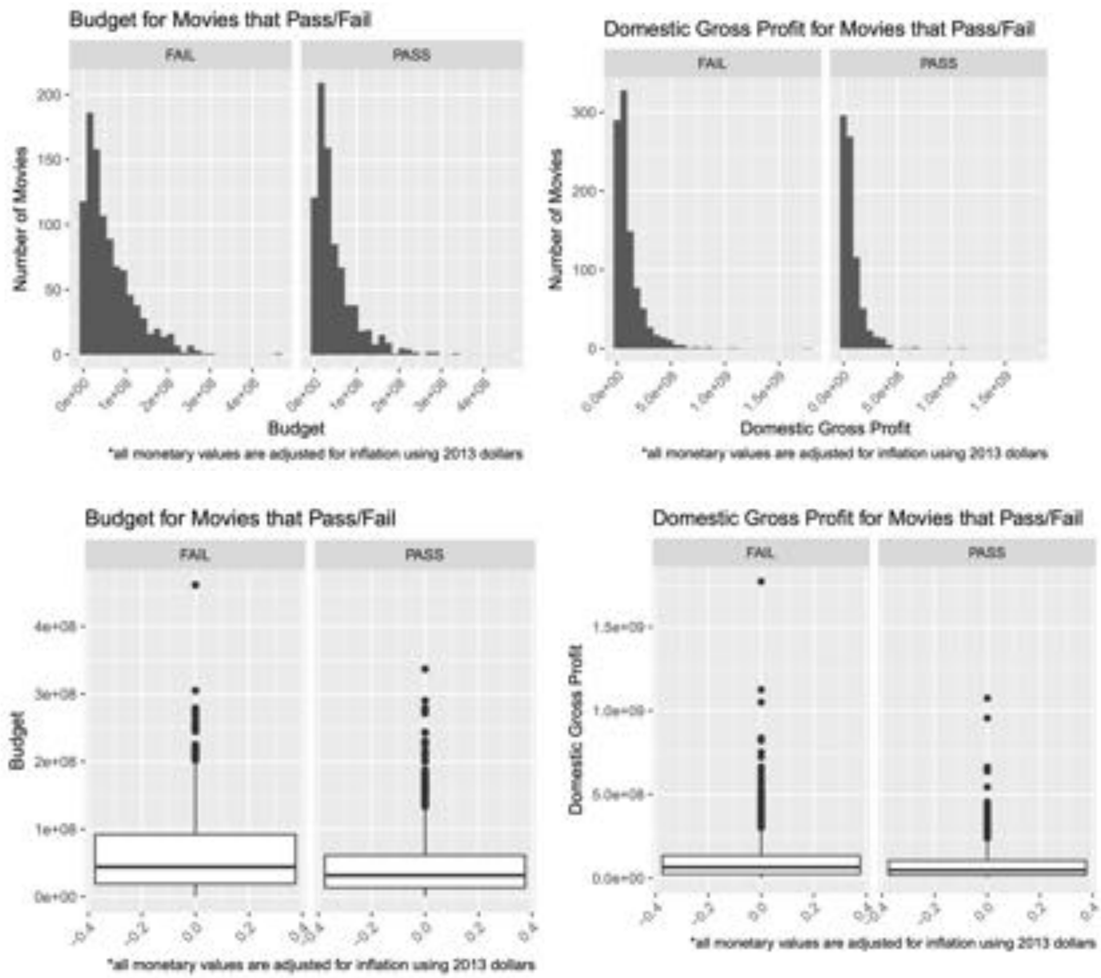


***Figure 3 (domestic) & Figure 4 (international)*: Film budget and gross profit (adjusted for inflation using 2013 dollars)** - In Figure 3 (left), most data is concentrated in the bottom left corner, meaning that most movies had relatively small budgets and low domestic gross profit. There is almost no relationship between budget, domestic gross profit, and film's pass/fail status of the test. The same holds for Figure 4 (right).

***Figure 5 (below)*: Comparing budget and domestic gross profit for movies that pass vs. fail Bechdel test**

These EDAs bolster the claim that there seems to be no relationship between budget, domestic gross profit, and whether or not the movie passed the Bechdel test. When separated by pass/fail, the distribution of the sample seems to be more or less visually similar, with the exception of some extraneous outliers.



We will now conduct a hypothesis test on the $\alpha = 0.05$ level for the difference between the mean gross profits of films that passed and failed the test. If we fail to reject the null hypothesis (H_0 = no difference between means), female inclusion in films does not likely correlate to lower profit. However, due to the absence of random assignment (films pass/fail the Bechdel test based on conditions; not randomly), we cannot deduce causations.

***Hypothesis Test #1*: Gross domestic profits (passed vs. failed test)**

1. Hypotheses: $H_0 = \mu_1 - \mu_2 = d_0 = 0$ and $H_A = \mu_1 - \mu_2 \neq d_0 = 0$
2. Conditions: Independence, 10%, 10 Success/10 Failure, Independent groups? **ALL MET**
3. Test statistics:

	binary	n	mean	sd
	<chr>	<int>	<dbl>	<dbl>
1	FAIL	991	107774371	140750940
2	PASS	803	79591919	102806062

$$SE(\bar{y}_1 - \bar{y}_2) = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = \sqrt{\frac{(140750940)^2}{991} + \frac{(102806062)^2}{803}} = 5.75784 * 10^6 \text{ and } t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{SE(\bar{y}_1 - \bar{y}_2)} = \frac{(107774371 - 79591919) - 0}{5.75784 * 10^6} = 4.89462$$

4. P-value (using pnorm in R): $P(|t| > 4.89462) \rightarrow 2 * P(t < -4.89462) \rightarrow$ 2 * pnorm(-4.89462) = $\mathbf{9.849586 * 10^{-7}}$
5. Conclusion: $p = 9.849586 * 10^{-7}$ and $p < 0.05$: we **reject** the null hypothesis. d_0 is not zero and **there is likely a difference in the means** of the scaled gross **domestic** profit of movies that pass vs. fail the Bechdel test.

***Hypothesis Test #2*: Gross intentional profits (passed vs. failed test)**

1. Hypotheses: $H_0 = \mu_1 - \mu_2 = d_0 = 0$ and $H_A = \mu_1 - \mu_2 \neq d_0 = 0$
2. Conditions: Independence, 10%, 10 Success/10 Failure, Independent groups? **ALL MET**
3. Test statistics:

	binary	n	mean	sd
	<chr>	<int>	<dbl>	<dbl>
1	FAIL	991	222529818	301721605
2	PASS	803	167359971	256191137

$$SE(\bar{y}_1 - \bar{y}_2) = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = \sqrt{\frac{(301721605)^2}{991} + \frac{(256191137)^2}{803}} = 1.31757 * 10^7 \text{ and } t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{SE(\bar{y}_1 - \bar{y}_2)} = \frac{(222529818 - 167359971) - 0}{1.31757 * 10^7} = 4.18725$$

4. P-value: $P(|t| > 4.18725) \rightarrow 2 * P(t < -4.18725) \rightarrow$ 2 * pnorm(-4.18725) = $\mathbf{2.823548 * 10^{-5}}$
5. Conclusion: $p = 2.823548 * 10^{-5}$ and $p < 0.05$: we **reject** the null hypothesis. d_0 is not zero, and **there's a difference in the means** of the scaled gross **international** profit of movies that pass vs. fail the Bechdel test.

We conducted the same exact tests without outliers (observations with high or low budgets relative to the majority, based off of figures 3 and 4) to ensure no outcomes were attributable to presence of these anomalies.

***Hypothesis Test #3*: Gross domestic profits without outliers (passed vs. failed test)**

1. Hypotheses: $H_0 = \mu_1 - \mu_2 = d_0 = 0$ and $H_A = \mu_1 - \mu_2 \neq d_0 = 0$
2. Conditions: Independence, 10%, 10 Success/10 Failure, Independent groups? **ALL MET**
3. Test statistics:

	binary	n	mean	sd
	<chr>	<int>	<dbl>	<dbl>
1	FAIL	980	105343921	128416990
2	PASS	794	79591919	102806062

$$SE(\bar{y}_1 - \bar{y}_2) = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = \sqrt{\frac{(128416990)^2}{980} + \frac{(102806062)^2}{794}} = 4.10213 * 10^6 \text{ and } t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{SE(\bar{y}_1 - \bar{y}_2)} = \frac{(105343921 - 79591919) - 0}{4.10213 * 10^6} = 6.27771$$

4. P-value: $P(|t| > 6.27771) \rightarrow 2 * P(t < -6.27771) \rightarrow$ 2 * pnorm(-6.27771) = $\mathbf{3.43596 * 10^{-10}}$
5. Conclusion: $p = 3.43596 * 10^{-10}$ and $p < 0.05$: we **reject** the null hypothesis. d_0 is not zero and **there's a difference in the means** of the scaled gross domestic profit of films that pass vs. fail the Bechdel test, **even without outliers**.

***Hypothesis Test #4*: Gross international profits without outliers (passed vs. failed test)**

1. Hypotheses: $H_0 = \mu_1 - \mu_2 = d_0 = 0$ and $H_A = \mu_1 - \mu_2 \neq d_0 = 0$
2. Conditions: Independence, 10%, 10 Success/10 Failure, Independent groups? **ALL MET**
3. Test statistics:

	binary	n	mean	sd
	<chr>	<int>	<dbl>	<dbl>
1	FAIL	814	113477521	101395614
2	PASS	714	99014250	96047061

$$SE(\bar{y}_1 - \bar{y}_2) = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = \sqrt{\frac{(101395614)^2}{814} + \frac{(96047061)^2}{714}} = 5.05475 * 10^6 \text{ and } t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{SE(\bar{y}_1 - \bar{y}_2)} = \frac{(113477521 - 99014250) - 0}{5.05475 * 10^6} = 2.86132$$

4. P-value: $P(|t| > 2.86132) \rightarrow 2 * P(t < -2.86132) \rightarrow 2 *$ pnorm(-2.86132) = **0.00421881**
5. Conclusion: $p = 0.00421881$ and $p < 0.05$: we **reject** the null hypothesis. d_0 is not zero and **there's a difference in the means** of the scaled gross international profit of films that pass vs. fail Bechdel test. We can thus say **female inclusion correlates to lower international profit**.

Since higher budgets tend to be associated with higher profits, we created a 95% confidence interval for the difference between means to explore the disparity, if any, between expected budgets for films that pass vs. fail the Bechdel test.

Confidence Interval for Difference between Means: $(\bar{y}_1 - \bar{y}_2) \pm t_{df}{}^* \times SE(\bar{y}_1 - \bar{y}_2)$

	binary	n	mean	sd
1	FAIL	991	62911555	58547867
2	PASS	803	46274167	48563305

1. Standard error & test statistics:

$$SE(\bar{y}_1 - \bar{y}_2) = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} = \sqrt{\frac{(58547867)^2}{991} + \frac{(48563305)^2}{803}} = 2.52902 * 10^6$$

Use qt() function in R to find $t_{df}{}^*$ when $df = min(n_1-1, n_2-1)$: qt(0.025, 802) = -1.962926

2. Confidence Interval: **[$1.16731*10^7$, $2.16017*10^7$]**

$(62911555 - 46274167) \pm (-1.962926) \times 2.52902 * 10^6 = 2.16017*10^7$ (upper) and $1.16731*10^7$ (lower)

3. Conclusion: 95% of the time, true difference between the two means falls in the interval [$1.16731*10^7$, $2.16017*10^7$]. From our data, **most films that underrepresented women had a budget that is 11,673,100 to 21,601,700 dollars higher than the budget of those that do sufficiently feature women. With a budget disparity that large, it comes as no surprise to us that our hypothesis tests revealed a correlation between films that passed the Bechdel test and experienced lower profit.**

Limitations

Since data was adopted from an earlier study, there could've been biases in data collection. For example, we are uncertain whether or not any specific films have been intentionally included or excluded. Secondly, since the Bechdel test only accounts for female representation in Hollywood films, we failed to eliminate possible third variables (i.e. genre) that could've impacted profits. For instance, audiences may likely prefer to see males over females in action films but mind less when it comes to romance films.

Conclusion

Overall, filmmakers accurately predicted that films with female prominence typically yield lower profit and are therefore less successful. However, we also found that such films generally had lower budgets to begin with. It is also worth noting how women are massively underrepresented in the film industry, with some female-representing films being rare exceptions. Hence, to not only conduct a better correlational study but to also foster gender equality, we need to collectively take actions that will incentivize filmmakers to produce more films that are inclusive of both genders. Since it's hard to draw conclusions specific to gender representation when so many variables are at play, it would be very hard to run a randomized experiment to examine this, and so rather than eliminate other variables, we suggest future research takes a multivariate approach to account for the different variables.

Works Cited

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