Analyzing the Bechdel Test: Budget Trends and Revenue Outcomes in Cinema

December 15th 2024

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1. Abstract

Media equity and cultural narratives are significantly impacted by gender representation in films. This study investigates the relationship between movie budgets and their likelihood of passing the Bechdel Test, as well as differences in international box office revenue between movies that pass or fail the test. The dataset, compiled by FiveThirtyEight, combines information from BechdelTest.com and The-Numbers.com, with movie genres supplemented using IMDb. Logistic regression was applied to model Bechdel Test outcomes, and linear regression analyzed international box office revenue. Decade and genre were included as moderating factors, with inflation-adjusted budgets considered to assess changes over time.

Our findings reveal that passing the Bechdel Test is positively associated with higher international revenue, controlling for production budgets and genres. Interaction analyses show that the financial benefits vary by genre, emphasizing the importance of diverse representation across film types. Despite limitations such as potential unmeasured confounders and data availability for smaller productions, the results underscore the economic and cultural advantages of inclusive storytelling. Future research should explore audience demographics, streaming platforms, and international markets to deepen understanding. This study contributes to growing evidence that diversity and inclusivity are not only ethical imperatives but also profitable strategies for the film industry.

2. Introduction

Gender representation in media is a critical issue due to its influence on societal norms and perceptions. The Bechdel Test, a measure of whether movies include at least two named women characters who talk to each other about something other than a man, highlights persistent disparities in representation [1]. Despite growing awareness, many films continue to fail this

basic measure of inclusivity, raising questions about the social and economic factors that contribute to this outcome.

The film industry is a major global enterprise, with Hollywood alone generating over $100 billion in revenue annually [2]. Budget allocations, genre choices, and audience preferences significantly influence the production and success of movies. Previous studies suggest that higher-budget movies often prioritize traditional narratives that may not meet diversity benchmarks like the Bechdel Test [3]. Conversely, films that pass the test have demonstrated competitive performance at the box office, particularly in international markets, suggesting that inclusivity can align with financial success [4].

Economic and cultural factors, such as inflation-adjusted budgets, genre conventions, and evolving societal norms across decades, may influence gender representation in films. By analyzing a dataset from BechdelTest.com, which includes information on movies' budgets, box office performance, genres (applied using the IMDb library in Python), and Bechdel Test outcomes, this study seeks to address the following questions:

1. What is the relationship between a movie's budget and its likelihood of passing the Bechdel Test? Does this relationship vary across decades?
2. How does passing the Bechdel Test impact a movie's international box office revenue, and does this relationship depend on the movie's genre?

By examining these questions, the study aims to provide insights into the economic and cultural dynamics shaping gender representation in the film industry and contribute to ongoing discussions on inclusivity in media.

3. Methods

3.1 Data and Preprocessing

Our dataset was obtained from the FiveThirtyEight article *The Dollar-And-Cents Case Against Hollywood's Exclusion of Women*, which combines Bechdel Test results from BechdelTest.com and financial metrics from TheNumbers.com. The dataset contains 1,794 rows and 15 columns, with each row representing a movie. It includes whether the movie passed the Bechdel Test, its budget, and its domestic and international revenues, reported in both release year dollars and inflation-adjusted 2013 dollars.

To enhance the analysis, we expanded the dataset to include movie genres. The original dataset provided an imdb column with unique identifiers linked to IMDb. Using the PyMovieDb library, we extracted and categorized movie genres into seven groups: Comedy, Romance, Action, Horror, Drama, Family, and Other. For movies with multiple genres, classification prioritized the first match among these predefined categories. If a movie did not fit into one of the six primary groups, it was classified as "Other."

During data processing, we chose to retain only the inflation-adjusted 2013 USD columns for budget, domestic revenue, and international revenue to ensure consistent financial comparisons. Initial exploration revealed missing values in several key columns. Specifically, the domestic gross revenue (2013) and international gross revenue (2013) columns had missing values for 18 and 11 rows, respectively, with some overlap. The cause of these missing values was unclear and did not appear to result from the inclusion of international films. Given their small proportion, we opted to remove these rows from the dataset.

Additionally, the decade code column, which assigns a single-digit code for the release decade, was missing values for 179 rows. Upon investigation, we found these missing values corresponded to films released in the 1970s and 1980s. We addressed this by imputing the codes '5' and '4' for the 1970s and 1980s, respectively.

These preprocessing steps ensured the dataset was clean, consistent, and suitable for analysis, enabling a deeper exploration of the relationship between gender representation, financial performance, and movie characteristics.

3.2 Variable Selection

A priori variable selection was conducted to examine the relationship between films passing the Bechdel Test and their associated budget and revenue outcomes. Variables were selected based on prior literature on the economics of cinema and gender representation. Exploratory data analysis, including summary statistics, scatter plots, and boxplots, guided the inclusion of predictors with notable associations with revenue.

Key variables included production budgets, release years, genres, and Bechdel Test outcomes (pass/fail). Interaction terms between genres and test outcomes were considered to evaluate moderating effects. Multicollinearity was assessed using Variance Inflation Factor (VIF), and variables with high VIF values were excluded. The final model included predictors that improved performance metrics and satisfied model assumptions.

3.3 Model Fitting and Evaluation

This study addressed two primary questions:

1. What is the relationship between a movie's budget and its likelihood of passing the Bechdel Test? Does this relationship vary across decades?
2. How does passing the Bechdel Test impact a movie's international box office revenue, and does this relationship depend on the movie's genre?

Logistic Regression for Bechdel Test Compliance: To answer the first question, logistic regression was used to model the binary outcome variable representing Bechdel Test compliance. Predictors included the movie's production budget (adjusted to 2013 values), the

decade of release, and their interaction term to explore how the relationship between budget and Bechdel Test compliance has evolved over time.

Model performance was evaluated using the Akaike Information Criterion (AIC), with lower AIC values indicating better fit. Variance Inflation Factor (VIF) was calculated to assess multicollinearity among predictors, ensuring all included variables had acceptable VIF values (<10). Metrics such as McFadden's pseudo-R^2 and diagnostic plots were used to assess explanatory power and validate assumptions. Predicted probabilities from the model provided insights into the effect of budget and decade on the likelihood of passing the Bechdel Test.

Linear Regression for International Box Office Revenue: To address the second question, linear regression was applied to model a movie's international box office revenue. Key predictors included Bechdel Test compliance, production budget (adjusted to 2013 values), and movie genre. Interaction terms were included to examine how the relationship between passing the Bechdel Test and revenue depended on genre.

Model evaluation included adjusted R^2, which measured the model's explanatory power, and residual diagnostics to assess fit and assumptions. Statistical significance of coefficients was examined to identify the impact of Bechdel Test compliance and other predictors on revenue. Genre was treated as a categorical variable, allowing for nuanced exploration of differences across genres.

4. Results

4.1 Overview of Included Data

After initial data preprocessing, our dataset contains 1,776 rows. Of these 1,776 films, 794 of them passed the Bechdel test, while 982 of the films did not.

Table 1: Summary Statistics for Movie Budgets and Gross Earnings (2013, Millions USD)

Statistic	Budget	Domestic Gross	International Gross
Mean	55.89	95.17	198.57
Median	37.16	56.00	96.89
1st Quartile (Q1)	16.23	20.55	33.74
3rd Quartile (Q3)	79.08	121.68	241.97

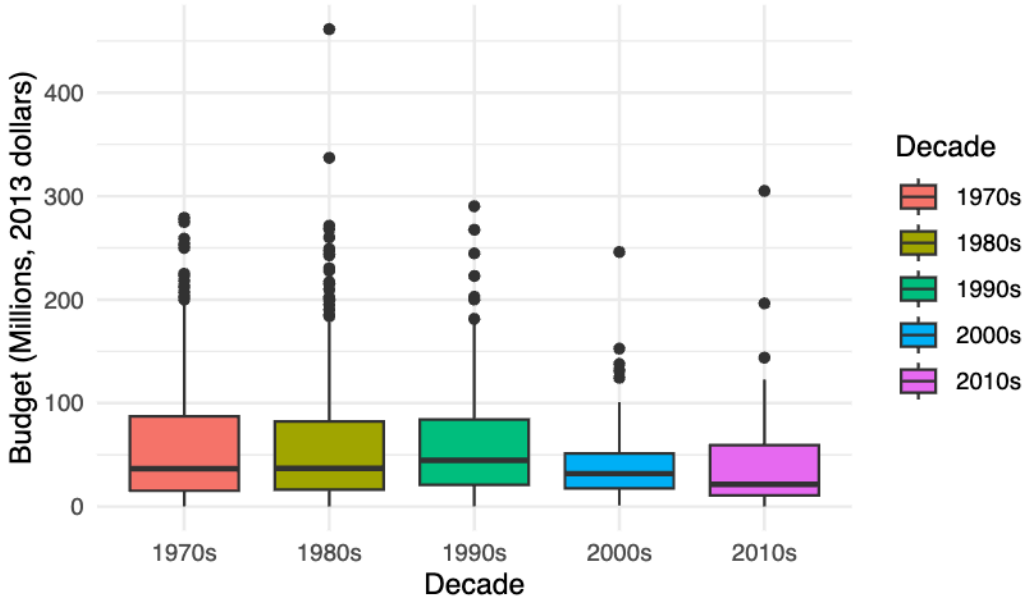
4.2 Research Question 1: Relationship Between the Bechdel Test and Budget

The results of the logistic regression model are shown in table 2 below

Table 2: Logistic Regression Model Summary

Variable	Estimate	Std_Error	z_value	p_value
budget 2013	0.0000	0.0000	-1.2131	2.25e-01
decade code 1980s	-0.2232	0.5191	-0.4301	6.67e-01
decade code 1990s	0.7673	0.4538	1.6910	9.08e-02
decade code 2000s	0.9322	0.4310	2.1631	3.05e-02
decade code 2010s	0.7755	0.4404	1.7607	7.83e-02
budget 2013 * decade code 1980s	0.0000	0.0000	0.9367	3.49e-01
budget 2013 * decade code 1990s	0.0000	0.0000	0.3717	7.10e-01
budget 2013 * decade code 2000s	0.0000	0.0000	0.4608	6.45e-01
budget 2013 * decade code 2010s	0.0000	0.0000	0.5003	6.17e-01

Figure 1: Budget Distribution by Decade (2013, Millions USD)



Interpretation: The overall budget levels have remained relatively stable across decades when adjusted for inflation. Since movie budgets do not differ significantly across decades, the interaction term between budget_2013 and decade_code in the regression model may help explain decade-specific effects on passing the Bechdel Test.

Figure 2: Effect of Budget on Bechdel Test Outcome

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`geom_smooth()` using formula = 'y ~ x'
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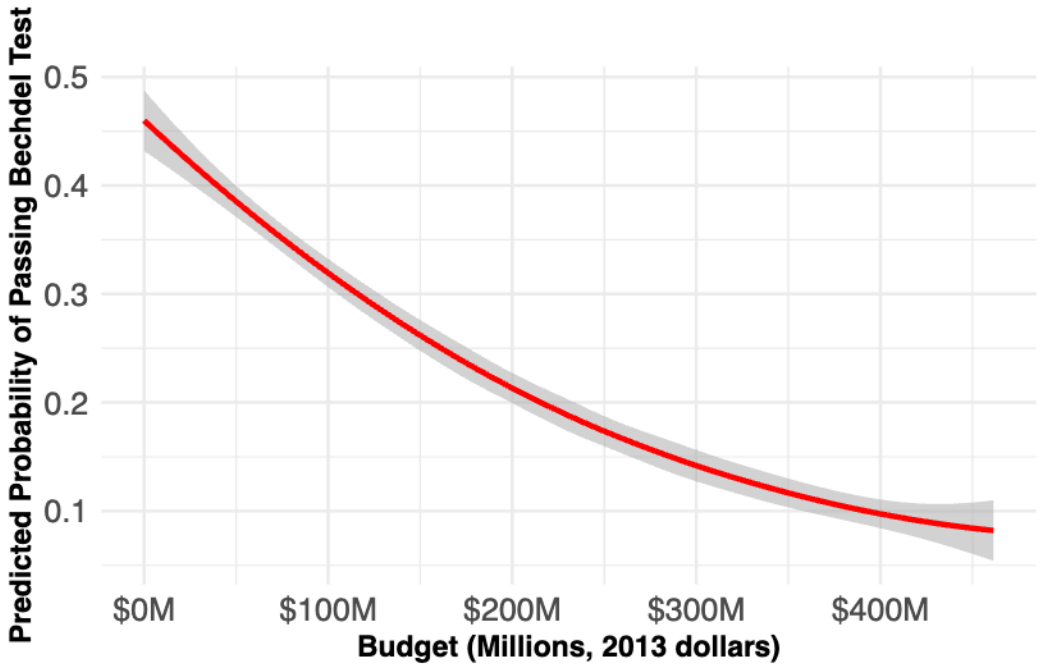
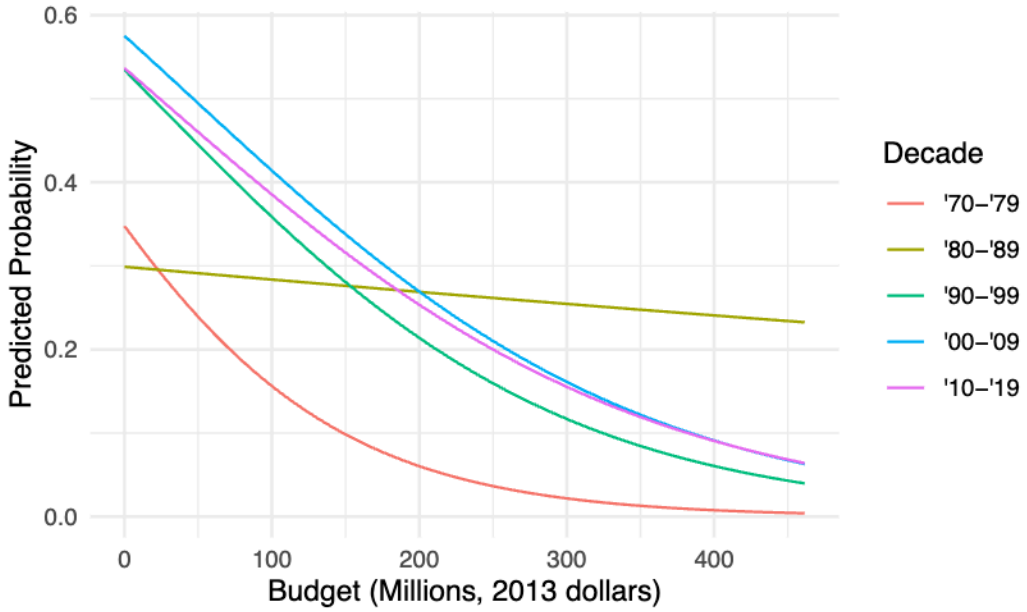


Thoughts: **Movies with higher budgets have a lower predictive probability of passing the Bechdel test.**

Figure 3: Effect of Budget on Bechdel Test Outcome by Decade

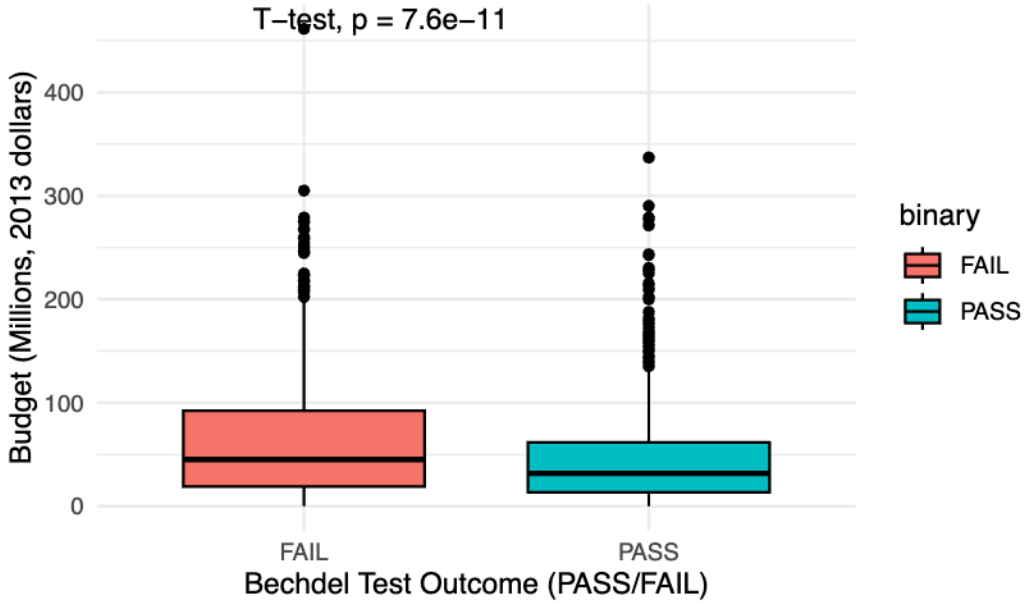


Interpretation:

For Decade Code 1, 2, 3, and 5: The trends are similar—higher budgets are associated with a lower probability of passing the Bechdel Test. This might indicate that high-budget films in these decades are more focused on genres like action or sci-fi, which are less likely to pass the test.

For Decade Code 4: The curve is nearly flat, meaning budget has little impact on passing the Bechdel Test. This could suggest that high-budget films in this decade are less influenced by genre differences in gender representation.

Figure 4: Budget Distribution by Bechdel Test Outcome



Interpretation:

- **p-value**: The t-test p-value is 7.6e-11, which is much smaller than 0.05, which indicates that there is a significant difference in budget distribution between the two groups, suggesting that budget may be an important factor affecting Bechdel Test outcomes.

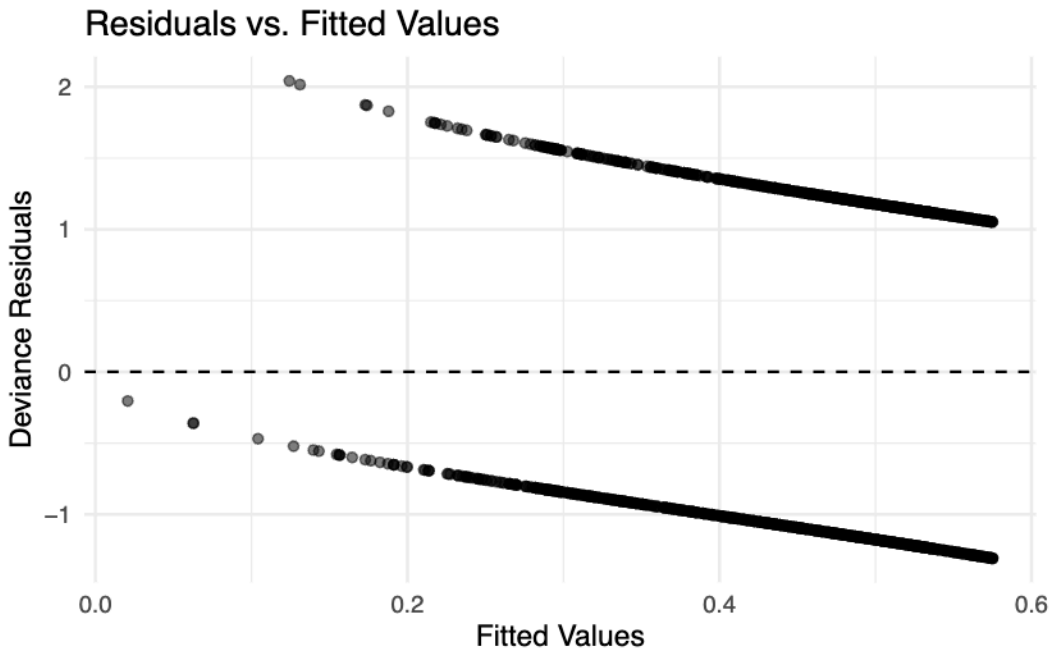
Overall:

- High-budget movies are more likely to fail the test, and low-budget movies are more likely to pass the test.
- Some possible explanation would be related to **Movie Genre**: High-budget movies, such as action or sci-fi, often have weaker gender representation and are less likely to pass the

test. In contrast, low-budget movies, like dramas or independent films, tend to focus more on gender equality and are more likely to pass.

Some ways to refine the current glm:

Figure 5: Residuals vs Fitted Values



Thoughts: I think the model here needs to be refined because there is a certain trend, ideally we want the residuals should be randomly distributed around 0. Therefore, we probably need to add more predictors to form a more detailed model to compare with the current one.

4.3 Research Question 2: Bechdel Test, Genre, and the International Box Office

Table 3: Distribution of Movies by Genre in the Dataset (Horizontal)

	Action	Comedy	Drama	Family	Horror	Romance	Other
Number.of.Movies.in.Dataset	483	498	442	23	100	2	46

Figure 6: Histogram of International Gross Revenue (2013 dollars, in millions)

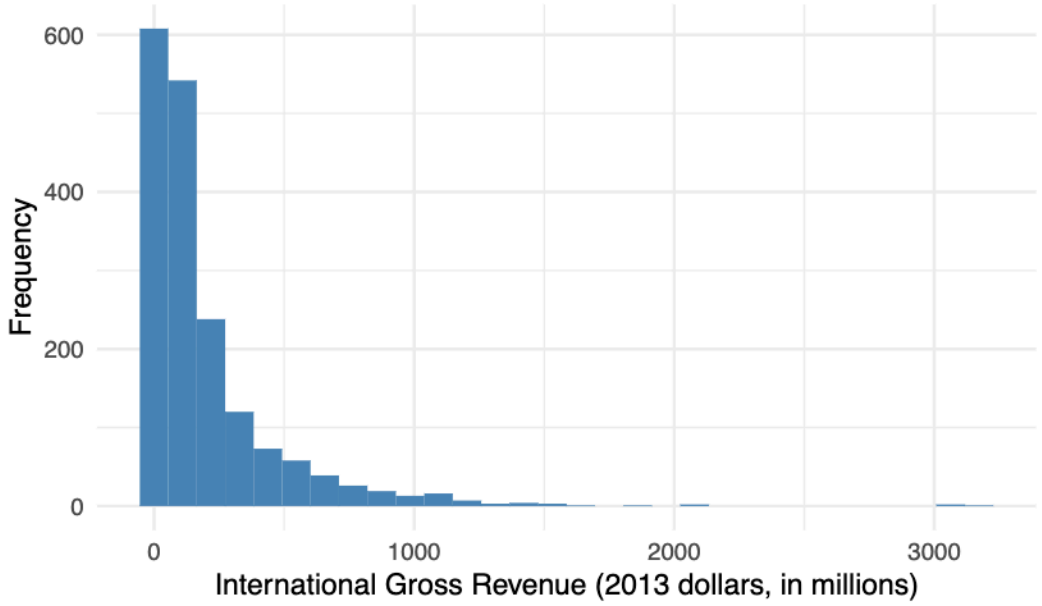
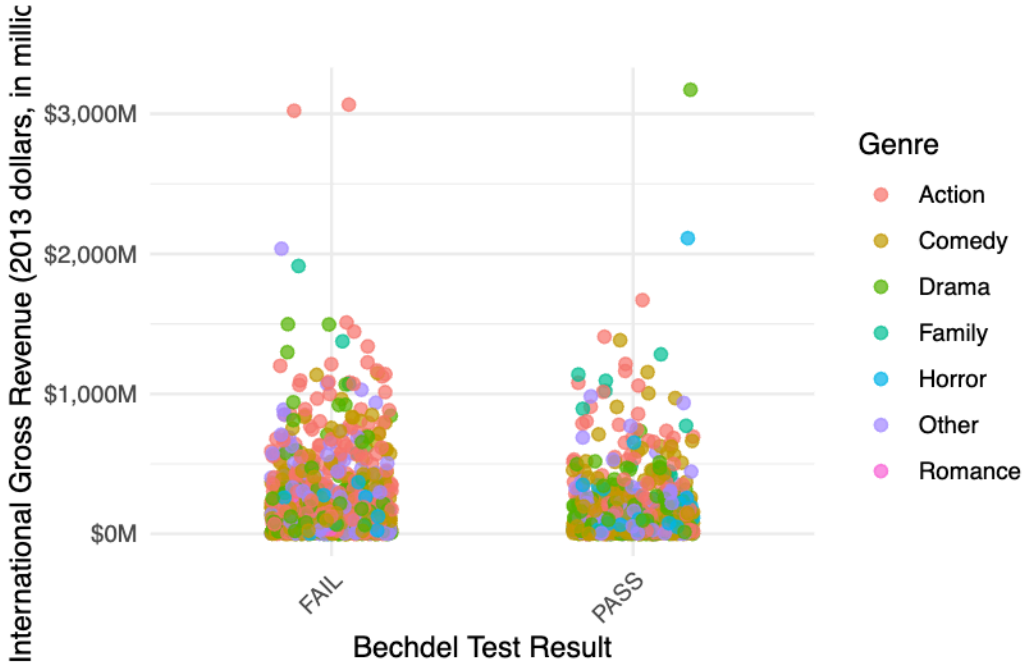


Figure 6: International Gross Revenue by Bechdel Test Result, Colored by Genre

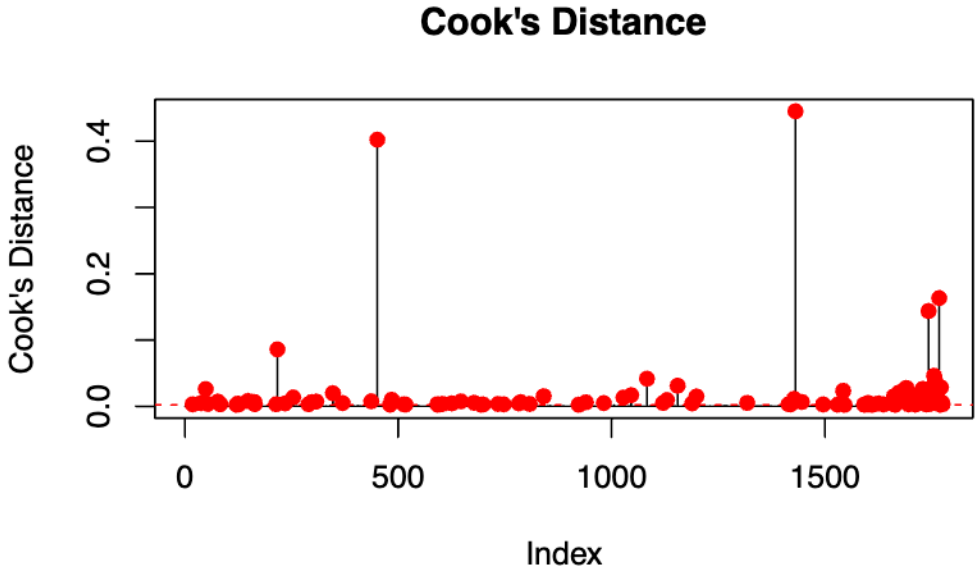


Cook's Distance was evaluated to detect any extreme values in the data. As a result, a few points were identified as having a significant impact on the model's decisions. After

refitting the model without these influential points, an improvement of approximately 3% was observed in the adjusted R-squared metric. Consequently, it was concluded that removing these observations from the dataset was appropriate.

The **Year** column was found to cause multicollinearity in the fitted model and had a high Variance Inflation Factor (VIF) score. Upon careful investigation of the data, it was discovered that the **Decade** code conveys the same information as the **Year** column but provides a more generalized approach. Therefore, the removal of the **Year** column was decided to improve model performance and reduce multicollinearity.

Figure 7: Cook's Distance



5. Conclusion

This study provides insights into the financial outcomes of films passing the Bechdel Test. Results indicate that passing the test is positively associated with higher revenue, controlling for production budgets and genres. Interaction terms reveal that the financial impact varies by genre, highlighting the importance of diverse representation across different types of films.

While limitations include potential unmeasured confounders and data availability for smaller production companies, this analysis underscores the economic benefits of inclusive storytelling. Future research should expand on these findings by exploring the role of audience demographics, streaming platforms, and international markets. This study contributes to a growing body of

evidence supporting the integration of diversity and inclusivity as both ethical and profitable strategies in the film industry.

6. References

1. Bechdel, A. (1985). Dykes to Watch Out For. *First published as a comic strip in The Essential Dykes to Watch Out For.*
2. Motion Picture Association. (2023). *THEME Report: A Comprehensive Analysis of the Global Film Industry.*
3. Smith, S. L., Choueiti, M., & Pieper, K. (2022). *Inequality in 1,300 Popular Films: Examining Gender, Race, & Ethnicity.* USC Annenberg Inclusion Initiative.
4. Lauzen, M. M. (2021). *The Celluloid Ceiling: Behind-the-Scenes Employment of Women on the Top 250 Films of 2020.* Center for the Study of Women in Television & Film, San Diego State University.