"Behind the Scenes:" An Empirical Investigation of Broadway Show Success Factors

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Abstract

This paper analyzes the impact of financial and objective factors on Broadway show success. The analysis differs from previous literature through its exclusive focus on Broadway productions that open between June and February, so defined as the "Pre-Season," as well as its attempts to establish causality through an instrumental variable regression. Two other methods of analysis are also used in accordance with past research: an ordinary least squares regression and relative risks hazard model. The results demonstrate the significant impact of first week attendance on long-term show success and reiterate the essential function of the Tony Awards in Broadway survival. This paper also introduces the positive impact of ticket pricing on show survival. Discussion on the implications surrounding the difficulty of obtaining show-specific budget data concludes the paper, arguing that this should be an area of future focus and collaboration between researchers and Broadway producers.

JEL Classifications: C26, C41, L82

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1. Introduction

Widely discussed through the lens of sociology and popular culture, Broadway's economic contributions often go understated and unsung. On a per unit basis alone, Broadway's financial profile demonstrates its position as a key component of American culture. Forty-one Broadway theaters – so-defined based on geography and seating capacity – grossed over $1.8 billion during the 2018-19 season, with total attendance surpassing 14.5 million.[1] And while Broadway's experiential good competitors – areas like the film and professional sports industries – accrue a significantly larger gross-revenue figure, the per-capita economics dramatically differs. For example, according to Statista, over 5,750 movie theaters exist in the United States, roughly 140 times the number of Broadway theaters (Theater Owners, 2019). Extending beyond industry-specific impacts, Broadway contributes handsomely to the overall New York City economy – with gains estimated to be at least $14.7 billion during the 2018-19 season in addition to supporting nearly 100,000 jobs.[2]

Despite the cultural and economic influence, the academic literature investigating Broadway – specifically from a financial perspective – remains sparse. Most of the literature that does exist, however, asks an interesting question – and one that this paper set out to build on: *"What makes a show successful?"*. Broadway shows – like corporations and movies – are labor-intensive endeavors with a perhaps surprisingly high-risk, high-reward profile for investors. Since 1960, approximately twenty-five percent of Broadway shows have turned a profit, or, "recouped," in theater parlance (Gates, 2013). Why then, is there effectively an endless queue of projects waiting to hit the stage, other than the very limited supply of possible venues? Like today's

[1] See https://www.broadwayleague.com/research/statistics-broadway-nyc/
[2] See https://www.broadwayleague.com/research/statistics-broadway-nyc/

technology startups, there are certain Broadway "unicorns." *Hamilton*, for example, has grossed over $600 million since its opening in 2015 on a reported budget of $12.5 million, recouping in less than a year. Though *Hamilton* may potentially be a once-in-a-generation production – akin to the likes of Facebook in the tech analogy – this paper seeks to illuminate some of its, and other productions', financial and objective characteristics responsible for either long-standing success or rapid, expensive failure. In order to provide Broadway producers and general managers with actionable takeaways from the available and collected data, this paper utilizes a three-pronged analysis with a variety of statistical methodologies, including an ordinary least squares regression, an instrumental variable analysis, and a relative risks hazard model on publicly-disclosed financial data as well as various objective production characteristics.

1.2 *Background & Data Disclaimer*

Prior to the analysis, it is first necessary to speak very briefly on attempts to ascertain the budget data for all of the shows in this dataset – referred to throughout the rest of the paper as "internal financials" – before going into the actual analyses done, as this process comprised a significant portion of the time spent collecting this study's data and should therefore help guide future researchers.

Even the earliest studies on Broadway discussed the importance of this data. Simonoff and Ma conclude their seminal paper – published nearly two decades ago and discussed in Section 2 – with: "Obtaining and using expenditure and budget information (such as salaries and advertising costs) could help explain not only longevity and revenue, but (perhaps) even more interestingly, profit or return on investment" (Simonoff and Ma, 2003, p. 149).

The record-keeping and reporting for Broadway financials vastly differs from public equities, though both file in accordance with Securities and Exchange Commission (SEC) mandates. "Offering Documents" are filed with the New York State Attorney General (NYSAG) and include items like the budget and a "recoupment schedule," which provides a path to profit given an attendance-based sensitivity analysis. The balance sheet and reported financial statements are also filed with the SEC and the NYSAG and can be accessed via Freedom of Information Law (FOIL) requests. Despite public accessibility, producers and general managers remain highly protective of these documents, making empirical analysis with a substantial sample size difficult. Future researchers interested in the financial determinants of Broadway show success should request for these "Offering Documents" through the NYSAG, though, since most of the files are stored offline, the wait times may pose a significant barrier (two years in the case of this study). Appendix C illustrates a sample budget obtained.

1.3 *Methodology and Paper Structure*

Given the difficulty of obtaining a sufficient sample size of private financial data, this paper applies three distinct analyses to build on results from the existing literature (see Section 2). Section 3 details the tremendous challenge of collecting large volumes of Broadway data before providing an overview of the datasets and variables utilized in the analyses. Section 4 presents results from an ordinary least squares regression with aggregate financial data and objective show-specific features as covariates. The dependent variable used is revenue per month.[3] Section 5 employs an instrumental variables regression that tracks the relationship between weather, first week attendance, a musical dummy, and monthly revenues. Last, in Section 6, this paper makes use of a survival analysis and builds on the work of previous authors by introducing time-varying, Tony award-specific characteristics into the model, in addition to previously unstudied financial metrics. Each method of analysis (Sections 4-6) will have a

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[3] "Grosses" and "Revenues" are used interchangeably throughout the paper.

subsection dedicated to discussing the intention behind the model, the empirical framework, the results, and a discussion of relevant findings and avenues for future work. The paper will conclude with a summary of results and recommendations for future research.

2. Literature Review

The original literature on factor-based determinants of a Broadway show's success uses three primary independent variables – critical reviews, first week attendance, and the annual Tony Awards ceremony. Reddy, Swaminathan, and Motley (1998) published the first academic paper to systematically study the determinants of success for Broadway shows, according to Simonoff and Ma (2003), who published a similar study, albeit with slightly differing results. Prior to the paper from Reddy et al., most economics literature concerned with the performing arts addressed the film industry, though there is some tangential discussion regarding Broadway and the theater – Reddy et al. provide an extensive table outlining these previous studies (Reddy et al., 1998). Reddy et al.'s dataset included two seasons' worth of shows from the early 1980s and added a random sample of forty productions from the early 1990s. They defined two dependent variables of "show success": attendance and box office receipts; they additionally looked at "show longevity" – the number of total performances (Reddy et al., 1998). Simonoff and Ma (2003) note a strong correlation between the total number of performances and gross revenues (also called "box office receipts") and treat these terms as interchangeable. Reddy et al. employed a two-equation linear regression model based on the premise that "a show's success, as represented by the total attendance (or box office receipts), is affected by the longevity of the show and that both are affected by information sources and various objective factors" (Reddy et al., 1998, p. 377). "Information sources" are independent variables such as critical reviews and the length of previews whereas "objective features" included ticket pricing, show genre, and key talent.

Results from the model indicate that newspaper critics from the *New York Times* – and, notably, *not* from the *Daily News* or *New York Post* – both predict and influence a show's success (Reddy et al., 1998). Of particular relevance for the motivations behind this paper, the authors found that marketing – quantified as total print advertisements and their square-inch sum –has a significant impact on longevity and attendance, whereas key talent – quantified through awards and total past performances – demonstrated an inconsistent impact (Reddy et al., 1998).

Simonoff and Ma (2003) published the second paper that charts an empirical analysis of the factors relating to Broadway success. Three significant differences exist between the studies. First, Simonoff and Ma used data over a three-year period and introduced shows still-running into the data sample, a relevant addition that this paper incorporates. Second, the authors introduced the Tony Awards as an independent variable. This, in turn, forced the authors to re-define longevity, since "the total number of performances of a show can be related to its opening date in a way that has nothing to do with audience approval" (Simonoff and Ma, 2003, p. 139). Put simply, a show may open earlier in the year and be forced to run longer in order to wait and see if it receives any Tony nominations. As a result, Simonoff and Ma define longevity in three ways: total performances, performances after the nominations, and performances after the award ceremony. Finally, and most significantly, the authors reject the use of a linear regression model in favor of the Cox proportional hazards model.

These changes produce slightly different findings compared with Reddy et al. – Simonoff and Ma (2003) find that critic reviews from the *Daily News*, not the *Times,* correlate with longevity. Winning a Tony Award is associated with greater success, although, interestingly, being nominated and then losing negatively impacts a show's longevity (Simonoff and Ma, 2003). The authors also find that increased early attendance is associated with greater success, a relationship that served as the foundation for some of the analysis this paper's ordinary least squares and instrumental variable analysis (Simonoff and Ma, 2003).

In a widely-cited study on the reasoning and implications for price discrimination in Broadway theater, Phillip Leslie's analysis on second-and-third degree discrimination significantly preceded the more recent shift towards dynamic pricing models (Leslie, 2004). Partial explanation for the paper's prescience stems from the vastly altered business model employed by producers in the early 2000s – a model that circulated around mail advertisements and predominately over-the-phone bookings. The rise of the internet and real-time analytics now allows producers to shift ticket prices week-by-week, as opposed to the fixed, tiered structure that limited producer pricing power in the early 2000s. Leslie finds that uniform pricing hurts profits without generating any added benefit to consumer surplus. He suggests that discounting practices of the time – often a flat rate of 50% – negatively impacted show profit and should have been lowered (Leslie, 2004).

In addition to being the Broadway literature's most-cited paper – a superlative primarily the result of the study's applications and implications on price discrimination and consumer demand more broadly – Leslie's findings impact this study by emphasizing the importance of ticket price fluctuations. While some of the variation exists as a result of tourism, Leslie's literature informed the decision to introduce variables that track average ticket prices week over week. To further add robustness, investigating a relationship with the theater's capacity emerged as useful from Leslie's findings. Intuitively, a higher average ticket price correlates with larger weekly gross box office receipts ("WGBOR"). However, Broadway's variance in capacity is significant – the Gershwin Theater can house slightly over 1,930 audience members, while the Hayes Theatre caps at just under 600 (List of Theaters, 2018). Theater size is a control is this study’s ordinary least squares model given it can be considered a random event – producers with a show waiting in the wings will likely jump at any newly available stage.

Two further studies have provided significant guidance on narrowing down this paper’s research question as well as shed valuable light on useful models and best practices. The first expands Simonoff and Ma’s (2003) findings on the importance of a Tony Award win. Boyle and Chiou (2009) compiled data from the 1996 to 2007 Broadway seasons and assessed the impact of the Tony Awards through a lens centered on information cascades – their findings are consistent with information cascade theory and meaningfully add to the existing literature.

Boyle and Chiou find that there is a statistically significant increase in a production’s market share – the study’s dependent variable, calculated as the difference in market share between a Broadway show and another leisure good – for the first three weeks after the nomination announcement. The authors also find that nominations in “Main” categories such as “Best Musical” or “Best Lead Actor” provide similar market share boosts. By contrast, nominations in “Other” categories, such as “Best Costume” or “Best Choreography”, have inconsistent and weak impacts on market share. Their analysis reiterates that an award win provides a significant boost in show success, whereas nominations without wins actually cause shows to experience a “penalty” (Boyle & Chiou 2009, p. 62).

The most recent follow-up to Simonoff and Ma (2003) proved very valuable as a result of its model structure and resulting implications on this paper’s own research design. Kulmatitskiy et al. (2015) build on previous literature by adding a secondary regression model for purposes of robustness, introduce more independent variables with market and macroeconomic focus, and, most significantly, define the “Characteristics of the Broadway Season” (see Section 3.2; Kulmatitskiy et al. 2015, p. 115). In addition to the proportional hazards model (PHR), the authors make use of a "log-linear regression model with Buckley and James estimators (BJR), specifically suited for censored data" (Kulmatitskiy et al. 2015, p. 114). Given there are multiple still-running shows on Broadway in this paper's dataset, a precedent methodology for treating those shows (i.e. for "censored data") is useful (Maddison 2004, 2005).

Kulmatitskiy et al.'s paper is the first to incorporate macroeconomic variables on an assessment of Broadway show survival rates – the authors included the unemployment rate and average consumer price index as primary indicators. Interestingly, these variables demonstrated statistically significant coefficients only in the months following the Tony Awards, providing initial evidence for the theory that show-specific attributes eventually give way to word-of-mouth success and general macroeconomic trends as determinants of longevity.

3. Data Collection

Data collection, particularly without a computer programming background, proved immensely time-and-labor intensive. While sufficient public data on Broadway productions exists, the sources that provide the data differ on the metrics they report as well as the ease with which these data can be accessed. For example, broadwayworld.com provides comprehensive Microsoft Excel files available for download with weekly financial data – gross revenues, average ticket prices, and so on. The website, however, lacks data for many productions. IBDB.com and Playbill.com, two alternate websites, provide data for nearly all shows, but without downloadable spreadsheets. Though valuable to have publicly accessible databases, a lack of meaningfully aggregated show information, coupled with an inability to write a web-scraping programs, resulted in the following inefficient, time-consuming process: an addition of or a change to one of the variables collected required manually repeating hundreds of web searches on a show-by-show basis.

Despite these challenges, this study compiled three distinct datasets. Discussion on the first follows below (3.3 “Show Data”). The second and third involve weather data and an expansion of the “Show Data” and are discussed in Section 5 due to their specific relevance for the instrumental variable analysis. Prior to any of these remarks, however, it is first necessary to expand upon and make clear this study’s defining feature: analysis of Broadway productions that only open during the “Pre-Season” period.

3.2 *The Tony’s and the Broadway Season – Implications for Study Design and Data Collection*

The Tony Awards are unique in their influence on Broadway, specifically when compared to other entertainment award ceremonies. While the Oscars, for example, have a demonstrated impact on movie success in a similar fashion as the Tony’s, the impact of a Tony award extends far longer than an Oscar win. Tony award winners can see statistically significant benefits 52 weeks beyond the awards ceremony, an impossibility in the movie industry due to vastly different supply and demand economics (Deuchert et al., 2005; Boyle and Chiou, 2009). Given this demonstrated value and the long-term implications, a model assessing the success of a Broadway production should take into consideration the timing of the Tony’s. Kulmatitsky et al. (2015) do so by deconstructing Broadway show openings into four segments: Pre-Season (June to February), Pre-Nominations (March to May), Pre-Awards (May to June), and Post-Awards.[4]

This paper's dataset includes shows exclusively from the Pre-Season period, meaning every show’s opening date must lie between June 1st and February 29th. To elaborate on the reasons behind this decision, it is first necessary to discuss why the Pre-Nominations and Pre-Awards segments are *not* of interest. First, it is reasonable to assume that shows opening during the Pre-Nominations period rely almost exclusively on success at the Tony’s to generate

[4] Tony nominations are typically released during the first week of May and awards, the first week of June.

momentum, given the proximity of the Pre-Nominations period to the nomination announcement date and awards ceremony. It is also reasonable to assume that opening with closer proximity to the nominations and awards influences a producer's decision-making on expenses like advertising as well as her willingness to tolerate initial losses.[5] Kulmatitskiy et al. agree: "We may presume that a new show opening in this period aims at being open at the announcement of nominations regardless of the show's inherent attributes" (Kulmatitskiy et al., 2015, p. 116). Since the eligibility cutoff for a given year's Tony's generally occurs about a week prior to the nomination announcements, very few productions open during the Pre-Awards period of May to June, making it of less interest for empirical study. What remains, then, is the Pre-Season period, which is of particular interest given the heightened importance of inherent show attributes and the gravity of the momentum that may be generated – or lost – by success in producer decision-making.

The fourth segment is the Post-Awards period. Post-Awards includes all shows from the Pre-Season, Pre-Nominations, and Pre-Awards periods that survive past the awards ceremony. Prevailing literature suggests, as mentioned, that success of a show Post-Awards revolves around winning a "Main" category award and simultaneously operating in a favorable macroeconomic environment (Boyle & Chiou, 2009; Kulmatitskiy et al., 2015). This study analyzes Post-Award success for the *Pre-Season* period through its model construction in the survival analysis (see Section 6).

3.3 *Show Data*

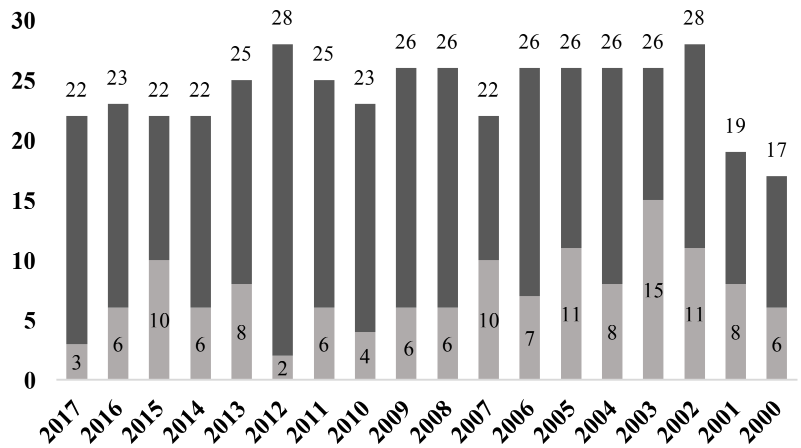
The initial step in the Show Data collection process was to determine the universe of Broadway productions that met the Pre-Season criteria outlined above using the time period from

[5] Losses in this context are the difference between weekly revenues and operating expenses.

2000 to 2017. This time period was selected for two simple reasons. First, to avoid an unnecessary increase in the number of shows still-running within the dataset, thereby increasing censored observations and, second, to obtain a large enough dataset for statistically significant analysis given between thirty and forty-five new productions open in a calendar year.[6] IBDB.com was used to tally all of the shows that opened between June and February from 2000 to 2017, generating an initial screen of 432 productions. These 432 observations were next screened based on their status as an "Open Run" or a "Limited Engagement," defined as a production with no contractual end-date or a contractual end-date, respectively.[7] "Limited Engagements" were removed in line with Kulmatitskiy et al. (2015) – previous literature, including Simonoff and Ma (2003) and Reddy et al. (1998), do not make this important distinction. Limited Engagements often consist of one of the following: a specialty concert *(Springsteen on Broadway)*, a Shakespeare production *(The Merchant of Venice)*, or a play with an "A-list" actor *(The Elephant Man,* starring Bradley Cooper). That filtering process left 133 remaining productions for this paper's analysis, only three of which are still on Broadway today (*Hamilton, Wicked,* and *Dear Evan Hansen)*. Figure 1(a) illustrates how the filtering process impacted the distribution of shows by opening year within the dataset. For example, only two shows from 2012 met the criteria specified, whereas 15 productions from 2003 are evaluated. Figure 1(b) highlights the monthly distribution of shows within this dataset's Pre-Season segment. As is quite clear, the vast majority of openings occur in the winter months prior to the New Year, a trend like explained by Broadway's significant tourist population.[8] Kulmatitskiy

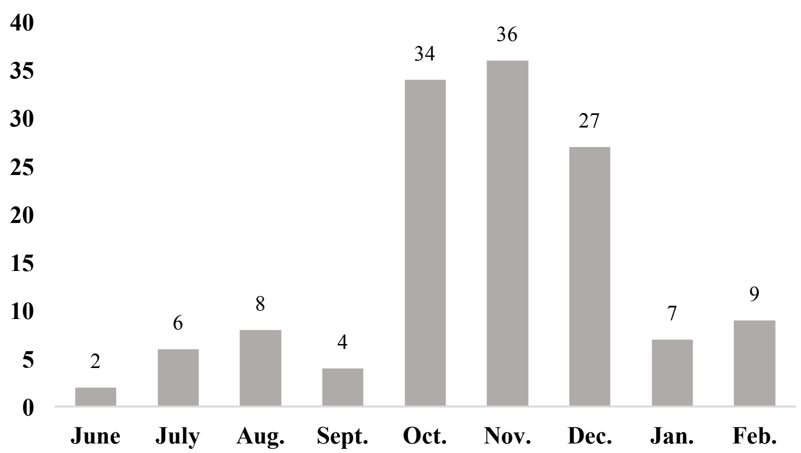
[6] See https://www.broadwayleague.com/research/statistics-broadway-nyc/
[7] "Limited Engagement" end-dates can be extended in the case of unexpectedly high demand.
[8] Tourists comprise 65% of audiences. See: https://www.broadwayleague.com/research/statistics-broadway-nyc/

Figure 1(a): Show Distribution by Year



Note: Floating values total all new productions in a given year's "Pre-Season." Light gray shading indicates the "Open Runs" chosen for analysis.

Figure 1(b): Show Distribution by Month



et al. (2015) obtained 222 observations from October 2000 to April 2009 across the Pre-Season, Pre-Nominations, and Pre-Awards segments, giving confidence that this study's total of 133 is reasonable given both Pre-Season and Open Run constraints.

Using broadwayworld.com, IBDB.com, and playbill.com, all of the publicly available financial data for these shows on a weekly and aggregate basis was collected, including: gross revenues (in 2017 dollars), performances, attendance, grosses vs. last week, weekly potential gross, actual gross as a % of potential gross (*Avg. Gross %*), weekly average ticket (in 2017 dollars), seats sold, total potential seats sold, actual seats sold as a % of potential total seats (*Avg. Capacity %*), and the differences week-to-week of each, if applicable. In addition to these financial metrics, certain objective variables were chosen to assess their potential impact on long-term show success. These include: preview, opening, and closing dates, number of previews, theater performed in, musical dummy, revival dummy, number of Tony nominations, number of Tony awards, days to nomination, and first week attendance measured as both a percentage of total capacity and an integer. Summary statistics are presented in Table 1. While both total gross and gross per

Table 1
Summary statistics (n = 133)

Variables	(1) Mean	(2) Median	(3) S.D.	(4) Min	(5) Max
Total Gross ($)	$5.67e+07	$1.18e+07	$1.63e+08	$301,085	$1.46e+09
Gross per Month ($)	$2.32e+06	$1.92e+06	$1.54e+06	$382,977	$1.14e+07
Total Performances	509.2	192	932.8	20	6729
Avg. Gross of Potential (%)	52.6%	49.8%	19.9%	14.8%	112.1%
Avg. Ticket ($)	$79.42	$76.32	$24.92	$34.47	$245.15
Avg. Capacity (%)	70.3%	72.2%	15.4%	25.1%	101.2%
First Week Capacity (%)	80.4%	85.6%	17.2%	33.0%	101.5%
Days to Nomination	181.9	179	52.7	68	322
No. of Previews	28.2	28	16.9	4	182
Tony Nominations	3.3	2	3.7	0	16
Tony Awards	0.9	0	2.1	0	11

All "avg." variables are measured based on weekly data collected for each production and are thus averages of averages. 133 productions sorted into 87 musicals, 46 plays / other. All grosses and ticket prices reported in 2017 dollars.
Note: Censored data (n = 3; e.g. – *Hamilton*) assumed to close on Nov. 17, 2019 in this Table.

month are reported, the latter will be used as the primary dependent variable in the OLS and instrumental variables analyses. Total gross statistics in Table 2 highlight the significant impact outliers – *Hamilton, Wicked, Mamma Mia!,* to name a few – have on the dataset; using gross per month helps control for that, as well as seasonal, variation. First week capacity has been shown to have a positive relationship with total performances in previous literature (Simonoff and Ma, 2003; Kulmatitskiy et al, 2015). Reddy et al. (1998) use ticket prices in their regression analysis, but later papers have surprisingly omitted this variable – gross per month and average ticket prices have a correlation coefficient of 0.88. Days to nomination is a new variable hypothesized to have a negative relationship with long-term revenues, with the basis of that hypothesis grounded in the large gap between any momentum generated from favorable reviews and the Tony awards.

4. OLS ANALYSIS

Linear regression analyses have produced meaningful results across the theater and film industries (Reddy et al., 1998; Brewer et al., 2009). Section 4 simply seeks to explore any potential relationships between the variables introduced in Table 1 and the dependent variable of grosses per month in order to motivate future analysis. Of course, Broadway productions involve myriad inputs and, without internal financials, any regression analysis will suffer from unavoidable omitted variable bias. Nevertheless, the metrics introduced here and any relationships found should add value to the industry. After all, once the curtains have opened, the statistics monitored day-to-day and week-to-week are not the fixed costs – actors, costumes, and so on – but the ability to maximize price and quantity; in this case, audience members and ticket prices.

4.2 *Empirical Framework*

As shown in Equation (1), a simple linear regression is utilized, where Y is the gross revenue per month in 2017 dollars earned by show *"j"*. This regression includes multiple show-specific covariates, each of which is explained in greater detail beneath Table 2. In addition to the analyzing the absolute dollar changes in gross revenue per month, a regression with $ln(Y_{ij})$ as the dependent variable is reported to evaluate elasticity. Results for log regressions are also included in Table 2. Given this study's exclusive focus on Pre-Season shows, this model was

$$Y_{ij} = \beta_0 + \beta_1(x_{1j}) + \ldots + \beta_i(x_{ij}) + \varepsilon$$
$$ln(Y_{ij}) = \beta_0 + \beta_1(ln(x_{1j})) + \ldots + \beta_i(ln(x_{ij})) + \varepsilon \quad (1)$$

constructed to highlight potential differentiating characteristics between shows that survived past the Tony nomination announcement date and those that closed before. Table 2 reveals a nearly even split in the dataset on this criterion. In establishing this framework, it became essential for this model to exclude the impact of the Tony awards on grosses per month. Inclusion would result in *ex ante* estimates that would add little value when assessing the variable's impact on monthly revenues considering there are over 60 productions that had closed and were unable to reap the benefits of winning awards and receiving nominations.[9]

4.3 *Results*

Table 2 demonstrates a host of valuable findings and provides several opportunities for future research. As was briefly mentioned, the use of an OLS analysis was purely exploratory. From this exploration emerges a number of relationships worth further evaluation, some of which will be carried out in Sections 5 and 6 of this paper. Gross per month and *ln*(Gross per month) are the only dependent variables under consideration. Many metrics for Broadway "success" exist – number of performances remains the next obvious choice given it tracks duration. However, total grosses and total performances remain highly correlated, as expected, so this OLS model opts to only look at grosses as a measure for success. Using 2017 inflation-adjusted dollars and gross per month in lieu of total grosses further aids in controlling for the tremendous year-over-year rise in revenues seen across the seventeen-year period within this dataset.[10] . Column (1) presents the results for all of the independent variables mentioned. Column (1)'s results reveal surprising findings – the only positive relationship with gross revenues per month is with the average weekly ticket price and average weekly capacity

[9] Shows may be nominated for and win Tony's even if they have closed.
[10] Industry revenues rose from $666 million during the 2000-01 season to $1.45 billion in 2016-17, a nearly 5% compound annual growth rate. See https://www.broadwayleague.com/research/statistics-broadway-nyc/

Table 2
Ordinary Least Squares Regression Results

Variables	Gross Per Month				*ln(*Gross per Month*)*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	Drop	Closed at Nom	Open at Nom	Drop	Closed at Nom	Open at Nom
Avg. Gross (%)	-1.0e+06***	4.3e+06***	3.2e+06***	4.9e+06***	0.83***	0.84***	0.84***
	(334,416)	(394,237)	(326,184)	(659,882)	(0.05)	(0.07)	(0.08)
Musical	-148,454**	332,575**	233,138***	488,886*	0.20***	0.17***	0.25***
	(62,798)	(133,965)	(69,009)	(272,623)	(0.03)	(0.04)	(0.05)
Revival	-110,781*	-240,881*	65,319	-257,261	-0.02	0.03	-0.05
	(58,314)	(142,305)	(92,143)	(245,616)	(0.03)	(0.05)	(0.05)
First Week Attn.	-51.9**	138.1***	119.8***	185.4**	0.42***	0.42***	0.45***
	(23.5)	(41.1)	(25.4)	(76.5)	(0.06)	(0.08)	(0.10)
Avg. Ticket	41,376***						
	(1,799)						
Avg. Capacity	500.0***						
	(44.7)						
Avg. Capacity (%)	-828,104**						
	(404,467)						
First Wk Attn. (%)	-161,010						
	(155,844)						
Days to Nom.	727.7						
	(451.0)						
Previews	-1,140						
	(1,567)						
Theater Size	-329.6*	1,084***	795.4***	882.5	0.535***	0.456***	0.518***
	(197.5)	(301.3)	(164.6)	(589.8)	(0.0734)	(0.101)	(0.114)
Observations	133	133	65	68	133	65	68
R-squared	0.973	0.821	0.907	0.784	0.940	0.934	0.923

All independent variables in (5) through (7) – excluding dummy variables – were regressed after a log-natural transformation, as was performed to the dependent variable. Columns (3) and (6) measure shows that closed before their respective Tony nomination date, while (4) and (7) measure shows open past that cutoff. Avg. Gross (%) is the average of the average weekly gross percentage of revenue earned by a show. Avg. Ticket is the average of the weekly average ticket price. Avg. Capacity is the average of weekly seats sold, whereas Avg. Capacity (%) measures the average of the average weekly seats sold as a percentage of total capacity. Musical is a dummy variable. Revival is a dummy variable. Days to Nomination is the number of days between the Tony nomination announcements and the show's opening date. Theater Size controls for capacity variances. Standard errors reported in parentheses.
Note: ***p-value <0.01; **p-value <0.05; *p-value <0.1.

measures. These findings diverge from previous literature that has shown positive and statistically significant relationships for *musical* and early attendance measures, though only Reddy et. al performed linear regression analyses (Reddy et al., 1998; Simonoff and Ma, 2003). What Column (1) reveals, then, is that the only positive impact on monthly revenues is an increase in both the average ticket price and the number of audience members. Economic interpretations from the average ticket coefficient are particularly striking – a $1 increase in the price of a ticket leads to over $40,000 in added monthly revenue. This interpretation remains quite flawed, however, since Broadway theaters operate on either a tiered or dynamic pricing system, so the use of a simple average may not accurately capture the impact of ticket price fluctuations. In addition, the correlation between *Avg. Ticket* and *Gross per Month* is quite high ($\rho = 0.883$), which suggests future models should use either performances or attendance when incorporating ticket prices as a covariate.[11]

Given the results of previous literature, the strongly negative coefficients from Column (1) for the vast majority of covariates cast doubt on the robustness and value of these results. To account for this and to explore other relationships within the data, ticket prices and capacity measures – along with statistically insignificant regressors – were dropped in Columns (2) through (7). The results and interpretations from these six regressions more closely mirror the literature – musicals gross more than plays, revivals generally gross less, and early attendance seems to matter. The use of a gross percentage covariate in a linear regression remains novel to the literature, and the results are economically profound. Interpreting, for example, from Column (5), a 1% increase in a show's average gross percentage leads to an 83 basis-point rise in monthly revenues.[12]

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[11] However, total grosses and average ticket have a significant lower correlation coefficient ($\rho = 0.508$).
[12] All independent variables in Columns (5) through (7) were log-transformed – see below Table 2.

The relative similarities between Columns (3) through (7) indicate that other explanatory factors drive the decision to close prior to the Tony nomination announcements. The larger magnitudes comparatively seen in Column (4) and (7) likely result from the *Open at Nom* sample's greater success on Broadway, both in terms of revenues and duration.[13]

Results from this initial exploration are clear: Broadway show factors that influence revenue include *Avg. Gross (%), Musical*, and *First Week Attendance*. However, the remain a handful of issues with *Avg. Gross (%)* that need further attention in future studies. This paper uses the average of all of the weekly gross percentage averages; as such, given this weekly reporting, it may be more appropriate to employ this variable in a longitudinal study. Survival analyses also appear useful for a metric like *Avg. Gross (%)* (see Section 6).

Table 3
Condensed OLS Regression Results

Variables	(1) Gross per Month	(2) *ln*(Gross per Month)
Musical	418,320**	0.21***
	(188,088)	(0.05)
First Week Attendance	417.2***	1.10***
	(44.5)	(0.07)
Theater Size	-63.6	0.12
	(398.7)	(0.12)
Observations	133	133
R-squared	0.641	0.813

The independent and control variables, excluding *musical*, were log-transformed for Column (2) to match *ln(*Gross per Month). Standard Errors reported in parentheses.
Note: ***p-value <0.01; **p-value <0.05; *p-value <0.1.

[13] Median performance totals for Open at Nom and Closed at Nom, respectively, are 491.5 and 117.

Distilling the original covariate list, then, leaves two final regressors of primary interest: *musical* and *first week attendance.* Table 3 illustrates the results of a linear regression performed on these final variables, revealing coefficients of even greater magnitude than found in Columns (2) and (5) of Table 2. Musicals gross over $400,000 per month more than plays; these productions often involve higher operating expenses and capitalization expenses, however, so without internal financials, it remains difficult to say whether musicals represent a better investment. And, although valuable to corroborate the findings of past literature for this dummy, this relationship retains a relatively low-impact real-world application. After all, the choice to produce a musical is effectively binary. Far from binary, however, are the options with respect to generating a high first week's attendance. Many factors – costs of advertising, word-of-mouth, critical reviews, and the talent profile, to name several – may correlate with better early attendance. Establishing this statistically and economically significant relationship, whereby a 1% increase in the first week's audience leads to a 1.1% increase in monthly gross revenues (~$25,000), adds meaningful weight to producers' capital allocation decisions regarding these potential confounding factors, as well as for future research to identify, if possible, which of these factors aids most in generating a larger initial audience.[14]

4.4 *Discussion of Results*

An exploration into financial and objective factors of Broadway shows yielded two relationships of particular consequence and provided numerous foundational observations for future research. Table 2 demonstrated the essential function of time-varying financial characteristics like ticket prices and both attendance and grosses as a percentage of potential. Future studies may consider use of a panel analysis the superior methodology that better captures

[14] Dollar increase calculated based on the data's average of grosses per month in Table 1.

the impact of such variables. Much of the data collected in this study even beyond ticket prices varies week-to-week and could therefore be modeled in a panel regression, which would alleviate the need to take the average of weekly averages as done here. Further, a host of new variables could be explored. An input that measures the magnitude of week-to-week changes between these variables may prove valuable to any longitudinal study. Although Reddy et al. (1998) find an inconclusive relationship with their talent variable and long-term success, there may be ways to expand on the authors' definition. In a similar vein, research on the movie industry has identified the impact of an established audience variable on total grosses, a variable becoming increasingly relevant to Broadway with the recent rise in blockbuster movie adaptations (*Harry Potter, King Kong, Mean Girls*; Brewer et al., 2009). With the proliferation of discount ticket booths – popularized by the company TKTS, whose booth sits front-and-center in Times Square – future research may look to expand on Leslie's (2004) analysis of price discrimination and/or evaluate the supply and demand economics underlying a producer's decision to send a block of tickets to these discount booths, given that this study highlights the importance of maximizing potential revenue. It is worth repeating that all of the shows studied here represent a specific segment of the Broadway season, leading naturally to the potential for comparative future work.

5. Instrumental Variable Analysis

Section 4, specifically Table 3, signals the sizable impact of both show type and early attendance on Broadway revenues. Despite the strong statistically significant relationship, there is reason to be suspicious of these results, with particularly worry surrounding omitted variable bias ("OVB"). As mentioned, a number of other factors exist that may impact a production's first week attendance – advertising costs, word-of-mouth, critical reviews, and the talent profile. It is also reasonable to assume that these factors, based on both previous literature and general intuition, positively correlate with a show's monthly and overall revenue. If these reasonable assumptions hold, then there exist legitimate overestimation concerns for the first week attendance coefficient in Table 3. Treatment for omitted variable bias includes randomization or the introduction of exogenous variation (Angrist and Krueger, 2001). Randomized experiments with Broadway productions obviously lack feasibility, introducing the need for an instrument – that is, an exogenous factor uncorrelated with the outcome variable, gross revenues, beyond its effects on the endogenous regressor, first week attendance (Angrist and Krueger, 2001). Doing so introduces a second novelty to this paper beyond its exclusive focus on the "Pre-Season": attempting to establish empirical causality between a Broadway show factor and long-term success.

Instrumental variable regressions ("IVR"), specifically a two-stage least squares model ("2SLS"), represent the most common statistical technique for implementing this exogenous instrument (Stock, 2001). In order to account for the endogeneity concerns resulting from OVB and to expand on the relationship found in Section 4 between early attendance and long-term Broadway success, this study utilizes an IVR with same dependent variables as before: average grosses per month, in addition to the two independent variables from Table 3.

5.2 *Instrumental Variable Data*

Before discussing the framework and results from this analysis it is first necessary to note a slight change in the dataset used. Section 3 described how an initial screen of productions with opening dates between June and February in the years 2000 to 2017 yielded 432 observations. That total was then slimmed to 133 productions designated an "Open Run," as opposed to a "Limited Engagement," since the latter possesses a contractual end date and generally includes difficult confounding factors to control for, such as the presence of a globally renowned actor in the cast or artistically experimental changes to a revival.[15] When focusing on the relationship between first week attendance, show type, and gross revenue per month using an exogenous factor, however, the need to distinguish between an "Open Run" and "Limited Engagement" subsides. "Limited Engagements" are thus included within this sample, provided the production runs for at least seven performances, increasing the number of observations from 133 to 351. All remaining data is otherwise unchanged – grosses per month are reported in 2017 dollars and the musical variable is a dummy for show type.

Discussion on the data collection for the instrument follows immediately below, where the instrument itself is introduced.

5.3 *Empirical Framework*

Under the assumption that there are endogeneity concerns resulting from OVB between first week attendance and revenue per month, the first stage in the 2SLS analysis requires the introduction of an exogenous factor, "Z_i,". This study used weather as its lone instrument, hypothesizing that adverse forecasts in the form of precipitation or unseasonal temperatures for a given week would deter would-be theatergoers. Given that the median show in the dataset runs for 101 days, it is reasonable to assume that weather does not correlate with the outcome variable, an assumption substantiated by previous literature (Boneysteele et. al, 2016). In the first-stage regression show below ("Equation 2"), first week attendance, measured as the aggregate number of seats sold, is given by X_i. Three weather metrics are used: the weekly sum of precipitation (*prcpsum*), the number of days with precipitation (*prcpdays*), and the weekly

(2)

[15] See reviews on the latest rendition of *West Side Story,* which required nearly 80 previews before officially opening: https://www.wsj.com/articles/worst-side-story-11582246801

average of the daily average temperature (*tavgavg*). All weather data was taken from the National Oceanic and Atmospheric Administration ("NOAA") database for the "NY City Central Park" station. Summary statistics for these data can be found in Table 4. The vector of controls includes measures to account for annual fluctuations within the data (*year* and *year3*). Log transformations were performed, as before, to demonstrate elasticity.

$$X_i = \beta_0 + \pi_1 Z_1 + \pi_2 Z_2 + \pi_3 Z_3 + v_i$$

$$\ln(X_i) = \beta_0 + \pi_1 \ln(Z_1) + \pi_2 \ln(Z_2) + \pi_3 (Z_3) + v_i$$

The second-stage regression uses the same dependent variables as Section 4: average grosses per month. Using monthly average metrics controls for seasonal and other non-obvious factors not accounted for in the total gross revenue figures. Equation 3 illustrates the second-stage, with Y_i as revenue per month and *X-hat* the results from the first-stage regression.

$$Y_i = \beta_0 + \beta_1 \widehat{X_i} + u_i$$

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(\widehat{X_i}) + u_i \tag{3}$$

Table 4
Summary statistics (n = 351)

Variables	(1) Mean	(2) Median	(3) S.D.	(4) Min	(5) Max
First Week Attendance	6,088	5,580	2,376	1,364	15,452
Precipitation Sum	0.89	0.65	0.97	0	8.75
Average Temperature	51.09	50.00	13.77	21.14	86.86
Revenue per Month	$2.13e+06	$1.71e+06	$1.38e+06	$319,267	$1.15e+07

Attendance measured as seats sold during the first full week of performances after the opening date – shows that opened midweek are counted based on attendance figures beginning the following Monday. Precipitation measured in inches of water, or, per the NOAA, total liquid content. Temperature measured in Fahrenheit. Revenue per Month calculated as total revenue (in 2017 dollars) divided by total months, with total months calculated as total days divided by 30.4167, the weighted number of days per month.
Note: Censored data (n = 3; e.g. – *Hamilton*) assumed to close Nov. 17, 2019.

5.4 *Results*

Results from the first-stage regression are depicted in Table 5, demonstrating mixed findings, both statistically and economically. As was hypothesized, precipitation appears to have an impact on theater attendance – one added inch of precipitation corresponds to approximately 340 fewer audience members for a Broadway show during its first week. Statistically significant both with and without the control for opening year, the results for *prcpsum* also highlight clear economic indications. As mentioned, theater capacity varies tremendously – from approximately 600 seats to nearly 2,000. In dollar terms,

Table 5
First Stage Regression Results

Variables	1st Week Attn.	1st Week Attn.	*ln*(1stWeek Attn.)	*ln*(1st Week Attn.)
	(1)	(2)	(3)	(4)
Prcp. Sum	-341.79**	-331.86**	-.053***	-.053***
	(164.77)	(164.71)	(.019)	(.019)
Prcp. Days	196.27*	212.20*	.144***	.158***
	(122.24)	(122.49)	(.058)	(.057)
Average Temp.	5.68	5.05	0.058	.057
	(9.21)	(9.21)	(.078)	(.078)
year		6.61		.004
year^3		0.12		.000

Coefficients reported in parentheses are negative. Standard Errors are reported below in parentheses, excluding for the control variables. Year is a categorical variable: $\{i = n - 2000; n = 2000, ..., 2017\}$.
Note: ***p-value <0.01; **p-value <0.05; *p-value <0.1.

340 fewer audience members would result in over $41,400 of lost revenue, which could amount to 5-10% of weekly operating expenses.[16]

[16] Assumes ticket cost of $122, the average price for a musical in 2019. See the Broadway League Statistics page.

The coefficients for *prcpdays* are perhaps surprising given the results from *prcpsum*. According to the model, for each added day of precipitation, Broadway theaters see an increase of approximately 200 audience members for that given week. Intuitively, these results appear to directly contradict the findings for *prcpsum*, which shows the opposite impact on attendance.[17] A potential explanation for this discrepancy could be that precipitation causes consumers to substitute away from an outdoor experience towards an indoor one, be it the movies, the theater, or staying at home. The *volume* of rain, however, may change behavior, as attending a Broadway shows requires transportation to-and-from the home in addition to waiting in line *outside* for the production to begin, an important contrast to the primarily all-indoor experience at the movie theater. It is also worth noting that the sum-of-the-parts for this regression is more valuable than its regressors as individuals – both *prcpdays* and *prcpsum* are very statistically insignificant when regressed as the lone precipitation covariate.[18] One issue with these data and results is that it remains unclear whether audience members purchased tickets in advance. Individuals with a pre-purchased ticket may be more inclined to attend a production regardless of the weather, making day-of buyer behavior of heightened interest. Should show advance data – the number of seats pre-sold prior to a given week – become publicly available, future research could incorporate such analysis.

Table 5 also illuminates the seemingly-negligent impact of air temperature on Broadway attendance. As is illustrated, an increase in the weekly average temperature by one degree Fahrenheit increases attendance by approximately four audience members; these results are not statistically significant. Several steps were taken to identify a stronger temperature instrument, attempting to tackle the primary issue of seasonality. Put simply, a warm week in November

[17] The correlation between prcpsum and prcpdays is 0.61.
[18] *p-vales* of 0.59 and 0.23, respectively.

would presumably yield better attendance than an unseasonably frigid week in March. To account for this, historical monthly data temperatures 1950 until 2019 was pulled from the NOAA database and then averaged. Multiple variables, including the difference in recorded and historical average temperature and a percentage change metric, demonstrated similarly negligent economic interpretations at high levels of statistical insignificance.

Table 6 illustrates more consistent results in the second stage compared with the mixed bag just discussed from the first stage. The overarching takeaway is clear: based on the instrumental variable analysis performed, there is a statistically and economically significant

Table 6
Second Stage (2SLS) Regression Results

	Gross per Month		*ln*(Gross per Month)	
Variables	(1)	(2)	(3)	(4)
First Week Attn.	381.9	385.1**	0.396	0.743***
	(287.2)	(163.9)	(0.525)	(0.301)
Musical	184,223		0.330*	
	(658,667)		(0.181)	
trend	21,433	22,454	0.008	0.010
	(22,575)	(22,542)	(0.012)	(0.011)
trend^3	48.6	45.3	0.000	0.000
	(88.2)	(77.8)	(0.000)	(0.000)
Observations	351	351	318	318
R-squared	0.629	0.626	0.480	0.615
First Stage F-stat	0.64	1.57	1.75	3.33

Observations with zero removed during log transformations, hence the decline from 351 to 318 from Column (2) to (3). First stage F-statistics are reported to assess instrument viability. Standard Errors in parentheses. Note: ***p-value <0.01; **p-value <0.05; *p-value <0.1.

relationship between the financial success of a Broadway production and its ability to sell tickets for the opening week *when attendance is the lone covariate*. When *musical* is added to the 2SLS analysis, although the coefficients retain similar direction and magnitude, no statistically significant relationship occurs. For the remainder of this section and the ensuing discussion, only Columns (2) and (4) will be referenced. The median weekly number of seats available for a Broadway production is approximately 7,600, or 950 per performance.[19] According to Column (2), should Broadway producers fill their theaters with just an additional 5% of capacity – 380 persons – monthly revenues would rise by nearly $144,000. Column (4) tells a similar story, albeit with slightly less magnitude. As is shown, each percentage-point increase in attendance leads to a 74-basis point rise in Gross Revenue per Month. Under the framework of the previous example, an additional 5% of capacity would lead to a rise in monthly revenues of 3.70%, or just over $78,500.[20] Of course, the removal of *musical* from this 2SLS leads to concerns regarding misspecification bias, but the similarity in the coefficients does provide confidence in cementing the positive relationship found during the OLS analysis.

5.5 *Discussion of Results*

Of the few economics studies on Broadway, many have indicated a positive relationship between the first week's attendance and longevity (Simonoff and Ma, 2003; Kulmatitskiy et. al, 2015). This is the first paper to introduce the notion of causality between the two variables and investigate that potential relationship via an instrumental variable regression.

Although the results reveal statistically significant outcomes and economically meaningful interpretations, there remains insufficient evidence to suggest a causal relationship between first week attendance and long-term financial success. Table 6 reports the first-stage F-

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[19] Calculated assuming an eight-performance week.
[20] Calculated based on the sample average monthly gross revenue of $2.13 million.

statistic for each of the regressions. These results indicate underlying complications within the model – specifically with regard to weather's strength as an instrument. Econometrics literature abounds on the treatment of weak instruments, with various methods of evaluating instrument strength depending on the number of regressors (Stock, Wright, and Yogo, 2003; Staiger and Stock, 1997; Cragg and Donald, 1993; Stock and Yogo, 2002). Using weather as an instrument for Broadway first week attendance fails all of the major tests put forth in the literature for models with one endogenous regressor. Staiger and Stock (1997) introduced the use of first-stage F-statistics for evaluating instruments, leading to a "rule-of-thumb" that $F < 10$ indicates a weak instrument; future research by Stock, Wright, and Yogo (2003) reiterated the validity of that test. The strongest first-stage F-statistic in the model above is 3.33, well below the necessary threshold. Stock and Yogo (2002) introduced another framework: comparing the minimum eigenvalue – equivalent to the first-stage F-statistic when the model contains one endogenous regressor – to a critical value. Those critical values test on two criteria – first, if the bias of the instrumental variable estimator relative to the bias of the OLS exceeds a threshold between 5% and 30%. The 30% relative-bias threshold for a chi-squared distribution with three degrees of freedom is 5.39, larger the model's eigenvalue of 3.33.[21] The second definition for a weak instrument looks at the largest rejection rate for a Wald test ($\alpha = 5\%$) for 2SLS and LIML estimators given a threshold "*r*" (Stock and Yogo, 2002). For 2SLS estimators on a χ_3^2 distribution, the highest threshold of 25% requires a critical value of 7.80, more than double the study's highest eigenvalue.[22]

One potential explanation for the failed hypothesis tests above stems from issues of classical measurement error within the dataset – specifically the measurement of first week

[21] Critical values at the 5% minimum threshold = 13.91.
[22] Critical values at 10% minimum threshold = 22.30.

attendance. The only publicly available data for attendance tracks the number of *seats* sold, not the number of *persons* in attendance. Referred to within the industry as "dropped seats," the difference between seats sold and audience members would add significance to the model for obvious reasons: it is reasonable to assume that adverse weather might deter theatergoers from attending a performance. As such, this ability to highlight consumer behavior within the model might strengthen the first-stage results. However, according to the Research team at The Broadway League, the primary trade association for the Broadway industry that releases much of the publicly available data used in this paper, dropped seats are tracked on a show-specific basis, making collection of this metric particularly burdensome for future research.

There are a multitude of ways to build off of these findings in future studies. Despite the inability to suggest causality with strong evidence, the results from this study's instrumental variable analysis highlight the essential financial importance of first week attendance. Establishing this relationship further underscores the importance of marketing and advertising campaigns prior to a production's opening. Future models that hone in on the relationship between advertising, early attendance, and long-term financial success may prove useful for producers. Data of interest would include dropped seats and advance sales, should those become more widely available, as well as potentially attendance and weather data (if using as an instrument) beyond the first week. The latter two points work in tandem – shows with lower advance sales may be more reliant on positive word-of-mouth or aggressive advertising to yield higher attendance in the second, third, and fourth weeks, making those metrics of "early attendance" and long-term success a potentially interesting relationship. Future research could also brainstorm improvements to the first-stage dependent variable; attempts to use first week attendance as a percentage of total capacity were employed in this study with no statistically significant results found. Lastly, there may be ways to improve the temperature metric in order to better adjust for seasonality concerns.

6. Survival Analysis

As mentioned, Simonoff and Ma (2003) reject Reddy et al.'s (1998) use of a linear regression – the high-level evidence being that a standard linear regression allows for the prediction of a negative dependent variable. Simonoff and Ma (2003) instead introduced a survival analysis as their theoretical framework, versions of which have been adopted in many of the papers discussed above (Maddison, 2004, 2005; Boyle and Chiou, 2009; Kulmatitskiy et al., 2015). Viewed through a strictly qualitative lens, two primary reasons explain the use and value-add of a survival model. First and foremost, any Broadway production categorized as an "Open Run" could theoretically stay on Broadway for decades. *Wicked* and *The Lion King* are two current examples of productions that have been open for over fifteen years, with no closing date announced or expected in the near future. Despite its present prestige, there were consecutive weeks in 2003, when *Wicked* opened, that it failed to sell-out.[23] Its producers were left with a choice – stay open and potentially operate at a loss for a few weeks in the hopes of a turnaround, or cut their losses and fold the show. Fortunately for *Wicked's* investors and the cast and crew, the producers decided to press on. That decision, however, often swings in the other direction after a producer evaluates data from the preceding weeks and makes a decision on whether or not to stay open. A model, then, that approximates the probability that a production will exit in week *"t"* given its survival through weeks "*t – 1"* acts as an excellent analog to a producer's real-life decision. Survival analyses accomplish exactly this.

6.2 *Empirical Framework*

[23] *Wicked* did not win Best Musical.

Kulmatitskiy et al. (2015) remain the only study to perform a survival analysis on the Pre-Season subset of shows. To reiterate, the value behind looking at this time period stems from the well-documented influence of the Tony awards on long-term financial success and the expected added importance of inherent show attributes (Boyle and Chiou, 2009). Building a model around the Tony awards requires looking at shows sufficiently removed from the last day of nomination eligibility – usually the end of April – in order to highlight the explanatory variables that push a show to a) make it to the Tony Awards or b) have enough brand equity to survive a subpar Tony showing. These shows reside within the Pre-Season period.

Tracking the duration of a Broadway production builds off of two underlying functions: a survival function and a hazard function. The survival function is shown below in Equation 4, where *T* equals the length of a Broadway show; *S(t)* tells us the probability a show performed for at least *t* weeks. Its counterpart, the hazard function, is a function of the probability density function *f(t)* and the original survival function. Though obvious from their respective formulae, a

$$S(t) = \Pr(T \geq t)\,;\ \lambda(t) = \frac{f(t)}{S(t)} \tag{4}$$

nevertheless essential distinction between the two is the hazard's interpretation as a *rate*, not a probability. Importantly, relative risk hazard models, like the one used in this study, allow for hazard rates to be differentiated on a particular input. This study utilizes a Cox (1972) relative risks model, shown below in Equation 5. The primary difference between a relative risks model and the Weibull duration used by Boyle and Chiou (2009) is the baseline hazard, $h_0(t)$.[24] In a relative risks model, the baseline function is unparameterized, whereas the Weibull model is

[24] This study uses the term "relative risks" model as opposed to "proportional hazards model" to reflect the use of time-varying covariates.

parametrized and uses maximum likelihood estimators.[25] Relative risk models demonstrate the multiplicative change of $\exp(\beta_j)$ of a given covariate x_{ij} on the overall rate hazard rate of failure. This study's model incorporates

$$h(t) = h_0(t)\exp\left(x_i(t)\beta\right) \quad (5)$$

many previously-studied variables of interest in addition to previously untested financial metrics, such as the average ticket price and gross revenue percentages. A full list of the covariates can be found in the ensuing results section. Though Kulmatitskiy et al. (2015) pioneered the distinction between the Broadway season, this model differs in one central way. This study's model introduces time-varying "x_i" variables that allow the analysis to treat the show's running-time as one continuous system. Kulmatitskiy et al. (2015) first analyze the Pre-Season, but then look at survival Post-Awards in conjunction with productions that opened in March, April, and May. In order to not account for the Tony Awards *ex ante* and evaluate Post-Awards success specifically for the Pre-Season, two time-varying dummies are introduced: *nperiod* and *aperiod.* These values equal one after the nomination announcements and awards ceremony, respectively. Importantly, the number of Tony awards and nominations a particular show earns are only recorded once *nperiod* and *aperiod* equal one. To illustrate this essential distinction using an actual show within the dataset: *The Little Dog Laughed*, which performed from October 26, 2006 to February 18, 2007, received two Tony nominations and one award. However, since the production closed well before the Tony awards ceremony and announcement date, both *nperiod* and *aperiod* are equal to zero throughout each week in the data, meaning the production's awards and nominations are also equal to zero in the data.[26]

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[25] Cox models are considered semi-parametric given the exponential relative risk function.

[26] The Tony Awards of that year occurred on Sunday June 10th, 2007. Were the show to have survived to the week ending June 17th, then the data would reflect the show's awards success: *nperiod* and *aperiod* would equal one, and *tonyn* and *tonya*, two and one, respectively.

Tony awards and nominations are recorded in this model in accordance with the two criteria set by Kulmatitskiy et al. (2015). First, only nominations and awards in the fifteen "Main" categories are recorded (see Appendix A for a full list).[27] Second, they are recorded as *Awards* and *Losing Nominations*, the latter simply calculated simply as the difference between total nominations earned and total awards won.

6.3 *Results*

Figures 2(a) illustrates the survival function through the Kaplan-Meier (1958) estimate and Figure 2(b) shows Nelson-Aalen estimate of the cumulative hazard function. Both of these nonparametric estimates account for censored data, of which, to reiterate, there are three. In order to better highlight the distribution of survival within this dataset, the analysis time axis was shortened to t=1000 (see Appendix B for unabridged estimates). As this aggregate Kaplan-Meier estimate reveals, most shows fail within one year of opening. The long right tail is indicative of hit productions that survived for at least three years.

While useful to use these simple duration models as a foundation, the purpose of a relative risk model is to allow differentiated hazard rates based on the vector of covariates. These results can be found in Table 7, where many valuable insights emerge. First and foremost, the *musical* hazard ratio indicates that, at any given moment, a musical has a 9% higher chance of failure than an otherwise identical non-musical, though the p-value is very insignificant. Revivals have a 43% higher chance of failure than an otherwise identical non-revival. Both first week attendance and average ticket price have a positive relationship with survival – a $1 increase in the average ticket prices leads to a 0.9% reduction in a show's rate of failure at any given moment during its performance run. Multiplied by a factor of ten, a reasonable ticket price

[27] Summary statistics from Table 1 include all possible Tony awards and nominations; their inclusion in Table 1 is strictly illustrative.

increase ($10), this reduction in failure risk becomes significantly more profound at 9%. Surprisingly, a 1% increase in a production's average gross percentage leads to a 13% increased risk of failure, though the large p-value makes it difficult to generate any defensible findings from this relationship.

Table 7
Relative Risks Hazard Model Results

Variables	$\exp(\beta_j)$	st.err.(β_j)	p-value
Musical	1.09	0.26	0.72
Revival	1.43	0.30	0.08
First Week Attn.	0.99	0.00	0.00
Avg. Ticket	0.99	0.01	0.12
Avg. Gross (%)	1.13	0.66	0.84
Tony Awards			
1 award	0.68	0.29	0.36
2+ awards	0.34	0.10	0.00
Losing Noms.			
1 losing nom	0.82	0.30	0.58
2+ losing noms	0.27	0.09	0.00
TVC			
nperiod	1.006	0.003	0.04
aperiod	1.004	0.002	0.07
Observations	8,545	8,545	8,545

TVC stands for time-varying characteristics, comprised of the dummy variables nperiod and aperiod. Tony Awards range from 1-5 and Losing Nominations, from 1-9. The results are condensed to "2+" to reflect the similarity of the hazard ratios and p-values above 1.

Figure 2a: Kaplan-Meier Survival

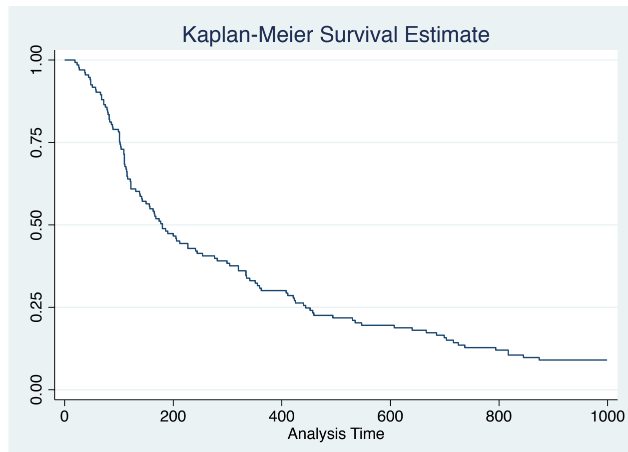
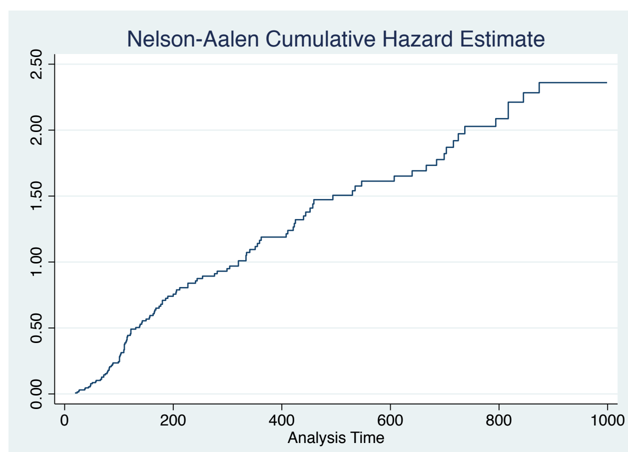


Figure 2b: Nelson-Aalen Hazard



What's abundantly, clear, however, is that Tony Awards dominate in explaining duration. Both awards and nominations reduce the risk of failure, with each additional award and losing nomination associated with 66% and 73% reduced risk, respectively. As both *TVC*s show, the rate of failure during post nominations and post awards is associated with a slightly increased rate of failure (6% and 4%, respectively), explained most likely as a result of productions having already passed an initial hurdle – getting to *nperiod* in the first place. Survival estimate graphs for *Tony Awards*, *Losing Nominations,* and *Avg. Gross (%)* can be found in Appendix B.

6.4 *Discussion of Results*

These results align closely to Kulmatitskiy et al. (2015), but with several important distinctions. Of greatest note, these results demonstrate that the introduction of time-varying characteristics that better account for Tony awards and nominations further cements the importance of these awards on Broadway survival rates. Kulmatitskiy et al.'s (2015) Pre-Season results show diminished rates of failure for musicals at statistically significant levels. Their Post-Awards results, however, show a statistically insignificant relationship between show type and survival times. This paper removes the need to distinguish between Pre-Season and Post-Awards through its use of *nperiod* and *aperiod.* In effect, this study's results reveal that Tony success accounts for the primary bulk of explanatory power regarding Broadway show survival; its importance dramatically outweighs that of being a musical or play when shows are treated as one continuous system.

Other show factors with strong explanatory power include the first week's attendance and the average ticket price. The results for first week's attendance lie in accordance with both Simonoff and Ma (2003) and Kulmatitskiy et al. (2015) and further entrench the importance of early attendance demonstrated repeatedly throughout this study. That increases in the average ticket price are associated with better survival rates suggests that Broadway productions resemble a Giffen good, although much more work is necessary to capture changes in consumer demand. *Hamilton*, at the very least, however, is a striking example of this relationship: the production's average ticket price during the 2016-17 season exceeded the industry average by over $125, while consistently grosses at the highest levels in Broadway history.[28] Additionally, given the vastly difference ticket pricing mechanisms Leslie (2004) outlines in his theoretical paper compared with those that exist today, it may be prudent to use productions with a smaller yearly distribution.

In contrast to Kulmatitskiy et al. (2015), *Losing Nominations* result in a higher reduced risk of failure in the "2+" category, though both *Awards* and *Losing Nominations* in the "Main" categories aid show survival. This may simply be the result of numerous successful productions – *Mamma Mia!* and *The Color Purple*, for example – within this dataset having relatively high levels of losing nominations.

Despite the valuable takeaways demonstrated, there remain several limitations to this model. First, macroeconomic variables are not considered, which Kulmatitskiy et al. (2016) find significant in the Post-Awards period. Second, the only financial metric considered is the average ticket price, when in reality there are myriad financial inputs essential to survival, including the size of the budget, the weekly operating expenses, and the advertising costs prior to and during the production run. Future work can expand on the results of this study's survival analysis in several ways, beginning with exclusive analysis for the Pre-Nominations period, though it is reasonable to expect similar explanatory dominance from the Tony's. Average ticket prices represent the first use of financial show factors within a survival analysis – future studies may look to incorporate related expenses, such as discounted ticket prices or advertising expenses, provided available data.

[28] 2017-17 season occurs from June 2016 to June 2017. *Hamilton* averages $11.4 million per month.

7. Conclusion

This paper adds meaningfully to the sparse economics-focused Broadway literature in several respects. It first underscores the importance of early success – defined as a show's first week attendance – for Broadway productions. All three of the models used reveal statistically and economically significant results surrounding the positive relationship between first week attendance and show success, either defined as revenue per month or a survival rate. This paper's survival analysis breaks with previous literature in that it finds a muted impact of the musical dummy variable once financial metrics like the average ticket price and time-varying dummies for the Tony nomination and awards period are introduced. Accumulating Tony awards and nominations in "Main" categories continues to preside as the strongest explanatory variable for Broadway show survival within a relative risks model.

Many questions arise as a result of this study's findings and, fortunately, there are many avenues for future research to take. This analysis could be performed on separate parts of the Broadway season, such as the Pre-Nominations period. The instrumental variable analysis could be further expanded to highlight causal relationships between additional Broadway show factors and monthly revenues – or an entirely different dependent variable for success. Last, as previous authors have stated and this paper echoes, the ability to perform high-level economic analysis on show-specific financial data would prove invaluable to Broadway producers already burdened by the infinite decision fatigue that defines creating a unique and long-lasting theatrical production.

8. References

Data Sources:

Broadway World

Playbill

Internet Broadway Database

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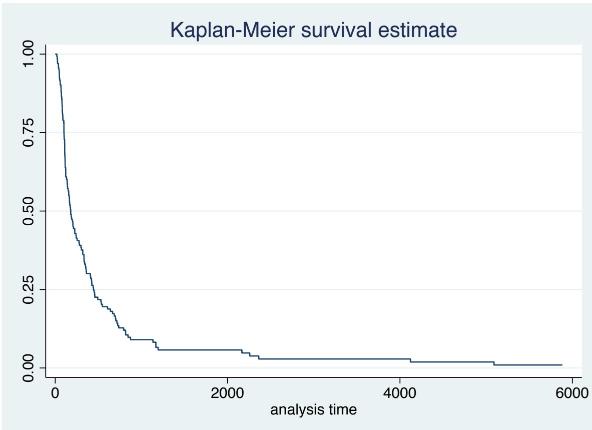
9. Appendix

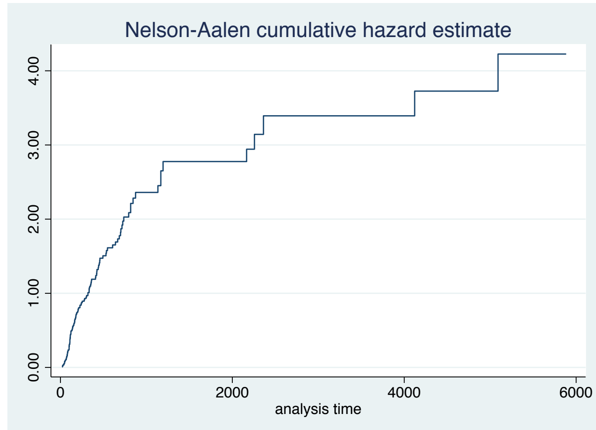
Appendix A: Full List of "Main" Tony Awards

1. Best Musical (Original)
2. Best Musical (Revival)
3. Best Play (Original)
4. Best Play (Revival)
5. Best Lead Actor (Musical)
6. Best Lead Actor (Play)
7. Best Lead Actress (Musical)
8. Best Lead Actress (Play)
9. Best Featured Actor (Musical)
10. Best Featured Actor (Play)
11. Best Featured Actress (Musical)
12. Best Featured Actress (Play)
13. Best Director (Musical)
14. Best Director (Play)
15. Best Special Engagement

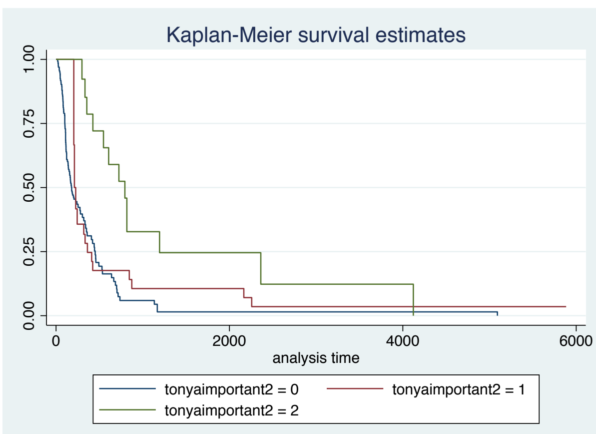
Appendix B: Additional Survival Analsis Charts

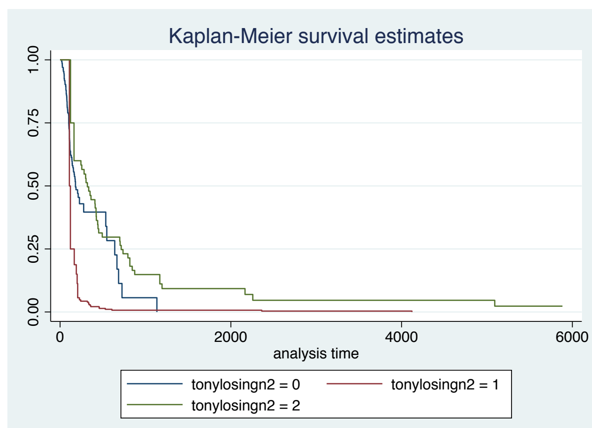
Kaplan Meier and Nelson-Aalen using the full dataset (t = 6000).





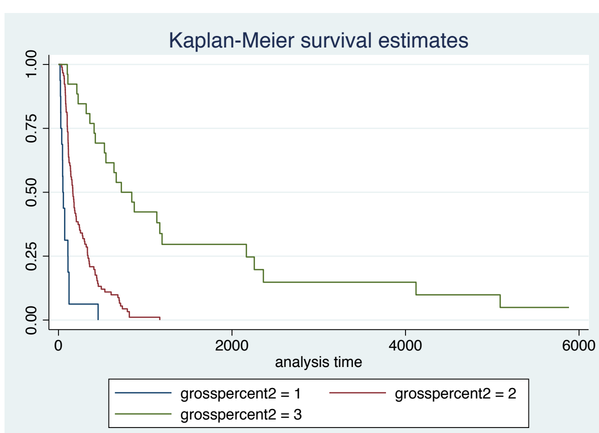
Survival estimated based on Tony Award and Nominations. Note: the green line represents “2+” as seen in Table 7.





Survival estimates based on median *Avg. Gross (%).*

Blue = median < 30%; Red = median >=30% but <= 70%; Green => 70%



Appendix C: Example Broadway Capitalization Table

ESTIMATED PRODUCTION CAPITALIZATION	21-Feb-12	
ESTIMATED DEVELOPMENT COSTS		
DEVELOPMENTAL EXPENSES	$ 244,435	
DANCE PRE-PRODUCTION	$ 30,000	
TOTAL OUT-OF-POCKET EXPENSES - DEVELOPMENTAL EXPENSES		$ 274,435
ESTIMATED PRODUCTION COSTS - OOT ENGAGEMENT		
PHYSICAL PRODUCTION	$ 2,204,350	
PRODUCTION FEES - CREATIVE STAFF	$ 1,104,227	
PRODUCTION FEES - PRODUCTION STAFF	$ 283,675	
ADVERTISING & PUBLICITY	$ 85,000	
REHEARSAL AND NY COMPANY TECH SALARIES	$ 1,456,694	
PRE-PRODUCTION & TECH EXPENSES	$ 1,039,476	
GENERAL & ADMINISTRATIVE COSTS	$ 105,173	
TOTAL OUT-OF-POCKET EXPENSES - OOT ENGAGEMENT		$ 6,278,595
ESTIMATED BROADWAY TRANSFER COSTS		
PHYSICAL PRODUCTION	$ 424,000	
PRODUCTION FEES - CREATIVE STAFF	$ 175,004	
PRODUCTION FEES - PRODUCTION STAFF	$ 76,325	
NY ADVERTISING & PUBLICITY	$ 1,500,000	
REHEARSAL AND NY COMPANY TECH SALARIES	$ 833,048	
PRE-PRODUCTION & TECH EXPENSES	$ 1,611,673	
GENERAL & ADMINISTRATIVE COSTS	$ 46,480	
TOTAL OUT-OF-POCKET EXPENSES - BROADWAY TRANSFER		$ 4,666,530
SUB-TOTAL OF ABOVE		$ 11,219,561
SECURITY BONDS & ROYALTY ADVANCES		
Actors Equity Association	$ 210,723	
IATSE	$ 17,500	
ATPAM	$ -	
Underlying Rights	$ 93,333	
Authors	$ 139,000	
Director/Choreographer	$ 119,884	
Scenic Designer	$ -	
Costume Designer	$ -	
Lighting Designer	$ -	
Sound Designer	$ -	
TOTAL SECURITY BONDS & ROYALTY ADVANCES		$ 580,440
MINIMUM CONTINGENCY & RESERVE		$ 700,000
TOTAL MINIMUM CAPITAL REQUIRED		$ 12,500,000
MAXIMUM CONTINGENCY & RESERVE		$ 1,700,000
TOTAL MAXIMUM CAPITAL REQUIRED		$ 13,500,000