STAR TURNOVER AND THE VALUE OF HUMAN CAPITAL

Evidence from Broadway Shows

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Abstract

A vast literature in finance and labor is concerned with the valuation of the human capital of key members of organizations. Finance papers often use CEO fixed effects and personal history and events to identify the impact of individuals on organizations. However, in these cases and in studies of CEO turnovers, it is difficult to control for everything that transpires in a complex organization.

Theater shows routinely turn-over actors in lead roles for a variety of reasons. However, all other elements of the show remain in place, including the director, the script, other actors and the physical theater environment. Even the lines stay the same. Therefore the theater provides a unique laboratory for assessing the value of human capital to an enterprise.

Our analysis focuses on transitions between top featured cast members in long-running Broadway shows. We compare revenues, capacity and ticket prices just before and just after the change in cast. We also characterize the performers in various ways, and control for the attributes of the show, as well as for team characteristics.

We find that only the most talented theater stars significantly affect the financial success of theater shows, supporting the MacDonald (1988) version of the superstar hypothesis. However, movie stars and well known performers from other fields of the performing arts do not seem to affect prices or revenues. Teams are important, and a departure of a team or someone who had worked with the current director before is detrimental to the performance of the show. Seasonal effects matter as well.

I Introduction

I.1 The basic idea

The purpose of this paper is to assess the value of human capital in a tightly controlled experiment using the theater as a laboratory. We also characterize individuals who are important to the enterprise using superstar theories.

Most people would agree that key players in an organization or a project (leaders or stars) provide significant value added. Yet, it has been difficult to assess the economic value of a specific individual, no matter how high up they are in the hierarchy in an organization, since most enterprises are team efforts and since most personnel replacements take place in an ever changing environment. All of this needs be controlled for by the econometrician. Thus, for example, the CEO literature in finance uses manager fixed effects or indirect indications of a CEO impact.

In long-running theater shows it is often the case that one actor replaces another, whereas the other actors, the director, the script, the set, and the physical theater stay the same. Even the lines the actor preforms do not change. This setup allows us to identify whether key individuals matter to the success of a theatrical enterprise in a tightly controlled experiment. If we find that some actors do make a difference (as we indeed do) we will try to characterize these individuals. Here we will be guided by the theoretical literature on stars. Rosen's (1981) seminal paper shows how stars can emerge even without a substantial talent differential among players. Later work by Alder (1985) suggests that stars can arise without any talent differential between players, and MacDonald's (1988) model shows how stars may evolve in an environment where experimentation leads to a dynamic revelation of talent. We find that the addition of a "theater star", i.e. a highly decorated specialized professional, can allow a theater to both increase ticket prices and attract more people, thus leading to a significant increase in revenues. In some cases we also find that the departure of a star has some economic significance. We interpret these findings as supporting MacDonald's (1988) version of superstars.

Our findings can inform other work on the value of stars and support other indirect evidence on the value of key players in diverse areas of human enterprise. In the CEO space, testing the star theories is more difficult, since it is rare that CEOs do not have a long career behind them, thus almost by definition conforming to the MacDonald (1988) "star" characterization. Also, as discussed, the environments in which CEO replacements take place are less tightly controlled

than ours. However, Malmendier and Tate (2009) find that media driven "superstar CEOs" have negative effects on their respective firms. One might assume that these people are closer to Adler (1985) type stars (i.e. people who do not have more talent than others but have good public relations) and thus the findings are consistent with our findings. Our framework can also provide some evidence for the "star" compensation debate, initiated by Rosen (1981) and extensively discussed in later work in different contexts, e.g. the Gabaix and Landier (2003) contribution to the CEO literature.

Additional results in this paper highlight the importance of team work, which has been a central theme of many studies in economics finance and strategy. Naturally, the role of human capital varies between enterprises and there are limitations as to how much one can generalize from one experiment to another. However, we believe that in addition to testing the superstar idea in the creative industries context, this paper may have implications for a wider array of human creativity.

I.2 Empirical Literature review and our contribution

There is an extensive literature which seeks to assess the value of human capital in various setting, using a variety of methods. We will discuss some of the relevant papers below.

In finance much of the work on the value of human capital focuses on CEOs and managers in general. Firms have thousands of employees and numerous moving parts and it functions in a constantly changing environment. Therefore assessing the marginal contribution of a CEO (or a CFO) to any measure of firm performance or strategy is a challenge. Ideally one would want to run the firm with one CEO, then roll back time, and run the firm through the same environment and challenges with another CEO. This is of course impossible, however, the experiment in this paper is close to this idealized setting. In the CEO realm, the best one can do is to use fixed effects. In the first study in this area, Bertrand and Schoar (2003) study a sample of more than 500 managers who switch firms (appear at least twice in the sample and stay at least 3 years at each job). Bertrand and Schoar (2003) use managers' fixed effects (as managers transition from one firm to another) to discern the impact of CEOs CFOs and other managers on enterprise value and policies, such as capital structure, acquisitions, dividend policies and cash holdings as well as firm performance measured by Tobin's Q and return on assets. Bertrand and Schoar (2003) use time varying firm controls to explain the remaining variation. The paper shows that managers'

fixed effects are significant in explaining firm value and policies and have a substantial explanatory power. The authors caution against a causal interpretation of their findings, as the allocation of managers to firms is not random. They conclude that the realizations of policies and value depend on executives in charge (ibid. p. 1204). (See also Fee, 2013). Bertrand and Schoar (2003) also relate managerial effects to CEOs' personal characteristics (specifically MBA degrees and age) an approach that we can follow in classifying our actors according to star theories. Graham et al. (2012), show that managerial fixed effects account for much of the variation in management compensation. Adams et al. (2005) show that various types of CEOs affect variability in returns. They consider CEO power. CEO is powerful if s/he is a founder, s/he is the only insider on the board or holds multiple titles. Power measures are shown to have ambiguous (differential) effects on firm performance, but they all increase volatility and variability of returns. The argument is that decisions arising from judgement errors are not well diversified. Again, the ideal experiment here would be to run the firm for a year with a CEO with "low power" and then rewind, and run the firm again, with a "high power" CEO. However, in real life this is not possible.

Other work on CEOs uses other indirect measures, exploiting life history or significant events in the life of a CEO to estimate indirect effects of CEO effectiveness (See Bennedsen et al., 2010, 2011 and Bernile et al. 2015)[1]. Gabaix and Landier (2008) provide a model analyzing "star CEOs" outsized pay when firms grow. Malmendier and Tate (2009) find that media driven "star CEOs" have negative effects on their respective firms, which in some ways supports our findings that "visibility stars" (people with more visibility than relevant talent), do not help a show. As noted, the empirical testing in all the settings we have surveyed so far, has been challenging, because in most cases the agents in question are part of a large organizations and there are numerous confounding factors which need to be controlled for and quantified. Other papers in the finance space consider the effect of "star analysts" on firms (See Groysberg et al., 2008). Baghai et al. (2017) show that talented individuals tend to leave firms as they approach financial distress, thus increasing distress costs and affecting capital structure. Swedish data allows the authors to assess the qualifications of the individuals, but the quantification of their value to the organizations is harder to measure.

[1] Celerier and Vallee (2015) compute the return to talent, as measured by the success in the vetting process of the French Grandes Ecoles and find that finance provides much greater returns to talent than other professions. Bohm Metzger and Stromberg (2015) do not find this effect for Swedish CEOs ranked by army test scores.

In the creative arts realm, empirical work on the value of performers has been inconclusive. Research into the music industry seems to find conflicting results. Hamlen (1991) measures voice quality and finds that singers with better voice quality seem to do better; however, the elasticity of record sales to an exogenously computed voice quality measure is less than one. On the other hand, Chung and Cox (1994) find that the distribution of gold records may be due to luck, applying the Yule distribution.

Much work has been done in the obvious area, namely, movies, where stars seem to be the name of the game. However, similar to the work on CEOs, the analysis falls short of the ideal experiment. The ideal experiment would be to shoot a movie with one star, and then go back in time, and shoot the same movie with another star. However, this is not possible. Thus the best one can do is to try some variety of fixed effects, controlling for anything else one can control for. Ravid (1999) runs revenues and rates of return of movies as dependent variables, and stars (defined in a similar way to this paper, i.e. Oscar nominated and decorated actors) as independent variables. However, in addition to the star status, each observation (movie) comprises of numerous other confounding variables, such as genre, budget, and critical reviews which the paper tries to control for as well as possibly other un-observables. John et al. (2017) use a fixed effects framework similar to Bertrand and Schoar (2003) to show that directors matter to the success of films.

Most papers in this line of research, however, suggest that acting stars, however defined, do not have much of an impact on revenues and rates of return of movie projects, implicitly supporting the notion of no visible talent differentials or alternatively of complete rent capture (See Ravid, 1999, De Vany and Walls, 1999, Elberse, 2007, McKenzie, 2012 and others). However, it may be that the complex interactions of various elements of movie making confound the effects of individual actors on the success of the project.

Elberse (2007) measures the value of stars by a pseudo-event study in the Hollywood stock exchange. But since HSX is only a prediction market, the findings are only indicative (and they show a very small increase in predicted revenues when stars join the cast). DeVany and Walls (1999) show most directly that one cannot use star presence or the hiring of individual stars to predict either rates of return or the probability of hits, although ex-post there were always some successful stars. Their conclusion is that “the movie is the star”. In other words, there are too many confounding factors, and therefore it is difficult to distinguish the effect of an individual on the outcome. The only study of the movie industry where stars did seem to make a difference is

Filson and Havlicek (2015) where a departure of a key actor lowers the performance of the next installment in a franchise. This provides support for our view in a much less clean setting. Here, as in our case, the main elements of the franchise stay in place and one key player is switched, however, obviously sequels are different from each other in many ways (See Filson and Havlicek, 2015, for a discussion, see Palia et al. (2008) for a discussion of sequel characteristic) whereas in our case everything stays the same.

In another area, Mollick (2012) considers the role of various types of employees in game design firms. He uses a unique data set and follows individuals as they switch projects and firms. Mollick (2012) finds that individual producers and designers account for almost 30% of the variation in game revenues (using random effects), controlling for game level predictors.

There are many other attempts to quantify the value of human capital in other contexts. Again, an ideal experiment generally does not exist but some work is able to carve interesting paths. The most exciting new work in this area focuses on the impact of individual teachers on students' learning outcomes. Rockoff (2004) studies the effect of teachers on students' test score using a teacher fixed effect model. Chetty, Friedman and Rockoff (2014a, 2014b) consider the impact of teachers on students' outcomes. Chetty et al. (2014b) use a quasi-experimental design based on teacher turnover (which is similar to our approach which in turn is based on performers' transitions) and find that changes in students' lifetime outcomes (including the probability of attending college, and the quality of college attended), are associated with variations in teachers' quality. We follow this creative idea, but our experiment is more tightly controlled and the results are more direct and immediately observable. On the other hand, our institutional setting is very different. A similar approach is used at Engelberg et al. (2016) who consider the assignment of pastors to churches in Oklahoma and find that individual pastors' ability can significantly affect Sunday attendance. Engelberg et al. (2016) also consider the effect of pastor departures and arrivals on their congregation and in that sense their approach is close to our work.

Our contribution then is to identify the value of an individual to an enterprise in a setting where the environment is inherently unchanged, and even what the individual does is tightly scripted.

III. Hypotheses and Research Design

III.1 Theories of the value of "stars" and our research design

A good starting point for the characterization of the value added of key individuals is the labor literature beginning with Rosen, (1981). Rosen's (1981) path breaking paper suggests that "stars" are not necessarily individuals with significantly superior intrinsic talent, but that some characteristics of the demand and supply functions in question may award individuals with somewhat greater talent, disproportionately high financial returns. In other words, people with very little additional talent can garner significantly higher payoffs. This lopsided outcome is a consequence of two phenomena- a willingness to pay which is convex in talent on the demand side, (i.e. non-talented individuals are poor substitutes for talented ones) and a cost of performance which is invariant to the number of people in the audience. As a simple illustration, assume there are only two performers, A and B. A is a bit more talented than B. For simplicity, we can assume a marginal cost of performance of zero per audience member (assuming that performances, or recordings, entail only fixed costs). If ticket prices to see both performers are equal, or possibly even if ticket prices for A's shows are slightly higher, all members of the audience will prefer performer A. The result is that A will attract everybody leading to very high payoffs (assuming she covers her fixed cost) and B will have no audience at all.

Rosen (1981)'s work has changed the way we think about the "star" phenomenon. From Rosen's paper, we take the implication that large financial rewards which define "stars" can be the result of only small differences in talent. Later work (Adler, 1985) deepened the puzzle, suggesting that perhaps stars do not have any superior talent at all and that it is consumers' tastes which create them. In our previous example, assume that A and B are equally talented, but that all my friends go to see A. I thus obtain additional utility from joining my friends, and there is no reason for me to see B. From Adler's (1985) work we take the implication that stars do not need to be more talented than other performers at all. Macdonald's (1988) dynamic model has a different take on the issue. He suggests that very low paid entry level artists are compensated in equilibrium by a possibility of much higher returns should they turn out to be successful. In this model the less talented exit early, and in period 2 of the two-period model, the probability of a great performance is much higher. In other words, in Macdonald's (1988) world, the high observed payoff of stars (with a low probability) compensates for a high probability of accepting wages below their opportunity cost in period 1, finding out that they are not talented, and migrating to other professions. If we map MacDonald's model to a complex reality, it will translate to an

ability revelation model, in which stars are people who, by a long process of elimination, turn out to be the best in their profession. In this framework, stars are very talented.[2]

Our analysis focuses on transitions between reasonably important cast members in theater shows. We look at various metrics of success just before and just after the change in cast, and try to draw conclusions. We also characterize the performers in various ways, and control for the attributes of the show.

III. 2 The Economic Setting and Hypotheses

The economics of theater transitions are very simple.

There is a monopoly element in theater shows (there is no other Phantom of the Opera or Hamilton) but it is probably more correct to think about shows as partial substitutes on the demand side. Thus the demand curve is presumably downward sloping and so is the marginal revenue (MR) curve.

The supply (MC) curve is approximately horizontal (zero marginal cost per audience member) until we reach capacity since there is very little cost to filling an empty seat. At capacity, the marginal cost is essentially infinite (nobody else can be accommodated).

Assuming that shows are not sold out (it turns out that most of the shows in our sample sell below 100%),[3] the equilibrium quantity sold is determined by the point where the MR curve cuts the horizontal axis and the price is determined by the demand curve. If a star is added to the show and she shifts out the demand curve, then the MR curve shifts out as well and a higher quantity (admissions) and a higher price (ticket price) are observed in equilibrium.

Similarly, if a star leaves a show we expect a shift of the demand curve in the opposite direction.

This analysis assumes that theater owners observe the demand curve and that they are able to maximize profits. In reality, they may overshoot- increasing prices too much as a star joins the show and thus the observed quantity (number of tickets) may decrease, or when a star leaves they

[2] John et al. (2017) document such a process in the market for film directors.

[3] One show in our sample, Wicked, is sold out before and after the transition. We ran the analysis with or without that show and the results did not change. In principle, one can analyze sold out shows if there is available data on re-sales. However, the data is spotty and it is not available for a large sample of shows or for a long period of time (not too many shows are sold out for long periods of time in the first place). Also, resales do not affect producers' or actors' revenues. Nevertheless, there seems to be anecdotal support to the idea that a "theater star" departure can lead to a drop in resale prices of sold out shows (See "How Scalpers made their Millions with Hamilton" by Tiff Fehr, *New York Times*, July 29th 2016)

may drop prices below the optimal level and observed admissions can actually increase. This can add noise to the analysis and lower the significance of our results.

Fortunately, our empirical analysis yields relatively clean findings, which may indicate that theater owners are good at optimizing revenues.

Hypotheses

The hypotheses we test are then very simple:

H1 (our null hypothesis): shows will perform equally well with all qualified performers (Adler, 1985 or the empirical movie literature- e.g. Ravid, 1999, Elberse, 2007).

H2a: Some types of performers will contribute more to the financial success of a show everything else equal. In particular, these performers can include celebrities with no discernible superior talent (confirming Adler, 1985).

H2b: Some types of performers will contribute more to the financial success of a show everything else equal. In particular, these performers are actors with somewhat greater talent (confirming Rosen, 1981).

H2c: Some types of performers will contribute more to the financial success of a show everything else equal. In particular, these performers are the most talented actors (confirming Macdonald, 1988).

There is a large literature on whether the presumed contribution of high level players or stars can justify lopsided salaries starting with Rosen (1981) and these ideas were developed in two different research areas, namely, finance, and economics of the creative industries. In the creative industries stars earn many millions for a movie or for a concert, whereas other artists work for practically nothing This bifurcation could not have had a more dramatic illustration than a recent rebellion against the actors' union (Equity) by Los Angeles Off Broadway actors demanding that they be allowed to work below the US minimum wage rather than close their shows. This protest took place practically at the doorsteps of Hollywood movie stars who make many millions of dollars for a few weeks of work. Similarly, the debate over "overpaid" CEOs and "underpaid" workers has been a recurring theme in the financial and general press.[4] We can discuss the issue further, but do not have sufficient data to answer this question directly from our experiment.

[4] See for example, "Misguided Political Attacks on CEO Pay" Wall Street Journal Opinion page, 7/20/2015.

We note that even H1 does not suggest that every legal resident of the US can act in every show. Landing a role in a prestigious Broadway show follows a rigorous audition process. Therefore, we expect most performers who are allowed to appear on the Broadway stage to be qualified. We also assume that the audience can tell the difference between various performers and will reward them according to their tastes. However, if H1 is true, then the results will be consistent with the findings on movies.

As discussed, Ravid (1999) and Elberse (2007) as well as De Vany and Walls (1999) find that star participation is not a predictor of the financial success of movies, which can be interpreted as a large available pool of interchangeable (or not ex-ante identifiable) qualified performers. Adler's "stars" hypothesis on the other hand (H2a), suggests that stars are "created" by the public as celebrities (perhaps people with TV experience, who are more recognizable by the general public) and audiences are willing to pay to see them on stage regardless of their "true" dramatic skills.

H2b suggests that it matters who the successful performers are. If they are somewhat more talented people, we support Rosen's (1981) conjecture. If they are the "best" actors, this will tend to confirm MacDonald (1988) hypothesis, which envisions a long vetting process, where only the more talented people end up in star positions (H2c). The distinction between somewhat talented and very talented is murky. However, we try to put empirical content into these characterizations by mapping actors with a theater background and accolades (theater stars) to "MacDonald stars". Actors with a movie background and accolades (movie stars) can be considered either "Rosen stars" (if you assume some substitutability in theater and movie acting) or "Adler stars" if we only consider their fame. We map other successful performers (visibility stars)- more directly to "Adler stars". We should note that in order to be meaningful, a "star" hypothesis should suggest how stars are identified ex-ante. Ex-post it is true by definition that some people will have done better than others (See DeVany and Walls,1999).

IV. Data and variables

IV.1 Transitions

This paper considers all shows that opened between 1/1/1990 and 1/1/2013 (as covered in the data base IBDB.com, a theater data base) and had at least 150 performances. Our preliminary sample includes 215 shows. The reason for the cutoff is that for shows with less than 150 performances (with 7-8 shows per week, this means that the shortest run in our sample is about 20

weeks) there will rarely be any changes in the cast. Therefore our sample essentially includes all shows with transitions[5].

The shows in our sample are reasonably successful but not necessarily super-successful. The most successful show to date, Phantom of the Opera has been running for more than 27 years, grossing world-wide as of 2014 more than 6 billion dollars (Isherwood, NY Times, August 17th 2014, http://www.nytimes.com/2014/08/18/theater/the-phantom-of-the-opera-retains-its-luster.html). A show that runs for 20 weeks may not even cover its investment, keeping in mind that unlike movies, theater shows involve a significant variable cost (per show, not per seat).

After identifying shows which ran for at least 150 performances, we use the website playbillvault.com and look for the playbill page image (See appendix A). Playbill is the program distributed in the theater, and it describes the show and the actors who perform in it. In the page of "who is who" in the playbill page image, we look for the first three featured actors[6]. For example, for the long running show Mamma Mia, the first actor to appear in playbill for the opening night is Louise Pitre, playing Donna Sheridan. The second actor in the list is David Keeley, playing Sam Carmichael and the third is Tina Maddigan, playing Sophie Sheridan (See appendix A for this page image). We should note that this method may omit a few important characters, but that should not affect our analysis unless these omitted character transitions are systematically different than the ones we are coding. Using the characters we identify, played by the three leading performers in Playbill, we find the performers who played them in the show, starting with the opening night cast. For example, as mentioned, Donna Sheridan, (lead character in Mamma Mia), was played in the opening night by the actress Louise Pitre.

We then search for transitions, i.e. changes in the cast occurring during the run. For example, Ms. Pitre performed from October 5th, 2001 (the first day of the previews) until October 19th, 2003. We now manually search IBDB.com for the replacement, in this example, the actress who replaced Louise Pitre in October of 2003. We find that Dee Hoty replaced Louise Pitre and performed from 10/19/2003 to10/24/2004.

[5] For 60 shows, we did not find any transitions, leaving us with 155 shows. We then eliminated all transitions that we cannot find a date for, which left us with 94 shows. After eliminating transitions that are within three weeks of each other we were left with 82 shows.

[6] As discussed later, we also tried transitions involving other members of the cast.

After we identify a transition,[7] we look for several measures of performance around that date, including gross revenue, capacity use (i.e. the number of seats sold as percentage of the total number of seats available) and the average ticket price.[8] Average ticket price may be important, because as mentioned earlier, if producers decide to lower prices, they may be able to fill the auditorium even if we have an inferior performer. Performance data is available on a weekly basis from IBDB.com. We calculate the difference in performance (gross, average ticket price, and capacity) before and after a transition. Performance before transition is the average of performance in the three weeks before the transition week and performance after transition is the average of performance in the three weeks after. The transition week is excluded because it is a mix of both old and new performers. We later regress the type of transition and control variables on difference in performance. [9]

Our approach is similar to experiments in physics or medicine because our environment is tightly controlled. In other ways our approach is similar to event studies- some information comes in and we observe a change in economic variables. However, in event studies we record changes in stock prices reflecting expectations and assessments and here we measure a concrete immediate economic impact.

The analysis is similar to diff in diff in as much as we observe changes due to a shock to the system. One of the critical assumptions in DID analysis is that "the treated and control groups would have followed parallel trajectories with respect to the outcome variables had the experiment not run" as nicely put in a very different context by Ben David and Bos (2017) and many others. Thus DID relies on similarities between the "treated group" and the "control group" which Ben David and Bos (2017) and others realize is "not testable" or very hard to test. The advantage of our setting is that we do not need a control group because of the tightly controlled environment before and after the change. As argued below, we believe the changes are reasonably exogenous, but endogeneity due to omitted variables should not be a concern.

We then look for ways to identify the "stars" in our sample. We collect credentials of all performers involved in the transitions in several areas: theater, movies and TV. Our theater

[7] Matching transitions is a tedious mostly manual job since the website does not have replacement chains but rather lists actors in different roles in different time periods.
[8] While list ticket prices do not often change, the mix of regularly priced seats and "premium seats" (well above list price) as well various discount seats sold through organizations such as playbill.com and tdf.org or for specific groups such as students or "30 under 30" may change rather dramatically through the run. This type of adjustment as well as changes in the mix of cheaper and more expensive seats, changes the average ticket price of shows.
[9] Three weeks seem reasonable for the impact of a change to be felt and also to identify any pre-transition trends. We also tried one week before and one week after the event.

credentials include information on 1) the number of Broadway shows in which the performer had participated by the time s/he joined the focal show,[10] 2) the number of Tony award nominations/wins actors had earned by the time they joined the focal show and 3) the number of other theater awards nominations/wins they had earned by the time they joined the focal show. We collect such information from Playbillvault.com and IBDB.com. We gather information on movie and TV credentials of performers from IMDB.com. These data include 1) the number of movies the actor had participated in by the time they joined the focal show, 2) the number of TV shows they had participated in by the time they joined the focal show, 3) the number of Oscar nominations/wins they had earned by the time they joined the focal show, and 4) the number of other screen awards nominations/wins they had earned by the time they joined the show. Because we only count the credentials until the time the performer joined the focal show, if a performer appears in several shows in our sample, she/he can be a "different person" in each show depending on awards and credits in between. In order to focus on professional credits that matter, we do not count appearances as "herself" in any movie or TV show. We do not count previous appearance in the same Broadway show as theater credits. We do not count shorts as movie credits. We do not count Razzies[11] as screen awards.

We try several characterizations of stars using movie awards and nominations, theater awards and nominations, theater credits, TV credits and movie credits. Empirically, it turns out that only major awards matter.[12]

One may worry about possible endogeneity issues, mostly that it may be that someone is replaced only if they fail. However, there are several reasons why we think that this may not be a major concern for our sample. First, all shows have succeeded by the time the replacement occurrs. It is difficult to argue that the major stars of a successful show should be replaced because of failure (as noted we only consider long running shows). It is also difficult to argue that except for the star replacement there is any other informational content to the transition, since a long running show is a known quantity. There are also no discernible trends in revenues prior to the transition- in 53% of the cases revenues increase between week -3 and week -2 (in 47% of the cases they decrease). The corresponding numbers between week -2 and week -1 are 51% (increases) and 49% (decreases). Secondly, empirically, the average impact of any replacement is negative (see

[10] We include as credits also appearances as understudies, standbys or swings.
[11] Razzies are awards by an "alternative" group for the worst movies, screenplays actors and directors of the year.
[12] More runs and results available from the authors upon request.

below). If the average transition were a result of a failure, and show producers knew anything about the business, then the average outcome should have been positive.

To address this issue further, we look at the career of every actor who has left a show in our sample. We check their IBDB page to see if they performed on Broadway (or in Broadway touring companies) again, and then check their IMDB page. We conclude that somebody "worked again" if they performed in a show within 15 months (allowing a year + a rehearsal period) or if they had an IMDB entry the same year of the transition or the following year. Clearly this is a crude measure and it bundles together people who work continuously with people who have spells of unemployment, but it is difficult to know when first readings of shows take place, or when a film or a TV show are actually shot. In other ways, the measure is severely biased against us, however, since we have no data on Off Broadway, or regional theater performances or performances overseas, for example, in London's West End. Most successful actors do appear in such venues sometime during their careers. For example, Carolee Carmello IBDB page shows her as "not having worked" since May of 2016, but she has been starring in a sold out Off Broadway show since April 2017 with rehearsals beginning much earlier. Furthermore, some of the musical theater stars perform in concerts, for example, Huey Lewis who is in our sample and these appearances do not count as "worked again",

However, even our crude criterion shows that a whopping 90% of the actors "worked again".

One may also be concerned that stars can select into shows that match them best. However, if anything, it is theater stars who need work and may take shows just to keep working, whereas movie stars, who generally view Broadway as a hobby can be much more selective as to what show they appear in. Nevertheless, we find that theater stars matter and movie stars do not.

Also, there are several additional institutional factors which diminish the endogeneity concerns. We learned that in general actors have a fixed contractual period, and should the show continue beyond that time, the contract needs to be re-negotiated. Busy actors may already be committed to other projects and often cannot stay beyond the contract period regardless of the success of the show. We have consulted several theater professionals and manually performed a press search for some replacements. We confirmed that generally departures were for exogenous reasons. Further, because of the method for our sample construction, we did not use in our statistical analysis any transitions that occurred within three weeks of each other (see below). The latter should be a prime example of replacements because of failures- you come into a successful show, you underperform and you get kicked out. However, in the cases we checked, there was always a

very legitimate reason for such replacements, either health (someone was hospitalized and could not continue in the play) or contractual (the reason for the short term commitment was another, previous commitment for the same dates).[13]Thus we are fairly comfortable with the view that the departures we observe are reasonably exogenous. Obviously the show producers will try to find the best replacement for the role.

We should also note that if a transition is not a surprise (as is often the case) this should not be a problem. In fact, it is the other way round since most theater tickets are bought in advance of the performance. We are testing to see whether a star can lead to a better financial performance of a show. If say, a star is replaced at a pre-determined date by a non-star and the theater goes empty, we prove our point. However, if the change is a surprise (say if an actor is suddenly sick and is replaced by an understudy) then it is hard to draw conclusions because people may find out that their favorite star will not perform only when they are already in the theater, whereas all pre-sales would have been based on the star presence.

One of the issues in every test of the value of individuals within a group project is the question of proper matching or team performance. There is work on this issue in the creative industries (See Sorenson and Waguespack, 2006, Cattani and Ferriani, 2008, Shamsie and Manor, 2012) and in the CEO literature (See for example, Matveyev, 2017). In our case, we try to control for possible team complementarities using two variables. The first variable codes the case in which there is a "cast change" in other words, several people leave a show together. Our industry sources suggest that this is not an unusual practice and the fact that cast changes occur often in our data increases our confidence that most departures occur for exogenous reasons.
If team work matters, then a transition involving a team may have more of an effect than a transition involving only one individual. We code a variable "cast change" as 1 if there is a cast change, and zero otherwise. We will explain below how we define teams as star or non-star teams.

Another possibility is that there is a team effect of people who had worked together previously. Since there are endless combinations, and following some discussions with theater professionals, we look for the director of each show where a transition is taking place. Then we go to that director's page in IBDB.com to see if the director had worked on a different show with the same actor. We consider positions of directors, assistant directors and associate directors in previous

[13] For example, Carolee Carmello opened the show Tuck Everlasting in Atlanta in February 2015 but had a previous commitment on Broadway and thus, regardless of the success of the show, had to leave Atlanta at a pre-specified time.

shows (prior to the current transition).[14] If the departing actor had participated in a previous show with the current director, our "old team" variable is coded as one, otherwise it is zero. If the incoming actor had worked with the director before, then our "new team" variable has a value of one.[15]

We also collect variables that characterize the show- a dummy for whether the show is a musical or a straight play and a dummy for a revival vs. a new production (IBDB.com). Another dummy characterizes seasonal effects. After observing the weekly grosses of Broadway shows in the past 20 years (our sample period), we find that there is a huge jump in gross sales in the week between Christmas and New Year every year. Otherwise, there seem to be no discernable trends. For example, in 2011 the gross in the peak week was approximately $35 million, 3.26 SD from the mean of $20.786 million and the only week which is more than 3 SD from the mean. 40 weeks were within one SD from the mean and 9 between 1 and 2 SD. For that reason we thought that weekly fixed effects can mostly add noise- furthermore, we have weekly data and the peak week is sometimes week 1 and sometimes week 52 of the year.

If a transition occurs within three weeks of this peak week, the change of gross revenue will be confounded by a seasonal effect. To address this concern, we use two dummies: before-peak and after-peak, which identify the transitions that occur within a three week window of the peak week respectively.[16]

Finally, we create a dummy to indicate whether the show has won any award. Obviously this is not the same as prior awards to the cast- it is just an indicator of the quality of the show itself as opposed to just being an "audience pleaser" (as we recall, by construction we do not have real failures in our data set). We also control for the number of years between the debut of the show and the time when the transition occurs coding a variable "time of transition". We adjust all dollar figures to inflation using the annual consumer price index for the relevant year from the BLS.gov web site. All dollar figures are in 2013 constant dollars.

As mentioned earlier, we clean up the data set by eliminating all transitions that occur within three weeks of each other because we cannot tell which of the transitions is related to the

[14] There is a difference between an assistant director and assistant to the director. The latter is not usually involved in the creative part of the job, but helps the director in various administrative tasks.
[15] Since some of the shows are long running, a director may be directing a few shows simultaneously. For example, if a show started its run in 2002 and we are looking at a 2010 transition, it may be that the incoming actors might have worked with the current director on a different show in say, 2005.
[16] This is similar to seasonal effects documented in movies, see Ravid (1999), Einav (2007)

observed economic changes (if any). We also drop cases where performers were replaced for just a few days.

Some of the shows we started with did not have any transitions (in other words, the original cast played from the opening night until the show closed) and in other cases there were transitions, but we did not have data on transition date or show performance. Furthermore, we eliminate the transitions that are within three weeks of each other and multiple transitions occurring on the same day are consolidated to one transition (a cast change). We ended up with 332 transitions involving 82 shows. We collected 998 performer-year combinations and 649 unique performers. All variable definitions are in appendix C.

IV.2 Definition of stars

One of the main challenges we face is the definition of stars. We characterize three groups of performers as stars, roughly enabling us to test our hypotheses.

The first definition is of "theater stars". These are the people who approximately match the Macdonald (1988) profile, i.e. these are actors who have been vetted through the profession. In our main specification, we define theater stars as performers who have earned at least two Tony nominations by the time they join the show. Tony Awards are considered the premium awards in theater business. Using this definition, 64 performer-year combinations are identified as theater stars out of 707 performer-year combinations. 51 unique theater performers are identified as stars using this definition out of a total of 498 performers.[17] We also tried other definitions, varying the number of Tony awards and nominations. We present the results for three Tony nominations in the paper. In other (unreported) tests we use an alternative definition based upon the total number of theater awards received by the performer. Results remain similar to the results we report in the text.

The second type of stars we identify are "movie stars". Movie actors are in the same profession as theater actors, although acting in movies is quite different than acting in shows. More importantly, typically movie stars are much more well- known than theater stars, and thus can fit more closely with the Rosen (1981) or Adler (1985) definitions. Specifically, we define movie stars as performers who have earned at least one Oscar nomination by the time they join the show. This definition is consistent with prior literature (See for example, Ravid, 1999, Basuroy et

[17] Examples of Theater stars include Alan Alda, Bebe Neuwirth, Brian d'Arcy James, Carolee Carmello, Harvey Fierstein, Idina Menzel, Judd Hirsch, Mercedes Ruehl, Nathan Lane, and Victor Garber.

al. 2003). 23 performer-year combinations are identified as movie stars and we identify 18 individual stars.[1819] Again, we use various other definitions and awards for robustness checks. There is some overlap between "theater stars" and "movie stars", and we discuss this further below.

Finally, we define "well known people" or celebrities. If it turns out that a "name" (somebody who is known from TV, writing or otherwise) is a draw, which is a common belief in the industry, this will be closer to the Adler (1985) definition. Specifically, we define "visibility stars" as the top 10% of performers in terms of the total number of appearances- as it turns out this group includes all actors who have made at least 50 appearances in movies, TV shows, and Broadway shows. We identify 70 such performer-year combinations including 57 distinct "visibility stars".[2021]

Once stars are identified, we can distinguish among three types of transitions for each star type: a type 1 transition is where non-stars are replaced by stars, a type 2 transition is where stars are replaced by non-stars, and type 0, is where there is no change in terms in the star status of the actors performing before and after the transition.

As discussed, sometimes, more than one person is replaced in a show. We call such scenarios "cast transitions". We combine these changes into one record and the transition type is determined by the overall direction of change among the cast members replaced and those who are coming in. Specifically, if the cast transition is a mixture of type1 change(s) and type 0

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[18] Movie stars include among others Jeff Goldblum, John Lithgow, Sally Field, and Kathleen Turner.

[19] All our "movie stars" (by definition) have acting nominations (or wins) for Oscars. One theater performer who is a well-known singer has an Oscar nomination for music. We ran all the relevant tables with and without this performer and the results do not change. In order to be fully transparent the results reported display the analysis with this performer identified as a movie star.

[20] Almost by definition, some "visibility stars" are also "movie stars" or "theater stars". If the power of the tests were to come from the visibility rather than the talent, then we would expect significant results for the visibility stars and possibly less significant results for the other types. However, as we will see below, we find no significant results for the visibility stars. We also tried the top 5% of performers, and the results were similar (see Appendix B). We present the 10% results in the table because the numbers of performers if we choose this characterization is of the same order of magnitude as the number of stars in other categories. Visibility Stars (who are not also theater or movie stars) include for example, Brooke Shields and Tom Bosley.

[21] A discussant suggested that we try Grammy winners (the most celebrated music awards) on the theory that in musicals (which are most of our sample) Grammy winning would also indicate a "star". However, only two performers in our sample had won a Grammy prior to their appearance in our data base (Julie Andrews and Huey Lewis). A handful won after the appearance in our shows. There were two nominees (who did not win) Keith Carradine and Ricky Martin. This does not allow us to establish an independent class of "music stars" and more importantly, shows that there is not a clear overlap of skills between music stars and Broadway performers. Mr. Carradine and Ms. Andrews is classified as a movie stars in our paper (and otherwise..). Mr. Lewis was nominated for an Oscar for the best original song.

change(s), the cast transition is coded as a type 1 change. Similarly, if the mix is composed of type 2 change(s) and type 0 change(s), the cast transition is coded as a type 2 change. However, if the mix is composed of both type 1 change(s) and type 2 change(s), we code the transition as a type 3 change (unknown) and drop them from the analysis. These cases are very rare. We control for cast transition in our regressions as well.

V. Analysis and Results

V.1 Summary Statistics and Means Comparisons

The following table, table 1, shows the summary statistics of our dataset. Gross change (000 $) is the change in average weekly gross revenue between the three weeks prior to the transition to the three weeks following the transition, excluding the transition week. Ticket price change is the change in the average ticket price between these two periods, and capacity change is the change in the ratio of seats sold over total seats between the two periods.

Most of the transitions in our sample (91%) are in musicals. 36% of the transitions are in revivals. In 22% of the cases we have cast changes. The average transition in our sample occurs just over 4 years into the run, but the transitions span the lifetime of the shows we cover.

Table 1 shows that on average, all transitions cause a drop in revenue, capacity and ticket prices. We also see, however, that there is a significant variation among shows (high standard deviation). The capacity change is relatively small on average, consistent with the notion that indeed producers are trying to optimize capacity.

Insert Table 1 here

We show the change in performance by transition type in Table 2 below. This table compares transitions when a “non-star” replaces a “non-star”, a “star” replaces a “non-star” and a “non-star” replaces a “star”, according to various “star” definitions. Only “theater stars” seem to increase ticket prices, capacity and revenues. For all types of stars there seems to be a drop in revenues, ticket prices and capacity when a star leaves the show. We should keep in mind that there are stars who are both theater stars and movie stars, and indeed the regression analysis below will show that this makes a difference.

Insert Table 2 here

V.2 Regression analysis

We run regression analysis with the performance change as the dependent variable and the type of transition as an explanatory variable, where the default is a non-star to non-star transition. We control for the year when the transition occurred, whether the transition is a cast transition, and for seasonal effects. We run two types of controls for the show characteristics. The baseline analysis is run with fixed effects which control for any observed and unobserved show features.[22] As a robustness check we also run OLS with standard errors clustered by shows, where we control for the type of show (musical vs. play), whether the show is a revival, and whether the show itself had won any award (which is another proxy for overall quality).

In tables 3 we test for any star effects for our main characterization of "stars", following our three empirical classifications, essentially testing hypotheses 1 and 2 within a regression framework.

Insert Table 3 here

The left panel in table 3 shows that for "theater stars" (theater stars are performers who had earned at least 2 Tony nominations by the time of the transition) transitions from non-stars to stars significantly improve the economic performance of a show relative to other transitions. Both capacity and ticket prices increase significantly as do revenues. When we examine the data, we see that not only the means, but the medians reflect the superior performance of "theater stars"

[22] Following a discussant's suggestion, we ran all regressions with random effects as well. The results were qualitatively similar.

where median capacity and revenue increase as a "theater star" enters and drop as they exit. These findings seem to support hypothesis 2 and suggest that even for the successful shows in our sample, adding vetted theater stars can make a difference. Specifically, table 3 seems to be consistent with the MacDonald version of the star phenomenon (H2c) - it is the most talented people, vetted through an external validation process (Tonys) who generate financial rewards. We should note that some people appear as "non-stars" in earlier years and as "stars" later on as their career evolves. Given that there are "personal fixed effects" which are hard to capture, we are encouraged by the fact that the classifications we have formed are empirically meaningful.

We cannot say whether the actors capture all the rent available but this is not critical to the argument (although it is important for the actors). The economic magnitudes of the changes associated with star inclusion are large- shows average about $750,000 per week in overall revenue, so the addition of a theater star can increase the weekly revenue by about 18%.

There are indications that teams matter- breaking up a team is costly and cast changes seem to have a negative effect on show performance. Also, reinforcing this idea, a departure of an actor who had worked with the current director before has a significant negative effect. It also seems that the time from the opening has an effect, but this effect is not easy to interpret. Seasonal effects matter as expected. The before-peak dummy has a strong positive effect; the after-peak dummy has a strong negative effect because the seasonal effect works against the change in this case.

In the middle panel we consider transitions involving movie stars (movie stars are performers who had earned at least one Oscar nomination by the time of the transition). Here both types of transitions (from star to non-star & from non-star to star) have no significant effect on show performance. This again supports the MacDonald (1988) view of stars. It is the theater specific talent or training that counts.[23] Interestingly, again, the team variable is significant in the same direction, i.e. breaking up a "team" is detrimental to the economic performance of a show.

Finally, we run an analysis with "visibility stars" (visibility stars are performers who have made at least 50 appearances in movies, TV shows, and Broadway shows, which is the top ten percent in terms of total appearances). As we see in the right most panel, neither type of transition has a significant effect on performance changes, suggesting that visibility stars do not affect the

[23] There are only two cases where a movie star replaces a theater star. In both of these cases, there was a very large drop in ticket prices, capacity and revenues. Obviously we cannot draw statistical inferences, but these cases are indicative.

economic value of Broadway shows. This does not provide support to the Adler (1985) view of stars. As noted before, some of our theater and movie stars are included in the set of visibility stars. However, it is clear that the addition of the other actors to the list just creates noise that dampens the significant effects found for theater stars. Again, the team variable is important. We notice that if a star leaves a show where he had worked with the director before (old team) there is an additional drop in revenues. Seasonal effects matter.

Our analysis so far identifies theater stars as the value drivers in the industry confirming the MacDonald (1988) characterization of stars (Hypothesis 2C). We also seem to show that other types of stars do not matter. We ran numerous other specifications of theater stars and results remain qualitatively similar.

The results make sense in the institutional context. Theater acting requires different skills than movie or TV acting. First, the training is different. For example, NYU Tisch School of the Arts with one of the most prestigious theater school and a very good film department, has a very different curriculum for theater actors and professionals and for film students.

The blog theaterfolk(https://www.theatrefolk.com/blog/stage-vs-screen-a-comparison-of-acting-techniques/) provides perhaps one of the clearest descriptions of the difference between theater acting and movie acting. “Theater is all about exaggerated body and facial gestures vs. subtle facial expressions which can be captured in a close up on film. Theater requires actors to project, speak in unnaturally loud voice with flawless diction and of course, there is no second take. In movies you can always re-record and microphones allow for much less clear annunciation. Theater performance requires a connection with the audience and ability to improvise should it be needed. In movies, you can always re-take the scene. This makes it clear why it is that movie actors, trained on subtle expressions, low voices and the ability to perfect a scene, may not do well in theater”

V.3 Theater stars Once Again

One concern with the foregoing analysis may be the way we classify “non-stars”. For example, in the analysis of movie stars, theater stars and visibility stars (who are not also movie stars) are considered non-stars. This may confound the results as we know now that theater stars matter. Hence, in table 4 below, we remove all the transitions from one type of star to another. For example, in the left panel (theater stars), we remove all the transitions from a theater star to a movie or a visibility star. We similarly reduce the number of observations in the other panels.

The results are consistent with the results in the previous table. Revenues increase more than in the previous table when a theater star joins the show, which strengthens the conclusion that theater stars make a difference. If we compare the two specifications, it seems that transitioning from other "stars" to a theater star is not as beneficial as transitioning from an unknown actor to a theater star, which makes sense. However, it is still dramatically better to put a theater star in the show than any other star in the first place, and removing any other "star" and including a "theater star" instead is still a very profitable proposition. The visibility stars and movie stars results are insignificant as they were in the previous table, so that the lack of impact is not driven by a transition to or from a "more prominent star" (a theater star) but apparently by lack of interest on the part of the audience in movie and visibility stars as theater actors. In all cases the team and seasonal variables are significant as they were before.

Insert Table 4 here

As a final concept check, we try to narrow the definition of a "theater star" to people with 3 Tony nominations. There are two Tony categories for actors (a leading actor and a supporting actor) for musicals, and similarly four Tony categories for plays. There are also the same eight categories for actresses. The Tonys separate between musicals and plays, but since 91% of our transitions are in musicals, we are basically looking at the musicals category. To get a sense for the nominations cutoffs, consider the "best actor in a musical" category. Out of 251 nominations between 1948 and 2017, 147 performers had only one nomination, 27 had 2 nominations. Only 14 performers had 3 nominations, and only two nominees had 4 nominations. Therefore, only 18 men had three nominations or more in this category over a 70 year period (as discussed, there is a separate process for women). Thus the threshold of three nominations identifies a very prestigious class of actors. In our sample we have 25 such men and women (34 performer years).

Table 5 below shows the results for 3 Tony nominations. The left panel is similar to previous results in magnitudes and significance except that the ticket price change for adding a star is in the right direction and magnitude but it is insignificant. This may be the result of fewer "stars" in

the sample. However, when we have "pure" transitions the magnitudes shoot up. The main change is in capacity- more people come when an unknown actor is replaced by a theater luminary and the increase in revenues is most dramatic- as described previously, the average show takes in about $750,000 per week so the change in revenues is about 50% of the average total revenue per week.

Insert Table 5 here

V.4 Robustness Checks

As a robustness check, we re-ran all regressions in the paper using OLS with standard errors clustered by shows. In these analyses, we are able to see the effect of show characteristics (they are dropped in the fixed-effects analysis). The results shown in table 6 confirm our previous analysis and suggest that theater stars affect performance in a very clear fashion. The only additional result is that revenues seem to drop if movie stars leave the show as well, although neither ticket prices nor capacity do not change significantly. We looked at these transitions in detail- this may be due to show characteristics captured by fixed effects but not by the control variables we have here as well as to seasonal effects (the specific timing of these transitions).

The coefficient of cast changes is negative as it was in the previous regressions, and usually significant. The old team variable is negative but the significance is generally in regressions where capacity is the dependent variable. We may conclude that there is some support for the team idea. Similarly, musicals seem to be somewhat less affected by changes than other types of shows.[24] Interestingly, show related awards (show quality) do not seem to make a difference. Possibly musicals (or not) and revivals (or not) are more important in determining how a transition would fare. Also, we should keep in mind that we are looking at the effect of the control variables on transitions- it may well be that awards do affect the fortunes of the show, but do not affect transitions.

[24] These results are consistent with survival analysis by Kulmatitskiy et al. (2015) which finds that musicals survive longer and revivals are less likely to have long runs.

To address the potential concern that our results may be driven by a few outliers, we ran four (unreported) robustness checks. First, we removed the transitions with extremely high gross change (top 5 and top 10 percentiles of gross change respectively). Then we removed the transitions with extremely low gross changes (bottom 5 and 10 percentiles of gross change respectively). The results of these four regressions remain similar to our main results.

Insert Table 6 here

V.5 Are stars overpaid?

We will now provide a partial answer to this question. According to tables 3, 4.5 and 6, theater stars, who are the stars that seem to matter most in this exercise, increase show revenues by at least $72,000 a week on average. Three time Tony nominees may bring the revenue bump to over $360,000 (consider the coefficients on non-star to star variable in tables 3,4 5 and 6) . The lower bound comes from table 6. The coefficients indicate a star value of at least $125,000 per week in all fixed effects models, which we believe may be more robust.[25]

We note that part of the increase comes from increased attendance and the other part comes from a significant increase in the average ticket price.

Since, as discussed, the show continues exactly as it had run before, except for the change in cast, the entire surplus must be due to the star's presence.

Even $72,000 a week is more than most theater stars get paid (the union (Equity) mandated minimum pay for a principal actor in a play or a musical was $1861 per week as of September 2015). However, as early as 2002 the New York Times, in discussing cost components of Broadway shows, said "and stars like Nathan Lane can make more than $50,000 a week".[26] Mr. Lane is a "theater star" (in his case the quotes are probably unnecessary) in our sample. Most salaries on Broadway are not released to the public (for one of the very few studies of movie star

[25] An indication that we are in the ball park for these effects can be found in an interesting article regarding the show "Love Letters". The show features two actors, a man and a woman. Deadline.com (Jeremy Gerard) wrote on November 17th, 2014: "Hawkeye Pierce and Murphy Brown — who knew? In a somewhat slumpy mood last week, the Broadway box office had a bit of good news for the latest *Love Letters* pairing of Alan Alda and Candice Bergen, lifting the revival almost $90,000 to $483,280 at the Brooks Atkinson". Alan Alda is a theater star in our listing.
[26] Jesse Mckinley, The New York Times, Sunday, May 19th 2002 – "And the Stub is all Yours".

salaries see Chisholm, 1997), but this bit of casual evidence seems to show that theater stars may actually capture their value. We also keep in mind that the weekly pay, as defined by Equity, includes rehearsal weeks and not just performance weeks, so that, for example, Mr. Lane was paid more than $50,000 for each week audiences got to see him. However, our work also suggests that it is important to pay the right people. If theaters pay outsized salaries to movie stars or celebrities, they are wasting their money, at least according to our analysis.

V.6 Alternative Definitions

As discussed earlier, we ran a few alternative definitions of various star categories. Appendix B contains a few of the more interesting runs.

One may worry that visibility stars are too broadly defined adding noise and leading to the insignificant results. To address this concern we run an analysis with a narrower definition for visibility stars – namely, a performer in the top 5 percent of total credits. The results are listed in appendix table B1. There are still no significant coefficients. Thus it seems that our conclusion that visibility stars do not matter is robust.

As another robustness check, we ran an (unreported) analysis that only includes transitions occurring two years after the start of the show. These transitions are unlikely to reflect managerial decisions and are most likely to be motivated by contract issues. The results are similar.

We also tried to see whether "multi-talented" stars matter – does movie luster add economic value to theater skills?. This analysis is presented in tables B2 and B3 using alternative definitions. The number of multi-talented people is rather small (20 unique performers for the narrower definition and 29 for the broader one), and the results are similar to the previous results. However, here sometimes the departure of a multi-talented star is significant as well. This provides some support to the view that theater stars who are also known through their movie career may be more attractive to audiences.

Finally although it seems evident that star transitions matter more for leading roles, we collected information about transitions in other random roles in shows. There were less star related transitions in this sample, both in absolute number and in relative terms (for example, we could find no cases of non-stars in minor roles who were replaced by stars, possibly not a surprising finding…). In unreported regressions, we found that transitions from "star" to "non-star" were

insignificant, although team and seasonal variables were significant. We believe that this supports our strategy of focusing on transitions for featured leading roles, and shows the pervasiveness and importance of teams. Possibly another conclusion from this exercise is that unless you have a very clean experiment, it is difficult to disentangle the influence of team-work from the value of individual participants in a creative enterprise.

VI. Conclusions:

We find that theater stars, i.e. people who are recognized as exceptionally talented theater actors, matter to the success of theater shows. Our experiment has more power than previous studies in other spaces to identify such effects and thus may not be inconsistent with work that found little or no effect of stars on the success of movies (Ravid, 1999, Elberse, 2007, DeVany and Walls, 1999) as well as inconsistent evidence on music stars and indirect evidence on star CEOs.

Using our approach, we are able to eliminate both time-varying and time-invariant omitted variable bias, which have been concerns in the CEO and movie literature. The CEO turnover literature compares the performance of firms before and after a CEO turnover. Since the performance of the firm is determined by many interlacing factors, that can change after a transition (such as firm strategy, the competitive environment, or support from the board), failure to control for these time-varying variables can bias the results. In our setting, since all other aspects of the show (including the script, the director, the other performers, the stage design, etc.) stay the same after the transition, we are able to minimize the concern of time-varying omitted variables. The movie literature compares the performance of two movies, one with a star and the other without a star. It is difficult to control all the other factors that contribute to the success of a movie (such as performance of other performers, the script, the director, etc.). Thus these time-invariant omitted variables pose a concern. In our setting, we are comparing transitions within a show thus eliminating the concerns of time-invariant omitted variables.

Our results can be interpreted as supporting theoretical papers such as MacDonald (1988) and Rosen (1981) and less supportive of models such as Adler (1985).

Our experiment also seems to suggest that if MacDonald type stars are correctly identified, they deserve a pay far outstripping union wages.

Movie stars and celebrities, however, do not seem to have the same effect on the success of theater shows, except that screen credentials can enhance the value of theater stars.

Our key contribution is in using a tightly controlled experiment to measure the contribution of key players in an organization and characterize these key players. While theater is a specific setting, one may surmise that if such experiments were possible in other areas of human enterprise the results would probably be amplified, since individuals are freer to express more aspects of their personality and creativity in many other professions.

This paper also adds to a long list of studies which find that teams matter a great deal to the success of any organization.

We also identify a significant seasonal effect in all regressions, and to some extent we see that musicals are helpful in sustaining a show momentum.

Our main conclusion, that it is theater stars that support long running shows rather than other types of stars, is echoed in the review of the show **Finding Neverland** by Times critic Ben Brantley . The review laments the replacement (from the previous sold out Cambridge MA. production of the musical) of Jeremy Jordan "who exuded a sweetness thinning anguish that seems to be about something other than an actor's being stuck in an uncomfortable production" with TV star Matthew Morisson and the replacement of the "very good" Michael McGrath with TV star Kelsey Grammer.[27] Mr. McGrath (two Tony awards and several other accolades) would be classified as a "theater star" in our paper and Mr. Jordan who had only one Tony nomination, but had also won the award could arguably be included as well.

To be fair, both Mr. Grammer and Mr. Morisson have one Tony nomination each (and a storied TV career).

[27] NY Times, first Arts page, 4/16/15

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Table 1: Summary Statistics (stars in this table are theater stars and the percentages are out of the total number of transitions)

	N.	Unit	Mean	Std. Dev.	Min	Max
Gross change	332	000 $	-22.10	156.89	-666.29	485.71
Ticket price change	331	$	-1.75	8.67	-38.10	23.34
Capacity change	331	Percent	-1.03	10.61	-38.56	26.80
Cast change	332	Dummy	0.22	0.42	0	1
Time elapsed from opening night	332	Year	4.33	4.10	0.07	16.08
Non-star to star	332	Dummy	0.05	0.22	0	1
Star to non-star	332	Dummy	0.11	0.32	0	1
Musical	332	Dummy	0.91	0.29	0	1
Revival	332	Dummy	0.36	0.48	0	1
Award	332	Dummy	0.71	0.45	0	1
Before peak week	332	Dummy	0.05	0.22	0	1
After peak week	332	Dummy	0.09	0.29	0	1
Old team	332	Dummy	0.02	0.12	0	1
New team	332	Dummy	0.02	0.14	0	1

Table2: Average performance changes for different types of stars

	Theater Star				Movie star				Visibility star			
	N	**Gross change**	**Ticket change**	**Capacity change**	**N**	**Gross change**	**Ticket change**	**Capacity change**	**N**	**Gross change**	**Ticket change**	**Capacity change**
No change	276	-22.34	-1.58	-1.08	315	-17.49	-1.43	-0.68	283	-18.90	-1.45	-1.00
Non-star to star	17	67.88	0.86	5.73	9	-66.94	-7.70	-5.55	23	-37.71	-3.48	-0.51
Star to non-star	38	-62.76	-4.33	-3.86	7	-177.89	-8.95	-11.44	22	-28.96	-2.06	-1.43

Table 3: Fixed effects Models (In this table and in all other tables standard errors are in brackets.)

Theater Star: At least two Tony nominations
Movie stars: At least one Oscar nomination
Visibility stars: At least 50 screen and theater appearances
Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percent.
Year dummies are included.

	Theater Star			Movie Star			Visibility Star		
	Gross change	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**
Star to non-star	31.572 (37.412)	3.146+ (1.806)	1.204 (2.474)	-67.141 (73.875)	-2.784 (3.558)	-3.378 (4.898)	-10.059 (39.116)	-1.494 (1.883)	2.103 (2.541)
Non-star to star	134.618** (47.536)	5.997** (2.295)	9.819** (3.143)	29.225 (63.472)	2.968 (3.057)	4.648 (4.209)	9.547 (38.886)	-0.805 (1.872)	2.760 (2.526)
Cast change	-56.796* (24.656)	-3.055* (1.190)	-4.614** (1.630)	-41.968+ (24.501)	-2.362* (1.180)	-3.832* (1.625)	-41.320+ (24.522)	-1.989+ (1.180)	-3.930* (1.593)
Time of transition	62.582+ (36.279)	6.262*** (1.752)	-4.088+ (2.399)	57.614 (36.653)	5.881** (1.765)	-4.354+ (2.430)	71.076+ (37.073)	6.650*** (1.784)	-3.756 (2.408)
Old team	-262.613** (95.362)	-13.242** (4.604)	-11.058+ (6.306)	-265.312** (96.537)	-12.971** (4.650)	-11.419+ (6.401)	-274.876** (97.163)	-13.045** (4.677)	-12.875* (6.312)
New team	38.605 (76.785)	-1.796 (3.707)	2.377 (5.077)	31.852 (77.945)	-2.036 (3.754)	1.966 (5.168)	34.825 (77.918)	-2.172 (3.750)	2.469 (5.061)
Before peak week	95.935* (42.750)	1.449 (2.064)	8.894** (2.827)	107.270* (42.880)	1.603 (2.065)	9.800*** (2.843)	102.375* (43.881)	1.762 (2.112)	7.848** (2.850)
After peak week	-226.298*** (36.521)	-11.821*** (1.763)	-12.704*** (2.415)	-226.586*** (37.404)	-11.822*** (1.802)	-12.699*** (2.480)	-229.800*** (37.089)	-11.903*** (1.785)	-13.132*** (2.409)
Observations	332	331	331	332	331	331	328	327	327
R-squared	0.324	0.385	0.256	0.304	0.369	0.229	0.308	0.377	0.228
Number of shows	82	82	82	82	82	82	82	82	82

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 4: Pure stars: removing all transitions involving other types of stars (Fixed effects)
Theater Star: At least two Tony nominations
Movie stars: At least one Oscar nomination
Visibility stars: At least 50 screen and theater appearances
Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percent.
Year dummies are included.

	Theater Star			Movie Star			Visibility Star		
	Gross change	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**
Star to non-star	25.470	1.926	2.711	-139.930	-9.823	-3.069	-9.562	-1.536	3.278
	(48.162)	(2.254)	(2.929)	(156.749)	(7.660)	(9.717)	(57.324)	(2.897)	(3.561)
Non-star to star	151.055*	5.733*	9.714*	128.904	8.171	8.418	3.408	-1.152	1.458
	(61.782)	(2.891)	(3.758)	(149.052)	(7.284)	(9.239)	(47.993)	(2.425)	(2.981)
Cast change	-58.991*	-3.325*	-4.587**	-32.573	-1.809	-3.337+	-45.935	-2.638	-4.177*
	(27.636)	(1.293)	(1.681)	(31.105)	(1.520)	(1.928)	(32.151)	(1.625)	(1.997)
Time elapsed	89.610*	8.161***	-2.935	75.580+	8.286***	-3.282	57.293	6.429**	-3.955
	(40.739)	(1.906)	(2.478)	(40.108)	(1.960)	(2.486)	(39.855)	(2.014)	(2.475)
Old team	-383.549**	-20.671***	-15.507*	-788.558***	-39.592***	-32.591**	-421.063***	-19.603**	-19.704**
	(127.220)	(5.953)	(7.737)	(163.308)	(7.980)	(10.123)	(117.225)	(5.924)	(7.281)
New team	78.132	-0.759	4.386	104.747	1.414	7.544	100.667	1.081	7.710
	(89.500)	(4.188)	(5.443)	(102.196)	(4.994)	(6.335)	(106.278)	(5.371)	(6.601)
Before peak week	76.419	0.458	6.774*	85.233	0.704	7.262*	98.220*	1.617	7.938*
	(49.257)	(2.305)	(2.996)	(51.855)	(2.534)	(3.214)	(49.710)	(2.512)	(3.088)
After peak week	-210.871***	-11.736***	-10.273***	-198.241***	-11.606***	-7.753**	-208.546***	-11.627***	-10.105***
	(40.407)	(1.891)	(2.458)	(42.519)	(2.078)	(2.636)	(43.251)	(2.186)	(2.686)
Observations	276	275	275	239	238	238	259	258	258
R-squared	0.330	0.430	0.243	0.356	0.458	0.234	0.295	0.355	0.226
Number of shows	71	71	71	64	64	64	66	66	66

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table 5: Theater stars as performers with at least 3 Tony nominations (Fixed effects)

Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percent. Year dummies are included.

	All transitions			Removing transitions involving movie and visibility stars		
	Gross change	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**
Star to non-star	-47.279	-0.146	-1.738	-80.804	-0.594	-1.411
	(46.606)	(2.267)	(3.078)	(67.838)	(3.208)	(4.194)
Non-star to star	125.342+	4.263	11.613**	366.644**	11.963*	16.584*
	(66.264)	(3.223)	(4.376)	(125.202)	(5.92)	(7.741)
Cast change	-43.915+	-2.354*	-4.005*	-56.604*	-3.234*	-4.295*
	(24.245)	(1.179)	(1.601)	(27.376)	(1.294)	(1.693)
Time of transition	50.987	5.751**	-4.822*	71.783+	7.655***	-3.635
	(36.44)	(1.772)	(2.406)	(40.715)	(1.925)	(2.517)
Old team	-252.505**	-12.907**	-10.969+	-339.024**	-19.637**	-13.856+
	(96.27)	(4.682)	(6.357)	(127.48)	(6.028)	(7.881)
New team	26.233	-2.111	1.636	73.575	-0.553	4.596
	(77.331)	(3.761)	(5.107)	(87.291)	(4.128)	(5.397)
Before peak week	102.025*	1.601	9.585***	94.077+	1.022	7.696*
	(42.529)	(2.068)	(2.808)	(48.388)	(2.288)	(2.992)
After peak week	-236.452***	-12.332***	-13.587***	-214.392***	-11.890***	-10.497***
	(36.814)	(1.79)	(2.431)	(40.017)	(1.892)	(2.474)
Observations	332	331	331	276	275	275
R-squared	0.317	0.369	0.25	0.345	0.431	0.235
Number of shows	82	82	82	71	71	71

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table 6: OLS Models

Theater Star: At least two Tony nominations
Movie stars: At least one Oscar nomination
Visibility stars: At least 50 screen and theater appearances
Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percent.
Year dummies are included.

	Theater Star			Movie Star			Visibility Star		
	Gross change	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**	**Gross change**	**Ticket price change**	**Capacity change**
Star to non-star	-17.532	-0.917	-0.939	-97.850*	-3.739	-6.973	-22.935	-0.753	-0.441
	(29.591)	(1.559)	(2.153)	(43.215)	(2.298)	(5.639)	(28.244)	(1.339)	(2.966)
Non-star to star	72.078***	2.495**	6.107**	-24.811	-2.820	-2.239	11.704	-0.264	3.201
	(20.371)	(0.833)	(2.071)	(42.495)	(4.162)	(5.458)	(26.352)	(0.987)	(2.729)
Cast change	-45.500+	-3.109*	-3.567*	-38.720	-2.754*	-2.923*	-41.533+	-2.932*	-3.629*
	(24.960)	(1.352)	(1.512)	(23.302)	(1.276)	(1.314)	(23.608)	(1.316)	(1.380)
Time of transition	1.764	0.092	0.104	1.711	0.093	0.102	1.995	0.104	0.093
	(1.827)	(0.119)	(0.146)	(1.859)	(0.121)	(0.140)	(1.867)	(0.122)	(0.148)
Old team	-130.939	-4.318	-9.206*	-148.830	-5.166	-10.492*	-144.794	-4.821	-10.282*
	(128.646)	(7.403)	(4.347)	(122.634)	(7.130)	(4.144)	(124.473)	(7.209)	(4.157)
New team	11.254	0.351	-0.305	6.882	0.141	-0.628	10.029	0.224	-0.199
	(34.539)	(2.264)	(1.958)	(34.153)	(2.305)	(1.819)	(34.117)	(2.358)	(1.735)
Before peak week	81.231*	1.447	6.401*	91.875*	1.916	7.296*	90.438*	1.902	5.501+
	(39.695)	(1.948)	(3.131)	(37.964)	(1.692)	(3.272)	(39.291)	(1.836)	(2.840)
After peak week	-224.800***	-13.254***	-9.762*	-225.194***	-13.270***	-9.860*	-231.381***	-13.455***	-10.273*
	(29.996)	(1.517)	(4.254)	(28.497)	(1.450)	(4.184)	(30.754)	(1.525)	(4.267)
Award	-9.602	0.527	-0.654	-2.956	0.769	-0.161	-6.887	0.626	-0.195
	(17.198)	(1.113)	(1.251)	(15.947)	(1.068)	(1.157)	(16.219)	(1.090)	(1.233)
Musical	35.339	4.912*	5.579*	23.379	4.232*	4.604*	33.024	4.765*	6.509**
	(24.483)	(1.934)	(2.297)	(26.334)	(1.881)	(1.942)	(26.247)	(2.081)	(2.299)
Revival	-2.102	-0.815	-0.569	1.166	-0.598	-0.354	-1.844	-0.732	-0.931
	(15.440)	(0.848)	(1.278)	(14.884)	(0.825)	(1.187)	(14.831)	(0.842)	(1.224)
Observations	332	331	331	332	331	331	331	330	330
R-squared	0.273	0.284	0.238	0.270	0.284	0.232	0.263	0.279	0.233

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

<u>Appendix A:</u> The opening night Playbill for the show Mamma Mia. We use the first three featured actors.

WHO'S WHO IN THE CAST

LOUISE PITRE (*Donna Sheridan*). Original Donna (North America), for which she was awarded the Dora Mavor Moore Award (Toronto), San Francisco Critics Circle Award and the U.S. National Broadway Award; Piaf* (*Piaf*); Mrs Johnstone* (*Blood Brothers*); Fantine (*Les Misérables*, Paris cast recording); *The World Goes 'Round; I Love You, You're Perfect, Now Change; Jacques Brel Is Alive and Well...; Who's Afraid of Virginia Woolf?* (Martha). Her CD "All of My Life Has Led to This" (containing two songs from *Mamma Mia!*) is in stores or at www.louisepitre.com. Oh, and she's French, so it's "Pee-trah" - not Petrie. *Dora Mavor Moore Award (Toronto).

DAVID W. KEELEY (*Sam Carmichael*). Broadway: *The Mikado*. Royal Alex: *Mamma Mia!* Stratford Festival of Canada: *Hamlet*, *The Three Musketeers*, *Richard III*, *Coriolanus*, *Love's Labour's Lost*, *The Changeling*. Citadel Theatre: *As You Like It*, *Oedipus*, *Oliver*, *Romeo and Juliet*, *Robin Hood*. Other theatre: *The Rocky Horror Show*, *Born Yesterday*, *Napoleon*. Film & TV: *Sugartime*, *A Saintly Switch*, *Forever Knight*, *The Dan Jansen Story*. David has two independent CDs released with "Due South" star Paul Gross, titled *Two Houses* and *Love and Carnage*.

TINA MADDIGAN (*Sophie Sheridan*). Broadway debut. Originated role of Sophie in Toronto and was nominated for National Star Award in North American tour of *Mamma Mia!* From the rocky shores of Newfoundland, Canada, Tina studied musical theatre at Sheridan College (Toronto). Regional credits: Sally (*Me & My Girl*), Sister Amnesia (*Nunsense*) and Cinderella in *Cinderella*. Tina thanks her high school teacher Jacinta for instilling the dream and her devoted mother for supporting the dream. Love to family, Darren and D.C.! www.tinamaddigan.com

JOE MACHOTA (*Sky*). Broadway debut. Recently created the role of Laurie in the pre-Broadway workshop of *Little Women*. National tours include *Footloose* (Ren McCormack), *Joseph...* (Joseph). Regional: *Gypsy* w/Betty Buckley (Tulsa), *Starlight Express* (Rusty) and played the lead role in *EFX!* for the vacationing Michael Crawford. New York workshops: *Romeo & Juliet* (Romeo), *Go Go Beach* (Woody). A graduate of the Boston Conservatory, Joe would like to thank all of his teachers, especially Fran, Lynne and Kerry.

JUDY KAYE (*Rosie*). Broadway: Carlotta, *The Phantom of the Opera* (Tony Award); Lily Garland, *On the Twentieth Century* (Theatre World Award, Drama Desk nomination, L.A. Drama Critics Circle Award); Emma Goldman, *Ragtime* (Theatre L.A. Ovation Award). Other roles: Musetta, *La Boheme;* Shirley Valentine; Mama Rose, *Gypsy;* Sally, *Follies;* Nellie Lovett, *Sweeney Todd;* Penny, *You Can't Take It With You;* Kitty, *The Royal Family*. Cabaret and concert performances, including the White House. Numerous recordings include solo disks *Diva by Diva* and *Songs From the Silver Screen*. She is the voice of Kinsey Millhone on the Sue Grafton "Alphabet Mysteries" recordings. For more, please visit: www.JudyKaye.com.

KAREN MASON (*Tanya*). Broadway: *Sunset Boulevard, Jerome Robbins' Broadway, Torch Song Trilogy*. Off-Broadway: *And the World Goes 'Round, Carnival*. TV/film:"Law & Order," "As the World Turns," *Sleeping Dogs Lie*. Concert/cabaret: four-time MAC Award winner, Carnegie Hall (w/NY Pops), Rainbow & Stars, Arci's, Davenport's (Chicago), Cinegrill (L.A.). CDs: *And the World Goes 'Round* (RCA); *Wonderful Town* (JAY); *Better Days* (including 1998 Emmy Award-winning song "Hold Me"); *Christmas! Christmas! Christmas!; Not So Simply Broadway* (Zevely Records); and her newest release *When the Sun Comes Out* (Jerome Records). Please visit www.KarenMason.com

KEN MARKS (*Bill Austin*). Broadway credits: *Present Laughter*, *Dancing at Lughnasa*. Off-Broadway: More than 50 productions including *Blur* (MTC), *When They Speak of Rita* (Primary Stages), *Henry V* (NYSF), *Birdseed Bundles* (DTW) as well as the Drama Dept., NYTW, MCC and Naked Angels. Regional: the Guthrie, Mark Taper Forum, ACT, Long Wharf, Seattle Rep. and ATL. Film/TV: *Bad Bride*, *The Confession*, "Law & Order," "Law & Order: SVU," "Trinity." Ken is a graduate of

Appendix B: Additional Robustness Checks

Table B1: Visibility Stars defined as performers with at least 68 credits (Fixed Effects).
Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percent.
Year dummies are included.

	Gross change	Ticket price change	Capacity change
Star to non-star	1.365	-0.978	3.667
	(45.409)	(2.188)	(3.002)
Non-star to star	6.128	1.112	2.854
	(43.985)	(2.119)	(2.908)
Cast change	-40.216	-2.246+	-3.684*
	(24.397)	(1.175)	(1.613)
Time of transition	58.084	6.001***	-4.551+
	(36.911)	(1.778)	(2.440)
Old team	-266.497**	-13.396**	-12.424+
	(98.238)	(4.733)	(6.494)
New team	32.626	-2.011	2.163
	(78.192)	(3.767)	(5.169)
Before peak week	107.766*	1.610	9.870***
	(43.021)	(2.073)	(2.844)
After peak week	-232.903***	-12.208***	-13.180***
	(37.125)	(1.789)	(2.454)
Observations	332	331	331
R-squared	0.300	0.365	0.230
Number of shows	82	82	82

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table B2: Multi-talented stars as at least two screen awards and two Tony nominations (fixed effects)

Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percent.

Year dummies are included.

	Gross change	Ticket price change	Capacity change
Star to non-star	-137.191+	1.573	-14.727**
	(74.329)	(3.646)	(4.806)
Non-star to star	117.649+	3.298	11.195*
	(67.233)	(3.298)	(4.348)
Cast change	-40.159+	-2.290+	-3.468*
	(23.862)	(1.171)	(1.543)
Time of transition	55.480	5.914***	-4.591+
	(36.069)	(1.769)	(2.332)
Old team	-263.301**	-12.862**	-11.339+
	(94.962)	(4.658)	(6.141)
New team	31.256	-2.010	1.786
	(76.660)	(3.760)	(4.957)
Before peak week	99.629*	1.623	9.107***
	(42.212)	(2.071)	(2.730)
After peak week	-239.856***	-12.207***	-13.868***
	(36.468)	(1.789)	(2.358)
Observations	332	331	331
R-squared	0.326	0.367	0.291
Number of shows	82	82	82

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Table B3: Multi-talented stars (At least two screen awards and one Tony nomination; fixed effects)

Gross Change is in thousands of 2013 constant dollars. Ticket price is in 2013 constant dollars. Capacity change is in percentage.
Year dummies are included.

	Gross change	Ticket price change	Capacity change
Star to non-star	-69.526 (51.042)	2.603 (2.499)	-5.835+ (3.327)
Non-star to star	167.673** (63.017)	5.657+ (3.086)	15.063*** (4.107)
Cast change	-42.733+ (23.730)	-2.435* (1.162)	-3.759* (1.547)
Time of transition	57.942 (35.994)	6.120*** (1.762)	-4.313+ (2.346)
Old team	-263.784** (94.529)	-12.878** (4.628)	-11.364+ (6.161)
New team	32.907 (76.320)	-1.944 (3.737)	1.973 (4.974)
Before peak week	104.364* (42.163)	1.298 (2.064)	9.603*** (2.748)
After peak week	-238.948*** (36.288)	-12.177*** (1.777)	-13.688*** (2.365)
Observations	332	331	331
R-squared	0.332	0.375	0.286
Number of shows	82	82	82

*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

Appendix C: Definition of Variables

Variables	Definition
Star to non-star	1 if the transition is from a star to non-star
Non-star to star	1 if the transition is from a non-star to star
Gross change	Change in average weekly gross revenues from three weeks before the show to three weeks after the show, in thousands of 2013 constant dollars.
Ticket change	Change in the average ticket price from three weeks before the show to three weeks after the show, in 2013 constant dollars.
Capacity change	Change in average capacity used (percentage of seats sold) from three weeks before the show to three weeks after the show.
Award	1 if the show has won any award.
Cast change	1 if the transition involves changing multiple performers on the same day.
Before peak	1 if the transition occurs within a three week window before the peak week.
After peak	1 if the transition occurs within a three week window after the peak week.
Time of transition	Years between the opening night and the transition.
Musical	1 if the show is a musical; 0 for play.
Revival	1 if the show is a revival of a previous show.
New team	1 if the new performers have worked with the director before.
Old team	1 if the old performers have worked with the director before.