SOCIAL SPILLOVERS IN CONSUMER DEMAND: THE MARKET FOR BROADWAY SHOWS

by

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I-Introduction

The study of social spillovers in consumption markets is both interesting and important for the development of economic theory, especially since social components influencing consumer demand have often been ignored in past empirical research. Including the impact of spillovers from social components enhances modelling of consumer demand. Determining the importance of social spillovers in consumer demand may also assist Broadway producers in their pricing decisions. If they are aware of the impact of such social spillovers on consumers, they will be better equipped to set prices that maximize their profits, and increase market efficiency.

This paper focuses on the presence of social spillovers in the market for Broadway shows and explores why prices remain low even in the presence of excess demand. Adopting a methodology similar to that used by Duncan Sheppard Gilchrist and Emily Glassberg Sands in *Something to Talk About: Social Spillovers in Movie Consumption*, this research examines the presence of social spillovers in the Broadway play market. More specifically, it explores whether a consumer's demand to attend a Broadway show is dependent on other consumers having previously attended. The model is set up such that the utility of attending a Broadway play is dependent on the quality of the performance and on prior attendance by others. Tickets sold in a given week increase the utility of attending that play, and this has an effect on the attendance in the following weeks. The model holds all other factors that influence the decision of attendance to a play fixed.

To observe if prior attendance influences attendance in subsequent weeks, weather shocks in the opening week of Broadway shows are used. Instrumental variables regressions, with weather shocks as the instruments, are performed to determine if social spillovers are significant. The first stage regression consists of instrumenting attendance in the opening week of a play on weather shocks in that week; the second stage involves estimating the effect of the weather shocks in the opening week on attendance in subsequent weeks (Gilchrist & Sands, p.3). Results are not significant, and possible explanations are outlined below in section VI.

Weather is an effective instrument for the instrumental variables regression as it may influence attendance in a given week because of the indoor nature of a Broadway show. Weather measures and opening attendance are controlled for seasonality resulting in unpredicted opening attendance and weather shocks. Such shocks should be exogenous to play quality and independent of supply and demand shocks afterward.

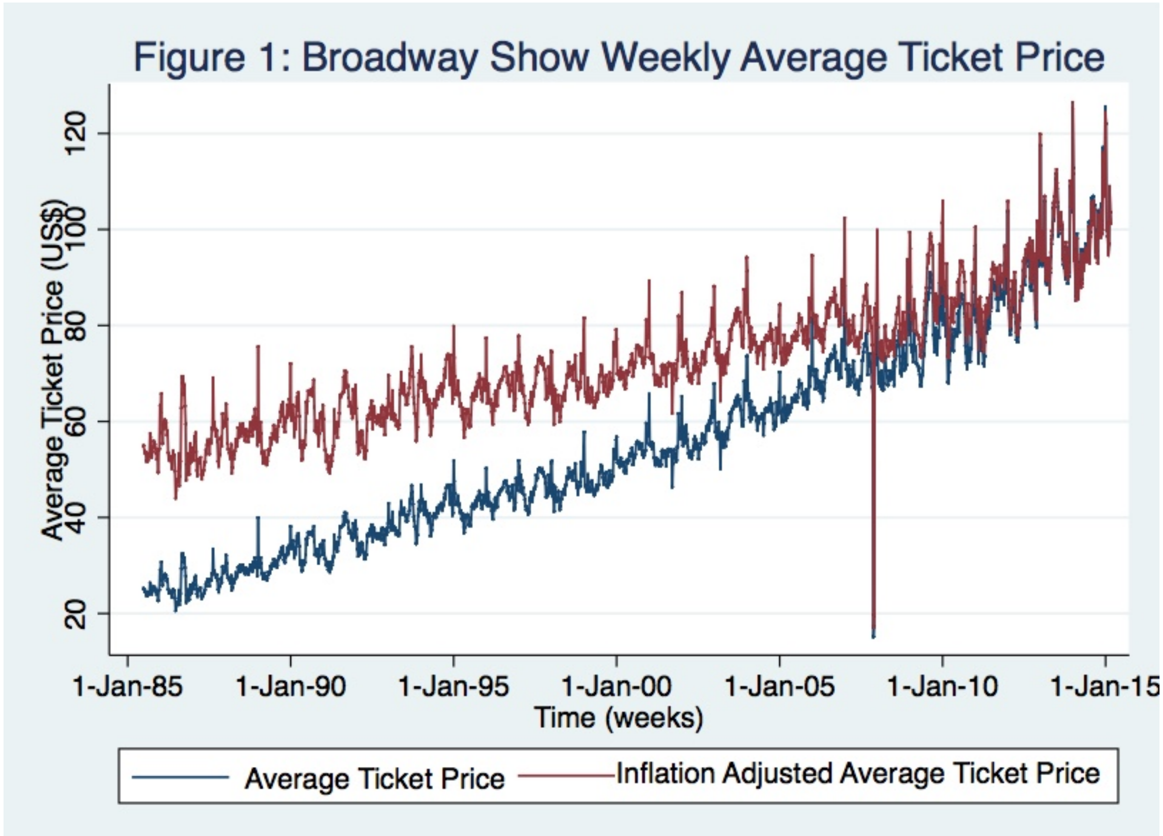
The theoretical model also allows the effect of cumulative attendance on key variables to be tested. These variables are seats sold, ticket prices, and revenues. Determining the effect of cumulative attendance on these variables reveals how social spillovers affect each of them, what are the dynamics between them, and the importance of spillovers. The results show that there is presence of social spillovers in the market for Broadway shows and each of the variables, seats sold, ticket prices, and revenues, is influenced by cumulative attendance since the opening of the show. Producers should take careful note of this type of network externality when making profit maximizing decisions.

Many studies have looked at the effect of price on demand, but often price has not been enough to explain the effects observed in restaurant, entertainment, or sporting event markets. The Broadway play market has much in common with these hospitality and event markets. Broadway shows are a popular attraction for tourists and an entertainment business with a long history in New York City where it has generated significant revenues and employment. Indeed, the Broadway show market is ideal for testing the impact of social spillovers on consumer demand in ways similar to Gilchrist and Sands' methodology. Section II addresses the motivation of this paper and provides some historical background on Broadway. Section III contains a literature review and theoretical discussion, including a summary of *Something to Talk About: Social Spillovers in Movie Consumption.* Section IV explains the model and methodology used for this paper, and its predictions. Section V describes the different sets of data used. The results and discussion of the economics behind the findings are discussed in sections VI and section VII presents concluding remarks.

II-Motivation & Broadway Background

2.1-Motivation:

The study of social spillovers in consumer demand remains a relatively underdeveloped area in the study of network externalities. In fact, the number of empirical studies focusing on the topic is small and the economic explanations resulting from existing studies remain unclear (Gilchrist & Sands, p.2). This paper attempts to further the understanding of social spillovers by examining the market for Broadway shows. This market was chosen because of the prominence of Broadway plays in the entertainment business and its historical significance for New York City. Furthermore, over the years, prices of Broadway show tickets have remained remarkably stable—indeed, noticeably so in real terms as suggested in Figure 1 which outlines nominal and real ticket prices since 1985. The presence of social spillover may explain why prices have not risen.



Note: This represents the weekly average Broadway show ticket price over the period of June 23rd, 1985 to March 7th, 2015 obtained from the Playbill website. The inflation adjustment is done using 2015 US Dollars. The sharp decrease in price in November 2007 was cause by the Stagehand strike that lasted 19 days. All shows that had contracts with Broadway theaters were affected, therefore no tickets were sold and prices dropped were these shows (Roberston, 2007).

2.2-Broadway History:

Plays in New York City began in the 1700s when the first stage was built on Nassau Street on the fringes of Manhattan and the first theater company was established (History of Broadway in New York City, 2016). In 1811, when city planners reorganized the rapidly growing city's layout using the grid system that is still in place, only the theater district around Broadway was not affected—something that makes this historic area unique. Broadway was initially an important retail area that attracted growing numbers of affluent New Yorkers and visitors, which led to cultural activities being set up in the vicinity. This ended up being the push that Broadway needed to become a flourishing center for theatrical productions in the 1900s. Such cultural vibrancy gave it the impetus to become so influential in New York City's history both in terms of the entertainment industry and community development. Much of Broadway's continuing success can be attributed to the first movies produced, which were adaptations of musicals. It is also noteworthy that many famous actors started their careers on Broadway (Broadway and Theater History, 2016). Not surprisingly, the Tony Awards, first held in 1947 to improve the quality of productions and recognize their excellence, were born on Broadway. During wartime, the Broadway entertainment industry organized food drives, promoted Liberty Bonds, raised funds for the Red Cross, and provided free entertainment for military families. After the terrorist attacks of September 11th, 2001, Broadway raised money for the families of victims. Likewise, many Broadway organizations have contributed to such social causes as Broadway Cares/Equity Fights AIDS.[1] Today, Broadway is helping to provide free healthcare to underinsured and uninsured, and supports women's health needs.[2] Broadway remains a vibrant part of the New York City economy, notably as a prominent tourist attraction. In 2016, it has generated gross weekly revenues exceeding $20 million; during the past 10 years, gross weekly revenues have exceeded $10 million per week (Broadway Grosses, 2016). These numbers do not include the complementary revenues associated with heightened activity in the transportation, hospitality, and retail industries.

Broadway ticket prices have long been a controversial subject. Bruce Weber (1994) argues that this is the root of the what he and others call the "Broadway Paradox." Weber

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[1] History of Theatre in New York City, 2016
[2] Phyllis Newman, 2016; The Al Hisrchfeld Free Health Clinic, 2015

argues that “the same high ticket prices that producers say are needed to pay the bills… keep a lot of people out of the theater” (Weber, p.C1). He contends, historically, producers and investors did not advertise discounted tickets in order to sell more of the high-priced ones because “Everyone wants to go to a show that he can’t go [to], and nobody wants to go to one [Broadway show] that anyone can go” (Weber, p.C7). Weber suggests that, similar to commercial airlines, Broadway lagged in price discriminating as producers were unwilling to sacrifice their profits from shows to invest in new marketing ideas, and discount tickets were negatively perceived by the industry.

Recently, however, ticket pricing has changed and consumer awareness has increased. Today, it is common knowledge that tickets are available from several sources. Indeed, tickets to musicals and theatrical productions can be purchased in six different ways, which facilitates price discrimination and increases Broadways profits. What is particularly striking, though, is that even with price discrimination, prices are still lower than expected, which suggests that the low prices may reflect the impact of social spillovers. The six ways to buy tickets consist of:

1- Purchasing tickets online using an authorized ticket broker’s website. Tickets purchased this way may cost up to 40% above the face value due to brokers’ margins;

2- Purchasing tickets at the box office of theaters staging plays. Typically, this is the cheapest way to purchase tickets;

3- Purchasing tickets by telephone using agencies such as Telecharge or Ticketmaster. These agencies usually charge an extra $5-$10 service fee;

4- Purchasing tickets at TKTS booths that sell tickets on the day of the show at 20%-50% of the initial price. Only cash payments are accepted at these booths which are operated by the Theatre Development Fund, a non-profit organization. Not all shows will have tickets available at the booths, and availability depends on a show's success;

5- Purchasing tickets from Broadway Cares/Equity Fights AIDS is another way and it allows consumers to support high profile charitable causes by buying tickets at twice the normal price. A portion of such ticket purchases is tax deductible;

6- Purchasing returned tickets is a final way for consumers to buy tickets. When a representation is sold out, box offices sometimes sell returned or unclaimed tickets in advance of showtime. This is most common for the very successful plays and musicals (Where To Buy Broadway Tickets, 2016).

In recent years, a secondary market for Broadway tickets has surfaced. Even if it is not a recommended avenue for purchasing, ticket scalpers have been successful in making sizeable profits through this illegal secondary market. When excess demand is so large, as is currently the case with the musical "Hamilton," the low face value of Broadway tickets creates a perfect opportunity for scalpers. With today's technology, scalpers quickly purchase the maximum number of tickets allowed per performances after tickets go on sale such that they sometimes acquire more than half the tickets available. They do this using "ticket bots," an illegal practice that negatively impacts both consumers and producers. Consumers are penalized because the ticket bots put upward pressure on ticket prices by increasing traffic on websites such as Ticketmaster by purchasing large amounts of tickets at once. Scalpers subsequently resell tickets at about six to ten times the initial prices. Consumer not quick enough to purchase tickets before the ticket bots, have been known to pay between $600-$1800 for seats that have a face value of less than $200. In these instances, producers lose potential revenues to scalpers. Recognizing this, "Hamilton" producers, recently increased ticket prices to capture profits reaped by scalpers. Nevertheless, despite such initiatives, producers realize the difficulty of limiting the secondary market (Fehr, 2016). A better understanding of social spillovers in consumer demand may be key for producers to capture profits currently pocketed by scalpers for such excess-demand as is the case for “Hamilton.”

III-Literature Review & Theoretical Discussion

Initial studies on art focused on determining price elasticities and how to interpret and explain taste for art to understand aggregate demand. Own price and cross-price elasticities have been found to vary depending on the type of art (visual, performing, etc.). Scholars have contended that taste for art is addictive or cultivated, meaning that increasing art consumption today will increase future consumption (Throsby, 1994). Some studies have suggested that when strong legal resale markets emerge, as is the case for Broadway show tickets where people line up at box offices to buy returned tickets, ticket prices tend to be lower (De Serpa, 1994). Such arguments, however, do not consider the social aspect that might shape consumers’ decisions to attend a sporting event, a musical, or a theatrical production. These interpretations also fail to explain why there might still be presence of excess demand as is the case with Broadway shows.

Scholars have also looked at herd behavior or informational cascades to try to explain why in some cases price is not the only key factor that affects demand and why some trends, restaurants, or activities are more successful than others (Banerjee, Bikchandani, Hirshleifer & Welch). Herd behavior exists when consumers follow what others are doing even when their private information would lead them to choose differently

(Banerjee 1992). Informational cascades are similar but also suggest why society tends to choose outcomes that are fragile, and where it is easy for something fashionable to quickly become outdated (Bikchandani, Hirshleifer &Welch, 1992). Herd behavior and informational cascades look at the social aspect of decision making and how consumers might end up choosing outcomes that do not reflect their private choices, as opposed to demand driven by others' consumption.

As explained in Moretti (2011), the presence of a network externality exists when a consumer's utility of consuming a good or service is directly dependent on the number of other consumers that have also consumed that good. Social learning occurs when a consumer is only interested in the additional information that the consumption of a good or service by others provides them. In his textbook, Tirole gives the following network externality example: a consumer of telephone services derives a greater level of utility when the number of other users in the network is greater than if there are only a few or if he is alone (Tirole, 1998, p.405). From this example, and from Moretti's differentiation between social learning and network externalities, we can determine that social spillovers are a form of network externality.

The first major paper that used spillovers to explain why low prices do not increase even when an increase could generate extra revenues was Gary S. Becker's *A Note on Restaurant Pricing and Other Examples of Social Influences* (Becker, 1991). Becker uses the example of two seafood restaurants in Palo Alto, California. One is very popular and consumers usually experience a wait time to get a seat and they pay low prices. In contrast, the other is often empty and charges higher prices. Becker tries to establish insight with this example on how social interactions may explain success and price differences. He reasons that there are factors that cannot be quantitatively measured by economists that need to be taken into account in cases of excess demand. He suggests that these factors might explain why producers do not increase their prices to reduce excess demand and increase their profits. One such factor is when a consumer's utility is an increasing function of quantity demanded by other consumers. According to Becker, this means that social interactions, such as attending a popular play, have an important role on pricing and demand decisions. Goods or services that are consumed in groups or that are more enjoyable in groups—such attending a play or eating at a restaurant—will give a consumer a higher level of utility when he consumes the good or service at the same time as others.

In their paper, Gilchrist and Sands use weather shocks on the opening weekend of a movie and the effects on viewership over the following five weekends to study social spillovers. The exogeneity of the weather shocks permits them to see if an individual's demand for a movie is dependent on movie consumption of others. They use a simple model that captures the idea that a consumer's utility is dependent on both the quality of a movie and on the shared experience of viewing a movie. The consumer will attend the movie if the difference between the utility derived from attending the movie and the cost of attending that movie is at least zero. To compute viewership in a given weekend, the viewership in the opening weekend is first computed. This represents the consumers who receive utility from attending the movie but not from the shared experience. Then, the cumulative viewership in following weekends is computed. From this model, Gilchrist and Sands come up with three predictions:

1- *The ratio of viewership in weekend w>1 to viewership in opening weekend decreases exponentially in weeks since opening.* $\frac{V_w}{V_1} = \frac{\lambda^{w-1}(1-(c-\alpha))}{1-(c-\alpha)} = \lambda^{w-1}$.

2- *Opening weekend viewership* V_1 *is increasing in movie quality* α*, i.e.* $\frac{\partial V_1}{\partial \alpha} > 0$*, but the ratio* $\frac{V_w}{V_1}$ *between viewing in a subsequent weekend and viewing in opening weekend does not depend on* α*, i.e.* $\frac{\partial\left(\frac{V_w}{V_1}\right)}{\partial \alpha} = 0$.

3- *Stronger network externalities increase viewership in subsequent weekends relative to opening weekend:* $\frac{\partial}{\partial \lambda}\left(\frac{V_w}{V_1}\right) > 0 \; for \; w > 1$ (Gilchrist & Sands, p.9).

Since weather has a seasonality component that depends on the time of the year, viewership changes according to variations related to seasons. For this reason, Gilchrist and Sands compute abnormal viewership to determine the effect that comes from weather shocks only. Weather shocks are computed in a similar manner so as to see only the effect on viewership due to unanticipated weather. Using the abnormal viewership and the weather shocks controls for seasonality and the time trend. Abnormal viewership and weather shocks should both be orthogonal to play quality. The authors find that viewership has a positive relationship with weather shocks (when weather is nice, attendance falls and when weather is too hot or too cold, attendance rises). Gilchrist and Sands use Least Absolute Shrinkage and Selection Operator methods to estimate the optimal instruments in linear instrumental variables models with many instruments (Gilchrist & Sands, p.18).

They determine that network externalities in consumption cause large and persistent momentum, and that this momentum not only results from learning but also from the shared experience of movie consumption. The estimates obtained are consistent with prediction 1, but the OLS estimates are greater than the IV estimates. This suggests that the OLS regression captures the average abnormal viewership, while the IV regression captures the marginal abnormal viewership, and that the social spillover effect is stronger on the marginal viewers than the average viewers. When testing for exogeneity of the weather shocks using the method employed in Moretti (2011), they conclude that the shocks are orthogonal to movie quality. When it comes to prediction 2, the authors find that when taking into account movie quality, the momentum of the estimates for low-quality and high-quality movies do not differ significantly. This means that there is no evidence to support that social learning is creating the momentum, but that it cannot be statistically rejected. Results are consistent with prediction 3; there is evidence that weather has a contemporaneous effect on ticket sales and that social spillovers cause a weather shock in the opening weekend to have a multiplicative effect on viewership in the following weekends. From their results, they determine that consumers substitute across movies as opposed to across activities, that different groups of consumers respond more strongly to the shocks, and that weather shocks are comparable to one fifth of the effect that advertisement has on demand.

In his paper, Moretti (2011) uses weather shocks as instruments to determine if social learning or network externalities cause a diffusion of the effect of a surprise. Focusing on the presence of social learning, he explains that these shocks will not influence movie consumption as they do not provide any extra information about movie quality even though viewership at a particular date might be lower. According to his model, consumers will know that the decreased viewership is due to weather and, therefore, they will not consider this decrease as additional information about movie quality. In the presence of network externality, the weather shock will have an influence as the number of people who have viewed the movie is now lower and this will provide a lower level of utility to a consumer who has utility that is dependent on others viewing the movie (Moretti 2011). Depending on the observed effect of weather shocks on Broadway play attendance, this will indicate if there is presence of social spillovers or social learning.

IV-Model, Methodology & Predictions

A methodology similar to that of Gilchrist and Sands is used to determine if there is presence of social spillovers in the market for Broadway plays that could explain the lower-than-expected prices. Unlike Gilchrist and Sands who use LASSO instruments, IV regression is used—as Moretti did in *Social Learning and Peer Effects in Consumption*—to estimate the coefficient on cumulative attendance with weather shocks as the instruments on the week of entry for Broadway shows.

4.1-A Simple Model of Network Externalities in Broadway Show Attendance:

From Gilchrist and Sands' *Simple Model of Network Externalities in Movie-Going,* the following theoretical model is built. There are consumers who have demand for Broadway shows of good quality and enjoy sharing the experience of attending a play with others. The utility received from attending a play is increasing in play quality and cumulative attendance (Gilchrist & Sands, p.7). Including cumulative attendance in the utility equation will help determine if social spillovers are important for consumers making decisions regarding play attendance. When a play opens in a given week, a consumer i observes its quality, α, and is able to determine his own valuation of attending the play, e_i. From the network externality theory, a consumer will attend a play by himself and learns every week how many other consumers have attended the show in prior weeks. This leads to demand for Broadway show tickets to be increasing in cumulative prior attendance,

CPV_{it}. On the opening week of a play, the cumulative attendance is zero as there have been no possible prior performances for consumers to attend.

In any given week, the utility derived by a consumer i attending a play that is performed on week t is given by: $U_{it} = \alpha + \lambda CPV_{it} + e_i$. The consumer will only decide to attend the Broadway show if his utility from attending the play is greater or equal to the opportunity cost of attendance, c, of that play. The opportunity cost of attending can be of various nature. Some examples are ticket prices, cost of transportation, or cost of overnight stay if visiting New York City. λ is the coefficient of interest in determining the presence of social spillovers in the market for Broadway shows. When $\lambda > 0$, cumulative prior attendance influences consumer i's utility. In other words, sharing the experience of attending a play with other consumers is important and increases utility. When $\lambda = 0$, the cumulative prior attendance term is removed from the utility equation. Consumers are indifferent to the shared experience of attending a social activity such as a Broadway play. The case of $\lambda < 0$ would signal that shared consumption experience would reduce utility, and this case would occur if a consumer is irrational. Since we assume that consumers are rational, this should not be a result.

Assumptions similar to those of Gilchrist and Sands are made to restrain the model, bring it as close as possible to reality, and impose that demand is decreasing in weeks since opening. These assumptions also avoid having any consumers wait as long as possible before attending a show to ensure that a maximum number of people have attended before them to increase their utility. The individual's valuation of attending the play, e_i, is uniformly distributed on $[0,1]$, positive utility is only derived when attending the play for the first time, and consumers are forward looking. $\lambda < 1$, and $\alpha - c \in [0,1]$, in order for the cumulative attendance to be between 0 and 1 (Gilchrist & Sands, p.7-8). All these assumptions allow the model to represent demand of a rational agent.

4.2-Empirical Model & Analysis:

To estimate cumulative prior attendance, the number of seats sold is used. The Broadway show data obtained from Playbill contains the number of tickets sold weekly for every play performed since June 23, 1985. The opening week attendance, V_{0n} is simply the number of seats sold for a play at week 0. Week 0 is the week a play enters Broadway for the first time. The consumers who purchased tickets for the opening week receive utility from attending a good play and from their own private valuation of attending. Shared experience of attending the play is not important for them and thus does not provide them extra utility. Once opening attendance is obtained, cumulative prior attendance can be calculated for the weeks following opening. This is done by performing a sum of the seats sold in prior weeks for each play, $CPV_{it} = V_t + \sum_{k=0}^{t-1} CPV_{ik}$. For example, the cumulative attendance in the tenth week after opening is the sum of attendance in each week, from week 0 to week 10.

The effect of a shock on the opening week attendance is followed over the next 20 weeks. 20 weeks is the length chosen after preliminary regressions were performed on 10, 15, 20, 30 & 40 weeks. The lengths of 10 and 15 weeks were determined to be too short because the effect of a change in opening week attendance is still perceivable at a significant level after 15 weeks. There still appears to be some network externality effect over 30 and 40 weeks, but there is a period when there is a lot of variation in the coefficients after the 20-week mark that may be caused by interactions with other factors. Since we are interested in social spillovers, we want to avoid confusion with other effects and restrain the time period to 20 weeks.

Each Broadway play or musical is assigned a show id, and the regressions are clustered at the show id level. Each play has certain specific characteristics that can influence the consumer's decision to attend, and treating every show as the same could result in serial correlation. Including a cluster effect reduces the possibility of serial correlation and heteroscedasticity as the outcomes are likely to be correlated (Woolridge, 2013, p. 483 & p.500).

To remove the seasonality effect of weather and attendance, "abnormal" opening attendance and weather "shocks" are measured. This removes the effect related to different seasons that could influence the results and reveals the network externality effects on subsequent weeks due to abnormal attendance in the opening week. To obtain abnormal attendance in the opening week, the following regression is first computed:

$$V_{t0} = \beta_1 + F_t'\phi_0 + \varepsilon_{t1}$$

F_t' is a vector of indictors to condition for year and month of the year. The attendance in the opening week is regressed on a constant and this vector of indicators and the residuals are obtained and labeled $V_{abn_{t0}}$. Including the vector of indicators for year and month in the regression conditions, the opening attendance for the time of year the play was released, leaving the attendance free of season-related components. The residuals represent the difference between the predicted number of seats sold and the observed attendance in the opening week of a play according to the time of year it enters Broadway:

$$V_{abn_{t0}} = V_{0t} - \widehat{V_{0t}}.$$

The weather shocks are obtained in a fashion similar to abnormal opening attendance. Using weather shocks as opposed to the raw weather measures helps capture unanticipated seasonal weather. We can use this unanticipated weather, which can influence attendance to indoor activities such as theatrical and musical productions, to determine if there is presence of social spillovers in the consumption of Broadway plays (Gilchrist & Sands, 2015, p.14). All k weather measures, for every t week are individually regressed on the same vector of indicators as abnormal opening attendance and a constant:

$$W_{tk} = \delta_k + F_t' \phi_k + \varepsilon_{tk}.$$

The residuals are obtained and labeled $W_{shock_{tk}}$. They represent the weather shocks, which are the difference between the observed weather measures and the anticipated weather measures:

$$W_{shock_{tk}} = W_{tk} - \widehat{W_{tk}}.$$

Once all the abnormal and shock variables are set up, the Ordinary Least Squares and Instrumental Variables estimation can be performed to estimate the coefficients.

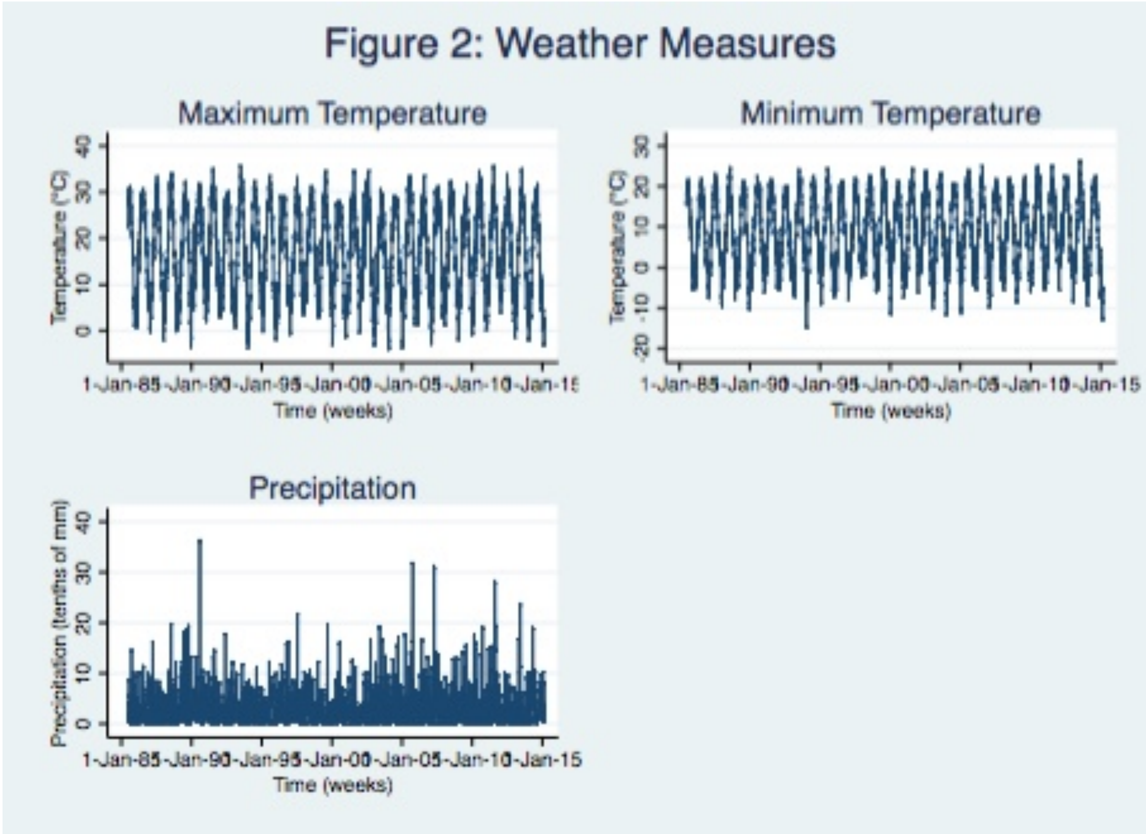

Figure 2: Weather Measures

Note: This figure represents the three different weather measures used as instruments for the IV regressions. This data comes from the National Centers for Environmental Information (NCEI), National Oceanic and Atmospheric Administration. There is a clear seasonal pattern through time for all variables. Precipitation represents all kinds of precipitations (ex: rain, snow, etc.)

OLS estimation is performed for the equation:

$$V_{abn_{tj}} = \alpha_{0j} + \alpha_{1j} V_{abn_{tj,0}} + \mu_{tj}.$$

This equation is regressed independently for all weeks 1 to 20, and also once for all these weeks together. This is done to observe how the magnitude of the network externality effects changes as time since entry increases and to also observe the overall effect.

Multiple IV regressions are performed with different weather shock instruments:

1- Precipitation only

2- Maximum temperature only

3- Minimum temperature only

4- Maximum temperature, minimum temperature and precipitation

These weather shocks are used as instruments instead of LASSO instruments to make the methodology easier to replicate and, because depending on the season, minimum temperature may be more influential than maximum temperature. New York City is located in a region with four distinct seasons where winter and summer temperatures are very different. In winter, people tend to be influenced strongly by how cold it will be in a given day, while during the summer, they are more influenced by how warm it will be. Before minimum and maximum temperatures can be used to set up the weather shocks that will be used as instruments, outliers are removed. This is done since retaining them could overemphasize or underemphasize the effect of network externalities in consumption. The following equations are used to remove the outliers:

$$[max = (Temperature - 23.556)^2 \times (|Temperature - 23.556| \leq 6.667)]$$ [3]

$$[min = \left(Temperature + (-1.5)\right)^2 \times (|Temperature - (-1.5)| \leq 6.667)]$$ [4]

The raw precipitation data is not transformed before obtaining the shocks because the reference point is "no precipitation" on the opening week. On a day when there is a forecast

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[3] This equation was adapted from the one used by Gilchrist & Sands (Something to Talk About: Social Spillovers in Movie Consumption, 2015). The degrees Fahrenheit were transformed to degrees Celsius to match the data. The mean was adjusted, from 75°F to 74.4°F, to reflect New York City's maximum average temperature in the summer (Data Tools: 1981-2010 Normals, 2016).

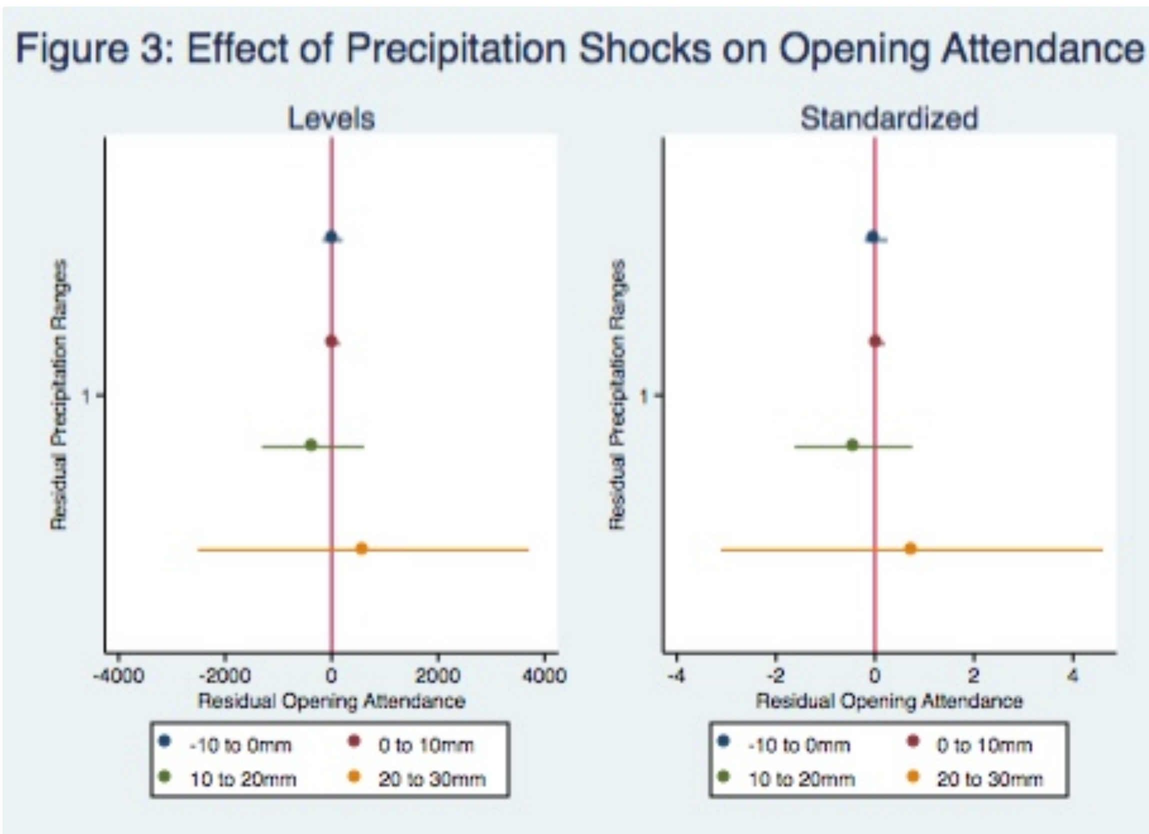
[4] This equation was adapted from the maximum temperature equation from *Something to Talk About: Social Spillovers in Movie Consumption* by Duncan Sheppard Gilchrist & Emily Glassberg Sands. Instead of using the maximum average temperature in the summer as the reference point, the minimum average temperature in the winter is used. The minimum temperature is most influential in the winter season in regions where the temperature goes below 0°C. If the temperature goes below the minimum average temperature, we expect consumer to be less inclined to leave his house. The minimum average temperature in the winter season for New York city is 29.3°F (Data Tools: 1981-2010 Normals, 2016). This value is converted to degrees Celsius to match the data.

of rain or snow, a consumer may reconsider attending a Broadway show until the next day when there is no precipitation forecast.

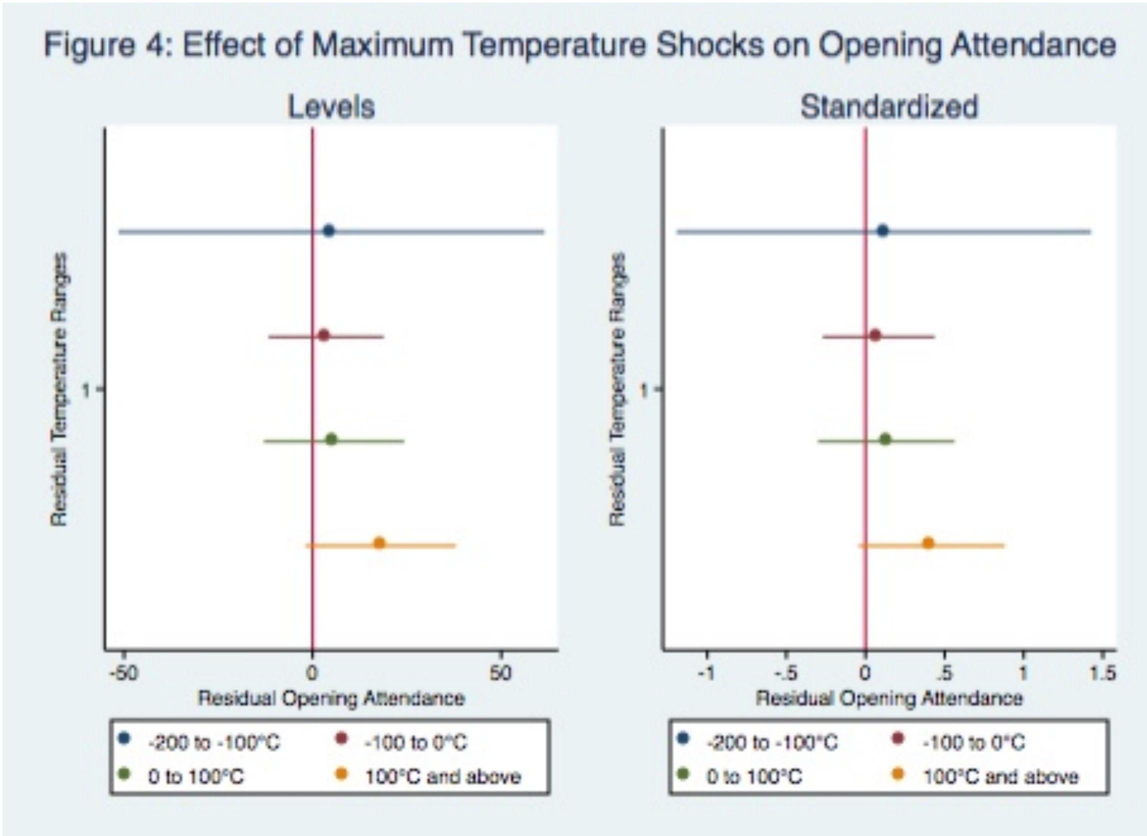
The first stage of the IV estimation consists of regressing abnormal opening week tickets sold on the instruments, the weather shocks, k:

$$V_{abn_{t0}} = \pi_0 + \pi_1 W_{shock_{tk}} + \mu_{t0}.$$

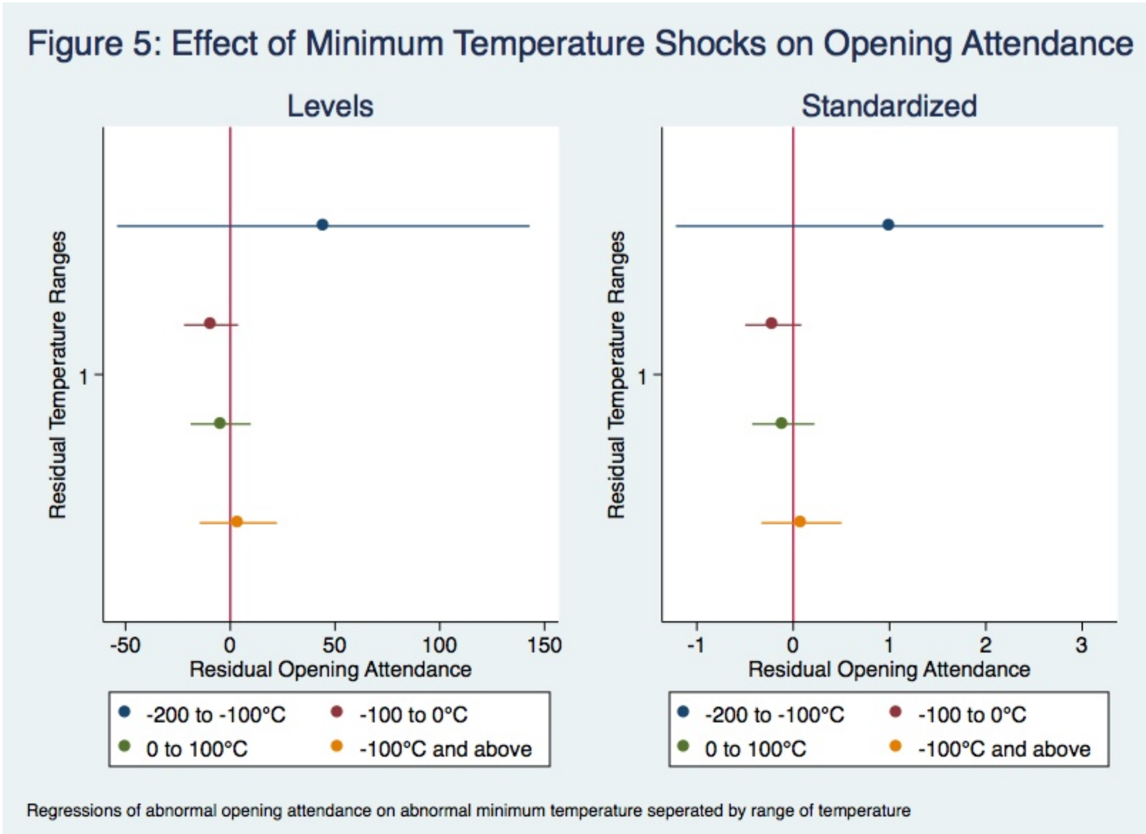
The fitted values, $\widehat{V_{abn_{t0}}}$, are obtained from this regression and used in the second stage. This stage determines the abnormal opening attendance that is caused by weather shocks.



Note: This represents the first stage regression of abnormal opening attendance on abnormal precipitation. Residual opening attendance is attendance in Week 0 that is unexplained by season, play quality or other play related factors. Residual precipitation represents all precipitation that are unexpected at the time of the year the play enters Broadway. This first stage regression determines the abnormal opening week attendance that results from a precipitation shock.



Note: This represents the first stage regression of abnormal opening attendance on abnormal maximum temperature. Residual opening attendance is attendance in Week 0 that is unexplained by season, play quality or other play related factors. Residual maximum temperature represents the maximum temperatures that are unexpected at the time of the year the play enters Broadway This first stage regression determines the abnormal opening week attendance that results from a maximum temperature shock.



Note: This represents the first stage regression of abnormal opening attendance on abnormal minimum temperature. Residual opening attendance is attendance in Week 0 that is unexplained by season, play quality or other play related factors. Residual minimum temperature represents the minimum temperatures that are unexpected at the time of the year the play enters Broadway This first stage regression determines the abnormal opening week attendance that results from a minimum temperature shock.

The second stage regression consists of:

$$V_{abn_{tj}} = \beta_{0t} + \beta_{1t}\widehat{V_{abn_{t0}}} + \varepsilon_{tj}.$$

This estimates the impact that unpredicted attendance at week 0 has on attendance in subsequent weeks. The coefficient β_{1t} expresses the strength of social spillovers in consumption of Broadway plays. The second stage is performed for every subsequent week separately as well as the overall period as is done for the OLS estimation. These steps are repeated with each of the four sets of instruments mentioned above.

To be certain that the weather shocks are orthogonal to cumulative subsequent attendance, the Durbin-Wu-Hausman test is performed. This test determines the consistency of the coefficient β_{2t} in the regression of the equation:

$$V_{abn_{tj}} = \beta_{0t} + \beta_{1t} V_{abn_{0t}} + \beta_{2t} \widehat{V_{abn_{t0}}} + \varepsilon_{tj}$$

If the coefficient is not significant, OLS estimation would be preferable (Davidson & MacKinnon, 2004 & Stata: Data Analysis and Statistical Software, 2016). The residuals, $\widehat{V_{abn_{t0}}}$ are obtained from the regression of opening unpredicted attendance on weather shock. Instruments must also satisfy the condition that they are correlated with the endogenous regressor, opening attendance, but uncorrelated with the error term, play quality. This is tested using the first stage regression. This is done using the 'estat firststage' command in Stata. When all the possible set of instruments (precipitation, minimum and maximum temperatures) are used to perform the last IV estimation, overidentification is tested. Testing for overidentification consists in determining if the set of instruments is correlated with the error term, ε_{tj} (Davidson & MacKinnon, 2004). If the test rejects the null hypothesis of presence of overidentification, the instruments are valid.

Since we cannot measure the exact level of utility each consumer receives from attending a play, we must estimate utility using another measure. We know a consumer will only attend a play if the utility derived from attendance is greater than the cost of attendance. Therefore, the number of seats sold in each week can be used as a proxy for utility. With this idea in mind, tickets sold are used to determine the presence of social spillovers using $U_{it} = \alpha + \lambda CPV_{it} + e_i$. Using an OLS regression of tickets sold in a given week on cumulative attendance will determine if social spillovers are of importance in the

Broadway show market. The same regressions are also performed on price and revenue to determine if presence of social spillovers influences these variables:

$$Tickets_i = \beta_{0i} + \beta_{1i}(CUMULATIVE_{Seats})_i + \varepsilon_i$$

$$Price_i = \beta_{0i} + \beta_{1i}(CUMULATIVE_{Seats})_i + \varepsilon_i$$

$$Revenue_i = \beta_{0i} + \beta_{1i}(CUMULATIVE_{Seats})_i + \varepsilon_i.$$

The coefficient of interest in all three cases is β_{0i} and, for social spillovers to influence the Broadway show market, this coefficient must be greater than zero.[5] For each of the variables, the natural logarithm is determined before the OLS regression.

All regressions are performed with standardized variables as well. This involves subtracting the mean and dividing by the standard deviation (Woolridge, 2013, p.189). This is done for two reasons. First, it allows an easier comparison with the results from Gilchrist and Sands. Second, the regressions are no longer in terms of units and, therefore, the scales of the regressors are no longer important and all explanatory variables are on the same level. By only looking at the size of the coefficients, we can determine which has the strongest impact on the dependant variable (Woolridge, 2013, p.190).

4.3- Empirical Predictions:

Since Broadway show consumption involves social interactions, the coefficients that measure the impact of social spillovers are expected to be positive and greater than zero. This should be the case for the set of OLS regressions as well as the OLS and IV regressions from the Gilchrist and Sands methodology. As time increases from week 0, the impact of

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[5] Moretti (2011) explains that a positive coefficient is a sign that consumers value shared experience and that they receive added utility when others consume the good prior to them or at the same time. While a coefficient of zero would reveal that consumers value the information provided by others' consumption of a good or service but, this does not provide them an increased level of utility.

abnormal opening week attendance should become weaker and should be replaced by the impact from attendance in previous weeks that have passed. Cumulative attendance last week becomes a better indicator to consumers as time goes on, especially if the play has been on Broadway for many weeks. With time, the opening attendance effect becomes less relevant to the decision of attendance. Considering consumers are rational and following the same reasoning as Gilchrist and Sands, we expect that weather shocks would influence attendance most significantly for a certain range of weather. When maximum temperature is above 23.6°C, it is expected that this will increase abnormal attendance in the opening week as it becomes too hot to be outside and enjoy outdoor activities. This will then be reflected in the size of the social spillover coefficient. With minimum temperature, this should occur when minimum temperature is above the minimum average temperature of -1.5°C. If the temperature falls below the minimum average temperature, it becomes too cold for people to leave their houses reducing attendance in the opening week and resulting in a decrease in the size of the social spillover coefficient. Abnormal attendance in week 0 is expected to have the greatest impact on subsequent tickets sold when precipitation is light. Precipitation above 26.43mm,[6] will discourage consumers to attend plays as the opportunity cost from attending a play increases due to their having to carry an umbrella or wear extra layers of clothes to stay dry.

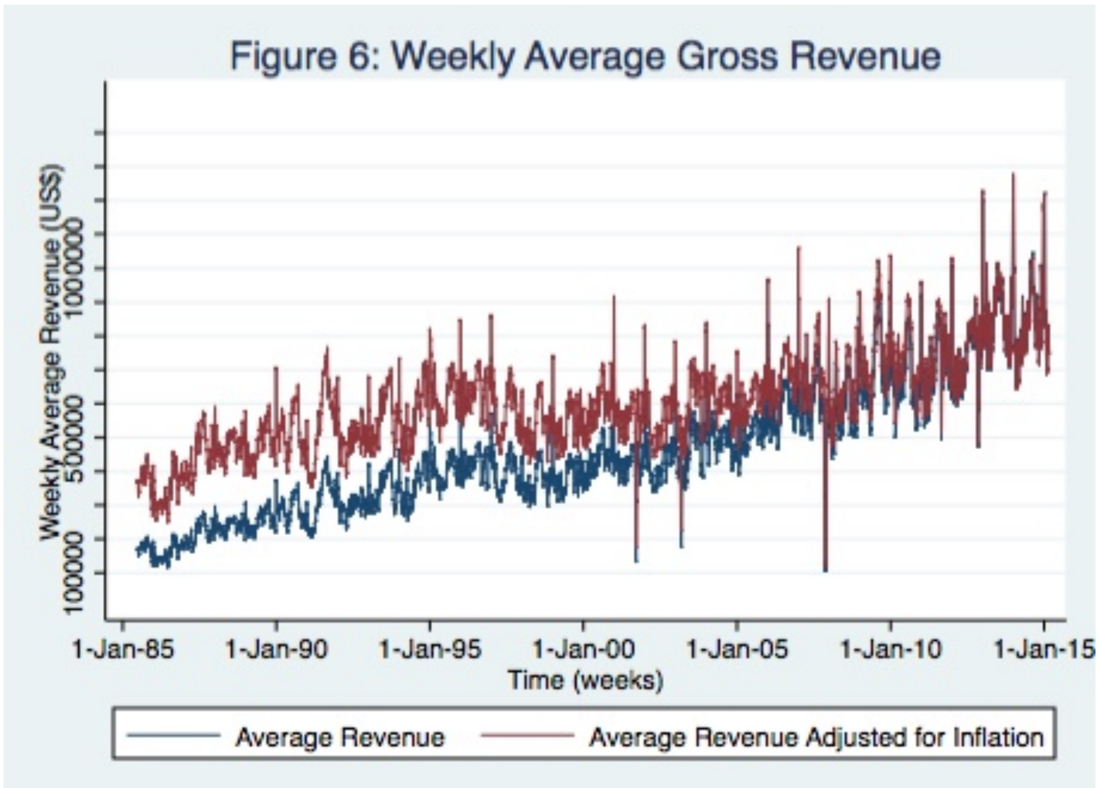
[6] On average, New York City receives 4.16 inches(105.71mm) of precipitation per month (NOAA, n.d.). Converting this number to a weekly level, we can estimate that an acceptable level of precipitation is 26.43mm per week.

V-Data & Descriptive Statistics

Table 1: Descriptive Statistics

	Mean	SD	MIN	MAX
Revenue	492131.5	351364.5	0	3201333
Price	59.53	27.82	0	245.1
Tickets	7710.3	3186.7	49	21631
PRCP	3.525	3.901	0	36.14
TMAX	16.89	9.206	-3.886	35.73
TMIN	8.7000	8.434	-14.76	26.10
N	26496			

Two different sets of data were used for this project. The first was data related to the plays and the second was weather data. The first was obtained from the Playbill website, which contains information related to all Broadway plays, including a synopsis, revenues, average ticket prices, number of tickets sold, and other information. This data was extracted from the website by Professor Taylor Jaworski using the software R and the XML package. Once this was completed, it was transferred from R to an EXCEL file and I was given access to this file. The second set of data used is historical weather data obtained from the National Centers for Environmental Information (NCEI), National Oceanic and Atmospheric Administration. The NCEI maintains and provides access to a large quantity of archived oceanic, atmospheric and geophysical data. They also maintain large databases containing the weather and climate information needed for this project (About Us, 2016). Minimum and maximum temperatures and daily precipitation between June 23rd 1985 and March 7th 2015 were provided by the NCEI into a comma delimited file from the Global Historical Climatology Network-Daily (GHCN-Daily), Version 3. This dataset is built from 30 data sources that are integrated and provide daily climate observations about precipitation and temperature. This third version was released in September 2012 and can be updated daily. It is also reconstructed on a weekly basis to include any new information obtained from the data sources and to apply quality assurance checks (NOAA-NCEI, 2016). The comma delimited file was transferred into an EXCEL file, where weekly averages for all weather measures were calculated. Both data sets were put in one file for use in Stata.



This figure represents weekly average gross revenue received from Broadway show ticket sales for the period of June 23rd, 1985 to March 7th, 2015. The inflation adjustment is done using 2015 US Dollars. The data comes from the Playbill website.

VI-Empirical Evidence & Discussion of Economic Implications

6.1-Gilchrist & Sands' Methodology:

Table 2: Regression Results-Effect of Abnormal Opening Attendance on Subsequent Attendance

	Week 1	Week 2	Week 3	Week 4
Abnormal opening	0.712	0.697	0.719	0.697
	(0.025)**	(0.029)**	(0.031)**	(0.035)**
Constant	5,603.136	5,736.900	5,805.526	5,970.484
	(65.569)**	(69.145)**	(73.770)**	(78.418)**
R^2	0.47	0.44	0.44	0.41
N	796	782	748	718

Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
0.680	0.661	0.667	0.654	0.635	0.619
(0.034)**	(0.034)**	(0.035)**	(0.038)**	(0.038)**	(0.039)**
6,021.035	5,990.228	5,986.003	5,978.418	5,975.935	6,090.441
(82.789)**	(84.981)**	(87.350)**	(91.576)**	(94.148)**	(96.101)**
0.37	0.36	0.35	0.34	0.32	0.32
684	662	636	599	576	536

Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
0.599	0.594	0.563	0.545	0.544	0.564
(0.042)**	(0.045)**	(0.046)**	(0.047)**	(0.049)**	(0.049)**
6,157.766	6,225.390	6,297.900	6,378.421	6,410.892	6,483.376
(102.752)**	(112.300)**	(120.984)**	(125.500)**	(131.215)**	(138.740)**
0.32	0.31	0.28	0.27	0.28	0.29
477	432	402	378	347	322

Week 17	Week 18	Week 19	Week 20	Weeks 1-20
0.539	0.518	0.528	0.513	0.643
(0.051)**	(0.054)**	(0.055)**	(0.056)**	(0.033)**
6,608.726	6,629.673	6,747.561	6,839.267	6,063.334
(143.810)**	(156.669)**	(160.848)**	(168.279)**	(83.475)**
0.28	0.26	0.26	0.26	0.35
302	279	268	251	10,195

Note: OLS regression of subsequent attendance on abnormal opening attendance for every week 1-20 independently and for the overall period. The variable abnormal opening represents abnormal attendance in Week 0. Subsequent attendance represents the seats sold in each of the 20 weeks as well as the cumulative of the seats in that time period. * $p<0.05$; ** $p<0.01$

When performing an OLS regression of tickets sold subsequent to show entry on unexpected seats sold in week 0, we can determine that there is presence of social spillovers in the Broadway show market. Overtime, there is a gradual decrease in the effect that abnormal opening attendance has on attendance in a given subsequent week. In every week and in the overall period, the coefficient on the abnormal opening attendance is significant and positive, indicating that there is a relationship between this variable and how many tickets will be sold in a subsequent week. As reported in Table 2, the coefficient in the first week since entry is 0.712, and slowly falls until it reaches 0.513 in week 20. This indicates that the longer a Broadway show runs, the smaller is the effect of abnormal opening week attendance in influencing the decision of consumers to purchase tickets. For every 100 unpredicted extra seats sold in the opening week, this results in 71 extra attendees for the show the following week, 62 in week 10, and 51 in week 20. These results are as expected due to the social nature of Broadway shows and since we expect the abnormal opening effect to be slowly replaced by the effect of prior subsequent weeks as time goes on. These results are similar to the ones obtained by Gilchrist and Sands for social spillovers in movie consumption.[7] The results obtained when performing the same regression but using the standardized variables are similar (See Table 6 in the Additional Tables section). The effect of unpredicted attendance in Week 0 on the total time period of 20 weeks is the same for the standardized and non-standardized subsequent attendance. This is the case as both the dependent variable and the independent variable have the same units, which implies that the standardization only affects the size of the constant. The coefficient of the overall time

[7] See Panel B of Table 2: Momentum from Viewership Shocks, from *Something to Talk About: Social Spillovers in Movie Consumption.*

period is very close to the average independent week coefficient. It can be concluded that over 20 weeks, 100 unpredicted seats sold may result in 64 seats over the course of 20 weeks or that an increase of one standard deviation will result in an increase in tickets sold over the 20 subsequent weeks of 0.643 standard deviation.

Results from the IV regressions are not reported as none of the coefficients are significant for all different types of weather instruments used. The first stage regression coefficients are significant; the issue arises at the second stage, suggesting that unpredicted seats sold in Week 0 caused by weather shocks have no impact on tickets sold in future weeks, and that there is no presence of social spillovers in the Broadway market. There are a few possible explanations for these results. Even though weather shocks are considered orthogonal to information related to the quality of a Broadway show, they may not be good instruments due the types of consumers. People attending plays can be separated into two categories: people from New York or within a reasonable driving distance from the city and tourists. New Yorkers and nearby consumers may adapt their behavior depending on the weather as we would expect. They are more flexible to decide to attend a play the following week if the weather this week is too bad to drive, commute, or walk to the play. Similarly, if the weather is too good, they may opt for an outdoor activity. Tourists may not be as flexible in their activity consumption as most have planned their visits to New York City ahead of time. We can assume that they may change different activities (attending a play, visiting a museum, shopping, a walk in Central Park) within their stay, but if the weather is too bad or too good during their entire stay, their choice of activities may remain unchanged despite the weather. This means that abnormal attendance in the opening week of a play caused by weather shocks may not influence tourists in the same way as the local population. If the 'tourist' effect exceeds the 'local population' effect, this could explain the IV results that suggest that abnormal opening tickets sold do not influence tickets sold in following weeks. Using weekly data may also reduce the expected effects, resulting in the coefficients not being significant under IV estimation. This could be the case because weather can vary greatly within a week, and using weekly averages may mitigate the effect of a particularly bad or good day. To determine the validity of these two explanations, further research needs to be performed using the weekly New York City population and the number of weekly tourists with the methodology suggested in Berry (1994)[8], as well as replicating the methodology of this essay using daily data.

6.2-Tickets sold, Ticket prices, and Revenues

The results from the second set of regressions are informative as they show that social spillovers may influence more than consumer utility. They also indicate that there is a dynamic effect between variables consumers and producers take into account when making utility maximizing and profit maximizing decisions that involve goods having a social component.

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[8] The market shares are used to determine the average utility goods provide to consumers. This average utility from goods and services is used in the utility equation that depends on price, quantity and unobservable factors such as social spillovers. A regression of this equation would determine the size and significance of the coefficient on unobservable factors revealing whether there is presence of social spillovers in the consumption market (Berry, 1994 p.242, 245-251).

Table 3: Regression Results-Social Spillovers on Determination of Ticket Price

	Week 1	Week 2	Week 3	Week 4
ln(cum_tickets)	0.321	0.355	0.348	0.363
	(0.036)**	(0.038)**	(0.038)**	(0.043)**
Constant	0.721	0.261	0.275	0.084
	(0.325)*	(0.360)	(0.380)	(0.437)
R^2	0.09	0.11	0.11	0.12
N	795	779	746	716

Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
0.403	0.434	0.434	0.409	0.392	0.421
(0.043)**	(0.043)**	(0.046)**	(0.045)**	(0.045)**	(0.050)**
-0.350	-0.720	-0.758	-0.520	-0.360	-0.719
(0.443)	(0.459)	(0.498)	(0.491)	(0.492)	(0.558)
0.13	0.15	0.15	0.14	0.13	0.14
682	661	635	599	576	536

Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
0.431	0.426	0.419	0.407	0.434	0.467
(0.060)**	(0.064)**	(0.065)**	(0.067)**	(0.066)**	(0.068)**
-0.865	-0.843	-0.805	-0.683	-1.032	-1.454
(0.668)	(0.722)	(0.746)	(0.770)	(0.769)	(0.788)
0.14	0.13	0.13	0.13	0.14	0.16
477	432	402	378	347	322

Week 17	Week 18	Week 19	Week 20	Weeks 1-20
0.462	0.434	0.409	0.451	0.204
(0.069)**	(0.075)**	(0.068)**	(0.072)**	(0.012)**
-1.419	-1.116	-0.855	-1.389	1.673
(0.810)	(0.880)	(0.801)	(0.857)	(0.129)**
0.16	0.14	0.11	0.13	0.14
302	279	268	251	10,183

OLS regression of subsequent ticket price on cumulative attendance for every week 1-20 independently and for the overall period. The variable ln(cum_tickets) represents the log of the cumulative tickets in each of the 20 weeks separately and for the overall period. * $p<0.05$; ** $p<0.01$

Unlike the regressions from Table 2 and Table 6, the effect from the social spillover does not follow a decreasing trend and the observed effect over the cumulative of the 20 weeks is smaller as opposed to larger for the ticket price variable. For every extra log cumulative tickets sold in a given week, Broadway show producers and investors increase the log of ticket price by on average 40¢. When looking at the overall time period, the increase of the log of price is only 20¢. Since the coefficients on cumulative tickets sold are significant for every week at the 0.01 level, this demonstrates a presence of social spillover in the market for Broadway shows and suggests social spillover is a factor to be considered in Broadway show ticket pricing. Unlike the regressions set up using Gilchrist and Sands' methodology, the standardized results are much larger than the non-standardized results (See Table 7 in Additional Tables section). They are between four to five times larger. Surprisingly, the standardized results increase over time as opposed to remaining constant. For every increase by one standard deviation of the log of cumulative seats sold, the resulting increase in the standardized log of price is 1.353 standard deviation of the log price in the first week, 1.775 in the tenth week, and 1.904 in the twentieth week. The effect for 20 weeks of an increase of the standardized log of cumulative tickets sold is an increase in 0.862 standardized log of price. From both the standardized and non-standardized results, it can be concluded that both consumers and producers consider social interactions—producers when setting prices and consumers in determining whether to attend a play. Consumers have a stronger reaction to overall price increases as opposed to short-term, weekly, price increases. The overall possible price increase by producers is smaller. As time since entry on Broadway increases, consumers substitute from considering the cumulative of tickets sold to the ticket price increases in their decision to consume or not a Broadway play. Since social spillovers impact ticket prices, and the effect is larger on the overall 20-week period, popular shows, such as "Hamilton," could benefit from increasing ticket prices.

Table 4: Regression Results-Social Spillovers on Determination of Attendance

	Week 1	Week 2	Week 3	Week 4
ln(cum_tickets)	0.916	0.948	1.026	0.978
	(0.013)**	(0.017)**	(0.034)**	(0.021)**
Constant	0.233	-0.486	-1.573	-1.308
	(0.115)*	(0.164)**	(0.339)**	(0.218)**
R^2	0.89	0.89	0.82	0.87
N	795	779	746	716

Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
0.981	0.985	0.995	1.039	1.017	1.001
(0.022)**	(0.022)**	(0.018)**	(0.023)**	(0.022)**	(0.022)**
-1.541	-1.752	-2.002	-2.613	-2.493	-2.403
(0.230)**	(0.239)**	(0.193)**	(0.248)**	(0.246)**	(0.243)**
0.85	0.84	0.85	0.84	0.84	0.84
682	661	635	599	576	536

Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
0.999	1.011	1.018	1.011	0.962	0.984
(0.022)**	(0.020)**	(0.022)**	(0.027)**	(0.031)**	(0.029)**
-2.485	-2.702	-2.868	-2.847	-2.354	-2.665
(0.243)**	(0.223)**	(0.248)**	(0.307)**	(0.363)**	(0.343)**
0.85	0.87	0.85	0.84	0.84	0.86
477	432	402	378	347	322

Week 17	Week 18	Week 19	Week 20	Weeks 1-20
0.974	0.992	1.008	1.056	0.299
(0.025)**	(0.020)**	(0.024)**	(0.043)**	(0.012)**
-2.591	-2.865	-3.103	-3.728	5.451
(0.291)**	(0.233)**	(0.292)**	(0.522)**	(0.128)**
0.88	0.87	0.86	0.83	0.33
302	279	268	251	10,183

OLS regression of subsequent attendance on cumulative attendance for every week 1-20 independently and for the overall period. The variable ln(cum_tickets) represents the log of the cumulative tickets in each of the 20 weeks separately and for the overall period. * $p<0.05$; ** $p<0.01$

For each week independently, an increase by one unit of the log of cumulative attendance results in an increase on average of one unit of the log of attendance. All coefficients are significant at the 0.01 level. Therefore, we can conclude that there is presence of social spillover in the market for Broadway shows. Looking at all the weeks together, the effect is much smaller, an increase of 0.299 only. Since the effect is smaller on the aggregate of weeks, it shows that consumers are short-sighted. Consumers do not care as much about attendance ten weeks ago compared to the attendance from last week when deciding whether to attend a musical or theatrical production this week. Results for the standardized variables are similar, with only the magnitude of the coefficient being larger and with the presence of a very small increase in the cumulative attendance coefficient over time (See Table 8 in Additional Tables section). Consumer utility is not only impacted by abnormal opening week attendance, but also by cumulative attendance as well. As the number of people who have already attended increases, the number of attendees in subsequent weeks rises as these people now have greater utility. The increase in utility comes from the social nature of the play. When an increased number of consumers have previously attended, consumers can now discuss the play with others and enjoy experiencing the activity with others. Combining the results from this regression with the results from Table 2, initially abnormal attendance plays an important role in determining consumer utility and whether consumers will attend a play, but as time since entry increases, cumulative attendance becomes more important.

Table 5: Regression Results-Social Spillovers on Determination of Gross Revenue

	Week 1	Week 2	Week 3	Week 4
ln(cum_tickets)	1.236	1.303	1.374	1.341
	(0.034)**	(0.042)**	(0.054)**	(0.053)**
Constant	0.954	-0.225	-1.298	-1.224
	(0.308)**	(0.401)	(0.542)*	(0.539)*
R^2	0.58	0.60	0.61	0.59
N	795	779	746	716

	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
ln(cum_tickets)	1.384	1.419	1.429	1.448	1.409	1.422
	(0.054)**	(0.051)**	(0.051)**	(0.051)**	(0.054)**	(0.058)**
Constant	-1.891	-2.472	-2.761	-3.134	-2.853	-3.122
	(0.564)**	(0.541)**	(0.543)**	(0.560)**	(0.598)**	(0.646)**
R^2	0.59	0.60	0.60	0.62	0.60	0.59
N	682	661	635	599	576	536

	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
ln(cum_tickets)	1.431	1.437	1.437	1.417	1.397	1.451
	(0.062)**	(0.068)**	(0.073)**	(0.076)**	(0.084)**	(0.081)**
Constant	-3.350	-3.544	-3.673	-3.530	-3.386	-4.119
	(0.692)**	(0.776)**	(0.836)**	(0.877)**	(0.970)**	(0.941)**
R^2	0.59	0.60	0.59	0.58	0.57	0.61
N	477	432	402	378	347	322

	Week 17	Week 18	Week 19	Week 20	Weeks 1-20
ln(cum_tickets)	1.436	1.426	1.417	1.507	0.503
	(0.080)**	(0.081)**	(0.076)**	(0.089)**	(0.018)**
Constant	-4.010	-3.981	-3.958	-5.117	7.124
	(0.934)**	(0.951)**	(0.897)**	(1.071)**	(0.191)**
R^2	0.60	0.59	0.54	0.56	0.32
N	302	279	268	251	10,183

OLS regression of subsequent gross revenue on cumulative attendance for every week 1-20 independently and for the overall period. The variable ln(cum_tickets) represents the log of the cumulative tickets in each of the 20 weeks separately and for the overall period. * $p<0.05$; ** $p<0.01$

When looking at the effect that cumulative tickets sold has on gross revenue, we can observe an increasing relationship. In week 1, the effect of an increase by one log of cumulative tickets sold is that the log gross revenues for a Broadway show increases by

1.236. In week 10, the resulting increase is 1.422 and in week 20, it is 1.507. The increase over time is not significant. The standardized coefficients also follow a slight increasing pattern, but the coefficients have a magnitude that is 2.5 times greater than the non-standardized ones (See Table 9 in the Additional Tables Section). Once again, both the standardized and non-standardized coefficients on the cumulative of weeks 1 to 20 are much smaller than the individual weeks, 0.503 and 1.243, respectively. Two things can be concluded from this. First, the network externality is reflected in Broadway show revenue and, second, the short-term effect is much greater than the long-term effect. Since both tickets sold in a given week and ticket prices are influenced by social interaction through cumulative tickets sold between entry on Broadway and a given week, the effect on gross revenue from tickets sold is magnified. Broadway theaters can generate extra revenue from social spillovers if they consider that network externalities are influencing consumers when they set the ticket prices. Since all three variables—tickets, ticket prices and revenues—are influenced by cumulative tickets, the effect is not only coming from seats sold and then transferred to the other variables, but each is affected and the effect is magnified when looking at revenue. This is the case as revenue represents the number of tickets sold multiplied by the price of the tickets.

VII-Concluding Remarks

The aim of this paper was to evaluate the presence of social spillovers in consumer demand in the market for Broadway shows. This study provides additional evidence that consumer demand is influenced by factors that economists cannot easily measure and also supports prior entertainment market research that has found that network externalities significantly affect consumer demand.

Initially, I attempted to reproduce Gilchrist and Sands' results reported in *Something to Talk About: Social Spillovers in Movie Consumption* but I was not entirely successful as the IV regression results were not significant for all the different weather shock instruments. Similar OLS results were obtained, showing that abnormal opening attendance has an effect on subsequent attendance and that this effect decreases over time. This indicates a presence of social spillovers in consumer demand in the market for Broadway shows.

The presence of network externality is also suggested through the effect that cumulative attendance has on attendance, ticket prices and revenues in the subsequent weeks a show opens on Broadway. Since all coefficients were significant and positive, cumulative tickets sold in prior weeks have a positive effect on subsequent attendance, ticket prices, and revenues. Testing for all three variables also determined the presence of dynamic interactions between the variables as the effect of the social spillovers is magnified for revenues.

The determination of the presence of social spillovers in the market for Broadway plays is important as it provides additional evidence that consumers not only consider prices when deciding whether or not to purchase a good or service. They consider other factors that are not as easily measurable. These influences—however difficult they may be to measure—must be considered if the theory of consumer demand is to be a closer representation of real life consumer behavior. The last OLS results provide new insights for Broadway producers as they set ticket prices and estimate potential revenues. Producers should not forget that the weekly effect is larger than the overall effect, especially if the show has the potential to be presented over a long period of time. In order to further the understanding of the Broadway play market, studies on the different types of consumers comprising the population attending Broadway shows and the strength of social spillovers for each group would be the logical next steps.

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Additional Tables

Table 6: Regression Results-Effect of Standardized Abnormal Opening Attendance on Standardized Subsequent Attendance

	Week 1	Week 2	Week 3	Week 4
zabnormal_opening	0.690	0.675	0.697	0.676
	(0.025)**	(0.028)**	(0.030)**	(0.034)**
Constant	-0.655	-0.614	-0.592	-0.541
	(0.021)**	(0.022)**	(0.023)**	(0.025)**
R^2	0.47	0.44	0.44	0.41
N	796	782	748	718

	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
zabnormal_opening	0.659	0.641	0.647	0.634	0.616	0.600
	(0.033)**	(0.033)**	(0.034)**	(0.037)**	(0.037)**	(0.038)**
Constant	-0.525	-0.534	-0.536	-0.538	-0.539	-0.503
	(0.026)**	(0.027)**	(0.027)**	(0.029)**	(0.029)**	(0.030)**
R^2	0.37	0.36	0.35	0.34	0.32	0.32
N	684	662	636	599	576	536

	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
zabnormal_opening	0.580	0.576	0.545	0.529	0.527	0.547
	(0.040)**	(0.043)**	(0.045)**	(0.045)**	(0.048)**	(0.047)**
Constant	-0.482	-0.461	-0.438	-0.413	-0.403	-0.380
	(0.032)**	(0.035)**	(0.038)**	(0.039)**	(0.041)**	(0.043)**
R^2	0.32	0.31	0.28	0.27	0.28	0.29
N	477	432	402	378	347	322

	Week 17	Week 18	Week 19	Week 20	Weeks 1-20
zabnormal_opening	0.522	0.502	0.511	0.497	0.623
	(0.050)**	(0.052)**	(0.053)**	(0.054)**	(0.032)**
Constant	-0.341	-0.334	-0.298	-0.269	-0.512
	(0.045)**	(0.049)**	(0.050)**	(0.053)**	(0.026)**
R^2	0.28	0.26	0.26	0.26	0.35
N	302	279	268	251	10,195

OLS regression of standardized subsequent attendance on standardized abnormal opening attendance for every week 1-20 independently and for the overall period. The variable zabnormal_opening represents standardized abnormal opening in each of the 20 weeks separately and for the overall period. To standardized the variables, the mean was subtracted from each value and the resulting was divided by the standard deviation * $p<0.05$; ** $p<0.01$.

Table 7: Regression Results-Social Spillovers on Determination of Standardized Ticket Price

	Week 1	Week 2	Week 3	Week 4
zln(cum_tickets)	1.353	1.499	1.467	1.531
	(0.151)**	(0.159)**	(0.162)**	(0.181)**
Constant	1.494	1.434	1.271	1.264
	(0.251)**	(0.226)**	(0.202)**	(0.201)**
R^2	0.09	0.11	0.11	0.12
N	795	779	746	716

	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
zln(cum_tickets)	1.699	1.832	1.833	1.728	1.653	1.775
	(0.180)**	(0.183)**	(0.196)**	(0.191)**	(0.190)**	(0.212)**
Constant	1.389	1.429	1.360	1.210	1.089	1.088
	(0.182)**	(0.170)**	(0.166)**	(0.152)**	(0.142)**	(0.144)**
R^2	0.13	0.15	0.15	0.14	0.13	0.14
N	682	661	635	599	576	536

	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
zln(cum_tickets)	1.821	1.797	1.768	1.716	1.833	1.970
	(0.251)**	(0.269)**	(0.275)**	(0.282)**	(0.280)**	(0.285)**
Constant	1.063	0.968	0.868	0.802	0.790	0.754
	(0.153)**	(0.150)**	(0.141)**	(0.134)**	(0.125)**	(0.118)**
R^2	0.14	0.13	0.13	0.13	0.14	0.16
N	477	432	402	378	347	322

	Week 17	Week 18	Week 19	Week 20	Weeks 1-20
zln(cum_tickets)	1.948	1.831	1.725	1.904	0.862
	(0.292)**	(0.315)**	(0.285)**	(0.303)**	(0.052)**
Constant	0.691	0.610	0.505	0.488	0.476
	(0.113)**	(0.112)**	(0.097)**	(0.091)**	(0.060)**
R^2	0.16	0.14	0.11	0.13	0.14
N	302	279	268	251	10,183

OLS regression of standardized subsequent ticket price on standardized cumulative attendance for every week 1-20 independently and for the overall period. The variable zln(cum_tickets) represents the standardized log of the cumulative tickets in each of the 20 weeks separately and for the overall period. To standardized the variables, the mean was subtracted from each value and the resulting was divided by the standard deviation. * p<0.05; ** p<0.01.

Table 8: Regression Results-Social Spillovers on Determination of Standardized Attendance

	Week 1	Week 2	Week 3	Week 4
zln(cum_tickets)	3.815	3.949	4.275	4.073
	(0.052)**	(0.071)**	(0.141)**	(0.088)**
Constant	5.626	4.975	4.740	4.058
	(0.084)**	(0.095)**	(0.164)**	(0.093)**
R^2	0.89	0.89	0.82	0.87
N	795	779	746	716

Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
4.088	4.103	4.144	4.326	4.236	4.169
(0.091)**	(0.093)**	(0.074)**	(0.094)**	(0.093)**	(0.090)**
3.670	3.334	3.072	2.935	2.633	2.408
(0.087)**	(0.081)**	(0.060)**	(0.069)**	(0.064)**	(0.057)**
0.85	0.84	0.85	0.84	0.84	0.84
682	661	635	599	576	536

Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
4.163	4.210	4.241	4.209	4.009	4.099
(0.090)**	(0.082)**	(0.090)**	(0.111)**	(0.130)**	(0.122)**
2.204	2.049	1.900	1.746	1.534	1.445
(0.051)**	(0.044)**	(0.044)**	(0.051)**	(0.054)**	(0.049)**
0.85	0.87	0.85	0.84	0.84	0.86
477	432	402	378	347	322

Week 17	Week 18	Week 19	Week 20	Weeks 1-20
4.057	4.130	4.198	4.397	1.245
(0.103)**	(0.082)**	(0.102)**	(0.181)**	(0.050)**
1.342	1.229	1.157	1.089	0.646
(0.035)**	(0.030)**	(0.030)**	(0.038)**	(0.047)**
0.88	0.87	0.86	0.83	0.33
302	279	268	251	10,183

OLS regression of standardized subsequent attendance on standardized cumulative attendance for every week 1-20 independently and for the overall period. The variable zln(cum_tickets) represents the standardized log of the cumulative tickets in each of the 20 weeks separately and for the overall period. To standardized the variables, the mean was subtracted from each value and the resulting was divided by the standard deviation. * p<0.05; ** p<0.01.

Table 9: Regression Results-Social Spillovers on Determination of Standardized Gross Revenue

	Week 1	Week 2	Week 3	Week 4
zln(cum_tickets)	3.054	3.220	3.394	3.313
	(0.084)**	(0.103)**	(0.134)**	(0.130)**
Constant	4.212	3.790	3.555	3.147
	(0.141)**	(0.146)**	(0.163)**	(0.142)**
R^2	0.58	0.60	0.61	0.59
N	795	779	746	716

	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
zln(cum_tickets)	3.419	3.506	3.531	3.578	3.481	3.512
	(0.134)**	(0.126)**	(0.125)**	(0.127)**	(0.135)**	(0.143)**
Constant	2.990	2.814	2.618	2.450	2.199	2.065
	(0.132)**	(0.116)**	(0.106)**	(0.100)**	(0.098)**	(0.095)**
R^2	0.59	0.60	0.60	0.62	0.60	0.59
N	682	661	635	599	576	536

	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16
zln(cum_tickets)	3.535	3.550	3.551	3.501	3.451	3.584
	(0.152)**	(0.169)**	(0.181)**	(0.188)**	(0.207)**	(0.199)**
Constant	1.930	1.782	1.635	1.505	1.372	1.299
	(0.092)**	(0.094)**	(0.092)**	(0.089)**	(0.089)**	(0.080)**
R^2	0.59	0.60	0.59	0.58	0.57	0.61
N	477	432	402	378	347	322

	Week 17	Week 18	Week 19	Week 20	Weeks 1-20
zln(cum_tickets)	3.546	3.522	3.500	3.723	1.243
	(0.197)**	(0.199)**	(0.187)**	(0.221)**	(0.044)**
Constant	1.201	1.086	0.981	0.932	0.662
	(0.074)**	(0.069)**	(0.062)**	(0.060)**	(0.048)**
R^2	0.60	0.59	0.54	0.56	0.32
N	302	279	268	251	10,183

OLS regression of standardized subsequent gross revenue on standardized cumulative attendance for every week 1-20 independently and for the overall period. The variable zln(cum_tickets) represents the standardized log of the cumulative tickets in each of the 20 weeks separately and for the overall period. To standardized the variables, the mean was subtracted from each value and the resulting was divided by the standard deviation. * $p<0.05$; ** $p<0.01$.