Featured in the News: from the Attention Aura to Competing Complements

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Abstract

This paper presents causal evidence of a special case, where the sales of a product increases when its close competitor experiences a boost in sales as a result of an exogenous increase in appeal. We identify such a counter-intuitive effect in the draw lottery market in the US that offers unique characteristics to overcome empirical challenges. Our key result found a substantial degree of complementarity with the cross elasticity of sales estimate of 0.2. Mediation analysis shows that the strong complementary between close competitive products is largely driven by the increased publicity and attention drawn to the entire product segment following the surge in interest in one of the products. In other words, a greater appeal of one product can exert positive spillover through an "attention aura" to the entire product segment, thus increasing the sales of competitors. Our evidence shows that such an effect can dominate the intrinsic substitution between competing products, rendering them effectively complements in sales.

Key words: lottery, substitutes, complements, news

JEL codes: L1

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1 Introduction

Could two almost identical and competing products be complements? This paper presents causal evidence of a special case, where the sales of a product increases when its close competitor experiences a boost in sales as a result of an exogenous increase in appeal. Such a counter-intuitive effect is largely driven by the increased publicity and attention drawn to the entire product segment following the surge in interest in one of the products. In other words, a greater appeal of one product brings a "*attention aura*" to the entire product segment, thus increasing the sales of competitors. Our evidence shows that such an effect can dominate the intrinsic substitution between competing products, rendering them effectively complements in sales.

As basic concepts in economics, economic complements and substitutes are defined by the signs of cross-price elasticity of demand. Conceivably, if one considers quality-adjusted prices, then holding absolute price levels constant, two goods are complements if one's demand increases when another grows more appealing. Throughout most economics textbooks and classrooms, the concept of complements grows synonymous to "products used together", while that of substitutes to "products used in place of each other". So how can two almost identical products be complements?

An important implicit assumption underlying such equivalences is that the consumers' demand for the segment remains relatively fixed as the products' prices and appeals change. However, if such changes in one product are sufficiently dramatic so as to draw strong consumer interest into the segment as a whole, then the increase in overall demand may overpower the substitution between the competing options to exhibit complementing behaviors. One of the channels that can facilitate such a shift in consumers' interest is publicity in the news. This paper documents such a causal chain from exogenous changes in appeal of one product to the hype about itself, which consequently drivers up the news exposure about the entire segment, eventually leading to an increase to its competing product.

Despite of the intuitive nature of complements versus substitutes as theoretical concepts, it is difficult to provide compelling evidence due to strategic interactions in the supply-side decisions on pricing and product design, as well as unobservable variations that confounds the identification. To overcome these challenges, our case study focuses on a special pair of products: Powerball (PB) and Mega Millions (MM)—the two largest draw-lottery products in the US managed by two separate organizations. These two games have exceptionally similar characteristics, rendering them "products used in place of each other". Owing to the random nature of lottery wins, their jackpots randomly fluctuate overtime, generating exogenous shocks to the appeal of the products. We exploit these exogenous random variations and our preferred estimates measure a 0.3% increase in sales of one lottery when its competing lottery gains 1% sales due to an exogenous shock in appeal, exhibiting substantial complementarity. Furthermore, mediation analysis using text data from TV news and newspaper reporting suggests that the complementarity can be almost entirely explained by the indirect effect through publicity in the news induced by the surge in demand, implying an attention aura.

These two lottery products exhibit unique characteristics that facilitate our empirical identification. They have highly similar products with almost identical rules and product features, and *exactly* overlapping availability in *all* markets. Each day, consumers can purchase lottery tickets with number combinations of their choice, and wait for the ensuing drawing event that takes place twice a week to randomly produce a series of numbers. If a ticket bought within the drawing cycle matches sufficiently well with the numbers drawn, the consumer with the matching ticket wins the jackpot.[1] Otherwise if no winning ticket is sold, the prize pool

[1] If multiple consumers purchased winning tickets during the same drawing cycle, the jackpot is shared among the winners.

carries over and the jackpot accumulates until claimed. The jackpot of Powerball reached as high as $1.58 billion in January of 2016, attracting much hype, publicity and attention to the games. After each win, the jackpot resets to its baseline level, set at $40 million for both games as of 2019.

To establish our results, we first leverage the random nature of a jackpot win and use a regression discontinuity (RD) framework to establish that, when a *large jackpot*, defined as one greater than $100 million, of one lottery is claimed, (i) its sales falls by as much as $2.3 billions per drawing cycle (16 standard deviations); and (ii) the sales of the competing lottery sees no impact. We then compare sales from drawing cycles following any win event, and find that, surprisingly, sales post a big win is in fact *greater* than sales post a lower-jackpot win. This suggests that the dramatic change in sales from the RD analysis should be interpreted as a surge in interest due to high-jackpot episodes that, in fact, exerts positive spillover toward later drawing cycles, as oppose to an intertemporal substitution that pulls in future demand into the present drawing cycle. Based on these results, we adopt a dummy instrumental variable, *post-big-win* that is defined as a drawing cycle being within 2 weeks post a large-jackpot win, to explore complementarity versus substitution between the two lottery products, leading to our main complementarity result. We unpack the mechanism using an IV-mediation analysis model to document the attention-aura effect. Lastly, to complement these analysis, we resort to daily lottery sales data by category by county in the state of Maine to further investigate sales patterns, and find results that corroborate with our underlying assumption that consumer attention is essential in this context, supporting our interpretation of the causal mechanism—from an exogenous surge in appeal, to increased interest in one product that attracts publicity to the product category, and leading to complementary behavior across competing products.

A literature explores the properties of complements versus substitutes between similar but different goods, such as local versus organic food (Meas et al., 2014) or alcohol versus other drugs among adolescents (Williams et al., 2004; Crost and Rees, 2013; Deza, 2015). A small but fast-growing literature explores the impact of media exposure (DellaVigna and Ferrara, 2015). These works explores the supply-side impact of media on political economy (Strömberg, 2004; DellaVigna and Kaplan, 2007; DellaVigna and Gentzkow, 2010), education outcomes (Gentzkow and Shapiro, 2008) and career choices (Bo et al., 2020). As far as we know, this is the first study that provides evidence of news media (non-advertisement) on consumption behavior.

A long economics literature studies lottery as a special product (Clotfelter and Cook, 1990). An earlier topic in the literature explores how social-economic backgrounds interact with lottery consumption behaviors. A more recent applied literature studies the impact of winning lotteries on health and other aspects of winners (Lindahl, 2005; Gardner and Oswald, 2007; Kuhn et al., 2011). More closely related to the current paper, a strand of recent economics literature studies consumption behavior on lottery. Kearney (2005) find lottery consumption displaces other household expenditures, and Guryan and Kearney (2008) documents a lucky-store effect, where sales at stores that sold winning tickets experience a sizable sales increase for the winning lotto game after the win. On the issues related to substitution, **?** documents cross-state boundary competition in lottery sales in West Virginia from 1987-2000; and Walker and Jackson (2008) studies substitutions between lottery as a whole and other gambling products, such as casinos and horce racing, and found mixed results.

The remaining paper proceeds as the following. Section 2 describes the essential features of the empirical context of draw lottery market in the US. Section 3 introduces the data used in this analysis. Section 4 lays out our empirical strategy and Section 5 reports the main findings. Finally, Section **??** offers additional discussions related to our results, and Section 6 concludes.

2 Context

These two largest draw lottery products, Powerball (PB) and Mega Millions (MM), provide an uniquely advantageous setting to identify consumers' responses to the change in products' relative appeal. First of all, the key source of variation in product appeal is purely random, unlike markets for other products, where changes in appeal are heavily influenced by deliberate strategic responses in product design that invites endogeneity concerns in identification.

Second, the variations in product appeal takes place frequently, therefore allowing us to compare consumer responses within a limited time window, minimizing other confounders introduced overtime.

Third, the product characteristics relevant to consumer choices are clearly observable and well measured, minimizing distortions driven by search costs. Product characteristics in price, odds of winning, availability and other related features are commonly known to consumers, and are stable overtime, thus isolating the exogenous variations in product appeal as the sole source of supply-side variation that changes consumer behaviors.[2]

Fourth, two products are *widely* available with *almost perfectly shared* availability, minimizing "heterogeneity bias" and "variety bias" (Handbury and Weinstein, 2015). A wide range of vendors are licensed to sell these products. [3] Both products are both sold in the 45 participating states in the US, as of 2019, since a cross-sell agreement implemented on January 31, 2010.[4] Furthermore, these two lottery products are almost always commonly available at the same licensed vendor due to regulations.[5]

Fifth, the key measures of demand are precisely maintained, thus minimizing measure errors. By regulation, sales records are well maintained by the use of dedicated electronic point-of-sale devices (POS) and regularly audited.[6]

3 Data

We rely on five different data sources for this study, covering Feb. 2nd, 2010 to Sep. 27th, 2019. The state-level lottery sales data comes from posted information on lottoreport.com, which collects lottery sales by state by drawing cycle from various state government releases. For instance, PB holds drawings every Wednesday and

[2]PB increased ticket price from $1 to $2, while raising the starting jackpot from $20 to $40 million, and the secondary prize from $0.2 to $1 million on 01/15/2012. See, for instance, `https://www.cbsnews.com/news/powerball-ticket-prices-jackpots-odds-to-rise/`. MM increased ticket price from $1 to $2 and starting jackpot on 10/28/2017 (Sat.), lowering the odds of winning the jackpot, while increasing the ods of winning secondary prices. See, for instance, `https://www.nbcnews.com/news/us-news/mega-millions-announces-higher-jackpots-ticket-price-increase-n814256`

[3]For example, in the state of Maine, the sales locations consist mainly of grocery stores, convenience stores, gas stations, high-way service stations, hardware stores, video stores, department stores, bowling alleys, taverns, restaurants, drug stores, newsstands, and non-profit organizations.

[4]On October 13, 2009, the Mega Millions consortium and the Multi-State Lottery Association (MUSL) reached an agreement to cross-sell Mega Millions and Powerball—an agreement implemented on January 31, 2010. See, for instance, `https://web.archive.org/web/20110714070121/http://megamillions.com/mcenter/pressrelease.asp?newsID=D0CC83C2-97D5-4E0F-9FD4-E6945DCB0B98`

[5]In the terms and conditions of Maine State Lottery license application (Maine, Terms and Conditions), Section 13.C, it specifically states that an licensee agrees to "make available for sale to the public, valid draw and instant lottery tickets during normal business hours." In addition, the variation of availability within each category is also minimal. According to the Terms and Conditions, "The applicant agrees to sell and maintain a minimum of 16 active instant ticket games at all times." (Section 13.F), and "The applicant agrees to sell all of the lottery's portfolio of draw games." (Section 13.G). As of 12/17/2019, the application form containing the Terms and Conditions is available at `http://www.mainelottery.com/pdf/Application%20Packet.pdf`.

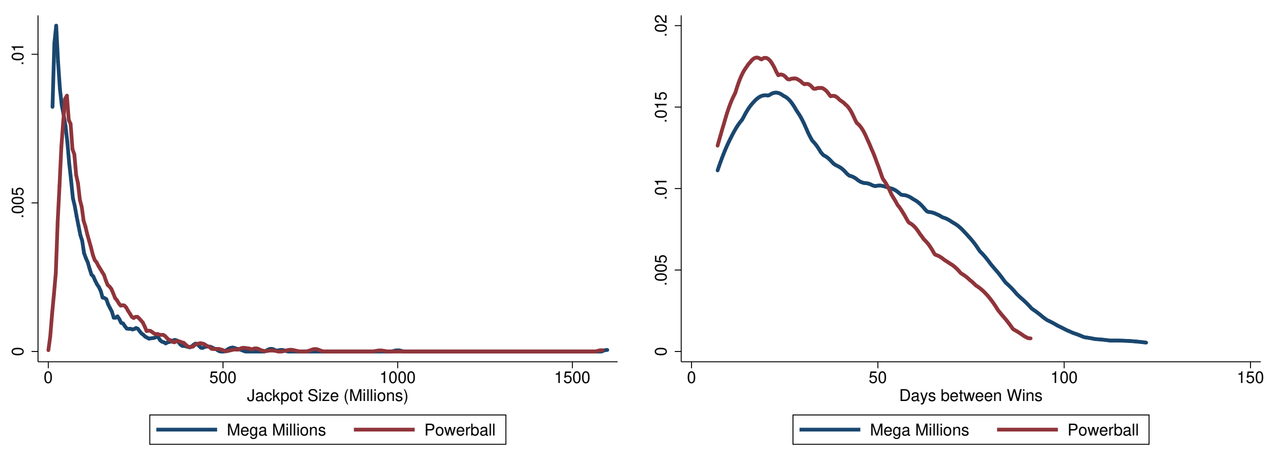
[6]Maine, Terms and Conditions, Section 13.H, states that "The applicant agrees to have installed by the Lottery or by the an authorized agent of the Lottery and use the following point of sale equipment issued to the applicant including the terminal, printer, flat panel advertising monitor, wireless ticket checker and wireless jackpot sign." Section 13.M states that "The applicant agrees to make available to the Maine State Lottery for inspection and audit those records the applicant is required to maintain."

Saturday, thus sales in any given week is recorded by two observations in our data, one covers PB sales from every Sunday to Wednesday, and every Thursday to Saturday. Similarly, MM holds drawings every Tuesday and Friday, thus the sales are recorded under every Tuesday and Friday, covering the days within the drawing cycle leading up to the drawing day.

Our TV news report data is obtained from archive.org, and newspaper text data is accessed through ProQuest News & Newspapers database.[7] In both services, we search for news containing either "Powerball" or "Mega Millions", and further filter out duplicated contents and results irrelevant to lotteries. We then produce count measures for the number of news mentioning each lottery product in a given time period, matching the drawing cycles in the sales data. To exploit the location-specific nature of local TV stations and local newspapers, we treat reports from national newspapers and TV networks as nation-wide news reports, and those from local sources as state-specific reports. As a result, our measures of news mentioning count for each product vary across drawing cycles and across states.

Our jackpot size data is obtained from reports provided to us from New Hampshire Lottery office, and cross-checked with records posted by lottoreport.com. Our county-level daily lottery sales data is generously provided by Maine Bureau of Alcoholic Beverages and Lottery Operations.

Over the sample period, these two products exhibit similar product characteristics. In addition to the similarity in their prices, odds and rules mentioned previously, they also behave similarly in overall jackpot size and time between wins (Figure 1). Essential to our motivation of the identification strategy, the data displays a consistent pattern where sales surge along with high jackpots (Figure 2).



(a) Distribution of Jackpots

(b) Distribution of Days between Wins

Figure 1: Jackpot Sizes and Winning Frequencies

Notes: This graph plots the distributions of jackpot sizes for every drawing cycle (panel a) and the days between two consecutive wins (panel b) by lottery.

We define a big win as the event where a jackpot at least $100 million above the starting jackpot was claimed. Under this definition, the big wins account for 53% of all winning events for PB, and 45% for MM. On average, two consecutive big wins are 64 days apart for PB and 89 days apart for MM, with the minimum gaps at 35 days for PB and 28 days for MM. We define a two-week event window pre and post a big win (14 days

[7] `https://archive.org/details/tv`.

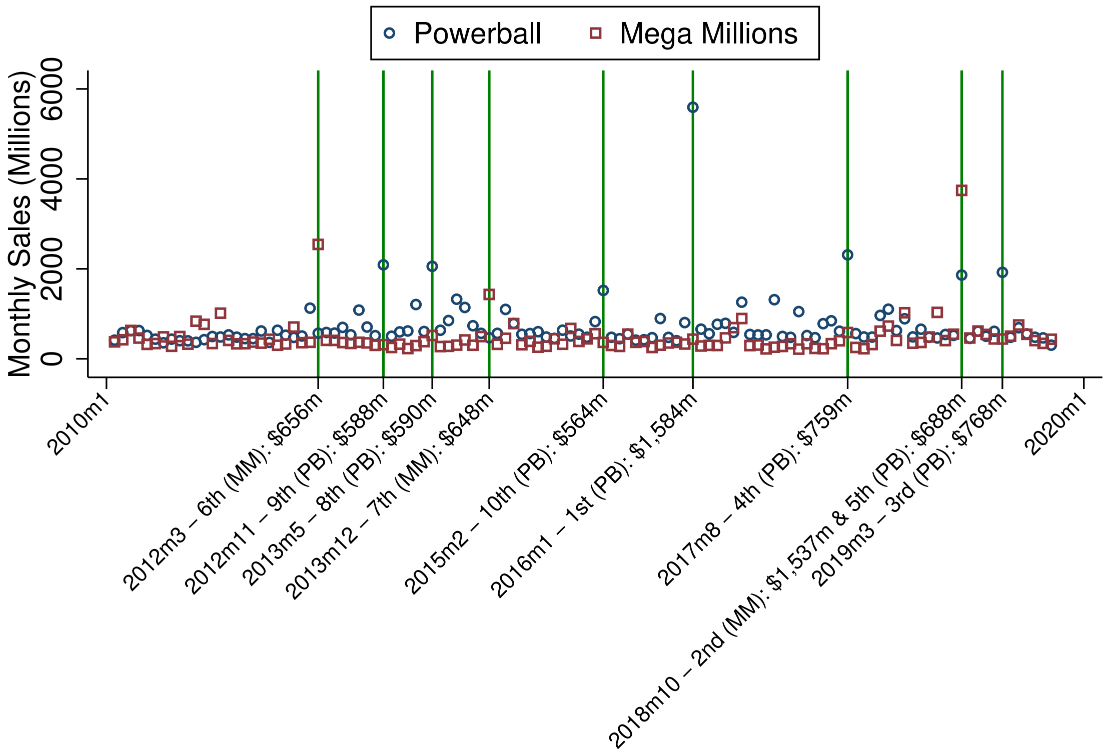


Figure 2: Monthly Sales in All Participating States

Notes: This graph plots total monthly lottery sales from all states by each lottery from Jan. 2010 to Sep. 2019. The vertical lines indicate the top-ten jackpots in recent history, with the horizontal axis labels marking: (1) the month and year of occurrence, (2) the rank of jackpot, (3) the associated draw lottery game, and (4) the jackpot size.

pre, and 14 days post). Based on the information with the minimum gaps, the event windows of consecutive big wins would not overlap.

Figures 3 and 4 plot monthly count of newspaper reports from Jan. 2010 to Sep. 2019 mentioning each lottery products, in newspapers and TV news, respectively. We observe that news mentions vary overtime and, in particular, increases dramatically during exceptionally high-jackpot drawing cycles. It is notable that both lottery products tend to be mentioned when one lottery product's jackpot reaches very high levels. This observation motivates our argument that increased news attention originated from one product may also raise public attention to its competition, leading to spillovers in demand.

4 Empirical Strategy

We first use a regression discontinuity framework to explore the changes in sales in response to claim of a large jackpot that resets the jackpot level to the default starting level. Then we use panel data regressions to unpack the changes in sales influenced by previous drawing cycles, trying to check if the drop in sales is primarily

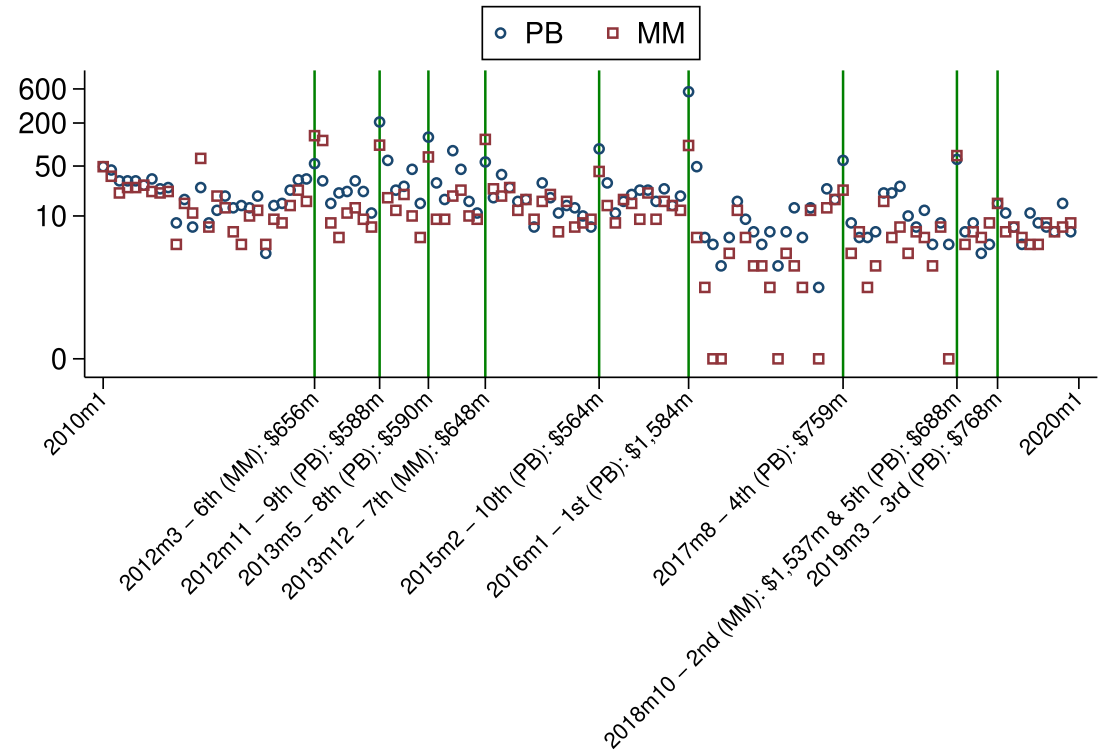


Figure 3: Newspaper Reporting

Notes: This graph plots monthly count of newspaper reports from Jan. 2010 to Sep. 2019 that mentioned each lottery product. The vertical lines indicate the top-ten jackpots in recent history, with the horizontal axis labels marking: (1) the month and year of occurrence, (2) the rank of jackpot, (3) the associated draw lottery game, and (4) the jackpot size.

driven by intertemporal substitution that pulls in future sales, or just fading consumer interests resulted from the lower jackpot. Following these analysis, we employ IV analysis to explore the complementarity versus substitution between the two products. Finally we use a IV-mediation model to investigate the role that news reports played in this mechanism. We layout our empirical strategies in this section, and report the results in the next section.

Sales Changes Following Big Win

Suppose that the sales, $y_{i,s,t}$, of a lottery product i by consumers in state s during the drawing cycle marked by drawing date t is influenced by jackpot size of the lottery itself, $v_{i,t}$. Let $d_{i,k}$ be the drawing date when lottery i is claimed with a sufficiently large jackpot, where k is the index in the set of such dates. Let $b_{i,t,k}$ be an indicator

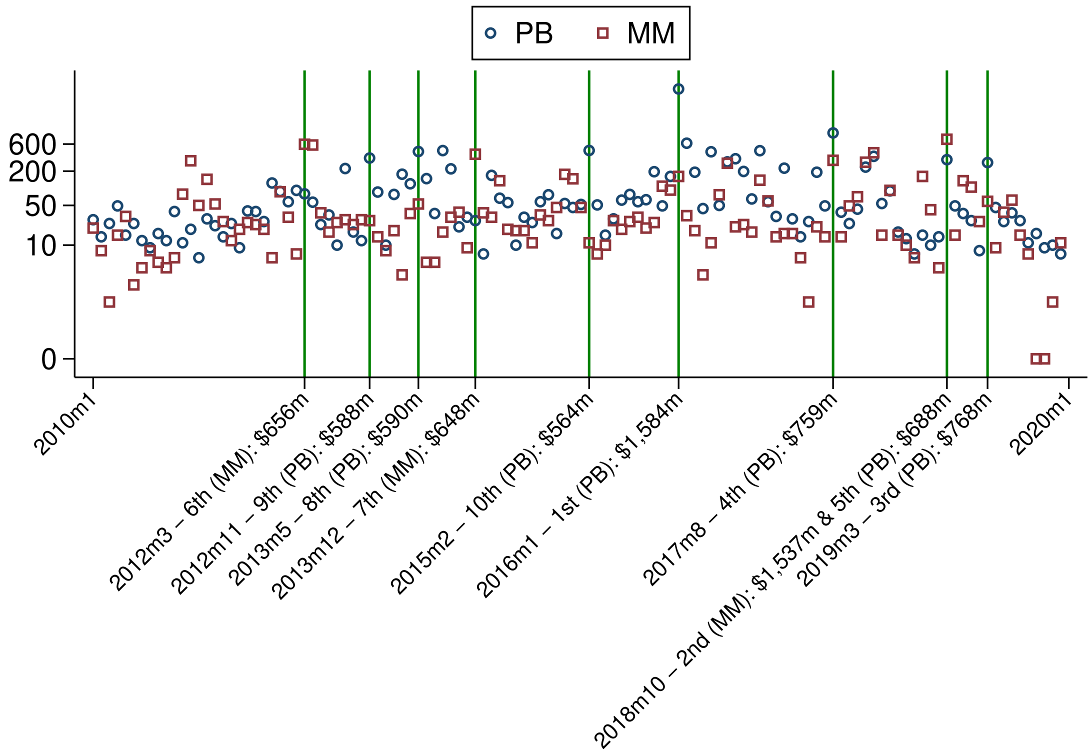


Figure 4: TV News Reporting

Notes:This graph plots monthly count of TV news reports from Jan. 2010 to Sep. 2019 that mentioned each lottery product. The vertical lines indicate the top-ten jackpots in recent history, with the horizontal axis labels marking: (1) the month and year of occurrence, (2) the rank of jackpot, (3) the associated draw lottery game, and (4) the jackpot size.

for the sales occurred post the big win, but sufficient far away from the next big win.[8] Then, we have

$$y_{i,s,t} = \kappa + b_{i,t,k}\beta + u_{i,s,t}, \tag{1}$$

where $u_{i,s,t}$ includes all other determinants of sales, including the jackpot of its competitor, $v_{-i,t}$, along with a vector of other product characteristics $L_{i,-i,t}$, such as price and availability of the lotteries, and consumer characteristics $X_{s,t}$, such as income and demographics. Assuming that, within each four-week event window, no variable in $u_{i,s,t}$ is uncorrelated with $b_{i,t,k}$, i.e., $\mathbb{E}[b_{i,t,k}u_{i,s,t}] = 0$, then β provides the causal effect of a change in jackpot of $100 million or higher. In other words, we use days to the big-win as the running variable in a RD framework and restricting to the sample within 2 weeks pre and post the drawing date by setting a bandwidth of 14, i.e., we choose all t such that $t - d_{i,k} \in [-14, 14]$.

Although most product characteristics $L_{i,-i,t}$ and consumer characteristics $X_{s,t}$ are likely to be uncorrelated to the big-win event, it is possible that sales of the competing lottery would be directly affected, leading to

[8]Specifically, $b_{i,t,k} = \mathbb{1}(d_{i,k} < t < d_{i,k} + \delta)$ with δ defined such that $\delta < (d_{i,k+1} - d_{i,k})/2$ for all k.

correlations between $y_{i,s,t}$ and $v_{-i,t}$. We investigate this possibility from two directions. First, we estimate the equivalence of (1), but replacing the dependent variable using the sales of the competing lottery, $y_{-i,s,t}$. Second, we estimate the (1) using a further restricted sample by excluding event windows of PB that overlap with those of MM.

Unpacking the Sales Changes Following a Big Win

When sales decrease following a big-win event, two alternative interpretation may explain the phenomenon—(1) intertemporal substitution from low-jackpot toward high-jackpot drawing cycles; versus (2) dissipating interest after the win. We explore these two alternatives by comparing sales in *all* the drawing cycles immediate following *any* win. Under case (1), we would see sales immediately following a greater jackpot to be lower than other baseline jackpot drawing cycles, whereas under case (2), the opposite would hold. Specifically, we estimate the following model

$$y_{i,s,t} = \alpha + p_{i,s,t'}\gamma_1 + p_{i,s,t}\gamma_2 + \sigma_s + \omega_t + \epsilon_{i,s,t}, \tag{2}$$

where $p_{i,s,t'}$ denotes the jackpot size of the previous winning jackpot with γ_1 being our estimate of interest. The model controls for the jackpot size of the current drawing cycle, $p_{i,s,t}$, state fixed effects, σ_s, and date of the week fixed effect, ω_t, to account for differences between a weekday drawing day (Tuesday for MM and Wednesday for PB) and a weekend drawing day (Friday for MM and Saturday for PB). We also estimate a similar model, replacing the jackpot size of the previous win, $p_{i,s,t'}$, with the sales during the previous drawing cycle, $y_{i,s,t'}$.

Complements versus Substitutes: an IV Model

To explore the complementarity versus substitution properties between the two lottery products, we resort to an IV framework. Time-varying unobservable characteristics in local markets may jointly influence sales of both lottery products, but a random shock to the interest of one product generated from a *previous* big-win event is unlikely to be correlated with any other unobservables that may influence the demand. We employ the indicator variable of a drawing cycle being within 2 weeks post a big win, $b_{i,t,k}$, as the IV to instrument for the sales of the lottery itself, $y_{i,s,t}$. The second-stage of model then regresses sales of the competing product with the closest drawing date, $y_{-i,s,t'}$, on the instrumented sales, $\hat{y}_{i,s,t}$, controlling for state fixed effects and weekend drawing date fixed effect.

IV Mediation Model

To further explore the mechanisms behind the complementarity versus substitute analysis, we turn to the news report data that counts the number of news that mentioned these two products. News producers pursues public interests. As the jackpot grows larger, the news producers expects an increase in interests regarding these products, thus pursues reader interests by producing related news contents. These broadcasted contents may further amplify consumers' demand, pushing up sales.

To test this hypothesis, and explore the share of variation explained by the variations from news reports, we follow an IV-mediation model by **?** and **?**, where the post-big-win indicator, $b_{i,t,k}$, works as the instrument for both the treatment variable—sales of the lottery itself, $y_{i,s,t}$—and the mediator—news mentioning of the lottery,

$m_{i,s,t}$. The model then estimates how much of the causal effect from one lottery's sales on its competition measured by the previous IV estimate can be explained by the mediator. The identification procedure first estimates a standard 2SLS model with the mediator, $m_{i,s,t}$, as the dependent variable in the 2nd stage. The procedure then estimates a new 2SLS model with the following structure.

$$\begin{aligned} \text{First stage:} \quad & m_{i,s,t} = b_{i,t,k}\gamma_M^Z + y_{i,s,t}\gamma_M^T + \epsilon_T \\ \text{Second stage:} \quad & y_{i,s,t} = \hat{m}_{i,s,t}\gamma_Y^Z + y_{i,s,t}\gamma_Y^T + \epsilon_T \end{aligned}$$

The identification assumption of this model is that the potential confounder that renders the sales of one lottery (treatment) endogenous to that of its competition (outcome) must also affect the news reports (mediator). Because we are mostly concerned about unobservable consumer preferences as the confounder, which is arguably well-known to local news media, we think this identification assumption is plausible in our context.

5 Results

5.1 Sales Changes Following Big Win

Table 1 reports our RD estimates, which are also presented in Figure 5. We find that (i) its sales falls by as much as $2.3 billions per drawing cycle (16 standard deviations) as reported in column (5); and (ii) the sales of the competing lottery sees little to no impact. In particular, result (ii) implies that big-win events generates little direct impact on the sales of its competition, despite the tremendous impact on its own.

One potential concern is that our results are primarily driven by outliers—drawing cycles with exceptionally high jackpots. We estimate our RD model by quintiles of jackpot sizes, Figure **??** reports these results. We further check this possibility by re-estimating our standard RD model on the sample excluding drawing cycles with jackpots greater than $500 million, and all the RD results remain robust.[9]

Unpacking the Sales Changes Following a Big Win

To unpack the dramatic change in sales following the big-win events, we compare sales from drawing cycles immediately following any win event. Table 2 reports these results. The significantly positive and sizable estimates indicate that the dramatic drop in sales is mainly driven by the dissipating interest in the product following the drop of the jackpot, however, consumers' interest dissipates *slowly* and positively spills over to trailing drawing cycles. In other words, big-win events raises its own sales even after the jackpot has been reset. These results overwhelmingly reject the intertemporal substitution hypothesis, and support the hypothesis of a dissipating interest following the big win.

5.2 Competitive Substitutes

We employ the indicator, *post-big-win*, as an IV to instrument for the sales of one product, to explain the variations of sales in its competition. The slowly dissipating interests results from Table 2 implies relevance of the instrument, whereas the little-to-none *cross products* effects post a big-win event, as reported from our RD

[9] Results available upon request.

Table 1: Regression Discontinuity at Big Win: 2-week Post vs. 2-week Pre

	ln(PB Sales)		ln(MM Sales)		PB Sales		MM Sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD Estimate	-1.074***	0.0186	-0.101**	-1.120***	-2281.1***	425.8***	-147.3***	-1835.2***
	(0.0382)	(0.0467)	(0.0451)	(0.0538)	(145.7)	(159.9)	(38.04)	(151.9)
Observations	22395	14637	19265	15971	22422	14658	19287	15994
Game	PB	MM	PB	MM	PB	MM	PB	MM

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports regression discontinuity estimates with local linear regression. The bandwidth is 14 days before (including) and after the drawing day that produced the winner(s). All models include the weekend drawing day dummy (Friday for MM, Saturday for PB) as the covariate, employs the triangular kernel, and the bias bandwidth is selected by MSE-optimal bandwidth. Standard errors are clustered at state-year level. Dependent variables in columns (5)-(8) are sales in 1000s of dollars. All results are robust to inclusion of state dummy as a covariate, and alternative cluster at week level.

Table 2: Slowly Dissipating Interests

	ln(PB Sales)		ln(MM Sales)	
	(1)	(2)	(3)	(4)
ln Jackpot Won: PB	0.0494***			
	(0.00442)			
ln Lagged Sales: PB		0.132***		
		(0.0182)		
ln Jackpot Won: MM			0.0815***	
			(0.00414)	
ln Lagged Sales: MM				0.162***
				(0.0104)
Observations	4712	4666	3890	3851
Ln(Jackpot Size)	Yes	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports OLS estimates using the subsample of a *single* lottery draw immediately following any win. The model regresses log sales on the previous winning jackpot size or sales of the winning draw, controlling for jackpot size of the sales dates, state fixed effects, and day-of-the-week fixed effects. Standard errors are clustered at state-year level. The reported results are robust to inclusion of concurrent jackpot size of the competing game.

estimates in Table 1, provides support for exclusion. To further avoid correlations from the instrument to the competing product, we focus on the sample where big-win events do not overlap across products.[10]

[10] The key results remain robust when all big-win event windows are included, see Subsection **??**.

Table 3 reports our key results on complementarity between these two products. We find that although OLS estimates imply an independent relationship between the sales, the IV results are significantly positive at a non-trivial magnitude, measuring a 23% cross-product elasticity in sales. The comparison between OLS and IV results suggests unobserved confounders that facilitates substitution between the two products.

Table 3: IV Estimates: PB and MM are Complements

	ln(MM Sales)		ln(PB Sales)	
	(1)	(2)	(3)	(4)
ln Closest Sales: PB	-0.0333	0.229***		
	(0.0273)	(0.0205)		
ln Closest Sales: MM			-0.0275	0.239***
			(0.0233)	(0.0440)
Observations	33940	33940	33944	33944
State FE	Yes	Yes	Yes	Yes
weekend draw FE	Yes	Yes	Yes	Yes
Model	OLS	IV	OLS	IV

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results of the same models as in Table **??**, but estimated with the sub-sample that excludes observations where the 4-week big-win windows of both games overlapped. The instruments for the IV models are the dummy variables for post big wins in the corresponding control lottery—post big PB win for column (2), and post big MM win for column (4). Standard errors are clustered at state-year level for OLS models, robust standard errors for IV models.

5.3 Attention Aura from News

We turn to the news data to unpack the mechanism using an IV-mediation analysis model. Tables 4 and 5 report the mediation analysis results. We find that almost all the complementarity is accounted for by the news exposure—evidence for the attention-aura effect.

6 Conclusion

This paper presents causal evidence of a special case, where the sales of a product increases when its close competitor experiences a boost in sales as a result of an exogenous increase in appeal. We identify such a counter-intuitive effect in the draw lottery market in the US that offers unique characteristics to overcome empirical challenges. Our key result found a substantial degree of complementarity with the cross elasticity of sales estimate of 0.2. Mediation analysis shows that the strong complementary between close competitive products is largely driven by the increased publicity and attention drawn to the entire product segment following the surge in interest in one of the products. In other words, a greater appeal of one product can exert

Table 4: Mediation Analysis: Lottery Mentioned in the News

	Mediator: TV News		Mediator: Newspapers	
	(1) ln(MM Sales)	(2) ln(PB Sales)	(3) ln(MM Sales)	(4) ln(PB Sales)
total effect	0.151***	0.647***	0.153***	0.568***
	(0.0254)	(0.139)	(0.0172)	(0.0864)
direct effect	-0.0296	0.0445***	0.164***	0.0613***
	(0.0689)	(0.00997)	(0.0222)	(0.00652)
indirect effect	0.181**	0.603***	-0.0117	0.507***
	(0.0914)	(0.164)	(0.00718)	(0.0953)
Observations	18191	18191	38828	38828
F-stat: Comp. Sales on IV	7489.8	149.4	7500.1	149.6
F-stat: News Mention on IV given Comp. Sales	12.0	26.1	69.6	77.6
Mediation Effect	119.6%	93.1%	-7.7%	89.2%

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results of mediation analysis, where the dependent variable is the log sales of one draw lottery (the focal lottery), the main treatment variable is the log sales of the competing lottery at the nearest drawing date, the mediator variable is the count of news that mentioned the focal lottery during its concurrent drawing cycle. The treatment variable and the mediator variable are both instrumented for by the dummy variable that the drawing day is within the post-big-win window of the competing lottery. All regressions control for state fixed effects. All standard errors are robust standard errors.

positive spillover through an “attention aura” to the entire product segment, thus increasing the sales of competitors. Our evidence shows that such an effect can dominate the intrinsic substitution between competing products, rendering them effectively complements in sales.

Table 5: Mediation Analysis: Lottery Mentioned in the News

	Mediator: TV News		Mediator: Newspapers	
	(1) ln(MM Sales)	(2) ln(PB Sales)	(3) ln(MM Sales)	(4) ln(PB Sales)
total effect	0.151***	0.647***	0.153***	0.568***
	(0.0377)	(0.172)	(0.0259)	(0.108)
direct effect	-0.0296	0.0445***	0.164***	0.0613***
	(0.100)	(0.0132)	(0.0321)	(0.00900)
indirect effect	0.181	0.603***	-0.0117	0.507***
	(0.131)	(0.199)	(0.00870)	(0.124)
Observations	18191	18191	38828	38828
F-stat: Comp. Sales on IV	3397.1	219.0	3402.5	219.3
F-stat: News Mention on IV given Comp. Sales	6.2	16.0	53.3	38.6
Mediation Effect	119.6%	93.1%	-7.7%	89.2%

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports results of mediation analysis, where the dependent variable is the log sales of one draw lottery (the focal lottery), the main treatment variable is the log sales of the competing lottery at the nearest drawing date, the mediator variable is the count of news that mentioned the focal lottery during its concurrent drawing cycle. The treatment variable and the mediator variable are both instrumented for by the dummy variable that the drawing day is within the post-big-win window of the competing lottery. All regressions control for state fixed effects. All standard errors are clustered at state-year level.

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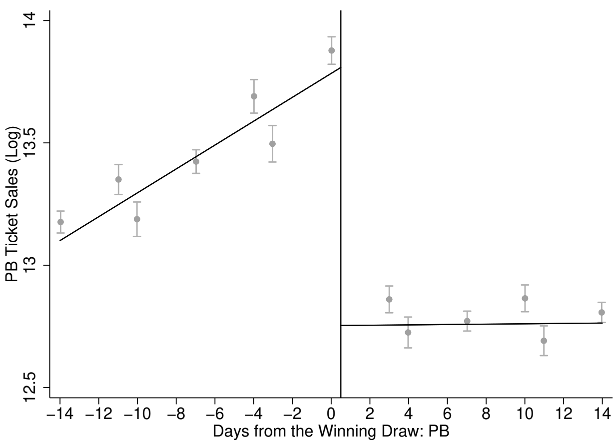
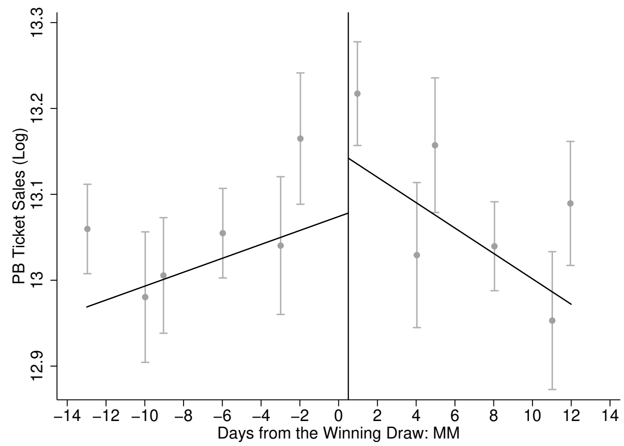
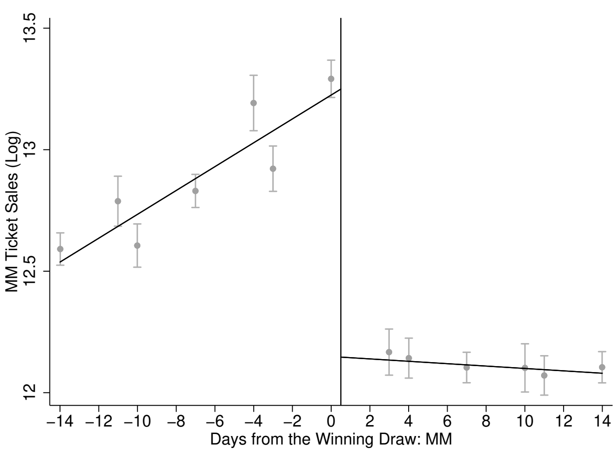


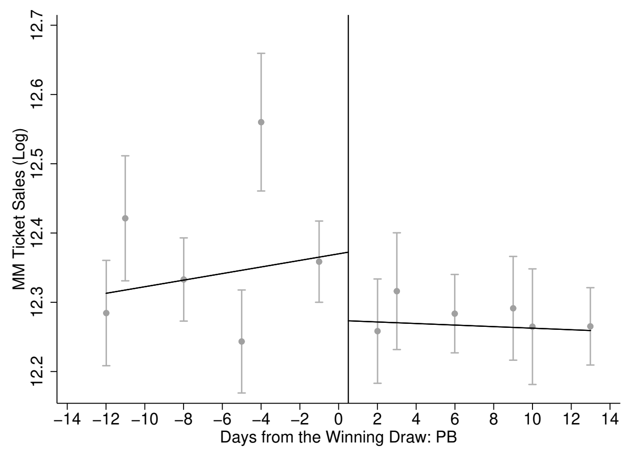
(a) PB Sales around Big PB Wins



(b) PB Sales around Big MM Wins



(c) MM Sales around Big MM Wins



(d) MM Sales around Big PB Wins

Figure 5: State-level Regression Discontinuity at Big Win: 2-week Post vs. 2-week Pre

Notes: This figure shows the graphs of regression discontinuity estimates around big wins of each game, as reported in Table 1. The dots in the graphs plot the point estimates of log sales in each observation bin, while the solid lines plot the local linear estimates. The two panes on the left, (a) and (c), plot the sales of each game around their own big win event. And the two panes on the right, (b) and (d), plot the sales around the other's big win event.