

University of Nevada, Reno

**An Analysis of the Gaming Industry in
Illinois**

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of Master of Science in
Economics

by

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Abstract

In 2012, Illinois passed legislation allowing Video Gaming Terminals (VGTs) outside of casinos. This legislation was passed in order to increase tax revenues from gambling in a market that had seen decreases in revenues and admissions over the past 8 years. Many mature gambling markets have also seen decreases in revenues and tax collections in recent years.

It was expected that the revenues from VGTs and the number of VGT machines would have a negative impact on the existing casinos through different measures including: casino revenue, slot revenue, table revenue, slot machines, tables, and admissions. Using OLS and VAR models, it was found that casino slot revenues decrease by about 0.12% for each 1% increase in VGT revenues. Admissions decrease by about 12 people for each VGT machine added to the market. According to the Granger Causality test, the causation is running from VGTs to admissions.

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Introduction

In September 2012 the state of Illinois voted to allow Video Gaming Terminals (VGTs) in entities other than traditional casinos. In layman terms, this means that slot machines are allowed in bars and other sanctioned locations. The law allows for up to 5 machines in each location. The motivation for the new legislation seems to have been fiscal as the tax revenues from casinos have been declining in recent years. Examined here is the substitutability or complementarity relationship that may exist between VGTs and casinos that will help determine the fiscal impact of this legislation.

This study examines the effect of VGT revenues and the number of VGT machines on casinos through six state level measures: total casino revenue, casino slot machine revenue, casino table game revenue, number of slot machines in casinos, number of table games in casinos, and the number of admissions to casinos. Admissions are calculated using turnstiles installed in all Illinois casinos that tally each person entering a casino. This is an important topic for gambling markets because it will help other states better understand the fiscal implications of allowing VGTs outside of casinos. These states will then be able to make more informed decisions about their own gambling markets. At the beginning of 2018, Missouri announced that they were considering similar legislation to allow VGTs (Zotos 2018). Casino owners in Missouri have expressed concern about how this legislation may impact their own revenue.

The findings of this thesis suggest that there is a statistically significant relationship between VGTs and casinos, with VGTs negatively impacting the casino market. Specifically, the main effects are through casino and slot revenues, the number of slot machines, and casino admissions, with the latter being most significantly impacted.

Admissions may be the main source of revenue cannibalization given that revenue per admission remains essentially constant. Based on the VAR model and Granger causality test, the decrease in admissions is being caused by an increase in the number of VGT machines. While this effect is clear and significant, its persistence is unclear.

Descriptive Narrative of the Gambling Industry

Heather Vacek from Baylor called gambling “America’s favorite pastime” (Vacek, 2011), and according to industry analysis from the American Gaming Association (AGA), Vacek’s claim has validity. In 2016, consumers spent \$38.96 billion dollars on commercial casino gaming. This amount is almost double the amount consumers spent on movie theatre tickets and about four times the amount spent on musical concerts. The AGA claims that commercial casinos employed 335,000 people across the United States in 2016.

While gambling has shown that it can dominate over other forms of entertainment, there is evidence that mature commercial casino markets are facing declining demand. The AGA reports growth statistics by state. In 2016 Missouri, New Mexico, South Dakota, Rhode Island, Illinois, and Louisiana all declined in gambling revenue and gaming tax receipts. These six states have mature gaming markets, all beginning in the 1990’s, that have been declining. Four out of six of these states also saw declines in either gambling revenues or gambling tax receipts at the end of 2015 according to the AGA. The state in question, Illinois, shows declining revenues and admissions over the past eight years.

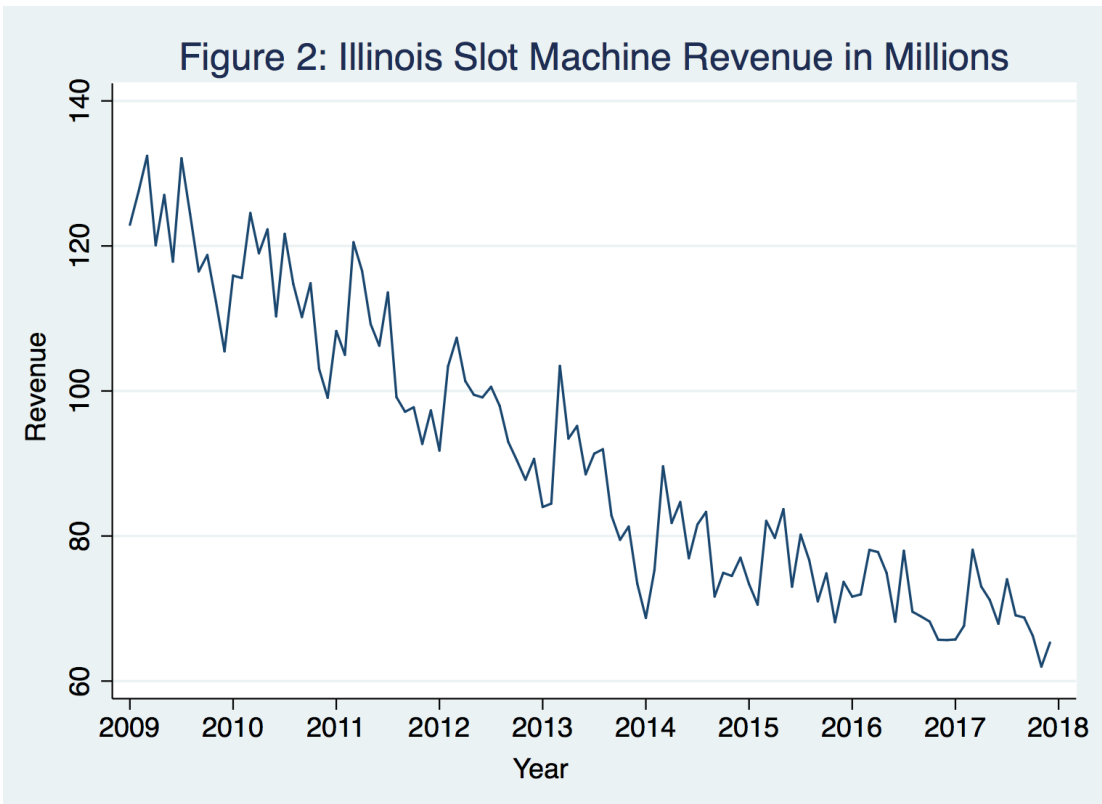
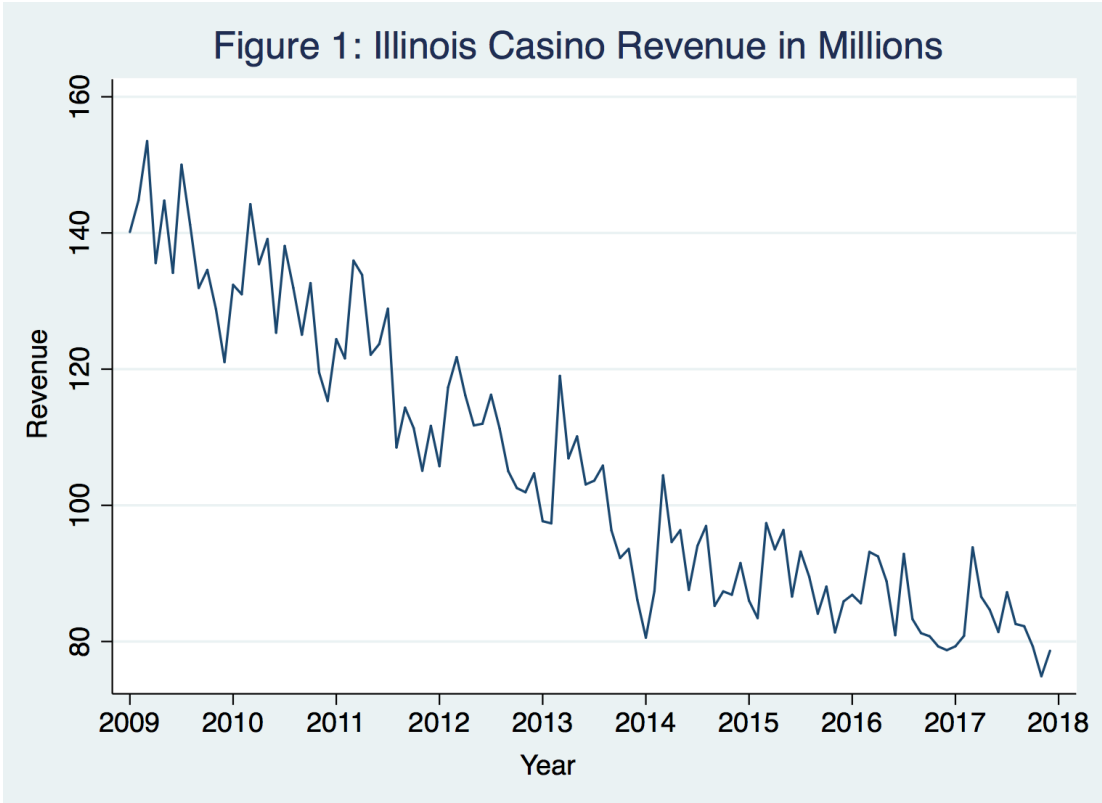
Table 1 provides descriptive statistics of the six measures of interest (total casino revenue, slot revenue, table revenue, number of slot machines, number of tables, and admissions) between 2009 and 2017 for Illinois. Table 2 provides a summary of the same six measures in 2009 whereas Table 3 provides a summary of the six measures in 2017.

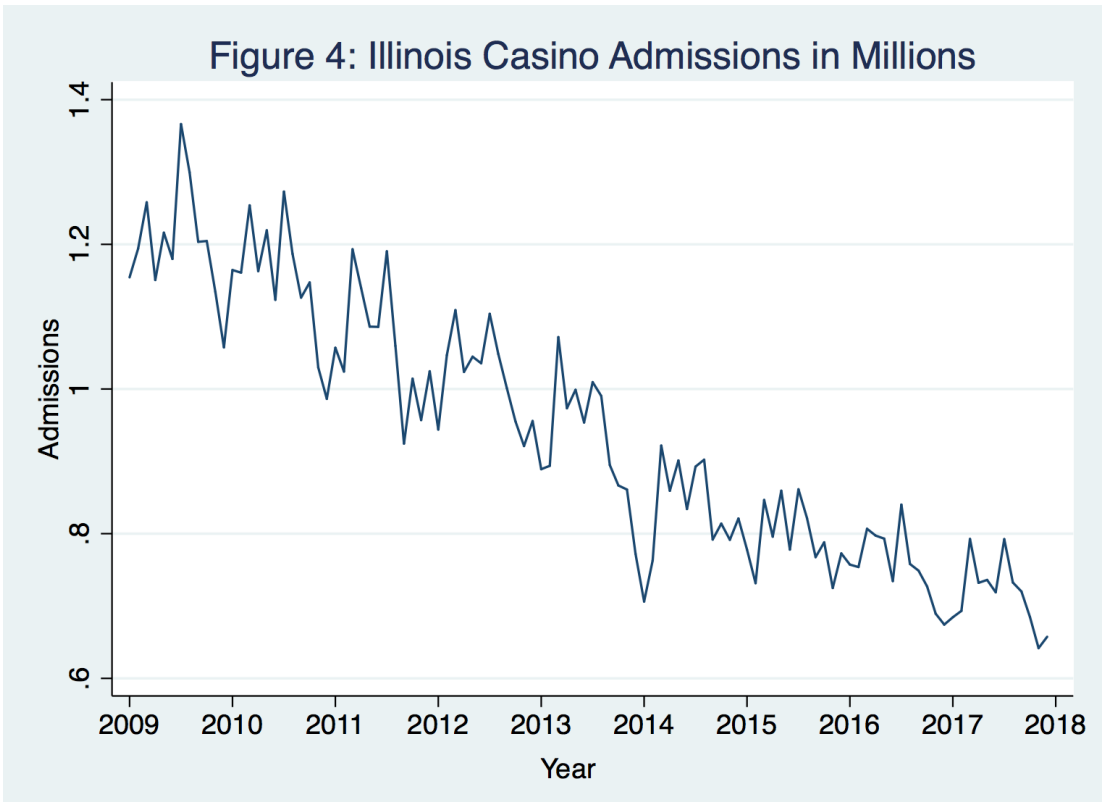
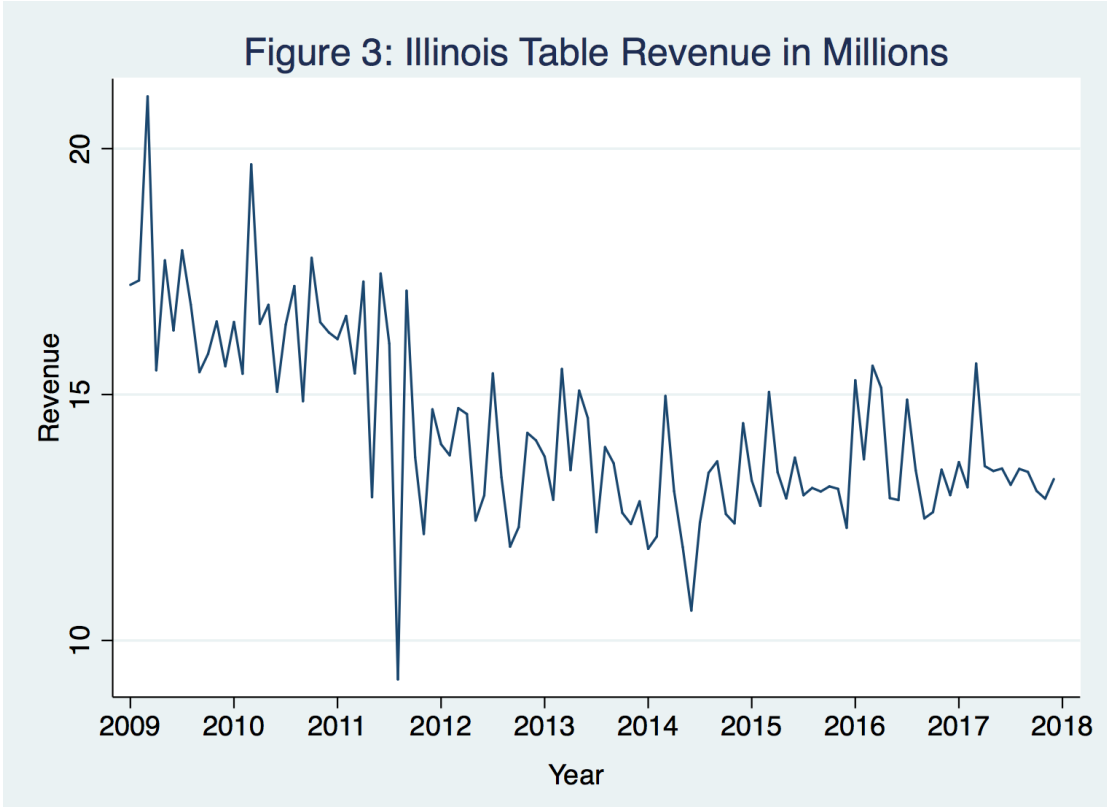
Comparing Tables 2 and 3, table games are making about \$3 million less in 2017 than they were in 2009. There are 15 more tables in 2017 than there were in 2009. The decrease across all three revenue measures is evident when comparing average revenues from 2009 to 2017. Admissions have decreased nearly 40% between 2009 and 2017. While the number of slot machines has decreased approximately 11%, real revenues from these machines have decreased over 43% from 2009 to 2017.

	Mean	Std. Dev.	Min	Max
Casino Revenue	\$105.408	\$20.798	\$74.904	\$153.485
Slot Revenue	\$91.097	\$19.367	\$61.984	\$132.422
Table Revenue	\$14.322	\$1.917	\$9.208	\$21.063
Slot Machines	9816	527	8944	10342
Tables	238	9	219	262
Admissions	940425	180176	641778	1366224

	Mean	Std. Dev.	Min	Max
Casino Revenue	\$138.377	\$9.198	\$121.038	\$153.485
Slot Revenue	\$121.441	\$7.962	\$105.463	\$132.422
Table Revenue	\$16.937	\$1.562	\$15.455	\$21.063
Slot Machines	10071	466	9074	10339
Tables	236	9	219	249
Admissions	1201563	80191	1057528	1366224

	Mean	Std. Dev.	Min	Max
Casino Revenue	\$82.620	\$4.946	\$74.904	\$93.827
Slot Revenue	\$69.078	\$4.407	\$61.984	\$78.109
Table Revenue	\$13.512	\$0.705	\$12.883	\$15.630
Slot Machines	9005	43	8944	9052
Tables	251	4	246	256
Admissions	715543	46812	641778	792645





This is not due to expanded casino competition in surrounding states. In fact, Iowa, Indiana, Missouri, and Wisconsin have all had casinos open for at least a decade prior to 2009. This suggests the decline is more endemic to the industry in Illinois and is consistent with the desire to expand gambling, in the form of VGT's, to offset the corresponding tax revenue decline.

The decline in demand is also evident by examining time series plots of these data. Figure 1 shows that total casino revenue has been trending down over the course of this sample period. However, there are signs of the decline leveling out in the last 3 years. Slot revenues comprised approximately 84% of total revenues in 2017 according to Table 3. Depicted in Figure 2, slot revenues demonstrate a similar trend downward over the sample period. Table revenue, shown in Figure 3, has decreased slightly over the course of the sample period, although not as severely as slot revenue. In fact, table revenue has begun to increase slightly near the end of the sample. The large decrease in table revenue around month 81 is a period where gamblers got lucky and casinos paid out a large amount of winnings to gamblers. The last measure, admissions, looks very similar to the slot machine revenue graph (Figure 2) and is also decreasing overtime as shown in Figure 4. This decline over the sample period suggests that fewer people are visiting the casinos each year. The casino revenue, slot revenue, and admission measures are also showing a decrease in volatility during the end of this sample period as shown in Figures 1, 2, 4.

How these measures relate to one another is also important to consider. Figure 5 shows the amount of casino revenue per admission. This graph has a slight U-shape. While the mean is approximately \$112 for the sample period, the amount made on each admission was about \$115 in 2009 and in 2017 after adjusting for inflation as shown in

Table 5 and Table 6. In July 2011, there were a particularly high number of admissions, creating a noticeably low ratio between casino revenues and admissions. Similarly in September 2011, admissions were particularly low which created a high ratio. Further research into these two time periods did not give a reason for the measures to be that different from the other ratios and these two months seem to be outliers. Overall, while revenue and admissions are both decreasing, the casinos have been able to maintain a constant revenue per admission over time.

	Mean	Std. Dev.	Min	Max
Casino Revenue Per Admission	\$112.10	\$4.20	\$102.40	\$123.67
Slot Revenue Per Machine	\$9,234.19	\$1,680.82	\$6,783.90	\$13,975.50
Table Revenue Per Table	\$60,217.96	\$8,526.12	\$38,048.88	\$88,497.70

	Mean	Std. Dev.	Min	Max
Casino Revenue Per Admission	\$115.26	\$4.89	\$108.69	\$122.00
Slot Revenue Per Machine	\$12,091.75	\$1,083.65	\$10,204.45	\$13,975.50
Table Revenue Per Table	\$71,958.96	\$6,877.04	\$65,441.46	\$88,497.70

	Mean	Std. Dev.	Min	Max
Casino Revenue Per Admission	\$115.53	\$2.69	\$110.10	\$119.61
Slot Revenue Per Machine	\$7,670.22	\$466.05	\$6,925.57	\$8,637.50
Table Revenue Per Table	\$53,954.79	\$3,351.17	\$3,351.17	\$63,538.44

Figure 5: Illinois Casino Revenue Per Admission

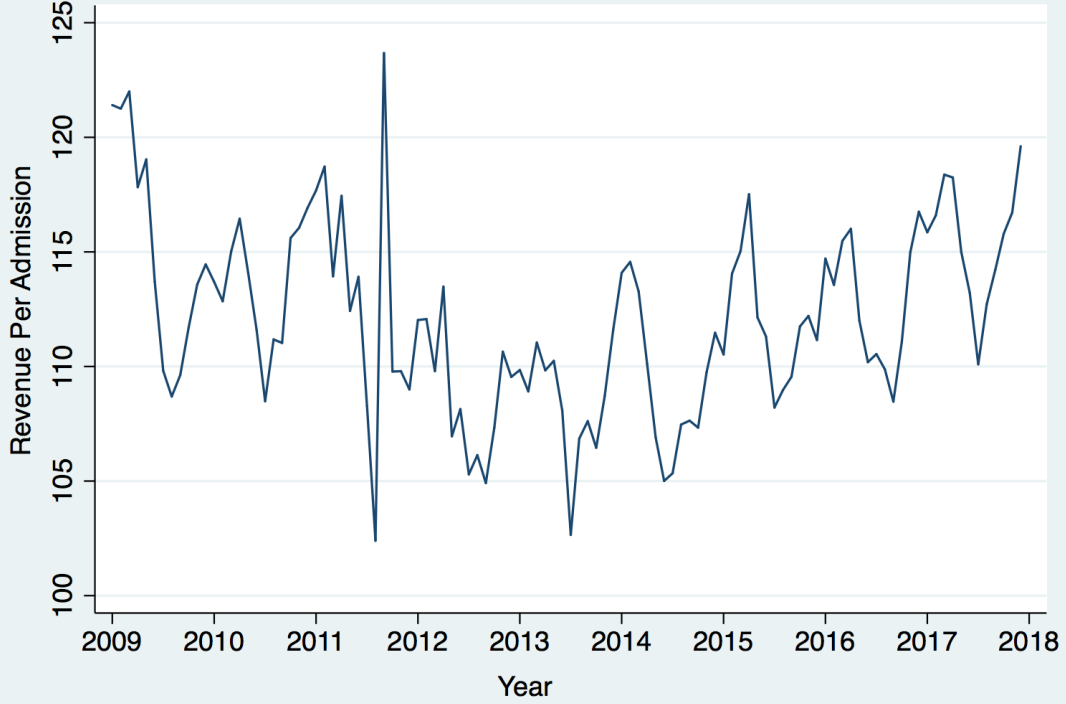
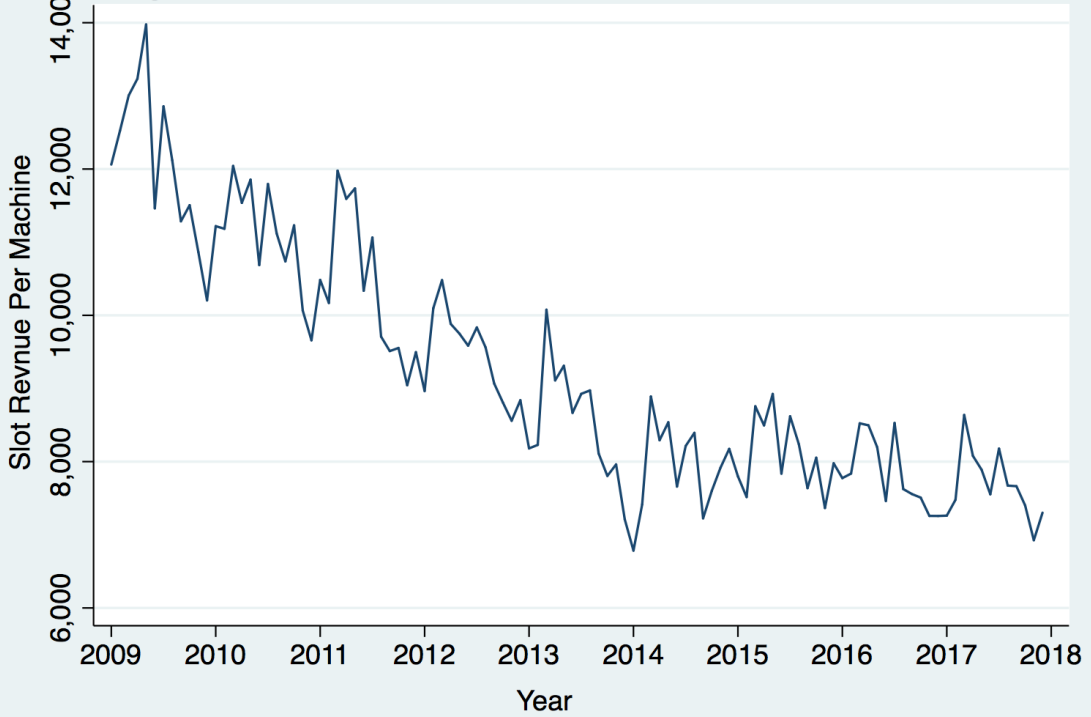
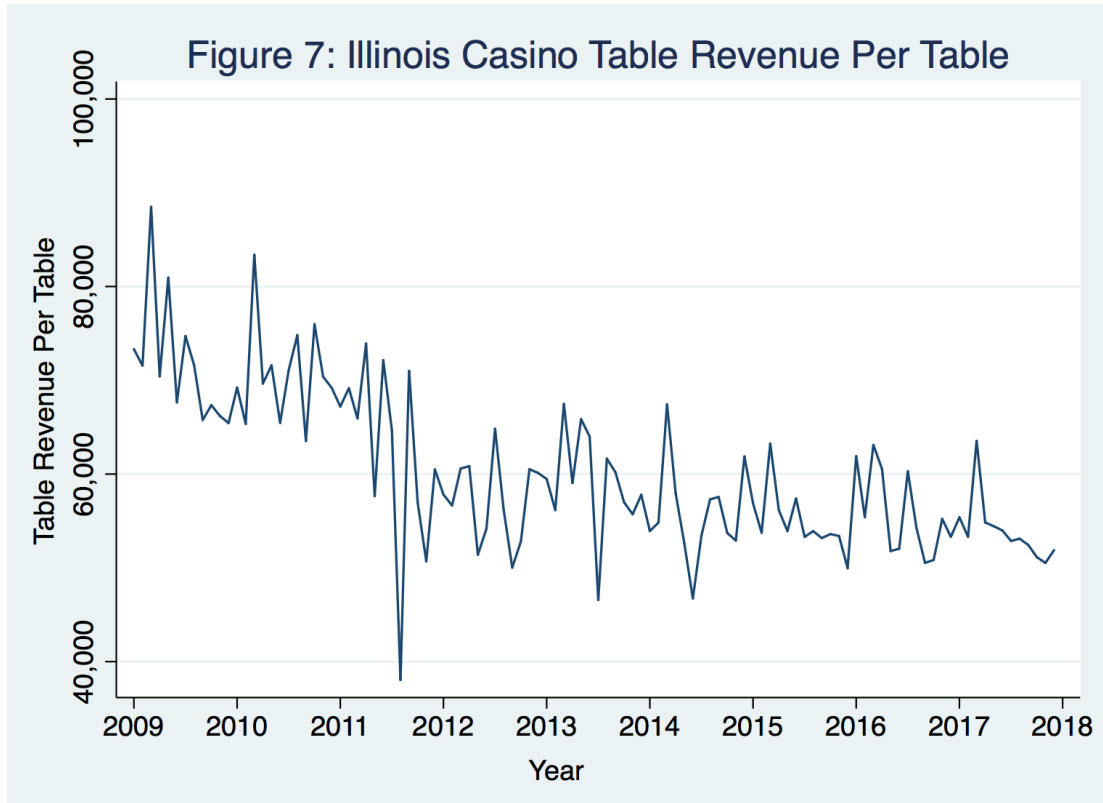


Figure 6: Illinois Casino Slot Revenue Per Slot Machine





Slot revenue per slot machine did not act similarly to revenue per admission. Referencing Figure 6 there is a clear trend downward in slot revenue per machine that seems to flatten out in the last three years of the sample.

Slot revenue per machine has declined approximately 37% from 2009 to 2017 as shown in Tables 5 and 6. The number of slot machines is declining as is the revenue gathered from slot machines on average. Also, since the recession in 2007, the preferences for \$0.01 slot machines has increased drastically which could help explain the decrease in overall revenue from slot machines.

Figure 7 illustrates the amount of table revenue per table and looks very similar to Figure 3 depicting just table revenues. The number of tables does not vary much over the eight years in the sample, but table revenue per table decreases 25% on average (see

Tables 5 and 6). The greatest number of tables is 262, whereas the lowest is 219, a change of only 43 tables over eight years. It is important to note that there are 20 more tables at the end of 2017 than there were at the beginning of 2009, so it could be that the increase in the number of tables that is also contributing to the decrease in table revenue per table.

The next two measures of importance are the total number of VGTs in Illinois and total VGT revenue. These data are collected over the time period that the VGTs have been legalized. Since this is a new market, there is tremendous growth between the implementation of the law and the most recent full year the VGTs operated.

	Mean	Std. Dev.	Min	Max
VGT Revenue	\$74.189	\$30.461	\$10.527	\$121.986
VGT Count	19319	6667	3381	28271
Establishments	4553	1493	807	6359

	Mean	Std. Dev.	Min	Max
VGT Revenue	\$26.773	\$9.179	\$10.527	\$39.967
VGT Count	8230	3156	3381	13369
Establishments	1983	771	807	3253

	Mean	Std. Dev.	Min	Max
VGT Revenue	\$110.370	\$6.503	\$96.539	\$121.986
VGT Count	26812	1060	24852	28271
Establishments	6097	199	5714	6359

	Mean	Std. Dev.	Min	Max
2013-2017	\$3,739.38	\$419.25	\$2,821.42	\$4,707.87
2013	\$3,301.97	\$271.56	\$2,989.50	\$3,970.55
2017	\$4,117.81	\$219.58	\$3,884.54	\$4,707.87

Figure 8: VGT Revenue in Millions

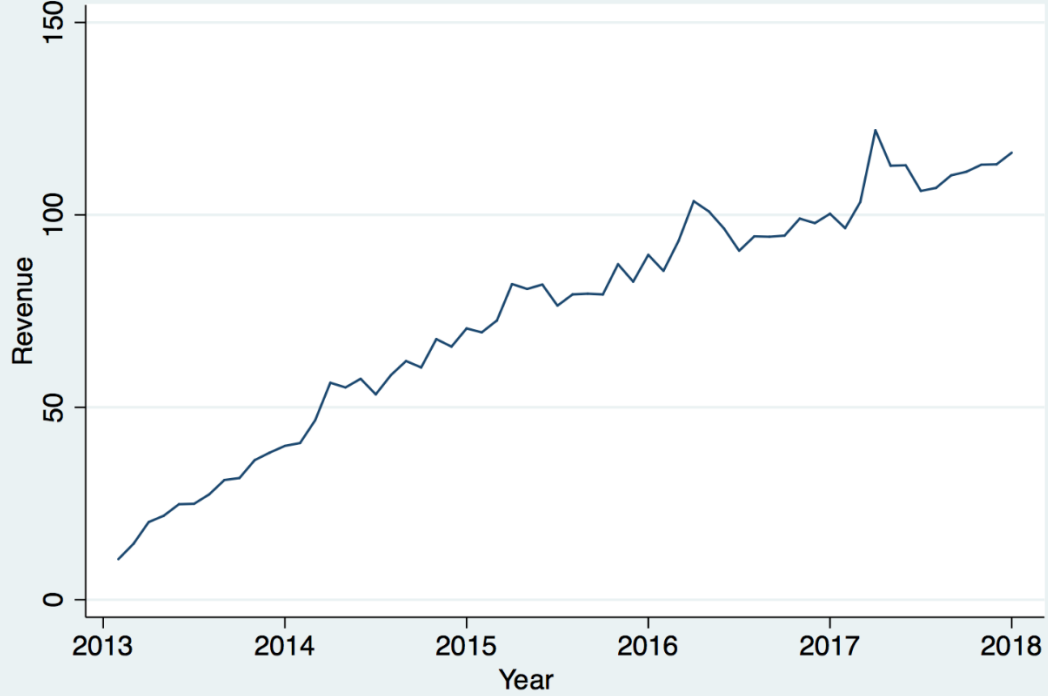
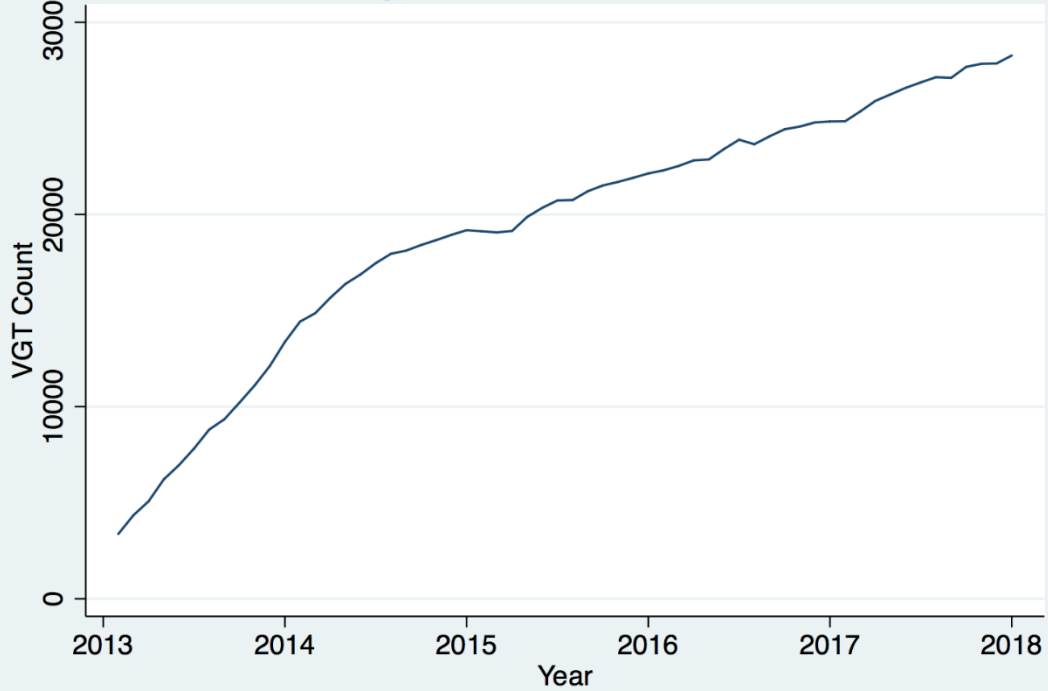
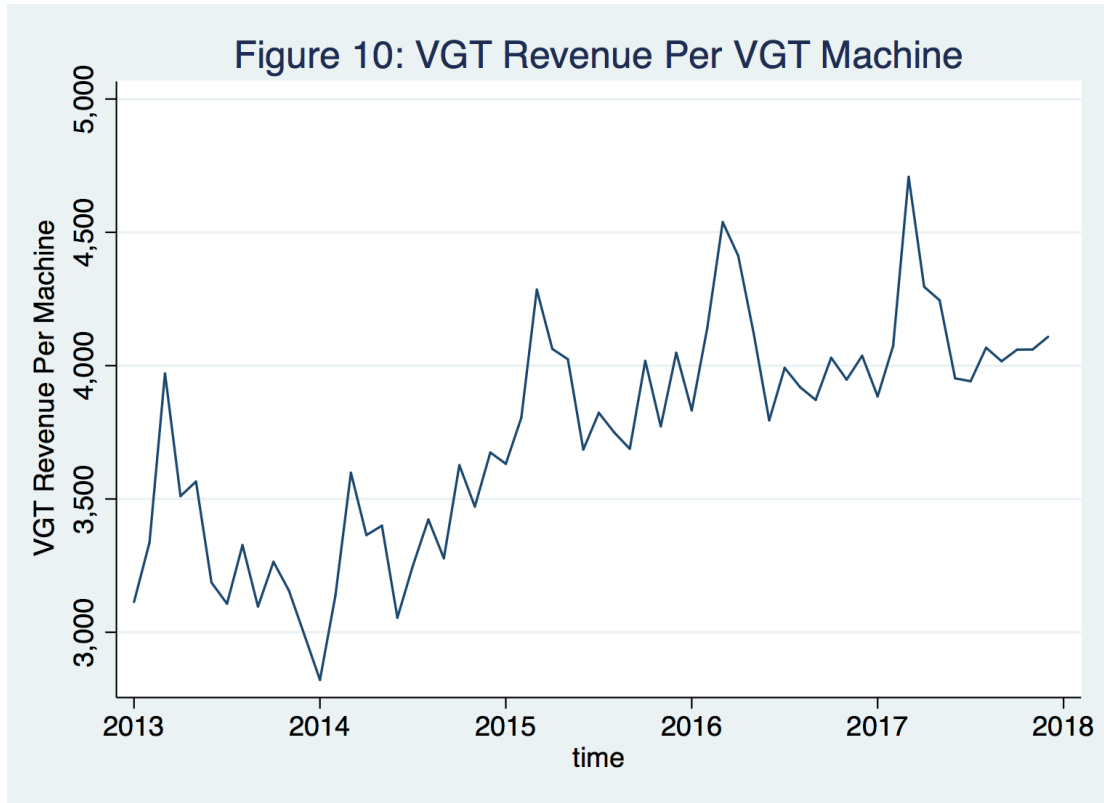


Figure 9: Number of VGTs





In fact, in terms of total revenue, the VGT market is now comparable to the large and mature casino market in 2017 as shown in Table 9. Tables 8 and 9 show VGT revenue has increased nearly 300% between 2013 and 2017. This growth has started to slow, increasing about 15% between 2016 and 2017. Thus, while this new VGT market took off rapidly, and is still growing, there is evidence that the growth is slowing substantially.

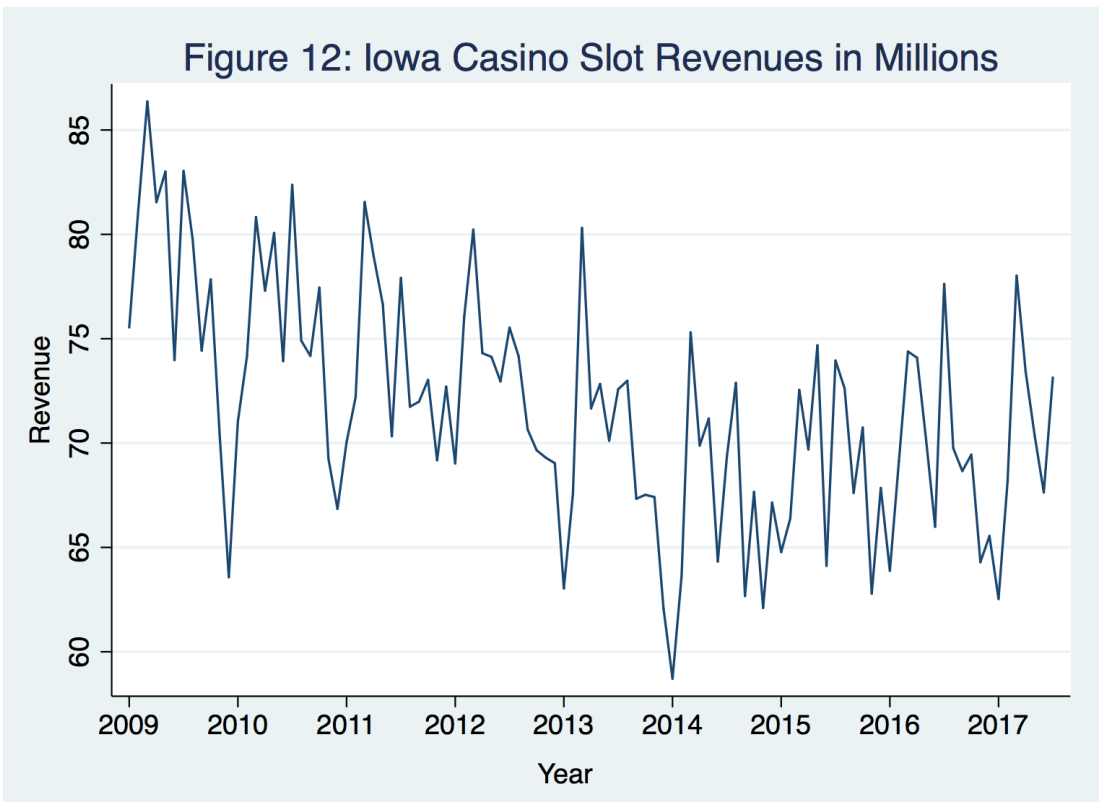
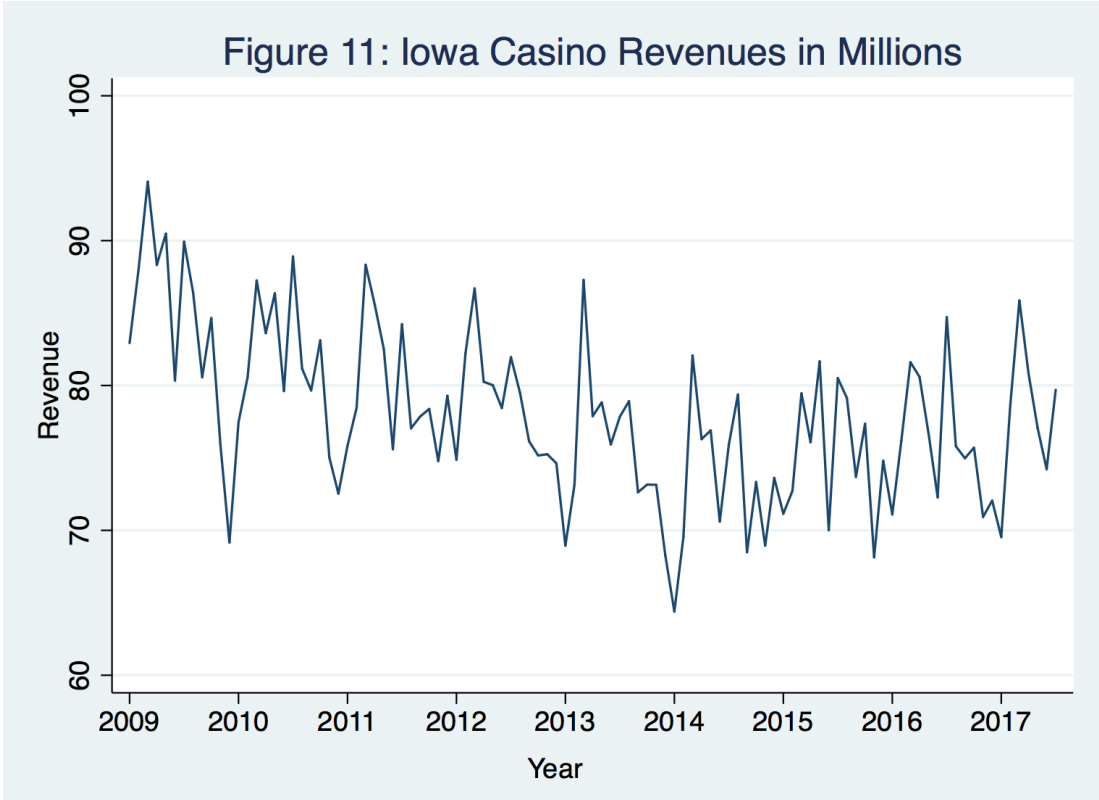
The number of VGTs also increased quickly, with an overall gain of approximately 10,000 machines in 2013. The subsequent four years saw fewer new VGTs each year, only adding about 3,500 machines during 2017. Still, the number of VGTs in Illinois grew by 225% from 2013 to 2017. VGT revenue per machine has also increased. Referencing Figure 10, there is a clear increase in VGT revenue per machine. It is also apparent that this revenue measure spikes during the first part of the year which

is similar to how casino revenues behave. The amount of revenue per machine increased 25% on average between 2013 and 2017. So while many new machines are being added, people are playing them at a faster rate than they're being added to the market.

It is helpful to also examine other casino markets in order to better understand changes in Illinois relative to industry-wide trends. For this purpose I examine the same revenue and casino measures for Iowa. Iowa is a natural comparison given the similarities between the Iowa and Illinois casino gambling markets. These two Midwestern states both legalized riverboat gambling in 1991. Illinois and Iowa exhibit similar regulatory structures and have a similar number of casinos. Both of these states also restrict the number of casino licenses.

Examining Iowa, there are noticeable declines in revenue and admissions during the sample period (see Table 11). Figure 11 shows a decline of casino revenues from 2009 through 2013 but exhibits a more obvious slight trend upward starting in 2014. Between 2009 and 2016 casino revenues declined about 10% overall. Slot revenues in Iowa show a similar trend as total casino revenues (see Figure 12), declining 10% from 2009 to 2016. This is not surprising given that slot revenue comprises approximately 90% of total revenue in Iowa.

Year	2009		2016	
	Mean	Std. Dev.	Mean	Std. Dev.
Casino Revenue	\$84.237	\$6.947	\$76.052	\$4.363
Slot Revenue	\$77.547	\$6.371	\$69.412	\$4.251
Table Revenue	\$6.691	\$0.671	\$6.640	\$0.409
Admissions	\$1,266,373	\$111,584	\$1,079,842	\$71,226



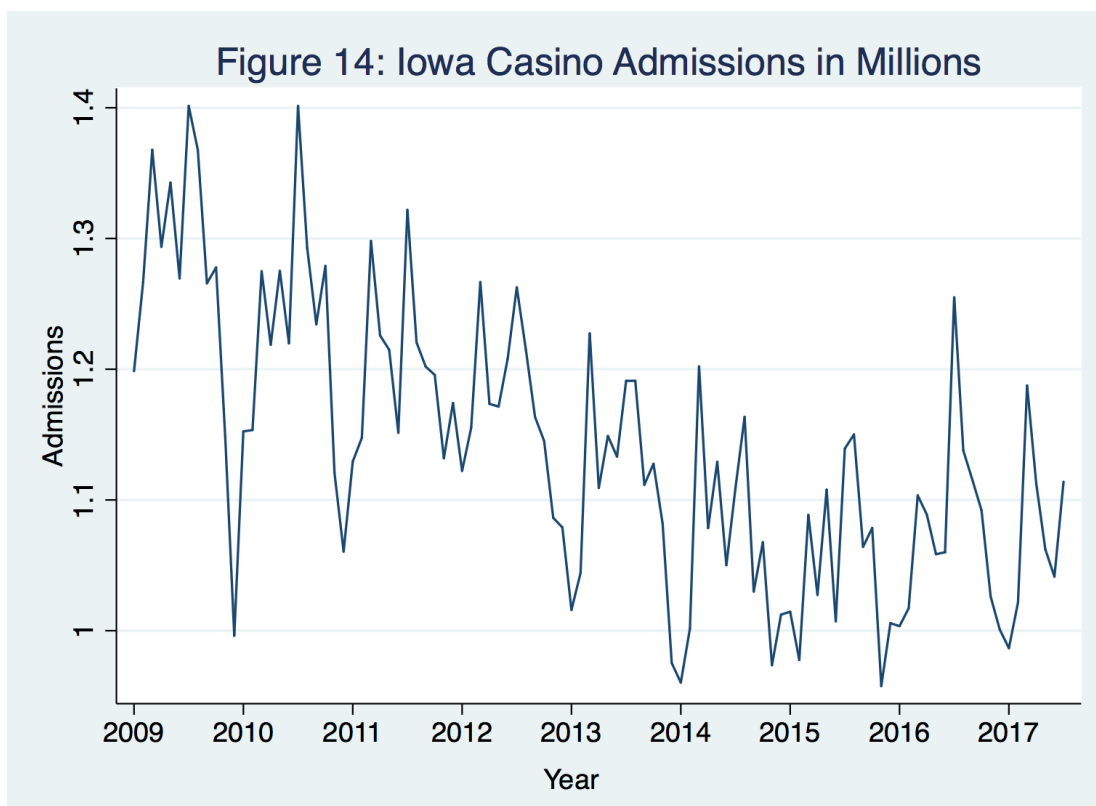
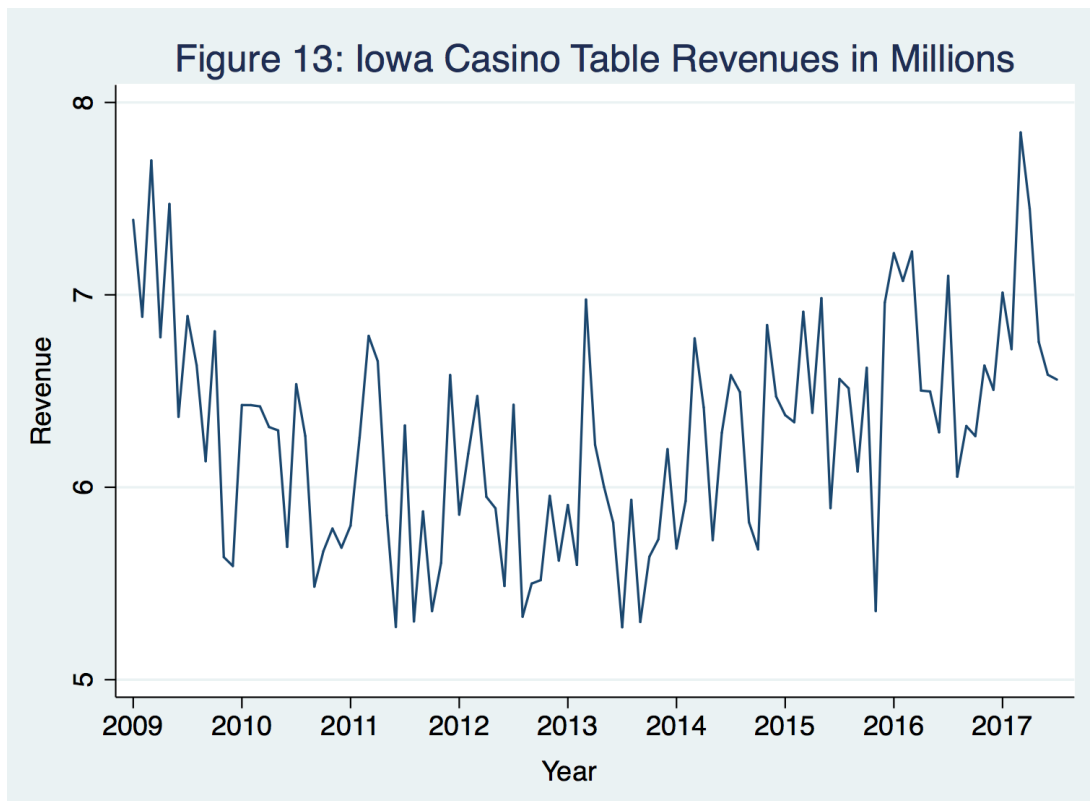


Figure 13 shows that table revenue exhibits a U-shape. There is a very small decrease in table revenues from 2009 to 2016 of 1%. Admissions, shown in Figure 14, exhibit a trend downward from 2009 through 2014 but perhaps increasing starting in 2015. Even with this downward trend lessening, casino admissions have declined nearly 15% between 2009 and 2016. Based on this analysis there is a downward trend for casino revenue, slot revenue, and admission between 2009 and 2016. The most notable decline is in the admissions measure. This gives reason to believe that the declines witnessed in Illinois are not unique to Illinois.

As mentioned above, Missouri is a mature gambling market that was started in 1990's and is experiencing declining revenues and tax revenues in recent years according to the AGA. Missouri is now proposing legislation that would allow VGTs in bars and convenience stores (Zotos 2018). While the bill is in early stages, it seems that Missouri, following the example of Illinois, could be trying to boost tax revenues in the wake of decreasing tax revenues from casinos.

It is also important to look at the political and social climate surrounding the gambling market and VGT market in Illinois. According to the Illinois News Bureau, the legislation passed in 1990 that allowed commercial riverboat casinos sold licenses for only \$25,000 even though they were valued at \$5 billion in 1990. The article also criticizes the rate in which VGTs are taxed. Currently, VGT revenues are taxed at 30% with 25% going to the state and 5% going to the municipality in which the VGT operates. The author of the article claims that there was about \$2 billion dollars, between 2012 and 2016, that the government of Illinois missed out on by setting the tax rate at 30% instead of the 37.5% to 50% rate paid by casinos.

It may seem like the establishments that house the VGTs are doing very well for themselves, but some of these business owners and operators would disagree. Written into the legislation is a clause that forces the “gaming parlors” (locations housing and licensed for VGTs) to profit share with the companies that operate the terminals. In an article by Becky Yerak in 2017 and published in the Chicago Tribune, the implications of profit sharing are examined about four and a half years after the VGT legislation went into effect. Two companies that own multiple locations that house VGTs are suing Illinois because the part of the act mandating profit sharing is “unconstitutional under the due process and equal protection clause”. The lawsuit goes on to state that “the amount in profits the Video Gaming Act divvies out to each party is not rationally related to the contributions or investments each party may make toward the business or the amount each party has at risk”. The main flaw of this mandate is that the businesses that house the VGTs are not allowed to service it, meaning that a machine could be out of service for days while the business waits for a technician. Yarek goes on to make an argument that the profit sharing requirement is preventing businesses from reinvesting profits into their businesses and making them more consumer friendly, thereby reducing the revenue generating potential of the VGTs.

Literature Review

Marionneau and Nikkinen (2018) published a review of gambling market cannibalization literature in the *Journal of Gambling Issues*. Marionneau and Nikkinen found only two papers that studied the effect that electronic gaming machines (commonly known as slot machines) have on casinos and whether the electronic gaming machines cannibalized

casino revenues. For one of the papers there was no quantified or qualified impact. The other paper, by Levitzky et al (2000), did find an impact on electronic gaming machines and is explored below. To the best of my knowledge, no study has examined the impact of introducing VGTs into a mature casino market. However, studies do exist on how various forms of gambling impact each other and a few of these studies are briefly reviewed.

In the paper by Levitzky et al. (2000) the authors use an OLS model, with different transformations of the independent variables as robustness checks, to determine casino revenue based on the number of table games, number of slot games, number of visitors, and the travel price index. While they did not have a result from machines similar to VGTs, they did find that electronic gaming machines within casinos cannibalize revenues from table games. They also found that electronic gaming machines are generating more casino revenues than table games. The authors state that there is a “current market trend of changing attitudes, away from table games toward more user-friendly and high tech/low pressure slot games”.

Elliot and Navin (2002) analyzed how casinos impact the decision of a state having a lottery and the amount of revenues lost from state-sponsored lotteries to casinos and pari-mutuel betting. They used panel data to estimate a probit model where the dependent variable is the decision to have a lottery and one of the explanatory variables is the existence of casinos. Elliot and Navin (2002) found the existence of casinos negatively effects the decision to have a lottery. In addition, based on the states that chose to have a lottery, they found that a significant portion of lottery revenues are lost to casinos and pari-mutuel betting. Furthermore, the cannibalization of lottery revenues by

pari-mutuel betting is so great that states are losing more money in lottery tax revenues than they are making from pari-mutuel betting tax revenues. The authors suggest high tax rates on pari-mutuel betting or revoking track licenses as the policy implications of their findings.

Walker and Nesbit (2014) analyzed how much casinos cannibalize revenues from neighboring casinos. They used a spatial OLS model where the dependent variable is casino revenue and include an explanatory variable for the number of casinos within 100 miles of a given casino. Walker and Nesbit (2014) also include variables that would determine own-casino revenues such as slot machine games, table games, and casino square footage. They find that casinos close to one another are substitutes, and more specifically the number of slot machines negatively effects neighboring casino revenues. Interestingly, table games have a positive effect on the revenues of neighboring casinos.

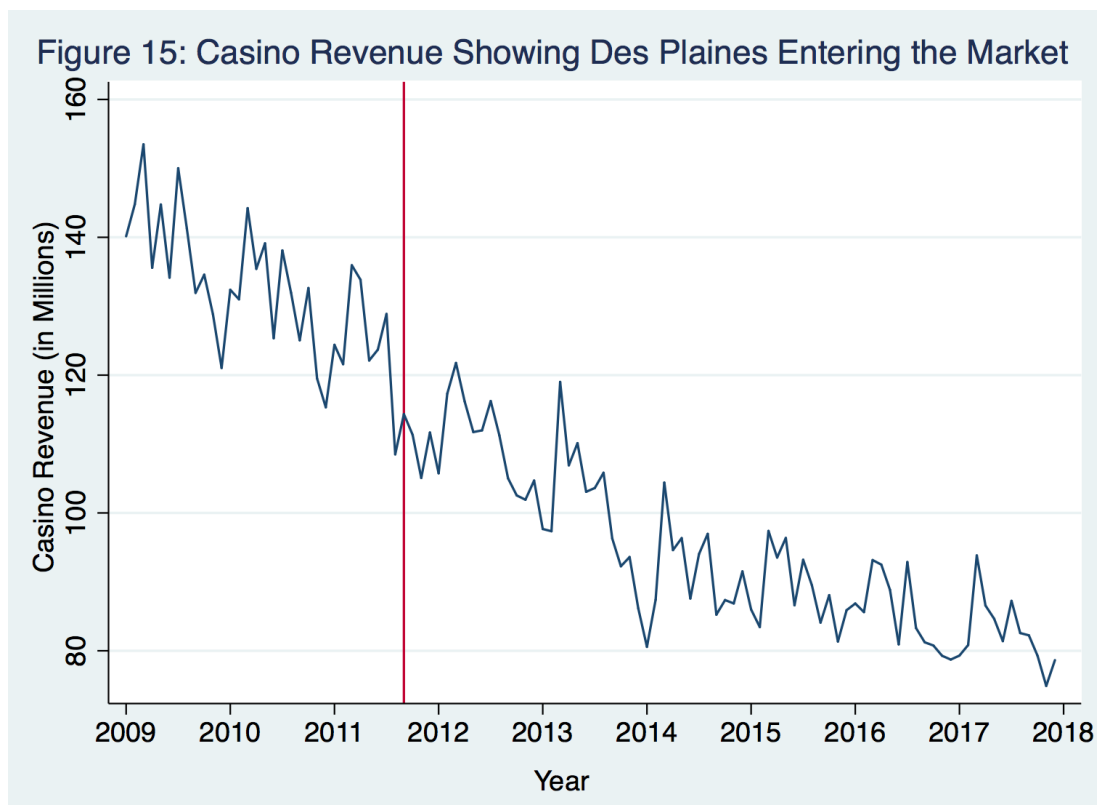
Data

Data for this thesis are gathered from reports provided online at the Illinois Gaming Board website. Two forms of data were merged together: riverboat casino monthly reports and video gaming monthly reports. All data was put into real terms and are adjusted to January 2018 dollars using the CPI. Casino data during the Great Recession causes too many non-stationarity issues. For this reason, and given that VGTs were not legalized until 2012, the sample selected dates from January 2009 to December 2017. In addition, the first four months of VGT data are omitted due to the rapid growth during this period which also introduces non-stationarity issues and is not representative of longer-run growth trends.

I also exclude data from a casino that opened in July 2011, choosing instead to examine casinos in continual operation over the entire sample period. The new casino also causes non-stationarity problems and, while omitting it did not solve these issues entirely, it did help. The justification for excluding the casino can be seen in Figure 15. While there may be an initial effect in period 33, it does not seem to be permanent.

Additional variables were created to help control for various trends and fluctuations in the data. Seasonal dummy variables and year dummy variables are included as well as an industry cycle variable. The industry cycle variable was gathered from the Illinois Department of Employment Security (IDES) using the Current Employment Statistics. This variable tallies the total employment in the arts, entertainment, and leisure industry in Illinois. This variable is intended to capture changes in revenue that are reflective of changes in the broader industry as a whole in order to better isolate changes resulting from the introduction of VGTs. On average, there are 50,000 workers in this industry during the sample period with employment trending upwards but cyclical like the casino measures. Finally, travel costs are controlled for by including the national average price for petroleum from 2009-2017. The petroleum data were collected from the U.S. Energy Information Administration. The average gas price during the sample period is \$3.26, with much higher prices between 2011 and 2015. The four main groupings of controls are intended to control for yearly and monthly variation, changes in the industry in Illinois, and variation in travel costs.

The Phillips-Perron unit-root test was used to test each of the variables in the model for stationarity. These results were also verified with the Augmented-Dickey



Fuller (ADF) test. Unfortunately, due to the small sample size of these data, any unit-root test is going to have low power. The Phillips-Perron and ADF tests showed that the following variables are trend stationary: casino revenue, slot revenue, slot machines, table revenue, number of tables, admissions, VGT machines, and the natural log of VGT revenue. Gas prices required first differencing to achieve stationarity.

Model

To analyze each of the six casino measures the following general OLS model is estimated:

$$Casino\ Measure_t = \beta_0 + \beta_1 VGT\ Measure_t + \beta_2 Controls_t + \varepsilon_t$$

This model is estimated six times, one for each of the casino measures (casino revenue, slot revenue, table revenue, number of slot machines, number of tables, and casino admissions). Each of the models has seasonal dummies, industry employment, and monthly US gas price average as controls. The independent variables of interest are the natural log of VGT revenue and the number of VGT machines. Given that most of the literature has found that various forms of gambling substitute for one another, I expect VGTs to be negatively correlated with casino revenues, slot revenues, number of slot machines, and admissions. I would not expect a significant relationship between table revenues/number of tables and the VGT measures as these are likely different markets/players.

Ideally, each model would have controlled for cyclical employment in the industry (or employment trend), national gas prices, state unemployment, and the month. However, there were issues of multicollinearity, and while that would not bias the coefficient estimates it would bias the standard errors. I used variance inflation factors (VIF) and correlation tables to determine the controls I include in each model. In most models, I used seasonal dummies in place of monthly dummies, as well as the industry employment and the first difference of US gas prices as controls.

Due to the stationarity issues with VGT revenue, the dependent variables in the models focusing on revenue measures (casino revenue, slot revenue, and table revenue) were also transformed by taking their natural log. This transformation was to ease interpretation of the models. The logged revenue measures are still trend stationary based on the ADF and Phillips-Perron stationarity tests.

Based on the results from the OLS models, a VAR model was used to further explore the relationship between admissions and the number of VGTs:

$$Admissions_t = \beta_o + \beta_1 Admissions_{t-k} + \beta_2 VGT\ Machines_{t-k} + \beta_3 Control_t + \varepsilon_t$$

$$VGT\ Machines_t = \beta_o + \beta_1 Admissions_{t-k} + \beta_2 VGT\ Machines_{t-k} + \beta_3 Control_t + \varepsilon_t$$

In these models there are three lags, therefore $k=1,2,3$. The control included in this model is industry employment. US gas prices was initially included but was found to be insignificant and consequently dropped. Three lags were chosen for this model because, based on the lag order selection criteria test, three lags were optimal in four out of the five different criterion that were used in the test. The criterion that chose lag three as optimal include: LR test statistic, final prediction error, Akaike Information criterion, and Hannan-Quinn information criterion.

Results

The OLS estimates are provided in Table 12. There is a statistically significant negative effect on casino revenues from VGT revenues. According to this model a 1% increase in VGT revenues will decrease total casino revenues by about .10%. As evidenced in Table 12, this decline is associated with a decrease in slot machine revenue, with table revenue not significantly impacted by VGT revenue. It should be noted, however, that in this model, and most models (unless otherwise specified), the significant coefficients are not robust to the inclusion of year dummies. With only 60 observations the issue of over parameterization is present, as well as the issue of multicollinearity between the year dummies and other variables of interest.

Casino revenues are also significantly influenced by US gas prices, industry employment, and the warmer seasons. Higher gas prices reduce casino revenue and revenues are greater in the Spring and Summer. Industry employment also has a statistically significant negative effect, although this effect is economically small.

Table 12: OLS Regression Results

VARIABLES	(1) ln(Casino Revenue)	(2) ln(Slot Revenue)	(3) ln(Table Revenue)	(4) Slot Machines	(5) Tables	(6) Admissions
ln(VGT Revenue)	-0.100*** (0.0143)	-0.121*** (0.0154)	0.0174 (0.0245)			
Industry Employ	-3.61e-06* (2.12e-06)	-3.93e-06* (2.27e-06)	-2.38e-06 (3.61e-06)	-0.0166* (0.00908)	0.000798** (0.000397)	1.245 (1.868)
D.US Gas Prices	-0.0892** (0.0419)	-0.102** (0.0450)	-0.0259 (0.0716)	-10.29 (166.0)	6.712 (7.260)	-82,785** (34,160)
Spring	0.161*** (0.0177)	0.176*** (0.0190)	0.0763** (0.0303)	83.65 (74.98)	-3.795 (3.278)	104,660*** (15,425)
Summer	0.122*** (0.0308)	0.138*** (0.0331)	0.0298 (0.0526)	292.9** (130.8)	-6.863 (5.722)	82,600*** (26,920)
Fall	0.0309 (0.0193)	0.0376* (0.0207)	-0.00713 (0.0330)	166.3** (79.29)	-2.883 (3.467)	25,997 (16,312)
VGT Machines				-0.0616*** (0.00523)	0.000813*** (0.000229)	-11.88*** (1.076)
Constant	20.22*** (0.196)	20.43*** (0.210)	16.19*** (0.334)	11,439*** (353.3)	185.3*** (15.45)	916,297*** (72,682)
Observations	60	60	60	60	60	60
R-squared	0.829	0.846	0.190	0.895	0.593	0.881

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Column 4 of Table 12 shows that the number of slot machines are negatively impacted by the number of VGT machines. The addition of 100 VGT machines is associated with a decrease of approximately 6 slots machines. In this case, the number of VGT machines still negatively influences the number of slot machines at the 10% level when year dummies are included. These results (not reported) show that an increase of 100 VGTs decreases slot machines by about 2 machines.

The number of slot machines are negatively impacted by an increase in industry employment, but the magnitude is small and is only significant at the 10% level. In this model summer significantly impacts the number of slot machines by increasing total machines in the state by about 293. Fall also causes an increase of about 166 slot machines.

The next set of models are looking at the impact that VGTs have on table revenues and the number of tables. An increase in VGT revenue does not significantly impact table revenues. This model also has a very low R^2 compared to the other models. No conclusion can be drawn and I and not much of a relationship was anticipated given the different markets. The only significant influence on table revenues in this model is the spring season which increases table revenues by about 8%.

The number of VGTs does significantly impact the number of tables according to this model, but the magnitude is very low and it does not make practical sense. The model says that for each 10,000 VGT machines, casinos decrease the number of tables by 8. In this model, the number of workers employed in the industry does significantly impact the number of tables, but again there is an issue with practical interpretation.

The last relationship modelled in the OLS regressions is how casino admissions react to the number of VGT machines in the market. There is a statistically significant negative relationship between casino admissions and VGT machines. This model shows that for each new machine added, there are about 12 fewer people going to casinos. This means that in 2017, when about 1,500 VGT machines were added, casinos would have seen a decrease of 18,000 admissions. This amount seems a little inflated, but still realistic. When the year dummies are added, the significance of the VGT variable remains, but the magnitude decreases to about 10 fewer people visiting casinos for each VGT added.

The relationship between VGTs and admissions seems to be driving the results. The significant results between casino revenues and VGT revenues can be explained by the significant result in admissions. Since revenue per admission is relatively constant, the effect on revenues could be captured entirely by the decrease in admission due to the number of VGT machines in the state.

Admissions are also influenced by a number of the control variables. A one dollar increase in US gas prices will decrease monthly admissions by 82,785. The warmer seasons have more admissions than winter. Spring increases admissions by 104,660 and summer increases admissions by 82,600.

The next model analyzed is the VAR model which takes a closer look at the relationship between admissions and VGT machines. The results are shown in Table 13. If VGT machines increase in September, admissions will decrease by about 55 people in October for each machine added. According to the insignificant lag for (in this example)

August, this effect does not initially look to be persistent. The number of VGT machines are not significantly influenced by the lag of admissions.

Some post regression tests were conducted to gain a better understanding of the relationship modelled in the VAR. According to Figure 16, all of the inverse roots of the estimates are in the unit circle. This means that admissions and VGT machines have

Table 13: VAR Results		
VARIABLES	(1) Admissions	(2) VGT Count
L.admission	-0.102 (0.138)	3.79e-05 (0.000776)
L2.admissions	-0.0769 (0.122)	-0.000995 (0.000689)
L3.admissions	-0.304*** (0.106)	-0.000771 (0.000598)
L.VGT_count	-54.54** (25.30)	1.174*** (0.142)
L2.VGT_count	-1.856 (37.73)	-0.211 (0.212)
L3.VGT_count	33.33 (23.44)	-0.0160 (0.132)
Industry Employ	7.834*** (1.592)	0.00788 (0.00896)
Constant	1.258e+06*** (190,926)	2,332** (1,075)
Observations	57	57

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

proportionate and bounded impacts on one another. The first lagged time period will experience the most severe effect, but then the effects will decrease each time period following. This implies that these results are stable.

The Granger causality test, shown in Table 14, shows that admission do not have a statistically significant impact on the number of VGT machines, but that VGT machines

do have a statistically significant impact on the number of admissions. This is the relationship I expected to see. It verifies the story that VGTs are influencing the market for casinos, but that casinos do not have as much influence over the market for VGTs.

Figure 16: Inverse Roots of AR Characteristic Polynomial

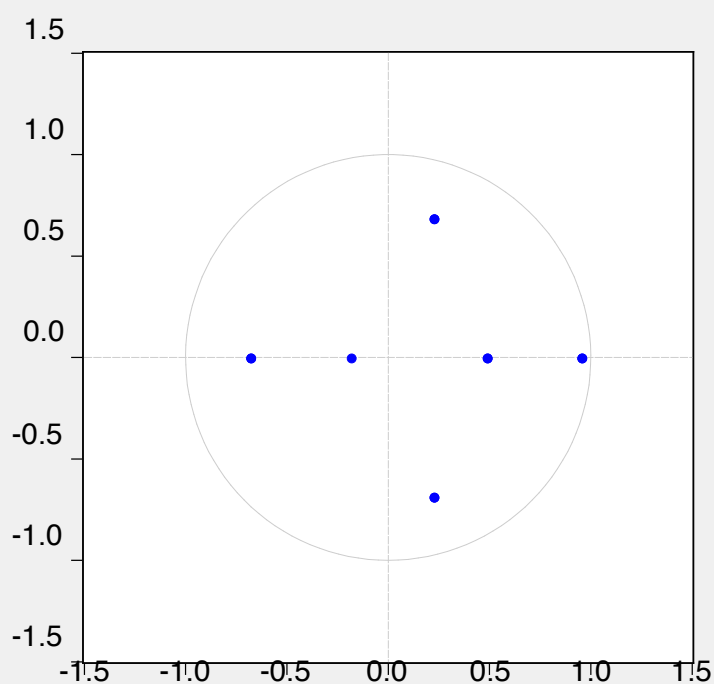
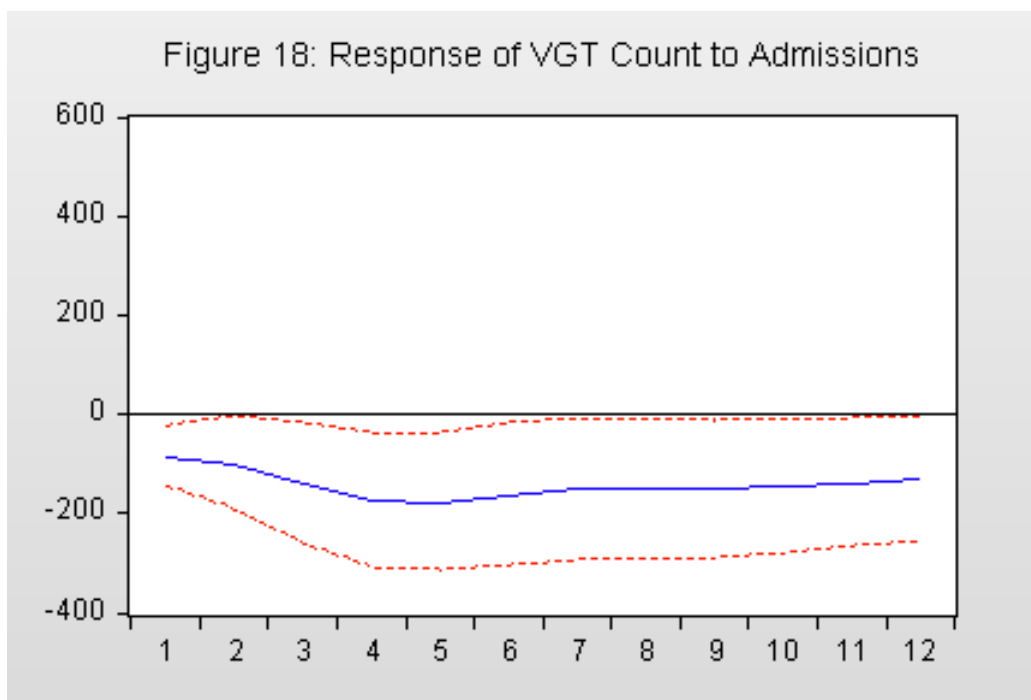
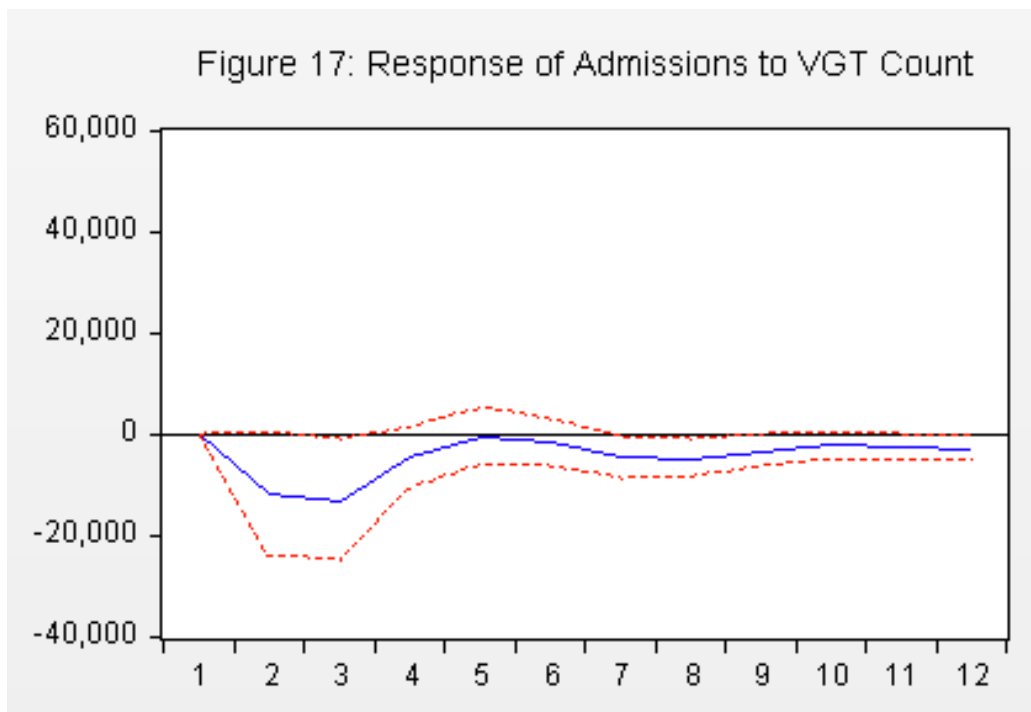


Table 14: Pairwise Granger Causality Tests

Table 14: Pairwise Granger Causality Tests			
Lags: 3			
Null Hypothesis:	Obs	F-Statistic	Prob.
VGT Count does not Granger Cause Admissions	57	3.09841	0.0350
Admissions does not Granger Cause VGT Count	57	1.16564	0.3322

The impulse response graphs show the first year after a shock to each market. The impulse response functions give a prediction of how casino admissions would be effected if VGT machines increased one standard deviation (about 6,700 machines). Admissions would initially decrease by about 15,000 people but would recover four months later.

This makes sense because the casinos during summer months (April-July) tend to see more admissions. The following months would see a more permanent decrease of about 1,000-3,000 admissions each month. Also, if admissions increased by



one standard deviation (about 180k people) VGT machines would be effected by about 200 fewer machines each month. The VGT effect is less cyclical and appears constant at a 200 machine decrease. These two response functions make sense with what the data has shown already. VGTs have a much bigger effect on admissions than the alternative case. This is shown by the large decrease in admissions initially.

Conclusion

Illinois has been experiencing a declining gambling market over the past eight year which led to the passing of legislation for VGTs in hopes of increasing tax revenue. Missouri could be looking to pass similar legislation, and other markets could do the same because many mature gambling markets are declining. While this paper did not look specifically at tax revenues, it did look at whether VGTs could possibly be cannibalizing the revenues of casinos, which are the tax base. The results suggest that VGTs are reducing demand for casinos, decreasing casino admissions and consequently revenue.

To explore the effects on tax revenues due to the impact of VGTs, the results from these models are helpful. Using 2017 values, a 1% increase in monthly VGT revenue amounts to \$1,103,700. The total monthly tax revenue collected from that amount, using the 30% tax rate, is \$331,110. This increase in tax revenue from VGTs would lead to a 0.1% decrease in monthly casino revenue amounting to \$82,620. Using the 50% tax rate on most casinos in Illinois, this would mean a decrease in monthly tax revenue of \$41,310 for each 1% increase in monthly VGT revenue. This clearly shows that, while

the casinos are being impacted by the VGTs, there is still a net gain in monthly tax revenue by the state.

There are also losses in the admissions taxes collected from casinos. Admissions taxes are set at \$3 for each admission. In 2017, Illinois made about \$25.8 million from admission taxes. Based on the model, for each VGT added to the market, Illinois loses \$36 per month in admission tax revenues. For 2017, about 3,500 machines were added. This would result in a reduction in monthly admissions of 42,000 people (according to the model) and a loss of \$126,000 in monthly tax revenue. Each VGT machine added about \$4,120 per month in 2017. For the 3,500 machines added this equates to a \$4.3 million increase in monthly tax revenue. Again, this is a net tax increase based on the model. While there is cannibalization on admission taxes due to VGTs, there is still a positive effect on the state and municipalities.

There appear to be short term impacts on admissions from VGT machines. Unfortunately, due to the sample size, I am not able to make inferences on the long term relationship. Ideally, I would like to perform the same analysis on a much longer time frame. Of course this will require more time to pass for an increased the number of observations.

Cointegration and a possible VECM model between admissions and the number of VGT machines is another component that should be explored. In addition, explicitly examining net tax revenues for gambling in the state is another natural extension. Furthermore, it would be interesting to examine how tax revenue disbursements to municipalities are changing due to VGTs. Even if tax revenues are not increasing, many parts of Illinois could be benefitting from the increase in local tax collection from VGTs.

It would also be beneficial to examine where these VGT machines are located and the demographics surrounding the VGT locations to better understand whether these VGTs are acting as a regressive tax.

References

- 2016 State of the States: AGA Survey of the Casino Industry. American Gaming Association, 2016, 2016 State of the States: AGA Survey of the Casino Industry, https://www.americangaming.org/sites/default/files/2016%20State%20of%20the%20States_FINAL.pdf
- Ciciora, P. (n.d.). Four years later, what effect has expanded video gambling had on Illinois? Retrieved February 2, 2018, from <https://news.illinois.edu/view/6367/420180>
- Elliott, D. S., & Navin, J. C. (2002). Has Riverboat Gambling Reduced State Lottery Revenue? *Public Finance Review*, 30(3), 235-247.
doi:10.1177/109114210203000304
- Levitzky, I., Assane, D., & Robinson, W. (2000). Determinants of gaming revenue: extent of changing attitudes in the gaming industry. *Applied Economics Letters*, 7(3), 155-158. doi:10.1080/135048500351708
- Marionneau, V., & Nikkinen, J. (2017). Market Cannibalization Within and Between Gambling Industries: A Systematic Review. *Journal of Gambling Issues*, (37).
doi:10.4309/jgi.v0i37.3988
- State of the States 2017: AGA Survey of the Casino Industry. American Gaming Association, 2017, State of the States: AGA Survey of the Casino Industry, www.americangaming.org/sites/default/files/research_files/2017%20State%20of%20the%20States.pdf.

- Vacek, H. (2011). The History of Gambling [Review of books *Jokers Wild: Legalized Gambling in the Twenty-first Century*; *Roll the Bones: The History of Gambling*; *Gambling: Who Wins? Who Loses?*; *Gambling: Mapping the American Moral Landscape*]. Center for Christian Ethics at Baylor University, 88-93.
- Walker, D. M., & Nesbit, T. M. (2014). Casino Revenue Sensitivity to Competing Casinos: A Spatial Analysis of Missouri. *Growth and Change*, 45(1), 21-40.
doi:10.1111/grow.12035
- Yerak, B. (2017, April 06). Illinois video gambling parlors sue state over profit-sharing rules. Retrieved February 2, 2018, from <http://www.chicagotribune.com/business/ct-video-gambling-illinois-lawsuit-0405-biz-20170404-story.html>
- Zotos, A. (2018, February 06). Bill to legalize slot machines in bars, convenience stores in Missouri moves forward. Retrieved February 8, 2018, from <http://www.kfvs12.com/story/37444560/bill-to-legalize-slot-machines-in-bars-convenience-stores-in-missouri-moves-forward>