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The Dynamics Evolution of Industrial Life Cycle: A Time Series Analysis of Gambling Industry in Atlantic City

This paper highlights the historical evolution of Atlantic City's gambling industry in an integrative framework. It has been developed from the perspectives of the industrial market, industrial organizations, industrial policies, and industrial innovation. Data mining was employed to obtain local official documents to verify the dynamic evolution of the industrial life cycle (ILC) in the introduction, growth, maturity, and decline stages via a time series analysis. The trajectory of Atlantic City's gambling industrial evolution revealed the process from the stages of introduction to decline via a set of variables to describe the special properties of this sector, such as product, market, and organization under a unique industrial environment, in which the decline stage of ILC was a particular proved via the evidence of gambling industry in Atlantic City. The dynamic evolution of the gambling industry presented the ongoing recovery process of the Atlantic City gambling industry to enrich the theory of ILC in service sectors.

Keywords: Gambling industry, Industry life cycle, Industrial evolution, Time series, Atlantic City

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Introduction

The industry life cycle (ILC) theatrically describes an industry via four evolution phases: introduction, growth, maturity, and decline, identified by several variables such as market growth rate, potential demand growth, product variety, competitors, market share, entry barriers, technological innovation, and guest behavior, in which any industry in a particular region or country could be presented as the four evolution stages (Saviotti and Pyka, 2008). Besides the qualitative description of the ILC theory, the extensive literature on the theory of ILC describes an industrial evolution via imperial evidence. This reveals the relationship between industrial structure, behavior, and performance at different industry stages. Gregor and Klepper (1982) developed the first ILC model (G-K) to explain the ILC as a function of changes in manufacturer numbers as industry evolution, which was followed by the ILC theory of Agarwal (1998) and the ILC model (K-G) of Klepper (1997).

Classical literature mainly underlines the valid empirical evolution of ILC or industrial features in different sectors and market environments. ILC theory on industrial evolution highlights the industrial features via multi-indicators, such as the transformation of products and processes and organizational changes (Malerba & Orsenigo, 1996). It concerns the changes in the number of manufacturers to state technological development leading to changes in product and economic scale (Lomi et al., 2005). However, previous studies focused solely on legality, density,

and type of organization of firms, especially in manufacturing. In addition, the ILC focuses on firm survival, which reveals a real transformation from their entry and competence substitution at the company level (Winter, 2002). The theory of ILC identifies the evolution process at an industry level based on industrial innovation and industrial policy (Teece, 2007; Wang & Ahmed, 2007). Practically, empirical analysis of ILC exploits more indicators that present the industrial features to reveal this process covering the whole stage of industrial evolution.

Gambling is an industry that relies exclusively on gambling income from individuals and institutions. It consists of operators providing different types of games and special customers-gamblers (Eadington, 1976). Therefore, the gambling industry has developed an economic activity categorized as casinos, welfare, and sports lottery, in which casino gambling and wagering are parts of the entertainment and leisure industry with the general characteristics of the service industry (Vogel, 2001). The service industry provides products with several features, including intangibility, inseparability, variability of quality and demand, and user participation. In general, gambling products and services are associated with the service industry as a special attraction to guests, which have always been part of tourism promotions to boost the tourism economy (Przybylski, 1998). Furthermore, the gambling industry was initially separated from the tourism industry by providing services mainly to adults, particularly to male adults, as a result of competition mechanisms and market-oriented operations, which brought about an organic integration of gambling and tourism via gradually assembling the hotels, restaurants, leisure and entertainment, resorts, conference, and exhibition industries (Ronald, 2013). In general, the gambling industry is closely allied to the tourism industry from an economic and strategic standpoint (Eadington, 1984).

Mainstream economics researchers still lack interest in the industry and economy of gambling despite its rapid growth globally. Eadington (1999) stated that the gambling economy has many distinct market characteristics in particular aspects of products, prices, and demand. As a part of economic activity, government regulation exerts a significant influence on the evolution of the gambling industry (Braunlich, 1996; Gu, 2001), especially on historical urban planning and infrastructure development (Rubenstein, 1984). Furthermore, O'Donnell et al. (2012) find that industrial-scale expansion is conducive to the development of the gambling industry, but is greatly influenced by the external economic environment (Eadington, 2011), especially external competition (Zheng, 2013). Hence, there is a research gap that needs to be abridged in the development and evolution of the gambling industry.

The research aims of this paper are presented in four targets. (1) To verify the theory of ILC via evidence of the Atlantic City gambling industry. (2) To depict the evolution process of its ILC via the historical data of Atlantic City's gambling. (3) To identify the main antecedents resulting from the recession of Atlantic City's gambling industry from the perspective of ILC. (4) To reveal how the relationship between microeconomic factors and the evolution stages of ILC affects the industry's dynamic evolution and its macroeconomic, market, and demand characteristics.

Methods and Materials

Methodology

The polynomial models can be used in those situations where the relationship between research and explanatory variables is curvilinear. Polynomial curve fitting is a kind of curve form, which

uses polynomial functions to fit real curves with time-series index t to approximate the trends of curves. The model is given by

$$y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_k t^k + \varepsilon \qquad (1)$$

In which, the fitting R^2 increases with the power k, when k→ ∞, the fitting R^2 =1, then the fitted polynomial function is optimal. To avoid more over-fitting, a cubic (third-order) polynomial regression model is selected as follows

$$y_t = at + bt^2 + ct^3 + L \qquad (2)$$

In which, y_t is the predictor, t is the time variable, and a, b, c, and L are parameters. L is the initial value when t=0, which presents the rate of change of growth, b presents the acceleration value, and c presents the rate of change of acceleration. The first-order and the second-order derivation of equation (2) are obtained respectively as

$$dy/dt = a + 2bt + 3ct^2 \qquad (3)$$

$$d^2y/dt^2 = 2b + 6ct \qquad (4)$$

In which, *dy/dt* is the rate of growth over time t, and d^2y/dt^2 is the rate of acceleration over time t. When $d^2y/dt^2 = 0$, $t^2 =b/3c$, the curve appears at an inflection point where y_t should be an increasing value before this point and a decreasing value after this point. Meanwhile, *dy/dt* has the greatest value with c<0, t^2=-b/3c>0, and b>0 in the quadratic curve. When

$$dy/dt = a + 2bt + 3ct2 = 0$$

$$d^2y/dt^2 = 2b + 6ct = 0$$

As a result, $t_1 = \frac{-b+\sqrt{b^2+4ac}}{3c}$, $t_2 = -\frac{b}{3c}$, and $t_3 = -\frac{b-\sqrt{b^2-4ac}}{3c}$. In which, t_1 presents the

demarcation point between the introduction stage and the maturity stage of ILC and t_3 presents

the demarcation point between the maturity stage and the decline stage of ILC respectively, which

(t_0, t_1) presents the introduction stage, (t_1, t_2) presents the growth stage, (t_2, t_3) presents maturity

stage, and (t_3, ∞) presents the decline stage.

Materials

ILC theory provides a stylized description of the evolution of an industry, like a product life cycle

that can describe its introduction, growth, maturity, and decline stages, to interpret the process of

an industry's evolution from small to large, from weak to strong (Storper, 1985). It highlights that

industrial structure, behavior, performance, and policy can be employed to analyze any existing

industrial structure and system under a given industrial base, historical culture, and environment

in each stage of regional industrial evolution (Agarwal, 1998).

In general, the theory of ILC proposes a link between the main industrial variables and the

life of the industry, and each stage of the ILC can be described by those variables in different

industries (Agarwal, 1998). In the early stage of ILC, the industry growth encourages the entry of

a large number of firms and the introduction of innovative products (Klepper, 1996). As a result,

outside enters with innovatively designed products from outside the industry and are vying for

market dominance (Gort & Klepper, 1982). In the growth stage of ILC, the new entry companies

bring fierce competition resulting from a higher quality and lower price of products followed by

increased sales and the expansion of the industrial scale (Agarwal & Bayus, 2002). The maturity

stage of ILC is marked by a shift in the process of the product and the changes in the number of

films (Cohen & Klepper, 1996b; Klepper, 1996), while the interaction among institutional

mechanisms, economic constraints, and technological possibilities affects a further expansion of the industrial scale that impedes the growth of products, market share, and the number of companies (Tushman & Murmann 1998; Murmann & Frenken 2006). In the decline stage of ILC, market share shifted to the most capable producers while sales did not grow indefinitely, causing other companies to withdraw from the industry, particularly in over-competitive industries (Bertomeu, 2009), powerless innovators (Klepper, 2002) forced leaving the industry and finally stepping in recession (Klepper & Miller, 1995).

More broadly, the ILC of tourism provides a theoretical reference to the ILC of gambling because of an inextricable link between the gambling industry and the tourism industry (Przybylski, 1998). Organically, the combination of the gambling industry with the tourism industry makes gambling activities a special attraction for tourists, leading to the rapid, widespread development of gambling worldwide (Goodman, 1996). The life cycle concept is systematically introduced into the area of tourism resort management and developed into a 5-stages tourism destination life cycle model while employing the visit numbers as the characteristic variable on those stages (Butler, 1980). The ILC model of tourism develops a dynamic and open systematical framework (Haywood, 1992), influenced by some factors such as the decision-making of the tourism operators, the environmental factors of resorts, the popularity, growth, accessibility, and competition of destinations, as well as the regulations of local government (Ioannides, 1992) where development and environmental policies are more important factors (Benedetto & Bojanic, 1993). The characteristic variables are mainly employed to analyze the life cycle in tourist destinations, such as the number of visits, beds, hotels, overnight stay, expenditure, tourism income, tax receipts, population, employment, tourism activities, and other tourism-related statistics data (Berry, 2001).

Furthermore, the industrial features in the stages of ILC are validly identified via more comprehensive measures such as the number of enterprises, scale, market structure, prices, and product quality (Kamat, 2010). Combining the characteristic variables of the tourist destination with the features of the gambling industry, several variables can also be selected, such as table game revenue, industry income, etc. (Moss et al., 2003, O'Donnell, 2012). In particular, considering some constraints and the feasibility of data collection, an integrative framework insisting on four characteristic indicators is designed to describe the ILC of gambling. (1) The indicators for product characteristics that represent a basic judgment on product evolution over its life cycle, from product introduction through product replacement, where the quantity, price, and quality of the products can reflect the fundamental features of the industry (Klepper 1997; Jovanovic and MacDonald 1994), especially in the gambling industry where the breadth and depth of game product lines are reflected along with table game revenue. (2) The indicators for industrial organizations that describe the evolution characteristics of ILC based on the number, size, and income of companies (Murmann & Frenken, 2006; Eberle et al., 2011) as well as the number, size, and revenue of casinos and employment of personnel. 3) The indicators for the industrial market emphasize the evolution of the gambling industry under the demand and supply of the gambling market, including the stranded tourist market (Butler, 2006; Murmann & Frenken, 2006), such that the gambling industry evolved under the demand and supply of gambling tourists. (4) The indicators for an industrial structure that presents the contribution of the industry to the regional economy, such as the income ratio and taxation revenue ratio (Gort & Klepper, 1982; Mazzucato & Giovanni, 2002, Dinlersoz & MacDonald, 2009), where the gambling industry contributes to the regional industry can be indicated by the ratio of income and revenue of the gambling industry.

The outlined literature provides the background for our empirical analysis and allows us to select the characteristic indicators from the gambling ILC to examine the evolution of the gambling industry in Atlantic City. The data employed in our analysis are source abstracts from Annual Report 1978-2017, New Jersey Casino Control Commission.

Empirical analysis

First of all, the nonlinear model is transformed into a multi-linear regression model, in which we set $x^1=t$, $x^2=t^2$, $x^3=t^3$, and select the ratio of annual total revenue to the number of tourists (Rev/Visit) as simple data. As a result, Y is significantly related to X with correlation coefficients X1(0.997), X2(0.976), and X3(0.939) accordingly. The scatterplots of Y and X are presented in Figure 1.
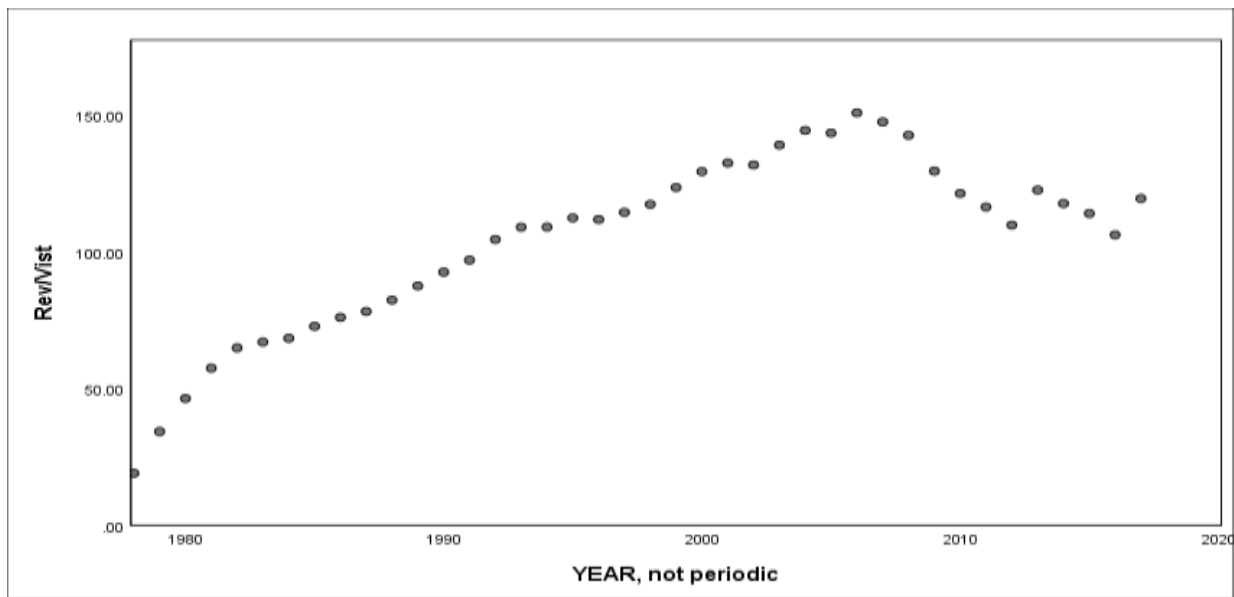

Figure 1 The scatterplots

Table 1 Model Summary with the serial number as the independent [a]

Model	R	R2	ΔR2	S. E	Adjusted Ad R	F	*df*1	*df*2	Sig.
1	.974a	.948	.943	7.64642	.948	217.531	3	36	.000

a. Predictors: (Constant), X3, X1, X2; b. Dependent: Rev/Visit

Table 2 Regression coefficients with the serial number as the independent [a]

Model	Un-Std Coef. B	Std. Err	Coef. β	t	Sig.
1 (Constant)	27.096	5.327		5.086	.000
X1	5.525	1.111	2.010	4.971	.000
X2	.011	.063	.163	.170	.866
X3	-.002	.001	-1.481	-2.484	.018

a. Dependent: Rev/Visit

The regression coefficients and standard output are shown in Table 2, where the regression coefficients by a (5.525), b (.011), c (-.002), and the intercept are given L (27.096). The regression equation is written as Y=27.096+5.525x1+0.011x2- 0.002x3. The t-test value is the significance level (see table 1). Take the inputs a, b, c, and L into the equation, and the output result is calculated as =0.0、 =1.8 and =33.2 accordingly. Therefore, the gambling ILC of Atlantic City can be described by the above regression equation. The evolution of the gambling industry started from its introduction stage since legal gambling in 1978, soon entered the rapid growth stage in 1980, evolved into a maturity stage before it accesses a peak in 2008, and dropped into a recession stage after 33 years of gambling development.

Dynamic analysis of the Atlantic City gambling industry

Atlantic City was once the largest tourist city in New Jersey known as the "World's Playground" as a tourist attraction. In late 1960, many famous resorts continued to have low occupancy rates, and most of them closed, turning to cheap apartments or nursing homes. Many of these hotels were demolished in the period leading up to the emergence of legal gambling. Exploring legal gambling has become a pivotal step since the city was revitalized (Johnson, 2010). Atlantic City legalized gambling in 1977 except in Nevada. Resorts International opened its first casino on May 26, 1978, two years after a series of major casino operators, including Caesars, Bally's, and Harrah's moved to Atlantic City. In 1988, Atlantic City surpassed Las Vegas as the largest gambling city in the United States, which gambling revenue peaking at $5.2 billion in 2006. Since it has fallen year after year to $2.56 billion in 2015, a decline of more than half (Cooper, 2007). Five of the city's 12 casinos closed from 2013 to 2016, resulting in an unemployment rate (6.3%) that surpasses the national rate (4%), leading to a wicked economy that Atlantic City once filed for bankruptcy protection in 2015. The gambling industry demonstrated a dynamic life cycle.

The aggregate number of visitors to Atlantic City grew rapidly from 7.08 million in 1978 to 2.9326 million in 1985, and 34.924 million in 2005 (see Figure 2). Gambling has been declining at a low market performance since 2006, with 22.437 million tourists in 2015. Atlantic City's gambling industry, however, experienced tremendous growth from 1978 to 1985, where total gambling revenue annually increased at a rate of 55.07 %. There was a steady growth period from 1986 to 2006 with total gambling revenue rising at a rate of 4.37 % each year. However, the growth curve turned from its peak in 2006 and began slowly falling until 2015.
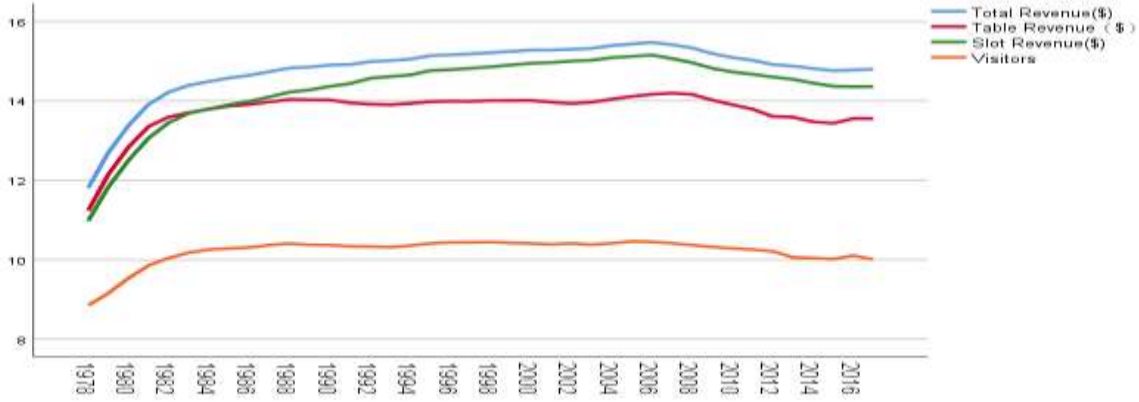
Figure 2 Dynamic evolution of industry life based on the industry market.

Slot machine revenue had the largest market share when it overtook table game revenue in Atlantic City in 1983, which steadily increased to its peak in 2006 and kept declining at an average of -13.11 percent each year from 2007 to 2015. Table games accounted for 58.33 % of total revenue compared to 41.67% of slot machine revenue in 1980. These figures have remained relatively stable since 1983, while the percentage dropped by 36.42 % from7 to 2014. 1983 and dropped by 36.42 percent from 207 to 2014. By 1984, slot machine revenue had surpassed table game revenue. However, it lost some market share to online gambling. This is because online gambling has seen its market share climb from 0.29% in 2013 to 9.23% in 2017 since it was launched in 2013.
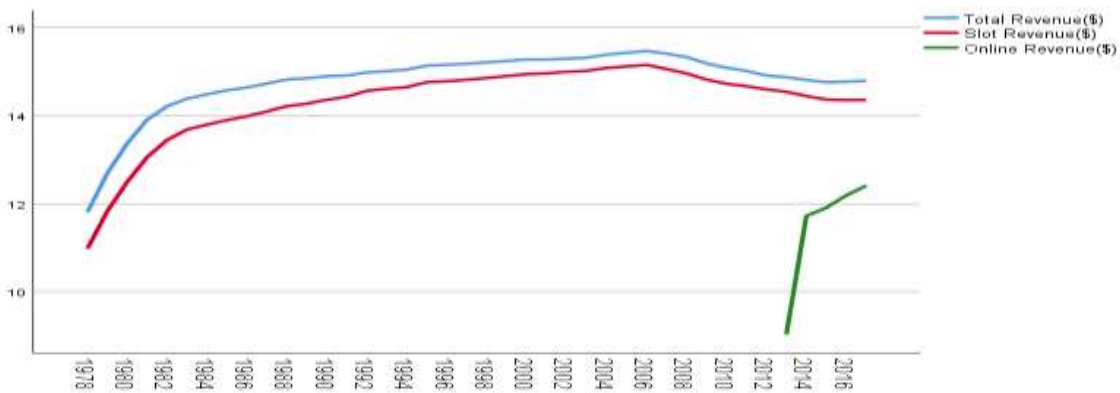
Figure 3 Dynamic evolution of industry life based on industry revenue.

Atlantic City's casino operators quickly accumulated 9 casinos from 1978 to 1983 and reached 12 in 1986. But they continued to close after 2013 when only 7 of 12 survived in 2017. The number of slot machines continually grew from 1978 to 2006 and began sliding after 2006. Table numbers appear stable except for a slight fluctuation from 1983 to 2005, then dropped rapidly after the industry declined. Atlantic City's casinos had 49,123 employees in 2007, but that number fell to 22,178 employees in 2017, which retracted from the numbers 30 years ago.
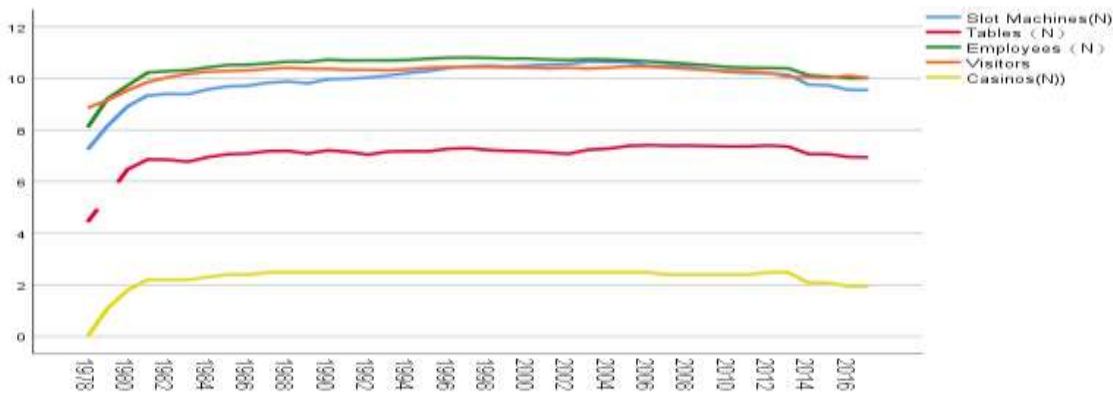

Figure 4 Dynamic evolution of industry life based on industry organization.

The number of low denomination slot machines between $0.10 and $0.20 has increased since 2005. In contrast, the number of high denomination slot machines between $0.25 and $0.50 has been declining steadily since 2001 in Atlantic City. In addition, the table game category enlarged with Blackjack, Craps, Roulette, Spanish 21, Three Card Poker, Baccarat, Mini-Baccarat, Big Six Keno, Let It Ride Poker, Pai Gow, Pai Gawker, Po Four Poker, Sic Bo, Caribbean Stud Poker, Casino War, Double Attack, Blackjack Texas, Hold'em Bonus Poker, Flop Poker, Ultimate Texas, Hold'em Asia Poker, Mississippi Stud, Criss Cross Poker, High Card Flush, Head-Up Hold'em, Double Draw Poker, Pack's Poker, Football Kings, and Electronic Table Games. Atlantic

City's casinos held 12 types of table games in 2001. In 2017, casino operators introduced 27 new table games to appeal to gamblers despite a decline in table game revenues from 2014 to 2017. Over a hundred types of online gambling games have been developed, many of which are similar to table games or improved versions.

Whenever the gambling industry in Atlantic City depresses, Atlantic City's explorers change it. Three casinos were authorized to operate 11 website platforms in 2013. Five Resorts, Caesars, Tropicana, Golden Nugget, and Borgata are reported to operate online gambling on 22 website platforms in 2017. Arguably, online gambling was an integral part of New Jersey's gambling industry when its revenue accounted for 4% of the state's total gambling revenue (TGR) in 2014, 6% in 2015, and 9.2% in 2017 respectively. After a decade of industry declines, online gambling increased by 32% in 2016 and 25% in 2017. As a result, Atlantic City's gambling revenue is boosted.

Discussion

Tourism once acted as the pillar of Atlantic City's economy from 1920 to 1960, but because of its recession after the 1960s, it morphed into the gambling industry by 1978. With 40 years of evolution, the gambling industry has crafted a classic ILC course from introduction to decline that demonstrated that it has a distinct specific mechanism ILC, which was online with the conclusion of Saviotti and Pyka (2008). The dynamic description of the ILC of gambling in Atlantic City builds a framework from the perspective of the characteristic variables in the ILC stages.

The gambling industry is the backbone of Atlantic City's economy affected by the economic environment. The city's local population fell to 35,000, a 12 % drop from its peak during the financial crisis in 2008. In light of the current market conditions, Atlantic City is experiencing

a saturated market. The number of visitors grew from 7.08 million in 1978 to 29,326 million in 1985 and reached 3.4924 million in 2005. Visitors, however, grew at an average annual rate of 0.96 % over the past 20 years, indicating that the market was relatively saturated. Furthermore, legal gambling in New Jersey shaped a competitive environment by attracting gamblers from Atlantic City. While Pennsylvania authorized 5 casino licenses in December 2006, attracting New York visitors to Connecticut's Revel Casino and Golden God Casino, its gambling industry quickly overpassed New Jersey to be the second-highest-earning gambling area in the United States. The legal gambling in 24 states further reduced Atlantic City's gambling market.

The casino operators entered rapidly, increasing to 12 after Atlantic City legalized gambling in 1978, resulting in its gambling industry surpassing Las Vegas in 1988. Atlantic City casinos became saturated, peaking in 2006, where 12 casinos had 35,000 employees in a small city that hosts only 35,000 residents. In addition, Atlantic City's gambling industry is highly monopolized, as the Trump family owns four casinos with 50% of the game tables and slot machines. This creates an oligopolistic market that thwarts the entry of novel products and business ideas into the region. This was only achieved when Borgata brought the Lavender style to Atlantic City in 2002. The result is a deterioration in the competitiveness of the gambling industry in the surrounding region due to the impediment to innovation.

In addition, the slot machine was the core game product that accounts for 70 % of total gambling revenue in Atlantic City. This is because guests could not find any other recreational products besides gambling. Borgata's Las Vegas style brought new variety to Atlantic City's gambling product structure in 2002, and online gambling changed the situation of Atlantic City's gambling product structure in 2013. Furthermore, the peripheral products of gambling continue to attract visitors to spend more on food and other entertainment than gambling. Atlantic City

authority neglects the fact that guests' expenditure covers far more of the non-gambling elements rather than gambling, such as catering, accommodation, shopping, and other entertainment. Atlantic City was given a casino city position that has hampered many years' development of other industries and was unsuccessful in rebuilding it like Las Vegas, whose position is a diversified city converging with gambling entertainment and vacation tourism.

While focusing on the gambling industry since 1976, gambling industrial policy adjustment has lagged behind the industry's development. There is no corresponding adjustment for industrial development strategy even though the gambling industry has entered the maturity stage since 1990. As a result of myopic market behavior and the recession in the gambling industry, New Jersey's industrial development policies lag behind their development in the U.S. and global markets. In 2012, New Jersey introduced new industrial policies and revised its industrial development race, including sports betting and online gambling. The gaming industry exerts a significant extrusion effect on other industries, which leads to insufficient development for local industries and fewer residents in cities supporting sustainable development.

Conclusions

The paper exhibits a complete cycle that happened in the gambling industry and examines whether industry variables present a cycle pattern as hypothesized by the theory of ILC that was demonstrated by Agarwal (1998), Klepper (1997), and Saviotti & Pyka (2008). Moreover, we analyze how different industry characteristics variables affect the evolution of the gambling life cycle (Kamat, 2010; Moss et al., 2003, O'Donnell, 2012). The unique longitudinal industry-level data reveals that dynamic evolution is affected by the factors of microeconomics and macroeconomics (Braunlich, 1996; Gu, 2001; Eadington, 2011), especially the external competition environment (Zheng, 2013). Based on the ILC of gambling, we found that an

industrial evolution can be described using multi-indicators using longitudinal industry data interrelated over time.

The research methodology applied to the gambling industry provides a valid tool for practitioners to understand their industrial situation using an ILC model. The caveat is that operators and administrators need to pay more attention to the development of the gambling industry. This is done with an accurate diagnosis of the ILC stage into which the regional gambling industry is emerging and its ongoing evolution (Teece, 2007; Wang & Ahmed, 2007). A staged industrial strategy is necessary for the gambling industry to ensure stable and sustainable growth. At this point, governments and casino operators need to keep an eye on the trend of market evolution and adopt market planning to maintain growth and prolong this stage. Particularly when the gambling industry enters the mature stage, a more active and effective strategy is needed to prevent a quick recession. In addition, they should pay attention to the effects of technological innovation on the industry, particularly network and communications technologies (O'Donnell et al.2012). Currently, these technologies are causing significant changes in consumer behavior, so product development strategies are being adjusted appropriately to prolong a stable stage and avoid a recession.

Limitations

This study has a few caveats that are mainly data-related issues. First, we select the rate of total revenue to the number of tourists as the time series sample, unlike sales or products, as usually done in the ILC literature. This is because the gambling industry is more interrelated with other industries, especially the tourism industry, so it is really difficult to judge who is the gambler or tourist. Though we think it is more rational for this industry, it is less compared to existing ILC

studies. Moreover, for the sake of space and focus of our paper, we briefly discuss the properties

of the gambling industry.

Acknowledgment

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