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FORECASTING GAMING REFERENDA

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Abstract: The purpose of this paper is to develop and test models to predict community support or lack thereof for commercial gaming using an artificial neural network. The findings reveal that there is a significant relationship between abolition of certain prohibitionary laws for gaming and sociodemographic and geographic variables. Specifically, increased proportion of minority populations within a geographical space, proximity to population centers, and church membership growth within the general public were variables found to be sensitive to changes in voting behavior toward gaming. Practical and theoretical implications are discussed within the framework of political science theory and commercial gaming. **Keywords:** development, gaming, gambling ballots, voting behavior, artificial neural networks. © 2005 Published by Elsevier Ltd.

Résumé: La prévision des referendums sur le Jeu. L'objectif de cet article est de développer et tester des modèles pour prédire le soutien ou l'opposition de la communauté en ce qui concerne le Jeu commercial en utilisant un réseau neural artificiel. Les résultats montrent qu'il y a un rapport significatif entre l'abolition de certaines lois prohibitives au sujet du Jeu et des variables sociodémographiques et géographiques. En particulier, on a trouvé que les changements dans le comportement de vote au sujet du Jeu dépendaient des variables de la croissance de la proportion des populations minoritaires dans un espace géographique, la proximité des agglomérations et la croissance d'appartenance à une église parmi le grand public. On discute des implications theoriques et pratiques dans le cadre des théories de sciences politiques et du Jeu commercial. **Mots-clés:** développement, Jeu, scrutins sur le Jeu, comportement de vote, réseaux neuraux artificiels. © 2005 Published by Elsevier Ltd.

INTRODUCTION

Many small communities throughout the United States are left in backwash despite extensive local development efforts and infusions of state and federal funds over the last several decades (Ullman 1985). Since the development depends largely on a mix of economic

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activities, diversification of the economic structure is crucial to growth. For example, communities that rely heavily on their tourism industry may exhibit more seasonal variation in their employment structure than those with a nonseasonal economic base. In the absence of a diversified economic base, they may be able to overcome the problems of seasonality and economic instability by diversifying their product and/or adding ''new products'' for tourist consumption (Walker and Jackson 1998:47). Las Vegas and Atlantic City are classic examples of the ability of gambling to support year-round tourism. Desperate for new income and employment opportunities and needing to introduce resilience to the local economy, many communities now offer a variety of incentives for new tourism businesses. One example can be found in the strong support for abolition of laws prohibiting gaming. Proponents supporting legalization argue that the expansion of gaming tourism can create significant positive long-term sociocultural benefits (better living conditions, more leisure opportunities, stronger cultural identity, etc.) and economic gains (improved job opportunities, better standard of living, increased disposable income, increase in tax revenue, and more) for many communities (Roehl 1999).

Although legalized gaming is considered vital to the regeneration and revitalization of inner cities and economically depressed areas, attempts to legislate gambling have generally been met with caution or resistance (Eadington 1998; Karlins 1997). This lack of support originates from both perceived and actual ethical concerns. Opponents argue that such activities defy religious beliefs and work ethics; invite political corruption, swindling, money laundering, and organized crime; erode traditional family and societal values and responsibilities; and instigate irresponsible behavior (Giacopassi, Nichols and Stitt 1999; Gupta and Derevensky 1998; Winters and Anderson 2000). In addition, gaming may produce negative fiscal externalities, such as increased state expenditures on public welfare and police protection (Smith and Wynne 2000). Nonetheless, according to Eadington, local communities react to gaming via three methods: judicially prohibiting the activity through the court of law, judicially legalizing the activity and controlling it through regulatory licensing laws, and overlooking the politically controversial issue (1991:19). For example, elsewhere in the United States, ballot measures to legalize casino gambling in Michigan, Florida, and Arkansas have all been rejected in recent years, as was a 1992 proposal in Ohio that would have let the city of Lorain to hold an election on casinos (Katz 1991). These outcomes accentuate the fact that there are limits to the public's acceptance of gambling, and attempts to legalize it may fail and/or create divisions within communities unless the factors behind public support/opposition are understood and critically examined. Thus, there is a need to assess the determinants differentiating a community that passes a gambling ballot from one that opposes commercial gaming. Ascertaining these determinants in advance has strong policy implications. If using key predictors, communities with high acceptance probability can be identified before such a ballot comes to a vote, thereby preventing potential conflicts and divisions between this business and residents.

To date, a majority of the attention gambling receives has been from business and the administrative and legislative sections of government. Although the scientific community has seemingly exhibited less interest, numerous tourism studies can still be found in the literature. Most are case studies dealing with social, economic, and political impacts of gambling (Caneday and Zeiger 1991; Friedman, Hakim and Weinblatt 1989; Hsu 2000; Nichols, Spears and Boger 2002). Studies of Las Vegas as a gambling Mecca continue to attract scholars' attention. A study by Douglass and Raento (2004) went so far as to search for the answer to the evolution of Las Vegas. They concluded that Las Vegas has continuously invented and reinvented itself throughout its history to such an extent that it has established a creative tradition. Then, there are studies that focus on individual gamblers by analyzing benefits and costs from a sociopsychological perspective (Platz and Millar 2001). One recent study by Oh and Hsu (2001) attempted to explain the volitional and nonvolitional aspects of gambling using Fishbein Ajzen's theory of reasoned action. In conjunction with the findings of their study, they concluded that gambling behavior contains a routine or habitual component. Moreover, in 1996 the entire third issue of *Journal of Travel Research* was devoted to the study of gambling and its relationship to tourism. Research conducted in the area of lottery adoption, in which attempts are made to examine the propensity of this business as a new source of income (Caudill, Ford, Mixon, and Peng 1995), has been excluded from this study. This paper is thus delimited to forecasting studies related to election/ballots.

Despite the existence of substantial literature on gambling and lottery adoption, from behavioral and socioeconomic viewpoints, the literature on the prediction of gambling ballot outcomes seems to be deficient. In fact, few studies in tourism have tested models to predict community support for gaming. One such study was conducted by Silverberg and Ulbrich (1996), using secondary data collected in South Carolina to predict ballot outcomes. This effort, though commendable, suffered from a lack of conceptual framework and from multicollinearity problems among variables. The present study was undertaken in order to understand the factors affecting both legalization and prohibition of gaming activities by using artificial neural networks (ANN). This tool has been shown to be superior when compared to other forecasting techniques in analyzing data with multicollinearity problems.

GAMING AND VOTING BEHAVIOR

Contemporary commercial gaming has become an important recreational activity for many Americans, yielding significant contributions to local and regional economies. Since 1931, when Nevada first legalized casino gaming, many communities throughout the United States have changed their attitudes toward legalization, due in part to prolonged recessionary economic conditions as well as federal and state budget deficits (Hsu 1999). Substantial increases in gaming revenues have been recorded in this country since the late '80s. In 2002, total

Table 1. Gaming Revenue: 13-Year Trend[a]

Year	Total Casino Revenue	Total Gaming Revenue[b]
1990	8.3	26.6
1991	8.6	27.1
1992	9.6	30.4
1993	11.2	34.7
1994	13.8	39.8
1995	16.0	45.1
1996	17.1	47.9
1997	18.2	50.9
1998	19.7	54.9
1999	22.2	58.2
2000	24.3	61.4
2001	27.7	65.3
2002	28.1	68.7

Note: All amounts in billions of US dollar.
Source: Christiansen Capital Advisors (AGA 2002a, 2003).
[a] Gross gambling revenue is the amount wagered minus the winnings returned to players, a true measure of the economic value of gambling. The gross is the figure used to determine what a casino, racetrack, lottery, or other gaming operation earns before taxes, salaries, and other expenses are paid.
[b] Gaming revenue includes pari-mutuel wagering, lotteries, casinos, legal bookmaking, charitable gaming and bingo, Indian reservations, and card rooms. Amount does not include deepwater cruiseships, cruises-to-nowhere, or noncasino devises.

revenues rose to a record high of $68.7 billion, a 158% increase over the 1990 figures (AGA 2002a, 2003). In 2001, direct employment in the casino sector rose to a high of 364,000, with wages totaling $11.5 billion. During the same year, more than $3.6 billion in taxes were paid to state and local governments (AGA 2002b; The National Gambling Impact Study Commission 1999). Table 1 illustrates the 13-year trend in US gaming revenues.

Until 1976, Nevada was the only US state where gambling was legal (Bybee 1999). At this writing, there was some form of gaming in every state except Hawaii and Utah. In total, 37 states and the District of Columbia had lotteries; more than 200 riverboat casinos were afloat in Illinois, Indiana, Iowa, Louisiana, Mississippi, and Missouri. Eleven states, including the riverboat states, had 432 legalized casinos (Table 2). Indian tribes had set up casinos in 28 states; 33 states permitted wagering on horse races; and dog races were allowed in 11 states (NCAKG 2002; National Indian Gaming Commission 2002; Perlman 1996).

Forms of gaming that can be considered for legalization include lotteries, head-to-head sports betting, bingo and raffles, casinos, slot machines, horse racing, dog racing, off-track betting, sports pool, lottery, and exotic off-track betting. To prevent conflicts and division within communities, a state may evaluate various factors before considering their legalization. Some of these include the revenues generated by gambling, the number of retail and entertainment jobs lost compared

Table 2. Status of Gaming in the United States

States	Casino Gambling	Indian Gambling	Lottery	Pari-mutuel Wagering	Bingo
Alabama		X (1)[a]		X	X
Alaska		X (2)			X
Arizona		X (14)	X	X	X
Arkansas				X	
California		X (47)	X	X	X
Colorado	X	X (2)	X	X	X
Connecticut		X (2)	X	X	X
Delaware			X	X	X
District of Columbia			X		X
Florida		X (2)	X	X	X
Georgia			X	X	X
Idaho		X (4)	X	X	X
Illinois	X			X	X
Indiana	X	X (1)		X	X
Iowa	X	X (na)	X	X	X
Kansas		X (4)	X	X	X
Kentucky			X	X	X
Louisiana	X	X (3)	X	X	X
Maine			X	X	X
Maryland			X	X	X
Massachusetts			X	X	X
Michigan	X	X (9)	X	X	X
Minnesota		X (10)	X	X	X
Mississippi	X	X (1)			X
Missouri	X	X (1)	X	X	X
Montana		X (7)	X	X	X
Nebraska		X (3)	X	X	X
Nevada	X	X (2)		X	X
New Hampshire			X	X	X
New Jersey	X		X	X	X
New Mexico		X (10)	X	X	X
New York		X (3)	X	X	X
North Carolina		X (1)			X
North Dakota		X (4)		X	X
Ohio			X	X	X
Oklahoma		X (23)		X	X
Oregon		X (8)	X	X	X
Pennsylvania			X	X	X
Rode Island			X	X	X
South Carolina		X (na)		X	X
South Dakota	X	X (8)	X	X	X
Tennessee				A	
Texas		X (1)	X	X	X
Vermont			X	X	X
Virginia			X	X	X
Washington		X (18)	X	X	X
West Virginia			X	X	X
Wisconsin		X (11)	X	X	X
Wyoming		X (1)		X	X

Sources: AGA 2002; National Indian Gaming Commission 2002; US National Gambling Impact Study Commission 2002; Montana Gambling Study Commission 1998; North American Pari-Mutuel Regulators Association 2002 and Indian Gaming Management Staff, US Bureau of Indian Affair 2002. Pari-Mutuel Wagering includes horse racing, greyhound, and Jai alai in 43 states.

[a] Number in parenthesis indicates number of tribes operating gaming business and according National Indian gaming commission; by 2001, 290 Indian gaming businesses have operated in 31 states.

to the gambling jobs created, the proportion of local residents obtaining employment in the local gaming business, the viability of gambling as a form of recreation entertainment for the locals, and the overall social, economic, and criminal effects of gambling (Israeli and Mehrez 2000; Perlman 1996; Weinstein and Deitch 1974). One of the first steps a state takes before initiating the legalization process (through constitution, statute, executive order, or regulation and licensing) is to identify the levels of resident support toward the implementation of such legislation. Usually, opinion surveys and polls are used for this purpose (Althaus 1996; Giacopassi, Nichols, and Stitt 2002; Perdue, Long, and Kang 1995), a costly endeavor lacking external validity. Existing secondary data sources, though limited in context, may prove to be a cheaper alternative for providing the necessary information for policymakers. When combined with local surveys, the predictive ability and efficacy of such data sources can be increased.

Synthesis of Theories of Voting Behavior

In this study, the authors adopted Hahn and Kamieniecki's definition of referendum: ''a measure passed by a governing body that does not become law until it is approved by a legally specified margin of voters'' (1987:1). According to them, the referendum process is being used as an instrument for recording public views on a wide range of issues that excite public passions, including gambling, obscenity, the environment, and nuclear power (1987:24). Figure 1 illustrates the conceptual framework that synthesizes the foundational theories and predictors associated with gaming referenda. Accordingly, the model consists of four sections, as noted below.

Political Socialization. The process of political socialization needs to be considered in order to understand the formation of a voter's

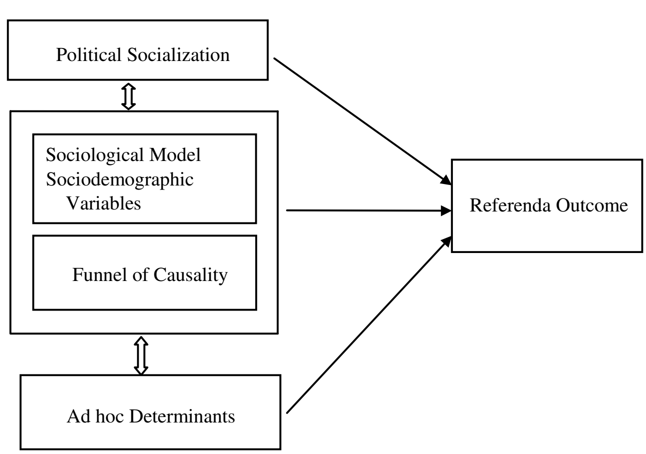

Figure 1. A Synthesized Framework for Predicting Ballot Outcomes

attitude and behavior toward politics. Political socialization allows the members of a society to pass information and attitudes about politics from one generation to another. According to Campbell (1979:53–64), the parent–child relationship (psychoanalytic approach), an individual's cognitive development (rational decisionmaking), and the imitation or identification with ''models'' (social learning theory) have been the three fundamental approaches used to study the political socialization process of individuals. The basic assumption is that parents not only influence their children's social behavior but also indoctrinate traditions and behaviors related to the electoral process. Their subtle cues and/or obvious actions communicate specific messages to their children about the importance of politics and voting (Dunham 1991:41). Within the context of gambling, one possible postulation is that when parents pass on their own negative views about gambling to their children, their voting behavior will reflect that view when they become adults.

Sociological Model. This model assumes that voters and political parties interact in an open market system where voters are presented with product choices (such as issues and candidates) during the campaign. After evaluating the products, they make their choices from the competing ideas and candidates. Moreover, socioeconomic status (Burdick and Brodbeck 1959; Mulcahy and Katz 1976; Shaffer 1972), education and income levels (Campbell 1979), occupation and class (Pomper 1975), religious affiliation (Lopatto 1985), and place of residence (Dunham 1991) were found to explain much of the error variation in voting behavior. Other determinants that were used as explanatory factors for voting choice include age, influence of primary groups, influence of secondary groups, political predisposition, race, sex, media influence (Campbell 1979; Clark and McGuire 1996; Rose 1992; Wink, Livingston, and Garard 1996), social status, diversity of population (Dahl 1996), interest in general politics (Joslyn and Ceccoli 1996), special interest groups' views/actions (Curriden 1993; Perlman 1996; Shapiro 1996), and public satisfaction/dissatisfaction with the political system and its authorities (Rahn, Kroeger, and Kite 1996).

Funnel of Causality. Some theoreticians have successfully incorporated the aforementioned factors and interpreted the voting process in terms of a ''funnel of causality''. According to Dunham (1991:59), the act of voting is at the tip of the funnel, and its axis is time. At the mouth of the funnel are basic characteristics of the voter, such as ethnicity, race, religion, education, occupation, class, parental class, and partisanship. These long-term influences help determine party identification, which in turn influences the evaluation of candidates, issues, and media campaign reports. As time passes and the voting time nears, conversations about the election with family and friends moderate the relationship between the inherent characteristics of a voter and the ultimate voting behavior. Evidently, these influences vary considerably from election to election, since conversations with others are considered short-term influences.

Ad hoc Determinants. Complementing the theoretical research in political science literature, extant empirical research in gaming suggests that referenda outcomes are influenced by a wide range of *ad hoc* variables, such as expectations of economic, social, or overall personal benefits from gambling; perceived changes in crowding and congestion, safety and security, community historic preservation efforts, commercial and resident real estate markets, employment opportunities, and the quality of social services and community life (Long, Clark, and Liston 1994); community size (Shapiro 1996); the individuals' socioeconomic positions (Canache 1996; Katz 1991); the snowball effect, such as legalization of gambling in neighboring states/communities (Goodman 1995); economic and fiscal instability in a state or community (Katz 1991; Lane 1993); and the presence or absence of other forms of gaming lottery within the same locale (Rose 1992). Public attitudes toward the legalization of gambling are also influenced by the residents' affiliation to political parties or constituencies (Perlman 1996; Shapiro 1996). Moreover, the use of ambiguous words (gaming and wagering vs. gambling) during campaigning through mass media channels is suspected of creating an atmosphere for the legalization of gambling. According to Lloyd (1996), in Missouri, for example, legislators beholden to the casino sector got around the first hurdle of gaining support by calling the ''wagering'' that takes place on riverboats ''gaming.'' Lloyd stated, '''gaming' emphasizes playing while 'gambling' emphasizes betting, risking, and especially losing'' (1996:58). The amount of money spent per capita on advertising (pre-vote) by the pro- and anti-gaming sides may play an important role in voting outcomes, especially in communities where the vote can go in either direction. However, it is difficult, if not impossible, to obtain reliable figures for a meaningful analysis. Furthermore, an important factor that is difficult to quantify but should be mentioned is the politician. In other words, in order to justify the initiation of a gaming project, most politicians would presumably believe *a priori* that the public approves of such an endeavor (comments by one of the anonymous reviewers of this paper).

Religious affiliation with Protestantism in general, and the Baptist denomination in particular, has had a positive relationship with the absence of gaming in US communities. Wohlenberg (1992) studied the factors explaining the legalization of state lotteries in early adopter states (those legalizing lotteries before 1980). The researcher attributed the early adoption of gaming to two variables: contiguity to states with lotteries and low protestant church memberships. States that were late to adopt gaming were found entirely in the South where the church membership was the highest.

According to Riggle and Johnson (1996), in addition to the aforementioned determinants, age groups showed marked differences in voting behavior. Age may be moderating the relationship between political perspectives (conservatism, liberalism, self-centered behavior) and voting behavior. Additional support for the political science literature comes from tourism studies investigating the role of sociodemographic variables in voting behavior. The research reconfirmed that factors affecting residents' support include political affiliation (Shapiro 1996), ethnicity, employment status (Perlman 1996), educational status, income level, affiliation to interest groups (Curriden 1993), and gambling habits of communities and proximity to population centers (Lane 1993). Moreover, information campaigns may also be instrumental in moderating the relationships between voting behavior and the overall mood of community residents (Bennett 1996).

Artificial Neural Networks and Tourism Literature

Artificial neural networks are analytic techniques modeled after the learning processes in the human cognitive system and the neurological functions of the brain. The extant literature suggests that the application of neural networks outperforms more traditional forecasting techniques, such as discriminant analysis, linear regression, and logistic regression, when relationships between variables are nonlinear and the multicollinearity problems among them are severe (Uysal and Roubi 1999). Thus, neural networks are not constrained by the Gauss-Markov regression assumptions (such as multicollinearity and normality) as some of the other statistical methods are. For example, within the tourism and recreation literature, Pattie and Snyder (1996) compared the techniques to traditional statistical prediction models in forecasting tourist behavior, and, using US National Parks data to develop and compare their models, found that these generated the most accurate prediction results. Law and Au (1999) compared neural networks to time-series and regression techniques in forecasting Japanese demand for travel to Hong Kong, and found that this technique outperforms multiple regression, naive, moving average, and exponent smoothing. Later, Law (2000) argued that some of the inherent complexities (due to the nonlinear relationships among related variables) of forecasting tourism demand limited the value of traditional statistical techniques. When the prediction accuracy is important, he suggested using neural network models. His empirical results indicated that utilizing a back-propagation neural network outperformed regression models, time-series models, and simple feed-forward neural networks in terms of forecasting accuracy.

The use of back-propagation artificial neural networks by de Carvalho, Dougherty, Fowkes, and Wardman (1998) to forecast travel demand from disaggregated discrete choice data allowed them to compare these with logit models. Three data sets were used: synthetic data fulfilling the underlying logit assumptions, synthetic data breaching the underlying logit assumptions, and the real data. The authors found that neural networks with no hidden layers exhibited almost identical performance to logit models in all three cases. For the synthetic data breaching the underlying logit assumptions and with real data, back-propagation neural networks with a hidden layer achieved much better performance than logit.

Researchers in other fields have also concluded that ANN usually outperform other forecasting techniques and are robust in terms of their predictive power. Olson and Mossman (2003) compared neural network forecasts of one-year-ahead Canadian stock returns with the forecasts obtained using ordinary least squares and logistic regression (logit) techniques. Their input data consisted of 61 accounting ratios for 2,352 Canadian companies over the period 1976–93. Their results indicated that back propagation neural networks, which consider nonlinear relationships between input and output variables, outperform the best regression alternatives for both point estimation and in classifying firms expected to have either high or low returns. Shang, Lin, and Goetz (2000) compared neural networks to logistic regression model in diagnosing methicilin-resistant staphylococcus aureus type infection. Their cross-validation results showed that neural networks were better than the logistic regression model in terms of both predictive power and robustness. Zheng, Hu, Patuwo, and Indro (1999) and Charalambous, Charitou, and Kaourou (2000), in two separate studies, compared neural networks to logistic regression in the context of bankruptcy prediction. Their results indicated that such models provided superior results to those obtained from logistic regression model. Basically, ANN are capable of predicting new observations (including ballot outcomes) from other observations (on the same or other variables) after executing a process of the so-called ''learning from existing data'' (Haykin 1998).

A major problem in neural network modeling is the concept of generalization: how well the learning system performs with data that does not belong to the training set. Traditional knowledge from data modeling and recent developments in learning theory clearly indicate that after a critical point Multilayer Perceptrons (the most widely used neural network topology) trained with back-propagation will continue to do better in the training set, but the test set performance will begin to deteriorate (Vapnik 1995). This phenomenon is called over-training. One method to solve this problem is to stop the training at the point of maximum generalization (for a given data and topology), a method called early stopping or stopping with cross-validation. It has been experimentally verified that the training error always decreases when the number of iterations is increased (for a sufficiently large network). If one plots the error in a set of data with which the network was not trained (the cross-validation set), one can observe that the error initially decreases with the number of iterations but eventually starts to increase again. Therefore, training, should be stopped at the point of the smallest error in the cross-validation data set.

Study Methods

Data for the study was collected using both primary and secondary collection techniques. Primary data related to gambling ballot outcomes (yes and nay votes for propositions) were obtained from an email survey of all 50 state election offices and related divisions. These offices responded by mail and/or email with either ballot data regarding all gaming and wagering related ballot issues (horse and greyhound race ballots, lotteries, casino gambling, etc.) or with a statement indicating that the status of such proposals is a current issue or has not been brought to a referendum. Data related to 64 ballots of 22 states proposing gaming ballots between the years 1919 and 1998 were extracted from the information received. For this analysis, only the results of gambling-related ballots proposed during the '90s were used (14 states with 24 ballot results: California, Colorado, Florida, Georgia, Louisiana, Nebraska, New Jersey, North Dakota, Oklahoma, Ohio, South Dakota, Texas, Utah, and Washington) because of the restriction placed on the availability of nationwide religious-affiliation data. The ballot data related to propositions about the legalization of casino (Type I) and parimutuel wagering (Type II) only.

Secondary data was compiled through a variety of sources. County-level religious data containing information about the number of churches and their members were compiled from the American Religion Data Archive (Braddely, Green, Jones, Mynn, and NcNeil 1992). This is centennial time series data containing statistics by county for 133 Judeo-Christian church bodies and provides information on the number of churches/members. It is, however, difficult to estimate exactly what percentage is actually represented by this number. Since the data used are cross-sectional (collected from various time spans), the reader is cautioned on the interpretation of the findings. Generally, this should not be problematic due to the stability of the rate of change in demographic data in the nation.

Other county-level data such as population estimates, age, personal income, ethnicity, gender, poverty level, and education were extracted from the US Census Bureau (1990, 1994, 1999, 2000) and state data centers. Per capita income data were obtained from Bureau of Economic Analysis (2000). Unemployment rate data were compiled from Bureau of Labor Statistics (2000). Population density (population per square mile) was calculated by dividing size of the county by population. Metropolitan Statistical Areas were defined by the US Office of Management and Budget based on published standards reported by the US Census Bureau. Table 3 illustrates the variables used in this study.

Analysis and Results

The following procedures were undertaken to prepare the data:

Step 1. The data was validated for missing and null values. The records that had such values were removed from the dataset.

Step 2. Records (rows) in the data set were randomized among themselves. The purpose of this was to have a truly random mixed data set in which any part represents the behavior of the whole.

Table 3. Independent Variables

1	Ballot type I (Gambling)—Unary encoding (UE)
2	Ballot type II (Wagering)—Unary encoding (UE)
3	Percent population voted
4	Medium family income
5	Percent population church members
6	Percent population male
7	Poverty level
8	Unemployment rate
9	Percent population minority (nonwhite)
10	Percent population older than 45
11	Metropolitan statistical area (MSA)—Unary encoding (UE)
12	Not MSA—Unary encoding (UE)

Note: Dependent variables are percent votes ''against gambling'' and percent votes ''for gambling.'' The data set includes 1,287 records from 1,287 counties.

Step 3. The randomized data set (1,287 records) was split into three separate data files: training, cross-validation, and testing. Since the records were randomized before the splitting, it is safe to say that each data set individually represents the general behavior of the model. A common practice is to split the data set into three parts using the following percentages: 60% for training (773 observations), 20% for cross-validation (257 observations), and 20% for testing (257 observations). To optimize the predictive power of the neural network model, both the cross-validation and the training data sets were used simultaneously. Once the predictive power of the training model reached the optimal level, the neural network weights were saved for the testing data.

Step 4. Sensitivity analysis was performed to determine the cause and effect relationship between the inputs and outputs of a trained neural network model.

Step 5. To establish reliability, data were converted to a binary classification problem using

$$\begin{cases} \sum_{i=1}^{n} \omega_i PY_i > .500 & \text{then the Resolution will Pass} \\ \text{otherwise} & \text{the Resolution will not Pass} \end{cases} \quad (1)$$

in which PY_i is the percentage of votes cast for legalizing gambling by county i, w_i is the weight for county i, and n is the total number of counties participating in the referendum.

Neutral Networks Architecture Specifications and Testing

Multilayered perceptron with one hidden layer was used because of its power estimating nonlinear functions. In this study, tangent hyperbolic PE functions in middle and output layers were used. The input layer included PEs for 12 independent variables with 10 in the hidden layer. The output layer included only one dependent variable: yes- or nay-votes in percentages. NeuroSolutions 2001, a simulation software, was utilized to develop the current neural network model.

Two neural network models were trained: one for percent-nay-votes (model 1) and another for percent-yes-votes (model 2) using data from 1,287 individual counties in the United States that held ballot referenda about commercial gaming. The same set of independent variables was used for both models. The reader is reminded of the fact that the prediction results obtained from models 1 and 2 are mirror images of each other. The assumption behind these seperate calculations (one for percent-yes-votes and another for percent-nay-votes) is that the deriving factors behind these two decisions may be quite different; therefore, they needed to be analyzed separately using sensitivity analysis. For example, major factors that impel people to vote for the resolution were expected to differ from one of those voting against the resolution. As far as the prediction is concerned, one can use either model 1 or model 2, because once aggregated they will both result in the same conclusion.

For both models, the input and output variables between +1 and −1 were normalized. This is a commonly exercised procedure in neural network modeling in standardizing variables. It ensures that each variable gets equal treatment regardless of the magnitude of its values. Both models were trained for 5,000 epochs. One epoch is one complete presentation of the data set (training and cross-validation) to the network being trained. This training process was repeated 10 times. Since the neural network training is a stochastic simulation process that starts at a random state with random weights, it is always advisable to replicate the run for a number of times to maximize the possibility of finding the global optimum. The best weights are saved for the minimum mean squared error obtained on the cross-validation data set for both models. Saving the best weights when obtaining the minimum mean on the cross-validation data set ensured the most generalized model with the highest prediction power. Once the training process was completed and the network weights were saved, the test data sets were then fed into both network models. The test results obtained from this procedure are presented in Table 4 for models 1 and 2.

Both network models predicted the output (percent ‘‘nay’’ votes and percent ‘‘yes’’ votes for a given county) with approximately 82% accuracy. The mean absolute percent error value is calculated by averaging the percent difference between the network output and the desired value for the selected test data set for both models. Table 4 also displays the prediction results.

The analysis proceeded with the calculation of the accuracy of the model prediction in terms of what the actual vote (for vs. against) would be for both models. Out of 257 test data records, in model 1 (percent-nay-votes) the trained neural network accurately predicted 201 counties against vote-turn-out, and in model 2 (percent-yes-votes) 198 counties. This finding indicates that in each of the two cases, on average, the neural network models predicted the vote outcome

Table 4. Neural Network Test Results for Percent "Nay" and "Yes" Votes

Performance	% Against	% For
MAPE[a]	18.03	18.52
MSE[b]	0.01	0.01
NMSE[c]	0.67	0.57
MAE[d]	0.09	0.08
Min abs. error	0.00	0.00
Max abs. error	0.39	0.43
R	0.69	0.65

[a] Mean absolute percent error.
[b] Mean squared error.
[c] Normalized mean squared error.
[d] Mean absolute error.

accurately for four out of every five counties in a data set that they have never examined.

One would rightfully assume that the percentage is not what counts in the end, as long as pass (55%) and no-pass (45%) is determined. In essence, this problem could have easily been treated as a binary classification problem (yes vs. no). The only additional data preprocessing step would have been to convert the vote percentages to yes (if percent yes is greater than .500) and to no (otherwise). This problem was initially treated as a prediction (forecasting) problem as opposed to a classification problem, because the researchers could utilize the data set in its most detailed representational form. Converting percentages to yes and no decisions would have unnecessarily aggregated the data, and hence causing the loss of the detailed information content. For instance, a county that heavily favored legalization of gaming (with 90%), and one that slightly favored the legalization (with 55%) would have had no difference in the classification problem formulation. There may be some additional information that could be gained from those counties that strongly felt one way vs. another. A classification problem formulation would have not revealed this type of information, but the prediction (forecasting) problem formulation did. Later, after the sensitivity analysis that allowed the researchers to gain insight into the variables affecting the yes-or-nay-vote, the data were converted to a binary classification problem to recheck the reliability of the results. As these suggest, both models 1 and 2 did an exemplary job in prediction and classification.

Sensitivity Analysis on Neural Network Model

Sensitivity analysis is a method for extracting the cause and effect relationship between the inputs and outputs of a trained neural network model (Davis 1989). In the process of performing sensitivity analysis, the neural network learning is disabled so that its weights are not affected. The basic idea is that the inputs are shifted slightly and the corresponding change in the output is reported as a percentage (Principe, Euliano and Lefebvre 2000). The first input is varied, between its mean plus-and-minus, a user-defined number of standard deviations (for example, 2) while all other inputs are fixed at their respective means. The network output is computed for a user-defined number of steps above and below the mean. This process is repeated for each input. As a result, a report is generated to summarize the variation of each output with respect to the variation in each input. The generated report contains column plots (along with numerical values presented on the *x*-axis) (Figures 2 and 3), reporting the sensitivity values for each input variable in terms of standard deviation of each output divided by the standard deviation of each input.

In Figures 2 and 3, the *x*-axis represents the input variables and the *y*-axis represents the sensitivity values. Sensitivity values presented in these figures indicate the relative importance of each input variable for the given output variable of a specific trained neural network model. The sensitivity results presented in Figure 2 show that the output variable percent of yes votes was more sensitive to the input variable percent minority, percent church members, metropolitan statistical area, and ballot type II. Similar to traditional regression coefficients, the sensitivity values can be interpreted as weights (importance) attached to the independent variables. Accordingly, percent minority has the highest sensitivity value (SV = .74), followed by percent church members (SV = .28), counties in (a or the) metropolitan statistical area (SV = .197), and ballot type II (SV = .20); among the rest, these independent variables showed the most sensitivity for passing ballots that accept gambling and wagering. According to the output, model 2 was impacted more by (or indicated greater impact from) wagering (ballot type I) than gambling; in other words, communities were more inclined to accept wagering than gambling (ballot type II).

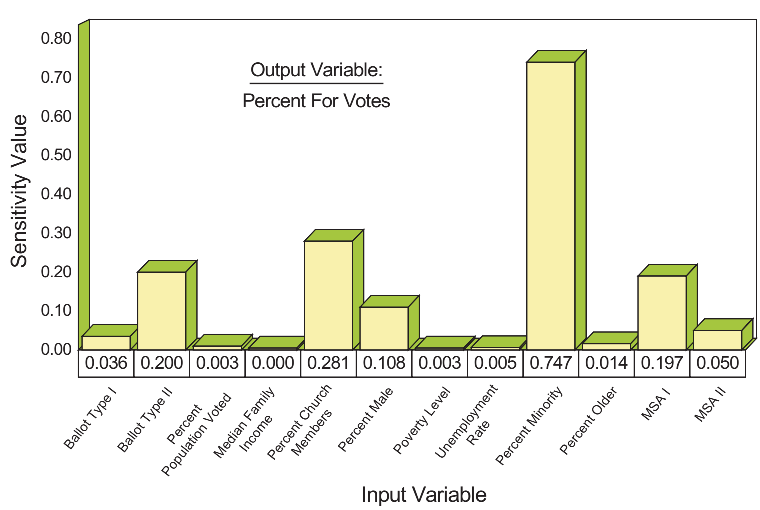

Figure 2. Sensitivity Values for Percent "Yes" Presented in a Column Plot

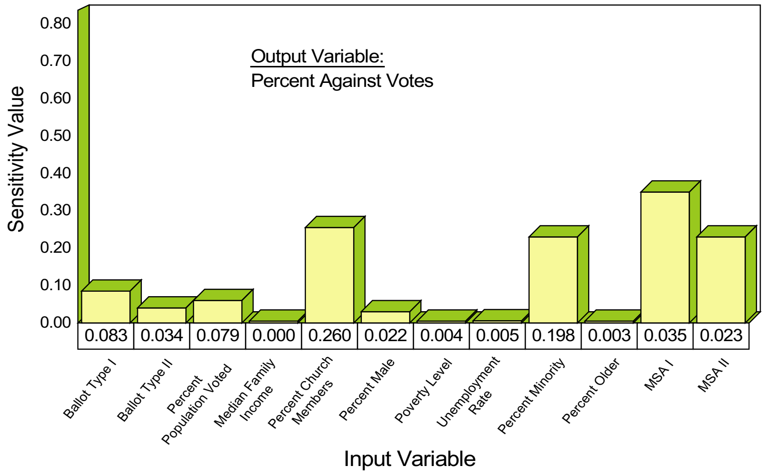

Figure 3. Sensitivity Values for Percent "No" Presented in a Column Plot

Similarly, the sensitivity results presented in Figure 3 show that the output variable percent of nay votes was more sensitive to only two input variables: percent minority (SV = .259) and percent church members (SV = .194). Low sensitivity values for both ballot types are an indication of opposition to gaming in general. Regardless of the type of ballot, when voting against gaming propositions voters tended to put both wagering and gambling in the same basket.

CONCLUSION

To date, tourism and hospitality literature has paid scant attention to the role of forecasting gaming ballot outcomes. In fact, with one notable exception (Silverberg and Ulbrich 1996), there are few known studies in the English literature that developed and tested models that can be used to predict community support for gaming. Extant studies in the area of lottery adoption, such as the ones conducted by Caudill et al. (1995), Filer, Moak, and Uze (1988), and Martin and Yandle (1990), have used similar models to predict such occurrences in various US states. These studies, though commendable, have each used a limited number of independent variables to explain error variation in the data. The research reported here attempted to overcome the multicollinearity problems encountered in previous studies by utilizing an ANN model. However, as with any study that relies on secondary data, the present study may be suffering from an omitted-variable problem as there may be other potential variables (such as dollars spent in promotion for one cause or the other and the politician factor).

Applications of artificial neural networks to tourism problems, though still scarce, have been increasing in recent years. Given their superb performance in forecasting, ANN have been employed to estimate expenditures (Law 2000), tourist behavior within US National Parks (Douglas and Snyder 1996), guest loyalty to international tourist hotels (Tsaur, Chiu and Huang 2002) and segment markets (Mazanec 1993).

The purpose of this study was to develop and test models that can be used as predictors of community support, or lack thereof, for commercial gaming in general. Specifically, the study examined the role of the factors that contribute to legalization and/or probation of gambling activities using ANN. Model 1 correctly predicted 201 out of 257 counties that would vote against gaming. Model 2 correctly predicted 198 counties out of 257 that would vote pro gaming. On average, both models accurately predicted the vote outcome for four out of every five counties (approximately 82% accuracy) on the data set that they have never examined during the model building process.

Earlier research findings that demonstrated a significant relationship between abolition of prohibitionary laws for gaming and sociodemographic and geographic variables gained additional support from the findings of this study. These also support Perlman's argument (1996) that an increased proportion of minority populations within a geographical space gave rise to the legalization of gaming. According to Dahl (1996), the willingness of residents to subscribe to norms, values, and rules for regulating the behavior of individuals depends upon the population's size and diversity. As the population increases, the community becomes more heterogeneous, giving rise to conflicting interests that result in the broadening of physical, psychological, and social distances among residents. The gradual relaxation of community attitudes toward minor vices and victimless crimes and the weakening of religious structures have contributed to pro-gambling influences in the United States (Goodman 1995). Hence, in such diverse communities, a united stance for the prohibition of gambling may be less likely.

As suggested by Lane's research (1993), proximity to population centers (operationalized as Metropolitan Statistical Areas) was an important variable for the legalization of gaming. A lottery adoption study conducted by Filer, Moak and Uze (1988) reported similar results. As with earlier studies (Curriden 1993; Shapiro 1996), increased church memberships within the general public was also found to be a sensitive variable to changes in voting behavior. This study supports the findings of Martin and Yandle (1990) who estimated the probability of the occurrence of a lottery in a state. Their results suggested that the percentage of a state's Baptist population was negatively related to the likelihood of the occurrence of a lottery.

From a practical standpoint, this study provides several policy implications. According to the review of the relevant gaming literature, there are limits to the public's acceptance of gaming. Attempts to pass such laws may fail unless the factors behind public support of gaming are understood and critically examined. Policymakers and the sector could use the findings of this and similar studies to assess the determinants that differentiate a community that passes a gambling ballot from one that strongly opposes it. The factors identified herein can be used as predictors for targeting those with high acceptance probabilities. Thus, resources devoted to promoting gambling can be efficiently utilized and potential conflicts that may arise between the sector and the communities may be prevented before a promotional campaign is initiated.

As with other studies, this research is not immune to limitations that can put restrictions on the use of its findings. Unlike regression analysis, sensitivity analysis does not allow the researcher to determine the direction of the effects. Artificial neural networks are known as a black-box approach to solving complex problems. Though empirical results are generally favorable compared to other techniques, they lack the theoretical explanations of independent variables. Recent developments in neural network research have sought to address this shortcoming by attempting to interpret the neural network weights (Intrator and Intrator 2001; Sato and Tsukimoto 2001). Hence, the results of this study must be evaluated carefully with theoretical foundations in mind. Otherwise, heuristic methods, such as ANN analysis, can lead to erroneous conclusions. Based on the theoretical foundation of this study, one can speculate on the directionality of the sensitivity values. For example, in areas where there is a proportionally higher church membership, gaming proposals are expected to be rejected. Thus, the findings of this research lend further support to the utilization of religious affiliation figures. Increases in minority populations and gaming proposals in metropolitan counties vs. rural areas can result in the acceptance of wagering laws.

There is also an ethical standpoint to consider. Since gaming taxes tend to be regressive in nature (Smith and Wynne 2000), the degree of vulnerability of low-income groups must be studied before such proposals are brought to the ballot box. Empirically, these findings can be substantiated by analyzing the location of casinos in the United States. Moreover, according to the conceptual model of this study, there are many additional factors that could have been used as explanatory factors. However, the lack of data availability prevented such an inclusive analysis. Therefore, the final analysis was delimited to the data at hand. When interpreting the findings, the reader is reminded that there might be other factors that play a crucial role in explaining the voting behavior of the population.

Further studies may examine voting outcomes based on various types of gaming. Although the findings of this study seem to indicate that models developed for lottery-adoption can be used for predicting gaming ballot outcomes, the inclusion of variables used in this study into similar future studies may enhance the predictive validity of the models. Lotteries are legal in 37 states. Thus, variables that are expected to explain the acceptance of low impact gaming (bingo, lottery, horse racing, etc.) might be very different than the variables used in predicting casino gambling. Other lines of research should be directed toward improving the forecasting ability of the models. In this study, a prediction accuracy of 82% was attained. Including other variables, newly developed techniques (such as genetic algorithms or rough sets) can help improve the predictive power of current models. For establishing external validity and reliability, duplication of this study in other countries is recommended. ■

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