A Forecasting Model of Gaming Revenues
in Clark County, Nevada[1]

B. Edwards, A. Bando, G. Bassett, A. Rosen
Economics and Law Section, Environmental Assessment and Information Sciences Division
Argonne National Laboratory
9700 S. Cass Ave. Bldg 900
Argonne, IL 60439

J. Carlson, C. Meenan
Science Application International Corporation
101 Convention Center Drive
Las Vegas, NV 89109

ABSTRACT

This paper describes the Western Area Gaming and Economic Response Simulator (WAGERS), a forecasting model that emphasizes the role of the gaming industry in Clark County, Nevada. It is designed to generate forecasts of gaming revenues in Clark County, whose regional economy is dominated by the gaming industry, and identify the exogenous variables that affect gaming revenues. This model will provide baseline forecasts of Clark County gaming revenues in order to assess changes in gaming related economic activity resulting from future events like the siting of a permanent high-level radioactive waste repository at Yucca Mountain.

1.0 INTRODUCTION

This paper describes the Western Area Gaming and Economic Response Simulator (WAGERS), a forecasting model that emphasizes the role of the gaming industry in Clark County, Nevada. It is designed to generate short-term forecasts of gaming revenues in Clark County, Nevada (which includes the city of Las Vegas). The gaming industry dominates the regional economy of Clark County. WAGERS incorporates a band of uncertainty around each estimate. In this way, the model provides not only a forecast range but also a way of determining uncertainty values.

WAGERS is meant to: 1) forecast Clark County gaming revenues and identify the exogenous variables that affect gaming revenues; and 2) provide baseline forecasts of Clark County gaming revenues in order to assess changes in gaming related economic activity resulting from future events like siting the repository. The model grew out of previous work that reviewed the literature on tourism and performed preliminary empirical analysis of the potential effects of the Yucca Mountain Project on the tourism industry in the Las Vegas Area (DOE, 1985, 1991).

WAGERS can be used in two ways. First, it can be used as a stand-alone forecasting model of gaming and other economic activity in southern Nevada. Second, it can be used as a source of model inputs to larger, more detailed, regional macro or input-output models.

Section 2 contains a background summary of the WAGERS model and a review of literature on related subjects. The structure of WAGERS, and its components, are described in Section 3. Estimates from preliminary runs of WAGERS appear in Section 4. The final section of this report contains a summary of the findings, possible applications for WAGERS and suggestions for extending the development of the WAGERS model.

DISCLAIMER

2.0 BACKGROUND AND LITERATURE REVIEW

Clark County, Nevada, which includes the city of Las Vegas, has a unique economic and demographic composition. Throughout the period 1960-1989, the gaming industry employed approximately one-third of Clark County's civilian labor force. Manufacturing, which accounted for 17.9 percent of total U.S. employment in 1989, employed only 3 percent of the work force in Clark County. For the state of Nevada, 26.1 percent of total receipts were accounted for by amusement and recreation services in 1977. This stands in contrast to a national figure of 11.8 percent. The emphasis of the economy on gaming, tourism and conventions, and the lack of a diversified industrial base leaves this region vulnerable to potentially strong negative perception-based impacts associated with siting a repository.

Tourism associated with the gaming industry is the dominant component of economic activity in Clark County. Since 1960, the hotel and gaming industries have employed over 30 percent of the total labor force of Clark County. Economic activity, and the overall economic welfare of the region, is determined to a large degree by the activities of these industries. To reflect these characteristics, WAGERS emphasizes tourism and gaming activities in forecasting total revenues for this county. WAGERS can be used to generate alternative economic scenarios. The model provides point forecasts that are the current best estimates of future gaming revenues and interval forecasts to indicate the uncertainty around the target forecasts. The effects of changes in variables affecting gaming revenues, including macroeconomic conditions, Atlantic City (New Jersey) gambling conditions, and strikes in Las Vegas, can be analyzed using WAGERS.

Several empirical studies have been done to forecast the economic impacts of tourism on a local economy, but the literature on forecasting gaming revenues in Nevada is not extensive. Cargill and Morus (1986) and Cargill and Eadington (1978) are among the studies that use time series analysis to model gaming revenues in Nevada. Their general conclusions are that such forecasting models can be developed for a specialized region like Nevada and that such an approach may be superior to other (more traditional) approaches; see e.g. BarOn (1979), Geurts et al (1976), Sheldon and Var (1985).

WAGERS uses both time series and econometric methods. Some of the equations in the WAGERS model that are based on time-series estimates include the forecasts of the variables that are exogenous to WAGERS. The main components of WAGERS (i.e., the forecasted gaming revenue equations) are based on econometrically estimated behavioral relationships.

3.0 METHODOLOGY

The basic assumption underlying WAGERS is that the gaming industry[a] provides a bundle of goods and services that are chosen from a set of competing alternatives. The goods consumed by visitors to the Clark County area (e.g., gaming and convention activity) are normal with downward sloping demand curves. Periods of increasing economic activity cause demand to increase and thereby result in increased consumption of gaming. Consumers of these goods will also weigh their expected costs. The decision to choose Las Vegas as a vacation site will likely depend on the cost of traveling to the area and the cost of complementary goods and services (e.g., hotel rooms) relative to the costs associated with other potential vacation and tourism sites.

WAGERS includes variables that explain variations in gaming revenues. These include those that are specific to the Clark County economy, such as the cost of meals and lodging in Las Vegas, and others that are macroeconomic and designed to include the effects of overall economic activity on gaming activity in Clark County.

WAGERS' estimates are currently based on the following explanatory variables: 1) real U.S. personal disposable income; 2) a deflator for personal consumption expenditures; 3) an index of meals and lodging costs in the city of Las Vegas; 4) slot, non-slot, and total gaming revenues in Atlantic City; 5) the number of strikes in Las Vegas; 6) tourist volume in Clark County; and 7) the unemployment rate of Clark County. The data used to estimate the parameters of the forecasting model extend from the second quarter of 1978 to the second quarter of 1990.

WAGERS uses disposable income to measure variations in aggregate economic activity. The variable reflects changes in purchasing power and serves as a demand-shifting variable. Higher levels of disposable personal income will potentially lead to higher levels of game participation and presumably higher gaming revenues. The inclusion of this variable captures national economic activity rather than variations in economic activity in Nevada or the Western United States, which might provide more power in predicting gaming activity in Clark County.

4.0 MODEL DESCRIPTION

WAGERS currently consists of two submodels: 1) External and 2) Gaming. The two submodels are combined to form the full WAGERS model specification.

4.1 External Submodel

The External Submodel consists of four equations that generate predicted values of exogenous variables that are used as inputs to the gaming module. In particular, the gaming module uses predicted values of the Runzheimer Index, slot revenues for Atlantic City, Non-Slot revenues for Atlantic City, the unemployment rate for Clark County and personal disposable income (PDI). Current forecast of PDI come from the DRI Quarterly Macroeconomic Model.[b]

The Atlantic City revenues are converted from nominal to real (1982) values using the Personal Consumption Expenditure Deflator. The predicted values for the Atlantic City slot and table revenues were estimated using time-series models. This produces the first two equations of the external module -- forecasting equations for slot and table revenue for Atlantic City. The third equation of the external module produces forecasted values of the Runzheimer Index, which represents an index of hotel and lodging costs for Las Vegas. This index captures changes in one of the components of the costs faced by both tourists and convention visitors. The unemployment rate for Clark County is used as an indicator of overall economic activity in Clark County. Currently, WAGERS estimates this variable using a single variable time series equation. The model allows the user to enter predicted values other than those generated by the external submodel, thus allowing for the possibility of comparing alternative scenarios.

4.2 Gaming Submodel

The Gaming Submodel is a mathematical representation of gaming revenues. The model is based on the historical relationship between Las Vegas gaming revenues and the exogenous variables. The inputs to this submodel are the exogenous driver variables from the External Submodel. WAGERS breaks gaming revenue into two categories, slot and non-slot.[c] The non-slot revenue includes table revenues (e.g., Blackjack) and sports betting. Slot and Non-slot revenues are generated separately in the submodel.

The Gaming Submodel also generates a measure of model uncertainty -- a boundary within which the forecasts are most likely. This allows WAGERS to express uncertainties about its forecast estimates. As the forecast period is extended into the future, the upper and lower bounds spread further apart, thus indicating increasing uncertainty for more distant forecasts.

5.0 MODEL ESTIMATES

The results of three simulations with the WAGERS model are presented in this section. The first simulation represents the baseline WAGERS simulation, which forecasts Clark County gaming revenues out to the fourth quarter of 2000. Two impact simulations are presented to illustrate the kinds of analyses that can be performed with WAGERS. Each of these impact simulations will assume that there is some exogenous change in tourist volume to Clark County. The reasons for such a change in tourist volume could be many. For one, economic or demographic conditions could change thus altering the attractiveness of Clark County as a tourist location. Additionally, a response by consumers to information about Clark County (or Southern Nevada) could make it a less (or more) desirable place to visit. Finally, marketing by Clark County entertainment concerns could induce higher levels of tourism.

5.1 The Baseline Simulation

The baseline simulation is constructed from runs of the Exogenous and Gaming Submodels of the WAGERS model. The baseline simulations shows total Clark County gaming revenues growing steadily (in real terms) throughout the next decade, approaching $4.3 billion ($1982) by the year 2000. The forecasted Runzheimer index will grow at a constant rate, suggesting steady increases in nominal hotel and lodging costs in Clark County over the coming decade. The Clark County unemployment rate is projected to average just above 7 percent throughout the coming decade. The baseline forecasted unemployment rate represents the average unemployment rate for the entire forecast period. The actual unemployment rate will vary with economic conditions. Table 1 contains selected values for the baseline simulation.

5.2 Impact Simulation 1

The first impact simulation performed with the WAGERS model assumes that tourist volume is less than the baseline projection of tourist volume by 10 percent, beginning in 1995 and continuing throughout the forecast horizon. The purpose of such a simulation is to illustrate the simulation properties of the WAGERS model. In particular, such a simulation allows us to examine the sensitivity of Clark County gamig revenues to changes in a variable that could be an

Table 1
Baseline WAGERS Simulation
(Thousands; Gaming revenues expressed in 1982 dollars)

	1989	1995	2000
Clark County Tourist Volume	18,208	24,120	28,583
Clark County Slot Revenues	1,491,142	2,523,786	3,384,373
Clark County Non-Slot Revenues	1,024,442	996,281	949,658

Table 2
Impact Simulation 1
10 Percent Decline in Tourist Volume in 1995
(Thousands; Gaming revenues expressed in 1982 dollars)

	1989	1995	2000
Tourist Volume (% Change)	18,208	21,708 (-10)	25,725 (-11)
Clark County Slot Revenues (% Change)	1,491,142	2,440,209 (-3.3)	3,285,331 (-2.9)
Clark County Non-Slot Revenues (% Change)	1,024,442	872,915 (-12)	803,463 (-15)

Table 3
Impact Simulation 2
10 Percent Increase in Tourist Volume in 1995
(Thousands; Gaming revenues expressed in 1982 dollars)

	1989	1995	2000
Tourist Volume (% Change)	18,208	26,532 (+10)	31,441 (+9.9)
Clark County Slot Revenues (% Change)	1,491,142	2,607,362 (+3.3)	3,483,416 (+2.9)
Clark County Non-Slot Revenues (% Change)	1,024,442	1,119,646 (+12)	1,095,854 (+15)

important determinant of gaming revenues. Table 2 contains the results of this simulation.

5.3 Impact Simulation 2

The next simulation assumes that tourist volume jumps by 10 percent in the first quarter of 1995 and stays above the baseline by this percentage over the remaining quarters of the simulation. Table 3 shows the results of this simulation.

These simulations and their results are intended solely to illustrate how gaming activity, as represented through WAGERS, could be affected by exogenous changes in tourist volume. Other components of the Exogenous Submodel could also have

be chosen for simulations. Tourist volume was chosen solely as a matter of convenience.

Figures 1 and 2 show a comparison of the impact simulations with the forecasted baseline. An examination of the results suggests that Clark County revenues are fairly sensitive to tourist volume. In addition, the results of these simulations suggest that non-slot revenues are more sensitive to tourist volume than are slot revenues. One possible explanation for this result is the wide availability of slot machines throughout the state of Nevada and access to these machines that is shared by the general population. Non-slot revenues might be more directly associated with tourists who participate in these games while on travel to Clark County.
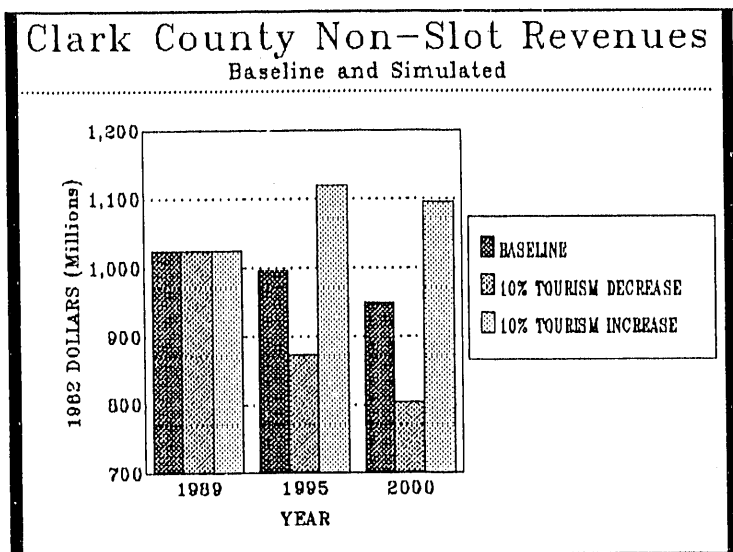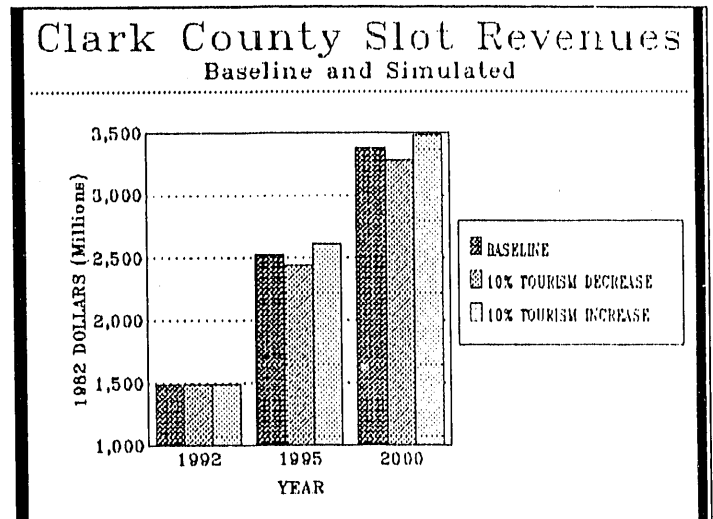

Figure 2 Slot Revenues

Figure 1 Non-Slot Revenues

6.0   FUTURE RESEARCH DIRECTIONS

This version of the WAGERS model provides forecasts for Clark County slot and non-slot revenues. The purpose is to develop a simulation model that can be used to estimate impacts on Clark County of economic and demographic changes that will affect the Clark County gaming industry.

Future developments in the WAGERS model can take many forms, including: 1) explicit incorporation of perceptions into the WAGERS model; 2) adding economic detail, which could include employment and industry-specific dimensions; 3) expanding the time horizon of the WAGERS model; and 4) developing a more sophisticated version that incorporates the

dynamics of the southern Nevada economy and feedbacks between the different sectors of this economy.

The Exogenous Submodel of WAGERS currently assumes one direction of causality. The Atlantic City gaming industry is assumed to affect the gaming industry in Clark County, but not *vice versa*. It is likely that the impacts are, in fact, simultaneously determined. This suggests one possible future direction for WAGERS, namely, to incorporate the Atlantic City gaming industry into the Gaming submodel. This would require the Exogenous submodel to produce forecasts of exogenous variables that will be necessary to forecast future gaming activity in both areas (i.e., to generate exogenous forecasts that will be common to both regions). One example of likely candidates for inclusion in the Exogenous Submodel would be demographic trends, such as regional population growth projections, that will invariably affect the performance of the gaming industry in these regions. It is also likely that variables that characterize regional economic conditions be included in the Gaming Submodel. The current treatment of the Clark County unemployment rate is a case in point. The significant role that gaming plays in the Clark County economy suggests that gaming activity will have an impact on the local unemployment rate, a factor that is not accounted for by WAGERS. The unemployment rate, as well as other measures of regional economic activity, could be incorporated into the Gaming Submodel.

A final area concerns seasonality of the WAGERS model. One obvious characteristic of the data is the strong seasonal component which thus far has been captured by the inclusion of seasonal binary variables in some of the equations. While this method of dealing with the seasonal nature of the data might be appropriate, an alternative means of capturing this is to employ some seasonalization algorithm to the series that make up WAGERS.

7.0 ENDNOTES

a. For purposes of this paper, we define "gaming industry" rather broadly to include slot and non-slot gaming activity, tourism and conventions.

b. This distinction was used previously in the SAIC report on tourism (1991).

c. Several other exogenous variables were considered, but not used. The reasons for this were: (1) lack of reliable data, (2) incompatibility of existing data with the data on included variables, and (3) initial data analyses revealed that the variables were statistically insignificant. Among the possible exogenous variables which have not been used in the model are: 1) state lottery revenues; 2) number of hotel rooms in Las Vegas; 3) number of conventions in Las Vegas; 4) total visitor volume in Las Vegas; 5) total advertising expenditures of the gaming industry; 6) riverboat gaming revenues; 7) Clark County population and income; 8) California population and income; and 9) petroleum revenues in the Mid-east. Many of these relationships were evaluated statistically in the US DOE tourism report (1991).

Our initial examination of the data indicated that the impact of the growth of state lotteries on Clark County gaming revenues was statistically insignificant. Similarly, the impacts of Clark County and California population and income, and Mid-east petroleum revenues, were determined to be statistically insignificant. The nature of the causal relationship between gaming revenues and the number of hotel rooms in Las Vegas in a given period of time, was found to be ambiguous. The data on the number of Las Vegas conventions and total advertising expenditures were not included because they are currently unavailable to us and they are highly correlated with the current values of gaming revenues. Finally, while a rapid growth in riverboat gambling might impact Las Vegas gaming revenues, it is too early to establish the existence the quantitative relationship between the two.

8.0 REFERENCES

BarOn, Raymond, 1979, "Forecasting tourism-theory and practice," *TTRA Tenth Conference Proceedings*, Bureau of Economics & Business Research, University of Utah, Salt Lake City, Utah, pp. 27-33.

Cargill, Thomas F., and William Eadington, 1978, "Nevada's Gaming Revenues: Time Characteristics and Forecasting," *Management Science*, **24**, August.

Cargill, Thomas F, and Steven Morus, 1986, "A vector autoregression model of Nevada economy," *Quarterly Review*, *Federal Reserve Bank of San Francisco*.

Geurts, Michael D., T.A. Buchman, and I.B. Ibrahim, 1976, "Use of the Box-Jenkins approach to forecast tourist arrivals," *Journal of Travel Research*, 14, pp. 5-8.

Sheldon, Pauline J., and Turgut Var, 1985, "Tourism forecasting: A review of empirical research," *Journal of Forecasting*, 4, pp. 183-195.

United States Department of Commerce, Bureau of the Census, *County and City Data Book: 1983*.

United States Department of Energy, 1985, *High-Level Nuclear Waste Transport and Storage Assessment of Potential Impacts of Tourism in the Las Vegas Area*, DOE/NV/10270-1, Science Applications International Corporation, December.

United States Department of Energy, 1991, *Estimating Gaming Revenues for Clark County*, Unpublished Draft, Science Applications International Corporation, April.

DATE
FILMED
5/20/92