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Adding Value with Benefit-Cost Analysis: Forecasting Net Social Benefit from Impacts of Slot Machine Gambling in Maryland

Abstract: The estimated impacts, benefits, and costs of legalizing slot machines in Maryland are analyzed building on and contrasting with results from an impact analysis. The analysis provides estimates of the components and the total net benefits to the state and its citizens; the role of uncertainty, distributional impacts, and a basic tax alternative. The results forecast mostly positive net benefits for Maryland both in comparison to doing nothing and in comparison to raising an equivalent amount in taxes. However, if slot revenue raised from the lower income population is given more weight, then doing nothing or raising taxes appears to be preferred.

Keywords: benefit-cost; gambling; regional; risk; slots.

JEL classifications: D6; H3; A1.

1 Introduction

Numerous studies can inform policy debates: impact analyses, multiattribute scores, budget analyses, and benefit-cost analysis (BCA) to name several (Vining & Boardman, 2006). Although these studies are not mutually exclusive, more study requires more time and effort while providing different perspectives and measures of performance. A statewide vote on the legalization of slot machine gambling in Maryland is used here to illustrate the added value from BCA. The *Washington Post* (2008) editorialized to recommend a "No" vote on slot machine legalization, prominently featuring results from an impact analysis (Shinogle et al., 2008). Would a BCA have provided different information of potential value to voters? This paper estimates the welfare impact of legalizing slots and illustrates substantive issues in regional public economics and BCA that are relevant to gambling; among them are the role of government revenue, social costs based on the actions of nonnormal gamblers, whether or how employment benefits are included, distributional impacts, uncertainty about quantitative measures, and the nature of alternative

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projects. Ultimately, the results are an ex ante estimate of whether legalizing slot machine gambling was likely to increase economic efficiency in the state while providing a baseline for retrospective analysis, a task which both this journal and the Government Accountability Office appear to encourage (Kopits et al., 2014; GAO, 2005). A more minor theme is the comparison of impact analysis and BCA including the analytical investment in moving from an impact analysis to a timely albeit back-of-the-envelope BCA (Carrigan & Shapiro, 2014).

In interdisciplinary work and even among many economists, a case must sometimes be made for the usefulness and distinction between impact analyses, such as an Environmental Impact Statement (EIS) or a socioeconomic impact of gambling analysis (Anielski & Braaten, 2008), and a BCA. Impact analyses are designed to be objective analyses, both quantitative and qualitative, of the impacts of an action in their natural units, whether deaths, dollars, or jobs. Generally, no numerical aggregation is possible and stakeholders are left to integrate results based on their own mental model or the textual hints of positive and negative tones of the authors. In contrast, BCAs both extend and modify an impact analysis. A BCA extends impact analysis by monetizing impacts allowing aggregation and may modify the empirical metrics used, based on a goal of measuring changes in economic welfare or economic efficiency.

The application here is a vote to allow gambling in the form of video lottery terminals, hereafter VLTs or slots, in the state of Maryland. The policy and associated state constitutional change was ratified by a statewide vote in 2008 to legalize VLTs in Maryland with five sites and a maximum of 15,000 slot machines (DLS, 2008). Legalized gambling existed in several neighboring states. The stated purpose of the legislation was to raise funds for a variety of purposes such as higher education, horse racing, local government, and small, minority or women-owned businesses. The analysis here focuses on the cost of raising the desired funds without analyzing the purpose for which the funds are spent. An alternative is analyzed that raises the same net government funds as if from legalizing gambling but instead raises the funds through general state taxation. Broader alternatives such as varying the scope of gambling or open access gambling are not analyzed as they were not estimable given the available information nor were they elements of the actual vote. The paper gives standing to citizens and corporations in Maryland as was the focus of the political debate. Limiting standing to Marylanders means that the loss of gambling benefits to other jurisdictions, as from government revenues, is ignored as are any other impacts occurring outside the state, such as external costs. Hence the analysis is not the standard one of whether the entire country would benefit or not; but only whether one political jurisdiction would benefit.

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The paper proceeds in Section 2 by establishing the standard benefit-cost structure and highlighting conceptual issues in its application to gambling. A sequence of models is then investigated. Section 3 develops a model using standard impacts to estimate the expected value of benefits and costs to Maryland on an annual basis at full implementation. Section 4 introduces more controversial elements such as induced changes in taxes or benefits from employing the previously unemployed and other markets' effects. Section 5 implements uncertainty using Monte Carlo analysis as many outcomes, such as external costs associated with gamblers, revenue estimates, and secondary effects are relatively uncertain. Sections 6–8 consider additional modeling issues such as an adjustment for "nonnormal" preferences exhibited by problem and pathological gamblers, for distributional impacts, and for raising funds via taxation instead of legalizing gambling.

2 Impact data and the standard benefit-cost structure

This paper illustrates the different and additional information provided by a BCA compared to an impact analysis. To illustrate this, the information basis for the BCA is an impact analysis prepared prior to the election for the introduction of slot machines (Shinogle et al., 2008), also referred to as the Maryland Institute for Policy Analysis and Research (MIPAR) report. The MIPAR report surveyed existing state government reports and the literature on numerous impact categories and summarized them in a qualitative fashion. Particular attention was paid to the costs of problem and pathological gamblers and the potential for overstating government revenue leading to an implicit negative tone regarding the policy proposal as was emphasized in a *Washington Post* editorial (2008).

This BCA incorporates information available at the time to the MIPAR group of researchers (of which the author was a part), but uses the BCA methodology to investigate how monetary aggregation and differing metrics can lead to a different conclusion. This case study of creating a BCA from an impact analysis should be viewed as representing a rapid and small-scale effort, generally using costs and benefits that are transferred from other settings or produced by other authors in order to obtain informative but approximate or back-of-the-envelope results. Approximately two additional weeks of effort were necessary to obtain initial benefit-cost results.

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Benefit-cost structure and data

Existing guidance for a BCA is relatively clear on general categories and metrics in the absence of uncertainty: consumer surplus, producer surplus, government revenues, and externalities where it is recognized that when changes in government revenue are identified, then the surplus measures are net of that revenue transfer to government (Boardman et al., 2011; Zerbe & Dively, 1994). The analytical challenge is to assess and value the impacts of a particular policy on the appropriate categories without double counting or other issues of mismeasurement. However, a recent review of the benefits and costs of slot machine gambling highlights the absence of methodological agreement on the details of a BCA applied to slots (Farrow & Carter, 2013). Among the larger areas of disagreement cited were the appropriate measures of consumer welfare for a choice with risk, distinguishing among transfers and private and external damages related to nonnormal gamblers, and the extent of intermarket substitution affecting (regional) general equilibrium outcomes. These issues are not resolved, but illustrated here. The section below develops as close as possible a standard, partial equilibrium analysis followed by sections addressing the additional issues.

3 Net standard benefits at full implementation

The central elements for a BCA of VLTs are the change in government revenue, the change in consumer benefits due to closer gambling locations, the change in producer surplus, and costs (primarily external) associated with nonnormal gamblers. Data generally reflect annual values at full implementation. The concepts and data behind each element are discussed below with later analyses building upon these items.[1]

Change in government revenue: The foundational estimate for the change in government revenue was modeled by the Maryland Department of Legislative Services, (DLS, 2008) based on five specific forecast locations meeting the total number of slots allowed in legislation. The forecast involved population location and distance to both the planned sites and existing competing sites, income, and a forecast net income per day per machine based on comparable venues. The forecast net income per day varied from $115 to $315 across the five sites. Allocations of expenditures that allow for partial "recapture" of Maryland residents' gambling expenditures outside the state, expenditures of nonresidents and expanded gambling

1 Later, Table 1 presents annual point estimates for these categories. That table also includes additional elements discussed later involving secondary impacts and uncertainty in the parameters.

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activity were included. Higher forecasts were generated by a group commissioned by proponents of legalizing gambling (DLS, 2008, p. 14) and later commentators noted the change in general economic conditions that might have lowered nearer term forecasts.

The change in government revenue is the expected annual steady state government revenue and was the focus of much of the policy discussion. The state estimated the gross total expected revenue (after gambler payouts at full implementation) as $1362 million yielding $913 million in gross state revenues, given the state share 67%, as specified in legislation (DLS, 2008, Shinogle et al., 2008, p. 8). The MIPAR report also investigated high, medium, and low alternative gross revenue forecasts of $1375; $1031; and $688 million. The estimates were based on differing assumptions about gambling expenditures by Marylanders in other states and its recapture with legalization and the statewide average increase in gambling due to greater proximity to gambling venues. Following guidance for BCA (Arrow et al., 1996; OMB, 2003), the expected value of the four gross income estimates, $1114, is used here as a point estimate resulting in a mean state income estimate of $746 million. The gross revenues determine the state net revenues and for later consideration, governmental expenses, which were identified in the legislation as specific percentages of government revenue. The uncertainty analysis in Section 5 smoothes the values reported in the MIPAR report by defining a continuous triangular distribution with the most likely case being the mean of the four estimates ($1114 million) and with upper and lower bounds as identified.

Producer surplus after taxes is typically defined as total revenue less total variable cost, after taxes, at the forecast level of operation. This producer's surplus is akin to operating profit after taxes, which may include a variety of components including some related to the ownership of capital. Maryland legislation at the time required a large share of after payout gross revenues, 67%, compared to neighboring states that extract from 42% to 48% (DLS, 2008). There is little in the secondary literature to inform the implications of government revenue shares on producer surplus. Grinols (2004) uses 20% of *gross* revenue as the gross profit to include depreciation, interest, and profit in his example of the regional effect of gambling. Alternatively, if all firms are incorporated outside Maryland, then the producer surplus within Maryland would be zero. At the same time, the legislative reports and data focus on total VLT revenue and not on what may be the consolidated profits of operators. Operators may open other businesses such as restaurants, which take advantage of the limited entry into the VLT business. This may generate producer surplus for Maryland from out of state gamblers and have some substitution effects (discussed in the next section) on other retail opportunities.

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Consequently the point estimate used for long-term producer surplus is 8% of the VLT operating revenues private operators received from the state based on the reported net income after taxes, depreciation, and before losses of all U.S. corporations in 2006 (U.S. Census Bureau, 2010). The distribution used for producer surplus as a percentage of private VLT income is triangular with a lower bound of zero (if all firms are owned out of state), a mode of 8%, and a maximum of 20%.

Consumer benefit: As surveyed in Farrow and Carter (2013), agreement is lacking on the appropriate modeling and estimation of consumer benefit from gambling. Some analysts have used standard Marshallian surplus measures linking price (typically the expected value per dollar lost by a gambler) and demand (Australian Productivity Commission, 1999). Assuming linearity of demand, the resulting consumer surplus can be estimated as gross expenditures divided by twice the absolute value of the relevant elasticity (Australian Productivity Commission, 1999). As a benchmark, this implies that a unitary elasticity demand curve is associated with consumer surplus equal to one-half expenditures (gross revenues), a relatively large amount compared to what is actually used in the MIPAR report based on work by Grinols (2004). Some authors distinguish normal from nonnormal gamblers where nonnormal gamblers exhibit some degree of addiction, an early application of behavioral welfare economics (Weimer, Vining & Thomas, 2009; Jin et al., 2015; Australian Productivity Commission, 1999). In such cases, a downward adjustment is made to surplus estimates for the addicted gambler based on the surplus that a normal gambler expects. In contrast, Grinols (2004) models consumer benefit as based on a reduced distance to gambling for an average consumer as distinct from the more traditional consumer surplus arguing that marginal gambling prices are essentially equivalent from venue to venue. The distance benefit is estimated by Grinols using a functional form for a representative consumer's utility that incorporates an intensity of gambling into a utility function to model both the number of visits and expenditures and distance to the gambling site. Other theoretical models of gambling behavior exist; for instance, Conlisk (1993) models gambling utility as being derived both from the pleasure of gambling and the disutility due to risk aversion with respect to income. Estimates based on risk preferences appear not to have been used in the empirical analysis of slots (Farrow & Carter, 2013).

The impact analysis of the MIPAR report used the distance surplus empirical approach of Grinols (2004) and an estimated average reduction in distance to a gambling venue of 55 miles. Consequently, they report a distance consumer benefit of $25 million for gamblers in Maryland who may have previously gambled in the neighboring states of Pennsylvania, Delaware, and West Virginia and for gamblers newly gambling in Maryland.

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For uncertainty analysis in later estimation, a triangular distribution of distance consumer benefit is used that has a minimum of $25 million, a most likely value of $40 million, and a maximum of $100 million.[2] As noted, a different conceptual basis for surplus may lead to a substantially different value, an element incorporated later into the pure error in the uncertainty analysis.

Government expenses: Administrative costs in the for-profit sector could be expected to be minimized for a forecast quantity. However, there is less structure to guide government cost estimation. Consequently, the estimate stated in Maryland legislation assuming 4.8% of total gross revenues (prior to payout to operators) was used as the expected administrative cost. Based on the enabling legislation, the funding for these costs was to be split with 2% from VLT revenue and 2.8% from general state funds. These costs are included as part of the direct "net" cost to government. On costs drawn from the general funds, a marginal excess burden of taxation of 25% is applied as the default estimate of the efficiency cost of taxes and as recommended in Federal Guidance (Boardman et al., 2011; Grinols, 2004; OMB, 1992). The distribution of these costs is derived from the uncertainty in the gross revenues with the cost percentages held constant.

Nonnormal/Problem and pathological gamblers (external and addictive impacts): Some gamblers develop behavior that has been variously called a mental disorder or an addiction, which has been observed to lead to increased probabilities of various costs (American Psychiatric Society, 2010). This area of large controversy in concept and estimation is surveyed by Walker (2007), Grinols (2004), Farrow and Carter (2013) and in the MIPAR report (pp. 12–14) among others. The controversy in economics tends to focus on which costs are internalized by the gambler and markets and which are appropriately considered external costs. Controversy exists over the dynamic consistency of individual choices regarding gambling; in monetary exchanges among friends, family, or others; lost productivity, illness, and so on. The MIPAR report focussed on the estimates of Grinols (2004) in which social costs associated with nonnormal gamblers are interpreted quite broadly to include both external effects and at least some of the private components of what a nonnormal gambler might be willing to pay to avoid their condition. Grinols surveys and averages cost estimates from nine studies, each of which included some or all of the categories: crime, lost business and employment costs, bankruptcy, illness, social service costs, government direct costs, regulatory costs, family costs such as divorce and separation, and gambling funds obtained under

2 The MIPAR report value is used as the minimum as it appears that the number was derived from an expected number of gamblers instead of all adults as was typically although not universally identified in Grinols. There is also uncertainty about the average decrease in distance for Maryland gamblers as a result of the legislation.

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false pretenses. He reports average costs, in 2003 dollars, for a pathological gambler of $10,333 and for a problem gambler of $2945. Walker (2007) and other authors dispute the inclusion of some of these components to focus solely on costs related to crime and legal costs such as may be associated with divorce or medical treatment. Walker reports a social cost estimate of $2945 (2003 dollars) for a pathological gambler. Consequently there is a debate about the shadow price or transfer value for an average nonnormal gambler both on conceptual grounds and on aspects of estimation and transferability to a local setting such as Maryland.

The total social cost has generally been found by applying the average cost per category of gambler to the prevalence of categories of nonnormal gamblers, a figure that is also uncertain. The MIPAR report used an estimate from the National Opinion Research Center that the incidence of nonnormal gamblers may double when casinos are available within 50 miles and consequently forecast that there would be an increase of about 34,000 pathological gamblers and 55,000 problem gamblers in Maryland. The range for the increase in total social cost was reported as $228.3 and $627.5 million based on the range of costs reported by Grinols and Walker and so the expected value, $428 million, is used as the point estimate. Uncertainty is modeled as a uniform distribution for the range.

Discussion of results: direct effects

The net annual benefit estimated by the direct effect model is an estimated net benefit of about $318 million in 2008 dollars as presented in Table 1.

The key driver of the benefits is the change in government revenue although the estimated "external" costs due to problem and pathological gamblers are a substantial cost. Other elements, such as administrative costs, consumer benefits, producer surplus, and government fee revenue are relatively small being of the order of tens of millions of dollars instead of hundreds of millions as is the case for government revenues and external costs due to problem and pathological gamblers. The conclusion, subject to the caveats in the development of the model as discussed above, is that the expected value of the direct effects indicates a positive net benefit for Maryland due to VLTs.

4 Changes in other markets

Legalization of slot machines introduces a new industry potentially leading to changes in supply and demand in numerous markets that are already distorted at least by taxes and in some cases by externalities and imperfect competition. The

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Table 1 Two models and results: direct effects and other markets' effects.

Video lottery terminals	**Direct effects only**	**Specific other markets' effects**	
Basic model	Mil 2008 $		Mil 2008 $
Benefits			
Change government revenue	$746		$746
Change government annual fee for problem gambling	$6		$6
Change producer surplus: MD profits	$29		$29
Change consumer surplus: distance	$25		$25
		New sales tax	$2
		Unemployment effects	$0
Welfare benefits	**$807**	**Modified benefits**	**$809**
Costs			
Change government revenue (2% admin)	$22		$22
Change government revenue: other costs	$39		$39
External and addictive costs	$428		$428
		Loss in lottery sales	57
		Loss in other taxes	28
		Change other MD consumer and producer surplus	37
Welfare costs	**$489**	**Modified costs**	**$611**
Annual net benefits	**$318**	**Modified net benefits**	**$198**

Details may not add to total due to rounding.

literature on general equilibrium effects is complex, in part because the characterization of the new policy can be an important determinant of the general equilibrium welfare effects (Just, Hueth & Schimtz, 2004, Appendix 9). The VLT policy studied here has elements of an open economy, prior tax and market imperfections; and a movement from an infinite tax on market entry into the slots market in the base case to introducing imperfect competition with the new policy. Such complexities may support a multimarket welfare analysis. The analysis here makes relatively small adjustments to the direct, partial equilibrium model to consider the possibility of these general equilibrium effects as additionally discussed by Boardman et al. (2011), Goulder and Williams (2003), Hines (1999), Florio (2014),

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and Whalley (1975). Each component that differs from the direct effects model is summarized below followed by a discussion of the results.

An important policy issue in regional analysis is the net effect on government revenue. The state legislative services (DLS, 2008) and the MIPAR report included estimates of changes in other state revenues. The largest of these changes are estimated reductions in existing lottery income (substituting one form of gambling for another) and a potential substitution effect from shifting expenditures from an existing taxable activity of any kind into a differently taxed activity, VLTs. Modest increases were estimated by DLS for some types of sales taxes. The point estimates are as in the MIPAR report; in the case of lottery sales an absolute dollar amount of $57 million and in the case of sales taxes, 2.5% of gross VLT revenue. In the latter case, the uncertainty analysis links the loss in tax income to the uncertain change in total revenues.

Consumer and producer surplus changes in other markets, including the labor market, are generally considered secondary, indirect, or general equilibrium effects. The conditions under which such effects may exist are complex as described above. Two adjustments are considered here as sensitivity analysis: (1) additional benefits in the labor market based on reduced opportunity cost compared to the baseline and (2) welfare changes in related output markets.

Concern for employment benefits is important in the gambling and other development literature but BCA generally excludes such impacts. The MIPAR report notes that essentially full employment existed in Maryland at the time and hence concluded that there would be no secondary (or multiplier) benefits related to employing the unemployed. Consequently, the point estimate for a secondary benefit for the unemployed is zero, which is also consistent with federal and textbook guidelines (OMB, 2003; Boardman et al., 2011). However, in times of significant unemployment, a social benefit (reduced opportunity cost) may exist (Boardman et al., 2011; Haveman & Krutilla, 1967; Haveman & Farrow, 2011; Haveman & Weimer, 2015; Bartik, 2012). The exact way to account for this impact that is conditional on high unemployment is debated, although Boardman et al. (2011) suggest an empirical approximation. That approximation assumes a random reservation wage between zero and the market wage as the opportunity cost of an unemployed worker, which is adjusted by the probability of hiring the unemployed. One way to account for the reduced opportunity cost when the baseline is measured at "full cost" is to record as a benefit the surplus accruing to previously unemployed workers whose reservation wage is less than the market wage (Haveman & Farrow, 2011).

In this analysis, the expected value of employment benefits is zero and labor is recorded entirely as a cost at the market wage. However, for the uncertainty anal-

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ysis some potential for hiring the unemployed for casino work existed even at the time of model development and became more important over time. The Maryland unemployment rate from late 2009 through 2013 was about 7%. In the uncertainty analysis, the probability of a benefit (reduced opportunity cost) from hiring the unemployed was modeled as being driven by the probability of hiring an unemployed person times a (total project) social value for employing unemployed labor. The assumed probability of hiring an unemployed person has its most likely value at 0 and increases continuously to 1; this triangular distribution has a mean value of one third, substantially less than assuming that all new jobs in times of high unemployment would ultimately result in a hire from the unemployed. The probability of the unemployment benefit generated from that distribution is then multiplied by one half of the estimated payroll, a proportion of payroll that results when the reservation wage for the unemployed is thought to range randomly between zero and the observed wage (Boardman et al., 2011, p. 101). The VLT operator's payroll was estimated as one third of the casino VLT expenditures (Grinols, 2004) resulting in a mean employment effect in the Monte Carlo results of $19 million, substantially smaller than the tax effects. No additional multiplier effect on other markets was included for labor.

The final adjustment to the direct impact model includes an estimate of changes in consumer and producer surplus in related markets. For reasons discussed above, including such changes in related markets is a difficult conceptual and empirical issue for BCA. Theoretical and applied analyses range from analyzing a single market in a partial equilibrium analysis to an economywide general equilibrium analysis (Just et al., 2004). Some studies focus on a small set of markets and use cross price elasticities (Chetty, 2009). Other studies seek to develop a full general equilibrium analysis, an effort made more complex for a regional economy as in this study (Goulder & Williams, 2003; Grinols, 2004). Standard benefit-cost guidance, as with unemployment, is to exclude secondary impacts although there are complex caveats for such exclusion. For instance, a leading textbook states "We can, and indeed, should ignore impacts in undistorted secondary markets as long as changes in social surplus in the primary market resulting from government projects are measured and prices in the secondary markets do not change" (Boardman et al., 2011, p. 113). That conclusion is moderated when there are significant market distortions such as externalities, imperfect competition, taxes, and an open economy. With particular regard to gambling, a review of the literature on regional substitution was prepared for the U.S. National Gambling Impact Study Commission by Rose (1998). He concluded that the substitution effect between gambling and other forms of spending "ranged from 35% to 75% for casinos that serve a mix of tourists and residents". Further, he cited two studies in Maryland with a range of

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substitution effects from 35% to 70% of gross gambling expenditures (not surplus), consistent with the overall conclusion of the review.

Two elements of the VLT context suggest that some macroeconomic substitution is likely appropriate. First, the state (DLS, 2008) and the MIPAR report expend effort to consider the change in taxes and other state revenues separate from gambling as a result of substitution effects away from other types of purchases. In addition, the regional impact and gambling literature is concerned about the source of the change in government revenues. A common term used is "cannibalized" (substituted) dollars, which are those expenditures that were already occurring in Maryland but are now shifted into gambling, which for Marylanders may have a subtle effect based on differential tax and consumer surplus across expenditure categories. For instance, Grinols adjusts revenue for such cannibalized dollars.

Consequently, as the Maryland economy is an open economy with numerous prior distortions and with regard to the concerns of the gambling literature, an indirect welfare cost is associated with changes in consumer and producer surplus in Maryland, although this is not quantified in the MIPAR report. In the absence of information about aggregate supply and demand responsiveness, which was not discussed in any of the existing reports, it is not possible with available data to implement a full general equilibrium model of Maryland. Instead, a bounding approach and proportionality assumptions taken from the literature are used to estimate the welfare changes in other markets, an ad hoc approach which highlights the usefulness of further research on the appropriate partial and general equilibrium surplus measures.

The welfare changes in other markets are assumed to be bounded by the consumer gains in the gambling market. The MIPAR report uses distance surplus, ultimately a relatively small value, as the measure of benefits to consumers. Consumers must gain in order to shift their expenditures into gambling and out of their current use. Consequently, the consumer surplus from gambling provides an upper bound on the surplus loss from substitution effects. A parallel assumption is made for producer surplus. When these effects are included, the minimum for the change in surplus due to the general equilibrium substitution effect is taken to be the low proportion from the Rose review, 35% of the bounded value, with a maximum effect of 100%. This implies an expected value of lost surplus due to substitution that is rounded to 68% and is assumed uniformly distributed between the two bounds. In this particular gambling analysis, the consumer's surplus is relatively small and so this general equilibrium effect is relatively small.

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Discussion of results: secondary effects model

Including point estimates of the taxation, employment, and secondary effects has in aggregate a measurable effect on the estimated net benefits, reducing them by 120 million to $198 million. However, the net benefit of legalization remains positive indicating a gain in economic welfare by allowing slots. Almost all of the change is the result of the loss of government revenue in other markets and secondarily, relatively minor shifts within Maryland in the surplus measures. As the point estimate of unemployment benefits is zero, unemployment benefits have no effect in the base case.

5 Uncertainty analysis: Monte Carlo simulation

These results include the statistical distributions discussed in each of the benefit and cost categories. The distributions are used as the basis for 10,000 trials in a Monte Carlo simulation using the Palisade@Risk software. The result is an extended sensitivity analysis compared to considering the sensitivity of the results for one or a few parameters. For instance, the possible benefits from hiring the unemployed now appear in some results as do the MIPAR estimates of lower forecast income.

Two sets of simulation results are reported. The first represents standard practice by including distributions for all the impact parameters of the model, which captures the variability in the model. The second includes a model of pure random error associated with model fit (Farrow, 2012). The distinction between the two models is that the first captures the effect of variability in the impacts and the second captures more fundamental uncertainty about how well the model corresponds to the data generating process.

The second analysis that includes random error may benefit from an additional explanation. The error augmented model is based on adding a distribution for a random error term to the basic Monte Carlo model. The estimation procedure described in Farrow (2012) is used here based on a subjective estimate of the accuracy of the overall model using a fit index ranging from 0 to 1, where 1 is a perfect fit. A value of 0.4 is used here to indicate that the model contains substantial uncertainty such that about 40% of the true variability, analogous to R^2, is captured in the model. This uncertainty can come through the impact of omitted factors, such as the general state of the economy, in the use of information transferred from other settings so that the variables are proxies for the true values, in correlations between outcomes, in the treatment of secondary and external impacts, and so forth. That estimate of fit is used through a transformation to adjust the model sum of squares from the Monte Carlo simulation to estimate the mean square error. The estimated

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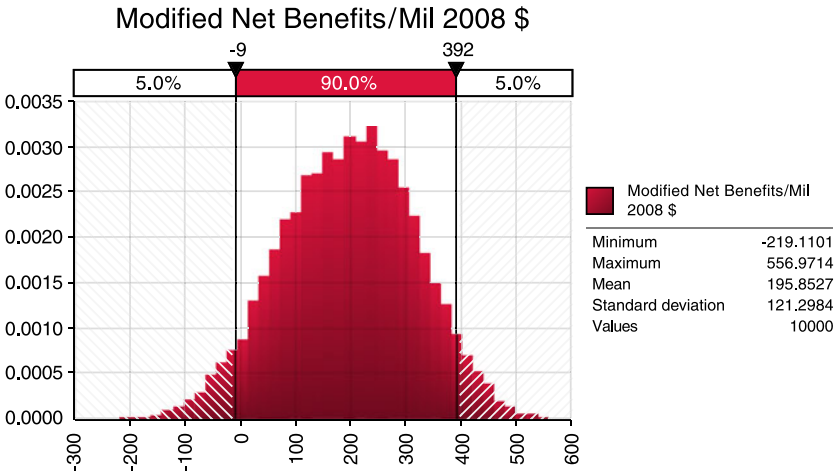

Source: Palisade@Risk V 5.5

Figure 1 Simulation results for model with other market impacts.

mean square error can be used as an estimate of the variance of the random error. When integrated into the simulation, the mean zero random error enlarges the overall degree of uncertainty without changing the mean value.

Discussion of results: other markets' model with uncertainty

The basic simulation result for the annual net benefits taking into account the variability in parameters but omitting pure uncertainty is presented in Figure 1. The mean of the simulated distribution is $196 million, only slightly lower than the mean of the point estimate. The mean in the simulation differs from that in the models with point estimates because not all impact distributions were symmetric around their mean. For instance, the revenue estimate has most of its statistical weight for values less than the most likely value used in the point estimates, and the unemployment benefits have substantial weight for a positive impact compared to the zero value used as the most likely estimate. The two-sided 90% confidence interval is from minus $9 million to $392 million with other statistics as reported in the figure. There is a 6% chance of negative net benefits, a concern for one side of the distribution, which is not directly identified in Figure 1. Hence there is some possibility that slots may result in a welfare loss to Maryland although the expected value remains positive.

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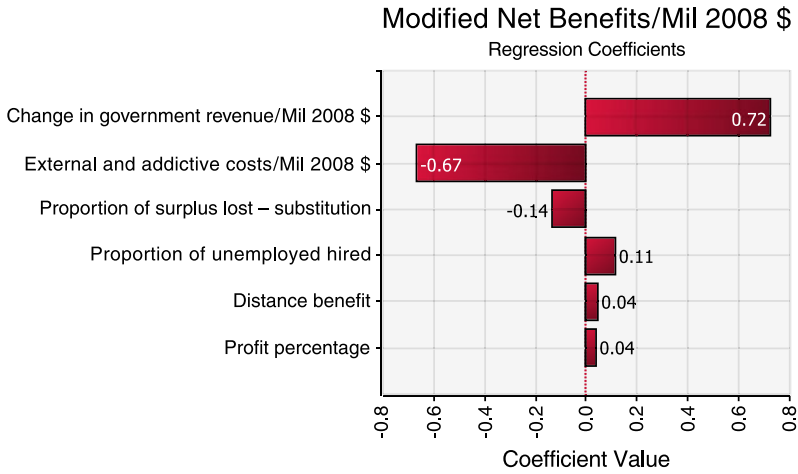

Source: Palisade@Risk V 5.5

Figure 2 Input influence on net benefit.

There are several ways to capture the influence of uncertainty within the benefit and cost impacts on the outcome. Figure 2 reports a method based on normalized regression coefficients obtained by a regression between the values drawn from the distributions and the annual net benefits. A stepwise regression is used in which insignificant regressors are not reported. The coefficient is interpreted as the number of standard deviations the output changes as a result of a one standard deviation change in the identified input. The impacts appear to fall into two categories. The largest effects are due to the forecasts for external costs and for revenues. The revenue forecast also drives several related impacts such as secondary tax and indirect consumer and producer surplus. A smaller category of impacts includes the reductions due to the substitution effect, the consumer distance benefit, the effect of unemployment, and the proportion of profit used in the calculation of producer surplus.

These simulation results may suggest to decision makers the wide range of possible outcomes, how the mean may change due to varying models, and convey the sense of uncertainty compared to the potentially misleading precision that may be conveyed by the point estimates such as those in Table 1. The individual policy decision maker or voter is left to determine whether the net value of this slot machine "lottery" is positive; in essence, leaving them to create their own confidence interval around the mean for which they would accept that the net benefits are significantly different and positive compared to zero.

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The degree of uncertainty is expanded when a subjective measure of model fit is used to estimate a pure random error. In comparison to the results in Figure 1 with a 90% confidence interval from −9 to 392 million, the same confidence interval for the net benefit in the simulation model with added uncertainty is significantly expanded from − $117 million to $509 million although the means, as designed, are essentially equal. When the expanded error is included (not shown in any figure), there is a 15% chance that net benefits will be negative. Including the random error component may be one way to offset the apparent tendency to underestimate uncertainty in decision-making and in effect, create "fatter" tails compared to the original distribution of the outcome.

6 Addictive preferences

A new area of research in BCA suggests that when a product is viewed as addictive – such as cigarettes, drugs, alcohol, or gambling – then there may be reason to adjust the observed behavior of those who are addicted. One approach is to use the preferences of a nonaddicted person as the baseline and so reducing surplus for the "over" consumption caused by the addiction (Bernheim & Rangel, 2007). The Australian Productivity Commission (1999) and Weimer et al. (2009) use a linear model with a similar conceptual basis. The latter authors empirically estimate the willingness to pay of those addicted to achieve an unaddicted state and estimate a downward adjustment for the modeled overconsumption of those who are addicted. The estimated adjustment factor for cigarettes was that those who are addicted receive about two thirds the consumer surplus of those who are not (once their "over" use adjusts the surplus of a normal user downward). Grinols (2004) similarly adjusts downward the average distance benefits by the estimated share of expenditures by problem and pathological gamblers, effectively reducing distance benefits by 30%.

There are several observations should one desire to make a downward adjustment to the results, If the distance consumer benefit is reduced by about one third, the amount suggested by Grinols or Weimer, Vining, and Thomas, the adjustment would be modest, about 8 million dollars in this case study. Alternatively, if the low prevalence of problem and pathological gamblers is applied to the average distance benefit without weighting for the larger expenditures of problem and pathological gamblers, then the change is less than 1 million dollars. However, as a direction for further research it appears that distinguishing theoretically and empirically the benefits received by those who do not gamble, those who gamble normally, and problem and pathological gamblers may be a useful direction (Farrow & Carter, 2013). Consequently, no additional adjustments for addictive

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preferences are incorporated here although the subject remains an area of possible research.

7 Distributional impacts

Federal Guidance includes consideration of the distributional impacts of an activity if they are substantial stating "Your regulatory analysis should provide a separate description of distributional effects (i.e., how both benefits and costs are distributed among subpopulations of particular concern) so that decision-makers can properly consider them along with the effects on economic efficiency" (OMB, 2003). There is ongoing interest in providing sensitivity analysis to the baseline, in which dollar impacts to all those affected are weighted equally, in order to explore the impact of alternative distributional assumptions (Zerbe, 2001; Adler, 2008; Farrow, 2011; HM Treasury, 2009). Although such adjustments have intuitive appeal, they are also inherently subjective as there is no known method to objectively determine such weights nor is there is a professional consensus on such weights.

Gambling provides a likely area of application for distributional sensitivity analysis because low-income and minority people are heavy participants in existing state sanctioned gambling in Maryland. The MIPAR report reviews the incidence of what they call the gambling tax and concludes that it is regressive. Carpenter, Perlman and Norris (2010) report zip-code data in which the codes in the lower quartile of income outspend on a per-capita basis those in the upper quartile by more than two to one. However, Carpenter, Perlman and Norris also report significant variation among types of lottery games so that the validity of a "distribution transfer" approach applying lottery information to slot machines is also uncertain.

The approach to distributional benefits used here is that suggested by Farrow (2011). The U.S. Census Bureau (2008*a*,*b*) uses weights for inequality aversion (Atkinson weights) that imply absolute (followed by relative) weights of 2.1 to 0.5 (∼4:1), and 1.4 to 0.7 (2:1) between the top and bottom segments of the income distribution. These values are used to weight costs or benefits for either the lower or upper quartile of the income distribution in Maryland. Costs and benefits in the middle two quartiles of income receive the default weight of 1. These weights are applied to those benefit and expenditure categories directly related to the source of funds and costs associated with gambling. Consequently, the distributional adjustment is applied to the distance surplus, to the gambling expenditures that are derived from Maryland sources, and to the external social costs in Maryland, which are assumed to be distributed in proportion to the sources of expenditures. Implicitly the distribution of the governmental and other benefits to education, local government, small and minority business, and horse racing is given the default weight of 1.

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Table 2 Distributional impacts as changes to benefits and costs.

Video lottery terminals	**Distributional effects augmenting other markets' model**	
	Highest to lowest weight 2.1, 0.5 (ratio ∼4:1)	**Highest to lowest weight 1.4, 0.7 (ratio 2:1)**
Change in weighted benefits	$3	$3
Weighted welfare benefits	**$827**	**$816**
Change in weighted costs		
Change in gross expenditures	$262	$93
Change in external and addictive costs	$305	$108
Total weighted welfare costs	**$1178**	**$812**
Weighted annual net benefits	**$ − 351**	**$3**

Details may not add to total due to rounding.

Thus the source of expenditures and the costs of nonnormal gamblers are assumed to fall more heavily on lower income households.

Discussion of results: distributional impacts

The result of distributional weighting can drive the annual net benefits substantially negative as indicated in Table 2. That table focuses on changes from the base values provided in Table 1. A distributional relative weight of 4:1 drives the point estimate of net benefits significantly negative, to − $351 million while a relative weight of 2:1 for the highest and lowest quartiles yields a positive net benefit of $3 million (essentially the break-even value of zero, given the uncertainty in these models). Although equal weighting of impacts is the base case in BCA, the use of distributional weights can change the sign of the benefits although the weights must be relatively large. This indicates the substantial importance for economic analysis and for decision makers to consider whether any adjustment for distributional impact is relevant.

8 An alternative: raising revenue via the income tax

The political debate focussed on legalization of VLTs as a means to raise money for higher education and other purposes in a time of particularly tight state budgets. The previous analyses focussed on an alternative with or without slots. However,

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some insight is gained by comparing the net benefits of VLTs compared to an alternative that would yield an equivalent change in net government revenue compared to the slots policy. This is also consistent with finding the largest improvement among a set of alternatives as opposed to relying on net benefits to indicate potential improvement (Coate, 2000). A possible alternative policy is to raise existing sales or income taxes in Maryland. The incidence of such a tax is assumed to fall entirely on Marylanders and no new good or service is being provided in direct exchange for the taxes as is the case for VLTs. Raising existing taxes is unlikely to impose substantially larger administrative costs, given the existing tax collection system. This alternative represents the standard case of a transfer from taxpayers to the government with its associated excess burden of taxation, valued at 25% as earlier (Boardman et al., 2011). This represents the entire welfare effect of the policy, a 25% loss of the net $602 million goal for a welfare loss of $151 million.

Discussion of results: alternative tax based model

Since the alternatives in this case, VLT gambling or raising taxes, are designed to generate the same net change in government revenue, the preferred alternative would be the lowest cost source of funding. Legalizing VLTs is estimated as the lesser cost method of raising funds except when the distributional weighting approach is used. With distributional weighting the result may be less clear depending on the specific weights chosen as sales taxes themselves are understood to be regressive and the Maryland tax system exhibits only a modest progressivity in income taxes.

9 New information and issue for retrospective analysis

Some time has passed since the policy debates on which this benefit-cost forecast is based. Consequently, it is possible to have very preliminary *in medias res* feedback on the accuracy of the forecast and any generic issues in its production in order to inform future analyses of either VLTs in Maryland or more generally, BCAs. The issues identified also begin to highlight topics for a potential retrospective analysis of the slots policy. The issues raised to date include the general state of the economy, revenue forecasts, the extent of nonnormal gamblers, and the estimation of consumer welfare. Each is discussed in turn.

State of the economy: The MIPAR impact report was developed in 2008 as the economy was softening and prior to the substantial changes in unemployment

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that evolved over the following year. Consequently, the MIPAR report focussed on the standard case of full employment even though supporters of government activity often cite employment as part of the benefits of an action. The state unemployment rate hovered around 7% for a number of years following the legalization of slots. Analysts in that case might be more likely to consider some partial and perhaps short-term adjustment in benefits due to employing previously unemployed labor. The uncertainty analysis in this study did incorporate some probability of workers being drawn from the unemployed. This case study demonstrates that uncertainty analysis for many projects may do well to consider the probability, even if small, for economic benefits from unemployed labor.

Revenue forecast: The state of Maryland accepted applications for slots at various sites. The demand for site licenses and VLTs was less than expected although new sites and new contractual terms have since been legislatively mandated. The early applications suggested less demand than forecast by the state of Maryland (DLS, 2008). The observed demand in 2011 prior to additional site and contract changes was more consistent with the medium or low predictions provided in the MIPAR report, although the cause may be different. The MIPAR report forecast the source of lower revenue to be due to less play per machine and less recapture of Maryland gambling revenue that had been spent out of state. By 2015, with the economy somewhat recovered, the total number of slot machines installed was fewer than the target and legislative changes allowed table games, with a smaller share going to the state. Slot machine revenues are forecast to be about $650 million for fiscal year 2015 (Maryland, 2015), which is at the lower end of the original forecast range. The range of gross slot machine revenue per day was approximately $150–$250 in 2015 with the top end being lower than originally forecast but the lower end being higher than the point estimate forecast (Maryland, 2015). Fewer machines than forecast were in operation, with some incentives appearing to encourage substitution of table games for slot machines.

Consumer benefits: Measuring the consumer benefits of increased access to gambling remains a difficult empirical exercise and no theoretical consensus exists. The evolution of thought on this issue may improve the integration of such estimates into BCA. However, it appears that the distance benefits as calculated by Grinols (2004) may have been incorrectly applied to the specifics of the Maryland case in the MIPAR report based on the change in distance traveled and the number of people to which the benefit applied (the representative consumer and not just gamblers). Such changes and corrections might increase the distance benefits from $25 to about $40 million, still a relatively small number. More importantly, evolution of alternative consumer surplus models may lead to larger changes.

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Nonnormal gamblers: As part of Maryland legislation, a baseline survey was conducted in 2010 as reported in Shinogle et al. (2011). The Maryland specific results indicated a baseline rate almost twice as high for existing pathological gamblers, 1.5% of adults, as assumed in the MIPAR report (0.8%) and a somewhat higher rate for problem gamblers (1.9 compared with the assumed 1.4%). The finding of a higher baseline would have to be matched with an observed change in prevalence associated with legalized gambling before it can be determined whether the change in nonnormal gamblers used here should be revised. Similarly, the evolving debate on the nature of costs associated with nonnormal gamblers and any adjustment for their consumer surplus may add or subtract from total costs of nonnormal gamblers in any potential retrospective analysis.

10 Conclusions and directions for research

Does BCA add informational value to that of an impact analysis? Unsurprisingly, this author's answer is yes. The analysis adds conceptual structure and quantitative consistency helping to identify the conditions under which the legalization of slots was likely to increase welfare for Marylanders. The impact of various assumptions on the magnitude of benefits can be investigated and some extensions, such as multidimensional uncertainty analysis through simulation and distributional impacts, can be more easily quantified. This BCA can also be viewed as an extension of a "real time" impact report for policy purposes. The level of effort required was relatively modest and yields a comparably modest level of accuracy. However, the benefit-cost framework informs several new issues including the net benefits to Maryland of VLTs, the importance of secondary impacts, the role of uncertainty, the comparison among alternatives, and the importance of distributional impact.

What analytical conclusion is reached? First, the BCA informs issues that are only implicit in an impact analysis. It appears, based on a modest sized analytical effort, that VLTs would have been forecast in 2008 to generate net benefits to the state of Maryland compared to the alternative of doing nothing and in comparison to raising funds through existing taxes. This is in contrast to the implicit conclusion of an impact analysis that VLTs would be detrimental to Maryland. However, there is substantial uncertainty about various point estimates so that there was a modest chance of negative net benefits based on information at the time of the voting even though the default, baseline mean estimate of social net benefits was positive. Finally, the analysis makes clear that differing and subjective weights on the distributional impacts of gambling can lead to an estimate with negative net benefits for VLTs. For economists, however, this is doubly uncertain territory both because of

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the subjective nature of distributional adjustments and because those in the lower portion of the income distribution are voluntarily choosing to gamble.

The results are effectively an ex ante estimate of the likely positive net value from VLT legalization. As the revenue forecast and the external and addictive costs were the largest determinants of uncertainty, their monitoring and more careful definition would be useful. The inclusion of general equilibrium effects is relatively ad hoc and should be viewed more as a sensitivity analysis and a potential area for further research. Finally, a full retrospective analysis may usefully inform how actual implementation differed from the forecasts presented here and how valuation methods or values may change over an intervening time period.

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