REVIEW OF NIEIR (NATIONAL INSTITUTE OF ECONOMIC AND INDUSTRY RESEARCH), 2003, *THE ECONOMIC IMPACT OF GAMBLING*, JULY.

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1. OVERVIEW

We have reviewed the paper prepared by NEIR (National Economics 2003) *Review of Economic Impact of Gambling*. The findings of that paper should be rejected on a number of grounds. These are set out in summary here, followed by a more detailed critique.

- **Model vs real world**. National Economics' report aims to model the real world. However, the findings as a form of objective reality. They say, "The economic impact … is positive" rather than saying "***the model predicts that*** the economic impact … is positive". This may appear a fine point but is a serious issue and informs the rest of our critique.

- **Accuracy required from the model**. The finding of the model, an increase in average weekly household income across NSW of $8.47 per week, implies accuracy for the model of 1 part in 100. Furthermore depending on how the model processes inputs, those inputs would require at least this order of accuracy and most likely significantly higher accuracy. However, there is no discussion of accuracy of the model, nor does it appear that it is of concern to the study. The finding of the report should have been framed in the following terms: "***There is a 95% probability that the predicted net benefit of gambling to NSW households is $1.035 Billion +/- $XXX Billion per annum***". Obviously, if the error was greater than the finding then the finding would have no substance.

- **Sensitivity testing**. For a model of this kind, the relationships can often be complex. If the model is to be used for decision making one would need to be confident that the findings of the model are robust. Values have been selected for inputs; however, the values can vary over time. One needs to be confident that the findings of the model do not change as inputs are varied across a reasonable range. As an example real interest rates are currently around 5%. If one made an investment decision based on this interest rate one would want to be sure that if interest rates rose to say 7%, the investment decision was still attractive. The authors have not carried out any testing to determine how sensitive the model is to variations in inputs.

- **Treatment of cost of problem gamblers**. The report appears to treat the cost of problem gamblers as a reduction in real household income, that is, as income from which one receives no benefit. This seems a reasonable approach. They state that they have used the estimates of the Productivity Commission report. However, they have departed from the Productivity Commission in two areas that significantly affect the findings of the model. Firstly they have taken the costs across '*severe gamblers' only* whereas the Productivity Commission took costs across severe and moderate categories. Secondly while the Productivity Commission had a range of costs, the authors have only *used the lower figure* of the range as an input to their model. If only a single figure was used then it would seem to me that the average of the range would be the most appropriate. Interestingly if severe and moderate gambler numbers are used and the average cost for problem gambling is used then the finding of the model would be a ***net reduction*** in household income of $690 million per annum from the effects of gambling.

- **Empirical data in support**. The authors make a testable assumption. This is that the presence of gambling leads to an increase in household income. We have carried out a statistical analysis based on household income and per capita expenditure on gaming for LGA's across NSW, using data provided to the SIA Review Panel by the NSW Department of Gaming & Racing in 2003. This was provided to one of the reviewers (Dr Stubbs) in her role as a member of the NSW SIA Review Panel to advise the Liquor Administration Board under the Gaming Machines Act 2001. There is ***no empirical evidence*** to suggest that the presence of gambling leads to an increase in household expenditure. That is, when tested in the real world (NSW) in a reasonably mature gaming market, National Economics' findings are erroneous. More interestingly an analysis of Victorian border towns with tourism based gambling industries shows that for these towns ***household expenditure decreases*** as gaming expenditure increases. **This is in direct opposition to National Economics findings.** From Map 4 of National Economics' report these LGA's should experience a significant increase in household expenditure from the presence of gaming as they are in the highest range of benefit of $20 per household per week. Whilst special pleading could be used to defend the model (eg the statistical analysis is measuring marginal effects, confusion of dependent variables, etc) we feel that the simplest explanation should be accepted (the principle of Occam's razor); that is, that the model is ***not supported by the evidence***. Accordingly the findings should be rejected.

2. DETAILED CRITIQUE

2.1 Model vs the Real World

The finding is based on an economic model of the local economy in LGA's across NSW. The model is only as good as the inputs to the model and the validity of the relationships between variables described by the model. However, this does not appear to have been recognised by National Economics. On page i) they state "The report finds that gambling in New South Wales has a net benefit to the income of New South Wales households…". On page 111 they say "The economic impact of legal gambling in New South Wales is positive. More correctly, the statements should be:

> "The report finds that the ***model used predicts*** that gambling in New South Wales has a net benefit to the income of New South Wales households…"; and
>
> "The ***model used predicts that the*** economic impact of legal gambling in New South Wales is positive."

2.2 Accuracy Required from the Model

National Economics claims to measure an increase in weekly household income of $8.47 per week. The median annual household income in NSW is of the order of $45,000. The effect they are trying to measure is $8.47*52/$45,000=0.98% or 1 part in 100. The model is implying a high level of precision. By comparison, if one had a car fitted with the best speedometer in the world, there would still be an error from the wear on the tyres. To obtain the same order of accuracy, i.e. one part in 100, the range of tyre wear would be around 6 mm. This is about the wear allowance on a new tyre. The precision implied in the model is the same as the error in one's speedo reading between having new tyres and worn tyres.

To obtain the accuracy implied in National Economics' study, the various inputs and relationships would require a similar order of accuracy. In fact, once they start being multiplied together, they need to be accurate to a much higher order to ensure the accuracy of the output is maintained.

To illustrate, assume we have two factors, 4.00 and 5.00, both accurate to one part in 100 i.e. 4.00 +/- 0.04 and 5.00 +/- 0.05. If the factors are added, the upper value is 4.04+5.05=9.09. The lower value is 3.96+4.95=8.91. The answer is then 9+/- 0.09. The level of accuracy is maintained.

If the factors are multiplied together the upper value is 4.04*5.05=20.4. The lower value is 3.96*4.95=19.6. The answer is then 20+/- 0.4. The level of accuracy is 0.4/20=0.02. The answer is only accurate to one part in 50. The accuracy has been degraded.

The techniques for evaluation of errors are well known and based on elementary calculus. The report should discuss this in detail and should report the finding in terms of likely error.

The relationships within National Economics' model are most likely based on functions derived from best-fit curves for a limited range of empirical data. Even though one relationship only is derived, in reality the relationship is the midpoint of an envelope. The upper and lower limits of the envelope can be calculated, usually to a 95% range i.e. a range where one can be sure the real answer lies with a one in twenty chance of being wrong. If a relationship was determined to have a slope of 0, i.e. a flat line, depending on the range of the envelope, an infinite number of lines could be drawn ranging from negative, i.e. sloping downwards to the right to positive, i.e. sloping upward to the right. The wider the envelope, the greater the upward or down wards slope. The answer could equally be that A does not vary with B, that A increases proportionally to B or that A decreases proportionally to B. However the implications of each answer are dramatically different.

Different runs of National Economics' model should have been presented across the likely range of relationships for a fixed data set to understand the errors associated with the error in the relationships defined within the model.

To summarise, there are three levels of error within the model, as there is within any such model. They are the error in the input data; any compounding of that error by multiplication of inputs with each other; and the error in any relationships contained within the model. All three errors should be accounted for.

National Economics' findings should then be presented in the following form:

> **"There is a 95% probability that the predicted net benefit of gambling to NSW households is $1.035 +/- $XXX billion per annum".**

If $XXX was larger than $1.035 billion per annum then no conclusion could be drawn from the output of the model. In other words it would not be possible to say whether there was a benefit from gambling or not. Moreover, any scientific paper which did not include a detailed discussion of errors would be almost certainly rejected. Such factors are not considered within National Economics' paper, and so no such discussion on errors is included.

2.3 Sensitivity Testing

A significant problem with National Economics model is that it has not considered issues related to sensitivity of the model arising from variations in inputs (e.g. interest rates, estimates of the range of costs of problem gambling, etc). By reporting a single answer, as National Economics model has done, there is an inherent assumption that the model is robust, i.e. the findings are insensitive to variation in key inputs. It could well be that reasonable variation in an input could change the output of the model and hence any conclusion.

A value is reported as the output of the model. This implies that the value reported is in the middle of the range and the model is linear. The model could well display other behaviours. For instance as inputs are varied linearly outputs might vary linearly, exponentially, parabolically or chaotically. The only way to find out how the model might behave is to carry out multiple runs of the model varying inputs across a reasonable range. For a simple linear model with one input one could run the model with a reasonable high and low value for the input and see what the range is on the output. One could then decide whether the findings were robust, that is the findings remained the same over a wide range of inputs or whether the findings only held true over a narrow range of inputs.

For a well-behaved linear model with a number of inputs, each input could be varied one at time across a reasonable range to determine whether the variation in that input alters the findings of the model.

For a complex model, a probability function could be assigned to each input and numerous runs of the model could be carried out using Monte Carlo techniques to determine input. The output could then be analysed statistically to determine the level of confidence that could be placed in the findings.

For an example of the dramatic impact of sensitivity on the findings of the National Economics model see the discussion below on Cost of Problem Gamblers.

2.4 Treatment of Cost of Problem Gamblers

The treatment of the cost of problem gamblers by National Economics is particularly problematic. Their finding that the presence of gaming increases household income is principally a result of their selective use of data from the Productivity Commission (1999).

The authors state on page 62 that "we have considered the relevant sections of the Productivity Commission report entitled "Australia's Gambling Industries". They then use the SOGS 7+ rating to determine the proportion of problem gamblers as a proportion of the adult population. They state that the proportion of problem gamblers is 1.09%.

At 6.4 they state that they have adopted the ***low range of costs*** for problem gamblers using $7,700 per problem gambler. We assume this is a typographical error and should be $7,000 (cf page 69 where the Productivity Commission range is quoted at $7,000 to $22,000).

National Economics' report has treated the problem gambler cost as a deduction from household income (refer table 9.1). The total calculated deduction is $2,880 million over five years. They have not substantiated to any plausible degree why they have a) used 1.09% for the proportion of problem gamblers rather than the 2.1% used by the Productivity Commission nor why b) they have only used the lower value of the Productivity Commission's range of estimates. The only justification is at the bottom of page 68 where they state that it is their ***belief*** that the lower range of estimates is a better representation.

If the report's problem gambler cost was adjusted using 2.1% rather than 1.09% the problem gambler cost would be:

$2,880 million * 2.1%/1.09% = $5,549 million.

Using this figure the net impact is reduced to a benefit of $2,504 million or half the value stated in Table 9.1 of the National Economics Report. If the Productivity Commission estimates are adopted then this should be the lower estimate.

The upper estimate would be $5,549 million * 22,000/7,000 = $17,440 million. Using this figure the net impact is reduced to a ***loss*** of $9,387 million. If the Productivity Commission estimates are adopted then this should be the upper estimate.

The average net impact based on the average cost of problem gamblers is a ***loss*** of $3,442 million over five years.

It appears that National Economics have selectively adapted and adopted the findings of the Productivity Commission. The output of the model is ***quite sensitive to variation in the problem gambler cost*** varying from $2,504 million positive impact over five years to $9,387 million negative impact over five years with an average $3,442 million negative impact over five years. It appears that the authors have selectively adapted and adopted data from the Productivity Commission Report to substantiate their finding.

2.5. Empirical Data in Support

Another important problem with National Economics' study is that they have treated a theoretical model as reality. They have not tested their model with empirical data, even though this is available. When actual data is analysed for NSW, the findings of their model are not supported. We have used the most recent comprehensive dataset provided by NSW Department of Gaming and Racing to test their model. Our findings are presented in summary below. The detailed findings can be made available to IPART on request, and will be the subject of a forthcoming academic paper.

At best an economic model is a theory. It attempts to describe how the real world works and then model that world. It is a fundamental principle of scientific method that one should test one's theory by experimentation, i.e. no matter how plausible the theory may sound, support comes from its ability to predict what happens in the real world. A second principle is that theories can be disproved but not proven. A third principle is that a theory that does not make testable predictions is meaningless.

The authors make an unambiguous hypothesis. On page i) they state that gambling in New South Wales has a net benefit to the income of New South Wales households of $1.035 billion per year, or $8.47 per household per week. This is equivalent to 1% of household income. This can be rephrased in statistical terms. The presence of gambling should account for 1% of household income across NSW.

In fact, it is not as simple as this. The report seems to calculate an effective household income so that intangibles such as services provided by clubs are seen as an addition to household income and inefficient costs such as debt finance cost are seen as deductions. All the impacts are direct benefits, but of the items under opportunity cost foregone, the two items of debt finance cost and problem gambler cost lead to an indirect reduction in household income in that these two items absorb household income that could be spent elsewhere. If these two items are taken out then if the model is correct there should be an additional $1,033 million of direct household income per year or another 1%. Hence if the model is correct there should be a direct increase in household income of 2% from the presence of gambling.

Data is available for the following for LGA's across NSW:

- Median household income
- Per capita expenditure on gaming machines

There is a wide range of expenditure on gaming across LGA's. If the presence of gambling increases household income, one would expect the effect to be detectable across the data set especially given some 160 data points. Four data sets were plotted and the Pearson correlation coefficient squared (R^2) and the line of best fit calculated.

The first data set was for all LGA's except for 7 where median household income for 2001 was not readily available. (The seven left out were Auburn, Bankstown, Bega Valley, Deniliquin, Hunters Hill, Lachlan and Murray). The midpoint of the median household range was generally taken, however for data points with per capita gaming expenditure exceeding $2,000 per annum a more precise median household income was linearly interpolated. This was because of the effect of these outliers on the findings. The data set contained two sets of outliers. The first was the City of Sydney with a per capita expenditure on gaming machines of over $6,000. The second was a group of LGA's on the Victorian border with per capita expenditure between $2,000 and $4,000. The LGA's were Wentworth, Balranald, Wakool, Berrigan and Corowa. The other three data sets plotted were the original set less the City of Sydney, the original set less the City of Sydney and the Victorian Border towns only.

The R^2 value can be construed as saying that the value of R^2 as a proportion of the variation of variable A is attributable to variation in variable B. For example if A was found to increase with increase in B and with an R^2 value of 0.1 one could say that 10% of the variation in B can be attributed to variation in A. The report found that the increase in household expenditure as a result of gaming as compared to no gaming was $8.47 per week or 1% (0.01). Accounting for direct inputs and outputs only the value as discussed above would be 2% (0.02). Accordingly one would expect to find R^2 values of this order. From table 9.1 gaming machines produce about 2/3 of the positive impact of gambling expenditure. Hence the expected value of R^2 would be 0.014 using gaming machine data only. Similarly the average value for per capita expenditure on gaming machines is $713. The theoretical slope can be calculated as $8.47*2*.67/$713=plus 0.016. Actual values from analysis of the data set are tabulated below:

Variation of Household income with increase in Gaming Activity across LGA's

Data set	Slope	Proportion of required slope	R^2	Proportion of required R^2
All LGA's	Plus 0.006	38%	0.0002	1/70
Less City of Sydney	Minus 0.0227	-142%	0.0017	1/8
Less City of Sydney and border towns	Plus 0.0193	120%	0.0005	1/28
Border towns only	Minus 0.0112	-70%	0.294	21

This data cannot be construed as supporting the output of the National Economics' model. In all cases, the value of R^2 is between one tenth and one hundredth of that which would be required to support the study. The only data set that gives the required relationship between gambling and household income is that which excludes the City of Sydney and the Border towns. The correlation is very weak. The outliers have a significant impact on the result. If the City of

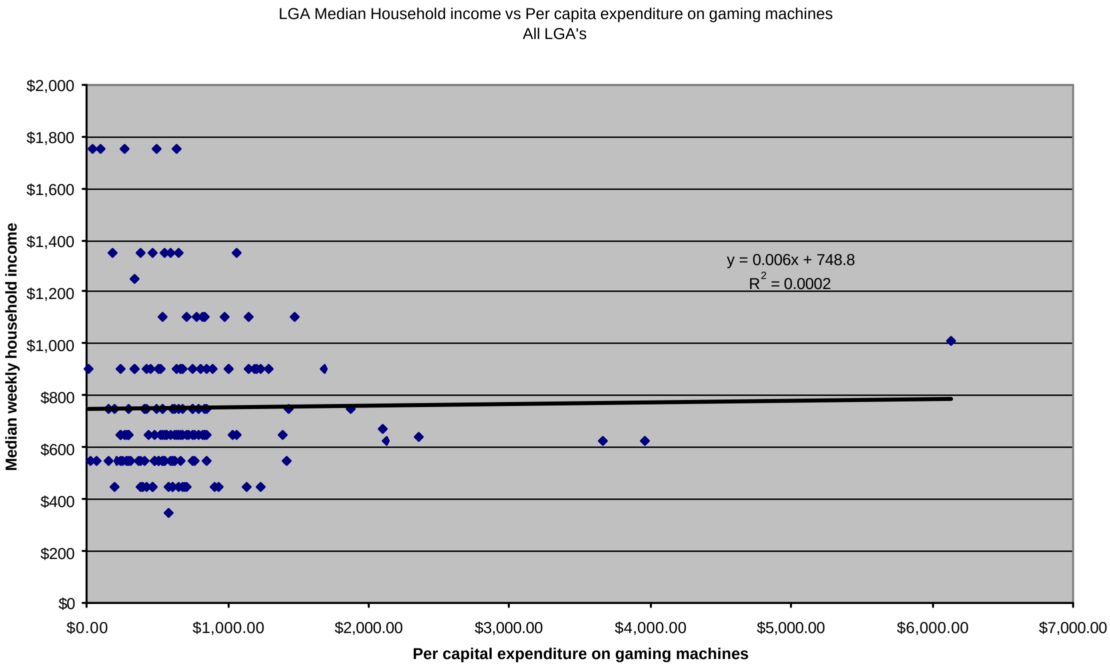
Sydney is included one could deduce that the presence of gaming is weakly correlated with an increase in household income of $6 for every $1,000 increase in per capita expenditure on gaming machines. The effect is around 1% of that expected from the study. Ignoring the City of Sydney (which seems reasonable given the fact that it has a large migrant worker population) the inference would be that the presence of gaming leads to a reduction in household income of $19.30 for every $1,000 increase in per capita expenditure on gaming machines. It appears from this population that around 2% of the variation in Household Income can be attributed to variation in per Capita Gaming expenditure. When the border towns are excluded there is once more a weak correlation with an increase in household expenditure following increase in gaming expenditure. The relationship, although extremely weak, is 1 to 2 orders of magnitude less than that required to verify the economic model.

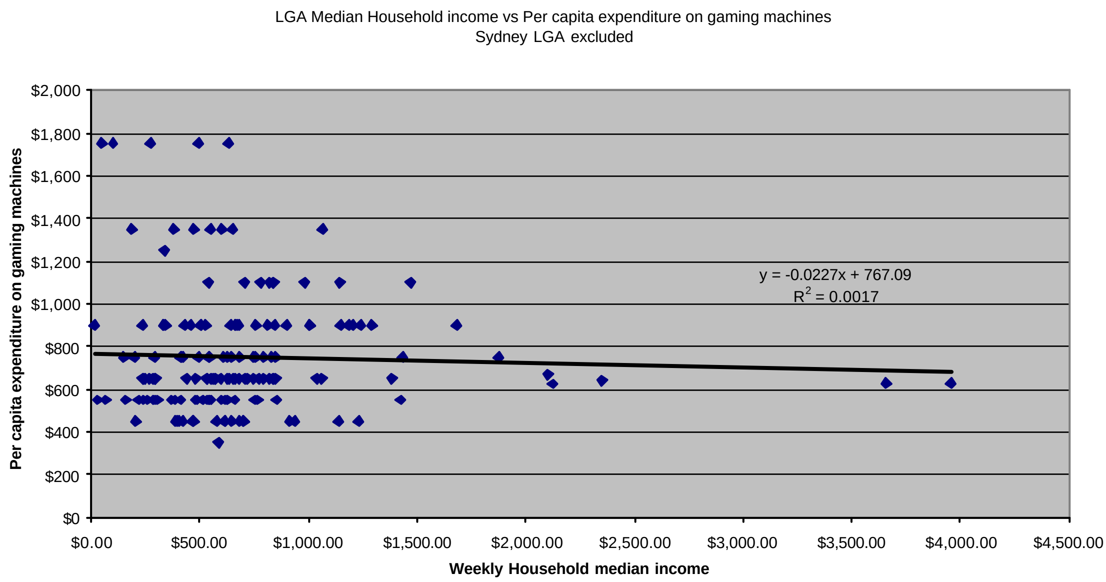
The case of the border towns is particularly interesting. From Map 4 of the report one would expect these towns to show the most marked increase in household income with increase in gambling, more than two times the average reported for NSW. In fact as gaming machine expenditure increases, median household income falls by $11.20 for every $1,000 increase in expenditure on gaming machines. R^2 is quite high being 0.29. In other words around 30% of the variation in household income in these areas can be attributed to variation in per Capita expenditure on Gaming Machines. One should have a high degree of confidence in this finding.

In summary when all data points are included the line of best fit shows an increase in household income with increase in Per Capita Expenditure on Gaming Machines. The effect however is so weak as to be non-existent. Most researchers would agree that with such a low correlation coefficient, the conclusion would be that there is no relationship at all.

The relationship is an outcome of one data point, the City of Sydney. The City of Sydney is qualitatively different to other LGA's because few of those employed there also live there. It seems reasonable to exclude this point. Once this is excluded the line of best fit shows a decrease in household income with increase in Per Capita Expenditure on Gaming Machines. Again the relationship is very weak. The relationship for the border towns is strong enough to encourage some confidence however the finding is seriously at odds with the findings of the National Economics' study.

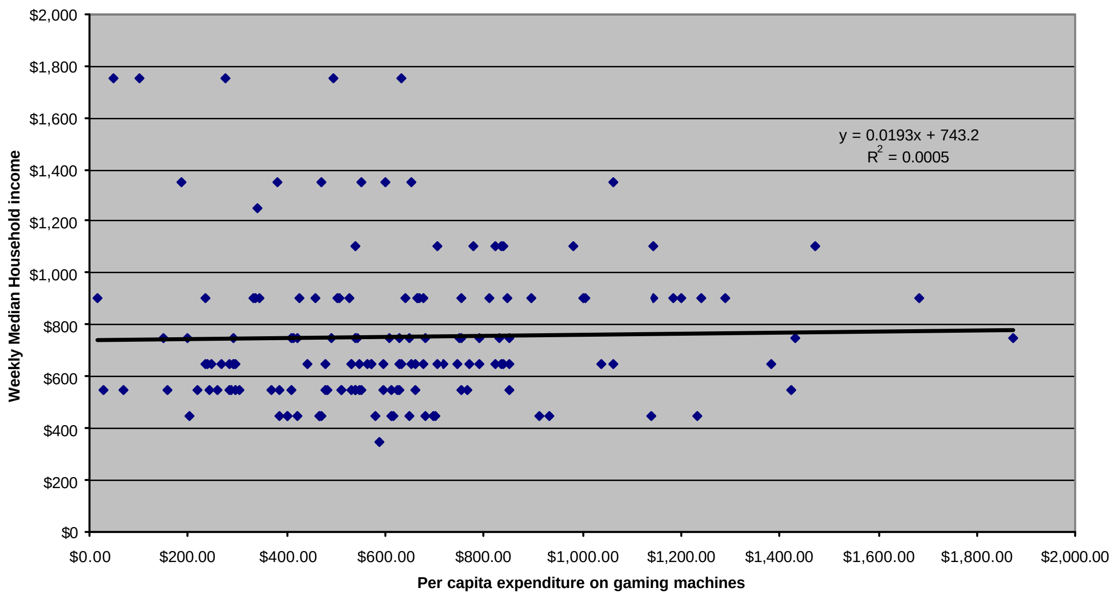
The analysis of the actual data from the state of NSW does not support the findings of National Economics' report and in fact supports the opposite conclusion i.e. that Median Household Income decreases with increased expenditure on gaming with the negative effect most marked in areas with a tourism based gaming industy. As the hypothesis put forward within the National Economics' report has been falsified the hypothesis should be rejected. Graphs of the various data sets are shown below.





LGA Median Household income vs Per capita expenditure on gaming machines
Sydney LGA excluded
Per capita expenditure on gaming machines
$2,000
$1,800
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
y = -0.0227x + 767.09
R2 = 0.0017
$0.00
$500.00
$1,000.00
$1,500.00
$2,000.00
$2,500.00
$3,000.00
$3,500.00
$4,000.00
$4,500.00
Weekly Household median income

LGA Median Household income vs Per capita expenditure on gaming machines
Sydney and Victorian Border LGA's excluded



Victorian border LGA's Median Household income vs Per capita expenditure on gaming machines