Independent Statistical Analysis of Nova Scotia Lottery Data

A report submitted to the

Nova Scotia Gaming Commission

by

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1. Introduction and Background.

On October 25, 2006, the CBC Television program *Fifth Estate* broadcast an episode about retail sellers in Ontario obtaining major lottery prizes that rightfully belonged to their customers. The program documented in detail the case of Bob Edmonds, apparently defrauded out of a $250,000 winning lottery ticket. It also presented statistical evidence (prepared by this report's author) that the Edmonds case was not an isolated incident, and that many other Ontario retail sellers had similarly defrauded customers out of major lottery prizes.

That program set off a storm of media coverage and controversy, and led to an Ontario ombudsman's investigation. It also raised questions about the possibility of retail sellers in other jurisdictions similarly defrauding customers out of major lottery prizes. (Indeed, corresponding data for British Columbia were obtained by media there, which led to an ombudsman's investigation in that province as well.)

Upon hearing of this issue, the Nova Scotia Gaming Commission (NSGC) asked us to investigate major retail seller lottery wins in Nova Scotia, and also the fairness of their Atlantic 49 winning draw numbers. Using data provided by the NSGC and the Atlantic Lottery Corporation (ALC), we issued an initial report on February 1, 2007, and a slightly revised report on March 1, 2007. Since then, the available data about insider wins has changed somewhat, apparently as a result of a review by KPMG Forensic Inc. So, we here present a revised report about major retail seller lottery wins in Nova Scotia, based upon the latest available data.

We consider herein the question of lottery wins by retail sellers of lottery tickets. We consider only major ($25,000 or more) lottery wins recorded in Nova Scotia during the period April 1, 2001 to November 1, 2006. The details of our investigation are presented below, and our findings are summarised in Section 7 on pages 18–19.

2. Total Retail Owner Major Lottery Wins.

We first consider wins by lottery retail owners, i.e. people listed as being the primary owner of a retail establishment that sells lottery tickets. (Stratification by business and game type is considered in Section 3, and other retail employees are considered in Section 4.)

Note: In the documents provided by NSGC and ALC, the word "retailer" is sometimes used to mean retail owners as above, but is sometimes used to mean all retail sellers (including owners, managers, and employees). To avoid confusion, in this document we always use "owner" to refer to owners as above, and "employee" to refer to all non-owner employees (including non-owner managers) of lottery retail selling locations. We use "seller" to include both owners and employees.

2.1. Number of Retail Owner Wins.

According to data provided by the NSGC and ALC, the total number of major ($25,000 or more) lottery wins in Nova Scotia in the period April 1, 2001 to November 1, 2006 is equal to $373 + 82 = 455$ (pooling the Draw games and the Scratch'n Win games together, for now).

According to the latest revised data (provided to me on June 1, 2007 by Steve MacDonald, Vice President, Corporate Development, NSGC), of these 455 major wins, a total of 29 (i.e., 6.4%) were by lottery retail owners. That figure is further broken down by business type: 25 from Independent Convenience stores, 2 from Petroleum (Gas) establishments, and 2 from Drug Stores.

Of these 29 major retail owner wins, 7 are from a single, specific Independent Convenience store (5 in 2001, plus 2 in 2002). The NSGC and ALC are already aware of, and investigating, this specific store. Hence, we shall *exclude* these 7 wins from the remainder of the analysis.

So, for the remainder of this analysis we consider only the remaining 448 major lottery wins during this period, of which 22 (4.9%) are recorded as being from retail owners.

Note: We were not provided with information about the *amounts* of the major prizes won, only that they were each at least $25,000. So, we do not consider amounts, just

the numbers of the major prizes.

2.2. Number of Retail Owners.

The NSGC and ALC have provided the total number of Nova Scotia retail owners at establishments which sell lottery tickets. The figures for the (fiscal) years 2000 through 2006 are 1010, 1010, 1015, 1002, 974, and 963, respectively. These figures do not change very much by year (though they do show a bit of decrease towards the end), and average to 996. (Note that the number of retail *locations* average to 1329, a somewhat higher figure, but this is because some owners own multiple locations.)

Now, these figures include everyone who was a retail owner for *any* part of the (fiscal) year in question. So, the number of retail owners at any one time (which is the relevant figure for determining how often we expect current owners to win) is somewhat less than this. Indeed, apparently 1262 people were retail owners at *some* point during the 22-month period from January 1, 2005 to November 2, 2006, indicating a turnover rate of about 300 owners replaced every 10 months. So, apparently the "instantaneous" owner count is more like 650 than 996. However, to avoid uncertainties, and to be maximally fair to the owners (when determining if their number of major lottery wins is excessive), we do not reduce the owner counts according to these turnover figures, but rather use the full fiscal year counts.

Thus, for the remainder of this analysis, we shall use the average figure of 996 owners of retail locations selling lottery tickets in Nova Scotia.

By comparison, the adult (19-plus) population of Nova Scotia may be computed as $908005 - 47455 - 55840 - 61725 - 12550 - 12530 - 12545 - 12155 = 693{,}205$, using data from the 2001 census which is available e.g. at:

$$\texttt{www.bcstats.gov.bc.ca/data/cen01/profiles/12000000.pdf}$$

Hence, retail owners comprise approximately 0.14% of the adult Nova Scotia population (although, as discussed above, they won 6.4% of the major lottery prizes, and 4.9% of those prizes under consideration).

2.3. Amount Spent on Lotteries by Retail Owners.

Another important factor is the amount that lottery retail sellers spend on lottery tickets, as compared to the general adult population. This is a tricky issue, and there

are only two previous related studies that we are aware of. The first is the survey conducted by the *Fifth Estate* for their October 2006 broadcast, which concluded that retail sellers spend about 1.5 times as much as does the general population on lotteries. The second is an OLG-sponsored survey conducted by Research Dimensions soon afterwards, which concluded that retail sellers spend nearly 1.9 times as much, fairly similar to the *Fifth Estate* figure.

To determine this factor more precisely, a study was conducted by Corporate Research Associates Inc. (CRA) in November 2006. This study concluded that lottery retail sellers overall spend about \$13.40 / \$8.79 = 1.5245 times, i.e. about 1.52 times, as much as the general population on lottery tickets. For retail owners alone, they obtain a factor of \$15.50 / \$8.79 = 1.763367, i.e. about 1.76. Restricting to Draw games, they obtained a factor of \$7.13 / \$4.20 = 1.6976, i.e. about 1.70, for sellers overall, and \$10.45 / \$4.20 = 2.488095, i.e. about 2.49, for owners alone. For Scratch'n Win, they obtained a factor of \$4.49 / \$3.62 = 1.2403, i.e. about 1.24, for sellers overall, and \$2.46 / \$3.62 = 0.679558, i.e. about 0.68, for owners alone.

Now, the CRA study is not without limitations. They surveyed just 402 sellers in total, across all of Atlantic Canada (which is broader than just Nova Scotia, our region of interest here). They did re-weighting of their survey results according to type of retail position (owner, manager, or employee), which is a necessary step but is always somewhat problematic. Their survey methodology included terminating the questions immediately if the respondent was a minor, which is reasonable since minors are not legally permitted to purchase lottery tickets, but which raises questions about how these minors were factored into the final conclusions. Also, the spending figures for the general population were taken from the CRA's October 2006 Market Pulse study. That study provided a self-reported figure, which is good for comparison with the self-reported retail seller spending figures. On the other hand, the general population weekly lottery spending figure found there (\$8.79) is somewhat lower than that found by simply dividing the province-wide average weekly 2006 Nova Scotia lottery spending by the total adult population (\$393,791,003 / 52 / 693,205 = \$10.92), and it is not clear which figure provides the most appropriate comparison.

Despite these limitations, the CRA study appears to be a fairly good and careful study of this issue. Furthermore, their estimate of the fraction by which lottery sellers

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outspend the general adult population on lottery tickets, 1.52, is quite consistent with previous studies as summarised above. Furthermore, the CRA study probes more deeply than the previous studies. Hence, overall we are comfortable with the CRA figures, and we use them for the remainder of this analysis (though we do also consider the robustness of our conclusions to modifications of these figures, in Subsection 2.6).

Note: Here and throughout, "the general adult population" always refers to the *entire* adult population, *including* those who never buy lottery tickets. (Alternatively, we could instead compare retail sellers to just the 74% of adults who do buy lottery tickets. But this factor of 74% would appear in both the numerator and the denominator of the following equations, so it would not affect the results at all.)

2.4. Expected Number of Retail Owner Major Wins.

Using all of the above figures (i.e., 996 Nova Scotia retail owners out of a total adult population of 693,205, who spend an average of 1.76 times as much on lottery tickets as the average adult), we would expect that of the 448 major lottery wins under consideration, the number that would be won by lottery retail owners would be about:

$$448 \times \frac{996 \times 1.76}{693205} = 1.132892 \,,$$

or just over one win.

2.5. Comparison of Actual Wins to Expected Number.

We see that lottery retail owners won 22 of the major prizes under consideration, although they would be expected to win just 1.132892 on average. Thus, they won over nineteen times as many prizes as expected. The probability of them winning 22 or more major prizes by pure luck alone can be computed using the "R" command:

$$\text{ppois}(21, 1.132892, \text{lower.tail=FALSE, log.p=FALSE})$$

This works out to 4.69×10^{-21}, or less than one chance in two hundred million trillion. This probability is *extremely* small, and is virtually impossible to arise by pure luck alone. We conclude: *Nova Scotia retail owners won over nineteen times as many of the major prizes as expected, and it is virtually impossible that this would occur by pure luck alone.*

Since the retail owners won 22 major prizes when they would be expected to win just over one, this suggests that they probably won about 20 major prizes that did not actually belong to them.

2.6. Robustness to Changes in Assumptions.

The above conclusion is that Nova Scotia lottery retail owners won major lottery prizes far more often than they reasonably could by pure luck alone. This conclusion uses the figure (taken from the CRA study) that on average, owners spend 1.76 times as much as the average Nova Scotia adult on lottery tickets. We now consider whether the conclusion changes if the assumption is modified to some extent.

In fact, it does not. For example, suppose the owners actually spend *three times* as much on lottery tickets as the CRA study estimated. We would then expect them to win about:

$$448 \times \frac{996 \times 1.76 \times 3}{693205} = 3.398675 \,,$$

or about 3.4 wins. In this case, the probability of them winning 22 or more major prizes by pure luck alone can be computed using the "R" command:

$$\text{ppois}(21, 3.398675, \text{lower.tail=FALSE}, \text{log.p=FALSE})$$

This works out to 1.7×10^{-11}, or about one chance in 59 billion. This probability is still *extremely* small, and still virtually impossible to occur by pure luck alone.

And even if they spent *seven times* as much as the CRA study estimated – much more than seems remotely possible – their expected number of major wins would then be:

$$448 \times \frac{996 \times 1.76 \times 7}{693205} = 7.93024 \,,$$

giving a probability of them winning 22 or more major prizes by pure luck alone computed by

$$\text{ppois}(21, 7.93024, \text{lower.tail=FALSE}, \text{log.p=FALSE})$$

which works out to 2.94×10^{-5}, or about one chance in 34,000, *still* extremely small.

In other words: *Our conclusion that retail owners have won more major lottery prizes than they could reasonably win by luck alone is quite robust, and remains true even if assumptions about their spending habits are significantly modified.* In short, this conclusion cannot be explained away.

3. Stratification by Business and Game Type.

The analysis in the previous section is for *all* retail owner wins, and for *all* lottery games, all pooled together. We now consider stratifying the wins by retail owner business type, and by lottery game type, to see if particular subgroups of the wins are themselves suspicious.

3.1. Independent Convenience Retail Owners.

Of the 29 major retail owner wins during this time period, Independent Convenience owners won 25 of them (86%). Even subtracting the 7 excluded wins, Independent Convenience owners still won 18 of the 22 relevant major owner prizes (82%), despite the fact that Independent Convenience owners make up only about 53% of all retail owners. This suggests that Independent Convenience owners are a major source of the excess wins. To clarify that, we now consider the Independent Convenience owners as a separate group.

The yearly figures for the number of Independent Convenience retail owners are 571, 560, 542, 513, 490, and 477. These figures are again relatively stable from year to year (though again with a slight downward trend), and average to 526. So, we use the figure of 526 Independent Convenience retail owners selling lottery tickets in Nova Scotia.

Using the figures mentioned previously, we would expect the number of major lottery wins by Independent Convenience retail owners on average to be about:

$$448 \times \frac{526 \times 1.76}{693205} = 0.5982941,$$

or about 0.6 of a win.

In fact, Independent Convenience retail owners won 18 of the major prizes under consideration. So, they won about thirty times as many prizes as expected. The probability of them winning 18 or more major prizes pure luck alone can be computed using the "R" command:

ppois(17, 0.5982941, lower.tail=FALSE, log.p=FALSE)

This works out to 8.55×10^{-21}, or less than one chance in one hundred million trillion. This probability is again *extremely* small, and virtually impossible to arise by pure luck alone. We conclude: *Nova Scotia Independent Convenience retail owners won*

about thirty times as many major prizes as expected, and it is virtually impossible that this would occur by pure luck alone.

Since the Independent Convenience retail owners won 18 major prizes when they would be expected to win less than one, this suggests that they probably won about 17 major prizes that did not actually belong to them.

Note: As of this writing, the Ontario Lottery and Gaming Commission (OLG) has unfortunately not similarly broken down their own (Ontario) major retail seller lottery wins by detailed business type. It seems likely that in Ontario as well, Independent Convenience sellers probably make up the majority of major seller wins.

3.2. Other Business Type Owners.

We now consider other retail owners, of all business types *besides* Independent Convenience.

The number of such owners is about $996 - 526 = 470$. Thus, similar to the above, the number of major lottery wins that we would expect them to win during the time period under consideration is about:

$$448 \times \frac{470 \times 1.76}{693205} = 0.5345974,$$

again less than one win.

The number of major lottery wins that they are actually recorded as winning during this time period is $29 - 25 = 4$, which is about 7.5 as many as expected.

The probability of them winning 4 or more major prizes pure luck alone can be computed using the "R" command:

ppois(3, 0.5345974, lower.tail=FALSE, log.p=FALSE)

This works out to 0.002227738, or about 0.22%, or about one chance in 450. This probability is still considerably less than the usual 5% (or even 2.5%) cutoff. We conclude: *Nova Scotia lottery retail owners from business types OTHER than Independent Convenience only won 4 major prizes, but this is still significantly more than we would expect them to by pure luck alone, and the statistical evidence suggests that probably a few of these prizes did not actually belong to them.*

3.3. Draw Versus Scratch'n Win.

The above analysis shows that the largest number of excess major lottery wins by retail owners is from the Independent Convenience business type. We now consider stratifying these major wins into the two main lottery game types, Draw games and Scratch'n Win (Instant) games.

The 455 total major lottery wins for the time period under consideration consist of 373 wins from Draw games, plus 82 wins from Scratch'n Win games. The 7 excluded wins are all Draw games, leaving 366 Draw and 82 Scratch'n Win wins under consideration. Also, of the 18 major wins by Independent Convenience retail owners, 15 of them are for Draw games. The question then becomes, if we look at the Draw and the Scratch'n Win games separately, in which case(s) are the number of Independent Convenience retail owner wins still suspiciously large?

For the Draw games, using the CRA figure that owners spend about 2.49 times as much as the average adult on Draw lottery tickets, we would expect the number of major Draw wins by Independent Convenience retail owners to be about:

$$366 \times \frac{526 \times 2.49}{693205} \; = \; 0.6915196 \,,$$

which is less than one. The actual number of such wins is 15, which is over 21 times as much as expected. The probability of Independent Convenience owners winning 15 or more major Draw prizes by pure luck alone is given by the "R" command:

$$\text{ppois(14, 0.6915196, lower.tail=FALSE, log.p=FALSE)}$$

This works out to 1.58×10^{-15}, or about one chance in six hundred trillion. This probability is again *extremely* small, and virtually impossible to arise by pure luck alone. We conclude: *Nova Scotia Independent Convenience retail owners won over 21 times as many Draw major prizes as expected, and it is virtually impossible that this can be explained by pure luck alone.*

For the Scratch'n Win games, using the CRA figure that owners spend about 0.68 times as much as the average adult on Scratch'n Win lottery tickets, we would expect the number of major Scratch'n Win wins by Independent Convenience retail owners to be about:

$$82 \times \frac{526 \times 0.68}{693205} \; = \; 0.04231037 \,,$$

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which is quite close to zero. The actual number of such wins is 3. Is this suspicious? Well, the probability of Independent Convenience owners winning 3 or more major prizes by pure luck alone is given by the "R" command:

$$\text{ppois}(2, 0.04231037, \text{lower.tail=FALSE, log.p=FALSE})$$

This works out to 1.22×10^{-5}, or about one chance in 82,000, again very small. So, even the three Scratch'n Win major wins by Independent Convenience retail owners are suspicious. If we instead assume that retail owners buy Scratch'n Win tickets at the same rate as the general population (rather than 0.68 times as much), then their expected number of wins would increase to 0.06222113, and their probability of winning 3 or more by pure luck would increase to 3.83×10^{-5} or about one chance in 26,000, still far too low to be explained by pure luck alone.

We conclude from this: *The 18 Nova Scotia Independent Convenience retail owner Draw major wins are highly suspicious, and the three Scratch'n Win major wins are also suspicious; they are each very unlikely to have arisen by pure chance alone.*

4. Retail Employee Major Lottery Wins.

We next turn to the issue of major lottery wins by retail employees, i.e. by lottery ticket sellers *other* than owners. According to the latest revised data provided by the NSGC and ALC, there were only 5 recorded major lottery wins by non-owner retail employees during the period under consideration (four from Independent Convenience employees, and one from a Petroleum (Gas) establishment). We now analyse whether or not that figure is suspicious.

4.1. Number of Relevant Retail Employees.

Determining the total number of relevant retail employees is somewhat problematic. It requires knowing the number of lottery retail locations, and also the average (mean) number of retail employees per location.

The NSGC and ALC have provided the number of Nova Scotia retail locations which sell lottery tickets, with figures for the (fiscal) years 2000 through 2006 of 1308, 1338, 1355, 1339, 1321, and 1312, respectively. These figures do not change very much by year, and average to 1329. So, we use the figure of 1329 total retail locations selling lottery tickets in Nova Scotia. (As mentioned earlier, the number of retail

locations is somewhat higher than the number of retail owners, since some owners own multiple locations.)

The November 2006 CRA survey concluded that the mean number of people working at lottery retail locations was 10.0, with a rather high standard deviation (i.e., statistical uncertainty) of 14.8. Unfortunately, we have not been provided with a store-by-store breakdown of their numbers. However, Table A5 of the Appendix of the CRA report indicates that of their 402 surveyed locations, 17% had 1–3 staff, 40% had 4–6 staff, 26% had 7–12 staff, and 15% had 13 or more staff (with 2% unknown). For these numbers to result in the stated mean, it must be that the small number (15%) of large retail locations had *very* large numbers of staff, averaging approximately 40 staff each. In other words, the distribution of number of staff at retail locations has a very heavy right tail, with most locations having relatively few staff, and a small number having an extremely large number of staff. (We return to this point below.)

Now, the above-mentioned Table A5 indicates that the staff counts in the CRA study included the location's owner (in addition to managers and others employees). Thus, to estimate the number of non-owner employees, we subtract one from the mean number (10.0), to obtain a mean of approximately 9.0 non-owner employees per retail location. (Note: the CRA survey also determined that the *median* number of staff per location is 6.0, but to determine the total number of staff it is important to multiply by the mean, not the median.)

Multiplying the total number of retail locations (1329) by the estimated mean number of non-owner employees per location (9.0) gives 11,961 total retail employees, i.e. just under 12,000, or about 1.7% of the total adult population. This is the figure we use below.

4.2. Expected Number of Retail Employee Major Wins.

As discussed earlier, the CRA study estimated that retail sellers overall (including owners and non-owner employees together) spend an average of 1.52 times as much as the general adult population on lottery tickets, while owners alone spend 1.76 times as much. With a mean of ten total staff per location, made up of one owner plus nine non-owner employees, this implies that the non-owner employees must spend about

$(1.52 - 0.1 \times 1.76)\,/\,0.9 = 1.49$ as much as the general adult population on average. That is the figure we use.

Using the above figures, we would expect that of the 448 major lottery wins under consideration, the number that would be won by non-owner lottery retail employees would be about:

$$448 \, \times \, \frac{11961 \times 1.49}{693205} \; = \; 11.51781 \, ,$$

i.e. between 11 and 12.

4.3. Comparison of Actual Versus Expected Numbers.

As discussed above, lottery retail employees overall won just 5 the major prizes under consideration, although they would be expected to win over 11 on average. Thus, they won considerably *fewer* major prizes than expected. Indeed, the probability of them winning 5 or fewer major prizes by pure luck alone can be computed using the "R" command:

$$\text{ppois(5, 11.51781, lower.tail=TRUE, log.p=FALSE)}$$

This works out to 0.02742506, i.e. about 2.7%, or about one chance in 36. This probability is small enough to be at least *somewhat* suspicious. We conclude: *Nova Scotia lottery retail non-owner employees were recorded as winning somewhat FEWER of the major lottery prizes than expected, and this probably cannot be explained by pure luck alone.*

Now, it is not immediately clear how to interpret a finding of too *few* employee lottery wins. Perhaps it simply means the employees have been extremely unlucky, or that they actually spend far less on lottery tickets than the various studies have indicated. However, these explanations are quite unlikely. It is far more probable that the majority of major employee wins are going undetected. This leads to the issue of *undercounting* retail employee wins, which is considered further in Subsection 5.3.

4.4. Independent Convenience Employees.

Of the 5 non-owner retail employee major wins, 4 are from Independent Convenience employees. Since Independent Convenience owners won a disproportionally large number of major wins, it seems appropriate to investigate Independent Convenience employees as well.

The yearly figures for Independent Convenience retail locations are 594, 590, 567, 538, 515, and 501. These figures are again relatively stable from year to year, and average to 551, so we use the figure of 551 Independent Convenience stores selling lottery tickets in Nova Scotia.

We also need an estimate of the number of retail employees who work at the 551 Independent Convenience stores. Due to the skewed distribution of the number of staff per location (as discussed above), and the presumption that Independent Convenience stores are *not* among the largest business types, it is not appropriate to simply use the overall mean of 10.0 staff per location. Unfortunately, the CRA survey does not break down the number of staff per location according to business type. So, to deal with this issue, we instead use a corresponding Ontario figure released by the OLG in October 2006 (apparently after consultation with the Ontario Convenience Stores Association), which indicates an average of 4 lottery-selling staff per Independent Convenience store.

As above, since we are excluding owners, we must subtract one from the mean number of staff, to obtain a mean of $4 - 1 = 3$ non-owner employees per Independent Convenience location. Using this figure gives a total of $3 \times 551 = 1653$ non-owner employees who work for Independent Convenience stores in Nova Scotia.

Using these figures, we would expect that the number of major lottery wins that would be won by non-owner employees of Independent Convenience stores would be about:

$$448 \times \frac{1653 \times 1.49}{693205} = 1.591752,$$

or about 1.6.

The actual number of such wins is 4, which is 2.5 times as much as the expected number. The probability of 4 or more wins arising by pure chance alone is given by the "R" command:

```
ppois(3, 1.591752, lower.tail=FALSE, log.p=FALSE)
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This works out to 0.07768079, or about 7.8%, i.e. about one chance in 13. That probability is high enough that it provides no clear evidence of suspicious winnings, i.e. it is possible that the 4 recorded wins did arise by pure chance alone. Thus, on the basis of the available data, there is no evidence that Independent Convenience

non-owner employees are receiving particularly too many or too few major lottery wins. However, again the issue of *undercounting* is relevant; see Subsection 5.3.

5. Possible Underestimation.

We note that all of the above analysis may in fact *underestimate* the true extent of excess retail seller wins in several ways.

In each case, there may well be additional unidentified excess lottery seller wins, so the problem may be larger than that reported here.

5.1. Minor Wins.

The analysis herein considers only *major* wins, of $25,000 or more, which are the only wins for which data has been provided.

This is a reasonable restriction, since major wins are the most important.

However, it seems plausible that lottery sellers may also be claiming excess wins for small prizes. Indeed, that may be easier since customers may be less aware of their entitlement to smaller prizes, and lottery companies are less likely to investigate these prizes.

So, to truly determine the total scope of excessive lottery seller wins, it would be necessary to also consider minor wins, i.e. wins of less than $25,000.

5.2. Unidentified Owner Wins.

This analysis only considers the 29 *identified* retail owner wins.

Now, the ALC apparently has a complete list of lottery retail owners. Hence, presumably all owners who claim major wins under their own name will be identified as owners. Their win will thus be counted as an owner win, and they may also perhaps be subject to investigation in an effort to avoid fraudulent claims.

However, there may also be cases where retail owners choose to get friends or relatives to claim major prizes on their behalf, to be divided up later. It appears to be virtually impossible to detect such cases.

This suggests that there may well be additional owner major lottery wins that have gone undetected, simply because they were claimed by others on the owner's behalf.

5.3. Unidentified Employee Wins.

By far the biggest undercounting concern comes from unidentified non-owner employee wins.

Of course, employees, like owners, may be able to avoid detection by getting friends or relatives to claim their major prizes on their behalf.

But in addition, it is our understanding that the ALC does *not* currently maintain a list of lottery retail employees. This means that employees can easily avoid detection simply by choosing not to identify themselves as retail employees when claiming their major prizes. In the absence of a list of employees, there appears to be no way to detect such actions.

This suggests that the undercounting of non-owner employee major wins may be far more serious than the undercounting of owner major wins.

Furthermore, there is considerable empirical evidence for that.

Indeed, as discussed above, the owners have won suspiciously many major wins, suggesting that many of their prizes did not actually belong to them, but also indicating that owners are normally detected when claiming major lottery prizes.

By contrast, the employees have actually won suspiciously *few* major wins. This indicates that, whether or not the prizes they were obtaining actually belonged to them, employees frequently – in fact, usually – escaped detection when claiming such prizes.

We conclude: *There is evidence that many of the employee major lottery wins are going undetected, and that the stated total number of employee major wins does not accurately reflect the true total.*

6. Recommendations.

The above analysis indicates that there have indeed been significant excess major lottery wins by lottery sellers – primarily by owners of Independent Convenience retail stores. This suggests that a number of those wins were obtained illegitimately, perhaps through acquiring winning tickets which rightfully belonged to other customers. This raises the question of how to prevent such misappropriation of prizes in the future.

We are not expert at retail fraud issues, so appropriate experts should be consulted about possible corrective measures. However, based on our own knowledge and perspective, we do recommend that various steps be taken if possible (if they are not already in place), including the following:

- Provide self-checking machines, to allow customers to quickly and easily check their own tickets themselves before redeeming them.

- Require customers to sign the backs of their tickets *before* redeeming them, to prevent sellers from claiming the tickets as their own.

- Ensure that all lottery redemption machines clearly indicate to the customer – both visually and orally – the worth of each redeemed ticket, to prevent customer confusion.

- Maintain a list of all employees who work at retail locations that sell lottery tickets, to more accurately identify major seller lottery wins when they occur. (Such a list could be gathered from e.g. the payroll files of the retail locations.)

- Carefully investigate all major seller lottery wins before paying prizes, to ensure that the winning ticket was indeed purchased by the seller as claimed. (Where possible, this could be done by examining the retail store's security video footage at the time of the ticket sale, to ensure that no other customer was present and purchasing the ticket at that precise time.)

Note that we do *not* recommend banning all retail sellers from purchasing lottery tickets. That solution certainly has some appeal. However, it would reduce the lottery customer base, and would also punish the many for the sins of the few. Furthermore, it might well be ineffective, since it would simply encourage retail sellers to have others claim their prizes for them to avoid detection. So, we are not convinced that such a ban is warranted, though we defer to experts in retail fraud on this point.

7. Summary of Findings.

What follows is a summary of the principal findings of the statistical analysis of retail seller major ($25,000 or more) lottery wins in Nova Scotia, presented by Professor Jeffrey S. Rosenthal to the Nova Scotia Gaming Commission (NSGC) on May 17, 2008.

- Of the 455 major lottery prizes awarded in Nova Scotia during the period 2001 to 2006, a total of 29 (6.4%) are recorded as being by lottery retail store owners, and a further 5 (1.1%) are recorded as being by non-owner lottery retail store employees.

- Seven of the major retail owner wins are from a single Independent Convenience store owner and are already under investigation, so they were excluded from our analysis. This leaves 448 major retail owner wins to be considered, of which 22 (4.9%) are recorded as being by lottery retail store owners.

- There are approximately 1,000 retail owners in Nova Scotia, or 0.14% of the total adult population. We would expect them to win, on average, just over one major lottery prize during this time period. The 22 major wins that they actually won are over nineteen times as many as expected. The probability of this arising by pure luck alone is less than one chance in two hundred million trillion, i.e. virtually inconceivable (and this conclusion is quite robust to modifications of the assumptions). This evidence strongly indicates that retail owners have managed to receive a number of major lottery prizes – probably about 20 – which did not actually belong to them.

- Of the 22 major retail owner wins under consideration, 18 of them (82%) are from Independent Convenience store owners (even though Independent Convenience store owners represent just 53% of all owners). This is about 30 times as many as expected, and the probability of it arising by pure luck alone is again virtually inconceivable. This indicates that the excessive owner win problem arises mostly from Independent Convenience owners.

- The remaining 4 major owner wins are from other business types besides Independent Convenience stores (2 Petroleum and 2 Drug Store). This number

is fairly small, but still has just a 0.22% chance of arising by pure luck alone. This indicates that while the excessive owner win problem arises *mostly* from Independent Convenience stores, it is probably not *entirely* restricted to that one business type.

- Of the 18 major Independent Convenience retail owner wins, 15 were for Draw games, as opposed to Scratch'n Win (Instant) games. This is over 21 times as many as expected, and indicates that the excessive owner win problem arises primarily from the Draw games. The remaining three major Independent Convenience retail owner wins were for Scratch'n Win games, and even this figure cannot be explained by pure chance alone.

- There are approximately 12,000 non-owner employees in Nova Scotia (i.e., people who work at retail outlets which sell lottery tickets, but do not own them), or about 1.7% of the total adult population. On average, they would be expected to win about 11 or 12 major lottery prizes during the period under consideration. In fact, only 5 major wins were recorded for this group. That figure is suspiciously *low*, which provides some evidence that major wins by non-owner employees (whether legitimate or not) may be going undetected. Hence, more careful monitoring of such wins is required, in order to determine whether or not they are excessive.

- The problem of excess retail seller lottery wins may in fact be *larger* than that reported here, due to smaller prizes (under $25,000) which were not considered here, and also due to major wins by retail employees (and perhaps also owners) which escaped detection.

- To prevent misappropriation of lottery prizes in the future, we recommend that various corrective steps be taken if possible, including: providing machines for customers to check their own tickets, requiring customers to sign tickets before redeeming them, ensuring that all retail redemption machines clearly indicate to the customer (both visually and orally) the amount won, maintaining lists of lottery retail store employees, and carefully investigating major retail seller lottery wins before paying prizes.