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The Distribution of Lottery Prizes across Countries

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Abstract

It has been 15 years since Cook and Clotfelter described the scale economies associated with state-run lotto games in an American Economic Review article entitled "The Peculiar Scale Economies of Lotto." U.S. states with larger populations are identified as having the ability to offer games with larger jackpots to attract higher sales per capita. The current paper extends this analysis to all current U.S. state and multi-state lotto-style lottery games as well as to a sample of international lotto games for comparative purposes. The development of the two major U.S. multi-state games over time is also examined to illustrate that changes in the structure of those games can be explained by an application of the scale economies concept offered by Cook and Clotfelter.

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1. Introduction

"Lotto" is among the most popular games offered by government-sponsored lottery associations, accounting for roughly one-quarter of total sales for state-run U.S. lotteries in the late 1990s and early 2000s and significant revenues for most foreign lottery associations as well. As of July 2008, 42 states had lotteries, and every state association offered some version of a lotto game either through their own game or through a multi-state association such as the thirty-one member Multi-State Lottery Association (Powerball) or the twelve-state Mega Millions association. State-sponsored lottery games are also played in every Canadian province, an overwhelming majority of European countries, and many other countries throughout Asia, Africa, Latin America, and Oceania. As is the case in the United States, most countries that have lottery associations also offer a version of Lotto in their product mix.

Lotto games generally consist of an individual picking a set of five or six numbers from a group of approximately 35-55 choices. Winning numbers are then randomly selected at a weekly or bi-weekly drawing. A player whose ticket matches all of the winning numbers wins the jackpot prize while players matching some, but not all, of the winning numbers win smaller consolation prizes. In part, lotto derives its popularity from the large jackpot prizes that can be won in this game. While other lottery games such as instant tickets, numbers, or keno might offer top prizes ranging from $100 to $100,000, lotto games typically advertise jackpot prizes starting at $1 million or higher.

The jackpot prize is funded by allocating a percentage of ticket sales to the jackpot prize pool. If no ticket matches the winning numbers, the money in the pool is carried over into the next drawing and is added to the allocated funds from ticket sales in the next period. Because the jackpot prize pool is allowed to roll-over in this manner, the grand prize can become quite large if no one hits the jackpot in a large number of successive periods. Indeed, advertised jackpots exceeding $50 million are quite common in lottery games in the United States and throughout the world, and occasionally lotto jackpots have been known to exceed $250 million.

It is this “roll-over” component of lotto that sets it apart from other games, and indeed is the factor that is used in this paper to differentiate between lotto games and other games of chance. Since the amount of money that is carried over into the jackpot prize pool varies from drawing to drawing, lotto is one of the few games of chance where the expected return varies significantly across time periods, and this factor has led lotto games to be widely studied in the academic literature on player behaviour.

It is important to note that many lottery associations offer similar games without a roll-over component. This includes games identified as lotto that do not have a roll-over jackpot as well as “roll-down” lotto games. In the roll-down games, if no one wins the jackpot prize, the funds allocated to the jackpot pool are applied to the amounts won by the lower-tier prizes instead of the money carrying over into the jackpot prize pool in the next drawing. Roll-down games offer the same expected return to players in every drawing so they do not elicit the same degree of interest from economists. Several lotto games are roll-over games until a certain jackpot is reached or until a certain number of roll-overs have occurred, at which point the next drawing is a roll-down game, effectively limiting the maximum size of the jackpot.

When offering a lotto game, the product’s sellers face multiple choices regarding the design of the game. Among the major issues to be addressed include: 1. the odds of winning the jackpot; 2. the odds of winning lower tier prizes; 3. the amount of the ticket price awarded to prizes versus the vigorish (that is, the profit collected by the game's sponsor); 4. the distribution of the prize pool among the jackpot prize and the lower tier prizes. This paper focuses on issue 1 and examines this concept among and between U.S. and foreign lotto games.

Cook and Clotfelter (1993) define the scale economies of lotto as "a strong tendency for per capita lotto sales to increase with the size of the population base." The primary source of these economies is identified as the ability of more populous states to fund larger jackpot pools with worse odds of winning . More populous states can advertise larger jackpots with lower odds of winning and have jackpots won with approximately the same frequency as smaller state lotto games because they can appeal to a larger consumer base. If the frequency and the size of jackpot prizes won are relatively more important to lottery ticket purchasers than the odds of winning a prize, then these scale economies can benefit larger states in terms of attracting more sales dollars, resulting in higher sales per capita. While this type of behaviour by consumers is not necessarily rational, the argument is made that expected returns from the purchase of a lottery ticket are not easily quantifiable from draw to draw while the advertised jackpot is readily observable, as is the frequency with which the jackpot is won.

Research by other economists has also confirmed the presence of scale economies in lotto games. Thiel (1991) finds that decreasing the probability of winning can have a positive impact on lottery sales using data on the Washington Lotto game. Garrett and Sobel (2004) find that lottery sales are influenced by both the jackpot prize as well as the probability of winning the top prize, but not by the overall expected value of lower prizes.

Other economists, including Walker and Young (2001), Garrett and Sobel (1999), and Forrest, et al. (2002) indirectly support the presence of scale economies by determining that lottery participants are attracted to games with greater skewness rather than higher overall expected returns. Quiggin (1991) confirms this result by finding that lottery players prefer games with high jackpot prizes in addition to smaller prizes.

This paper extends the analysis on the scale economies of lotto in two ways. In the original paper, Cook and Clotfelter look for evidence of scale economies in U.S. state lotto games by multiplying the probability of winning the jackpot of a state game by the population of that state. If states tend to offer lotto games with odds of winning that are not dependent on population, then this calculated ratio should be higher for more populous states, ceteris paribus. However, if states construct their lotto games to take advantage of consumer preferences for larger jackpots, then the ratio should be relatively more constant across states, regardless of population. While Cook and Clotfelter calculate this ratio for 13 state games and one multi-state lotto game, the current paper will consider and analyze state lotto games as they are currently offered in 35 U.S. states (and D.C.), as well as the multi-state U.S. games and a sample of lotto games offered globally. This will be discussed and analyzed more formally in section two of this paper.

One of the implications of the scale economies of lotto is that when populations change, the operators of a lotto game should adjust the game structure, and more specifically the probability of winning the jackpot, to increase sales per capita. While populations have grown over the past three decades since lotto games were first offered in the U.S., adjustments in games on an annual basis to reflect this growth in population have not occurred. From an economic standpoint, this is likely because any potential gains to per capita sales would potentially be offset by the added costs of changing the game's structure. However, multi-state games can increase their population base much more rapidly than a single state game by adding new states as members. As with population growth among current member states, the addition of a smaller state as a new member of a lotto game may not require a change in the probability of winning the jackpot, again because costs of changing the structure would outweigh the potential gains from higher sales. However, the addition of a larger state that represents substantially higher sales of tickets may require a change in the structure of the game. If the odds of winning the jackpot remained the same, the result would be a lotto game that has more frequent winners, ultimately becoming a game of lower advertised jackpots being won too frequently to take advantage of the larger number of participants. The dynamics of when the two U.S. multi-state games have elected to change their odds of winning are examined more formally in section three of this paper.

II. The Presence of Scale Economies in Lotto Games

The first comparative analysis of scale economies offered by Cook and Clotfelter is a calculation of the population times the probability of winning for states that offer lotto games. This calculation will be referred to as the population to odds ratio. If larger states desire to offer higher jackpots at lower odds in order to increase sales, then this ratio should be relatively constant across states and there should be relatively high variability among the types of games being offered. There should also be a strong negative correlation between the probability of winning the jackpot and the population of a state. Cook and Clotfelter include states offering lotto games in 1990 and the population to odds ratios for those states. Lotto games offered by states that are also members of Lotto America, the primary multi-state game offered at the time, are excluded. For the state games that are considered (including the Tri-State game which is multi-state), there is some variability in the types of games offered and odds of winning; however, as will be noted later, that variability is relatively small compared to current game structures. Summary statistics on 1/p (odds of winning), population, and the ratio of population to odds of winning for all games considered in this section are provided in Table 1.

Tables 2, 3 and 4 provide game structure and population information on U.S. states that currently offer lotto games. Three separate tables of information are offered to distinguish among primary, secondary and tertiary lotto games. Primary games are those lotto games that offer the largest jackpots (defined by higher minimum advertised jackpot and lower probability of winning the jackpot) for a representative state. Since all states that offer lotto games, with the exception of Florida, are also members of either the multi-state Powerball or Mega Millions game, the multi-state games are considered the primary lotto game for most states, and will typically have the highest advertised jackpots in those states. Secondary lotto games with lower minimum jackpots are also offered in individual states as well as through multi-state coalitions, particularly the MUSL (Multi-State Lottery Association), which offers the Powerball game. In addition to Powerball, the MUSL also offers Hot Lotto and Wild Card 2 lotto games with lower minimum jackpots and better odds of winning that are available in a subset of states that belong to the MUSL..[1] Tertiary games are lotto games that are offered in addition to a secondary game that have jackpots with even lower minimum prizes. These are typically offered either in larger states or in smaller states that are also members of Hot Lotto. All of the tertiary games have better odds of winning than the respective higher-jackpot secondary game and typically they have a “choose 5” format.

It is necessary to divide games in this manner in order to properly identify scale economies according to odds of winning and population, if they indeed exist. If all games are analyzed simultaneously, then the population to odds of winning ratio will obviously be significantly higher for the lower tier lotto games relative to larger games offered in the same state. Determining if states attempt to take advantage of scale economies in this way would be problematic.

A direct comparison of games and structures offered by U.S. states to those considered in Cook and Clotfelter is difficult. There is only one independent state game today. All others belong to multi-state coalitions, and Cook and Clotfelter deliberately do not include the multi-state game in their analysis, nor do they include any states that belong to Lotto America. This same analysis would not be possible today unless only Florida’s lotto game is to be used for comparison. Thus, while Cook and Clotfelter come to the conclusion that states will tend to take advantage of scale economies by offering odds of winning so that their population to odds ratio is close to one, this is not necessarily going to be the result for all current U.S. game structures.

Such an outcome is apparent, however, in the primary U.S. game structures. The three primary lotto games are represented by populations that are significantly higher on

[1] For a list of states that also offer multi-state lotto games, see information provided at the bottom of Tables 2, 3, and 4.

average than those described in Cook and Clotfelter. Each of the primary games takes advantage of its somewhat higher population by offering a game structure with a lower probability of winning, providing population to odds ratios that are even lower on average than those in Cook and Clotfelter. This is a clear demonstration of how a game represented by a more populous constituency can take advantage of its higher population with its choice of game structure. In fact, Cook and Clotfelter explain that one way states can offer higher advertised jackpots without substantially increasing the time between jackpot wins is to combine with other states in offering lotto games with lower probabilities of winning. This has obviously occurred since the Cook and Clotfelter paper and is apparent both in the observation that only one state remains independent of the multi-state games as well is in the timeline of multi-state game development, which will be represented in section 3 of this paper.

In comparing the secondary games to those analyzed by Cook and Clotfelter, it is apparent that they tend to offer similar, if somewhat lower odds on average, but the variability among game structures is much greater with almost 60% more variability in the probability of winning (measured by standard deviation) than those games examined by Cook and Clotfelter. In fact, the range of odds of winning in the Cook and Clotfelter games is from 1/974,000 to 1/12,914,000 while the current range for odds of winning among the secondary games is 1/325,000 in Rhode Island to 1/41,416,000 in California. States certainly appear to offer a wider variety of lotto games today and, by considering the population to odds ratio, it becomes apparent that population is at least one factor in this determination. In 1990, there was a correlation coefficient of 0.91 between the population of a state and the corresponding probability of winning the jackpot in its lotto game. The correlation coefficient for the same two variables under the secondary state lotto structures is 0.87. Both provide strong evidence that population is an important factor in determining odds of winning.

One significant difference between the state games studied in 1990 and the secondary state games in the current analysis is the population to odds of winning ratio. This ratio is approximately 125% higher on average for current secondary lotto structures than it was in 1990 and requires explanation since a higher ratio is one indication that states are not offering odds proportionate to their populations. A first explanation is that the lotto games of two states in the sample are dramatically skewing the average results. Looking at Table 3, where states are sorted by population to odds of winning, it is apparent that Georgia and North Carolina have significantly higher ratios than the other states. Until 2006, Georgia offered its state lotto game in combination with the Big South lotto, a multi-state game offered by Georgia, Virginia and Kentucky. The Big South lotto was replaced by these states with Win for Life, which has the structure of a lotto game, but offers a $1,000 a week for life to the winner rather than a roll-over jackpot. Since this is not a roll-over style lotto game it is not included in this analysis, so the Georgia Fantasy 5 game is considered a secondary lotto game, rather than tertiary, as it would have been classified prior to 2006.   While an explanation can be offered for the Georgia game, North Carolina is an outlier. Given the population of North Carolina of over 9 million residents, it has the ability to offer a game with worse odds of winning the jackpot while maintaining relatively frequent jackpot wins. Without Georgia and North Carolina in the mix, the population to odds ratio would be 1.23 on average as opposed to 2.29.

The tertiary lotto games have summary statistics that are very different from the first two groups of games. The odds of winning these games are 10 times better on average than those of the secondary lotto games, making the population to odds ratio approximately 5.5 times higher on average. As mentioned previously, most of the tertiary games have a choose 5 of N structure and a third of these games have a 5/39 structure, regardless of population. This is apparently not an attempt to take advantage of scale economies to increase per capita sales so another explanation must be offered. Matheson and Grote (2007) analyze this very issue and find that larger states, like California and Texas, that offer lotto games more similar to the odds of winning the multi-state game do not tend to benefit from additional sales as much as smaller state lotto games with substantially better odds of winning. If consumers of lotto products prefer more variety in their choices of products, then offering lotto games with substantially better odds of winning, albeit with lower jackpots, is one way to stimulate further sales of lottery products. Rather than attempting to increase per capita sales by taking advantage of scale economies in all of their lotto games, the tertiary games in particular can be better explained through a "love for variety."

These differing results among primary, secondary and tertiary U.S. games can be further substantiated by considering the correlation coefficients of population for each state/region relative to both odds of winning and the population to odds ratio in Table 1. For both the primary and secondary states, there is a strong correlation between population and the odds of winning indicating that larger states typically have worse odds of winning for their lotto jackpots. There is very weak correlation between population and the population to odds ratio, indicating that the odds of winning tend to be adjusted according to population differences. In fact, this correlation is very close to zero for the secondary state games. For the tertiary U.S. lotto games, the results are exactly the opposite. Based on the 0.91 correlation coefficient between population and the population to odds ratio for this group, it appears that the lotto games serving greater populations in this group do not tend to have substantially different odds of winning than their smaller counterparts. This indicates that game structures are selected based on some factor other than population, such as added variety of games.

While the structure of primary and secondary U.S. lotto games appears to fit sufficiently with the concept of states taking advantage of scale economies, the statistical evidence for lotto games offered outside of the U.S. is mixed. As a starting point for the consideration of lotto games offered globally, Garrett (2001) provides a thorough comparison and analysis of lottery games offered around the world. Based on data provided by the 1998 La Fleur's World Lottery Almanac, 89 countries are identified as offering lottery games in 1997 and of those, 53 offer lotto.[2] According to Garrett's study, one important reason for only 53 of these 89 countries (just under 60%) offering lotto is the tendency for low income countries to not have lotto games. In fact, only 40% of the low income countries (defined as having per capita GDP of below $1200) that had lottery games in 1997 also offered lotto according to Garrett. The infrastructure required to offer games with periodic drawings is somewhat more complex than that required to sell instant win tickets. Furthermore, in poor countries, even the relatively low prizes awarded by instant win games can represent "life changing" amounts while significantly greater prizes are required for the same effect in richer nations.

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[2] The lottery games offered by seven countries are eliminated from analysis by Garrett because of lack of data. These seven may or may not also offer Lotto as one of their variety of games.

Tables 5 and 6 provide information on a sample of lotto games offered globally, with the games again separated into primary and secondary games. Since the only multi-national games included in the analysis are in Europe, Table 6 is entirely made up of European countries.[3] The first major difference to note on the global lotto games relative to their U.S. counterparts is provided in Table 1: there is very low correlation between population and the odds of winning. The correlation coefficient is .18 for primary games and .49 for secondary lotto games. While the table does not contain information on all lotto games offered globally, this is an indicator that for the lotto games considered, scale economies do not appear to be a significant factor in determining odds of winning across countries. In fact, for both sets of global games, but particularly for the secondary European lotto games, there is greater correlation between population and the population to odds ratio than there is between population and the odds of winning. This result is similar to the result for the U.S. tertiary games, in which the games were more likely chosen for a particularly preferable structure rather than on the basis of scale economies. This can be noted from the tables by the frequency of 6/49 games that appear: 11 of the 35 global lotto games have selected this structure.

Further evidence that global lotto games do not fully take advantage of scale economies can be seen in the population to odds ratios in the two tables. The four lotto games with the highest ratios on both global lotto tables are offered in Japan, France, the United Kingdom and Brazil, countries that represent four of the largest six regions according to population on the table. Note that Japan's population to odds ratio is well out of the range of most of the others in the group. In fact without the inclusion of

[3] While Australia offers two national lotto games of very different odds, the jackpots are similar enough to place both lotto games in the primary category.

Japan's national lotto game, the average population to odds ratio would be closer to 1.40. The unusual results for Japan may be due to the fact that Japan offers a "football lotto" game with a roll-over component that typically offers a higher jackpot than its standard lotto game. Therefore, Similar to the argument for the lotto for the state of Georgia, Japan's 6/43 lotto game may be considered subsidiary to a larger game with higher jackpots and may be more appropriately considered a secondary game.

For the European games, Matheson and Grote (2008) explain this difference from typical U.S. multi-state lotto games, in particular, in that European lotto games tend to be "more egalitarian." They tend to devote a relatively larger portion of the prize pool to lower tier prizes and tend to have jackpots that are won more frequently. In fact, according to Matheson and Grote, "the UK lotto only infrequently rolls over, and Euromillions rolls over at a rate less than one-third that of its big American counterparts." That these lotto games should, in fact, be won more frequently than the American multi-state games can be confirmed by considering that the UK lotto has a population to probability ratio of 4.346 which is almost six times higher than the corresponding ratio for Powerball.

III. U.S. Multi-State and State Games

Evidence from the previous section using cross-sectional information is suggestive that current U.S. state and multi-state lotto game structures have odds of winning that are consistent with the concept of taking advantage of scale economies. Regions with larger populations offer primary and secondary lotto games that tend to have worse odds of winning than regions with smaller populations although this effect is not evident in tertiary games. As an extension of this concept, lotto games should adjust game structures when populations change by a significant factor. In particular, they should lower the odds of winning and increase jackpot prizes when population has increased sufficiently to finance the higher jackpots without having substantially greater periods of time between jackpot wins.

U.S. population increased by approximately 1% per year on average between 2000 and 2005 and has had a similar trend since that time. Individual states had population growth rates of between -.16% and 3.6% annually for that same time period (Population Division, U.S. Census Bureau). While it is possible for lotto games to adjust odds of winning in response this population growth, frequent adjustments of game structures would likely not be worth the cost as the potential benefits from added sales per capita would likely be small relative to the costs of making the changes.[4] While state lotto games can only experience changes in their potential consumer base by in-state population growth (since tickets can only physically be sold within the state), multi-state games can and have experienced more significant growth by adding new states as members of the multi-state coalitions. For this reason, the focus of this section will be on the structural changes in the multi-state games over time as a method of analyzing their ability to take advantage of scale economies.

Tables 7 through 10 provide information on both game structure changes and annual changes in population for Powerball and Big Game/Mega Millions since their

[4] This is a concept that requires more detailed analysis, but it seems reasonable to assume that decreasing the odds of winning the jackpot by 1% per year (or by approximately 1 in 1.5 million for the current Powerball game for example) would result in explicit outlays for advertising and promotion of the new game that may well offset any added benefits. And continual (annual) adjustments to the game structure may result in smaller gains or even declines in sales per capita if consumers either have a preference for the previous game structure or come to understand that the adjustments are not necessarily to their benefit.

existence.[5] Tables 7 and 8 indicate initial support for the claim that the multi-state games have been able to take advantage of the increasing populations for their lotto games. All of the structural changes that occurred resulted in worse odds of winning the jackpot than the previous game structure. This has resulted in ever-increasing advertised jackpots (on average), but without sacrificing extended periods of time between jackpot wins. The latter can be confirmed by the last column of the two tables. Both games saw a significant increase in number of roll-overs after the first structural change. The Powerball game went from an average of almost 6 roll-overs before the jackpot was won to over 8.5. A similarly high increase can be seen in the Big Game; however, the changes to the Big Game rollovers can be explained by the game going from one draw per week to two draws per week so the number of weeks between rollovers was fairly constant and even declined on a comparable basis. Since those initial game structure changes, however, the average jackpots have been increasing while average rollovers between jackpots won has been declining. This is a pattern that should occur if scale economies exist for these lotto games.

The strict definition of scale economies according to Cook and Clotfelter is that sales per capita should be higher for games with worse odds and higher jackpots. To examine this claim, further evidence is provided in the form of annual information on the two multi-state games in Tables 9 and 10. By considering annual information, population changes can be taken into account, both in terms of population growth and in terms of added populations due to new states becoming members. Similar to the earlier tables, populations can then be compared to odds of winning to determine the average

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[5] The Lotto America game became Powerball in 1992; however, sales data has only been collected on the Powerball game so analysis of Lotto America is not included.

population to odds ratio for each multi-state game for each year. If this ratio grows too high due to added populations, jackpots should tend to be lower on average since they will be won more frequently. It will eventually become advantageous for the lottery associations to adjust game structures to maintain a similar frequency of jackpot wins at higher advertised jackpots to stimulate sales per capita.

For both multi-state games, the population to odds ratio increases until the game structure changes and then declines. The only exception to this occurs in 1996 for Powerball and this is due to Georgia leaving the Powerball game to join the Big Game in that year. For Powerball, this ratio is allowed to grow to ever smaller numbers (1.04, .97, and .77) before the game structure is adjusted. This is suggestive that while there is not an "optimal" population to odds ratio that is being managed by the association, it has become more willing to adjust the structure in response to higher populations. Additionally, each time the structure is adjusted, sales per capita increase for the first year of sales following the change and then decline in the following years. This increase in sales per capita following the structural change is expected if scale economies are present. Consumers appear to be responsive to the higher jackpots and lower odds as predicted. Once the odds of winning are adjusted and populations continue to increase in following years, sales per capita will again decline if sales are either stable or decreasing.

While the timeline for the Powerball game tends to indicate the presence of scale economies, the evidence on the Big Game/Mega Millions is mixed. In spite of the statistics from Table 8, which provide initial support for the presence of scale economies, Table 10 reveals a lotto game that attempts to take advantage of larger populations by lowering the odds of winning the jackpot, but is less successful in its more recent attempts at stimulating sales per capita. The change from weekly to bi-weekly draws did provide an increase in per capita sales in 1998 and 1999. However, this cannot be attributed to scale economies. The next two structural changes that lowered the odds of winning and increased jackpots did provide for increases in sales per capita in the years following the change. But the most recent change in 2005 witnessed a marginal increase in per capita sales during the year of the change (from $18.13 per person to $18.61 per person) followed in the year after the change by a dramatic decline to $14.63 per person.

As this is the only occurrence of a change in structure not followed by an increase in sales per capita according to the concept of scale economies, it deserves further examination. In 2005, California joined the Mega Millions game. The addition of approximately 35 million people increased the population base by almost 30%, suggesting that lottery authorities would have to seriously consider changing the game structure upon the addition of California to the game, which they did. The population base increased by just under 30% and the odds of winning declined by just over 30%, maintaining a population to odds ratio of 0.89. Theoretically, this should result in higher average jackpots and approximately the same amount of roll-overs before a jackpot is won as the previous structure. However, in 2006, the year following this change, the average advertised jackpot was only marginally higher than the average jackpot of 2004. In order for that to occur, given the new odds of winning and added population, the jackpot must be won more frequently than before, and this is evident in the average roll-over declining from 7.17 draws before a jackpot is won in 2004 to 5.06 draws in 2006. Average sales per draw did indeed increase, but not enough to account for the increase in population, in part because advertised jackpots did not increase enough to attract new sales dollars.

IV. Conclusion

Many new insights into lottery games can be developed by re-examining the evidence on the scale economies of lotto. This paper has demonstrated a remarkable difference in the types of lotto games that have apparently taken advantage of scale economies and those that have not. American lotto games, particularly the primary and secondary games, appear to use population as an important factor in setting odds of winning lotto, while tertiary lotto games and lotto games offered globally appear to use factors other than population. Likewise, the two large multi-state lotto games in the U.S. apparently adjust their odds of winning based on population and Powerball, in particular, has benefited from these changes by increasing sales per capita immediately following the adjustment.

Much more can be done to further substantiate these results, however. First and foremost, more information on international lotteries must be used in comparison to the U.S. games. There is no information on tertiary international games in the current paper and, by adding the data on these games in particular, more rigorous statistical analysis can be performed to test for the existence of scale economies in lotto games of varying varieties. While the current paper provides initial evidence in support of U.S. games taking better advantage of the scale economies that are available in lotto, this result can be either supported or disproved with the more rigorous analysis and provide clear recommendations for lottery associations as they seek relatively higher sales in their lottery game offerings.

Table 1: Summary Statistics for Lotto Games

Games Considered	N	Mean and Standard Deviation: 1/p (thous)*	Pop (thous)	Pop x p	Correlation Coefficient: population to: 1/p:	Pop x p
Cook and Clotfelter	14	8,374.36	8,871.43	1.02	0.91	0.54
		5,573.68	7,414.59	0.39		
Primary U.S. State	3	114,925.67	94,549.00	0.81	0.98	0.50
		81,010.96	70,980.98	0.09		
Secondary U.S. State	28	8,845.95	9,246.14	2.29	0.87	-0.02
		8,814.98	8,013.04	3.98		
Tertiary U.S. State	18	879.17	7,300.33	12.75	-0.18	0.91
		742.27	8,362.56	15.29		
Primary Global	23	51,587.74	42,164.65	2.24	0.18	0.44
		128,141.95	57,448.81	4.22		
Secondary Global	12	12,308.00	22,168.50	1.72	0.49	0.91
		7,022.95	22,622.06	1.46		

Table 2: Primary U.S. State Lotto Games

Game	Structure	1/p (thous)	Pop (thous)	Pop x p	Min Jackpot
Mega Millions	5/56 + 1/46	175,712	158,626	0.903	12,000,000
Florida Lotto	6/53	22,957	18,251	0.795	3,000,000
Powerball	5/55 + 1/42	146,108	106,770	0.731	15,000,000

Mega Millions is currently played in CA, GA, IL, MD, MA, MI, NJ, NY, OH, TX, VA, and WA.

Powerball is currently played in AZ, CO, CT, DE, DC, ID, IN, IA, KS, KY, LA, ME, MN, MO, MT, NE, NH, NM, NC, ND, OK, OR, PA, RI, SC, SD, TN, VI, VT, WV, and WI.

Sources: Lottery data supplied by lottery association websites. Population data supplied by the U.S. Census Bureau, July 1, 2007 Annual Estimates of Population.

Table 3: Secondary U.S. Lotto Games

State	Game	Structure	1/p (thous)*	Pop (thous)	Pop x p	Min Jackpot
Georgia	Fantasy 5	5/39	576	9,545	16.571	Pari-mutuel
North Carolina	Carolina Cash 5	5/39	576	9,061	15.731	50,000
Nebraska	Pick 5	5/38	502	1,775	3.536	50,000
Rhode Island	Wild Money	5/35 + bonus	325	1,058	3.255	20,000
Multi-State	Hot Lotto	5/39 + 1/19	10,939	25,023	2.288	1,000,000
Kentucky	3 Line Lotto	6/39	2,175	4,241	1.950	100,000
Missouri	Lotto	6/44	3,530	5,878	1.665	1,000,000
Maryland	Multi Match	6/43	4,064	5,618	1.382	500,000
Pennsylvania	Match 6	6/49	9,323	12,433	1.334	500,000
Illinois	Lotto	6/52	10,179	12,853	1.263	2,000,000
Massachusetts	Megabucks	6/42	5,246	6,450	1.230	400,000
South Carolina	Mega Match 6	6/37	3,875	4,408	1.138	550,000
Louisiana	Lotto	6/40	3,838	4,293	1.119	250,000
Michigan	Classic Lotto 47	6/47	10,738	10,072	0.938	1,000,000
Colorado	Lotto	6/42	5,246	4,862	0.927	1,000,000
Texas	Lotto	6/54	25,827	23,904	0.926	4,000,000
Washington	Lotto	6/49	6,992	6,468	0.925	1,000,000
Arizona	The Pick	6/44	7,059	6,339	0.898	1,000,000
California	Super Lotto Plus	5/47 + 1/27	41,416	36,553	0.883	7,000,000
Tennessee	Lotto Plus	6/44	7,059	6,157	0.872	25,000
New York	Lotto	6/59	22,529	19,298	0.857	3,000,000
Ohio	Classic Lotto	6/49	13,984	11,467	0.820	1,000,000
Wisconsin	Megabucks	6/49	6,992	5,602	0.801	10,000
New Jersey	Pick 6 Lotto	6/49	13,984	8,686	0.621	2,000,000
Multi-State	Tri-State Megabucks	6/42 + bonus	5,246	3,254	0.620	500,000
Oregon	Megabucks	6/48	6,136	3,747	0.611	1,000,000
Indiana	Hoosier Lotto	6/48	12,272	6,345	0.517	1,000,000
Connecticut	Classic Lotto	6/44	7,059	3,502	0.496	1,000,000

Hot Lotto is currently played in DC, DE, ID, IA, KS, MN, MT, NH, NM, ND, OK, SD, and WV.

Tri-State Megabucks is currently played in ME, NH, and VT.

*All probabilities are based on $1 play. Several states offer lotto games at 2 plays for $1 or 3 plays for $2, which essentially changes the odds of winning for a given lottery ticket purchase.

Sources: Lottery data supplied by lottery association websites. Population data supplied by the U.S. Census Bureau, July 1, 2007 Annual Estimates of Population.

Table 4: Tertiary U.S. Lotto Games

State	Game	Structure	1/p (thous)*	Pop (thous)	Pop x p	Min Jackpot
California	Fantasy 5	5/39	576	36,553	63.460	50,000
Minnesota	Northstar Cash	5/31	170	5,198	30.576	25,000
Illinois	Little Lotto	5/39	576	12,853	22.314	100,000
Ohio	Rolling Cash 5	5/39	576	11,467	19.908	100,000
Michigan	Fantasy 5	5/39	576	10,072	17.486	100,000
New Jersey	Jersey Cash 5	5/40	658	8,686	13.201	Pari-mutuel
Pennsylvania	Cash 5	5/43	963	12,433	12.911	125,000
Washington	Hit 5	5/39	576	6,468	11.229	100,000
Arizona	Pick 5	5/39	576	6,339	11.005	50,000
Louisiana	Easy 5	5/37	436	4,293	9.846	50,000
Montana	Cash	5/37	218	958	4.394	20,000
Minnesota	Gopher 5	5/47	1,534	5,198	3.389	100,000
Multi-State	Wild Card 2	5/31 + 1/16	1,359	3,893	2.865	100,000
South Dakota	Dakota Cash	5/35	325	796	2.449	20,000
DC	Rolling Cash 5	5/35	324	588	1.815	20,000
Kansas	Super Cash	5/32 + 1/25	2,517	2,776	1.103	100,000
Delaware	Multi-Win Lotto	6/35	1,082	865	0.799	50,000
New Mexico	Roadrunner Cash	5/34 + bonus	2,783	1,970	0.708	20,000

Wild Card 2 is currently played in ID, MT, ND and SD.

*All probabilities are based on $1 play. Several states offer lotto games at 2 plays for $1 or 3 plays for $2, which essentially changes the odds of winning for a given lottery ticket purchase.

Sources: Lottery data supplied by lottery association websites. Population data supplied by the U.S. Census Bureau, July 1, 2007 Annual Estimates of Population.

Table 5: Primary Global Lotto Games

Country/Region	Game	Structure	1/p (thous)	Pop (thous)	Pop x p
Japan	National Lottery	6/43	6,096	127,433	20.904
Brazil	Mega-Sena	6/60	50,064	190,011	3.795
Dominican Republic	Loto	6/38	2,761	9,366	3.392
South Africa	Lotto	6/49	13,984	43,998	3.146
Poland	Duzy Lotek	6/49	13,984	38,518	2.754
Europe	Euromillions	5/50 + 2/9	76,275	206,317	2.705
Northern Europe	Viking Lotto	6/48	12,272	25,983	2.117
Netherlands	Lotto	6/45	8,145	16,571	2.034
Ukraine	Super Loto	6/54	25,827	46,300	1.793
Romania	Loto 6/49	6/49	13,984	22,276	1.593
Bosnia and Herzegovina	Loto	6/42	5,246	4,552	0.868
Greece	Lotto	6/49	13,984	10,706	0.766
Puerto Rico	Loto	6/42	5,246	3,944	0.752
Australia	Powerball	5/45 + 1/45	27,490	20,434	0.743
Czech Republic	Sportka	6/49	13,984	10,229	0.731
Serbia	Loto	7/39	15,381	10,150	0.660
Germany	Lotto 6 aus 49	6/49 + bonus	139,838	82,401	0.589
Croatia	Loto	6/45	8,145	4,493	0.552
Hong Kong	Mark 6	6/49	13,984	6,980	0.499
Israel	Lotto	6/34 + 1/10	13,449	6,427	0.478
Australia	Oz Lotto	7/45	45,380	20,434	0.450
New Zealand	Powerball	6/40 + 1/10	38,384	4,116	0.107
Italy	Super Enalotto	6/90	622,615	58,148	0.093

Euromillions is currently played in Austria, Belgium, France, Ireland, Luxembourg, Portugal, Spain, Switzerland and the UK

Viking Lotto is currently played in Denmark, Estonia, Finland, Iceland, Norway and Sweden

Sources: Lottery information is provided by the lottery agency websites. Population data is based July 2007 estimates provided by the CIA World Factbook.

Table 6: Secondary Global Lotto Games

Country/Region	Game	Structure	1/p (thous)	Pop (thous)	Pop x p
France	Loto	6/49	13,984	63,714	4.556
United Kingdom	National Lottery	6/49	13,984	60,776	4.346
Spain	La Primativa	6/49	13,984	40,448	2.892
Belgium	Lotto	6/42	5,246	10,392	1.981
Sweden	Lotto	7/35	6,725	9,031	1.343
Spain	El Gordo	5/54 + 1/10	31,625	40,448	1.279
Austria	Lotto	6/45	8,145	8,200	1.007
Switzerland	Lotto	6/45	8,145	7,555	0.928
Portugal	Totoloto and Loto 2	6/49	13,984	10,643	0.761
Denmark	Lotto	7/36	8,348	5,468	0.655
Ireland	Lotto	6/45	8,145	4,109	0.504
Finland	Lotto	7/39	15,381	5,238	0.341

Sources: Lottery information is provided by the lottery agency websites. Population data is based July 2007 estimates provided by the CIA World Factbook.

Table 7: Game Structure Changes for MUSL Powerball Game

Game Dates	Game Structure	Number of Draws	Average Draw Sales	Average Jackpot (mil)	Number of Rollovers	Average Rollover
4/22/92 - 11/1/97	5/45 + 1/45	578	8,558,294	18.00	85	5.79
11/5/97 - 10/5/02	5/49 + 1/42	514	11,845,823	33.21	53	8.60
10/9/02 - 8/27/05	5/53 + 1/42	302	17,858,856	54.11	35	7.51
8/31/05 - 12/29/07	5/55 + 1/42	244	22,281,576	75.92	29	7.41

Table 8: Game Structure Changes for Big Game/Mega Millions

Game Dates	Game Structure	Number of Draws	Average Draw Sales	Average Jackpot (mil)	Number of Rollovers	Average Rollover
8/31/96 - 2/6/98	5/50 + 1/25	75	8,511,118	15.79	17	3.35
2/10/98 - 1/19/99	5/50 + 1/25*	99	5,499,301	15.73	12	6.25
1/22/99 - 5/14/02	5/50 + 1/36	346	10,568,963	30.81	36	8.50
5/17/02 - 6/21/05	5/52 + 1/52	324	18,079,951	48.43	36	7.89
6/24/05 - 12/31/07	5/56 + 1/46	263	25,536,470	67.56	33	6.91

*Switched from weekly draws to bi-weekly draws on 2/10/98.

Table 9: Timeline for MUSL Powerball Game

Year	Annualized Sales (thous)	1/p (thous)	Annual Pop (thous)	Pop x p	Sales per capita	Average Sales (thous)	Average Jackpot (mil)	Number of Rollovers	Average Rollover
1992*	416,921	54,979	39,053	0.710	10.676	4,009	7.62	13	4.53
1993	865,643	54,979	39,458	0.718	21.938	8,323	18.24	10	9.30
1994	815,367	54,979	45,564	0.829	17.895	7,765	17.37	14	6.50
1995	1,165,215	54,979	61,994	1.128	18.796	11,204	23.26	15	5.73
1996	1,095,551	54,979	56,968	1.036	19.231	10,534	20.23	20	4.20
1997	873,361		57,400		15.215	8,318	19.54	14	6.29
1997a	841,776	54,979	57,400	1.044		8,094	18.22		
1997b	985,482	80,089	57,400	0.717		9,476	26.41		
1998	1,539,096	80,089	57,801	0.722	26.627	14,799	34.13	12	7.00
1999	1,033,508	80,089	58,215	0.727	17.753	9,938	29.67	11	8.09
2000	1,129,375	80,089	60,105	0.750	18.790	10,756	33.13	13	7.15
2001	1,375,466	80,089	64,976	0.811	21.169	13,226	37.37	8	11.13
2002	1,478,893				18.595	14,220	42.07	10	10.10
2002a	1,105,284	80,089	77,837	0.972		10,628	32.68		
2002b	2,724,257	120,527	81,941	0.680		26,195	73.38		
2003	1,992,136	120,527	83,125	0.690	23.966	18,306	58.76	10	9.50
2004	1,803,447	120,527	91,617	0.760	19.685	17,341	54.56	12	7.58
2005	1,960,887				21.223	18,675	55.74	14	6.21
2005a	1,566,204	120,527	92,395	0.767		15,060	39.65		
2005b	2,590,922	146,108	92,395	0.632		25,605	86.58		
2006	2,389,956	146,108	105,516	0.722	22.650	22,980	81.13	10	8.60
2007	2,124,978	146,108	106,662	0.730	19.923	20,432	67.03	16	5.50

*Including the first year when Powerball sales began in April 1992.

Table 10: Time Line for Big Game/Mega Millions

Year	Annualized* Sales (thous)	1/p (thous)	Annual Pop (thous)	Pop x p	Sales per capita	Average Sales (thous)	Average Jackpot (mil)	Number of Rollovers	Average Rollover
1996*	389,989	52,969	46,831	0.884	8.328	7,498	14.41	4	2.00
1997	474,650	52,969	47,224	0.892	10.051	9,128	16.81	12	3.25
1998	549,351	52,969	47,590	0.898	11.543	5,549	15.04	13	6.15
1998a	313,852	52,969	47,590	0.898		6,036	10.83		
1998b	567,727	52,969	47,590	0.898		5,518	15.31		
1999	1,005,652				18.007	9,578	29.70	10	8.50
1999a	542,419	52,969	48,000	0.906		5,216	22.17		
1999b	1,023,568	76,275	56,143	0.736		9,842	30.16		
2000	1,135,058	76,275	57,837	0.758	19.625	10,914	29.90	10	8.60
2001	843,445	76,275	58,414	0.766	14.439	8,110	26.30	12	6.67
2002	1,687,770				22.247	16,074	42.20	13	7.00
2002a	1,877,335	76,275	58,919	0.772		18,051	46.10		
2002b	1,550,183	135,146	95,528	0.707		14,906	39.89		
2003	1,696,160	135,146	96,111	0.711	17.648	16,309	43.38	11	7.27
2004	2,159,479	135,146	119,137	0.882	18.126	20,569	53.30	12	7.17
2005	2,597,883				18.613				
2005a	2,161,131	135,146	119,990	0.888		20,780	60.16		
2005b	2,986,990	175,712	155,980	0.888		28,721	87.36		
2006	2,302,228	175,712	157,342	0.895	14.632	22,137	54.96	16	5.06
2007	2,834,205	175,712	158,626	0.903	17.867	27,252	69.69	12	7.50

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