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Paul M. Sommers

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MIDDLEBURY COLLEGE
MIDDLEBURY, VERMONT 05753

http://www.middlebury.edu/~econ

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Paul M. Sommers
Department of Economics
Middlebury College
Middlebury, Vermont 05753
psommers@middlebury.edu

Monopoly Power

Knowing exactly which monopolies can win you the game
is one thing, getting ownership of them is another.

— Kaz Darzinskis,
Winning Monopoly [**2**]

Everyone has opinions as to what are the best properties and color-group monopolies in the board game of Monopoly.[1] If no particular square were more or less likely to be landed on than any other square, then players would prefer high-rent Boardwalk and Park Place, the blue monopoly. If, however, as Stewart [**5**], Abbott and Richey [**1**], and Friddell [**3**,**4**] have pointed out, the steady-state probabilities of occupying each square are not even,[2] then lesser-valued properties with higher landing frequencies could be better lots to own. In this brief note, we examine the attractiveness of erecting houses and ultimately a hotel on the twenty-two different properties which make up the eight different color-group monopolies.

What is meant by the word "attractiveness" in this context? One criterion which is frequently employed in economics to judge the profitability (or attractiveness) of an investment in practice is its payout (or payback) period. If, for example, a player is (un)lucky enough to be the first to land on, say, Boardwalk and elects to buy this unowned property, the title deed card to Boardwalk costs $400. If during the course of the game, this same player also acquires ownership of Park Place (and hence succeeds in completing the blue color-group monopoly), a house can be bought from the Bank for $200. If the first house is put on Boardwalk, the owner can collect $200 from players who land on this owned property, four times the rent on Boardwalk before the property was monopolized. The payout period (henceforth, ratio) for Boardwalk with one house would therefore be $600/$200 or 3.[3] That is, rent-paying opponents would have to land on Boardwalk three times in order for the owner of this property to accumulate rental income sufficient to cover his or her costs. The payout ratio criterion ranks properties in terms of this ratio, asserting that a property with a payout ratio of three is generally preferred to a property with a payout ratio of, say, four, all else equal. Of the twenty-two properties with one house on a monopoly, Boardwalk has the best payout ratio (3.0) and Mediterranean Avenue has the worst (11.0). Of the twenty-two properties with a hotel on each lot,[4] the three properties with the best payout ratio all belong to the light blue color group: Connecticut Avenue (.617), Oriental Avenue (.636), and Vermont Avenue (.636). Three of the four properties with the worst payout ratio belong to the green color group: North Carolina Avenue (1.02), Pacific Avenue (1.02), and Pennsylvania Avenue (.943). Mediterranean Avenue (again, with one hotel) has the worst payout ratio (1.24).

In a typical circuit of the board, there is obviously no guarantee that a player will land on any one square in particular. Yet the steady-state probability of occupying each square can be computed. Taking into account multiple rolls of the dice (when a player throws a double), special squares such as *GO TO JAIL*, and instructions on *CHANCE* and *COMMUNITY CHEST* cards, Abbott and Richey **[1]** set up a transition matrix for a Markov model in order to determine the steady-state probabilities. These long-term probabilities of occupying the different property squares are shown in Table 1, with Illinois Avenue being the most landed-on property (p = .0299).

(Table 1 about here)

To get a better idea of the comparative value of the various monopolies, the payout ratio will be re-defined as follows:

$$\text{payout ratio} = \text{cost} \div (\text{rent} \times \text{probability})$$

Here, the cost refers to the investment in houses or a hotel, the rent is as given on each of the title deed cards, and the probability is the steady-state likelihood of landing on a particular square per circuit of the board per player. The re-defined payout ratio factors into the rents the relative frequency with which players will land on various properties and hence represents the expected number of times an opposing player must land on a particular square before the owner can recover his or her original investment. To gauge the relative attractiveness of the eight different color-group monopolies, the group payout ratio can be expressed as follows:

$$\sum_j Costs_j \,/ \sum_j (\mathrm{Re}\,nt_j \times \mathrm{Pr}\,obability_j)$$

where j denotes the number of properties in each two- or three-lot monopoly. Smaller average payout ratios are preferred to larger ones.

(Table 2 about here)

Table 2 summarizes the results of calculating the payout ratio for any number of houses (with hotels being counted as "5" houses) on each of the eight monopolies, assuming the same number of houses are on each property of the monopoly.
The orange monopoly is seen to be the most desirable color group with at least three houses erected on each lot. The blue monopoly is best with one or two houses on each lot. Surprisingly, with the exception of the purple and light blue monopolies, the marginal benefit of building more than three houses on any given monopoly is minimal. On average, a player would be no better off adding a fourth house to any of the lots in the yellow monopoly than he or she would be by adding a fourth house to a less expensive monopoly, say, the fuchsia monopoly. The orange monopoly has a superior payout ratio than the blue monopoly even though houses cost half as much as those on Boardwalk or Park Place.

Concluding Remarks

The steady-state occupation probabilities indicating how often players are likely to land on each square enable one to determine what properties and hence which color groups are most desirable to acquire in Monopoly. With three or more houses, the orange monopoly has marginally the most favorable payout ratio. After all, since the probability of occupying the Jail square is highest on the board and the second most common dice rolls are 6 and 8, players emerging from Jail are likely to land on the orange squares. Since the expected returns on investment in a third house, fourth house, or a hotel are similar for all but the purple monopoly, there might be something to be said for owning and developing the light blue monopoly where houses cost only $50 apiece.

As one meanders from Baltic Avenue to Boardwalk, one can with a little luck and a working knowledge of these probabilities parlay a few hundred dollars into a vast Trump or Turner-like real estate fortune.

Table 1. Steady-State Occupation Probabilities

Color Group	*Property*	*Probability*
Purple	Mediterranean Ave.	.02005
	Baltic Ave.	.02034
Light Blue	Oriental Ave.	.02124
	Vermont Ave.	.02179
	Connecticut Ave.	.02163
Fuchsia	St. Charles Place	.02550
	States Ave.	.02171
	Virginia Ave.	.02424
Orange	St. James Place	.02681
	Tennessee Ave.	.02822
	New York Ave.	.02809
Red	Kentucky Ave.	.02611
	Indiana Ave.	.02563
	Illinois Ave.	.02990
Yellow	Atlantic Ave.	.02536
	Ventnor Ave.	.02515
	Marvin Gardens	.02434
Green	Pacific Ave.	.02519
	No. Carolina Ave.	.02468
	Pennsylvania Ave.	.02349
Blue	Park Place	.02057
	Boardwalk	.02480

Source: S.D. Abbott and M. Richey [**1**: Table 3, p. 169].

Table 2. Average Payout Ratios For Each Monopoly

Number of houses	Purple	Light Blue	Fuchsia	Orange	Red	Yellow	Green	Blue
1	363	218	194	141	148	148	152	135
2	176	103	91	68	73	67	71	62
3	77	43	41	31	35	36	40	35
4	54	35	36	28	35	36	40	35
5[a]	44	30	34	26	34	35	41	35

[a]A hotel counts as "5" houses.

Notes

1. Monopoly is a registered trademark of Hasbro, Inc.

2. According to Abbott and Richey **[1]**, the most frequently landed on square is Jail (p = .117).

3. The reciprocal of the payout ratio interprets as the rate of interest or return which would render the discounted present value of its expected future marginal yields (rents) equal to the investment cost of the property. For example, in the case of Boardwalk, the reciprocal of the payout ratio is .333. At a 33.3 percent interest rate (i = .333), we find that the present value of an income stream of $200 each time a player lands on Boardwalk (in perpetuity) would be $200 ÷ i = $200 ÷ .333 or $600, the cost of acquiring the title deed to Boardwalk and purchasing one house.

4. A player must have four houses on each lot of a complete color group before he or she can buy a hotel.

References

1. S.D. Abbott and M. Richey, Take a walk on the boardwalk, *The College Mathematics Journal*, Vol. 28, No. 3, May 1997, pp. 162-71.

2. K. Darzinskis, *Winning Monopoly*, Harper and Row, New York, 1987.

3. T. Fridell, How to win at monopoly, *Computerworld*, Vol. 32, No. 19, May 11, 1998, p. 92.

4. T. Fridell, Monopoly analysis, MathSofts Mathcad web page at www.mathsoft.com.

5. I. Stewart, Monopoly revisited, *Scientific American*, Vol. 275, No. 4, October 1996, pp. 116-119.