The Mathematics of Gambling:
Getting Rich

by Edward O. Thorp

Most of you are interested in getting rich. You search for winning systems and try them out, and quite a few of you are successful with your systems. But have you stopped to take stock of how rich you are getting and how fast you are getting rich? That is what we are going to do in this month's column.

The famous American fiction writer, John D. McDonald, characterized levels of wealth in 1970 in his Travis McGee series. He said $100,000 was "adequate." If you had $250,000, that was "comfortable," wheras $1,000,000 was "substantial." If you had as much as $5,000,000, he called that "impressive." Since inflation has cut the dollar approximately in half as far as real buying power since 1970, today's numbers would probably be "adequate," $200,000; "comfortable," $500,000; "substantial," $2,000,000; and finally, "impressive," $10,000,000. Where do you stand in this classification?

Let's see first where Mr. Average stands. The United States currently has a net worth at today's market price of about $8 trillion. About $2 trillion comes from the market value of all the companies on the New York and American stock exchanges. About $1 trillion of that $2 trillion represents the market price of the stocks that are traded. The second $1 trillion represents the market price of the bonded indebtedness of these companies. Notice that there is a little double counting. For example, some companies own the stocks of other companies on the exchange, and so the market value in these cases gets counted twice. Still the figures are approximately correct. Another $2.1 trillion comes from the market price of all single-family dwellings. About $1.5 trillion is equity ownership and about $0.6 trillion is mortgage balances outstanding. There is also other private property, and there is public property in the form of equipment, buildings and land.

Divided among our 220,000,000 citizens, this $8 trillion comes to about $36,000 per person. If the publicly or government-owned part amounts to $2 trillion, that leaves about $6 trillion in private wealth which would correspond to about $27,000 of private wealth per citizen.

Your Net Worth

How do you compare with this average? To find out, make a list of all the property you own and its approximate market value. Add up all these market values to get your total *assets*. When you do this, remember that it is not what an asset is worth to you that counts, it is what you can sell it for to someone else. The old family photo album might be worth $10,000 to you. That is, you would pay that top amount in ransom to get it back from a thief, but at an auction, it might fetch only $1. Then you must enter $1, not $10,000, as the market value of this asset.

Next list your liabilities, namely your outstanding debts and obligations, and determine their approximate market value. That is, what it would cost to pay off a liability now. For example, if the mortgage on your house has a balance of $38,500 and the early payment penalty comes to $1,200, put down $39,700. Don't forget to list any federal or state taxes which are going to be due because of income but which have not yet been paid. Some liabilities are tricky to value. Suppose you have child support payments of $100 per month for 16 years until the child is 21. Then your obligation could be "paid off" now by purchasing or creating an annuity which pays the support amount of $100 per month for 16 years for you. Suppose this annuity would cost you $12,000 now to purchase. Then put down $12,000 as the value of this child support obligation.

But what if you have alimony of $300 per month unless your ex-wife remarries? If you do not know if or when that will happen, you can't say how long the payments will go on. So you can't say how much an annuity to cover them would cost. All you can do is make a very rough estimate.

Add up all the liabilities that you have to get your total liabilities. As we have seen, there may be uncertainty in the value of an individual liability and therefore also in your total liabilities. There also may be uncertainty in the value of your total assets. For instance, you get royalties from a book; who can determine the market price of this uncertain income stream? You don't know how big it will be or how long it will last. But putting these difficulties aside, take your best estimate of your assets, subtract from this your best estimate of your total liabilities, and the difference is your net worth. This is the money estimate of your total wealth.

How Many Millionaires Are There?

The most talked-about group of rich people are the millionaires. You may be one already or you may not be. But in either case, it will help in setting your own goals and in measuring what you have achieved so far to know how many millionaires there are. I happen to live in a Southern California resort area with so many millionaires that Mercedes are thought of like Fords or Volkswagens, and it takes a Rolls to be at all distinctive. So the question is quite interesting to me.

In 1972, there were about 180,000 millionaires in the United States. Today, there are a few more people and the average real wealth measured in terms of quantity of goods and services the wealth can buy is a little greater, but the num-

ber of millionaires is much larger. According to a recent Kiplinger letter, there are more than 520,000 millionaires in the United States now. Most of this increase from 1972 is due to inflation. What now costs a million dollars could have been purchased on average for about $585,000 in 1972. And in 1972, there were about 520,000 people worth $580,000. Inflation alone can explain the increase in the number of millionaires from 1972 to 1979.

I have found a simple formula which seems to describe the number of wealthy people. In 1972, the formula was $N(W \geq W_0)=1.8 \times 10^{15}/(W_0)^{53}$. In the formula, the left side is the number N of people who have wealth W greater than or equal to some cutoff level W_0. The right side computes this. For example, to find the number of people in 1972 who had $1,000,000 or more of wealth, that is, net worth, substitute $W_0=1,000,000$ in the righthand side. After simplification, you get 180,000. This formula is good for wealth cutoff levels of $200,000 or more. To see how many people had $200,000 or more of net worth in 1972, substitute 200,000 for W_0 and you will get 2,630,000 as the formula's estimate of the number of people with a net worth of at least $200,000 in 1972. At the other extreme, if you substitute 1,000,000,000 (one billion) for W_0, the formula estimates that there were 1.8 billionaires in the United States in 1972. That is about right.

As of 1970, Mr. Y of *Beat the Dealer* fame was worth at least $14,000,000 if all those warrants he got for his company were not offset by liabilities. The formula estimates there were about 2,200 people in the United States worth $14,000,000 or more in 1972, two years later.

The inflation factor from 1972 to 1980 is about 2, so the formula for 1980 should be modified as follows: $N(W \geq W_0)=1.8 \times 10^{15} \times (2/W)^{53}=5.71 \times 10^{15}/W_0^{53}$. That gives about 571,000 millionaires in 1980, which is pretty close to current estimates. It shows about 5.7 billionaires, which is not far off. This formula is good from about a $400,000 cutoff upward. In general, if things cost F times as much in a different year as

they do now, the formula for that other year is the following simple modification of the 1980 one: $N(W \geq W_0)=5.71 \times 10^{15} \times (F/W_0)^{53}$.

Now as your money piles up, you can keep track of how many people are still ahead of you.

How Fast Are You Getting Rich?

To find out how fast you are getting there, you need to know, first of all, how much you make each year. Add all your estimates of money or other additions to your wealth which you expect for 1980. Examples are salary, dividends, interest, gambling winnings, investment profits, and so on. That is your total income. From this, you must deduct your total expenses of all kinds, such as living expenses, debt servicing, gambling losses, and investment losses. Also subtract any new liabilities, debts or any wealth that you consume. An example is the depreciation in market value of your automobiles. The difference between your total income and your total expenses is your net savings. That is how much your wealth or your net worth will increase during 1980.

The total gross national product for 1980 will be about $2 trillion. The disposable income for the United States, that is, what we private citizens get after the government takes its piece, is about $1.5 trillion, which yields about $6,800 per citizen. If we use a figure of about 100,000,000 workers, the average income per worker is about $15,000. If savings are about seven percent, then the average savings per worker would be about $1,050. How do you compare?

$1 Million a Year

My work in investments has brought me in contact with several dozen people in the elite group that had *income* of at least $1 million in a recent year. Most of these fortunate few are very prominent in fields such as investments, entertainment, industry, or real estate. How many people are there like this in the United States? I have found that a similar formula describes high incomes. In 1972, adjusted gross incomes above $200,000 were described quite accurately by the formula $N(I \geq I_0)=6.3 \times 10^{14}/I_0^2$. The left side of the

formula is the number of people in 1972 with incomes greater than or equal to I_0. The righthand side tells how to compute this. For example, if we chose I_0 equal to 1,000,000, then we get 630 with adjusted gross incomes of $1,000,000 in the year 1972. The Internal Revenue said there were, in fact, 624 such people. So the formula fits quite well.

Because people in high tax brackets have many loopholes and exemptions which reduce their adjusted gross income, they end up paying about half the top tax bracket which would otherwise apply to their income. That means that probably the 624 people with adjusted gross incomes of $1,000,000 or more typically had twice this in actual realized net income. It follows that a more appropriate formula would be the following: $N(I \geq I_0)=2 \times 10^{13}/I_0^{53}$. In addition, there are reasons to believe that the exponent of I_0 should be 5/3 instead of 2, so I have put that change in the formula as well. Notice that the new formula gives about 2,000 people with incomes of a million or more in 1972.

In the same way, using the inflation factor, we get the formula for any other year. The formula for 1980, using an inflation factor of 2, turns out to be $N(I \geq I_0)=2 \times 10^{13} \times (2/I_0)^{53}=6.35 \times 10^{13}/I_0^{53}$. If you know the inflation factor which relates any other year to 1980, then you can get the formula for that year from the 1980 formula as follows: $N(I \geq I_0)=6.35 \times 10^{13} \times (F/I_0)^{53}$. Notice that the 1980 formula shows that the number of people making an income of $1,000,000 or more is going to be about 6,350.

There you have it. You can tell now and in future years approximately how many people are at a specified high wealth level or a specified high income level. You can tell where you stand in the great race to the top of the money pile.

The Inflationary Illusion

What counts is real buying power, not nominal dollars. For instance, many people feel that it takes $10 now to buy what $1 could get you 50 years ago. So a millionaire is like a person with $100,000 in 1929. With inflation

raging at historic high rates, we now see our money wealth and money income going up very rapidly, even for people who are standing still.

For example, suppose inflation continues on into the future, year after year, at a ten percent rate. An easy calculation shows that if the median income were $14,000 in 1980, then inflation alone would make it $36,000 in 1990; and in the year 2000, it would take $94,000 to equal $14,000 in 1980. In the year 2010, the median income would soar to $244,000 but buy no more. In 2020, it would be $634,000. In the year 2025, the median income would be $1,000,000 and still buy no more than $14,000 buys today. If the population stayed the same, we might expect 50 million people to be earning $1 million or more a year in the year 2025, yet be no richer than they are today.

In the year 2030, it would take $1,634,000 to buy the same amount, and in the year 2080, the median income would be carried by this ten percent inflation rate to $193,000,000. So the real way to keep track of your expanding wealth and expanding income is to correct it for the inflation rate. Economists refer to this as calculating it in constant dollars using some specified base year, such as 1980.

This inflationary illusion creates vast wealth in terms of nominal dollars without creating real wealth. It reminds me of a joke. A patient with a disease that is incurable by present medical techniques is frozen in suspended animation until the time when science can heal him. He prudently invests his money in a well-managed trust fund before being frozen. Two hundred years later, he is awakened and healed. He asks eagerly about the state of his investments. He learns that the $100,000 that he put aside 200 years earlier has now grown into $400 million. A friend was suspended at the same time. The friend has also been recently revived, and our hero rushes to the nearest telephone to call his friend and tell of his incredible wealth. Our hero picks up the receiver, dials the operator, and the operator says, "that will be twelve billion dollars for three minutes, please." ∎

BLACKJACK PLAYER

fully expected to extract $100,000 or so from the Lake before traveling farther north to Reno. Then we would return to Vegas and play the day shift there for a week or two.

Team optimism was high. We continued winning 80 percent of the sessions with George. It appeared that nothing could stop us from making well into seven figures over the next several months.

The second session of the day was also a winner but not as profitable. When all four teams returned, we found we were up $20,000 for the morning session. We'd won another $4,000.

The following day at 1 p.m., I dispatched four teams once again and sat down by the phone. It didn't ring until 4 p.m., which I thought was a good sign. When the team was having trouble with equipment or finding a favorable table, the phone would ring frequently, and I would have to redeploy the troops. When the team was "down," that is, playing and getting in lots of hands per hour, the phone rarely rang. As I picked up the phone, I wondered if perhaps we'd won $50,000 for the trip yet. At the levels we were betting, that kind of win would have been realistic.

It was Harry, a Big Player. "Ken, there's this guy across the pit who's taking my picture. Whenever I look at him, he ducks. When I turn away, he pulls out a camera."

I knew Harrah's was into photography (they had photographed some of my teammates on former trips). I felt Harry would probably get barred there soon, but decided that as long as he was "down," he might as well get as many hands in as necessary. We could use Harry later in other casinos. So I told him, "Hell, why not go back and play it? What have we got to lose? If they bar you, we'll just send you somewhere else."

The other teams hadn't checked in yet. I thought this was curious, but things seemed to be going well.

At 5 p.m., one counter, Rich, called. "Hi, Rich. What's happening?"

"I'm in jail," Rich said.

"Oh, no. What happened?"

"Well, I was in Harrah's, playing with Harry. They pulled me into the back room. They searched me, found George, and arrested me. I'm at the Zephyr Cove jail now. My bail is $2,000."

"Don't worry, Rich. Someone will be right down."

"Better bring some more bail money. There's a few more of us coming here, too."

Just then, Harry walked in the door. "I couldn't find Rich. He just disappeared. So I left the casino."

I was surprised that they hadn't arrested Harry too. Then the phone rang again. It was Jerry's oldest son. He, too, had been arrested, as had another one of our Big Players.

I dispatched one of our teammates to the jail with $6,000 in cash to bail out our people. They'd been charged with "bunco-steering," a Nevada gambling crime. The computers were confiscated, and our teammates would not be arraigned until the district attorney could be reached to evaluate this rather unusual arrest.

Jerry was shaken. His underage son had been arrested. We decided that agents might be searching the area for the rest of the team. We quickly packed up the electronic gear, grabbed the team's bank (now $90,000 after paying the bail), and hid it in a cigarette carton box.

The team dispersed. Some drove back to Las Vegas, others to Los Angeles and San Francisco. I drove back to my San Francisco apartment with three teammates. The next day, I contacted lawyers. One lawyer wanted a retainer of $25,000 to handle the case. A second lawyer was interested in the civil rights aspect of the case and offered to do it on a time-and-expense basis. I chose the latter.

It turned out we had underestimated the exchange of intelligence among the Tahoe casinos. In Vegas, it's rare that one casino communicates information to the others. But in Tahoe, $25 chip players are rare; $100 players stand out even more. For there to be four players simultaneously betting up to two hands of $1,000 was clearly unusual. Casino personnel apparently had exchanged information,