

## **Projections in Accumulations of Stock Value at Different Dividend Tax Rates**

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*This paper illustrates how to achieve financial independence both during one's career and during the retirement years by investing in stocks of quality companies which pay increasing dividends. The formula derived here computes the returns of such investments and, using historical data, projects future returns at dividend tax rates of 0%, 15% and 40%. The study of different aspects of the formula and investments at the different tax rates reveals some rather surprising results.*

### **INTRODUCTION**

For countless waves of immigrants, the American dream has beckoned just as the yellow brick road called to Dorothy in "The Wizard of Oz". The image of America's "golden paved streets" springs from the dream that hard work will take you to the top. When you do your job, the job will continue to take care of you for life. Even after your working years, the company pension and the government will take care of you for life. This dream, however, doesn't include the modern realities of company downsizing, voluntary retirement, company mergers, bankruptcies nor any other business calamities. Rather, as the working years go by, so do those dreams of financial security. The typical worker has become an economic slave who cannot afford to stop working, not even for those imagined "golden years." For the sake of economic survival, the worker continues to work, even when the job becomes loathsome, the organization, impersonal, and most of the fellow employees are strangers.

"Is there any way out of this morass?" screams the lead character in *Willy Wonka and the Chocolate Factory*. It can often seem that there is no chance for success considering the typical worker is destined to spend his/her life at the bottom layer of Maslow's Hierarchy of Needs, the physiological need of food, water, clothing and shelter, living from paycheck to paycheck somehow trying to break even at the end of each month. No hope of moving up to Maslow's third level of financial security; to say nothing to aspiring to the pinnacle of Maslow's pyramid, self-actualization.

Baumol, Blinder and Wolff (2003) in Downsizing in America report the following: (1) over half of full time employees (approximately 100 million) earn less than \$35,000; (2) 84 percent earn less than \$65,000; (3) 10 percent earn in the range of \$65,000 to \$100,000; and (4) 5.7 percent earn in excess of \$100,000. The median employee earning is \$33,636, far short of the \$65,000 studies cite as necessary for a family to maintain a middle class standard of living. Where is the middle class if only 33 percent of jobs pay in excess of \$45,000 annually?

Besides income, the net worth of an employee is also a measure of financial independence and the situation is not good. For example, in the 55 to 64 age group, Baumol, Blinder and Wolff (2003) write that the median net worth is \$235,000. It is important to note that this amount includes the value of the home. Thus, most people reach retirement with a net worth composed almost entirely of their home's value. Of course, the age bracket 55 to 64 should be the one with the highest net worth, as this is the point of the family life cycle when income should be the highest and expenses the lowest. In the other age brackets, Baumol, Blinder and Wolff (2003) show that the statistics for the median net worth ages are just as dire: 25 to 34 is \$15,125; 35 to 44 is \$102,600; 45 to 54 is \$188,000; 65 and over is \$173,000. The net worth probably will not increase in the foreseeable future since the savings rate for July, 2005 was (-.2%). These facts give rise to two questions: (1) How will future retiree retirements be funded? and (2) How will current employees enjoy a rewarding life style?

To answer the first, the funding of future retirement benefits seems to be a function of social security benefits. When the baby boomers retire, most will rely solely on social security benefits, since very few will have any financial assets. This benefit structure is scheduled for changes and not for the better for those who depend upon it for all or a substantial portion of their annual income.

In Shakespeare's "King Lear" the King is growing old and begins to worry about what is going to happen to him should he become feeble. The King decides to divide his English kingdom among his three daughters, who can do no wrong in his eyes, and has every expectation that his daughters will care for him in his old age. However, this scenario does not come true when two of his daughters repel their father to the point of trying to kill him. The third daughter so despised him that she fled to France and forfeited her inheritance rather than care for him. Within a few years, the aging King was driven mad by his daughters' behavior. Like King Lear, many retirees will look for support from their children, and like the King will learn that those you expect the most from may well disappoint.

Economically speaking, the younger "sandwich generation" will be squeezed with expenses of our making and those of its own. If social security cannot and the younger generation cannot fund these retirements, then this answer is woefully short of a solution. Although the Baby Boomers may find themselves out of time, there is yet hope for those with a little more time.

The answer to the second question, a comfortable lifestyle for those still working, involves a disciplined investment plan. As the American Dream evaporates, the employee cannot be dependent on income from his/her job for many obvious reasons: company downsizing, company mergers, voluntary retirement programs, outsourcing, and the physical inability to continue a demanding work schedule. The job cannot be the primary source of income necessary to maintain a chosen lifestyle. Rather, investment income should be the primary source for lifestyle maintenance, and thus financial independence. This is possible through a disciplined investment plan, involving only quality stocks which pay out an increasing dividend. A quality stock can be defined as one from a company with an A+ balance sheet that makes a product or provides a service that the world currently requires and will require in the future. The financial

strength of the company should be such that it is thought of in financial circles in terms of safety as a “United States Treasury” substitute. Some of these stocks are listed in Table 1 according to Standard & Poor’s Outlook (January 2005).

**TABLE 1  
QUALITY STOCKS AND DIVIDEND INCREASES**

<b>Company</b>	<b>1979-2004 Dividend Increase %</b>
<b>Anheuser-Busch</b>	<b>2380%</b>
<b>Abbott Laboratories</b>	<b>3317%</b>
<b>Automatic Data Processing</b>	<b>2099%</b>
<b>Bank of America</b>	<b>1513%</b>
<b>Johnson &amp; Johnson</b>	<b>2526%</b>
<b>Lowe’s Co.</b>	<b>1081%</b>
<b>McDonald’s Corp.</b>	<b>4625%</b>
<b>Walgreen Company</b>	<b>1623%</b>
<b>Wal-Mart Stores</b>	<b>32400%</b>

As you can tell from the list in Table 1, these companies provide a wide range of products and services. Obviously, the dividend increases over the period of 25 years have been substantially higher than the rates of both inflation and salary increases. Also of importance is the federal tax rate on these dividends. Since there is currently a maximum federal tax rate of 15% on both dividends and capital gains if the stock is held for at least one year, one would rather have dividend income than salary income taxed at a maximum of almost 36%.

Through investments in increasing dividend paying stocks representing quality companies, one can achieve financial independence both during one’s career and during the retirement years. We show this in this paper by deriving a formula (referred to as the Q-DRIP (Quarterly Dividend Reinvestment) formula) that can be used to determine future returns for various stocks at tax advantaged dividend rates. More specifically, if one were to make a one-time purchase of shares of stock from a company and then, for each quarter for a certain number of years, reinvest the dividends earned from the stock to buy additional shares of stock, the formula determines accumulations at different dividend tax rates, given that the value of the stock and dividend increase at certain but perhaps different fixed rates per year.

After deriving the Q-DRIP formula, we apply it to a \$5000 purchase of Coca Cola stock using different but historically conservative values for the rates of increase for both the value and the dividend of the stock. Inspired by the discussion in the last presidential campaign in which Senator John Kerry proposed to increase the dividend tax rate to 40% and President George Bush proposed to eliminate it all together, we compare future returns of the Coca Cola stock at the different tax rates of 0%, 15% and 40% over a 35 year period. Perhaps unexpectedly, the zero percent dividend tax rate generates considerably more of a return return, particularly when compared to the 40% tax rate.

In case an investor is willing to wait to the end of the year to reinvest the dividend, another formula referred to as the A-DRIP (Annual Dividend Reinvestment) formula is derived. This A-

DRIP formula reduces to a formula for which a calculator can be used if the rates of increase of the stock price and dividend are the same. Even if the two rates are approximately the same, this “calculator” formula is useful in approximating results obtained from the A-DRIP formula.

The Q-DRIP and A-DRIP formulas are compared and it is shown, as one would expect, that the Q-DRIP formula generates more of a return. The affect that the dividend tax rate has on the two formulas is also studied and determined.

Fourteen blue chip stocks ranked number 1 for safety by the *Value Line Investment Survey* are chosen and their accumulations in value at 0%, 15% and 40% dividend tax rates over a 20 year period are calculated. Historical data for each of the stocks is used to determine input values for the variables in each of the formulas.

Finally, different aspects of the formulas which lead to some rather surprising results are investigated.

## Q-DRIP FORMULA

To derive the Q-DRIP (Quarterly Dividend Reinvestment) formula, the formula used to compute accumulations in stock value, consider an arbitrary stock and let:

- C = the initial cost per share of stock,
- D = the initial declared dividend per share,
- X = the proportion of the dividend to be reinvested to purchase shares of stock,
- S = the number of shares initially purchased,
- $r_D$  = the rate of increase of the dividend per share ( $r_D > 0$ ),
- $r_S$  = the rate of increase of the price per share of stock ( $r_S > 0$ ),
- $S_B$  = the number of shares owned at the beginning of the  $n^{\text{th}}$  quarter,
- $S_E$  = the number of shares owned at the end of the  $n^{\text{th}}$  quarter,
- $S_P$  = the number of shares purchased at the end of the  $n^{\text{th}}$  quarter.

Although the dividend policy can be changed by the board at any time, normally the dividend is declared annually and distributed quarterly. Thus, typically the amount of dividend at the end of each quarter will remain constant throughout year and will not change until the end of first quarter of the following year. This assumption is made in this paper. Hence, the amount of dividend (DIV (n)) generated by one share of stock and used by the investor to purchase additional shares of stock at the end of the  $n^{\text{th}}$  quarter is:

$$\text{DIV (n)} = \frac{D(1+r_D)^{\left[\frac{n-1}{4}\right]}}{4} \bullet X, \quad (1)$$

where  $[\ ]$  denotes the greatest integer function. Also, the price (PRICE (n)) per share of stock over this same time period is:

$$\text{PRICE (n)} = C(1+r_S)^{\frac{n}{4}}. \quad (2)$$

Thus the quotient,

$$\text{DIV}(n)/\text{PRICE}(n) = \frac{D(1+r_D)\left[\frac{n-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{n}{4}}} \quad (3)$$

represents the number of shares of stock purchased by the investor from the dividends of a single share of stock at the end of the  $n^{\text{th}}$  quarter. This continuing process is illustrated in Table 2.

**TABLE 2**  
**SHARES PURCHASED FROM THE DIVIDENDS OF ONE SHARE OF STOCK**

Year	Quarters			
	1	2	3	4
1	$\frac{D(1+r_D)\left[\frac{1-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{1}{4}}}$	$\frac{D(1+r_D)\left[\frac{2-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{2}{4}}}$	$\frac{D(1+r_D)\left[\frac{3-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{3}{4}}}$	$\frac{D(1+r_D)\left[\frac{4-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{4}{4}=1}}$
2	$\frac{D(1+r_D)\left[\frac{5-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{5}{4}}}$	$\frac{D(1+r_D)\left[\frac{6-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{6}{4}}}$	$\frac{D(1+r_D)\left[\frac{7-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{7}{4}}}$	$\frac{D(1+r_D)\left[\frac{8-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{8}{4}=2}}$
3	$\frac{D(1+r_D)\left[\frac{9-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{9}{4}}}$	$\frac{D(1+r_D)\left[\frac{10-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{10}{4}}}$	$\frac{D(1+r_D)\left[\frac{11-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{11}{4}}}$	$\frac{D(1+r_D)\left[\frac{12-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{12}{4}=3}}$
4	$\frac{D(1+r_D)\left[\frac{13-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{13}{4}}}$	$\frac{D(1+r_D)\left[\frac{14-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{14}{4}}}$	$\frac{D(1+r_D)\left[\frac{15-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{15}{4}}}$	$\frac{D(1+r_D)\left[\frac{16-1}{4}\right] \cdot X}{4} \cdot \frac{1}{C(1+r_S)^{\frac{16}{4}=4}}$
5	.....	.....	.....	.....

Also note that

$$\begin{aligned}
 S_E &= S_B + S_P \\
 &= S_B + S_B \cdot [\text{DIV (n)/PRICE (n)}] \\
 &= S_B + S_B \cdot \left( \frac{D(1+r_D)^{\lfloor \frac{n-1}{4} \rfloor} \cdot X}{C(1+r_S)^{\frac{n}{4}}} \right) \\
 &= S_B \left( 1 + \frac{D(1+r_D)^{\lfloor \frac{n-1}{4} \rfloor} \cdot X}{C(1+r_S)^{\frac{n}{4}}} \right) \\
 &= S_B \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \frac{(1+r_D)^{\lfloor \frac{n-1}{4} \rfloor}}{(1+r_S)^{\frac{n}{4}}} \right) \tag{4}
 \end{aligned}$$

Because  $\left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \frac{(1+r_D)^{\lfloor \frac{n-1}{4} \rfloor}}{(1+r_S)^{\frac{n}{4}}} \right)$  occurs as a factor in the above expression for each

value of  $n$ , then, by induction, at the end of  $n^{\text{th}}$  quarters,

$$S_E = S \left[ \prod_{i=1}^n \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \frac{(1+r_D)^{\lfloor \frac{i-1}{4} \rfloor}}{(1+r_S)^{\frac{i}{4}}} \right) \right]. \tag{5}$$

Therefore, at the end of  $n$  quarters the investor will have accumulated a value in stock of  $A$  dollars where

$$\begin{aligned}
 A &= (\text{Cost per share at the end of the quarter}) \cdot S_E \\
 &= C(1+r_S)^{\frac{n}{4}} \cdot S \left[ \prod_{i=1}^n \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \frac{(1+r_D)^{\lfloor \frac{i-1}{4} \rfloor}}{(1+r_S)^{\frac{i}{4}}} \right) \right] \\
 &= CS(1+r_S)^{\frac{n}{4}} \left[ \prod_{i=1}^n \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \frac{(1+r_D)^{\lfloor \frac{i-1}{4} \rfloor}}{(1+r_S)^{\frac{i}{4}}} \right) \right] \quad (\text{Q-DRIP formula}) \tag{6}
 \end{aligned}$$

### EXAMPLE USING THE Q-DRIP FORMULA

Assume that an employee of Coca Cola is 25 years of age and begins with 100 shares of stock valued at \$ 50.00 per share with a declared dividend of \$ 1.00 per share. How much will the employee accumulate in value of stock at the end of a 35 year period if the dividend is taxed at (1) 40 % (2) 15 %, and (3) 0 % given that the values of the stock and the dividend increase at the following annual rates?

- Stock value and dividend both at 7 %
- Stock value at 8 % and dividend at 10 %
- Stock value at 10 % and dividend at 12 %

The different accumulations in value of stock are given in Table 3. It is interesting to note that over the past 15 years, the value of Coca Cola stock has increased at a rate of 10.8 % and its dividend at a rate of 12.5 % per year. Also observe that the 0% dividend tax rate generates a substantial difference in total return, particularly when compared to the 40% tax rate.

**TABLE 3**  
**DIVIDENDS FROM COCA COLA REINVESTED QUARTERLY OVER A 35 YEAR PERIOD USING THE Q-DRIP FORMULA**

(1) The dividend is taxed at 40 %.

Stock value rate of increase	Dividend rate of increase	Accumulation
7 %	7 %	\$ 79,805.6
8 %	10 %	\$128,806.0
10 %	12 %	\$242,468.0

(2) The dividend is taxed at 15 %.

Stock value rate of increase	Dividend rate of increase	Accumulation
7 %	7 %	\$ 94,329.8
8 %	10 %	\$162,224.0
10 %	12 %	\$304,158.0

(3) The dividend is taxed at 0 %.

Stock value rate of increase	Dividend rate of increase	Accumulation
7 %	7 %	\$104,274.0
8 %	10 %	\$186,270.0
10 %	12 %	\$ 348,407.0

Now consider the last row in Table 3 where there is a 0% dividend tax rate, a 10% rate of increase in stock value and a 12% rate of increase in the dividend. What would happen if the investor reinvested none of the dividend but instead spent it at the end of each quarter? At the end of 35 years, he/she would have accumulated only \$140,512, a return of almost 60% less than had the dividend been reinvested. And what would have happened if the dividend at the end of each quarter was put in a piggy bank or under a mattress? In this case, the accumulation would be \$183,679, approximately 47% less of a return. What a difference compound interest and the reinvesting of the dividend makes!

### A-DRIP FORMULA

Formula 6, the Q-DRIP formula, is some what simplified if the investor is willing to wait until the end of the year to reinvest the dividend. This is especially true if we assume  $r_D = r_S$ . To derive this annual dividend reinvestment (A-DRIP) formula, let the representations of C, D, X, S,  $r_D$  and  $r_S$  be as before; but let  $S_B$ ,  $S_E$ , and  $S_P$  respectively represent the number of shares owned at the beginning of the  $m^{th}$  year, the number of shares owned at the end of the  $m^{th}$  year and the number of shares purchased at the beginning of the  $m^{th}$  year.

Then at the end of the  $m^{th}$  year,

$$\text{ADIV (m)} = D(1+r_D)^{m-1} \cdot X \quad (7)$$

represents the amount of dividend generated by one share of stock and used to purchase additional shares,

$$\text{APRICE (m)} = C(1+r_S)^m \quad (8)$$

represents the price per share of stock, and

$$\text{ADIV (m)/APRICE (m)} = \frac{D(1+r_D)^{m-1} \cdot X}{C(1+r_S)^m} \quad (9)$$

represents the number of shares purchased from the dividends of a single share of stock.

We have

$$\begin{aligned} S_E &= S_B + S_P = S_B \cdot [\text{ADIV (m)/APRICE (m)}] \\ &= S_B + S_B \cdot \left( \frac{D(1+r_D)^{m-1} \cdot X}{C(1+r_S)^m} \right) \\ &= S_B \left( 1 + \frac{D(1+r_D)^{m-1} \cdot X}{C(1+r_S)^m} \right). \end{aligned} \quad (10)$$

Since  $1 + \frac{D(1+r_D)^{m-1} \cdot X}{C(1+r_S)^m}$  occurs as a factor in the above expression for each value of  $m$ , then at the end of  $m$  years,

$$S_E = S \left[ \prod_{i=1}^m \left( 1 + \frac{DX}{C} \cdot \frac{(1+r_D)^{i-1}}{(1+r_S)^i} \right) \right]. \quad (11)$$

Moreover, since the cost per share of stock is  $C(1+r_S)^m$ , then the accumulation A of value in stock at the end of  $m$  years is,

$$\begin{aligned} A &= C(1+r_S)^m \cdot S \left[ \prod_{i=1}^m \left( 1 + \frac{DX}{C} \cdot \frac{(1+r_D)^{i-1}}{(1+r_S)^i} \right) \right] \\ &= CS(1+r_S)^m \left[ \prod_{i=1}^m \left( 1 + \frac{DX}{C} \cdot \frac{(1+r_D)^{i-1}}{(1+r_S)^i} \right) \right]. \quad (\text{A-DRIP formula}) \end{aligned} \quad (12)$$

### The Case Where $r_D \approx r_S$

Now let's assume that  $r_S = r_D$ , then  $\frac{1+r_D}{1+r_S} = 1$ , and the accumulation A of value in stock at the end of  $m$  years is,

$$\begin{aligned} A &= C(1+r_S)^m \cdot S \left[ \prod_{i=1}^m \left( 1 + \frac{DX}{C} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{i-1} \cdot \frac{1}{1+r_S} \right) \right] \\ &= CS(1+r_S)^m \left( 1 + \frac{D}{C} \cdot \frac{1}{1+r_S} \cdot X \right)^m. \quad (\text{A-DRIP formula when } r_S = r_D) \end{aligned} \quad (13)$$

This formula can be applied using only a calculator and is a valuable tool in estimating A, particularly if  $r_D \approx r_S$ .

## COMPARING THE Q-DRIP AND A-DRIP FORMULAS

It is intuitively clear that one would accumulate more value in stock applying the Q-DRIP formula rather than the A-DRIP formula and this is indeed the case. To see this, first note that at the end of any year  $j$ , the number of shares owned using the Q-DRIP formula is equal to

$$\begin{aligned}
 & S \prod_{i=1}^{4j} \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \frac{(1+r_D)^{\lceil \frac{i-1}{4} \rceil}}{(1+r_S)^{\frac{i}{4}}} \right) = \\
 & S \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^0 \cdot \frac{1}{(1+r_S)^{\frac{1}{4}}} \right) \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^0 \cdot \frac{1}{(1+r_S)^{\frac{2}{4}}} \right) \\
 & \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^0 \cdot \frac{1}{(1+r_S)^{\frac{3}{4}}} \right) \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^0 \cdot \frac{1}{(1+r_S)^{\frac{4}{4}}} \right) \\
 & \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^1 \cdot \frac{1}{(1+r_S)^{\frac{1}{4}}} \right) \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^1 \cdot \frac{1}{(1+r_S)^{\frac{2}{4}}} \right) \\
 & \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^1 \cdot \frac{1}{(1+r_S)^{\frac{3}{4}}} \right) \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^1 \cdot \frac{1}{(1+r_S)^{\frac{4}{4}}} \right) \\
 & \cdot \\
 & \cdot \\
 & \cdot \\
 & \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{j-1} \cdot \frac{1}{(1+r_S)^{\frac{1}{4}}} \right) \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{j-1} \cdot \frac{1}{(1+r_S)^{\frac{2}{4}}} \right) \\
 & \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{j-1} \cdot \frac{1}{(1+r_S)^{\frac{3}{4}}} \right) \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{j-1} \cdot \frac{1}{(1+r_S)^{\frac{4}{4}}} \right) = \\
 & S \prod_{k=1}^j \prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right).
 \end{aligned}$$

Since the price per share of stock at the end of each year  $j$  is the same in both formulas, it is necessary only to show that:

$$\prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right) > \left( 1 + \frac{D}{C} \cdot X \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right) \quad (14)$$

for each value of  $k$ .

This is easy to see, for since  $0 < \frac{1}{1+r_S} < 1$ , then

$$1 > \frac{1}{(1+r_S)^{\frac{1}{4}}} > \frac{1}{(1+r_S)^{\frac{2}{4}}} > \frac{1}{(1+r_S)^{\frac{3}{4}}} > \frac{1}{1+r_S} > 0;$$

and by applying the Binomial Theorem for  $n = 4$ , it follows that

$$\begin{aligned} & \prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right) \\ & > \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right)^4 \\ & = 1 + \left( \frac{D}{C} \cdot X \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right) + \dots + \left( \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right)^4 \\ & > \left( 1 + \frac{D}{C} \cdot X \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right). \end{aligned}$$

#### Example Using the A-DRIP Formula

Now let's take our Coca Cola example and apply the A-DRIP formula. From the results indicated in Table 4, one can see that the accumulations in value of stock of Coca Cola using the Q-DRIP formula (Table 3) exceed the accumulations of Coca Cola using the A-DRIP formula .

**TABLE 4**  
**DIVIDENDS FROM COCA COLA REINVESTED QUARTERLY OVER A 35 YEAR PERIOD USING THE A-DRIP FORMULA**

(1) The dividend is taxed at 40 %.

Stock value rate of increase	Dividend rate of increase	Accumulation
7 %	7 %	\$ 78,872.2
8 %	10 %	\$126,371.0
10 %	12 %	\$237,112.0

(2) The dividend is taxed at 15 %.

Stock value rate of increase	Dividend rate of increase	Accumulation
7 %	7 %	\$ 92,683.8
8 %	10 %	\$157,612.0
10 %	12 %	\$294,178.0

(3) The dividend is taxed at 0 %.

Stock value rate of increase	Dividend rate of increase	Accumulation
7 %	7 %	\$ 102,070.0
8 %	10 %	\$ 179,828.0
10 %	12 %	\$ 334,596.0

## HOW THE DIVIDEND TAX RATE AFFECTS THE FORMULA

What part does  $X$  (the proportion of the dividend to be reinvested to purchase shares of stock) play in the formula? To answer this question, first consider the A-DRIP formula where  $r_s = r_D$ . From (13),

$$\begin{aligned} A &= CS(1+r_s)^m \left( 1 + \frac{D}{C} \cdot \frac{1}{1+r_s} \cdot X \right)^m \\ &= C(1+r_s)^m \cdot S \left( 1 + \frac{D}{C} \cdot \frac{1}{1+r_s} \cdot X \right)^m, \end{aligned} \quad (15)$$

where  $C(1+r_s)^m$  represents the price per share of stock at the end of the  $m^{\text{th}}$  year and

$S \left( 1 + \frac{D}{C} \cdot \frac{1}{1+r_s} \cdot X \right)^m$  represents the accumulation of stock at the end of the  $m^{\text{th}}$  year. Notice

that the expression  $\left( 1 + \frac{D}{C} \cdot \frac{1}{1+r_s} \cdot X \right)^m$  has the same form as an ordinary compound interest

formula. Thus, by considering  $\frac{D}{C} \cdot \frac{1}{1+r_s}$  to be a fixed annual rate of increase in the

accumulation of shares of stock (which is certainly a legitimate assumption), multiplying it by  $X$  has the affect of decreasing it by  $1 - X$ , the dividend tax rate.

Next, assume the dividends are being reinvested annually and  $r_s \neq r_D$ . Then by (12),

$$A = C(1+r_s)^m \cdot S \prod_{i=1}^m \left( 1 + \frac{D}{C} \cdot \left( \frac{1+r_D}{1+r_s} \right)^{i-1} \cdot \frac{1}{1+r_s} \cdot X \right)$$

where

$$S \prod_{i=1}^m \left( 1 + \frac{D}{C} \cdot \left( \frac{1+r_D}{1+r_s} \right)^{i-1} \cdot \frac{1}{1+r_s} \cdot X \right)$$

represents the accumulation of stock after  $m$  years. Since  $r_s \neq r_D$ ,

$$\left( \frac{1+r_D}{1+r_s} \right)^{i-1}$$

changes each year. However, if we think of

$$\frac{D}{C} \cdot \left( \frac{1+r_D}{1+r_s} \right)^{i-1} \cdot \frac{1}{1+r_s}$$

as a variable annual rate of increase in the accumulation of shares of stock, then multiplying it by  $X$  also has the affect of decreasing it by the dividend tax rate,  $1-X$ .

If the dividends are being reinvested quarterly using the Q-DRIP formula, then by the proof used to show (14), for each year  $k$ ,

$$\prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right) > \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right)^4.$$

Since

$$\frac{1}{(1+r_S)^{\frac{1}{4}}} > \frac{1}{(1+r_S)^{\frac{2}{4}}} > \frac{1}{(1+r_S)^{\frac{3}{4}}} > \frac{1}{1+r_S},$$

then it is also true that

$$\prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right) < \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{1}{4}}} \right)^4,$$

and therefore,

$$S \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{1+r_S} \right)^4 < S \prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right) < S \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{1}{4}}} \right)^4.$$

Thus, for each year  $k$ ,

$$S \prod_{i=1}^4 \left( 1 + \frac{D}{C} \cdot \frac{X}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \right)$$

is fairly tightly bound between two formulas both of which can be considered to be “*variable annual rate of increase*” functions. In each case,  $X$  has the affect of decreasing their rates of increase by the dividend tax rate,  $1-X$ . For the rest of this paper,

$$\frac{D}{C} \cdot \frac{1}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}} \tag{16}$$

will be referred to as the variable rate of increase of the Q-DRIP formula.

## ACCUMULATIONS IN VALUE OF STOCKS

In Tables 5 and 6, we choose 14 blue chip companies ranked number 1 for safety by *The Value Line Investment Survey* and project the accumulation in the value of each of their stocks at the end of a 20-year period given a one-time investment of \$5,000 using dividend tax rates of 40%, 15% and 0%. In each case, we choose the values of  $r_D$  and  $r_S$  to be what they have averaged over the past 12 years. In Table 5, the dividends are reinvested quarterly, and in Table 6, they are reinvested annually.

**TABLE 5**  
**ACCUMULATION IN VALUE OF DIFFERENT STOCKS FOR A 20 YEAR PERIOD**  
**WITH A ONE TIME INVESTMENT OF \$5000 UNDER THE ASSUMPTION THAT**  
**THE DIVIDENDS WILL BE REINVESTED ON A QUARTERLY BASIS**

<b>Quarterly</b>							<b>Accum</b>	<b>Accum</b>	<b>Accum</b>
<b>Stocks Name</b>	<b>C</b>	<b>D</b>	<b>S</b>	<b>DVYD</b>	$r_D$	$r_S$	<b>X = .6</b>	<b>X = .85</b>	<b>X =1</b>
Abbot Labs	48.24	1.10	103.65	0.023	0.099	0.098	42,066.70	46,868.50	50,005.30
Exxon Mobil Corp.	55.68	1.16	89.80	0.021	0.033	0.087	30,889.10	32,912.70	34,189.10
Johnson & Johnson	64.47	1.36	74.11	0.020	0.131	0.133	75,694.30	82,940.70	87,613.10
Kimberly-Clark	65.00	1.80	76.92	0.028	0.054	0.069	25,104.50	28,193.30	30,223.60
McDonald's Corp	30.89	0.55	161.86	0.018	0.122	0.061	23,604.10	27,497.90	30,131.50
McGraw-Hill	43.28	0.66	115.23	0.015	0.064	0.13	63,610.90	66,357.80	68,061.80
<b>Quarterly</b>							<b>Accum</b>	<b>Accum</b>	<b>Accum</b>
<b>Stocks Name</b>	<b>C</b>	<b>D</b>	<b>S</b>	<b>DVYD</b>	$r_D$	$r_S$	<b>X = .6</b>	<b>X = .85</b>	<b>X =1</b>
New Plan	26.46	1.72	188.96	0.065	0.021	0.004	13,276.40	19,643.30	24,605.10
Proctor & Gamble	55.73	1.12	89.72	0.020	0.105	0.119	57,858.20	62,872.50	66,084.60
SLM Corporation	48.45	0.88	103.20	0.018	0.164	0.161	121,327.00	132,038.00	138,907.00
Tootsie Roll Ind.	30.84	0.28	162.13	0.009	0.135	0.109	42,015.00	47,485.50	49,031.20
Wal-Mart	47.30	0.60	105.71	0.013	0.174	0.113	54,490.40	60,391.90	64,231.00
Sara Lee	20.79	0.79	240.50	0.038	0.086	0.048	24,019.50	31,204.80	36,494.80
3 M	77.06	1.68	64.88	0.022	0.047	0.098	38,171.20	40,847.90	42,541.90
Wilmington Trust	35.05	1.20	142.65	0.034	0.072	0.107	50,963.20	57,457.40	61,739.20

The variables listed in the table represent the following: C = the initial cost per share of stock; D = the initial declared dividend per share; S = the initial number of shares purchased with \$5000 ( $S = 5000/C$ ); X = the proportion of the dividend to be reinvested to purchase shares of stock; DVYD =  $D/C$ ;  $r_D$  = the rate of increase of the dividend per share of stock;  $r_S$  = the rate of increase of the price per share of stock.

**TABLE 6**  
**ACCUMULATION IN VALUE OF DIFFERENT STOCKS FOR A 20 YEAR PERIOD**  
**WITH A ONE TIME INVESTMENT OF \$5000 UNDER THE ASSUMPTION THAT**  
**THE DIVIDENDS WILL BE REINVESTED ON AN ANNUAL BASIS**

<b>Annually</b>							<b>Accum</b>	<b>Accum</b>	<b>Accum</b>
<b>Stocks Name</b>	<b>C</b>	<b>D</b>	<b>S</b>	<b>DVYD</b>	$r_D$	$r_S$	<b>X = .6</b>	<b>X = .85</b>	<b>X =1</b>
Abbot Labs	48.24	1.10	103.65	0.023	0.099	0.098	41,640.40	41,166.00	49,101.70
Exxon Mobil Corp.	55.68	1.16	89.80	0.021	0.033	0.087	30,729.60	32,664.00	33,879.40
Johnson & Johnson	64.47	1.36	74.11	0.020	0.131	0.133	74,866.90	81,621.70	85,948.30
Kimberly-Clark	65.00	1.80	76.92	0.028	0.054	0.069	24,896.50	27,840.80	29,763.00
McDonald's Corp	30.89	0.55	161.86	0.018	0.122	0.061	23,351.90	27,042.10	29,514.00
McGraw-Hill	43.28	0.66	115.23	0.015	0.064	0.13	63,306.30	65,900.80	67,505.40
New Plan	26.46	1.72	188.96	0.065	0.021	0.004	13,254.20	19,023.00	23,554.80
<b>Annually</b>							<b>Accum</b>	<b>Accum</b>	<b>Accum</b>
<b>Stocks Name</b>	<b>C</b>	<b>D</b>	<b>S</b>	<b>DVYD</b>	$r_D$	$r_S$	<b>X = .6</b>	<b>X = .85</b>	<b>X =1</b>
Proctor & Gamble	55.73	1.12	89.72	0.020	0.105	0.119	57,338.60	62,049.90	65,050.80
SLM Corporation	48.45	0.88	103.20	0.018	0.164	0.161	119,890.00	129,778.00	136,077.00
Tootsie Roll Ind.	30.84	0.28	162.13	0.009	0.135	0.109	44,780.60	47,127.50	48,591.20
Wal-Mart	47.30	0.60	105.71	0.013	0.174	0.113	53,895.80	59,422.10	62,990.60
Sara Lee	20.79	0.79	240.50	0.038	0.086	0.048	23,581.60	30,276.40	35,120.00
3 M	77.06	1.68	64.88	0.022	0.047	0.098	37,937.00	40,481.80	42,085.40
Wilmington Trust	35.05	1.20	142.65	0.034	0.072	0.107	50,336.70	56,412.10	60,384.50
See Table 5 to find the representations of the variables listed in this table.									

### A STUDY OF DIFFERENT ASPECTS OF THE FORMULA

By studying the formula a little more closely, we are able to make three observations. The first is that the greater the value of the *variable rate of increase of the Q-DRIP formula*

$$\frac{D}{C} \cdot \frac{1}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^i}$$

in the accumulation of shares of stock of a company (see (16)), the more affect X , the proportion of the dividend reinvested to purchase additional shares of stock, (for X<1) has in decreasing the

percentage of the accumulation of the shares of stock (from the accumulation when  $X=1$ ) and therefore reducing the percentage in their cumulative total value.

To verify this, it is sufficient to show that if  $S > 0$ ,  $0 < X < 1$ , and  $r'_i < r_i$  for  $i = 1, 2, 3, \dots, k$ , then the percent decrease from the accumulation of  $S$  using  $r_i$  to the accumulation of  $S$  using  $Xr_i$  is less than the percent decrease of the accumulation of  $S$  using  $r'_i$  to the accumulation of  $S$  using  $Xr'_i$ . Mathematically, this means the following must be true:

$$-\frac{S \prod_{i=1}^k (1 + Xr_i) - S \prod_{i=1}^k (1 + r_i)}{S \prod_{i=1}^k (1 + r_i)} < -\frac{S \prod_{i=1}^k (1 + Xr'_i) - S \prod_{i=1}^k (1 + r'_i)}{S \prod_{i=1}^k (1 + r'_i)}.$$

First observe that

$$\begin{aligned} r'_i > r_i &\Rightarrow r'_i(1 - X) > r_i(1 - X) \\ &\Rightarrow r'_i - Xr'_i > r_i - Xr_i \\ &\Rightarrow r'_i + Xr_i > r_i + Xr'_i \\ &\Rightarrow r'_i + Xr_i + 1 + Xr_i r'_i > r_i + Xr'_i + 1 + Xr_i r'_i \\ &\Rightarrow (1 + r'_i)(1 + Xr_i) > (1 + r_i)(1 + Xr'_i) \\ &\Rightarrow \frac{1 + Xr_i}{1 + r_i} > \frac{1 + Xr'_i}{1 + r'_i}. \end{aligned}$$

Therefore,

$$\begin{aligned} \frac{\prod_{i=1}^k (1 + Xr_i)}{\prod_{i=1}^k (1 + r_i)} &> \frac{\prod_{i=1}^k (1 + Xr'_i)}{\prod_{i=1}^k (1 + r'_i)} \Rightarrow \frac{\prod_{i=1}^k (1 + Xr_i)}{\prod_{i=1}^k (1 + r_i)} - 1 > \frac{\prod_{i=1}^k (1 + Xr'_i)}{\prod_{i=1}^k (1 + r'_i)} - 1 \\ &\Rightarrow \frac{S \prod_{i=1}^k (1 + Xr_i) - S \prod_{i=1}^k (1 + r_i)}{S \prod_{i=1}^k (1 + r_i)} > \frac{S \prod_{i=1}^k (1 + Xr'_i) - S \prod_{i=1}^k (1 + r'_i)}{S \prod_{i=1}^k (1 + r'_i)} \\ &\Rightarrow -\frac{S \prod_{i=1}^k (1 + Xr_i) - S \prod_{i=1}^k (1 + r_i)}{S \prod_{i=1}^k (1 + r_i)} < -\frac{S \prod_{i=1}^k (1 + Xr'_i) - S \prod_{i=1}^k (1 + r'_i)}{S \prod_{i=1}^k (1 + r'_i)}. \end{aligned}$$

This affect of  $X$  decreasing the percentage in the accumulation of shares of stock and consequently their cumulative total value can be particularly seen in McDonald's Corporation and in Sara Lee Corporation where changing  $X$  from 1 to .60 causes a decrease in the total accumulation of almost 22 % in McDonald's and approximately 34 % in Sara Lee. In both

cases,  $r_D$ , the rate of increase of the dividend, is considerably larger than  $r_S$ , the rate of increase of the price of the stock, which means that the variable rate (16),

$$\frac{D}{C} \cdot \frac{1}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}},$$

is relatively large and becomes even larger as  $k$  increases in value. With Sara Lee, the affect is even more pronounced because its dividend yield  $\frac{D}{C}$  is so high. This percent decrease would even be more dramatic if we were to extend the time period beyond 20 years. For example, over a 35-year period, McDonald's decrease would be more than 50% and Sara Lee's more than 60%.

Next it is observed that when comparing the accumulation in the value of the shares of stock of McDonald's and Sara Lee Corporations, Sara Lee's accumulation is greater than McDonald's even though its values for  $r_D$  and  $r_S$  are less than those of McDonald's. The reason for this rather surprising result can be found by examining the variable rate formula (16),

$$\frac{D}{C} \cdot \frac{1}{4} \cdot \left( \frac{1+r_D}{1+r_S} \right)^{k-1} \cdot \frac{1}{(1+r_S)^{\frac{i}{4}}}$$

for the accumulation of shares of stock for both of the companies. Notice that the dividend yield  $\frac{D}{C}$  for Sara Lee is more than twice that of McDonald's. Moreover, it turns out that for each

stock, the value for  $\frac{1+r_D}{1+r_S}$  is only slightly greater than one with McDonald's value exceeding

Sara Lee's by only about 2%. Thus, until the value of  $k$  becomes quite large, the variable rate for Sara Lee exceeds that of McDonald's. This means that initially the Sara Lee investment will generate more shares of stock; and, it in fact, generates enough additional shares to where their accumulation in value exceeds that of McDonald's. McDonald's cumulative total will eventually pass Sara Lee's but this will not occur with the Q-DRIP formula (6) (with  $X = 1$ ) until  $n = 188$  (47 years)!

Finally, it is observed that if  $r_1$  and  $r_2$  denote two rates of increase and  $r_1 > r_2$ , the difference between the effective rate of increase derived from  $r_1$  by compounding it quarterly and  $r_1$  is greater than the difference between the effective rate obtained by compounding  $r_2$  quarterly and  $r_2$ . That is, if  $r_1 > r_2$ , then

$$\left[ \left( 1 + \frac{r_1}{4} \right)^4 - 1 \right] - r_1 > \left[ \left( 1 + \frac{r_2}{4} \right)^4 - 1 \right] - r_2.$$

(This assertion is easily verified by expanding both  $\left[ \left( 1 + \frac{r_1}{4} \right)^4 \right]$  and  $\left[ \left( 1 + \frac{r_2}{4} \right)^4 \right]$ .)

Thus, the greater the variable rate of increase in the accumulation of shares of stock in a company, the greater the difference will be between the amount of stock accumulated on a quarterly basis and on an annual basis. This can be seen to a limited degree when comparing the differences in the accumulated values of stock using the A-DRIP and Q-DRIP formulas with Kimberly-Clark and McDonald's corporation where for  $X = 1$ , McDonald's investment accumulates approximately \$618 extra and Kimberly-Clark about \$461 extra. Observe that

although Kimberly-Clark has a higher dividend yield, both companies have approximately the same rate of increase in price per share of stock and McDonald's corporation has a much higher rate of increase in its dividend per share of stock. Because of its higher dividend yield, Kimberly-Clark's variable rate of increase in the accumulation of shares of stock is initially higher than that of McDonald's, but after 6 years, McDonald's variable rate exceeds that of Kimberly-Clark and each year thereafter the difference becomes even greater. If instead of a 20-year period, we were to determine the accumulation for a 35-year period, McDonald's investment would accumulate more than \$13,000 extra where as Kimberly-Clark only a little more than \$3000 extra.

## CONCLUSION

In this paper, we have derived a formula that can be used to predict future returns from companies of interest by using historical data as input. Through application of the formula, we have shown that one can indeed achieve financial security by investing in quality companies that pay increasing dividends. We also investigated different aspects of the formula including the affect that the dividend tax rate has on earnings. We showed that a high dividend tax rate could noticeably reduce the total return, particularly if it is in effect for a long period of time. Some surprising results were also found. For example, one company's dividend rate and stock value rate of increases being greater than another does not necessarily mean that it will generate a greater return. The dividend yield also plays a large part in determining the return. Finally, the investor is presented with a formula which can be used as a prognostication tool in selecting companies in which to invest over a long period of time for maximum gain.

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