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**Contingent Claims Analysis - PERCS**

**0. Introduction**

The PERCS security is a Preference Equity Redemption Cumulative Stock, invented by Morgan Stanley in the mid-1980's. The PERCS is a cumulative preferred stock with an initial maturity of three to five years, with mandatory conversion at maturity and subject to early conversion at a premium at the option of the issuing corporation. The upside potential of the PERCS is limited relative to the common: if the common stock price at expiration,  $S_T$ , is less than the "PERCS Capped price,"  $X$ , the PERCS holder receives one common share per PERCS share; if  $S_T \geq X$ , the PERCS holder receives  $X/S_T$  common shares per PERCS.<sup>1</sup> If the PERCS is called (forced conversion) prior to maturity the redemption prices are larger than  $X$  by an amount that decreases with time to maturity.

The structure of the security is similar to a "buy-write" option strategy, where the holder buys the underlying common stock and sells a call option against his/her share. The security is designed to be issued at a price very close to the current stock price (in fact, the PERCS security is sometimes used in an exchange offer for common on a one-to-one basis). In order for the PERCS security to be worth as much

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<sup>1</sup> $X/S_T$  is clearly less than one when  $S_T > X$ . The payoff per PERCS is thus capped at  $X$  per PERC:  $X/S_T$  shares each worth  $S_T$  equals a payoff of  $X$ .

as a common share, the PERCS holder must be compensated for giving away some of the upside potential of the common stock. What the PERCS holder receives in exchange is a higher dividend stream than the common stock holder receives. This is, in essence, the price the PERCS holder receives for "selling the call option."

Before discussing the valuation of the PERCS security, it is useful to contrast the terms on PERCS to the common stock underlying the instrument:

*Dividends.* The PERCS dividend is set higher than the current common dividend. The PERCS dividend is a preferred dividend, fixed at its dollar level at the time of issue: should the management raise, cut or eliminate the common dividend, the preferred dividend would remain the same.<sup>2</sup>

*Preferred status.* The PERCS dividend would have higher priority than the common dividend and the PERCS dividend is cumulative, so any arrearages or passed preferred dividends would have to be paid in full before any common dividends could be resumed.

*Voting.* PERCS, in some cases, have voting rights, but not generally.

*Liquidation.* In liquidation, PERCS would have a priority claim to common, but this issue is probably moot because shareholders can force early conversion if it is in their interest.

The rest of the paper is organized as follows: Section 1 derives the valuation model for PERCS under the simplifying assumptions that the company does not redeem the PERCS prior to maturity, that all dividends on the PERCS and the common are expected to be remain unchanged from current levels. Section 2 applies the model to an example company, discusses estimation of the call value and uses the model to evaluate the fairness of an exchange offer to trade in common shares for PERCS on a one-for-one basis; Section 3 gives some concluding comments.

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<sup>2</sup>The PERCS contract usually specifies a limit on the dividends paid to common shares during the life of the PERCS security.

## 1. PERCS Valuation model

We start by defining some notation:

$T$  = maturity date of the PERCS

$t$  = some date prior to  $T$

$S_t$  = common stock price (date  $t$ ) of the firm with both PERCS and common outstanding

$PERCS_t$  = PERCS price (date  $t$ )

$X$  = PERCS cap price

$S^*_t$  = price of pseudo-common stock on date  $t$  (the common stock of a firm identical to the PERCS issuing firm but with *only regular common stock outstanding*)

PDIV = dividend on PERCS

SDIV = dividend on common

$S^*DIV$  = dividend on pseudo-common

$N_p$  = number of PERCS shares outstanding

$N_s$  = number of common shares outstanding

$N_{s^*}$  = number of pseudo common shares

$E_t$  = total value of equity of company (date  $t$ ) =  $N_s S_t + N_p PERCS_t$

$E^*_t$  = total value of equity of pseudo-company =  $N_{s^*} S^*_t$

As a first step in valuing the PERCS security, we outline the cash flows to the PERCS holder and to the common holder for a hypothetical firm with the following data:

Stock price	\$30
Current common dividend	\$1.20 annual/paid quarterly (4% annual yield)
Number of common shares outstanding after the PERCS issue	80 million shares
PERCS new issue price	\$30 (exchange offer)
PERCS dividend	\$2.40 annual (8% annual yield)
Number of PERCS shares outstanding after the PERCS issue	20 million shares
PERCS capped price	\$40 (33% premium)
PERCS expiration	3 years

Assume the following: 1. The company does not redeem the PERCS prior to maturity; 2. The dividends

on the common remain unchanged; 3. All dividends on the PERCS and the common are paid. Under these conditions, the cash flows accruing to the holder of the PERC, the holder of the common, and the holder of "pseudo common" (defined below) is shown on the following table.

<b>Quarter</b>	<b>Cash Flow to PERC Holder</b>	<b>Cash Flow to Common Holder</b>	<b>Cash Flow to "Pseudo Common"</b>
0	-30	-30	-30
1	0.60	0.30	0.36
2	0.60	0.30	0.36
3	0.60	0.30	0.36
4	0.60	0.30	0.36
5	0.60	0.30	0.36
6	0.60	0.30	0.36
7	0.60	0.30	0.36
8	0.60	0.30	0.36
9	0.60	0.30	0.36
10	0.60	0.30	0.36
11	0.60	0.30	0.36
12	0.60 + Redemption Value	0.30 + Stock Value	0.36 + Pseudo Stock Value

The PERCS holder receives a higher dividend than the common stock. The pseudo common stock is the common stock that would be outstanding if the company did not issue the PERCS security and paid an equivalent amount in total dividends.<sup>3</sup> Define the price per share of pseudo common to be  $S^*$  and the total value of the pseudo common to be  $S^*$  times the number of shares that would have been outstanding: i.e., the total value of the pseudo equity,  $E^* = 100$  million times  $S^*$ .

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<sup>3</sup>80 million shares of common @ 0.30 per share plus 20 million PERCS shares @ 0.60 per share = \$36 million in total dividends, divided by 100 million pseudo equity shares outstanding yields 0.36 per share quarterly dividend.

*Fundamental learning point.* The value of the total equity (Common plus PERCS) at any point in time must equal the total value of the pseudo equity, i.e.,

$$N_p \text{PERCS}_t + N_s S_t = N^* S^*_t$$

This follows from the fact that the total cash outlay in the first three years is the same and the PERCS plus the common own the same equity of the company that the pseudo equity would own at the end of three years.

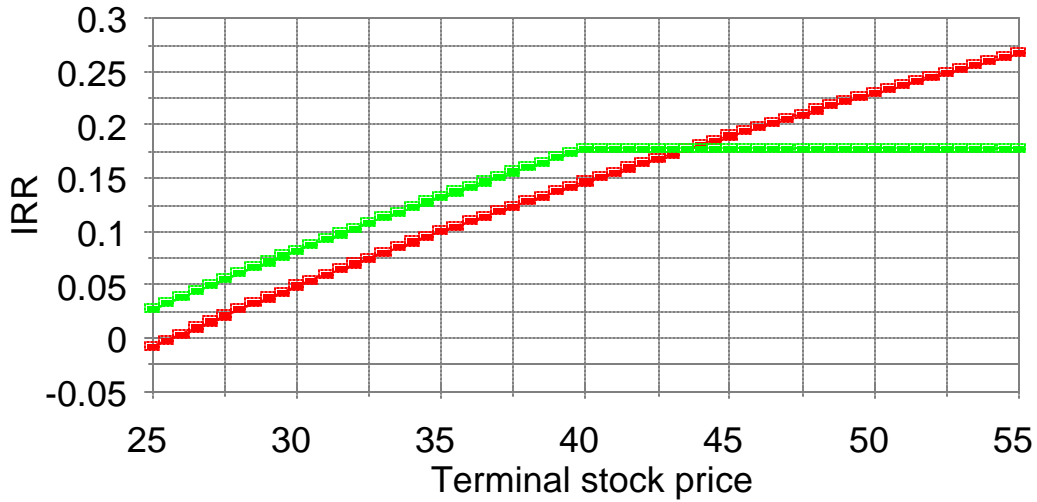
Will the stock price at the end of three years be equal to the pseudo stock price? Only if the terminal stock price is less than or equal to the PERCS capped price. In this instance, the PERCS will be converted one-for-one and the share price will be the total share value divided by 100 million shares, which is the same as the pseudo share value. If the stock price exceeds the PERCS cap price, however, there will be fewer shares outstanding, the PERCS will own a smaller fraction of the equity, the common will own a larger fraction of the equity and  $S_T > S^*_T$ .

*Example.* Suppose the stock price ends up at \$50. Each share will be converted into  $X/S_T = 40/50 = .80$  shares of stock. In total, there will be  $.80(20 \text{ million PERCS}) = 16$  million new shares of equity, for a total of  $80 \text{ million} + 16 \text{ million} = 96$  million. The total value of the equity is  $\$50(96 \text{ million}) = \$4,800$  million. Had the company remained all common stock with 100 million shares, the shares would be worth  $\$4,800/100 = \$48$  per share.

Figure 1 shows the returns to the PERCS holder and a pseudo share holder as a function of the terminal stock price. The returns are calculated as the annualized internal rate of return on the respective securities, assuming the cash flows on the table on page 4 and terminal payoffs as described above. If the stock price ends up below (above) \$44, the PERCS holder earns a higher (lower) rate of return than he/she would have on a pseudo share.

# PERCS vs. Common Stock Returns

IRR's as function of terminal price



**Figure 1**

The payoff on the pseudo shares, the common shares and the PERCS shares can be written as contingent claims on the value of pseudo shares as follows:

Payoff at maturity	if $S_T^* < 40$	if $S_T^* \geq 40$
Pseudo share	$S_T^*$	$S_T^*$
PERCS share	$S_T^*$	40
Common share	$S_T^*$	$S_T^* + (1/4)(S_T^* - 40)$

A pseudo share is simply a share at date T. A PERCS share receives the equivalent of a pseudo share at maturity if the stock price ends up below the PERCS cap price of \$40, but receives a payoff equal to \$40 worth of stock if the pseudo share (and hence the common share) ends up worth more than \$40. The

tricky thing about the regular common stock is that its payoff is not like a simple common stock payoff: the common stock receives the payoff on one pseudo share *plus the payoff on one long call option for every four shares of common stock* (the one-to-four ratio being the number of PERCS per common share).

The payoff at maturity on the PERCS shares is same as the payoff on a covered call write on one pseudo share: buying a pseudo share and *selling a call option against the pseudo share*. The cash flows prior to maturity show that the PERCS pays an *excess dividend, XSDIV, relative to the pseudo share of PDIV - S\*DIV, or .60 - .36 = .24*. Therefore, assuming that the PERCS will only be redeemed at maturity, and assuming that all dividends will be paid on both the PERCS and the pseudo common (in fact, we will assume they are riskless), the PERCS valuation formula becomes:

$$\text{PERCS}_t = S^*_t + \text{PV}(\text{XSDIV}) - \text{CALL}(S^*_t, F_{S^*}, T-t, r, X, S^* \text{DIV})$$

where PV(XSDIV) is the present value of the annuity of excess dividends defined above at the riskless rate, and CALL is the value of a constant-dividend yield adjusted Black-Scholes call value with the following parameters:

- $S^*_t$  = Stock price = value of the pseudo shares
- X = Exercise price = PERCS cap price
- T = Time to maturity = time to maturity of PERCS
- r = risk free rate = risk free rate on bill maturing at the same time as the PERCS
- $F_{S^*}$  = Volatility = standard deviation of the rate of return on the pseudo shares
- Dividend yield = dividend yield on the pseudo shares

The next section applies the model to our example company.

## 2. Applying the PERCS model

Our example company is offering to exchange 20 million PERCS shares for 20 million common shares (one fifth of the outstanding stock). The current price of the common is \$30 per share. It would seem that, if the PERCS are worth less than \$30, the offer would not be fair to the shareholders who exchange their shares, and you would not expect to see many shares tender. Similarly, if the PERCS are worth more than \$30, many shares would tender and the offer would not be fair to the non-tendering shareholders. But this logic assumes that the current share price would be the reigning share price if the firm did not offer the PERCS.

It may be the case that information is transmitted to the market by the company's announcement of the PERCS issue. The dividend on the common is less than the PERCS; is the company issuing the PERCS in conjunction with a unexpected dividend decrease? If so, this could be considered bad news. If the common dividend is not being changed, then the PERCS issue represents a nominal increase in the total dividends being paid and this might be considered good news. The valuation of the PERCS and the question of its fairness is a function of  $S^*$ , not the stock price before the offer.

Therefore, the stock price to plug in the Black Scholes model is the value of a pseudo share, so an estimate of the impact of the signalling information (e.g., the change in total dividends) on  $S^*$  should be taken into account. Because this is difficult to do, it is useful to examine the sensitivity of the call value to the assumed value of  $S^*$ . Also, the volatility should be the volatility of the pseudo share and the dividend yield should be the dividend yield on the pseudo share. We consider these two parameters next.

The volatility of a stock can be estimated using historical stock returns or by estimating the implied volatility of traded options on the stock. Historical volatilities are usually estimated using daily stock return data for recent 30-180 day period. For frequently-traded stocks, standard deviations based on daily

returns data have good statistical properties. More recent data is preferred to more distant data to the extent that volatilities change over time. The assumption that is made in using historical volatility estimates to predict future volatility is that the future volatility will be the same as the most recent volatility.

The implied volatility of a traded option is the value of the volatility that, when plugged into the Black-Scholes model (with other parameters for  $S$ ,  $X$ ,  $r$ ,  $T$  and dividends known), yields the market price of the option. As such, the implied volatility of a stock is a *forward-looking* definition of the volatility of the stock: it is the value of the volatility that the market believes will occur based on how they are pricing traded options. Using the implied volatility from a traded option assumes that the volatility for the maturity of the option you are trying to estimate will be the same as the volatility for the maturity of the traded option. The implied volatility also assumes that the model used to price the options is correct and that the market price of the stock and the market price of the option used are set in efficient markets at the same time. For most applications, some sensitivity to the volatility estimate is in order.

The dividend that should be used to value the PERCS should be the dividend on the pseudo shares, in our example,  $.2(2.40) + .8(1.20) = 1.44$  per annum. Because the model is assuming a steady dividend stream, the constant dividend yield model for the call value will work reasonably well in pricing the call option. Alternatively, you could simply subtract the present value of the annuity of dividends of .36 per quarter (discounted at the riskless rate by our assumption that the future dividends are known with certainty) from the pseudo stock price and plug in a zero dividend yield). If you use the constant dividend yield model, the dividend yield would be  $1.44/S^*$  and, as such, will depend on the value of  $S^*$  you use.

The exercise price is the PERCS capped price, \$40 in our example. The time to maturity is the time to maturity of the PERCS, three years in our example (1095 days). The risk free rate should be the

rate on a pure-discount Treasury bond maturing at the same time as the PERCS. Such a bond may not exist and you may have to estimate its value with the yield on a Treasury note or bond.

Assuming the risk free rate is 9%, the following tables analyze the value of the imbedded call option in our example PERCS shares using the program BS\_PUB.WK1. The first table assumes the volatility of the stock is 30%, the second assumes the volatility is 35% and the third assumes the volatility is 40%. On each table, the value of the call is calculated for S\* values of \$25 to \$35. In each case, the dividend yield (also shown) is  $1.44/S^*$ .

**Volatility = 30%**

Stock price S*	Dividend yield $1.44/S^*$	Call value
\$25	5.76%	1.79
\$26	5.54%	2.13
\$27	5.33%	2.49
\$28	5.14%	2.89
\$29	4.97%	3.32
\$30	4.80%	3.78
\$31	4.65%	4.27
\$32	4.50%	4.79
\$33	4.36%	5.34
\$34	4.24%	5.91
\$35	4.11%	6.50

**Volatility = 35%**

Stock price S*	Dividend yield 1.44/S*	Call value
\$25	5.76%	2.47
\$26	5.54%	2.85
\$27	5.33%	3.27
\$28	5.14%	3.71
\$29	4.97%	4.18
\$30	4.80%	4.68
\$31	4.65%	5.20
\$32	4.50%	5.75
\$33	4.36%	6.32
\$34	4.24%	6.91
\$35	4.11%	7.52

**Volatility = 40%**

Stock price S*	Dividend yield 1.44/S*	Call value
\$25	5.76%	3.17
\$26	5.54%	3.60
\$27	5.33%	4.06
\$28	5.14%	4.54
\$29	4.97%	5.05
\$30	4.80%	5.58
\$31	4.65%	6.13
\$32	4.50%	6.70
\$33	4.36%	7.29
\$34	4.24%	7.90
\$35	4.11%	8.53

The fairness of the PERCS security depends on whether the PERCS value is greater than (unfair to non-tendering shareholders), equal to (fair), or less than (not fair to tendering shareholders) the pseudo

share value. This boils down to a comparison of the extra dividends paid to the PERCS and the value of the call they give up. The above tables show the call values for a range of parameters. The present value (at the riskless rate) of the extra dividends paid to PERCS relative to pseudo shares is  $0.24PVFA_{9\%/4=2.25\%,12} = \$2.50$ .<sup>4</sup> As the above tables indicate, at the assumed level of volatility, interest rates, etc., the PERCS offer is only a good deal for the PERCS buyers if the volatility is relatively low and, even then, only if the stock price drops from its current level. If  $F = 35\%$ , the call value more than offsets the extra dividend stream for prices above \$25; at  $F = 30\%$ , the call value more than offsets the extra dividend income for stock prices above \$27.

### 3. Concluding remarks.

This paper shows how simple contingent claims theory can be used to study the economics of an innovative security. In the case of PERCS, with some simplifying assumptions, we used the Black Scholes model to estimate the value of the PERCS security and assess the fairness of an exchange offer of PERCS for common shares.

In the example we used, with assumed parameters and assuming the value of the pseudo shares would remain at about \$30, it appeared that the PERCS was probably not a good deal for shareholders to exchange their shares for. But this may be hasty. Our model assumed perfect markets (no taxes and no transactions costs). Some shareholders may value the higher dividend more than the potential for capital gains (hence the call option). Some may believe that the common dividend will be cut again later, and thus

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<sup>4</sup>I approximated the effective quarterly rate by dividing by four. This is technically incorrect, but this is already an approximation because these dividend streams are not truly riskless. The value of these dividends is not that sensitive to these errors.

the extra dividend is larger than we assumed.