

Profitability

Profitability is composed of six variables: gross profits over assets ($GPOA$), return on equity (ROE), return on assets (ROA), cash flow over assets ($CFOA$), gross margin ($GMAR$), and accruals (ACC). $GPOA$ is calculated as gross profits ($GPROF$) over total assets (TA).

$$GPOA = \frac{GPROF}{TA}$$

ROE is calculated as net income (NI) over book equity (BE), which is shareholders' equity (the difference of Total Liabilities and Shareholders' Equity ($TLSE$) with Total Liabilities (TL)) - preferred stock (the sum of redeemable preferred stock (RPS) and non redeemable preferred stock ($NRPS$)).

$$ROE = \frac{NI}{BE}$$

ROA is calculated as NI over TA .

$$ROA = \frac{NI}{TA}$$

$CFOA$ is calculated as $NI + \text{depreciation } (DP.DPL) - \text{changes in working capital } (CWC) - \text{capital expenditures } (CX)$ all over TA .

$$CFOA = \frac{NI + DP.DPL - CWC - CX}{TA}$$

$GMAR$ is calculated as $GPROF$ over total revenue ($TREV$).

$$GMAR = \frac{GPROF}{TREV}$$

Finally, ACC is calculated as $DP.DPL - CWC$ all over TA .

$$ACC = \frac{DP.DPL - CWC}{TA}$$

We then standardize all components of profitability to z-scores and then standardize all profitability scores into z-scores.

$$Profitability = z(z_{gpoa} + z_{roe} + z_{roa} + z_{cfoa} + z_{gmar} + z_{acc})$$

Growth

Growth is measured by differences in profitability across a time span of four years. Though AQR recommends measuring growth across a time span of five years, public information that is both consistent and well-organized in 10-K forms is only available for a time span of four years, and it is still too early in the most recent year (2015) for most companies to have submitted a 10-K form. Thus, we measure growth using a time span of four years, which we will update once this year's 10-K form is submitted for each company in the Russell 3000 Index. As of now,

$$Growth = z(z_{\Delta gpoa_{t,t-4}} + z_{\Delta roe_{t,t-4}} + z_{\Delta roa_{t,t-4}} + z_{\Delta cfoa_{t,t-4}} + z_{\Delta gmar_{t,t-4}} + z_{\Delta acc_{t,t-4}})$$

Safety

Safety is composed of six variables: beta (BAB), idiosyncratic volatility ($IVOL$), leverage (LEV), Ohlson's O (O), Altman's Z (Z), and earnings volatility ($EVOL$). BAB is calculated as the negative covariance of each company's daily price returns ($pret_{c_i}$) relative to the benchmark daily market price returns ($pret_{mkt}$), in this case the S&P 500, over the variance of $pret_{mkt}$.

$$BAB = \frac{-cov(pret_{c_i}, pret_{mkt})}{var(pret_{mkt})}$$

$IVOL$ is the standard deviation of daily beta-adjusted excess returns. In other words, $IVOL$ is found by running a regression on each company's price returns and the benchmark, then taking the standard deviation of the residuals. Leverage is -(total debt (TD) over TA).

$$Leverage = -\frac{TD}{TA}$$

$$\begin{aligned}
O = & -(-1.32 - 0.407 * \log\left(\frac{ADJASSET}{CPI}\right) + 6.03 * TLTA - 1.43 * WCTA \\
& + 0.076 * CLCA - 1.72 * OENEG - 2.37 * NITA - 1.83 * FUTL \\
& + 0.285 * INTWO - 0.521 * CHIN)
\end{aligned}$$

$ADJASSET$ is adjusted total assets, which is $TA + 0.1 * (\text{market equity } (ME, \text{ calculated as average price per share for the most recent year } * \text{ total number of shares outstanding } (TCSO) - BE))$.

$$ADJASSET = TA + 0.1 * (ME - BE)$$

CPI , the consumer price index, is assumed to be 100, since we only care about the most recent year. $TLTA$ is book value of debt (BD , calculated as TD - minority interest (MI) - ($RPS + NRPS$)) over $ADJASSET$.

$$TLTA = \frac{BD}{ADJASSET}$$

$WCTA$ is current assets (TCA) - current liabilities (TCL) over TA .

$$WCTA = \frac{TCA - TCL}{TA}$$

$CLCA$ is TCL over TCA .

$$CLCA = \frac{TCL}{TCA}$$

$OENEG$ is a dummy variable that is 1 if total liabilities (TL) is greater than TA .

$$OENEG = TL > TA$$

$NITA$ is NI over TA .

$$NITA = \frac{NI}{TA}$$

$FUTL$ is income before taxes (IBT) over TL .

$$FUTL = \frac{IBT}{TL}$$

INTWO is another dummy variable that is 1 if *NI* for the current year and *NI* for the previous year are both negative.

$$INTWO = MAX(NI_t, NI_{t-1}) < 0$$

CHIN is *NI* for the current year - *NI* for the previous year all over the sum of the absolute value of *NI* for the current year and the absolute value of *NI* for the previous year

$$CHIN = \frac{NI_t - NI_{t-1}}{|NI_t| + |NI_{t-1}|}$$

Altman's *Z* is calculated using weighted averages of working capital (*WC*, calculated as *TCA* - *TCL*),

$$WC = TCA - TCL$$

retained earnings (*RE*, calculated as *NI* - dividends per share (*DIVC*) * *TCSO*),

$$RE = NI - DIVC * TCSO$$

earnings before interest and taxes (*EBIT*, calculated as *NI* - Discontinued Operations(*DO*) + (*IBT* - income after tax (*IAT*)) + interest expense (*NINT*)),

$$EBIT = NI - DO + (IBT - IAT) + NINT$$

ME, and *TREV*, all over *TA*.

$$Z = \frac{1.2 * WC + 1.4 * RE + 3.3 * EBIT + 0.6 * ME + TREV}{TA}$$

EBIT is likely an overestimate for a given company due to potentially missing information. *EVOL* is calculated as the standard deviation of *ROE* for a four year span. AQR recommends the past five years, but for the same reason stated in the Growth section, we use a four year span.

$$EVOL = \sigma \left(\sum_{i=t-4}^t ROE_i \right)$$

Likewise, we standardize each variable and then standardize each safety measure, so

$$Safety = z(z_{bab} + z_{ivol} + z_{lev} + z_o + z_z + z_{evol})$$

Payouts

Payouts is composed of three variables: net equity issuance (*EISS*), net debt issuance (*DISS*), and total net payout over profits (*NPOP*). *EISS* is calculated as the negative log of the ratio of *TCSO* of the most recent year and *TCSO* of the previous year.

$$EISS = -\log\left(\frac{TCSO_t}{TCSO_{t-1}}\right)$$

Though AQR uses split-adjusted number of shares, we are currently using *TCSO* given available information and will adjust for splits in future iterations of qmj. *DISS* is calculated as the negative log of the ratio of *TD* of the most recent year and *TD* of the previous year.

$$DISS = -\log\left(\frac{TD_t}{TD_{t-1}}\right)$$

NPOP is calculated as $NI - \Delta BE$ over a four year span all over sum of *GPROF* for the past four years (for the same reason as explained in the Growth section).

$$NPOP = \frac{NI - \Delta BE}{\sum_{i=t-4}^t GPROF_i}$$