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 low accruals (ACC). $GPOA$ is calculated as gross profits ($GPROF$, found in tidyincome) over total assets(TA, found in tidybalance).

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

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

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

ROA is calculated as NI over TA.

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

$CFOA$ is calculated as net income + depreciation ($DP.DPL$, found in tidycash) - changes in working capital (CWC, found in tidycash) - capital expenditures (CX, found in tidycash) all over TA.

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

$GMAR$ is calculated as $GPROF$ over total revenue ($TREV$, found in tidyincome).

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

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

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

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,

$$Growth \ = \ z(z_{\Delta gpoa} \ + \ z_{\Delta roe} \ + \ z_{\Delta roa} \ + \ z_{\Delta cfoa} \ + \ z_{\Delta gmar} \ + \ z_{\Delta acc})$$

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 by scraping publicly available beta scores from Yahoo Finance, which uses the S&P 500 as its benchmark. Idiosyncratic volatility is the standard deviation of daily beta-adjusted excess returns, which is the daily rate of return of the company(R, found in tidydaily) - BAB*(market rate of return(R_m, found in tidydaily)).

$$IVOL \ = \ \sigma(\sum_{d=n_{t-1}}^{n_t} R_d \ - \ BAB \ * \ (R_{md}))$$

d is the day, n, starting at $t-1$ (1 year ago), and n_t is the day before the most recent trading day. Leverage is -(total debts (TD, found in tidybalance) over TA).

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

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

$ADJASSET$ is adjusted total assets, which is TA + 0.1 * (market equity (ME, calculated as average price per share for the most recent year (using closing price data from tidydaily) * total number of shares outstanding ($TCSO$, found in balance sheets)) - BE).

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

CPI 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, found in tidybalance) - (RPS + $NRPS$)) over $ADJASSET$.

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

$WCTA$ is current assets (TCA, found in tidybalance) - current liabilities (TCL, found in tidybalance) 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, found in tidybalance) is greater than TA.

$$OENEG = TL > TA$$

$NITA$ is NI over TA.

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

$FUTL$ is income before taxes(IBT, found in tidyincome) 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), retained earnings (calculated as NI - dividends per share ($DIVC$, found in tidyincome) * $TCSO$), earnings before interest and taxes ($EBIT$, calculated using earnings before interest, taxes, depreciation, and assets ($EBITDA$) from Yahoo Finance - $DP.DPL$ - amortization (AM, found in tidycash)), ME, and $TREV$, all over TA.

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

$EVOL$ 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 the a four year span.

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

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.

$$EISS \ = \ -log(\frac{TCSO_t}{TCSO_t - 1})$$

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.

$$DISS \ = \ -log(\frac{TD_t}{TD_t - 1})$$

$NPOP$ is calculated as NI - ΔBE 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).

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