Elements of Performance Econometrics

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1 Portfolio Performance in Event Time

1.1 Events and 'Event Time'

1. Voluntary Corporate Events

- Much of corporate finance involves an informed party (the firm or its managers) voluntarily selecting the type and timing of an economic event
- Examples of such events are
  - Security sales/repurchases/exchanges
  - Mergers/acquisitions/takeovers
  - Restructurings/recaps/LBOs/buildups
  - Accounting disclosures, dividends
  - Bankruptcy, law suits, antitrust challenges
- Voluntary events convey managerial private information and thus cause stock prices to change
- The event study methodology is designed to measure the resulting stock price change—or abnormal stock return—and to relate the change to theories explaining the economic value of the event itself

2. 'Event Time' v. Calendar Time

- Suppose you want to estimate the valuation impact of corporate acquisitions. You collect stock returns for a large sample of firms that announced acquisition bids at different calendar dates over some 20-year sample period

- Calendar Time Analysis:

  – To illustrate, suppose you invest one dollar in the stock of the first firm announcing an acquisition in your sample, and you hold this stock for a period one year

  – When the second sample acquisition comes along (say two weeks after the first), you split your dollar between the two firms and hold both going forward, with equal weights

  – You continue to split your initial dollar equally across all new acquisition announcement throughout the sample period, always dropping firms after a holding period of one year

  – Presuming there was no survivorship bias in your acquisition sampling strategy, you have now effectively implemented a feasible portfolio strategy in calendar time (we discuss in section 3 how to measure calendar time performance)

- 'Event Time' Analysis:
  - Notice that in the above calendar time analysis, we are giving equal weight to returns in periods with an event announcement (event periods) and returns in non-event periods
  - Suppose instead we want to give equal weights to all events, measuring the average impact of acquisition announcements in the sample
  - To do this, we rearrange the return series of all acquisition firms in our 20-year sample period so that they overlap in 'event time' (but not in calendar time)
  - This is done simply by defining the event day (the acquisition announcement day) as 'day 0', while all other calendar dates are enumerated relative to day zero. Thus, ten calendar days prior to event day zero is day -10. 20 calendar days after the event day is day +20
  - Rearrange the returns for all acquisition firms in the sample in this manner. All sample firms are now lined up in event time
  - When you average the returns to the sample firms in event time, you can see that the average over, e.g., day zero is not affected by returns in non-event days. This average essentially equal-weighs events to form an estimate of the return impact of the acquisition sample announcements

1.2 Abnormal Return Estimation in Event Time

1. Return Generating Process

- Suppose stock returns are distributed multivariate normal. That means we can write the return generating process as a linear factor model such as the following "market model"

$$r_{jt} = \alpha_j + \beta_j r_{mt} + \epsilon_{jt} \tag{1}$$

r_{jt} = firm j's total return in excess of the risk-free rate over day t, r_{mt} = excess return on the market portfolio, ϵ_{jt}= mean zero error term

2. Expected Return

$$E(r_j) = \alpha_j + \beta_j E(r_m) \tag{2}$$

- Note that in eq. (2), the firm-specific constant term α_j is part of the measure of expected return. Thus, it's a firm-specific expected return model, unconstrained by any asset pricing restriction on the cross-section of expected return

- Because eq. (2) is an unconstrained measure of expected return, it can be used to study the market reaction to firm-specific events, but not to identify pricing anomalies in the cross-section of average returns

- To address pricing anomalies in the cross-section, we require an asset pricing model for $E(r_j)$. Asset pricing models imply $\alpha = 0$

3. Abnormal (Unexpected) Return

- Let $\gamma_{j\tau}$ denote the abnormal return over some event day τ. For example, the event day could be the day of the first Wall Street Journal article on a merger proposal. Two approaches to estimate $\gamma_{j\tau}$:

- Residual approach (RA)

$$\gamma_{j\tau} \equiv r_{j\tau} - E(r_j) = r_{j\tau} - (\hat{\alpha}_j + \hat{\beta}_j r_{m\tau}) \tag{3}$$

- Regression parameter approach (RPA)

$$r_{jt} = \alpha_j + \beta_j r_{mt} + \gamma_{j\tau} d_{jt} + \epsilon_{jt} \tag{4}$$

d_{jt} = dummy variable with value 1 in period τ and 0 otherwise. Thus, here $\gamma_{j\tau}$ is estimated directly as a parameter in the return generating process, assuming $E(\epsilon_j) = 0$

- Let CAR denote cumulative abnormal return over $w = \tau_2 - \tau_1 + 1$ event days in calendar time:

$$\text{RA}: \ \text{CAR}_{\text{jw}} = \sum_{\tau=\tau_1}^{\tau_2} \gamma_{j\tau} \tag{5}$$

$$\text{RPA}: \ \text{CAR}_{\text{jw}} = w\gamma_{jw} \tag{6}$$

- In the RPA approach, when the event period exceeds a single day, γ_{jw} is estimated using a d_{jt} which takes on a value of 1 each period in the interval $[\tau_1, \tau_2]$ and zero otherwise. Thus, γ_{jw} becomes the daily abnormal return averaged over the days in the event window. So, the total (cumulative) event period abnormal return is simply $w\gamma_{jw}$

- RA or RPA?

  – RPA provides a more obvious link to standard econometrics (the regression produces γ and its standard error directly)

  – The two approaches yield identical estimates provided the events are uncorrelated with the excess return on the market portfolio

  – The sample data produces a spurious correlation between the event dates and the market return even if the true (population) correlation is zero. The conditional estimate of β_j in RPA controls for this spurious covariance and is therefore unbiased, given the sample

4. Statistical Significance

- Step 1: Compute the average abnormal return (AAR) across N firms:

$$AAR_\tau \equiv \frac{1}{N}\sum_{j=1}^{N}\gamma_{j\tau} \tag{7}$$

- Step 2: Compute the z-value of AAR:

$$z(AAR_\tau) \equiv \frac{1}{\sqrt{N}}\sum_{j=1}^{N}\frac{\gamma_{j\tau}}{\sigma_{\gamma j}} \quad \sim N(0,1) \tag{8}$$

where $\sigma_{\gamma j}$ is the standard error of $\gamma_{j\tau}$ provided directly by the EA regression

- If the N sample events are independent, and replacing the true values of $\gamma_{j\tau}$ and $\sigma_{\gamma j}$ with their OLS estimates, then

$$z(AAR_\tau) \overset{a}{\sim} N(0,1) \tag{9}$$

- Table 1, extracted from Eckbo and Masulis (1992), illustrates the test procedure and results for a large sample of seasoned equity offering announcements

1.3 The Matched-Firm, Buy-and-Hold Procedure

1. Why Matched Firm?

- Any performance analysis requires making some assumption as to what constitute a stock's expected return $E(r_j)$. This expected return is also often referred to as the "benchmark return"
- As in the analysis above, any performance measure is computed as

$$\gamma_j \equiv r_j - E(r_j) \tag{10}$$

- The issue is what you use to generate the benchmark return $E(r_j)$
- Your estimate of $E(r_j)$ may come from an asset pricing model. Asset pricing models provide benchmark returns in the form of large, diversified portfolios presumed to represent pervasive (economy-wide) risks (e.g., market portfolio, Fama-French portfolios, etc.). We discuss this in Session 2
- Alternatively, if you think asset pricing models are too "noisy", you may instead choose to benchmark your sample firm's performance with the average return over the event period to a "similar" firm that did not undertake the event
- The definition of "similar" is based on observable firm-specific characteristics, such as equity size, book-to-market ratio, industry, etc.

- The basic assumption is that these firm-specific characteristics represent the true (unknown) risk factors that determine a stock's expected return, so that

$$E(r_j) = E(r_{Matching\ Firm}) \tag{11}$$

2. The Buy-and-Hold Return

- We want to compute the total return from holding the stock of event firm j over a total of T periods (say, five years, or $T = 60$ months). To keep the notation simple, ignore the possibility that the stock is delisted during the holding period

- The T-period (excess) buy-and-hold return, or BHR, is

$$\mathrm{BHR} \equiv \prod_{t=1}^{T} (1 + r_{jt}) - 1 \tag{12}$$

- For a sample of N stocks, the (equal-weighted) average buy-and-hold return, or $\overline{\mathrm{BHR}}$, is

$$\overline{\mathrm{BHR}} \equiv \frac{1}{N} \sum_{j=1}^{N} \left[\prod_{t=1}^{T} (1 + r_{jt}) - 1 \right] \tag{13}$$

- The abnormal or unexpected value of $\overline{\mathrm{BHR}}$ is

$$\overline{\mathrm{BHAR}} = \overline{\mathrm{BHR}} - E(\overline{\mathrm{BHR}}) = \overline{\mathrm{BHR}}_{Event\ Firms} - \overline{\mathrm{BHR}}_{Matching\ Firms} \tag{14}$$

- Since $\overline{\text{BHR}}$ equal-weighs returns in *event* time, it does not constitute a realizable portfolio return ex ante. The reason is that investors do not know the future number of events (here given by N) ahead of time, and thus cannot rebalance their investments in the event portfolio accordingly

3. The "Bad Model" Problem

- BHAR cumulate returns over long periods (five years)
- The longer the period of cumulation, the greater the potential error in BHAR caused by using the wrong benchmark for expected return
- Example: Suppose the CAPM holds, so the market portfolio is the only risk factor. The expected return on the market portfolio makes up a relatively small proportion of a stock's expected return over a single day, but a relatively large proportion over the stocks expected five-year return
- Now suppose that we use the CAPM when it is the wrong model. The model error makes up a greater proportion of expected returns compounded over long than over short periods
- Since the model we use is always wrong, long-horizon measures such as BHAR are particularly sensitive to the bad-model problem

4. "Pseudo" Market Timing

- $\overline{\text{BHAR}}$ also suffers from a selection bias that may cause you to falsely conclude that firms time the market
- Example: IPOs:
- Suppose that more firms issue equity as their stock price increases. For example, the higher stock price may represent the discounted expected cash flow from new and valuable investment projects that will need external financing. Or, the price increase may reflect a reduction in risk and thus in the cost of equity capital, which in turn increases the number of investment projects with positive net present value. Either way, this issue behavior has nothing to do with managers predicting future returns
- The catch: If firms behave this way, issues will on average be followed ex post by underperformance. Why?
  - Suppose expected one-period returns are zero for all periods and all IPOs
  - Suppose the stock return distribution is a bimodal $+10\%$ and -10% in each period
  - Let there be a single IPO at time zero
  - Sample path 1: Suppose the the return in period one is -10%. Then there will be no new IPOs at time one

  - Sample path 2: Suppose the return in period one is +10% and that there are four IPOs in this period
  - The one-period $\overline{\text{BHAR}}$ for these two equally likely sample paths:
  - It is 2% for the "up" sample and −10% for the "down" sample, with an equal-weighted average of −4%(!)

- This result is referred to as "pseudo market timing" because it may easily be confused with real forecasting ability on the part of issuing firms' managers
- We discuss the empirical implementation of the matched-firm procedure when discussing the 'New Issues Puzzle'

2 Event-studies: Some Complicating Issues

2.1 Self-Selection

- Suppose γ_j is the abnormal return to bidders, and that theory suggests the following linear cross-sectional model:

$$\gamma_j = x_j\phi + \epsilon_j \tag{15}$$

- Self-selection causes $E(\epsilon_j) \neq 0$, so linear estimates of ϕ are biased
- Why? Suppose managers each period receive a mean-zero private signal η_j showing the true value of a merger bid that period
- Suppose also that managers will make a bid only if the merger has positive value for shareholders, i.e., only if

$$x_j\phi + \eta_j > 0 \tag{16}$$

- In this case, the first public announcement of the merger bid causes the market to impound the following expected return into firm j's stock price:

$$E(\gamma_j|\eta_j > -x_j\phi) = x_j\phi + E(\eta_j|\eta_j > -x_j\phi) \tag{17}$$

- In effect, the market's inference truncates the residual term η_j that measures the value of managers' private information

- OLS and GLS ignore this truncation, causing the nonlinear expectation term to end up in the error term ϵ_j, biasing the estimate of ϕ

- Solution: Assume some distribution for the private signal η_j, e.g.

$$\eta_j \sim N(0, \omega^2)$$

  and estimate

$$\gamma_j = x_j\phi + \omega\frac{n(x_j\phi/\omega)}{N(x_j\phi/\omega)} + \zeta_j \tag{18}$$

  where $n(\cdot)$ and $N(\cdot)$ are the standard normal density and cumulative distribution functions, respectively

- The nonlinear term is derivedas follows:

  – Define

    $z_j \equiv \eta_j/\omega$

    $\theta_j \equiv -x_j\phi/\omega$

  – Since $\partial n(z_j)/\partial z_j = -z_j n(z_j)$, the conditional expected value of η_j is

$$\begin{aligned}
\omega E(z_j|z_j \geq \theta_j) &= \frac{\omega}{1-N(\theta_j)}\int_{\theta_j}^{\infty} z_j n(z_j) dz_j \\
&= -\frac{\omega}{N(-\theta_j)}\int_{\theta_j}^{\infty}\frac{\partial n(z_j)}{\partial z_j} dz_j \\
&= \omega\frac{n(-\theta_j)}{N(-\theta_j)}.
\end{aligned}$$

- Table 2, extracted from Eckbo (1992), illustrates the effect of the bias correction for a sample of bidder firms in horizontal mergers. The the dependent variable is the abnormal return to bidders over the month of the first public announcement of the merger event

2.2 Partial Anticipation

- Bidder specific information released prior to the event may cause the market to infer with certainty that the bidder has received a potential target

- This raises the probability of a subsequent merger announcement from 0 to

$$\Pr(\eta_j \geq -x_j\phi) = N(x_j\phi/\omega) \tag{19}$$

- In this case, the conditional expected abnormal return in response to the merger proposal becomes

$$[1 - N(x_j\phi/\omega)]E(\gamma_j|\eta_j > -x_j\phi) \tag{20}$$

- An example of an alternative treatment of the effect of partial anticipation:

- q = commonly known probability that firm will announce a merger in any given period

  v = the economic value of the merger

- Expected returns conditional only on knowledge of the market return follow the CAPM (where r indicates excess return):

$$r_{jt} = \beta_j r_{mt} + u_{jt}$$

- Ex ante, the value qv is impounded in the firm's stock price. In equilibrium,

$$E(u_{jt}) = 0$$

$$(1-q)(u_{jt}|Merger) + q(u_{jt}|No\ Merger) = 0$$

$$(1-q)(v|d=1) + q(-v|d=0) = 0$$

$$-qv + (v|d=1) = 0$$

where d = dummy variable indicating the merger event

- Define $\alpha_j \equiv -qv$ and $\gamma_j \equiv v$. Then, since $\alpha_j + \gamma_j d_t = 0$, we can write

$$r_{jt} = \alpha_j + \beta_j r_{mt} + \gamma_j d_{jt} + u_{jt}$$

- The <u>economic effect</u> of the acquisition:

  $v = \gamma_j$

- The <u>announcement effect</u> of the acquisition: $(1-q)v = \alpha_j + \gamma_j$

- Partial anticipation of the acquisition attenuates the announcement effect relative to the economic effect.

- Since $\alpha_j = -qv$, tests for the presence of partial anticipation are tests for $\alpha_j < 0$

- The joint hypothesis that the event has positive value and is partially anticipated is a test of

$$\gamma_j > 0 \quad \text{and} \quad \alpha_{\mathrm{j}} < 0.$$

- Table 3, extracted from Eckbo (1992), implements the partial anticipation correction as well as the correction for selection bias discussed above

2.3 Sequential Events

- The initial event announcement may trigger a number of sequential events
  - Takeover bid may trigger target management resistance or rival bids
  - Horizontal merger may trigger antitrust complaint
  - The IPO may trigger a follow-on seasoned equity offering
  - Merger program announcements trigger future takeovers
  - A corporate action may trigger a shareholder lawsuit
- The market reaction to the initial event incorporates the expected value of these triggered events, confounding the estimation of the true economic effect of the event based on the initial announcement alone
- The triggered events may lower the value of the initial corporate action, by lowering the event's success-probability and impose costs
- To avoid ex post selection biases and biases of interpretation, event study sampling procedures should clearly outline the potential for triggering events
- For example, the average initial announcement effect in a sample of ex post successful mergers is a biased estimator for the expected value of "merger activity", even if the initial announcement was a zero-probability event

2.4 Common Event Dates

- Suppose an event takes place in an industry with a total of R_j rival firms. You may form a portfolio of these firms, and estimate the industry abnormal return parameter γ.

- However, this portfolio estimation may fail to reveal abnormal returns if the event has a positive impact on some individual firms and a negative and offsetting impact on others.

- Alternatively, examine

$$H_0: \quad \gamma_{ij} = 0, \qquad i = 1, ..., R_j,$$

  i.e., that the event parameters across the R_j individual rival firms associated with the j'th merger in the sample are jointly equal to zero

- H_0 is tested using in a "seemingly unrelated regression" (SUR) framework, as follows:

- Matrix notation (dropping subscript j):

$$\underline{r} = X\underline{\delta} + \underline{\epsilon},$$

$$\begin{aligned}
\underline{r}' &= [\underline{r}'_1 ... \underline{r}'_R], \quad \text{the 1xTR}_\text{j} \text{ vector of returns} \\
X &= [I \otimes \overline{X}], \quad \text{a TR}_\text{j}\text{x3R}_\text{j} \text{ matrix} \\
\overline{X} &= [\underline{1}\ \underline{r}_m\ \underline{d}], \quad \text{the Tx3 matrix of regressors} \\
\underline{\delta}' &= [\alpha_1 \beta_1 \gamma_1 ... \alpha_R \beta_R \gamma_R], \ \text{the 1x3R}_\text{j} \text{ coeff.vector,} \\
\underline{\epsilon} &= [\underline{\epsilon}'_1 ... \underline{\epsilon}'_R], \quad \text{a 1xTR}_\text{j} \text{ vector of error terms.}
\end{aligned}$$

$I = R_j \text{x} R_j$ identity matrix

$\underline{1}$ = Tx1 unity vector

$\underline{\epsilon} \sim MVN(0; \Sigma \otimes I)$.

- The $R_j \text{x} R_j$ contemporaneous covariance matrix Σ is estimated from the residuals produced by the first–pass OLS regression of the SUR system

- Since this is a SUR system with *identical* (market model) regressors, OLS estimation of each of the R_j equations is asymptotically efficient and provides identical parameter estimates to a GLS procedure.

- However, significance tests of cross–equation constraints on the R_j event parameters require a procedure which accounts for the contemporaneous cross–correlation of the error terms $\underline{\epsilon}$.

- Restate H_0 as

$$H_0: \quad \underline{0} = C_3 \underline{\delta},$$

where

$\underline{0} = R_j$x1 vector of zeros

$C_3 = [I \otimes \underline{c}_3'] = R_jx3R_j$ matrix

$\underline{c}_3$ = 3x1 vector where the third element equals one and the remaining two elements equal zero

- Replacing the true values of $\underline{\delta}$ and Σ with their OLS estimates, the following quadratic form has a limiting χ^2 distribution with R_j degrees of freedom under H_0:

$$\hat{\underline{\delta}}' C_3' \{C_3 [X'(\hat{\Sigma}^{-1} \otimes I_T) X]^{-1} C_3'\}^{-1} C_3 \hat{\underline{\delta}} \quad \sim \chi^2(R).$$

- An example of this test is in Table 4, extracted from Eckbo (1992)

3 Portfolio Performance in Calendar Time

3.1 Linear Factor Model of Expected Returns

1. Arbitrage Pricing Theory

- Suppose APT holds and that there are a total of K priced risk factors
- Let F_{kt} denote the realized value of the k'th risk factor in period t, and let $f_{kt} \equiv F_{kt} - E(F_k)$ be the unexpected factor shock over the period
- Let λ_k denote the k'th factor's risk premium
- The APT model says that

$$E(r_j) = \sum_{k=1}^{K} \beta_{jk}\lambda_k \tag{21}$$

where β_j is the sensitivity of firm j's excess return to factor risk of type k (the firm's 'beta' with respect to factor k)

- The term $\beta_{jk}\lambda_k$ is factor k's contribution to the expected return of stock j
- Example: If the CAPM holds, the only factor is the market portfolio, and $\lambda_M = E(R_{Mt} - R_{Ft}) = E(r_{Mt})$, so

$$E(r_j) = \beta_{jM} E(r_M) \tag{22}$$

2. The Return Generating Process

- Given the APT model in eq. (1) above, we can always write

$$r_{jt} = E(r_j) + \sum_{k=1}^{K} \beta_{jk} f_{kt} + \epsilon_{jt} \quad (23)$$

- That is, a firm's realized excess return is the sum of the expected (excess) return and the unexpected return. The unexpected portion has two components: (1) factor shocks (the sum of the product of the factor betas and the factor shocks) and (2) firm-specific or "idiosynchratic" shocks (ϵ)

- Substituting the APT model for $E(r_j)$ we get

$$r_{jt} = \sum_{k=1}^{K} \beta_{jk}(\lambda_k + f_{kt}) + \epsilon_{jt} \quad (24)$$

- Since eq. (4) contains unobservable terms (λ_k and f_{kt}), it is not useful for performance evaluation. A "trick" to solve the problem of observability:
  - Form a well diversified stock portfolio that has $\beta_k = 1$ for factor k and $\beta_l = 0$ for all factors $l = 1, ..., K,\ l \neq k$. This portfolio is what we call a factor mimicking portfolio for factor k
  - Under the CAPM, the market portfolio has a market beta of 1 and a beta of zero against all other factors (in the CAPM, there are none). Thus the market portfolio mimics the underlying "market factor"

- Let r_{kt} denote the realized excess return to the factor-mimicking portfolio for factor k. Since this portfolio must also obey the APT, we have that

$$E(r_k) = \beta_k \lambda_k = \lambda_k \tag{25}$$

- Substituting $\lambda_k = E(r_k)$ into eq. (4) yields a regression equation that is stated in terms of observables:

$$r_{jt} = \sum_{k=1}^{K} \beta_{jk}[E(r_k) + r_{kt} - E(r_k)] + \epsilon_{jk} = \sum_{k=1}^{K} \beta_{jk} r_{kt} + \epsilon_{jk} \tag{26}$$

3.2 The Abnormal Return Measure ("Jensen's Alpha")

- Taking the expectation on both sides of eq. (6) yields:

$$E(r_j) = \sum_{k=1}^{K} \beta_{jk} E(r_k) \tag{27}$$

- Define the firm's "alpha" as

$$\alpha_j \equiv E(r_j) - \sum_{k=1}^{K} \beta_{jk} E(r_k) \tag{28}$$

- Thus, alpha is a return in excess of the expected return given by the (APT) model. It is therefore a measure of abnormal performance

- Notice again that, contrary to the event study technique, we are now <u>not</u> treating alpha as part of the stock's expected return. Rather, alpha <u>is</u> the abnormal return (the part of the stock's average return that is not explained by the asset pricing model)

- Alpha is estimated by adding a constant term to the return generating process in eq. (6):

$$r_{jt} = \alpha_j + \sum_{k=1}^{K} \beta_{jk} r_{kt} + \epsilon_{jk} \tag{29}$$

- The term "Jensen's" alpha comes from the first study to implement an alpha meausure, namely by Micheal C. Jensen back in 1968 (Jensen (1968)). This is the same Jensen that also gave us modern agency theory in corporate finance (!)

3.3 What are the Risk Factors?

- 1. Factors suggested by equilibrium theory:
  - The market portfolio (CAPM)
  - Aggregate consumption (CCAPM)
- 2. Empirical factors based on firm characteristics:
  - firm size
  - book-to-market
  - return momentum
  - stock liquidity

  Factor-mimicking portfolios for these factors are generated by

  - (1) sorting the stock universe on pairs of characteristics (e.g. size and book-to-market, size and liquidity) and
  - (2) forming a portfolio that is long in the highest return fractal and short in the lowest return fractal
  - This produces a factor portfolio with a positive excess return, i.e., a positive risk premium

Examples:

- Fama and French (1993): Size (SMB) and book-to-market ratio (HML)
- Carhart (1997): Momentum (UMD)
- Pastor and Stambaugh (2003), Eckbo and Norli (2002), Eckbo and Norli (2005): Liquidity (PS, LMH)

- 3. Empirical factors based on macro-economic risks:
  - market portfolio (RM)
  - seasonally adjusted, percent change in real per capita consumption of nondurable goods (RPC)
  - difference in the monthly yield change on BAA-rated and AAA-rated corporate bonds (BAA−AAA)
  - unexpected inflation (UI)
  - return spread between Treasury bonds with 20-year and one-year maturities (20y−1y)
  - return spread between 90-day and 30-day Treasury bills (TBILLspr)

Factor-mimicking portfolios for these factors are generated by regressing large stock portfolios on the raw factors, constraining the portfolio betas to be 1 against the mimicked factor and zero against the others (as explained above)

3.4 Some Factor Risk Premium Evidence

- Table 5 and Table 6, extracted from Eckbo and Norli (2005), shows monthly risk premiums for characteristics-based and factor-mimicked risk factors over the period 1972-2002

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Table 1
Extracted from Eckbo and Masulis (1992): Percent average abnormal stock returns relative to the issue announcement (a), offer–begin (b), and offer expiration (e) dates for seasoned common stock offers classified by issuer type and flotation method, over the period 1963-1981.

The regression model is

$$\tilde{r}_{jt} = \alpha_j + \beta_j \tilde{r}_{mt} + \sum_{n=1}^{6} \gamma_{jn} d_{nt} + \tilde{\epsilon}_{jt}$$

where $\tilde{r}_{jt}$ and $\tilde{r}_{mt}$ denote the continuously compounded daily rates of return to firm j and the value–weighted market portfolio; the five dummy variables d_{nt} each take on values of one over the intervals corresponding to each of the six columns in the table, and zero otherwise. The issuing firm's abnormal return over event period n is $w_{jn}\gamma_j$, where w_{jn} is the number of days in the event period. (z–value, and percent negative in parenthesis)[1].

Offering method/ issuer type	Event Period: a-60 through a-2	a-1 through a	a+1 through b-1	b	b+1 through e-1	e
I. Firm commitments[2]						
Industrials	12.05	-3.34	0.97	-0.21	0.91	-
(N=389)	(11.89, 24.7)	(-21.48, 82.5)	(1.18, 47.6)	(-1.75, 55.5)	(1.69, 44.2)	
Utilities	0.77	-0.80	-0.80	0.19	-0.08	-
(N=646)	(2.29, 48.9)	(-11.57, 66.9)	(-2.09, 55.6)	(4.53, 41.2)	(-0.19, 50.5)	

[1] The estimation uses 450 daily stock returns from the CRSP tape, starting on day $a-60$. For event period n, $z_n = (1/\sqrt{N})\sum_{j=1}^{N}(\hat{\gamma}_{jn}/\hat{\sigma}_{\gamma jn})$, where the "hat" denotes OLS estimate and $\hat{\sigma}_{\gamma jm}$ is the estimated standard deviation of $\hat{\gamma}_{jn}$. Under the null hypothesis of zero abnormal return, z_n is approximately standard normal for large N.
[2] Since firm commitment offers have no formal offer expiration day, we use $e = b + 20$ in this offer category, which is comparable to the length of a typical rights offer (see below). The average number of trading days between the issue announcement and the beginning of the offer period is 26 for the industrial offers and 33 for the public utility offers.
[3] The average number of trading days from a to b is 31 for industrial and 38 for utility offers, while $e - b$ (i.e., the length of the subscription period) averages 12 for industrial standbys and 13 for utility standbys.
[4] The average number of trading days from a to b is 40 for industrial and 45 for utility offers, the $e - b$ averages 14 for industrials and 21 for utilities.

Table 2
Extracted from Eckbo, Maksimovic, and Williams (1990): Cross-Sectional Estimates for Bidders.

Maximum likelihood ML estimates of the coefficients γ_1 and the standard deviation of managers' private information ω_1 in three cross-sectional models of the form

$$CAR_j = (1 - p_{2j} p_{3j}) H(x_j) + \epsilon_j, \quad j = 1, ..., J,$$

where CAR_j is the abnormal stock return to bidder j relative to the merger proposal announcement, p_{2j} is the probability of a government challenge, p_{3j} is the probability that the challenge will be successful, and x_j is a vector of explanatory variables. The first model is the standard linear model estimated using OLS which does not correct for truncation bias. The second model adjusts for truncation bias, while the third model also adjusts for the possibility of prior anticipation of the merger event. Total sample of 145 listed bidders, 1963-1978.[1].

Explanatory Variables[2]

Constant	CR	NR	VR	PM	TI	$\hat{\omega}_1$	lnL	χ^2 statistic
Standard Linear Model $H(x_j) = x_j \gamma_1$								
1.99E-4	4.14E-4	1.51E-4	-2.12E-4	-6.01E-4	-1.51E-3		197.5	1.38
(0.01)	(0.49)	(0.38)	(-0.05)	(-0.04)	(-0.82)			(5df)
Model with Correction for Truncation Bias[3] $H(x_j) = x_j \gamma_1 + \omega_1 \frac{n(z_j)}{N(z_j)}$								
-.1476	-8.32E-4	-3.11E-4	8.26E-3	7.82E-2	-4.64E-3	4.63E-2	205.6	17.6[4]
(-8.84)	(-2.18)	(-0.77)	(1.48)	(1.61)	(-1.81)	(6.12)		(6df)
Model with Correction for Truncation Bias and Prior Anticipation[3] $H(x_j) = [x_j \gamma_1 + \omega_1 \frac{n(z_j)}{N(z_j)}][1 - N(z_j)]$								
.164	-4.54E-3	-2.78E-3	4.14E-2	.142	-9.72E-3	4.74E-2	208.8	24.0[4]
(3.18)	(-3.47)	(-0.96)	(2.34)	(1.87)	(-3.52)	(3.85)		(6df)

[1] The procedure for estimating CAR_j is given in Table 2. p_{2j} is computed as $N(x_j \hat{\gamma}_2)$ using the values from the first row of Table 3. p_{3j} is set equal to the sample proportion 59/80 since $\hat{\gamma}_3$ in Table 3 is insignificantly different from zero. For each firm, prior to the estimation, the dependent and independent variables are standardized by the standard error of the market model regression used to generate CAR_j. The non-linear models are estimated using the likelihood function L_1 in expression (11), using the OLS estimates of the coefficients as initial (starting) parameter values. The normal distribution is approximated to nine digits. The numbers in parentheses are t-values for the linear model and asymptotic t-values for the nonlinear model.
[2] The payment method PM is 1 if the payment is cash and/or debt and 0 otherwise. The remaining variables are defined in Table 1. The takeover index TI is available only up through 1978, thus the

Table 3
Extracted from Eckbo (1992): Cross-sectional Estimates for Pairs of Bidder and Target Firms, 1963-1983.

Maximum likelihood estimates of the coefficients ϕ, ω in non-linear cross-sectional models with the total announcement-induced abnormal stock returns (AR_j) to equal-weighted pairs of bidder and target firms as dependent variable, where

$$AR_j = H(x_j\phi, \omega) + \zeta_j, \quad j = 1...N.$$

Asymptotic t-values in parentheses[a].

Merger Category	Constant ϕ_0	$ln(V_B/V_T)$ ϕ_1	R ϕ_2	C ϕ_3	dC ϕ_4	ω	χ^2 statistic
I. Sample without Antitrust Overhang $H(\cdot) = [x_j\phi + \omega\frac{n(x_j\phi/\omega)}{N(x_j\phi/\omega)}][1 - N(x_j\phi/\omega)]$							
25 U.S. Nonhorizontal	-.024 (-.92)	-.002 (-.53)	-.001 (-1.55)	.004 (1.98)	-	.001 (.33)	3.3 (3df)
31 Canadian Nonhorizontal	.093 (1.01)	-.006 (-.77)	-.007 (-1.85)	.013 (2.42)	-	.034 (2.66)	12.2[b] (3df)
42 Canadian Horizontal	-.048 (-.97)	-.010 (-1.67)	-.012 (-2.05)	.023 (3.41)	-.066 (-2.95)	.021 (2.52)	20.1[b] (4df)
II. Sample with Antitrust Overhang $H(\cdot) = [(1 - p_{rj}p_{cj})(x_j\phi + \omega\frac{n(x_j\phi/\omega)}{N(x_j\phi/\omega)}) - p_{rj}c][1 - N(x_j\phi/\omega)]$							
81 U.S. Horizontal	.091 (1.01)	-.014 (-1.42)	-.004 (-2.24)	.006 (2.41)	-	.021 (2.01)	16.1[b] (3df)
46 U.S. Challenged	.241 (.60)	-.021 (-1.98)	-.003 (-1.81)	.015 (3.66)	-.065 (-2.38)	.042 (3.12)	23.3[b] (4df)

[a] The dependent variable AR_j for Canadian mergers equals the event parameter γ_j estimated from the market model (3), while for U.S. mergers it is equal to the market model estimate of γ_j times 31. The explanatory variables x_j are the log of the ratio of the total equity size of the bidder and the target ($lv(V_B/V_T)$, the number of identified non-merging industry rivals (R), the pre-merger four-firm industry concentration ratio (C), and the merger-induced change in the industry's Herfindahl Index (dC), computed as $2s_Bs_T$ where s_i is the pre-merger market share of firm i. OLS estimates are used as initial (starting) parameter values in the non-linear estimation, with the OLS regression standard error as the initial value for ω. The probabilities $\hat{p}_{rj}$ are computed from the parameter estimates in Table VI, while the value of $\hat{p}_{cj}$ is set equal to 52/80 for all j. These probabilities, and the cost of going to court $c = .01$, are treated as constants in the estimation above. The

Table 4
Extracted from Eckbo (1992): Cross-equation Tests of Event Parameter Restrictions for Non-Merging Industry Rivals, 1963-1981.

In this table, the null hypothesis is that the abnormal returns across the rival firms associated with a given merger are jointly equal to zero, i.e., $H_0 : \gamma_{ij} = 0, \;\; i = 1, ..., R_j$. The test statistic for H_0 is

$$\frac{1}{(\overline{X}'\overline{X})^{-1}_{33}} \underline{\hat{\gamma}}'\hat{\Sigma}^{-1}\underline{\hat{\gamma}} \quad \sim \chi^2(R_j),$$

where $\overline{X} = [\underline{1}\ \underline{r}_m\ \underline{d}]$ is the Tx3 matrix of market model regressors for merger j, $(\overline{X}'\overline{X})^{-1}_{33}$ is the $(3,3)$ element of $(\overline{X}'\overline{X})^{-1}$, Σ is the R_jxR_j contemporaneous residual covariance matrix estimated from the first-pass OLS regression of the R_j individual market model equations, and $\hat{\underline{\gamma}}$ is the R_jx1 vector of event parameters. The table reports the *sum* of the N values of this χ^2 statistic across a sample of N mergers (which itself has a limiting χ^2 distribution with $\sum_j^N R_j$ degrees of freedom), and in parenthesis the percent of the N individual χ^2 values that reject H_0 at a 5% level of significance.[a].

Merger Category	Industry Rivals U.S. Mergers		Industry Rivals of of Canadian Mergers	
	$\sum_j^N \chi^2(R_j)$	df	$\sum_j^N \chi^2(R_j)$	df
Nonhorizontal	630 (4.3)	700	602 (6.1)	623
Horizontal	2910[b] (11.3)	2141	1316[b] (8.1)	1044
Horizontal Challenged	510[b] (16.4)	401	n.a.	
Horizontal Challenged-A[c]	206[b] (20.3)	144	n.a.	

small [a] For rivals of Canadian mergers, the event parameter γ_{ij} used in the test statistic of this table corresponds to the one-month event parameter in the market model (eq. (3) in the text). For rivals of U.S. mergers, the event parameter has been scale up by a factor of 31 to reflect the total abnormal return over the 31-day event period.
[b] Statistically significant at the 5% level.

Table 5
Descriptive statistics for characteristic based risk factors, January 1973 to December 2002 sample period.

The size factor (SMB) is the return on a portfolio of small firms minus the return on a portfolio of large firms (See Fama and French, 1993). The momentum factor (UMD) is constructed using a procedure similar to Carhart (1997): It is the return on a portfolio of the one-third of the CRSP stocks with the highest buy-and-hold return over the previous 12 months minus the return on a portfolio of the one-third of the CRSP stocks with the lowest buy-and-hold return over the previous 12 months. The SMB, HML, and UMD factors are constructed by Ken French and are downloaded from his web-page. The liquidity factor LMH is constructed using an algorithm similar to the one used by Fama and French (1993) when constructing the SMB and HML factors. To construct LMH, we start in 1972 and form two portfolios based on a ranking of the end-of-year market value of equity for all NYSE/AMEX stocks and three portfolios formed using NYSE/AMEX stocks ranked on turnover. Next, six portfolios are constructed from the intersection of the two market value and the three turnover portfolios. Monthly value-weighted returns on these six portfolios are calculated starting in January 1973. Portfolios are reformed in January every year using firm rankings from December the previous year. The return on the LMH portfolio is the difference between the equal-weighted average return on the two portfolios with low turnover and the equal-weighted average return on the two portfolios with high turnover. The PS factor is constructed as in Pastor and Stambaugh (2003) using order-flow related return reversals.

(A) Characteristic based factors

	N	Mean	Std Dev
Excess return on the value-weighted market portfolio (RM)	360	0.400	4.760
Difference in returns between small firms and big firms (SMB)	360	0.164	3.378
Difference in return between firms with high and low book-to-market (HML)	360	0.491	3.233
Difference in return between winners and losers (UMD)	360	0.986	4.334
Difference in return between firms with high and low turnover (LMH)	360	0.175	2.851
Pastor-Stambaugh liquidity factor (PS)[1]	360	-0.028	0.087

(B) Correlation between characteristic based factors

	RM	SMB	HML	UMD	LMH	PS
RM	1.000					
SMB	0.257	1.000				
HML	-0.473	-0.312	1.000			
UMD	0.093	0.101	-0.314	1.000		
LMH	-0.673	-0.544	0.522	-0.098	1.000	
PS	0.278	0.064	-0.151	-0.024	-0.147	1.000

[1] Note that, in contrast to the five other risk factors in Panel A, the mean value of the PS factor cannot be interpreted as a risk premium. See the text for details.

Table 6
Factor mimicking portfolios and macroeconomic variables used as risk factors, January 1973 to December 2002.

A factor mimicking portfolio is constructed by first regressing the returns on each of the 25 size and book-to-market sorted portfolios of Fama and French (1993) on the total set of six factors, i.e., 25 time-series regressions producing a (25×6) matrix B of slope coefficients against the factors. If V is the (25×25) covariance matrix of the error terms in these regressions (assumed to be diagonal), then the weights on the mimicking portfolios are: $w = (B'V^{-1}B)^{-1}B'V^{-1}$ (see Lehmann and Modest (1988)). For each factor k, the return in month t for the corresponding mimicking portfolio is calculated from the cross-product of row k in w and the vector of month t returns on the 25 Fama-French portfolios.

(A) Raw macroeconomic variables

	N	Mean	Std Dev
Excess return on the market index (RM)	360	0.400	4.760
Difference in return between firms with high and low turnover (LMH)	360	0.175	2.851
Change in real per capita consumption of nondurable goods (ΔRPC)[a]	360	0.041	0.697
Difference in BAA and AAA yield change (BAA−AAA)	360	0.010	1.167
Unanticipated inflation (UI)[b]	360	-0.020	0.254
Return difference on Treasury bonds (20y−1y)[c]	360	0.131	2.652
Return difference on Treasury bills (TBILLspr)[d]	360	0.051	0.112

(B) Correlation between raw macroeconomic factor and the factor mimicking portfolio

Mimicking factor	ΔRPC	BAA−AAA	UI
$\widehat{\Delta RPC}$	0.208 (0.000)	0.026 (0.622)	−0.061 (0.250)
$\widehat{BAA-AAA}$	0.018 (0.733)	0.159 (0.002)	−0.031 (0.559)
$\widehat{UI}$	−0.003 (0.949)	−0.033 (0.529)	0.183 (0.001)

(C) Correlation between macroeconomic factors

	RM	LMH	$\widehat{\Delta RPC}$	$\widehat{BAA-AAA}$	$\widehat{UI}$	20y−1y	TBILLspr
RM	1.000						
LMH	-0.679	1.000					
$\widehat{\Delta RPC}$	0.070	-0.024	1.000				
$\widehat{BAA-AAA}$	0.032	-0.085	-0.180	1.000			
$\widehat{UI}$	-0.055	0.016	-0.566	0.492	1.000		
20y−1y	0.233	-0.014	0.034	0.035	-0.059	1.000	
TBILLspr	0.111	0.003	0.031	0.045	-0.052	0.374	1.000

[a]Seasonally adjusted real per capita consumption of nondurable goods are from the FRED database.
[b]Unanticipated inflation (UI) is generated using a model for expected inflation that involves running a regression of real returns (returns on 30-day Treasury bills less inflation) on a constant and 12 of it's lagged values.
[c]This is the return spread between Treasury bonds with 20-year and 1-year maturities.
[d]The short end of the term structure (TBILLspr) is measured as the return difference between 90-day and 30-day Treasury bills.