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FIFTY BETAS

By Philip Brown and Terry Walter,  
University of Western Australia.

As the title suggests, this paper provides "beta" estimates for 50 Australian industrial companies, selected at random. In the sections that follow we review briefly a rationale for the use of beta and the procedures we adopted to estimate it. The paper is an outcome of numerous requests made at the Macquarie Seminars to provide a few numbers to talk about.

A Rationale for Using Beta

Investors generally try to avoid taking needless risk. By

investment *risk* we mean dispersion in the rate of return around some point of central tendency, usually taken to be the average or expected value.

One way to be precise about investment risk is to measure it by the variance of the rate of return, so that the average rate of return is commonly the measure of central tendency, and the variance the measure of risk. Thus "mean-variance" and "expected return-risk" are often used (somewhat imprecisely) as if they were interchangeable. But where does "beta" fit in?

A share's beta is defined by the ratio of (a) the covariance of the rate of return on that particular share and the average rate of return on all investment assets, divided by (b) the variance of the average rate of return on all investment assets. It is essentially an *ex ante* concept which has its origins in the one-period, equilibrium capital asset pricing theories of Sharpe, Treynor and others. In this paper we provide only an intuitive interpretation.

Often when a share's price rises (or falls), it appears to do so in response to some factor which pervades the whole market; while on other occasions it might appear to go against the market as a whole. This observation leads to the following proposition: the variance in the rate of return on a share can be decomposed into two effects, namely an effect due to changes in the market (which can affect the prices of different shares to different degrees but affects almost all shares to at least some degree), and a residual effect (what is left after removing the market effect). Beta is simply a measure of the degree to which the rate of return on a share on average responds to the market effect.

Beta, as a concept, acquires meaning in the context of an efficiently-diversified portfolio because beta determines a share's contribution to the variance of the portfolio's rate of return. According to the equilibrium capital asset pricing theory, an

efficiently diversified portfolio is one in which the needless (residual) risks have been diversified away, so that only the market effect remains. Intuitively, the more sensitive a share's price is to a change in the market, the greater the expected movement in the value of any portfolio which contains that share. In this sense beta is an index of risk.

#### Estimating Beta

Since beta is an *ex ante* concept which depends on investors' predictions of future rates of return, it can never be observed. But it can be estimated, provided it remains reasonably constant over time. To estimate beta, we need the following data:

- (a) a reliable index of market rates of return over perhaps 50 periods (we say "perhaps" because the exact number is unknown, although in principle it can be estimated)
- (b) rates of return over the same time period for the shares whose betas we wish to calculate.

The formula we used for beta is the formula for the slope term in an ordinary least squares regression line. If we denote  $R_j$  as the rate of return on share  $j$  and  $R_{\pi}$  as the rate of return on the market index, we have

$$R_{jt} = \alpha_j + \beta_j R_{\pi t} + \mu_{jt} \quad \dots (1)$$

where  $t$  denotes each time period (with  $\alpha_j$  and  $\beta_j$  independent of  $t$ )  $\mu_{jt}$  is a random (non-market) effect, and  $\alpha_j$  and  $\beta_j$  are calculated using the familiar regression procedures.

#### Data

We began with a random sample of 50 actively-traded industrial shares listed on the Melbourne Stock Exchange at January 1, 1964. Thirteen of the companies first chosen were delisted at various stages during the period, the principal reason being as a result of a successful takeover bid. For each company removed another was

substituted, again by a random selection procedure.

Weekly closing prices were collected from Melbourne Stock Exchange quotation sheets for these shares for the 557 weeks beginning January 1, 1964 and ending August 30, 1974. When we were unable to obtain a sale price in Melbourne, we referred to the Sydney lists. Adjustments were made to each share's price series for changes in the basis of quotation (resulting from dividends, bonus priority and rights issues, calls, share splits, consolidations, returns of capital and capital reconstructions.) The weekly closing prices were then converted into weekly rates of return.

Our "market index" was simply the average rate of return for the 50 firms in our sample. It differs in two major respects from the Statex Accumulation Index: our index was re-balanced weekly, while the Statex index is re-balanced annually; and the members of our index were actively-traded shares selected randomly, while the members of the Statex index are selected systematically according to market capitalisation. Needless to say, however, there was a high correlation between our index and the Statex Accumulation Index ( $r^2$  is 0.82) over the time period for which we could make a comparison. Presumably the Statex Accumulation Index, expressed as a rate of return, could well be used by anyone who wishes to calculate beta for one of his favourites.

### Results

The following table gives the estimates of beta and related statistics for each of the 50 shares still on our data file at August 30, 1974.

Column (2) contains the estimate of  $\alpha_j$  in equation (1). Although  $\alpha_j$  has a well-defined *ex ante* interpretation, its *ex post* interpretation is less clear. It is (by calculation) the weekly rate of return on the share when the market rate of return was zero; but the figures in column (2) would most probably bear little relationship to

Table: Market Model: Results for 50 Randomly Selected  
Industrial Shares--Weekly Data, January 1964 -  
August 1974.

| Name               | $\hat{\alpha}$ | $\hat{\beta}$ | $r^2$ | Prob.<br>$t(\hat{\alpha})$ | Prob.<br>$t(\hat{\beta})$ | Prob.<br>$F(\hat{\alpha}, \hat{\beta})$ | No.<br>weeks |
|--------------------|----------------|---------------|-------|----------------------------|---------------------------|---|--------------|
| (1)                | (2)            | (3)           | (4)   | (5)                        | (6)                       | (7)                                     | (8)          |
| Ansett             | .0012          | .75           | .08   | .28                        | .03                       | .15                                     | 359          |
| Arnotts            | -.0028         | .88           | .25   | .20                        | .24                       | .62                                     | 86           |
| ACT                | -.0010         | 1.06          | .27   | .17                        | .23                       | .49                                     | 556          |
| Barret Burston     | .0004          | .73           | .09   | .40                        | .00                       | .03                                     | 523          |
| Bowling Centres    | -.0014         | 1.86          | .07   | .37                        | .00                       | .02                                     | 475          |
| Bradmill           | .0005          | 1.04          | .15   | .38                        | .34                       | .87                                     | 552          |
| Brick and Pipe     | .0000          | 1.15          | .21   | .49                        | .06                       | .29                                     | 534          |
| BHP                | .0006          | 1.13          | .23   | .32                        | .07                       | .30                                     | 556          |
| CUB "Z"            | -.0013         | 1.30          | .35   | .27                        | .01                       | .06                                     | 202          |
| Carrier Air        | .0013          | .98           | .06   | .27                        | .44                       | .82                                     | 500          |
| Clyde Indust       | .0004          | .73           | .09   | .38                        | .00                       | .03                                     | 551          |
| Cockburn Cement    | -.0010         | .41           | .04   | .33                        | .00                       | .00                                     | 214          |
| CBC of Sydney      | .0007          | 1.32          | .38   | .41                        | .02                       | .14                                     | 113          |
| Commercial Union   | -.0031         | .51           | .05   | .12                        | .00                       | .00                                     | 203          |
| CIG                | -.0002         | .90           | .16   | .44                        | .16                       | .60                                     | 379          |
| Consol Foods       | -.0007         | .54           | .05   | .31                        | .00                       | .00                                     | 537          |
| Consol Home        | .0026          | 1.03          | .06   | .16                        | .44                       | .59                                     | 461          |
| Cyclone            | .0003          | .84           | .11   | .43                        | .06                       | .28                                     | 550          |
| Dunlop             | -.0013         | 1.19          | .22   | .16                        | .03                       | .10                                     | 556          |
| Email              | .0003          | 1.36          | .18   | .44                        | .00                       | .02                                     | 556          |
| Fairfax (John)     | -.0000         | .84           | .16   | .50                        | .09                       | .39                                     | 256          |
| Fibre Containers   | .0006          | .41           | .04   | .33                        | .00                       | .00                                     | 374          |
| Gadsden (J)        | .0024          | .74           | .15   | .14                        | .03                       | .09                                     | 182          |
| Goliath Cement     | .0014          | .66           | .03   | .15                        | .00                       | .00                                     | 509          |
| Gollin             | .0005          | .62           | .05   | .38                        | .00                       | .01                                     | 530          |
| Hanimex            | .0013          | 1.27          | .15   | .25                        | .02                       | .09                                     | 542          |
| Hardie (James)     | .0007          | .99           | .16   | .30                        | .46                       | .86                                     | 535          |
| Hardie Trading     | -.0013         | .65           | .08   | .18                        | .00                       | .00                                     | 402          |
| Humes              | -.0001         | .90           | .12   | .47                        | .17                       | .63                                     | 552          |
| Huttons            | .0010          | .44           | .03   | .25                        | .00                       | .00                                     | 528          |
| ICI Aust           | -.0008         | .94           | .16   | .26                        | .24                       | .62                                     | 554          |
| Jennings (AV)      | .0015          | 1.78          | .25   | .21                        | .00                       | .00                                     | 554          |
| Jones (Henry)      | .0012          | .85           | .09   | .23                        | .10                       | .35                                     | 543          |
| Luke (KG)          | -.0003         | .75           | .11   | .41                        | .01                       | .04                                     | 496          |
| National Bank      | -.0002         | 1.06          | .20   | .44                        | .24                       | .77                                     | 556          |
| National Consol    | -.0011         | .98           | .20   | .18                        | .39                       | .63                                     | 554          |
| NKS                | .0015          | .70           | .12   | .22                        | .01                       | .05                                     | 233          |
| Nylex              | .0004          | 1.17          | .17   | .41                        | .06                       | .29                                     | 550          |
| Overseas           | .0009          | 1.06          | .20   | .30                        | .31                       | .75                                     | 352          |
| Project Develop    | -.0040         | 2.21          | .14   | .12                        | .00                       | .00                                     | 504          |
| Rocla              | -.0004         | 1.20          | .19   | .40                        | .03                       | .19                                     | 525          |
| Rothmans           | .0002          | .83           | .10   | .43                        | .05                       | .25                                     | 550          |
| Sleigh (HC)        | -.0015         | 1.01          | .14   | .16                        | .45                       | .61                                     | 556          |
| Southern Motors    | .0007          | .81           | .05   | .40                        | .17                       | .63                                     | 333          |
| Swan Brewery       | -.0007         | .85           | .15   | .28                        | .04                       | .18                                     | 556          |
| TV Corp            | .0003          | .60           | .05   | .42                        | .00                       | .00                                     | 446          |
| Thomas Nationwide  | .0010          | 1.41          | .23   | .27                        | .00                       | .00                                     | 556          |
| United Telecasters | -.0025         | 1.21          | .06   | .18                        | .15                       | .40                                     | 535          |
| Waltons            | -.0014         | 1.27          | .21   | .17                        | .00                       | .02                                     | 556          |
| Woolworths         | -.0015         | .78           | .16   | .08                        | .00                       | .01                                     | 556          |

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the values for  $\alpha$  which might have been calculated for those same shares over some other time period. Our values for  $\alpha$  ranged from a minimum of  $-.0040$  (Project Development) to a maximum of  $.0026$  (Consolidated Home Industries); the average ( $-.0001$ ) was little different from zero. Since the average  $\alpha$  would have been exactly zero if price quotations had been available for all 50 shares for every week, we conducted a t-test on each share's  $\alpha$ -estimate to see whether it differed significantly from zero. Column (5) shows that this was the case at the 10 per cent confidence limit for only one share (Woolworths).

Column (3) contains the beta estimates. They ranged from a minimum of  $.41$  (Cockburn Cement and Fibre Containers) to a maximum of  $2.21$  (Project Development). The average was  $.97$ . It is easy to show that the average beta for the economy as a whole must be exactly unity and that our average beta would also have been exactly unity had price quotations been available for all 50 shares for every week. Thus to test the significance of each share's beta estimate, the relevant statistical null hypothesis to be rejected is that the "true" value for each share's beta was unity. Viewed in this light, column (6) discloses 35 betas were significantly different from unity at the 10 per cent confidence limit, 29 at 5 per cent and 21 at 1 per cent.

Column (7) is related to columns (5) and (6), in that column (7) gives the probability of having jointly observed each share's  $\alpha$  and  $\beta$  values had their true values been zero and unity respectively. Twenty-four pairs of  $(\alpha, \beta)$ 's were significantly different from  $(0, 1)$  at the 10 per cent confidence limit, 20 at the 5 per cent limit, and 13 at the 1 per cent limit.

Column (4) gives the proportion of the variance in each share's weekly rate of return which was accounted for by the market index (including that share.) The proportion ranged from a minimum of only 3 per cent (Huttons) to a maximum of 38 per cent (Commercial

Banking Company of Sydney). The average was around 15 per cent, which is consistent with other estimates we have obtained using monthly data.

The final column gives the number of rates of return used to estimate these statistics. One week was lost when we calculated a rate of return, making 556 the maximum possible number.

#### Concluding Remarks

Our objective was simply to provide some estimates to illustrate how beta can be calculated, and how it varies from share to share. Estimates were given for 50 industrial shares selected randomly. A large data file, nearing completion, shortly will permit us to make similar estimates for all listed industrial shares with paid-up capital in excess of \$1 million, while an even larger data file, scheduled to be available some time next year, will include every security listed on the Australian Associated Stock Exchanges.

We have not attempted any more than a quick "once-over-lightly", for the question of how to develop statistically efficient estimates of beta is extremely complex, and improved estimators can be expected to be known in the future. For the present, however, beta can be estimated using ordinary least squares regression techniques and the Statex Accumulation Index as a surrogate for the market factor.

Some issues we did not address are as follows. Do monthly (rather than weekly) rates of return yield better estimates of beta? How many weeks' (months') data are needed to estimate beta efficiently? Does a share's beta change over time, and if so, in what manner? What factors explain differences in shares' betas? To what extent do differences in shares' betas explain differences in their rates of return? What are the practical uses of beta? These and many other related questions have been asked by both academics and practitioners and some tentative answers could have been provided. They were, however, beyond the scope of our present task.

September 16, 1974.