The Sensitivity of Australian Industry Betas to Macroeconomic Factors

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Abstract

This paper examines the stability of Australian industry betas in relation to the variation of key macroeconomic factors. Betas of several industries were found to be sensitive to at least one macroeconomic factor and some industries, to two factors. The exchange rate factor was observed to be influential on the beta variablity of most industries while current account balance, trade balance, interest rates and unemployment were influential in the case of some industries. Inflation was not found to be significant for any industry.

Keywords: Beta, market model, macroeconomic factors

Amidst the ongoing debate surrounding the validity of the Capital Asset Pricing Model (CAPM), the CAPM continues to be widely applied in the finance industry for a variety of purposes. The beta estimates required as inputs to the model continue to be estimated from the market model. In all these applications there is a presumption of the stability of beta values over the estimation period chosen. But the stability of beta over time is hardly a settled issue. There is considerable empirical evidence for the instability of betas in Australia (Faff, Lee and Fry (1992), Brooks, Faff and Lee (1992, 1994) and in other markets (Bos and Newbold (1984) and Murray (1995). Consequently, a number of researchers have investigated the time variation of betas.

A variety of explanations have been offered for the time variation of beta and a number of approaches have been suggested for understanding and modelling the time variation of betas (see Brailsford, Faff and Oliver (1997) for a synopsis of these methods). One strand of research has explored the variation of betas due to exogenous macroeconomic factors. The motivation for such a line of reasoning is clear. It is well established in the finance literature that macroeconomic variables are sources of systematic risk in stock returns. For example, Chen, Roll and Ross (1986) and Lockwood (1996) have shown that industrial production, changes in the risk premium, twists in the yield curve and inflation changes are significant in explaining returns. The idea that changes in macroeconomic factors may also affect the value of the betas follows logically. A number of studies have explored this idea. Fabozzi and Francis (1978) and Bos and Newbold (1984) show that the business cycle factors of unemployment and inflation may contribute to beta instability. Lockwood (1996) examines equity fund betas using the same variables as Chen, Roll and Ross (1986). Lockwood uses monthly returns for 171 mutual funds for the period 1978 to 1991 and applies a nonlinear factor model. He finds that on average equity fund betas are negatively related to inflation changes and default risk premia while bond fund betas, on average, are negatively related to changes in risk-free rates, industrial production growth, and the term structure. However this study does not show the sensitivity of beta to the change of the economic variables. It only shows whether a particular category of mutual fund is positively or negatively related to a change in a economic variable. Extending the analysis of the affect of macroeconomic influences on the betas of industry portfolios has many benefits to the finance practitioner and to the academic.

Industry analysis has long been a cornerstone in the practice of professional investment management and in the theories of risk investment. Financial analysts have long recognised that firms within an industry have many commonalities such as their sensitivity to the business cycle, degree of operating leverage, industrial relations issues, product life cycles, international tarriffs/quotas on products, environmental issues, raw material availability, product technological development etc. As a result of these commonalities, the existence of an 'industry risk' for each industry is recognised.

An understanding of the sensitivity of industry betas to macroeconomic factors would therefore be of benefit to both the finance practitioner as well as the academic. By identifying those macroeconomic variables affecting industry betas, investment managers may be able to hedge against the systematic risks stemming from particular macroeconomic variable. For example, if equity fund betas fall as inflation rises, managers can shift the allocation away from industries with betas that are highly inflation sensitive. Therefore by identifying inflation sensitive industries, fund managers or portfolio managers can improve their hedging activities.

The value of industry analysis is well supported in the academic literature as well. Abell and Krueger (1989) measure the sensitivity of industry beta estimates to a number of macroeconomic variables with a view to identifying the macroeconomic variables that are most significant in affecting the beta stability characteristics of different industries. Using U.S. data, their sample consists of 17 industry portfolios over the 1980 to 1986 period based on monthly data. They test the influence of macroeconomic variables on the market model betas using a variant of the single index market model (SIMM), which they describe as the variable beta model (VBM). Their results show that interest rates, budget deficits, trade deficits, inflation and oil prices are among the more important macroeconomic descriptors that are found to significantly changes in betas.

An understanding of the beta variability over time can also contribute to the debate surrounding the "Is Beta dead?" debate. If the factors affecting the time variation of beta can be properly understood, such factors can be incorporated in capital market models with variable betas used for predictive purposes, thereby enhancing the power of these models. Such evidence may support the argument that beta may not be "dead" after all as proposed by the Fama and French (1992) study.

Given these strong motivations, the objective of this paper is to examine the macroeconomic influences on betas, based on Australian industry sector indices using Abell and Krueger's VBM. Moreover, the measurement of the sensitivity of beta to a macroeconomic variable change or using the VBM model is not known to have been performed in an Australian context, as far as the authors are aware.

The rest of the paper is organised as follows. Section 2 provides a description of the methodology, consisting of several subsections. Subsection 1 explains the VBM, while subsections 2 and 3 discusses the macroeconomic variables chosen for the analysis and the stepwise regression procedure employed to identify the significant variables. Section 3 describes the data, definitions of variables and industry definitions and sample selection criteria. Section 4 presents the results of the analysis while section 5 provides the conclusions of the paper.

2. Methodology

2.1 The Variable Beta Model (VBM)

The VBM as presented by Abell and Krueger (1989) is an extension of the SIMM to allow beta B_t to vary over time with a set of exogenous descriptors x_{jt}. The model is defined as follows.

$$R_i = \alpha + B_t R_{mt} + e_t \qquad (1)$$

$$B_t = \beta_o + \beta_1 x_{1t} + \ldots + \beta_j x_{jt} + \delta_t \quad (2)$$

where δ_t is a random error term. The β_j are the coefficients of proportionality by which beta is adjusted in response to movements in the descriptors. The β_j estimates are obtained by substituting (2) into (1), yielding:

$$R_t = \alpha + \beta_o R_{mt} + \beta_1 (R_{mt} * x_{1t}) + \ldots + \beta_j (R_{mt} * x_{jt}) + \omega_t \quad (3)$$

ω_t includes the random disturbances from the risk that is specific to a single return as well as the unpredictable variation in beta. $E(\omega_t) = 0$.

An example of a hypothetical VBM can be described as follows:

$$R_t = \alpha + \beta_o R_{mt} + \beta_1 (R_{mt} * r_t) \quad (4)$$

where r_t is an interest rate. The term β_o does not represent the "pure" beta of the SIMM, nor can it take on the same value because of the multiplicative way in which the descriptors enter the model. In this example, it may be considered as a separate influence of the market after incorporating the influences of interest rates. The primary use of the VBM comes from the information contained in the β_i coefficients. For example, from equation (4) if β_o has a positive value and β_1 has a negative value, the negative β_1 indicates that the beta of the SIMM is reduced in response to interest rates.

2.2 The Macroeconomic variables

The selected macroeconomic variables and the notations employed to represent them are listed in Table 1.

Table 1
Macroeconomic Variables

Current Account Balance (CAB)	Default Risk Premia (DPR)
Trade Balance (TB)	Term Structure (TS)
Money Supply (M1)	Inflation (INF)
Exchange Rate of the Australian Dollar -Reserve Bank Weighted Average (EXCH)	Industrial Production (IP)
Unemployment Level (UN)	Risk Free Rate (Rf)

The macroeconomic variables selected for the study are those that have been demonstrated in previous research such as Chen, Roll and Ross (1986), Abell and Krueger and Lockwood (1996), to be influential in exerting a systematic risk factor in stock returns and on betas. The rationale for using the variables such as default risk premia, term structure, inflation, industrial production and the risk free rate can be explained in terms of the arguments in Chen, Roll and Ross (1986). They posit that any macroeconomic variable that affect stock prices, or that influences dividends would also influence stock market returns. An economic variable that has no direct influence on current cash flows but does describe the changing investment opportunity set will also influence stock market returns.

Stock prices can be written as expected discounted dividends:

$$p = \frac{E(b)}{k} \tag{4.23}$$

where b is the dividend stream and k is the discount rate. This implies that actual returns in any period are given by

$$\frac{dp}{p} + \frac{b}{p} = \frac{d[E(b)]}{E(b)} - \frac{dk}{k} + \frac{b}{p} \tag{4.24}$$

According to Chen, Roll and Ross (1986), systematic forces that influence stock market returns are those that change discount factors, k, and expected cash flows, E(b). The discount rate is an average of the rates over time, and it changes with both the level of discount rates and the term-structure spreads across different maturities. Changes in the riskless interest rate will therefore influence pricing and time value of future cash flows that can then influence stock market returns. The discount rate also depends on the risk premium; hence changes in the premium will influence returns. On the demand side, changes in the marginal utility of real wealth, as measured by real consumption changes, will influence pricing, and this effect can be captured by risk premia.

As for the inflation variable, changes in the expected rate of inflation would influence cash flows as well as interest rates. Also relative prices in the economy changes along with general inflation, which can cause a change in asset valuation associated with changes in the average inflation rate. Finally, changes in the expected level of real production would affect the current real value of cash flows. As the risk-premium measure does not capture industrial production uncertainty, innovations in the rate of productivity activity should have an influence on stock returns through their impact on cash flows.

2.3 The Stepwise Regression Procedure

In the VBM procedure, the decision to include the multiplicative macroeconomic terms was made on the basis of stepwise regressions. The stepwise regression procedure is an automatic search method developed to economise on computational efforts as compared with all-possible-regressions approach, while arriving at a reasonably "good" subset of explanatory variables. This search method develops a sequence of regression models, at each step adding or deleting an explanatory variable. The criterion for adding or deleting an explanatory variable can be stated equivalently in terms of R-square, coefficient of partial correlation or F statistic (Neter, Wasserman and Kutner (1985)). The stepwise regression search algorithm used in the analysis is specified in terms of the R-square. Stepwise variable selection is a combination of forward selection and backward elimination. There are two criteria: one for entering a variable and the other for removing a variable. The forward selection starts with a model that contains only the constant term. At each step, a variable is added to a model that results in the largest increase in multiple R^2, provided that the change in R^2 is large enough to reject the null hypothesis that the true change is 0, using a preset significance level. Then the variables in the model are examined to see if either of them meet the removal criteria. This involves looking at the variable that changes R^2 least, provided that the change is small enough so that it cannot reject the null hypothesis that the true change is 0, using a preset significance level. At each step, a new variable is entered using the same rule as in forward selection and then the variables already in the model is examined for removal, using the same rules as in backward elimination. The process is stopped when no more variables meet the entry criterion. Of course, the significance level for entering a variable should be smaller than the significance level for removing a variable, if not the process will not end.

3. Data, Definitions and Sample Period

The data examined in this study is comprised of daily returns for the accumulation indices of the Australian industry indices drawn from a 15-year sample ranging from January 1983 to December 1997. The data is sourced from Datastream. The Australian All Ordinaries Accumulation Index is used as the market index.

The analysis is conducted for a full 15-year period (1983:1-1997:12) and also over three non-overlapping five-year sub-periods (1983:1-1987:12; 1988:1-1992:12 and 1993:1-1997:12). A further 10-year sub-period (1988:1-1997:12) is also examined. This break-up of data into different sub-periods allows the analysis of issues such as the effect of the stock market crash of October 1987 on industry beta stability.

Industry Selection Criteria

Since the October stock market crash in 1987, there have been some significant changes in the ASX industry groupings. Some sub-indices were removed and new ones were added. The sample consists of two groups: the first group consists of industries that are listed in the stock exchange before 1983 while the second group consists of industries listed between 1983 and 1987 and added to the first group's list of industries. These two groups of industries must still be listed in the stock exchange at the end of 1997. The reason for including the industries added to the stock exchange list between 1983 and 1987 is to increase the sample size and to allow analysis of beta stability for the full 10-year period of 1988:1 to 1997:12 and its two 5-year sub-periods of 1988:1 to 1992:12 and 1993:1 to 1997:12. This allows an up-to-date comparison of beta stability among industries for investment analysis. Table 2 and Table 3 show the lists of industries selected according to this procedure.

Table 2
Australian Industry Sector Indices – Dates of Commencement

Industry Sectors	Base Date*
1. Gold	31-12-1984
2. Other Metals	30-06-1987
3. Diversified Resources	31-12-1979
4. Energy	31-12-1979
5. Infrastructure & Utilities	29-12-1995
6. Developers & Contractors	31-12-1979
7. Building Materials	31-12-1979
8. Alcohol & Tobacco	31-12-1979
9. Food & Household Goods	31-12-1979
10. Chemicals	31-12-1979
11. Engineering	31-12-1979
12 Paper & Packaging	31-12-1979
13. Retail	31-12-1979
14. Transport	31-12-1979
15. Media	31-12-1979
16. Banking and Finance	31-12-1979
17. Insurance	31-12-1979
18. Telecommunication	29-12-1995
19. Investment & Financial Services	30-06-1987
20. Property	31-12-1979
21. Miscellaneous Industrials	31-12-1990
22. Diversified Industrials	30-06-1987
23. Tourism & Leisure	05-08-1994

(Source: Datastream – Banking & Finance Department, Curtin University)

Table 1 shows the dates that the industry sector indices are listed in the stock exchange. There are a total of 23 industries at current. From the table, the industries that were listed before 1983 and are not dropped from the list at the end of 1997 are selected and is shown in column 1 of Table 3 below. Those industry sector indices that are listed in-between 1983 and 1988 and are not dropped from the list at the end of 1997 are selected and added to the first group of industries. These industries are shown in column 2 of Table 3 below.

Table 3
Australian Industry Indices Meeting the Selection Criteria

1983:1-1987:12 and 1983:1 – 1997:12	1988:1-1992:12, 1993:1-1997:12 and 1988:1-1997:12
1. Diversified Resources	1. Diversified Resources
2. Energy	2. Energy
3. Developers & Contractors	3. Developers & Contractors
4. Building Materials	4. Building Materials
5. Alcohol & Tobacco	5. Alcohol & Tobacco
6. Food & Household Goods	6. Food & Household Goods
7. Chemicals	7. Chemicals
8. Engineering	8. Engineering
9. Paper & Packaging	9. Paper & Packaging
10. Retail	10. Retail
11. Transport	11. Transport
12. Media	12. Media
13. Banking and Finance	13. Banking and Finance
14. Insurance	14. Insurance
15. Property	15. Property
	16. Diversified Industrials*
	17. Investment & Financial Services*
	18. Gold*
	19. Other Metals*

* newly added industries

Definitions of macroeconomic variables

Quarterly changes in 90-day Treasury note rates (RF) are used to measure the monthly change in the risk-free rate. The difference between the quarterly yields on corporate AAA rated bonds[1] and 10-year Commonwealth bonds is used to measure the default risk premia (DRP) in a particular quarter. The difference between the yield on 10-year Commonwealth bonds in a particular quarter and the quarterly return on 90-day Treasury notes in the previous quarter is used to measure the effects of the slope of the term structure.

The SIMMs and VBMs are estimated using the same 10-year sample period (avoiding the effect of stock market crash period affecting the validity of results) for the analysis of the stability of beta, that is, the 19 industry sector accumulation indices over the period 1988:1 to 1997:12 but using quarterly data. The reason for using quarterly data for the economic series and for the accumulation indices is that some of the economic variables are measured quarterly, for example CPI in Australia. Therefore to be consistent, all other variables and indices returns are collected quarterly.

With the exception of interest rates and the dollar exchange rates, all variables are transformed into annual rates of change.

4. Results

The results for the stepwise regression for the Variable Beta Model (VBM) show that in nine of the industries at least one macroeconomic descriptor is found to be significant in influencing beta for the period 1988:1 to 1997:10. The summary results for the nine industries that have at least one significant macroeconomic descriptor is shown in Table 4. The results in table 4 shows that in seven industries, one macroeconomic descriptor is significant, but in two industries there are more then one significant macroeconomic descriptors. None of the macroeconomic variables are significant in the other 11 industries. The stepwise regression for the Other Metals industry is discussed in detail in the Appendix. These results are quite similar to the U.S. results of Abell and Krueger (1989) where out of seventeen industries seven industries had at least one significant macroeconomic factor and in four cases there were more than one one significant macroeconomic factor.

From Table 4, it can be seen that five of the macroeconomic descriptors are significant in at least one instance. Chen, Roll and Ross (1986) found default risk premium (DRP), industrial production (IP) and term structure (TS) to be significant in explaining stock returns in U.S. However, for beta sensitivity, these variables are not found to be significant. What is surprising is that the inflation variable (CPI) does not affect any of the industry's beta, even though according to Hardouvelis (1987), Pearce and Roley (1985) and Abell and Kruger (1989) for U.S. data, CPI is significant in explaining stock returns. The last variable M1, though significant in Abell and Krueger (1989)'s study, was also not found to be significant in any industry. However, this appears to be consistent with Ranjit (1993)'s findings in Australia where an analysis of different stock price indices and pre- and post announcement effects of money supply essentially confirm the absence of a significant money supply announcement effect in Australia.

The interpretation of the VBM results is as follows. In the case of Other Metals industry, the positive sign on the Rm*EXCH coefficient implies that the SIMM beta is increased by 0.115% in response to a 1.0% increase in the Trade Weighted Exchange Rate Index (TWI). According to the Loudon (1993)'s study on Australian industries relation to exchange rate exposure, companies within the Other Metals industry are largely export oriented. By reducing foreign price competitiveness, an appreciating $A is likely to depress returns for export oriented industries inducing a negative relationship between equity and currency returns. Therefore an increase in beta appears to be consistent to Loudon (1993)'s finding.

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[1] These are Telestra AAA rated bonds, compounded semi-annually and expires in the year 2002.

Roll (1992) found that exchange rates could explain a small portion of many national index return movements, including those of Australia while Loudon (1993) also found a small number of Australian industries to have significant exposure to the value of the Australian dollar. From Table 4, it can be seen that 7 out of 19 industry betas (≈ 37%) have significant exposure to the value of the Australian dollar. This appears to be consistent with these studies.

It can also be seen that the Alcohol and Tobacco and Food and Household industries beta are significantly related to Current Account Balance (CAB). While it is difficult to explain the positive relationship of CAB with the Alcohol and Tobacco industry, the Food & Household industry's beta is inversely related to CAB (-1.155%) and this may be attributed to improvement measures taken by the Government to slow down the rate of growth in the economy. The faster the rate of growth, the more the country imports, and the worse the current account deficit as the greater will be the level of foreign debt. Polices may be aimed at slowing import demand which reflects a shift of foreign products to domestic food and household products. According to McGrath and Viney (1997) this was clearly evident in the policy responses of the Australian government throughout the latter part of 1980s and into 1990, with increases in interest rates and cuts in government expenditure aimed largely at slowing the economy in order to slow import demand and contain the current account deterioration.

For the Retail industry, Visible Trade Balance (VTB) and Interest rates (IR) are the other variables that are significantly related to betas (-0.0736% and –0.657% respectively). An increase in trade balance implies an increase in exports over imports or less imported goods in which case increases the demand for domestic retail goods and hence explaining the drop in beta to VTB. On the other hand an increase in interest rates leads to a drop in consumer spending which causes a drop in retail profits and hence depressing the industry returns. This appears to reduce the beta.

For the Investment and Financial Services Industry, unemployment rate (UNR) and interest rates (IR) are the other variables that are significantly related to beta (2.548% and –0.359% respectively). An increase in interest rates brings lower returns for investments hence explaining the drop in beta. While it is difficult to reconcile the fact of a large increase in beta (2.395%) towards an increase in unemployment rate, a 1% increase in UNR is certainly negative economic news. Investors may adopt a pessimistic view of the economy and thus invest less domestically.

The findings that the R-square of the VBMs always represents an improvement over that of the SIMMs, during the 1988-1997 period suggests that the use of the VBM may also be of use in explaining industry returns.

5. Conclusions

Exchange rates, current account balance, interest rates, visible trade balance and unemployment are among the more important macroeconomic descriptors that are found to influence significant variation in betas of some industries. This information is useful for portfolio managers to manage systematic risk and more effective portfolio management. For example, hedging against a rise in interest rates can be achieved by tilting the portfolio towards the Retail and Investment and Financial services industries, whose betas are less sensitive to a rise in interest rates.

While the results provide important guidance to portfolio managers, a word of caution is appropriate. It is important to appreciate that some industries are dominated by only a few stocks. For example, News Corporation consists of 70% of the Media industry, Foster's consists of 65% of the Alcohol and Tobacco industry. Consequently, beta instability of some industrial sectors may reflect the situation of only a few companies.

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