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Docherty, Paul; Chan, Howard; Easton, Steve. "Can we treat empirical regularities as state variables in the ICAPM? evidence from Australia" Pacific-Basin Finance Journal Vol. 22, p. 107-124 (2013)

Available from: <http://dx.doi.org/10.1016/j.pacfin.2012.10.004>

Accessed from: <http://hdl.handle.net/1959.13/1051652>

Can we treat empirical regularities as state variables in the ICAPM? Evidence from Australia

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Key words: Asset pricing, Fama-French model, macroeconomic risk, ICAPM.

JEL classification: G11, G12, G17

The financial assistance provided by ARC Linkage Grant (LP0560381) and the linkage partner Acorn Capital and a competitive research grant provided by Platypus Asset Management are both gratefully acknowledged. We also wish to thank an anonymous referee, Abul Shamsuddin, Glenn Pettengill, and staff of Platypus Asset Management for helpful comments and discussions. We gratefully acknowledge comments made by participants at the Australasian Finance and Banking Conference, the Asian Finance Association conference, the Mid-West Finance Association Conference, as well as at Deakin University, La Trobe University, Monash University, and the Universities of Melbourne and Queensland.

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Abstract

By examining the correlation between the size, value and momentum empirical regularities and macroeconomic variables we investigate whether these regularities may be explained as risk factors within Merton's (1973) ICAPM. We examine the commodity-based Australian economy where financial asset claims are highly sensitive to macroeconomic volatility. The size and momentum premia covary pro-cyclically, while the value premium is countercyclical and negative at the business cycle peak. All three regularities become insignificant after controlling for the Chen, Roll and Ross (1986) factors and a macroeconomic model successfully forecasts returns for both the size and momentum premia. Our results suggest that these regularities may be explained as macroeconomic-risk factors. We argue that covariance between macroeconomic risk and empirical regularities may explain inconsistencies in prior Australian market literature.

1. Introduction

The central implication of Merton's (1973) intertemporal capital asset pricing model (ICAPM) is that sources of risk other than market portfolio co-movements are priced in equity returns. Time variation in the investment opportunity set results in changes in the marginal utility of consumption. Risk factors that are priced in equity returns are those state variables that encapsulate changes in the feasible set of investments. Cochrane (2001) argues that macroeconomic variables may proxy for changes in the marginal utility of consumption. As such, for an empirical regularity to be a state variable and therefore be considered a risk factor in the context of Merton's (1973) ICAPM model, the empirical regularity should be correlated with information about fundamental risk in the economy that affects the investment opportunity set. This paper provides an empirical analysis of whether empirical regularities previously identified in the Australian market covary with macroeconomic risk factors such that they may be considered as state variables.

The value (HML), size (SMB) and momentum (WML) premia are empirical regularities that have been reported in most international markets (Fama and French, 1998). However, the Australian evidence regarding the significance of these empirical regularities is mixed.¹ Gharghori, Lee and Veeraraghavan (2009) synthesise this evidence by providing a detailed examination of empirical regularities and report that the Fama and French (1993) model does not adequately model returns in Australia. While the cumulative evidence provided by these studies may bring into question the validity of the Fama and French (1993) in the Australian market; most of the existent literature suffers from a key limitation. With the exception of O'Brien, Brailsford and Gaunt (2010), these previous studies have examined relatively short

¹ The prior Australian studies that report mixed results regarding the significance of the Fama and French (1993) factors include Faff (2001), Gaunt (2004), Gharghori, Chan and Faff (2007), Griffin, Ji and Martin (2003), Halliwell, Heaney and Sawicki (1999) and O'Brien, Brailsford and Gaunt (2010).

investment horizons of up to 20 years. The significance of empirical regularities would be expected to be time-varying in the manner reported in previous studies if those empirical regularities are related to innovations in the business cycle, warranting a thorough examination of the covariance between empirical regularities and macroeconomic factors in an Australian context using a long time-series.

Several studies have directly tested the relationship between macroeconomic risk and empirical regularity returns, with mixed results. HML and SMB have been shown to be related to future GDP growth (Vassalou, 2003), lagged macroeconomic variables (Petkova, 2006) and the Chen, Roll and Ross (1986) factors (Aretz, Bartram and Pope, 2010). Other studies find that these empirical regularities are not related to macroeconomic risk, but rather explained by stock characteristics (Daniel and Titman, 1997) or behavioural biases (Shleifer, Lakonishok, La Porta, and Vishny, 1997). Similarly, some studies identify that WML can be explained by macroeconomic variables (Chordia and Shivakumar, 2002), while others report that momentum profits persist after controlling for risk factors (Griffin, Ji and Martin, 2003).

Given that the debate regarding the source of the size, value and momentum premia remains unresolved, the comprehensive out-of-sample test and the long time series used in this paper provide an important contribution to the literature. The Australian market is used to examine the relationship between empirical regularities and macroeconomic variables. In contrast with other economies, the Australian economy can be characterised as a commodity exporter and a durable goods importer. For example, Docherty, Chan and Easton (2011) report that 41.9% of firms listed in the Australian market were classified as belonging to the materials GICS sector. As a result, Australia's terms of trade are often negatively correlated with countries

such as Japan and the United States.² The structural composition of the Australian economy means that returns on real assets are highly sensitive to the business cycle and exogenous factors such as the weather.

Only a limited number of previous studies have considered the relationship between empirical regularities and macroeconomic risk in the Australian market. Phua, Chan, Faff and Hudson (2010) report that momentum returns are higher after periods when the market return is above 10% per annum. Nguyen, Faff and Gharghori (2009) and Chan, Faff and Kofman (2011) report no relationship between SMB or HML and GDP growth and default risk respectively.³ Aretz, Bartram and Pope (2010) argue that analysis that uses a single macroeconomic variable to explain empirical regularities may suffer from an omitted variable bias. To overcome this problem, we contribute to the existing literature by undertaking the first comprehensive empirical analysis of whether the Australian size, value and momentum premia may be state variables in the context of Merton's (1973) ICAPM. Of note, Chan, Faff and Kofman (2011) report that while default risk can explain some of the inter-temporal cross-sectional variation in returns, further work is required. We attempt to fill this void by considering a larger set of macroeconomic variables.

The analysis undertaken in this paper uses three empirical techniques to investigate the relationship between empirical regularities and macroeconomic state variables. First, we perform an economic state analysis, where the returns on empirical regularities are compared across different holding periods and during economic expansions and contractions to determine whether the empirical regularities examined in this paper bear characteristics that

² The negative correlation between terms of trade of Australia and these countries was identified by Downes, Louis and Lay (1994) for the period 1979 to 1993. Across the longer time series of 1975 to 2011, the correlation between terms of trade in Australia and the United States is -0.317.

³ Chan, Faff and Kofman (2011) report some evidence that default risk is priced in Australian equity returns; however they show that the default factor is not related to SMB or HML.

are consistent with state variables. Second, we estimate a version of the Chen, Roll and Ross (1986) model and investigate whether these factors may explain empirical regularity returns. If empirical regularities were state variables, then the returns on these empirical regularities should be explained by the Chen, Roll and Ross (1986) model, which consists of factors shown to proxy for innovations in the macro-economy. Finally, a macroeconomic forecast model is used to generate ex-ante estimates of empirical regularity returns, which are then compared with their ex-post returns.

This paper provides evidence that the size and momentum empirical regularities covary procyclically. Both are positively related to industrial production growth and the returns on the momentum mimicking portfolio are positive (negative) and statistically significant during the top (bottom) decile of periods of economic expansion (contraction). Both of these empirical regularities lose their significance after controlling for the Chen, Roll and Ross (1986) factors and when their returns are successfully forecasted using a macroeconomic predictive model. The value premium, which is often recognised as the most pervasive empirical regularity, has negative returns during the top decile of periods of economic expansion. We report robust evidence that the HML factor covaries counter-cyclically with the economic cycle and can be explained by the Chen, Roll and Ross (1986) model. These results provide support for the argument that the Australian size, value and momentum empirical regularities may all be explained as macroeconomic risk factors. This result is consistent with the variation in the SMB, HML and WML premia reported across different sample periods in previous Australian studies.

The paper proceeds as follows. Section 2 provides an explanation of the data and empirical regularities. An analysis of the performance of asset pricing anomalies across macroeconomic states is provided in Section 3. An application of the Chen, Roll and Ross (1986) model is

provided in Section 4 and Section 5 outlines the ability of a macroeconomic forecast model to explain anomaly returns. Section 6 provides a summary.

2. Data

Asset pricing tests are performed using the period January 1975 to December 2006. Three decades of evidence allows for an examination of the relationship between empirical regularities and macroeconomic risk over multiple economic cycles.⁴ An overview of the number of firms and aggregate market capitalisation in each year of our sample is reported in Table 1. The initial sample covers more than 95% of the aggregate market capitalisation of the Australian market in every years of our sample. Even after filter rules are applied (as discussed below), the final sample comprises 32,835 firm-years. As our sample covers the majority of stocks listed on the Australian market, we are confident that it is representative of the total population.

Monthly price relative and market capitalisation data are obtained for each firm from the Australian Graduate School of Management (AGSM) database. The value-weighted market index and monthly 90-day bank bill rate is also obtained from the AGSM file, with the latter used as a proxy for the risk-free rate given Australian treasury notes were not issued for a period during our sample. These monthly returns are converted into quarterly values for our estimation of the Chen, Roll and Ross (1986) model, as several of the economic fundamentals used as dependent variables in this model are only reported quarterly.

The book value of each firm is obtained from Aspect Financial for the period 1992 to 2006. Prior to 1992, accounting data was collected from the Australian Stock Research Service Summarised Balance Sheet and Profit and Loss Statements. The consumer price index (which

⁴ Using data from the Melbourne Institute of Applied Economic and Social Research, from January 1975 to December 2006, there were eight periods of expansion and eight periods of contraction - see web page <http://melbourneinstitute.com/research/macro/bcchronology.html> accessed 5 December, 2009.

is used to measure the rate of inflation), the level of industrial production, the 10-year government bond interest rate and the dividend yield on the market are all sourced from Datastream.

Consistent with Fama and French (1993), all listed trusts and financial firms are deleted from the sample as leverage has a different meaning for financial institutions. When constructing the independent variables, firms with a negative book value are removed from the study, as are those firms with extremely high book-to-market values⁵.

To be included in the study in year t , a firm must have a book value and market price as at December of year $t-1$ and December of year $t-2$. This filter rule is required to construct the time series of returns generated for the momentum empirical regularity portfolio and to ensure all other empirical regularities are examined using a comparable sample. To avoid look-ahead bias, only firms with a balance date greater than or equal to six months prior to portfolio formation are included. This conservative six-month delay in the use of accounting data is consistent with Fama and French (1993).

2.1. Empirical regularities

Empirical regularity returns are constructed as zero-investment mimicking portfolios in a manner consistent with previous literature. The four empirical regularities examined are the market risk premium and mimicking portfolios formed on firm size, book-to-market ratio and past performance. The market risk premium is calculated as the value-weighted return on the market index less the 90-day bank-accepted bill rate.

Fama and French (1993) constructed their three-factor asset pricing model by forming six portfolios, sorted by market capitalisation and the book-to-market ratio. We replicate this technique to create empirical regularity portfolios based on size and book-to-market ratio.

⁵ All companies with a book-to-market ratio greater than ten were removed from the sample.

Each December, six portfolios (2x3) are constructed based on a two-way partition on size using the median of market capitalisation as the break point and an independent three-way partition on the book-to-market ratio (split at the bottom 30%, middle 40% and top 30% of the variable). Fama and French (1993) only use NYSE firms to calculate breakpoints and then calculate portfolios from a sample comprising all stocks from the NYSE, AMEX and NASDAQ. As there is only one exchange studied in this paper (the Australian Stock Exchange) breakpoints are calculated based on the entire sample. The value-weighted returns on the SMB (HML) empirical regularity is calculated as the average of the three (two) small firm (high book-to-market) portfolios less the average of the three (two) large firm (low book-to-market) portfolios. All portfolios are held for the following calendar year and reformed annually. Rebalancing takes place in December given the June tax year end in Australia.

The momentum time-series (WML) is constructed in a manner similar to Carhart (1997).⁶ Each December, firms are ranked on their returns from January to November and the sample is split into three groups; winners (top 30%), medium (middle 40%) and losers (bottom 30%). The conservative one month lag between the formation period and the implementation of the momentum strategy is consistent with prior literature (Jegadeesh and Titman, 1993). Six portfolios (2x3) are formed at the breakpoints of the independent sorts on size and momentum. The WML portfolio is calculated as the average of all portfolios that include the

⁶ Carhart (1997) creates equally weighted portfolios of winners (top 30% of returns over the previous year) and losers (bottom 30% of returns). Given the concentration of market capitalisation in a few large stocks and the number of extremely small companies listed on the Australian market, equally weighted returns may be driven by microcap stocks. Therefore, the WML variable is a value-weighted portfolio that is constructed using a two-way split based on momentum and firm size.

best performing firms from the previous year less the average of all portfolios with the worst performance.⁷

Summary statistics for each of the empirical regularities are provided in Table 2. All empirical regularities provide positive average returns of similar magnitude to those calculated in previous Australian studies that have similarly looked at a long sample period (Brailsford, Gaunt and O'Brien, 2012; O'Brien, Brailsford and Gaunt, 2010). The returns on all monthly values of the empirical regularities are significantly different from zero at the 5% confidence level. The Jacque-Bera statistic shows that the return distribution of all empirical regularities is significantly different from normal at the 1% confidence level. As the skewness of a sample affects the t-statistic more than the kurtosis, all t-statistics are calculated using the Johnson (1978) adjustment to reduce the effect of this non-normal distribution.

[INSERT TABLE TWO ABOUT HERE]

2.2. Macroeconomic Fundamentals

Two groups of macroeconomic fundamentals are examined in this paper. The first group are the state variables employed by Chen, Roll and Ross (1986), and the second group are a series of macroeconomic forecast variables shown in the prior literature to predict equity returns. The selection of macroeconomic fundamentals is motivated by Campbell (1996), who argues that proxies for state variables of time-varying investment opportunities should be chosen based on their ability to explain cross-sectional movements in asset returns and to forecast market returns.

Campbell and Cochrane (2000) argue that the Chen, Roll and Ross (1986) factors better explain returns than the CAPM and consumption-based models, making them superior

⁷ The HML, SMB and WML factors were also calculated using sequential sorts, as applied in Liew and Vassalou (2000). The summary statistics for the mimicking portfolios are substantively similar to those created using independent sorts; therefore results are omitted for brevity.

candidates as state variables. The factors documented by Chen, Roll and Ross (1986) are unexpected inflation, changes in expected inflation, industrial production growth, the default risk spread and the term spread. With the exception of the default risk spread, this paper examines all the Chen, Roll and Ross (1986) factors as state variables. Griffin, Ji and Martin (2003) observe that the default risk spread cannot be accurately measured outside of the United States due to the illiquidity of bond markets.⁸ Each of the Chen, Roll and Ross (1986) factors are measured quarterly, as inflation and industrial production data are both only reported on a quarterly basis in Australia.

The change in expected inflation (DEI) is calculated using the MA(1) process described by Fama and Gibbons (1984). Unexpected inflation (UNIF) is calculated as the difference between realised inflation and expected inflation. Industrial production growth (IP) is the quarterly change in seasonally adjusted real industrial production⁹ and the term spread (UTS) is calculated as the difference between the short term risk-free rate and the 10-year government bond yield. Aretz, Bartram and Pope (2010) note that the direction of the relationship between HML and some macroeconomic variables changes after controlling for changes in the slope of the term spread and omitting this variable may have biased previous research. To help overcome any omitted variable problems, the Chen, Roll and Ross (1986) model is augmented with an additional variable measuring the change in the slope of the term spread (ATS) each quarter. Summary statistics for these variables are reported in Panel A of Table 3. As all of the variables are specified as the change in the underlying economic indicator, the mean value for all of the variables is close to zero, though each of the variables

⁸ Chan, Faff and Kofman (2011) examine the relationship between default risk and firms in an Australian context, however they measure firm-specific default risk as opposed to aggregate default risk

⁹ Previous research, such as Vassalou (2003), creates mimicking portfolios to capture industrial production growth expectations. These models have very low explanatory power. Hence, a parsimonious model is constructed where unexpected industrial production is merely the change in industrial production after adjusting for inflation and seasonal effects.

exhibits moderate variance about the mean, with the standard deviations of the quarterly observations ranging from 0.9% (DEI and ATS) to 1.7% (UTS).

Ex-ante estimates of the empirical regularities are calculated using macroeconomic variables that prior studies have shown may predict market returns. These variables are the value-weighted market dividend yield (DIV), the short term risk-free rate (RF), market volatility (VOL) and the term spread (TS). Each of the variables is calculated on a monthly basis. Similar variables have also been used in past research examining empirical regularities. Chordia and Shivakumar (2002) and Griffin, Ji and Martin (2003) both study momentum profits by calculating predicted return with reference to market dividend yield, term spread, default risk spread and treasury bill yields. The default risk spread is not included in our forecast model due to the illiquidity of Australian bond markets. The results reported by Chan, Faff and Kofman (2011) imply that the exclusion of default risk should not affect our models. They report that while default risk is priced in the cross-section of Australian returns, it is not related to either SMB or HML.

The dividend yield is calculated as total dividends paid between month m to month $m-12$ divided by the value of the value-weighted market index at month m . This variable is included as Fama and French (1988) show dividend yields are related to expected stock returns. The 90-day bank accepted bill rate is used as a proxy for the short-term rate of interest. Fama (1981) reports a negative relationship between the risk-free rate of interest and future equity returns, validating the inclusion of this variable. Market volatility is estimated using a GARCH(1,1) model. Unlike historical volatility, forecast volatility from this model captures the time-varying aspect of volatility and does not require the use of arbitrary sample periods. French, Schwert and Stambaugh (1987) show the expected market risk premium is positively related to the predictable volatility of stock returns. The term spread is measured in

the same way that it is calculated for the Chen, Roll Ross (1986) model. This variable is included because Keim and Stambaugh (1986) show that it forecasts stock and bond returns.

Summary statistics for macroeconomic predictive variables are reported in Panel B of Table 3. The annualised mean values of the value-weighted dividend yield (3.9%) and the risk-free interest rate (9.5%) are similar to those reported in previous studies.¹⁰ The large size of the mean risk-free interest rate can be explained by the high interest rates in Australia in the late 1980s. The mean values for the ex-ante volatility in the market return (16.1%) and the term structure of interest rates (0.2%) are also intuitively appealing.

[INSERT TABLE THREE ABOUT HERE]

Aretz, Bartram and Pope (2010) identify that macroeconomic variables are often highly correlated; creating the possibility that one macroeconomic factor might proxy for another more fundamental factor. In unreported results, we show that in our sample, the risk-free rate and term spread are negatively correlated ($\rho=-0.712$) while the dividend yield and risk-free rate are positively correlated ($\rho=0.528$). Robustness tests are undertaken to ensure that multicollinearity does not affect the statistical validity of the results.¹¹

3. Economic States Analysis

Lakonishok, Shleifer and Vishny (1994) argue that for an empirical regularity to be explained as a fundamental risk factor it must underperform in some states of the world and these must, on average, be bad states where the marginal utility of wealth is high - such that investing in these riskier firms is unattractive to risk-averse investors. Lakonishok, Shleifer and Vishny (1994) report that the value premium cannot be considered a risk factor as it never

¹⁰ Brailsford, Handley and Maheswaran (2012) report that for the period 1975-2006, the average annual dividend yield on the market (Treasury bill yield) was 4.9% (9.2%).

¹¹ To ensure results are not affected by the downward bias of the standard errors induced by multicollinearity, the forecast model is estimated with the risk-free rate excluded. The results were substantively robust to this change in the model.

underperforms over long holding periods. They did not examine other empirical regularities. We extend upon the study of Lakonishok, Shleifer and Vishny (1994) by using our Australian sample to test the performance of the SMB, HML and WML mimicking portfolios across various holding periods.

Implementing the Lakonishok, Shleifer and Vishny (1994) methodology, we examine the frequency of underperformance of empirical regularities over one-year, three-year and five-year periods with an annual rolling window. The examination of returns across long periods allows for an assessment of the buy-and-hold performance of investment strategies over appropriate horizons for long-term investors.

Figure 1 shows the performance of the SMB, HML and WML portfolios across various holding periods. All empirical regularities experience occasional underperformance across the investment holding periods examined, satisfying Lakonishok, Shleifer and Vishny's (1994) preliminary test of a risk factor. Lakonishok, Shleifer and Vishny (1994) report that value never underperforms growth over five-year investment periods, however we report evidence to the contrary. The HML portfolio is negative on 12 occasions (38.7%) for one-year holding periods, 8 occasions (27.6%) for three-year holding periods and 4 occasions (14.6%) for five-year holding periods. The frequency of underperformance of the HML empirical regularity is slightly less than the values derived by Petkova and Zhang (2005), who report that growth portfolios outperform value in 43% of annual holding periods, 33% of three-year holding periods and 27% of five-year holding periods. SMB and WML underperform with similar frequency. This underperformance in some time periods may help to explain the inconsistencies reported in previous studies regarding the significance of the Fama and French (1993) factors in Australia.

[INSERT FIGURE ONE ABOUT HERE]

We also perform tests to determine the periods in which empirical regularities earn positive (and negative) returns. Lakonishok, Shleifer and Vishny (1994) and Petkova and Zhang (2003) examine the economic states in which the value portfolio underperforms the growth portfolio by assessing four market states based on the ex post market risk premium. Griffin, Ji and Martin (2003) investigate WML across various macroeconomic regimes, where the state variables are GDP growth, industrial production growth, the ex-post market risk premium and the value-weighted market dividend yield.

The performance of all empirical regularities is studied across economic states defined by three variables; the ex-post market risk premium,¹² the cyclical component of the Westpac-Melbourne Institute coincident index of economic activity¹³ and the value-weighted market dividend yield. These variables are designed to proxy for changes in the investment opportunity set, as all three variables are positively related to economic conditions. Four regimes are defined as follows: peak (top 10% of observations), expansion (next 40% of observations), contraction (40% of observations from median to 10th percentile) and trough (bottom 10% of observations). The breakpoints of the four regimes are consistent with the methodology employed by Petkova and Zhang (2005). Average returns for each empirical regularity is calculated for all four regimes. The analysis of returns across economic states provides an examination of the direction of any relationship between the empirical regularities and economic fundamentals, as well as providing an informal test of nonlinearities in this relationship.

¹² To control for the relationship between empirical regularities and beta, we use the component of the market risk premium that is orthogonal to the empirical regularity being tested. We orthogonalise the variable by regressing it against the ex-post market risk premium, and using the residual as our empirical regularity. Our results are not substantially affected by orthogonalising the variables.

¹³ The Westpac-Melbourne Institute coincident index of economic activity is used as a proxy for GDP as monthly values of GDP and Industrial Production are not available for Australia. We use the Hodrick-Prescott filter to extract the cyclical component of this time-series.

Panel A of Table 4 reports the results of the analysis of portfolio returns across various economic states, as defined by the market risk premium (Panel A), the cyclical component of the coincident index of economic activity (Panel B) and the market dividend yield (Panel C).

In Panel A (Panel B) the returns on the momentum empirical regularity are positive and significantly different from zero at the 1% (5%) confidence level during peaks and negative and significant at the 1% (5%) confidence level during troughs. This result is consistent with prior empirical evidence that suggests that returns on momentum portfolios are procyclical (Cooper, Gutierrez and Hameed, 2004; Stivers and Son, 2010). It could be argued that the covariance across economic states, as defined by the ex post market risk premium, suggests that momentum profits can be explained by systematic risk. However, Grundy and Martin (2001) showed that neither the capital asset pricing model or the Fama and French (1993) model capture momentum returns.

The evidence provided in Table 4 relating to SMB is inconclusive, as the difference between portfolio returns in peaks and troughs is not significantly different from zero for any of the portfolios. In contrast, the HML empirical regularity displays a strong counter-cyclical property. The difference between returns during the peak and trough periods is negative and significantly different from zero at the 5% confidence level regardless of the variable used to define the economic regime. This result is most evident in Panel A, where HML returns are negative and significantly different from zero at the 5% confidence level during the best 10% of months in the sample the HML returns are positive and significantly different from zero at the 1% confidence level during periods characterised by the worst 10% of market returns. While previous studies, such as Lettau and Ludvidson (2001) and Chen, Petkova and Zhang (2008), have identified that the value premium covaries counter-cyclically, we report a reversal of the value premium in periods of extreme expansion. This reversal is consistent with Petkova and Zhang (2005), who report that value frequently underperforms growth and

note that value is riskier during recessions and should earn higher expected returns during these periods. A negative value for HML in some economic periods is also consistent with our results reported in Figure 1, which shows that HML is time-varying and underperforms relatively frequently, even when long holding periods are used.

[TABLE FOUR ABOUT HERE]

A formal examination of the performance of the size, value and momentum empirical regularities across economic states is carried out through the estimation of cross-sectional regressions in the periods defined above as economic peaks and troughs. Cross-sectional regressions allows for an investigation of the joint explanatory power of all variables and provides a directional estimation of the marginal relationship between returns and the firm characteristics that are used to construct the empirical regularities examined in this paper.

The multivariate regression that tests for the relationship between returns and the firm fundamentals associated with each of the empirical regularities is specified as follows:

$$R_{i,m} = \alpha_{0,m} + \gamma_1 \ln(\text{SIZE}_{i,t}) + \gamma_2 \ln(\text{B/M}_{i,t}) + \gamma_3 \text{MOM}_{i,t} + \varepsilon_{i,m} \quad (1)$$

where $R_{i,m}$ is the one-month return on company i in month m , $\text{SIZE}_{i,t}$ is the market capitalisation for stock i calculated in December of year t , $\text{B/M}_{i,t}$ is the book-to-market ratio for firm i calculated using book-value of equity and market capitalisation from the accounting balance date and $\text{MOM}_{i,t}$ is the average monthly return from January to December of year t for stock i .

Consistent with prior literature, the regressions use the natural logs of the size and book-to-market variables (Fama and French, 1992). The natural logarithm is not an appropriate functional form for momentum due to the existence of negative values for this variable. The

average coefficients across the time series are calculated using the weighted-least-squares approach.¹⁴

The results of cross-sectional regressions that are estimated across various economic states are reported in Table 5. These results provide an expansion on the portfolio analysis reported in Table 4, as cross-sectional regressions allow for an analysis of the marginal relationship between returns and the characteristics upon which the empirical regularities are constructed.

The explanatory power of the cross-sectional Carhart (1997) model appears to be asymmetric across the business cycle. In all three panels, the intercept term is significantly different from zero at the 1% confidence level during economic peaks but insignificant during troughs. The adjusted R^2 of the model is also higher during troughs. The model is not able to fully explain returns during the peak periods of economic expansion. This result suggests that there may be additional state variables other than those examined in this paper that explain returns in the Australian market.

The average coefficient on the size variable is negative and significantly different from zero in all three panels during peak periods, and only significant in Panel A during times of economic troughs. This result provides support to the hypothesis that the size empirical regularity is asymmetrical and only generates superior returns during periods of economic expansion. The coefficient on the momentum variable is insignificant across all panels. We posit that this is due to the inability of the historical return variable to capture the momentum empirical regularity in the cross-section of returns.¹⁵ This result does not have any

¹⁴ This methodology is advocated by Greene (2008).

¹⁵ Lewellen (2002) reports that the momentum premium is explained by negative cross-serial correlation as opposed to positive autocorrelation. This result suggests that the momentum premium cannot be captured in the cross-section of returns and is consistent with our results in Table 5.

implications for the relationship between the time-series momentum premium and macroeconomic risk.

Further evidence is provided which suggests that the value premium covaries counter-cyclically with the business cycle. The difference between the coefficient relating to the book-to-market variable in peak and trough periods is significantly different from zero at the 5% confidence level in Panel A and Panel B. Of note, this variable is negative (positive) and significantly different from zero at the 5% confidence level for peak (trough) periods where the economic states are conditioned by the ex post market risk premium. This result is consistent with Liew and Vassalou (2000), who report that HML is negatively related to future economic growth in Australia.

[INSERT TABLE FIVE ABOUT HERE]

4. Chen, Roll and Ross (1986) Model

Each of the empirical regularity portfolios is examined within the framework of a macroeconomic instrument model to determine whether they possess characteristics consistent with risk factors in the context of Merton's (1973) ICAPM. Contemporaneous values of the Chen, Roll and Ross (1986) factors are used as proxies for state variables. This analysis is motivated by Griffin, Ji and Martin (2003), who investigate the importance of the Chen, Roll and Ross (1986) model for explaining momentum profits and Aretz, Bartram and Pope (2010), who include these factors within a broad set of macroeconomic variables to determine whether SMB, HML and WML capture fundamental risk.

We extend upon Griffin, Ji and Martin (2003) by estimating six regressions, with each of the empirical regularities as the dependent variable and the extended sample of Chen, Roll and

Ross (1986) factors described above used as the independent variables. The estimated model may be expressed as follows:

$$R_{i,t} = \alpha_{0,t} + \beta_{DEI,t}DEI_t + \beta_{UNIF,t}UNIF_t + \beta_{IP,t}IP_t + \beta_{UTS,t}UTS_t + \beta_{ATS,t}ATS_t + \varepsilon_{i,t} \quad (2)$$

where $R_{i,t}$ is the return on empirical regularity i in quarter t , DEI_t is expected inflation in quarter t , $UNIF$ is unexpected inflation in quarter t , IP is industrial production growth in quarter t , UTS is the term spread in quarter t and ATS is the change in the term spread slope in quarter t .

Griffin, Ji and Martin (2003) argue that a empirical regularity can be shown to be a risk factor within Merton's (1973) ICAPM framework if it loses its explanatory power after controlling for state variables. This can be measured by comparing the expected returns on the empirical regularity portfolios with their associated realised outcomes.

The expected value of each of the empirical regularities is calculated using the two-stage cross-sectional methodology. In the first stage, Equation 2 is estimated for the returns on 25 test portfolios constructed from cross-sorts on size and book-to-market. The second stage of the two-stage cross-sectional regression estimates the risk premium associated with each factor using Fama and MacBeth (1973) cross sectional regressions across the empirical regularity portfolios.

The model used to estimate risk premia is specified as follows:

$$r_{p,t} = \alpha_{p,t} + \gamma_{DEI,t}\hat{\beta}_{DEI,p,t} + \gamma_{UNIF,t}\hat{\beta}_{UNIF,p,t} + \gamma_{IP,t}\hat{\beta}_{IP,p,t} + \gamma_{UTS,t}\hat{\beta}_{UTS,p,t} + \gamma_{ATS,t}\hat{\beta}_{ATS,p,t} + \varepsilon_{p,t} \quad (3)$$

where $r_{p,t}$ is the return on empirical regularity portfolio p in quarter t , $\gamma_{s,t}$ is the risk premium associated with factor s at quarter t and $\hat{\beta}_{s,p,t}$ is the coefficient estimate for factor s in portfolio p at quarter t , as derived from the estimation of Equation 2.

The beta estimates and risk premia obtained from Equations 2 and 3 respectively are used to estimate the expected value of the empirical regularities using an equation in the following form:

$$E[r_{p,t}] = \alpha_{p,t} + \hat{\gamma}_{DEI,t} \bar{\beta}_{DEI,p,t} + \hat{\gamma}_{UNIF,t} \bar{\beta}_{UNIF,p,t} + \hat{\gamma}_{IP,t} \bar{\beta}_{IP,p,t} + \hat{\gamma}_{UTS,t} \bar{\beta}_{UTS,p,t} + \hat{\gamma}_{ATS,t} \bar{\beta}_{ATS,p,t} + \varepsilon_{p,t} \quad (4)$$

where $E[r_{p,t}]$ is the expected return on empirical regularity portfolio p at quarter t and $\hat{\gamma}_{s,t}$ is the risk premium estimate for factor s at quarter t .

Table 6 reports the results of the estimation of Equation 2 and Equation 4. It is noted that the explanatory power of each of the models is relatively low, particularly compared with the adjusted R^2 reported by Fama and French (1996). However, the focus of this section is on the significance of the coefficients and the difference between the expected and realised values of the empirical regularities.

The Chen, Roll and Ross (1986) factors were constructed to mimic economic innovations. For the Chen, Roll and Ross (1986) model to be valid in an Australian context, it must explain aggregate returns in the Australian market. In Table 6, it is reported that when the aggregate market risk premium is used as the dependent variable, the coefficients are positive and significant for two Chen, Roll and Ross (1986) factors; unexpected inflation and industrial production growth. The difference between the expected value of the market risk premium, derived from the Chen, Roll and Ross (1986) model, and the observed market risk premium is not statistically significant. Hence, the Chen, Roll and Ross (1986) model is applicable in the Australian context.

When the SMB empirical regularity is regressed against the Chen, Roll and Ross (1986) factors, the coefficient on the industrial production growth variable is positive and significantly different from zero at the 5% confidence level, which is consistent with the

results reported by Vassalou (2003). None of the other macroeconomic factors are significantly related to SMB.¹⁶ The difference between the realised returns on the SMB mimicking portfolio and its expected value ($TA - E(TA)$) is insignificant. Variation in the size empirical regularity is captured by the Chen, Roll and Ross (1986) model, which provides empirical support for the hypothesis that SMB is explained by macroeconomic risk in the Australian context.

The coefficient on the industrial production growth variable is positive and significantly different from zero at the 5% confidence level when WML is the dependent variable. This result is similar to those for the SMB empirical regularity and provides evidence that the returns on these variables are pro-cyclical. The Chen, Roll and Ross (1986) factors also capture time-variation in the WML empirical regularity, as the mean of the difference between the realised returns on the empirical regularities and their equivalent expected values is insignificant. This result differs from Griffin, Ji and Martin (2003), who report that the difference between the expected observed momentum profits and expected returns are positive and significant, which is not consistent with the momentum strategy bearing a positive risk premium. It should be noted that Griffin, Ji and Martin (2003) only include Australia as part of the Asian region, they do not perform stand-alone tests of whether momentum in Australia can be explained by the Chen, Roll and Ross (1986) model. Furthermore, Griffin, Ji and Martin (2003) do not find evidence of a momentum premium in many Asian countries; hence the results from their analysis of the Chen, Roll and Ross (1986) model are not informative for this region.

When the model is regressed against HML, the coefficient on the industrial production variable is negative and significantly different from zero at the 5% confidence level, which

¹⁶ Previous studies such as Vassalou and Xing (2004) and Petkova (2006) have reported a negative relationship between SMB and the default risk spread. This relationship was not tested in this paper due to the illiquidity of Australian bond markets.

confirms the earlier evidence that this empirical regularity covaries negatively with the aggregate state of the economy. HML is also positively related to the level of the term structure, which is consistent with prior evidence reported by Hahn and Lee (2006) and Petkova (2006). The mean difference between the expected and realised values of HML is insignificant, suggesting that the HML empirical regularity can be explained by the Chen, Roll and Ross (1986) factors in the Australian context.

The insignificant difference between the observation returns for the SMB, WML and HML empirical regularities and their expected values, as derived from the Chen, Roll and Ross (1986) model, indicates that these empirical regularities may be explained by innovations in the macroeconomic variables, as opposed to firm-specific characteristics.

[INSERT TABLE SIX ABOUT HERE]

5. Macroeconomic Forecast Model

Given the returns on the size, value and momentum empirical regularities are shown to covary with the business cycle, we also investigate whether the future returns of empirical regularities can be predicted using lagged values of macroeconomic conditioning variables. Petkova and Zhang (2005) follow Ferson and Harvey (1991) by estimating the ex-ante market risk premium by regressing realised future values of the market excess return on four state variables; namely the value-weighted market dividend yield, the default risk spread, the term spread and the treasury bill rate. Chordia and Shivakumar (2002) estimate a model where profits from momentum portfolios are regressed on these variables. Rather than mining for superior forecast models, we apply an adapted version of Chordia and Shivakumar's (2002) model that is applicable in the Australian setting in this paper. We independently regress the returns on each of the empirical regularity portfolios against the macroeconomic forecast variables described in Section 2.2.

The one-month ahead predicted return on the empirical regularities is forecast from the estimation of the following regression:

$$r_{i,m} = \alpha_{0,m} + \beta_{TS,m}TS_{m-1} + \beta_{RF,m}RF_{m-1} + \beta_{DY,m}DY_{m-1} + \beta_{VOL,m}VOL_{m-1} + \varepsilon_{i,m} \quad (5)$$

where $r_{i,m}$ is the return on empirical regularity portfolio p in month m , $\beta_{r,m}$ is the coefficient estimate of factor r in month m and TS_{m-1} , RF_{m-1} , DY_{m-1} and VOL_{m-1} are the values for the term spread, risk-free rate, value-weighted market dividend yield and predicted market volatility respectively in month $m-1$.

The regressions are estimated across a rolling window from $m-60$ to $m-1$ and all t -statistics reported are adjusted using the Newey-West (1987) approach.

The one month ahead forecast value for each of the empirical regularities is estimated as follows:

$$E[\widetilde{r_{p,m}}] = \alpha_{p,m} + \hat{\beta}_{TS,m}TS_{m-1} + \hat{\beta}_{RF,m}RF_{m-1} + \hat{\beta}_{DY,m}DY_{m-1} + \hat{\beta}_{VOL,m}VOL_{m-1} \quad (6)$$

where $E[\widetilde{r_{p,m}}]$ is the forecast value of empirical regularity portfolio p in month m and $\hat{\beta}_{r,m}$ is the coefficient estimate of factor r in month m .

Consistent with Chordia and Shivakumar (2002), the difference between the realised return generated by the empirical regularity and the forecasted value is calculated each month ($RES_{j,t}$). A significant value of the mean of the differences ($RES_{j,t}$) in the same direction as the return on the empirical regularity would provide evidence of an unexplained return consistent with mispricing.

Table 7 reports the coefficients and predicted values of each empirical regularity derived from the macroeconomic forecast model. It is noted that the adjusted R^2 of the model is low, ranging from 0.022 (MRP) to 0.071 (HML). Chordia and Shivakumar (2002) also report low adjusted R^2 when momentum profits are regressed on this model and argue that this does not

affect the estimation errors of forecast returns. Ferson, Sarkissian and Simin (2003) identify that forecast regressions based on macroeconomic variables may be spurious, given the series of macroeconomic variables are often highly persistent. This issue affects the estimates of standard errors, as opposed to coefficients, hence has no impact upon our calculation of $RES_{j,t}$. However, we have to be careful interpreting the significance of coefficients when estimating Equation 5. Based on the simulations conducted in Ferson, Sarkissian and Simin (2003), adjusting the standard error to overcome this problem corresponds to critical t-statistics of approximately 2.6 for models with a similar R^2 and autocorrelation in independent variables as observed in our study. Therefore, we place little emphasis on coefficients that are only significant at the 5% confidence level, as this significance may be spurious.

When MRP is tested as the dependent variable, the coefficients on all four macroeconomic variables are significantly different from zero at the 1% confidence level and the difference between the forecast and realised returns (RES) is insignificant. This evidence helps to overcome Fama's (1991) and Cochrane's (2001) contention that the ICAPM should not be used as a "fishing license" for choosing multiple factors, as only variables related to future market returns should be included.

The results reported in Table 7 show that SMB is negatively related to future values of the term structure. For the WML forecast model, the coefficients on the term structure and risk-free rate are negative and statistically significant. The coefficients on the dividend yield and volatility variables are positive and significantly different from zero but only at the 5% confidence level hence this significance may be spurious. The direction of these significant coefficients confirms our earlier results suggesting that momentum covaries procyclically. The unexplained return (RES) is insignificant for both SMB and WML. This insignificance provides further empirical support for the contention that the size and momentum empirical

regularities are explained by cross-sectional differences in conditionally expected returns that are predicted by macroeconomic variables.

Our results for the size and momentum empirical regularities are broadly consistent with the literature. Petkova (2005) similarly shows that in the United States market, the significance of the SMB mimicking portfolio disappears after controlling for lagged macroeconomic variables. Chordia and Shivakumar (2002) report a significantly negative value for WML after controlling for forecast variables, which they argue is consistent with momentum being a risk factor, as it indicates that the predictive variables capture all of the returns on the momentum portfolio plus additional returns. Conversely, Griffin, Ji and Martin (2003) report a significantly positive RES value, which is argued to provide evidence in favour of mispricing. In our study, the insignificance of the RES variable for the momentum premium after controlling for macroeconomic forecast variables is argued to be consistent with a risk-based explanation for momentum. The economic interpretation of our result is consistent with Chordia and Shivakumar (2002).

For the HML forecast regression, the coefficients on the risk-free rate of return and dividend yield are both negative and significantly different from zero while the term structure coefficient is positive and significant. The coefficient on the volatility variable is also statistically significant but only at the 5% confidence level. The direction of these coefficients confirms earlier evidence that suggests HML covaries counter-cyclically. Despite further evidence showing that the value premium covaries negatively with the business cycle, indicating that it can be explained as a form of macroeconomic risk, we are not able to

forecast future returns on the HML mimicking portfolio using macroeconomic predictive variables.¹⁷

[INSERT TABLE SEVEN ABOUT HERE]

6. Summary

This paper investigates whether the size, value and momentum empirical regularities covary with macroeconomic factors and as such may be considered state variables in the context of Merton's (1973) ICAPM model. The literature provides mixed evidence about whether these empirical regularities may be explained as macroeconomic risk factors; warranting a re-investigation of this question in an out-of-sample context. The study is undertaken in an Australian context, which is an economy characterised as a commodity exporter and a durable goods importer. The underlying macroeconomic characteristics of the Australian market are fundamentally different to many other developed economies such as the United States. An examination of the performance of empirical regularities across economic states is important, given the mixed results in past studies regarding the significance of SMB, HML and WML in an Australian context which suggests that these empirical regularities are time-varying. Chan, Faff and Kofman (2011) report returns that exhibit inter-temporal cross-sectional variation that can be partly explained by default risk, motivating our comprehensive analysis of the relationship between empirical regularities and macroeconomic variables.

We report evidence that returns on the SMB and WML empirical regularities covary procyclically with macroeconomic variables, suggesting they represent sources of state variable (or macroeconomic) risk that are able to be hedged. Returns on both of these empirical regularities lose their explanatory power after controlling for predictive variables,

¹⁷ This result is inconsistent with Petkova (2005) who shows that in the United States, the returns on the HML mimicking portfolio become insignificant after controlling for macroeconomic forecast variables.

indicating that the size and momentum empirical regularities are explained by cross-sectional differences in conditionally expected returns. An application of the Chen, Roll and Ross (1986) model also generates expected returns for SMB and WML that are not significantly different from the realised returns on these portfolios. Based on these results, it is argued that SMB and WML can be explained as risk factors within the ICAPM framework.

Returns on HML vary counter-cyclically across the business cycle. This result has important implications for practitioners as it provides evidence that investing in value stocks provides a valuable hedge against poor market-wide performance. Despite the pervasiveness of the value premium, we are able to identify that the HML mimicking portfolio are statistically significantly negative during periods categorised as being in the top decile of economic activity. This underperformance in some economic states is consistent with a risk explanation for the value premium. The returns on HML are not significantly different from the expected returns generated by the Chen, Roll and Ross (1986) model; however returns persist after controlling for variables shown in prior literature to predict market returns.

All three empirical regularities examined in this paper covary with the business cycle, although the direction of this covariance is negative for HML and positive for both SMB and WML. These results support the contention that empirical regularities may be explained as macroeconomic risk factors. We contend that these three anomalies are correlated with innovations in the investment opportunity set, as proxied by macroeconomic variables, and hence may be classified as state variables within the context of Merton's (1973) ICAPM model.

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Table 1: Summary statistics for empirical regularities

This table outlines the number and characteristics of firms that are used to create portfolios in December of year $t-1$. No. stocks is the number of firms included in our sample after excluding property trusts, financial firms and firms with negative book values. The mean market capitalisation and aggregate total of all stocks in our sample is also reported for each year.

Year	No. Stocks	Mean Market Capitalisation (\$ millions)	Aggregate Market Capitalisation (\$ millions)
1974	747	14.4	10744.7
1975	785	19.5	15295.6
1976	802	20.3	16319.5
1977	811	22.5	18243.4
1978	790	27.3	21592.0
1979	771	41.2	31764.0
1980	772	62.9	48550.1
1981	770	54.5	41941.8
1982	743	51.3	38127.3
1983	721	76.0	54780.7
1984	748	70.2	52515.6
1985	802	94.3	75622.7
1986	931	139.0	129444.7
1987	1119	127.9	143103.4
1988	1103	143.8	158643.7
1989	981	197.7	193959.3
1990	852	184.0	156755.3
1991	780	275.6	215003.7
1992	855	288.6	246738.8
1993	871	482.9	420615.5
1994	1011	377.9	382037.6
1995	1051	433.4	455485.3
1996	1055	486.4	513184.0
1997	1096	844.5	925582.4
1998	1098	870.0	955252.6
1999	1148	966.0	1108987.9
2000	1284	508.8	653313.6
2001	1286	931.6	1198008.2
2002	1250	902.0	1127525.1
2003	1265	962.7	1217841.3
2004	1388	1020.9	1417036.8
2005	1518	750.1	1138656.2
2006	1631	1155.4	1884388.4

Table 2: Summary statistics for empirical regularities

This table reports summary statistics for all of the empirical regularities examined in this paper; namely the market risk premium (MRP) and mimicking portfolios constructed on size (SMB), book-to-market ratio (HML) and momentum (WML). Monthly data is reported for all of the variables. The Jarque-Bera statistic reports whether the time-series values of each of the mimicking portfolios are normally distributed. All t-statistics reported are adjusted using the Johnson (1978) method.

	MRP	SMB	HML	WML
Mean	0.006	0.006	0.005	0.004
t-statistic	2.256*	2.372*	2.185*	2.520*
Median	0.010	0.003	0.005	0.005
Maximum	0.157	0.169	0.211	0.193
Minimum	-0.404	-0.212	-0.294	-0.189
Jarque-Bera	3885.9**	27.0**	936.2**	874.7**

* Denotes statistical significance at the 5% confidence level.

** Denotes statistical significance at the 1% confidence level.

Table 3: Macroeconomic variables summary statistics

This table reports summary statistics for all of the macroeconomic variables examined in this paper. Panel A reports the quarterly values of the summary statistics for the Chen, Roll and Ross (1986) factors; namely changes in expected inflation (DEI), unexpected inflation (UNIF), industrial production growth (IP), changes in the term structure of interest rate (UTS) and changes in the slope of the term structure (ATS). Panel B reports summary statistics for the annualised monthly value of the macroeconomic predictive variables; namely the value-weighted market dividend yield (DIV), the risk-free rate (RF), market volatility (VOL) and the term spread (TS). The Jarque-Bera statistic reports whether the time-series values of each of the macroeconomic variables are normally distributed.

Panel A: Chen, Roll and Ross (1986) Factors

	DEI	UNIF	IP	UTS	ATS
Mean	-0.001	-0.001	0.010	0.001	-0.001
Median	0.000	-0.002	0.011	0.003	-0.001
Maximum	0.022	0.040	0.064	0.041	0.029
Minimum	-0.022	-0.043	-0.036	-0.050	-0.027
Std. Dev.	0.009	0.016	0.015	0.017	0.009
Skewness	0.162	0.036	-0.081	-0.630	0.041
Kurtosis	2.687	3.044	5.269	3.664	3.928
Jarque-Bera	1	0.1	26.7**	10.5**	4.5

Panel B: Annualised Predictive Variables

	DIV	RF	VOL	TS
Mean	0.039	0.095	0.161	0.002
Median	0.038	0.086	0.148	0.003
Maximum	0.065	0.214	0.622	0.046
Minimum	0.025	0.043	0.082	-0.062
Std. Dev.	0.008	0.043	0.068	0.018
Skewness	0.689	0.584	2.844	-0.685
Kurtosis	3.276	2.103	15.444	4.045
Jarque-Bera	30.7**	33.6**	2893.9**	46.0**

* Denotes statistical significance at the 5% confidence level.

** Denotes statistical significance at the 1% confidence level.

Table 4: Portfolio performance across economic states

This table reports the returns on each of the empirical regularities across various economic states. The empirical regularities reported are mimicking portfolios formed on size (SMB), book-to-market ratio (HML) and momentum (WML). Four regimes are defined for each state variable. These regimes are defined as follows: peak (top 10% of observations), expansion (next 40% of observations), contraction (40% of observations from median to 10th percentile) and trough (bottom 10% of observations). Panel A reports the mean returns on each of the empirical regularities where the component of the value-weighted market risk premium that is orthogonal to the size premium is used as the state variable. Analogous results using the coincident index of economic activity and the value-weighted dividend yield on the market are provided in Panel B and Panel C respectively. *t*-statistics are reported in parentheses below their associated means.

Panel A: Market Risk Premium

	SMB	HML	WML
Peak	0.005 (0.576)	-0.028 (-2.500*)	0.032 (4.371**)
Expansion	0.010 (2.641**)	0.000 (0.010)	0.010 (5.247**)
Contraction	-0.001 (-0.327)	0.012 (4.270**)	-0.002 (-1.039)
Trough	0.014 (2.253*)	0.032 (3.721**)	-0.022 (-2.994**)
Peak-Trough	-0.009 (-0.881)	-0.060 (-4.234**)	0.053 (5.210**)

Panel B: Coincident Index of Economic Activity

Peak	0.010 (1.297)	-0.011 (-1.033)	0.016 (2.214*)
Expansion	0.010 (2.385*)	0.006 (1.887)	0.006 (3.084**)
Contraction	0.000 (0.059)	0.007 (2.043*)	0.005 (2.015*)
Trough	0.003 (0.468)	0.016 (2.056*)	-0.017 (-2.345*)
Peak-Trough	0.007 (0.666)	-0.026 (-2.049*)	0.033 (3.225**)

Panel C: Market Dividend Yield

Peak	0.007 (1.034)	-0.004 (-0.623)	-0.001 (-0.323)
Expansion	0.001 (0.456)	0.007 (2.533*)	0.002 (1.108)
Contraction	0.010 (2.437*)	0.005 (1.129)	0.007 (2.383*)
Trough	0.002 (0.188)	0.011 (1.555)	0.004 (0.789)

Peak-Trough	0.005	-0.015	-0.006
	(0.384)	(-2.169*)	(-0.823)

* Denotes statistical significance at the 5% confidence level.

** Denotes statistical significance at the 1% confidence level.

Table 5: Cross-sectional analysis of returns across peak and trough economic states

This table reports the results from cross-sectional regressions, which are estimated to test the performance of the Fama and French (1992) model, augmented with momentum, across peak and trough economic states. The figures reported are the time-series average of coefficients reported estimates across economic states defined as troughs (bottom 10% of values for the state variable) and peaks (top 10% of values for the state variable). The multivariate regression that tests for the relationship between returns and the firm fundamentals associated with each of the empirical regularities is specified as follows:

$$R_{i,m} = \alpha_{0,m} + \gamma_1 \ln(\text{SIZE}_{i,t}) + \gamma_2 \ln(\text{B/M}_{i,t}) + \gamma_3 \text{MOM}_{i,t} + \varepsilon_{i,m}$$

where $R_{i,m}$ is the one-month return on company i in month m , $\text{SIZE}_{i,t}$ is the market capitalisation for stock i calculated in December of year t , $\text{B/M}_{i,t}$ is the book-to-market ratio for firm i calculated using book-value of equity and market capitalisation from the accounting balance date and $\text{MOM}_{i,t}$ is the average monthly return from January to December of year t for stock i . Panel A reports the results from the estimation of this equation across economic states defined using the ex-post market risk premium, orthogonalised with respect to the size premium, as the state variable. Analogous results using the cyclical component of the coincident index of economic activity and the value-weighted dividend yield on the market are provided in Panel B and Panel C respectively. t -statistics are reported in parentheses below their associated coefficient values and the adjusted R^2 for each equation is reported in the final column.

	α	Size	B/M	MOM	Adj. R^2
Panel A: Market Risk Premium					
Peak	0.196 (4.315**)	-0.007 (-2.838**)	-0.008 (-2.286*)	0.010 (1.254)	0.030
Trough	0.011 (0.381)	-0.003 (-2.181*)	0.016 (5.469**)	-0.001 (-0.306)	0.049
Peak-Trough	0.185 (3.448**)	-0.004 (-1.347)	-0.024 (-5.201**)	0.011 (1.227)	
Panel B: Coincident Index of Economic Activity					
Peak	0.151 (3.618**)	-0.007 (-2.997*)	-0.005 (-1.162)	-0.039 (-1.489)	0.016
Trough	0.006 (0.186)	-0.003 (-1.832)	0.009 (2.322*)	-0.006 (-0.280)	0.028
Peak-Trough	0.146 (2.786**)	-0.004 (-1.528)	-0.013 (-2.437*)	-0.033 (-1.015)	
Panel C: Market Dividend Yield					
Peak	0.062 (2.332**)	-0.004 (-2.552*)	0.001 (0.206)	-0.028 (-1.491)	0.010
Trough	0.097 (1.400)	-0.005 (-1.475)	0.002 (0.649)	-0.029 (-1.096)	0.035
Peak-Trough	-0.035 (-0.468)	0.001 (0.411)	-0.001 (-0.318)	0.001 (0.010)	

* Denotes statistical significance at the 5% confidence level.

** Denotes statistical significance at the 1% confidence level.

Table 6: Chen, Roll and Ross (1986) regressions

Returns from each of the empirical regularities are regressed on the Chen, Roll and Ross (1986) factors. The model is estimated as follows:

$$r_{p,t} = \alpha_{0,t} + \beta_{DEI,t}DEI_t + \beta_{UNIF,t}UNIF_t + \beta_{IP,t}IP_t + \beta_{UTS,t}UTS_t + \beta_{ATS,t}ATS_t + \varepsilon_{i,t}$$

where $r_{p,t}$ is the return on empirical regularity i in quarter t , DEI_t is expected inflation in quarter t , $UNIF_t$ is unexpected inflation in quarter t , IP_t is industrial production growth in quarter t , UTS_t is the term spread in quarter t and ATS_t is the change in the term spread slope in quarter t . Coefficient estimates are shown for each empirical regularity, with t -statistics reported in parentheses underneath their associated coefficient. The adjusted R^2 is also reported for each model. The equation above is estimated for each of the empirical regularities; namely the market risk premium (MRP) and mimicking portfolios constructed on size (SMB), book-to-market ratio (HML) and momentum (WML).

Expected returns for each of the empirical regularities are estimated using the following equation:

$$E[r_{p,t}] = \alpha_{p,t} + \hat{\gamma}_{DEI,t}\hat{\beta}_{DEI,p,t} + \hat{\gamma}_{UNIF,t}\hat{\beta}_{UNIF,p,t} + \hat{\gamma}_{IP,t}\hat{\beta}_{IP,p,t} + \hat{\gamma}_{UTS,t}\hat{\beta}_{UTS,p,t} + \hat{\gamma}_{ATS,t}\hat{\beta}_{ATS,p,t} + \varepsilon_{p,t}$$

where $E[r_{p,t}]$ is the expected return on empirical regularities i at quarter t and $\hat{\gamma}_{s,t}$ is the risk premium estimate for factor s at quarter t . The final column reports the difference between the average value of the empirical regularity and its expected value. Associated t -statistics are reported underneath in parentheses. All t -statistics are adjusted using the Newey-West (1987) approach.

	C	DEI	UNIF	IP	UTS	ATS	Adj. R^2	E(TA)	TA-E(TA)
MRP	0.001 (0.264)	-0.175 (-0.877)	0.450 (2.938**)	0.564 (4.347**)	-0.091 (-0.655)	0.104 (0.398)	0.091	0.003 (2.654**)	0.003 (0.943)
SMB	0.003 (0.962)	0.184 (0.542)	-0.077 (-0.393)	0.284 (2.154*)	-0.054 (-0.333)	0.35 (1.23)	-0.012	0.011 (3.720**)	-0.006 (-1.369)
HML	0.008 (2.451*)	-0.058 (-0.223)	-0.219 (-1.045)	-0.334 (-2.318*)	0.401 (2.757**)	-0.443 (-1.393)	0.073	0.002 (1.392)	0.003 (1.078)
WML	0.003 (1.365)	0.404 (1.843)	0.157 (1.126)	0.190 (2.020*)	-0.014 (-0.128)	-0.206 (-0.800)	0.016	0.007 (2.578*)	-0.003 (-0.841)

* Denotes statistical significance at the 5% confidence level.

** Denotes statistical significance at the 1% confidence level.

Table 7: Macroeconomic Forecast Model

Returns from each of the empirical regularities are regressed on variables shown in the prior literature to predict stock returns. The model is estimated as follows:

$$r_{p,m} = \alpha_{0,m} + \beta_{TS,m} TS_{m-1} + \beta_{RF,m} RF_{m-1} + \beta_{DY,m} DY_{m-1} + \beta_{VOL,m} VOL_{m-1} + \varepsilon_{i,m}$$

where $r_{p,m}$ is the return on empirical regularity i in month m , $\beta_{r,m}$ is the coefficient estimate of factor r in month m and TS_{m-1} , RF_{m-1} , DY_{m-1} and VOL_{m-1} are the values for the term spread, risk-free rate, value-weighted market dividend yield and predicted market volatility respectively in month $m-1$.

This equation is independently estimated with each of the empirical regularities as the dependent variable; namely the market risk premium (MRP) and mimicking portfolios constructed on size (SMB), book-to-market ratio (HML) and momentum (WML). The regressions are estimated across a rolling window from $m-60$ to $m-1$ and all t -statistics reported are adjusted using the Newey-West (1987) approach.

The one month ahead forecast value for each of the empirical regularities is estimated as follows:

$$E[r_{p,m}] = \alpha_{0,m} + \beta_{TS,m} TS_{m-1} + \beta_{RF,m} RF_{m-1} + \beta_{DY,m} DY_{m-1} + \beta_{VOL,m} VOL_{m-1}$$

where $E[r_{p,m}]$ is the forecast value of empirical regularity i in month m and $\hat{\beta}_{r,m}$ is the coefficient estimate of factor r in month m . The final column reports the difference between the realised return on the empirical regularities and the forecasted value is calculated each month ($RES_{j,t}$). Newey-West (1987) adjusted t -statistics are reported in parentheses under their associated coefficients and the adjusted R^2 value is also reported for each equation.

	A	TS	RF	DY	VOL	Adj. R^2	$\widehat{R(TA)}$	RES
MRP	-0.001 (-0.117)	-0.863 (-7.111**)	-0.907 (-4.523**)	1.590 (7.802**)	0.065 (5.126**)	0.022	-0.004 (-0.378)	0.010 (0.586)
SMB	0.055 (5.072**)	-0.613 (-3.475**)	-0.082 (-1.183)	0.569 (1.772)	0.026 (1.362)	0.028	0.015 (1.287)	-0.012 (-0.866)
HML	0.006 (0.46)	0.672 (6.415**)	-0.762 (-5.917**)	-1.263 (-4.347**)	-0.063 (-2.480*)	0.071	-0.122 (-5.199**)	0.130 (5.445**)
WML	0.027 (3.931**)	-0.370 (-3.943**)	-0.355 (-4.385**)	0.274 (2.127*)	0.024 (2.001*)	0.035	0.004 (2.472*)	0.000 (0.327)

* Denotes statistical significance at the 5% confidence level.

** Denotes statistical significance at the 1% confidence level.

Figure 1: Portfolio performance over one-year, three-year and five-year holding periods

This figure reports the average monthly returns for mimicking portfolios formed on size (SMB), book-to-market ratio (HML) and momentum (WML). The returns are calculated over rolling windows of one-year, three-year and five-year periods. Average monthly returns are reported on the y-axis and the year of portfolio formation is on the x-axis.

Panel A: Average monthly returns for one-year holding periods

Panel B: Average monthly returns for three-year holding periods

Panel C: Average monthly returns for five-year holding periods