Are the Fama-French Factors Proxying News Related to GDP Growth? The Australian Evidence

Annette Nguyen, Robert Faff and Philip Gharghori

Department of Accounting and Finance, Monash University, VIC 3800, Australia.

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Corresponding author
Philip Gharghori
Department of Accounting and Finance
Faculty of Business and Economics
PO Box 11E
Monash University
Vic 3800 AUSTRALIA
Telephone: 61 3 9905 9247
Fax: 61 3 9905 5475
Email: philip.gharghori@buseco.monash.edu.au

Annette Nguyen
Email: annette_ng@yahoo.com.au

Robert Faff
Postal address: Same as corresponding author
Telephone: 61 3 9905 2387
Email: robert.faff@buseco.monash.edu.au

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Abstract

Inspired by Vassalou (2003), we investigate the contention that the Fama-French (1993) model's ability to explain the cross sectional variation in equity returns is because the Fama-French factors are proxying for risk associated with future GDP growth in the Australian equities market. To assess the validity of Vassalou's findings, we augment the CAPM and the Fama-French model with a GDP growth factor and run system regressions of the GDP-enhanced models using the GMM approach. Our results suggest that news about future GDP growth is not priced in equity returns and that any ability that SMB and HML exhibit in explaining equity returns is not because they contain information about future GDP growth.

EFM Classification: 310

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Keywords: GDP growth, Fama-French model, Asset pricing

1. Introduction

Liew and Vassalou (2000) claim that both SMB and HML contain important information about future GDP growth. Specifically, they found that the returns of SMB and HML are strongly associated with future GDP growth in many different countries, including Australia. Vassalou (2003) explored this argument further and created a mimicking portfolio that captures news related to future GDP growth. She found that augmenting the CAPM with her GDP growth factor significantly improves the ability of the model to price equities and more importantly, when news related to future GDP growth is present in the model, SMB and HML retain no incremental power in explaining equity returns.

Vassalou's findings suggest that any ability the Fama-French factors exhibit in explaining returns comes from the fact that they are proxying risk associated with future GDP growth. To the best of our knowledge, Vassalou's (2003) analysis of news about future GDP growth in relation to the Fama-French factors has only been performed in the US. Therefore, the primary aim of this paper is to examine the robustness of Vassalou's findings using data drawn from the Australian market.

A number of studies have documented that the size and the book to market premiums are much stronger in Australia than in the US (Gaunt, 2004 and Gharghori, Chan and Faff, 2006a). Fama and French (1998) analysed the book to market effect in thirteen major equity markets around the world and found that the highest book to market premium was observed in Australia.[1] Therefore, if Vassalou's finding that the significance of the Fama-French factors occurs because they are proxying news about future GDP growth is generalisable to other markets, then it is likely that this will be observed in Australia. This is because the size and book to market premiums are much larger in Australia.

Further, although the Fama-French model works reasonably well in Australia, it is not as strongly evident as it is in the US. Specifically, the adjusted R^2s in Australia are much lower in Australia, only about 50-60% compared to 80-90% in the US (Gaunt, 2004 and Gharghori, Chan and Faff, 2006a). Thus, it is possible that other factors, such as news about future GDP growth, may explain the remaining 40-50% of variation in equity returns that is left unexplained by the Fama-French model. Hence, even if news about future GDP growth is not inducing the significance of the Fama-French factors, there is still a possibility that news about future GDP growth will be priced in Australian stocks.

[1] Fama and French found that the average annual book to market premium for a portfolio of high book to market firms is 12.32% higher than a portfolio of low book to market firms in the Australian setting.

We follow Vassalou's procedure and construct a mimicking portfolio that captures news about future GDP growth. To test whether GDP growth is priced in equity returns we augment the CAPM and Fama-French model with the GDP factor and run system regressions on the GDP-enhanced models. This setup enables us to draw inferences on whether the Fama-French factors are proxying risk associated with future GDP growth. Specifically, if SMB and HML mainly contain information about future GDP growth, then in the presence of the GDP factor, SMB and HML should lose their ability to explain equity returns.

The results of our system regressions indicate that news about future GDP growth is not priced in equity returns and that GDP growth is not inducing the significance of the Fama-French factors. Conversely, the systems analysis shows that SMB and HML earn significant positive premiums which implies that the Fama-French factors are priced and systematic. This result supports the risk-based argument of Fama-French (1996).[2] In other words, even though the Fama-French factors are not capturing risk associated with future GDP growth, the positive premiums on SMB and HML indicate that they may be capturing some form of risk.

As an extension of Vassalou (2003), we condition the Fama-French model with the same macroeconomic variables used to construct the GDP factor. We then compare the performance of the GDP-augmented Fama-French model with both the standard Fama-French model and the conditional Fama-French model through a series of nested and non-nested tests. We find that the GDP-augmented Fama-French model considerably under-performs the conditional Fama-French model and that it's performance is only comparable to the standard Fama-French model. This is an interesting result as it suggests that augmenting the Fama-French model with the GDP factor does not improve the model's explanatory power.

The rest of the paper is organised as follows. Section 2 discusses the existing literature. Section 3 outlines the data. Section 4 presents the research questions. Section 5 outlines the methodology. Section 6 reports the results and Section 7 concludes.

2. Literature Review

Fama and French (1993, 1996) contend that the size and book to market effects represent some form of undiversifiable risk and factors such as SMB and HML are capturing fundamental risk(s) in the economy which affect the investment opportunity set. This concept

[2] Alternatively, the observed positive premiums on SMB and HML could be explained with a behavioural argument such as the one proposed by Lakonishok, Shleifer and Vishny (1994).

can be understood in the context of the ICAPM (Merton, 1973) where SMB and HML capture risks associated with unidentified state variables of special hedging concerns to investors. Specifically, Fama and French claimed that SMB and HML are proxies for default risk, i.e. default risk is the state variable that investors wish to hedge against.

However, numerous studies have documented that although SMB and HML contain information about default risk, it is not the main reason why they are significant in explaining equity returns. Vassalou and Xing (2004) found that although default risk is related to size and book to market, SMB and HML both contain important information that is relevant in pricing equity returns which is not related to default risk. In the Australian context, Gharghori, Chan and Faff (2006a, 2006b) found that default risk is not systematic and is not priced in equity returns. Meanwhile, a number of studies have documented that macroeconomic variables are powerful predictors of equity returns. Therefore, it may be that SMB and HML are capturing risks associated with macroeconomic variables. Understanding the link between asset returns and macroeconomic variables has long been a goal of financial economics and is one of the aims of this paper.

Lettau and Ludvigson (2001) provided important insights on why and how macroeconomic variables such as consumption, asset wealth and labour income have the ability to forecast excess returns on common stocks. They found that expected returns on common stocks appear to vary within business cycles and that the consumption aggregate wealth ratio proxies for investors' expectations of future returns on the market portfolio. The economic intuition is that investors want to maintain a flat consumption path over time and will attempt to smooth out their future consumption when variability in future asset wealth is expected. That is, when excess returns are expected to be higher in the future, rational investors will react by increasing current consumption above its common trend. The reverse occurs when excess returns are expected to be lower in the future. In this way, deviations from trends in consumption, asset wealth and labour income are predictors of excess stock returns.

One assumption of the CAPM is that investors have homogenous investment horizons. In other words, the relationship between risk which is measured by beta and expected returns is assumed to be linear and static. In reality, investment horizons vary therefore, it is reasonable to contend that the relative risk of a firm's cash flow is likely to vary over the business cycle. For example, during recessions, small firms are likely to experience more variability in returns than bigger firms, i.e. the beta of small firms will tend to increase during recession periods. On the other hand, risk averse rational investors living in a dynamic economy will anticipate and hedge against the possibility that investment opportunities in the future may change unfavourably. Consequently, they will demand higher premiums during recession periods. Hence, beta and expected premiums will vary depending on the nature of information available to investors at any point in time.

Jagannathan and Wang (1996) tested a conditional version of the CAPM where beta and the expected returns of the market portfolio are allowed to vary over time conditional on information present in the market. They found that when adding the return on human capital to the CAPM, the pricing errors of the model were significantly reduced and firm size did not have any additional explanatory power. Their finding presented an important piece of information on whether the extent of changes in beta and the market risk premium is explained by macroeconomic variables.

Liew and Vassalou (2000) examined the link between the return on equities and macroeconomic variables from a different perspective. Since SMB and HML did a good job in explaining equity returns, their aim was to ascertain whether the profitability of SMB and HML could be linked to future GDP. Their intuition is that during periods of high economic growth, small firms tend to have relatively higher earnings than big firms. However, whether these high earnings will persist in the future is not known to investors, therefore, earnings of small firms are discounted more heavily compared to big firms which leads to higher returns. However, during periods of low economic growth, investors would rather hold big capitalisation stocks with low book to market ratios since their returns are more stable over time, which results in a lower return premium for small firms over big firms. In other words, high book to market firms and small capitalisation stocks are better able to prosper during periods of high economic growth and the reverse occurs during periods of low economic growth.

Their research has two parts. First, they examined the returns of SMB and HML during different states of future economic growth. They found that the returns on SMB and HML were higher in good states than in bad states in most countries. However, Australia is one of the countries where the returns on HML tend to be higher in bad states than in good states. Second, they tested the relationship between the returns on SMB and HML with the GDP growth rate. They found that the regression coefficients on SMB and HML were positive in most countries which indicated that there was a positive relationship between SMB and HML with GDP growth. However, in Australia the coefficient on the SMB factor is positive and significant while for HML, it is negative but insignificant. This evidence indicates that it is unlikely that HML contains information about future GDP growth while on the other hand, it is possible that SMB might.

Second, Liew and Vassalou found that even in the presence of the market factor and the business cycle variables, in most countries, the sign and magnitude of the coefficients for SMB and HML remained relatively stable. In Australia, when the market factor is present in the model, the regression coefficient of SMB on future GDP growth is positive and statistically significant while the coefficient on HML is negative and insignificant. These results indicated that SMB could be used to predict future GDP growth in Australia while HML did not have any explanatory power in explaining GDP growth. Nevertheless, Liew and Vassalou's overall findings signified that SMB and HML contained important information about future GDP growth. Therefore, it is possible that SMB and HML are proxying for future GDP growth.

Based on this evidence, Vassalou (2003) extended Liew and Vassalou's research by testing whether a model which includes news related to future GDP growth along with the market factor can explain the cross section of equity returns as well as the Fama-French model. Specifically, she tests whether augmenting the CAPM with a factor that captures news about future GDP growth will significantly improve the ability of the model to explain the variation in equity returns. In addition, if the Fama-French factors are proxying news about future GDP growth then in the presence of the GDP growth factor, the Fama-French factors should lose their ability to explain the cross-sectional variation in equity returns.

Since news related to future GDP growth is unobservable ex-ante, to capture news about future GDP growth, Vassalou created a mimicking portfolio using eight portfolios as base assets: six equity portfolios and two fixed income portfolios. The reason why Vassalou used the returns on a mimicking portfolio to capture news related to GDP growth is as follows: If news related to future GDP growth is the state variable that affects the investment opportunity set in the context of the ICAPM (Merton, 1973), then investors are concerned about future GDP growth and wish to hedge their risk exposures on this state variable. Cochrane (2001) points out that the purest way of hedging against state variable risk exposure is by shorting a mimicking portfolio that includes all assets that are affected by that state variable, which in this case is future GDP growth.

Vassalou augmented the CAPM with the GDP growth factor and found that the premium associated with the GDP growth factor is positive and statistically significant. In addition, she found that the GDP augmented CAPM has similar pricing errors compared to the Fama-French model which led her to test whether including SMB and HML in the pricing kernel would improve the performance of the model. Notably, the pricing errors were only reduced at a marginal level which suggests that including SMB and HML into the GDP augmented CAPM will not improve the model's explanatory power in pricing equity returns.

3. Data Issues

3.1 General

The sample for this study consists of monthly data for firms listed on the Australian Securities Exchange for the period January 1990 to March 2005. Monthly share prices, market capitalisations and monthly returns on the 13-week Treasury note, which is our proxy for the risk-free asset, are obtained from the AGSM database. Accounting data regarding total assets, intangibles, total equity and total liabilities are obtained from Aspect Financial. Data on long-term government bonds and corporate bonds are obtained from the RBA website and DataStream. Specifically, TERM is constructed by subtracting the return of the UBS 0-3 year maturity Treasury bond index from the return of the UBS 10 year maturity Treasury bond index. DEF is the difference in returns between the UBS 2-10 year maturity corporate bond index and the 2-10 year maturity UBS Treasury bond index. Our first control variable, TERMY is the lagged yield spread between the 10-year government bond and the 13-week Treasury note. DEFY is the lagged default spread between the UBS 10-year maturity corporate bond index and the UBS 10-year maturity Treasury bond index. Finally, RF is the yield on the 13-week Treasury note.

3.2 Creation of Independent Variables

Following Vassalou (2003), we construct a mimicking portfolio based on assets that are affected by GDP growth.[3] Lamont (2001) suggested that the mimicking portfolio should include all available assets whose unexpected returns are maximally correlated with unexpected components of the economic variable. However, since it is impractical to regress all such assets on the risk factor, following Vassalou (2003), we only include six equity portfolios and two bonds portfolios to cover both the share market and the fixed income

[3] Breeden, Gibbons and Litzenberger (1989) formed a maximum correlation portfolio (MCP) that is highly correlated with the growth rate of real consumption. Lamont (2001) extended this argument to the idea of an "economic tracking portfolio". His intuition was that changes in asset prices reflect changing information about future economic conditions. Therefore, it is possible to come up with an economic tracking portfolio of assets whose returns track economic variables such as inflation, expected output or future GDP growth. The main advantage of such tracking portfolios is that if the tracking portfolio earns a risk premium, then the signs and the degree of significance of such risk premiums can reveal the identities of the state variables that are important determinants of expected returns.

market.[4] In order for these eight portfolios to capture only news related to future GDP growth, we introduce other control variables TERMY, DEFY and RF, which are known to predict the returns of the base assets in our models.[5] To extract the information about GDP growth from the base assets, we run the following regression:

$$GDPGR_{t,t+4} = \alpha + cB_{t-1,t} + k_1 TERMY_{t-2,t-1} + k_2 DEFY_{t-2,t-1} + k_3 RF_{t-1,t} + e_{t,t+4} \qquad (1)$$

where $GDPGR_{t,t+4}$ is the GDP growth rate between t and t+4; $B_{t-1,t}$ is the vector of returns on the eight base assets between t-1 and t and $TERMY_{t-2,t-1}$, $DEFY_{t-2,t-1}$, $RF_{t-1,t}$ are the control variables.

As GDP is reported quarterly, equation 1 is estimated using quarterly data. Thus, $GDPGR_{t,t+4}$ is the annual growth in GDP. We then use the coefficients of the linear regressions and the explanatory variables to generate our GDP factor as follows:

$$GDP_{t-1,t} = cB_{t-1,t} \qquad (2)$$

where $GDP_{t-1,t}$ is the return of the mimicking portfolio between t-1 and t and $B_{t-1,t}$ is the vector of returns on the eight base assets between t-1 and t.

As the base assets are observed on a monthly basis, the mimicking portfolio for news about GDP growth is constructed using monthly data.

Following Fama and French (1993), firms are sorted into two size groups (Small and Big) based on their market capitalisation value and three book to market[6] groups (High Medium Low) using a 30-40-30 split. Six portfolios are formed from the intersection of the two size and three book to market groups: small/low, small/medium, small/high, big/low, big/medium and big/high. Small Minus Big (SMB) is the difference between the simple average of the value weighted returns on the three small-firm portfolios and the simple average of the value weighted returns on the three big-firm portfolios. High Minus Low (HML) is the difference between the simple average of the value weighted returns on the two high book to market portfolios and the simple average of the value weighted returns on the two low book to market portfolios. The portfolios are formed based on rankings in December t-1 and are held from January t to December t, that is the portfolios are rebalanced annually. [7]

[4] The six equity portfolios are the excess returns on the six Fama-French portfolios described below. The two bond portfolios are TERM and DEF.

[5] Vassalou also included CAY, the detrended wealth variable which represents deviations from a common trend found in consumption, asset wealth and labour income. This variable is computed following Lettau and Ludvigson (2001). We do not have data for this variable and hence we exclude it from our analysis.

[6] Book-to-market is book equity divided by market capitalisation. Book equity is proxied by net tangible assets which is equal to shareholders equity less intangibles. Negative book equity firms are removed from the sample.

[7] As most Australian firms have a June financial year end, we rank firms in December so that for most firms, there is a six-month lag between their book value and market value.

Our proxy for the market portfolio is the value weighted market index from the AGSM file. Our proxy for the risk free asset is the monthly return on the 13-week Treasury note.

3.3 Creation of Dependent Variables

Our dependent variables are constructed following Fama and French (1993). Firms are sorted into five groups based on their market capitalisation (size) and five groups based on book to market and 25 portfolios are formed from the intersection of these two groupings. The returns on these 25 portfolios then become dependent variables in all of our regressions.

4. Research Questions

4.1 Research question 1: Is news related to future GDP growth priced in the cross section of equity returns?

Fama and French (1993) claim that SMB and HML proxy for a state variable(s) of special hedging concern to investors in the context of the ICAPM (Merton, 1973). If the Fama-French factors are priced in the cross section of equity returns and news related to future GDP growth is the state variable that the Fama-French factors are proxying, then we expect that news about future GDP growth will also be priced.

4.2 Research question 2: Are the Fama-French factors proxying news related to future GDP growth?

If SMB and HML mainly capture news related to future GDP growth, then when news about future GDP growth is present in the model, SMB and HML will lose their ability to explain equity returns. However, if SMB and HML are not proxies for GDP growth, our complementary aim is to discover whether news about GDP growth can explain some variation in equity returns which is left unexplained by the Fama-French model. In other words, we will assess whether the GDP growth factor is priced in the presence of the Fama-French factors and whether augmenting the Fama-French model with the GDP growth factor will price equity returns better than the standard Fama-French model.

The second objective of this paper is to extend the analysis of Vassalou by conditioning the Fama-French model on the set of macroeconomic variables used to construct the GDP growth factor. This leads to our final research question.

4.3 Research question 3: Which of the GDP augmented Fama-French model and the conditional Fama-French model is superior in pricing equity returns?

If news about future GDP growth is priced in equity returns, then it is sensible to expect the performance of the conditional models to be similar to the GDP augmented Fama-French model since they both incorporate the same macroeconomic variables in the construction of their models.

5. Methodology

The first stage of the analysis will involve individual regressions of a GDP augmented Fama-French model according to:

$$r_{pt} = \alpha_p + b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + e_{pt} \qquad (3)$$

where r_{pt} is the return of the portfolio in excess of the risk free rate; r_{mt} is the return of the market portfolio in excess of the risk free rate; SMB_t is the return on the mimicking portfolio for the size factor; HML_t is the return on the mimicking portfolio for the book-to-market factor; and GDP_t is the return on the mimicking portfolio for future GDP growth.

The next stage of our analysis is the system regressions on various asset pricing models. The empirical modelling is based on the GDP augmented Fama-French model: [8]

$$E(R_p) - RF = b_p[E(R_m) - RF] + s_p E(SMB) + h_p E(HML) + g_p E(GDP) \qquad (4)$$

The empirical counterpart for this model is given by equation (3). After applying expectations to equation (4), a comparison with the GDP augmented Fama-French model of equation (3) allows us to observe the standard zero intercept restriction that forms our null hypothesis H_0: $\alpha_p = 0$; p = 1, 2,..., N. The restricted form of Equation (3) is given by:

$$r_{pt} = b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + e_{pt} \qquad (5)$$

where p = 1,2,….N

This standard asset pricing test can be modified to allow direct estimation of the factor premiums on the four risk factors:

$$r_{pt} = b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + e_{pt} \qquad (5)$$

$$r_{mt} = \lambda_m + e_{mt} \qquad (6)$$

$$SMB_t = \lambda_{SMB} + e_{st} \qquad (7)$$

$$HML_t = \lambda_{HML} + e_{ht} \qquad (8)$$

$$GDP_t = \lambda_{GDP} + e_{gt} \qquad (9)$$

Equations (6), (7), (8) and (9) in effect impose a mean-adjusted transformation to the independent variables in equation (5) so that the null hypothesis is effectively a test of the intercept α^* being equal to the non-zero restriction:

[8] We only present the system specification for the GDP augmented Fama-French model. The other models are nested versions of this one which we do not present to conserve space.

$$H_0: \alpha^* = b_p\lambda_m + s_p\lambda_{SMB} + h_p\lambda_{HML} + g_p\lambda_{GDP}$$

Following Faff (2001), the generalised method of moments (GMM) approach is chosen as the system based method used to perform the asset pricing tests. The system of equations (5), (6), (7), (8) and (9) contain 5N + 4 sample moments equations with 4N + 4 unknown parameters (i.e. $\Phi = b_1, b_2,.., b_N, s_1, s_2,.., s_N, h_1, h_2,.., h_N, g_1, g_2,.., g_N, \lambda_m, \lambda_{SMB}, \lambda_{HML}, \lambda_{GDP}$). Hence, the test has N over identifying restrictions and is given by:

$$GMM = (T - N - 1)^* g_T(\hat{\phi})' \cdot S_T^{-1} \cdot g_T(\hat{\phi}) \tag{10}$$

where $g_T(\hat{\phi}) = \frac{1}{T}\sum_{t=1}^{T} f_t(\hat{\phi})$, is the empirical moment condition vector; and the GMM statistic is (asymptotically) distributed as a chi square statistic with N degrees of freedom.

We run system regressions on the following models: CAPM, Fama-French, GDP-augmented CAPM and GDP augmented Fama-French. If GDP growth is priced in equity returns then we expect the GDP factor premium (λ_{GDP}) in the GDP-augmented CAPM and GDP-augmented Fama-French system regressions to be significantly positive. If GDP growth is inducing the significance of the Fama-French factors then in the system regression of the GDP-augmented Fama-French model, the factor premium on SMB (λ_{SMB}) and HML (λ_{HML}) will be insignificant which indicates that in the presence of the GDP growth factor, SMB and HML lose their explanatory power. However, if SMB and HML are not proxies for future GDP growth and GDP growth is priced, then we should observe significantly positive factor premiums on all the factors in the GDP augmented Fama-French model.

Recall that our GDP growth factor is created using a number of macroeconomic variables. For that reason, one can argue that it is these macroeconomic variables that enable the GDP growth factor to explain cross-sectional variation in equity returns that the Fama-French factors cannot. Therefore, we propose that by conditioning the Fama-French model with the same set of macroeconomic variables used to construct the GDP growth factor, the conditional Fama-French model will be able to explain the same amount of variation in equity returns as the GDP-augmented Fama-French model.

We employ the “J” test proposed by Elyasiani and Nasseh (2000) to assess the performance of the non-nested models. The idea is that if one model is superior, then the fitted values from the other model should not have any explanatory power when estimating that model. Specifically we set up two competing alternative hypotheses:

H_{1a}: The GDP enhanced Fama-French model explains equity returns better than the conditional Fama-French model.

H_{1b}: The conditional Fama-French model explains equity returns better than the GDP enhanced Fama-French model.

To test these hypotheses, we augment the GDP enhanced Fama-French model with the fitted values obtained from the conditional Fama-French regression. Similarly, we augment the conditional Fama-French model with the fitted values estimated from the GDP enhanced Fama-French model. Our regression equations are as follows:

$$r_{pt} = \alpha_p + b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + condfit_t + e_{pt} \tag{11}$$

$$\begin{aligned} r_{pt} = \alpha_p &+ (b_1 + b_2 TERMY_{t-2,t-1} + b_3 DEFY_{t-2,t-1} + b_4 RF_{t-1,t}) r_{mt} \\ &+ (s_1 + s_2 TERMY_{t-2,t-1} + s_3 DEFY_{t-2,t-1} + s_4 RF_{t-1,t}) SMB_t \\ &+ (h_1 + h_2 TERMY_{t-2,t-1} + h_3 DEFY_{t-2,t-1} + h_4 RF_{t-1,t}) HML_t + gdpfit_t + e_{pt} \end{aligned} \tag{12}$$

where $condfit_t$ is the fitted value in period t obtained from the conditional Fama-French model; and $gdpfit_t$ is the fitted value in period t obtained from the GDP augmented Fama-French model.

In addition to the non-nested test outlined above, we compare the performance of the GDP augmented Fama-French model with the Fama-French model by employing the Maximum Likelihood Ratio Test (MLRT) first suggested by Rao (1973).[9] The MLRT statistic is given by:

$$MLRT = T^* \left\{ \left[\frac{\det(\hat{\sum} r)}{\det(\hat{\sum} u)} \right] - 1 \right\} \tag{13}$$

where $\det(\hat{\sum} r)$ = the determinant of the maximum likelihood estimate of the error covariance matrix from the restricted system;

$\det(\hat{\sum} u)$ = the determinant of the maximum likelihood estimate of the covariance matrix from the unrestricted system;

T^* = (T-k-p)/p

and where T is the number of time series observations; k is the number of factors; and p the number of equations in the multivariate regression system.

[9] For examples of application of the MLRT, see Connor and Korajczyk (1988) and Faff (1992).

6. Results

6.1 Estimation of the Mimicking Portfolio

The results from the regressions of GDP growth four quarters ahead on the current returns of the eight base assets are reported in Table 1. The high adjusted R^2 (54.5%) from the regression suggests that a significant amount of the variation in future GDP growth is forecast by the eight base assets. In addition, the p-value for the chi-square test is 0.007 which enables us to reject the null hypothesis that all the coefficients of the eight base assets are jointly zero. The t-statistics for the bond portfolios are very significant. This indicates that changes in bonds prices have significant explanatory power in predicting future changes in GDP growth. The t-statistics for the equity portfolios are much lower and insignificant which implies that only a small portion of variation in equity returns can explain GDP growth over the next year. This however does not imply that the equity portfolios should be excluded from the construction of the mimicking portfolio.

[Insert Table 1 about here]

Vassalou (2003) in fact found that the coefficients on both of the bond and equity portfolios are insignificant. Her explanation is that there is much more information in GDP growth which is not captured by the base assets, but this is because the additional information which is not captured by the mimicking portfolio is not relevant for equity returns. Moreover, her mimicking portfolio has a much lower average adjusted R^2 than ours[10], and yet her GDP growth factor is priced. Therefore, we contend that while our equity portfolios as a whole do not have significant explanatory power in explaining future GDP growth, our mimicking portfolio does a good job in extracting the information in GDP growth which affects equity returns.

6.2 Basic Descriptive Statistics and Correlations of the Independent Variables

Panel A of Table 2 reports basic descriptive statistics for the independent variables. The time-series mean of SMB (3.4% pm) and HML (0.93% pm) are significantly positive. The mean of the market premium (0.32% pm) although positive is not statistically significant. Finally, the mean of GDP is only 0.01% pm and is clearly insignificant (t-statistic is 0.5). The descriptive statistics suggest that SMB and HML are the factors that are most likely to be priced in equity

[10] Vassalou reported an adjusted R^2 of 38.62% for her mimicking portfolio.

returns. In addition, it is unclear whether the market factor will be priced while it is unlikely that the GDP factor will be priced.

Panel B of Table 2 reports correlations for the independent variables used in the analysis. Recall that our aim is to test whether the Fama-French factors are proxies for news about future GDP growth. If this is the case, then we should expect high positive correlations between the Fama-French factors and GDP as documented in Liew and Vassalou (2000). This however is not observed. Specifically, the correlation between GDP and SMB is negative (-0.41) while the correlation between GDP and HML is only 0.11. Therefore, the low correlations between GDP and the Fama-French factors indicate that it is unlikely that GDP growth is inducing the significance of the Fama-French factors. However, this preliminary analysis is only descriptive and we will base our main conclusions on the findings of the system regressions.

[Insert Table 2 about here]

6.3 Asset Pricing Tests

Table 3 reports the results of individual regressions on the GDP augmented Fama-French model. The coefficients on the market factor and the Fama-French factors are very similar to those of unreported Fama-French regressions. Specifically, the market factor is significant for all 25 portfolios, SMB is significant for all small and medium sized portfolios and HML is significant for more than half of the high book to market portfolios. The GDP factor, on the other hand, is insignificant for all 25 portfolios. The average adjusted R^2 for these 25 regressions is 55.1% which is the slightly less than for the Fama-French regressions. In addition, the regression intercepts are significant for 10 (out of 25) portfolios as opposed to 11 portfolios in unreported Fama-French regressions. The results of the individual regressions therefore indicate that the performance of the GDP enhanced Fama-French model and the standard Fama-French model is very similar and any improvement from augmenting the Fama-French model with the GDP growth factor is marginal.

[Insert Table 3 about here]

If news about future GDP growth is inducing the significance of the Fama-French factors, then in the presence of a superior proxy for news about future GDP growth, SMB and HML should lose their ability to explain equity returns. If this is the case, the factor loadings on SMB and HML will become insignificant while the loadings on the GDP factor should be significant. However, this is not observed. When GDP is introduced in the Fama-French model, the explanatory powers of SMB and HML are unaffected while the loadings on GDP are clearly insignificant. Overall, the results of our individual regressions suggest that it is unlikely that SMB and HML are proxies for risk(s) associated with future GDP growth.

Table 4 presents the results of restricted system based GMM estimation and tests of the non-linear cross equation restrictions implied by the CAPM, the GDP-augmented CAPM, the vanilla Fama-French model and the GDP augmented Fama-French model. In the system regressions, we focus our analysis on the GMM statistics and the estimated factor premiums. If the factor premium is positive and significant, we conclude that the factor is systematic and priced in the cross section of equity returns. On the other hand, if the factor premium is insignificant or negative and significant, we conclude that the factor is not priced and therefore not systematic.[11]

[Insert Table 4 about here]

The first system regression reported is for the CAPM. The GMM statistic is insignificant implying that the model cannot be rejected. The market premium (λ_m) although positive, is not significant (t-statistic is 1.608). Similarly, the market premium is not significantly positive in the GDP-enhanced CAPM system regression (t-statistic is 1.557). However, in the Fama–French and GDP enhanced Fama-French system regressions, the market premium is positive and statistically significant (t-statistic is 2.078 for the Fama-French model and 2.113 for the GDP augmented Fama-French model).

The second system regression reported is for the Fama-French model. In addition to the market factor discussed above, the Fama-French factors, SMB and HML also have significantly positive premiums (t-statistic of 8.33 for λ_{SMB} and 2.61 for λ_{HML}). This is consistent with the results from the individual regressions where both SMB and HML (particularly SMB) were found to be significant explanators of returns. Furthermore, the magnitude of these factor premiums (the estimated premiums for SMB and HML are 45% p.a. and 8% p.a., respectively) suggests that the Fama-French factors are capturing risk(s) which is priced and systematic in equity returns but not explained by the market factor.[12] These estimated premiums are very similar to the actual premiums reported in Table 2 (the

[11] The four factors employed in this analysis have been constructed such that a positive premium is consistent with a risk-based explanation for the factors. Thus, an observed negative premium would be inconsistent with a risk-based explanation and would therefore indicate that the factor is not priced and is not systematic.

[12] Alternatively, the positive premiums could be due to behavioural factors (Lakonishok, Shleifer and Vishny, 1994).

premium on SMB is 41% p.a. while it is 11% p.a. for HML). The GMM statistic is insignificant which supports the overall favourability of the model.

The third system regression is performed on a GDP augmented CAPM. The aim of this system regression is to identify whether GDP is priced in equity returns. Specifically, if GDP is priced, then the premium on the GDP factor should be positive and significant. The result of this system regression indicates that the premium on the GDP factor although positive, is clearly insignificant (t-statistic is 0.54). The GMM statistic is insignificant which means that we cannot reject the test of the over-identifying restrictions (at the 5% level). In fact, the GMM statistic is always insignificant regardless of which model is being implemented. Therefore, we focus our analysis on the premium estimates which leads us to conclude that in the system regression of the GDP enhanced CAPM, the GDP factor is not priced.

The last system regression we report is for the GDP augmented Fama-French model. Recall that our aim is to test whether SMB and HML are proxying for risk(s) associated with future GDP growth. If SMB and HML are proxies for future GDP growth, then in the presence of the GDP factor, SMB and HML should lose their ability to explain equity returns. Specifically, the factor premiums on SMB and HML should be insignificant while the premium on the GDP factor should be significantly positive. This is not the case. The premiums on the Fama-French factors remain significantly positive and annualise to about 45% p.a. for SMB and 8% p.a. for HML. On the other hand, the premium on the GDP factor although positive only annualises to 0.25% p.a. and is clearly insignificant (t-statistic is 0.8). This finding reinforces the result of the GDP enhanced Fama-French individual regressions in Table 3 where the GDP factor does not absorb the explanatory powers of SMB and HML. As a whole, the results indicate that GDP is not priced in equity returns, is not systematic and that the Fama-French factors, SMB and HML, are not proxies for news about future GDP growth.

Table 5 presents the results of the "J" test which assesses the GDP augmented Fama-French model against the conditional Fama-French model. Specifically, the conditional Fama-French model is augmented with the fitted value gdpfit from the GDP enhanced Fama-French model. Similarly, the GDP enhanced Fama-French model is augmented with the fitted value condfit from the conditional Fama-French model. To conserve space we only report the coefficients and t-statistics for gdpfit and condfit.

[Insert Table 5 about here]

The results in this table clearly favour the conditional model as opposed to the GDP augmented model. There are only two (out of 25) portfolios where the coefficients on gdpfit are significant. However, unlike gdpfit, the coefficients on condfit are significant for 24 (out of 25) portfolios which clearly favours the conditional Fama-French model. This suggests that there is relevant pricing information in the conditional Fama-French model which is not captured by the GDP augmented model. Overall, the results of "J" test allow us to reject the hypothesis that the GDP enhanced Fama-French model is correctly specified.

The result for the MLRT is incorporated in Table 4 which assesses the performance of the GDP augmented Fama-French model against the Fama-French model. The MLRT statistic is 0.627 and is clearly insignificant (p-value is 0.91) which implies that we are unable to reject the hypothesis that all the 25 coefficients on the GDP growth factor are jointly equal to zero. This indicates that the GDP enhanced Fama-French model does not explain variation in equity returns better than the standard Fama-French model. In other words, augmenting the Fama-French model does not improve the model's explanatory power. This once again confirms that news about future GDP growth is not priced in equity returns.[13]

7. Summary and Conclusion

The primary aim of this paper is to test in an Australian context, the contention that the Fama-French factors' ability to explain equity returns occurs because they are proxying news about future GDP growth. Fama and French (1993, 1996) claim that SMB and HML are capturing risk associated with an unidentified state variable(s) of special hedging concern to investors. Therefore, if the Fama-French factors are proxies for risk associated with future GDP growth, then one can argue that the state variable that investors are hedging against is related to GDP growth. On the other hand, if the Fama-French factors are not proxies for risk associated with future GDP growth, we also seek to ascertain whether news about future GDP growth can explain variation in equity returns which is left unexplained by the Fama-French model.

We found that news about future GDP growth is not priced and is not systematic in equity returns. The test of a GDP enhanced Fama-French model indicates that news about future GDP growth is not inducing the significance of the Fama-French factors. In addition, augmenting the GDP factor into the Fama-French does not explain variation in equity returns

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[13] In the final stage of the analysis, we examined the sensitivity of our results to the choice of base assets used to construct our GDP growth factor. Consistent with Vassalou (2003), a mimicking portfolio which only includes bond portfolios has a significant positive premium while the premium on the mimicking portfolio which only includes equity portfolios, is negative although insignificant. However, regardless of how the GDP factor is constructed, the premiums on the Fama-French factors remain positive and significant. This suggests that SMB and HML are not proxies for news about future GDP growth. Results are suppressed to conserve space.

better than the Fama-French model. The findings of the nested tests in fact favour the Fama-French model over the GDP enhanced Fama-French model. We also study the link between macroeconomic factors and equity returns through the use of a conditional Fama-French model. We found that the conditional Fama-French model is superior to the GDP enhanced Fama-French model in explaining equity returns.

Based on the findings of Liew and Vassalou (2000), we may attribute the inability of the GDP growth factor in explaining equity returns to the fact that the relationship between GDP and the Fama-French factors in Australia is quite weak. Therefore, it will be interesting to examine Vassalou's finding in other countries where the relationship between GDP and the Fama-French factors is much stronger.

Consistent with prior work (Faff, 2001), we find evidence which favours a risk-based explanation for the Fama-French model.[14] Specifically, the significant factor premiums on SMB and HML in the system regressions of the Fama-French model and the GDP enhanced Fama-French model suggests that the Fama-French factors may be capturing some form of systematic risk. However, what type of risk, if any, the model is capturing remains a puzzle. We do not find evidence supporting Vassalou's (2003) claim that the Fama-French factors are proxies for risk associated with future GDP growth.

[14] We acknowledge that the findings could be interpreted from a behavioural perspective.

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Table 1 Estimation of the Mimicking Portfolio for the GDP Factor

This table reports the coefficients and t-statistics of the base assets used to construct the GDP growth factor for the period January 1990 to March 2005. The base assets include six equity portfolios and two bond portfolios, TERM and DEF. SL, SM and SH are returns on the small/low book-to-market; small/medium book-to-market and small/high book-to-market portfolios, respectively. BL, BM and BH are returns on the big/low book-to-market; big/medium book-to-market and big/high book-to-market portfolios, respectively. TERM is the difference in returns between the UBS 10 year maturity Treasury bond index and the UBS 0-3 year maturity Treasury bond index. DEF is the difference in returns between the UBS 2-10 year maturity corporate bond index and the 2-10 year maturity UBS Treasury bond index. The set of control variables include TERMY, DEFY and RF. TERMY is the lagged yield spread between the 10-year government bond and the 13-week Treasury note. DEFY is the lagged default spread between the UBS 10-year maturity corporate bond index and the UBS 10-year maturity Treasury bond index. Finally, RF is the yield on the 13-week Treasury note. The Wald statistic testing that the coefficients on the eight base assets are jointly equal to zero is distributed $\chi^2(8)$. The p-value for this Wald statistic is reported in parentheses below the test statistic.

The Mimicking Portfolio		
Base Assets	SL	-0.0054
		(-0.45)
	SM	-0.0106
		(-0.63)
	SH	-0.0026
		(-0.18)
	BL	0.0054
		(0.16)
	BM	0.0294
		(0.54)
	BH	0.0045
		(0.13)
	TERM	0.1807
		(3.46)
	DEF	0.5369
		(2.18)
	Constant	0.0510
		(5.12)
Control Variables	TERMY	0.3739
		(2.98)
	DEFY	-0.0040
		(-0.43)
	RF	-0.3367
		(-3.23)
	Adjusted R^2	0.545
	$\chi^2(8)$	20.7521
	p-value	*(0.0078)*

Table 2 Basic Descriptive Statistics and Correlations

This table reports basic descriptive statistics and correlations for the four factors used in the analysis for the period January 1990 to March 2005.

	R_m	SMB	HML	GDP
Panel A: Basic Descriptive Statistics				
Mean	0.0032	0.0341	0.0093	0.0001
Mean std error	0.0025	0.0051	0.0036	0.0002
t-statistic	1.3080	6.6485	2.5848	0.4997
Median	0.0070	0.0210	0.0086	0.0004
Maximum	0.0731	0.3645	0.2989	0.0083
Minimum	-0.1059	-0.2029	-0.1777	-0.0123
Std. Dev.	0.0334	0.0694	0.0487	0.0033
Skewness	-0.5649	1.0872	1.4151	-0.7196
Kurtosis	3.3687	6.2601	13.6586	4.5124

Panel B: Correlations				
R_m	1			
SMB	0.084	1		
HML	0.014	-0.205	1	
GDP	0.438	-0.411	0.116	1

Table 3 Individual Regressions of a GDP-Augmented Fama-French Model on 25 Size and Book-to-Market Sorted Portfolios

This table reports the results of individual regressions of a GDP augmented Fama-French model on 25 size and book-to-market sorted portfolios for the period January 1990 to March 2005 according to:

$$r_{pt} = \alpha_p + b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + e_{pt} \quad (3)$$

Sz	BM	α_p	b_p	s_p	h_p	g_p	adj R^2
1	1	0.0264	1.3853	1.2246	-0.3917	0.2838	0.484
		(3.44)	*(5.03)*	*(9.35)*	*(-3.15)*	*(0.11)*	
1	2	0.0205	1.0629	1.4464	-0.1733	-0.8889	0.553
		(2.79)	*(4.32)*	*(9.36)*	*(-0.77)*	*(-0.29)*	
1	3	0.0399	1.2252	1.1651	-0.401	-4.6196	0.463
		(4.30)	*(4.61)*	*(9.18)*	*(-1.77)*	*(-1.51)*	
1	4	0.0139	1.2438	1.269	0.1415	1.28	0.63
		(2.34)	*(9.15)*	*(9.88)*	*(0.64)*	*(0.78)*	
1	5	0.0131	0.9627	1.6134	1.5034	-1.1364	0.58
		(1.05)	*(2.63)*	*(5.31)*	*(2.13)*	*(-0.40)*	
2	1	0.0045	1.0769	0.9936	-0.7904	1.7712	0.595
		(0.90)	*(4.65)*	*(10.14)*	*(-3.84)*	*(1.26)*	
2	2	0.0041	0.9287	1.038	-0.1355	-0.1609	0.591
		(0.89)	*(6.17)*	*(8.37)*	*(-0.71)*	*(-0.10)*	
2	3	0.0078	1.2353	1.1117	0.2182	-0.142	0.487
		(1.37)	*(6.69)*	*(4.86)*	*(1.07)*	*(-0.10)*	
2	4	0.0023	0.7838	0.9208	0.0527	1.3251	0.527
		(0.55)	*(5.52)*	*(7.22)*	*(0.32)*	*(0.74)*	
2	5	0.0065	0.6811	0.725	0.1843	0.601	0.581
		(2.21)	*(4.97)*	*(9.06)*	*(1.70)*	*(0.53)*	
3	1	0.0022	1.0706	0.7153	-0.3723	1.4678	0.593
		(0.44)	*(7.12)*	*(12.07)*	*(-3.11)*	*(1.08)*	
3	2	-0.0022	0.8271	0.6633	-0.0446	2.5317	0.554
		(-0.61)	*(5.81)*	*(6.48)*	*(-0.37)*	*(1.95)*	
3	3	0.001	0.896	0.4386	0.0074	0.0526	0.588
		(0.33)	*(9.27)*	*(9.58)*	*(0.09)*	*(0.05)*	
3	4	0.0044	0.7279	0.3417	0.153	0.7692	0.464
		(1.40)	*(8.38)*	*(5.60)*	*(1.75)*	*(0.69)*	
3	5	0.006	0.8652	0.6064	0.5736	1.7867	0.275
		(0.76)	*(3.98)*	*(3.28)*	*(1.38)*	*(0.62)*	
4	1	0.0001	0.9425	0.3328	-0.0878	-0.5145	0.555
		(0.03)	*(8.69)*	*(6.21)*	*(-1.54)*	*(-0.59)*	
4	2	0.0054	0.9104	0.2378	0.0518	-0.2704	0.59
		(2.31)	*(10.38)*	*(5.36)*	*(1.06)*	*(-0.33)*	
4	3	0.0027	0.7582	0.2362	0.0134	0.7783	0.646
		(1.35)	*(12.71)*	*(6.2)*	*(0.25)*	*(1.40)*	
4	4	0.0093	0.715	0.1012	0.0444	0.2213	0.472
		(3.19)	*(11.73)*	*(2.13)*	*(0.62)*	*(0.37)*	
4	5	0.0088	0.7976	0.1026	0.2515	0.3476	0.259
		(2.63)	*(4.85)*	*(1.50)*	*(2.07)*	*(0.25)*	
5	1	0.003	0.9069	0.0021	-0.1082	0.1703	0.687
		(1.63)	*(17.56)*	*(0.07)*	*(-2.76)*	*(0.40)*	
5	2	0.0042	1.0498	-0.0315	-0.0481	-0.0551	0.849
		(3.65)	*(19.86)*	*(-1.47)*	*(-2.02)*	*(-0.14)*	
5	3	0.0076	0.9769	-0.0617	0.0761	0.4052	0.753
		(4.51)	*(20.49)*	*(-1.76)*	*(2.46)*	*(0.81)*	
5	4	0.0038	1.0837	-0.0305	0.2586	1.1382	0.647
		(1.73)	*(10.45)*	*(-0.75)*	*(3.06)*	*(1.43)*	
5	5	0.0046	0.8986	0.1198	0.426	0.6666	0.345
		(1.25)	*(5.79)*	*(2.02)*	*(4.72)*	*(0.49)*	
	average						0.551

Table 4 Generalised Method of Moments (GMM) System Tests of the Asset Pricing Models Specified

The test of the GDP-augmented Fama-French model is based on the following system:

$$r_{pt} = b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + e_{pt} \qquad (p = 1, 2, \ldots, N) \qquad (5)$$

$$r_{mt} = \lambda_m + e_{mt} \qquad (6)$$

$$SMB_t = \lambda_{SMB} + e_{st} \qquad (7)$$

$$HML_t = \lambda_{HML} + e_{ht} \qquad (8)$$

$$GDP_t = \lambda_{GDP} + e_{gt} \qquad (9)$$

The generalised method of moments test statistic (GMM), testing that the asset pricing models hold, is distributed as a chi-square with N degrees of freedom. The associated p-value is contained in parentheses below the GMM statistic. The associated t-statistic for the factor premium is contained in parentheses below the coefficient estimate. The MLRT, testing that the 25 coefficients on the GDP growth factor are jointly equal to zero has an F distribution with (25,174) degrees of freedom. The sample period is January 1990 to March 2005.

	GMM	λ_m	λ_{SMB}	λ_{HML}	λ_{GDP}	**MLRT**
CAPM	30.78	0.0033				
	(0.196)	*(1.61)*				
FF	31.85	0.0039	0.0383	0.0063		
	(0.162)	*(2.18)*	*(8.33)*	*(2.62)*		
CAPM GDP	31.62	0.0032			0.0001	
	(0.169)	*(1.58)*			*(0.54)*	
FF GDP	32.461	0.0040	0.0374	0.0065	0.0002	0.627
	(0.145)	*(2.11)*	*(8.24)*	*(2.68)*	*(0.85)*	*(0.914)*

Table 5 Non-nested "J" Test Results Between the GDP Augmented Fama-French Model and the Conditional Fama-French Model on 25 Size and Book-to-Market Sorted Portfolios

This table reports the results of individual regressions testing the GDP augmented Fama-French model versus the conditional Fama-French on 25 size and book-to-market sorted portfolios for the period January 1990 to March 2005 according to:

$$r_{pt} = \alpha_p + b_p r_{mt} + s_p SMB_t + h_p HML_t + g_p GDP_t + condfit_t + e_{pt} \quad (11)$$

$$\begin{aligned} r_{pt} = \alpha_p &+(b_1 + b_2 TERMY_{t-2,t-1} + b_3 DEFY_{t-2,t-1} + b_4 RF_{t-1,t})r_{mt} \\ &+ (s_1 + s_2 TERMY_{t-2,t-1} + s_3 DEFY_{t-2,t-1} + s_4 RF_{t-1,t})SMB_t \\ &+ (h_1 + h_2 TERMY_{t-2,t-1} + h_3 DEFY_{t-2,t1} + h_4 RF_{t-1,t})HML_t + gdpfit_t + e_{pt} \end{aligned} \quad (12)$$

Sz	BM	gdpfit	condfit
1	1	-0.7955	0.9996
		(-0.57)	*(2.67)*
1	2	1.2812	0.9733
		(1.22)	*(3.87)*
1	3	-0.7630	1.0423
		(-0.97)	*(2.92)*
1	4	1.2218	0.9186
		(1.27)	*(2.39)*
1	5	*2.9539*	*0.9915*
		(0.87)	*(5.66)*
2	1	1.6672	1.0449
		(2.12)	*(4.63)*
2	2	-19.9109	1.0282
		(-0.16)	*(5.72)*
2	3	8.0006	1.0316
		(0.74)	*(2.96)*
2	4	0.7610	0.9924
		(0.77)	*(5.19)*
2	5	0.7679	0.9006
		(1.01)	*(3.23)*
3	1	0.6674	0.9778
		(0.90)	*(6.11)*
3	2	0.8336	0.9521
		(1.61)	*(1.85)*
3	3	13.9616	1.0230
		(0.71)	*(6.84)*
3	4	0.7516	0.9911
		(0.56)	*(2.61)*
3	5	0.5719	1.0029
		(0.26)	*(3.79)*
4	1	0.0034	0.9998
		(0.00)	*(3.44)*
4	2	0.5553	1.0276
		(0.35)	*(4.12)*
4	3	1.1456	0.9880
		(1.17)	*(2.88)*
4	4	6.8645	0.9605
		(1.57)	*(4.03)*
4	5	-3.8158	1.0161
		(-0.81)	*(4.29)*
5	1	1.9330	1.0546
		(1.00)	*(2.81)*
5	2	0.8434	0.9840
		(1.06)	*(4.54)*
5	3	2.3613	0.9360
		(1.90)	*(3.83)*
5	4	1.3910	0.7369
		(2.47)	*(3.08)*
5	5	0.5898	1.0194
		(0.54)	*(3.37)*