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Manchester Business School Working Paper No. 559
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This study explores the information content of HML and SMB by linking the Fama-French factors to shocks in the state variables which predict future investment opportunities. It shows that the HML factor contains information about shocks to default spread. Moreover, the Fama-French model explains the cross-section of average returns on portfolios sorted on size and book-to-market ratio better than both a model that includes shocks to the state variables and a model that includes news related to future industrial production growth in addition to the market factor. Furthermore, when loadings on HML and SMB are present in the model, loadings on shocks to default spread lose its explanatory power for the cross-section of returns. The results provide economic interpretation for the empirical success of HML factor but different from the US evidence that shocks to state variables subsume Fama-French factors.

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ON THE INFORMATION CONTENT OF THE FAMA AND FRENCH FACTORS IN THE UK

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September 2008

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Abstract

This study explores the information content of HML and SMB by linking the Fama-French factors to shocks in the state variables which predict future investment opportunities. It shows that the HML factor contains information about shocks to default spread. Moreover, the Fama-French model explains the cross-section of average returns on portfolios sorted on size and book-to-market ratio better than both a model that includes shocks to the state variables and a model that includes news related to future industrial production growth in addition to the market factor. Furthermore, when loadings on HML and SMB are present in the model, loadings on shocks to default spread lose its explanatory power for the cross-section of returns. The results provide economic interpretation for the empirical success of HML factor but different from the US evidence that shocks to state variables subsume Fama-French factors.

1. Introduction

Fama and French (1993, 1995, 1996) argue that a model which includes HML and SMB factors alone with the Market factor explain most of the cross-sectional variation in average returns of portfolio sorted on size and book-to-market. HML is the return of a portfolio long in high book-to-Market stocks and short in low book-to-market stocks whereas SMB is the return of a portfolio long in small stocks and short in big stocks.

The outstanding performance of the Fama-French model has ignited a great debate among the finance academics over the economic intuition behind the HML and SMB factors. Fama and French (1993) argue that the superior performance of HML and SMB factors might be because they work as a proxy for time variation in the investment opportunity set. This risk based explanation is in the spirit of Merton's (1973) Intertemporal Capital Asset Pricing Model (ICAPM).

Campbell (1996) argues that the empirical implementation of the ICAPM should neither be based on selecting important macroeconomic variables nor on running a factor analysis on the returns variance covariance matrix. Rather, factors should be chosen on the basis of their ability to forecast changes in future investment opportunities.

A growing body of research supports the risk-based explanation behind the HML and SMB factors by linking them to macroeconomic variables and business cycle fluctuations. One interpretation of the relation between HML and shocks to term spread is in the context of cash flow maturities of assets. Cornell (1999), Campbell and Voulteenaho (2003) and Lettau and Wachter (2007) argue that growth stocks are high duration assets which make them like long-term bonds and more sensitive to shocks in the long end of the term structure. In contrast, value stocks have lower duration than growth stocks which makes them more similar to short-term bonds and more sensitive to shocks in the short end of the yield curve.

Fama and French (1989) find that term spread tends to be low near business cycle peaks and high near troughs. Moreover, Hahn and Lee (2006) show that term spread and short term interest rate, proxy by the one-year treasury yield, move in opposite directions. Thus, they predict that increases (decreases) in the term spread to be associated with higher (lower) returns on HML on average.

The default spread has long been used as a proxy for the state of business conditions and, in particular, as a measure of credit market conditions (see, for example, Gertler, Hubbard, and Kashyab (1990) and Kashyab, Lamont, and Stein (1994)). Chan and Chen (1991) argue that small firms are often marginal firms which are particularly dependent on external financing and have financial leverage and cash flow problems. The earnings prospect for these firms is more sensitive to changes in the business conditions. Therefore, they predict negative association between shocks in default risk and the average returns on SMB. This suggestion is supported by Petkova (2006) findings of negative covariation between average returns on SMB and shocks to default spread though it is only marginally significant.

Some imperfect capital market theories (e.g., Bernanke and Gartner (1989), Gertler and Gilchrist (1994), Kiyotaki and Moore (1997)) argue that a change in credit market conditions will affect small and large firm's risk differently. Information asymmetry between firms and their creditors induces agency costs which make it required for firms to use collateral when borrowing in the credit market. However, small firms are usually supported with less collateral than large firms and are less able to raise external funds. Consequently, lower liquidity and higher short-term interest rates will have more adverse effect on small firms compared with large ones.

Perez-Quiros and Timmermann (2000) find that small firms show higher cyclical asymmetries in risk and expected returns than large firms. They discover that small firms are more strongly affected by tighter credit market conditions (as measured by higher interest rates, higher default premia, and lower money supply growth) than large, better collateralized firms. Hahn and Lee (2006) build on these results and suggest the use of the negative of changes in the default spread as alternative macroeconomic proxy for SMB.

Fama and French (1992b) argue that book-to-market equity is associated with relative profitability. Stocks with lower B/M ratio signal stronger earnings and are less subject to default risk. On contrast, high B/M ratio firms have persistently poor earnings. An increase in default risk is commonly interpreted as a signal of the market expectations of worsening credit market conditions. This will raise the discount rate which will consequently hit firms with high book-to-market ratios more heavily than firms with low book-to-market ratios.

Chan and Chen (1991) predict that small firms will be more sensitive to news about the state of the business cycle. Levis and Kalliontzi (1993) confirm this proposition while studying the size premia in the UK during different business cycles in the period 1960 to 1991. They find that small firms tend to underperform in economic contractions and outperform during periods of economic expansions. This argument was supported by the evidence provided by Liew and Vassalou (2000), Vassalou (2003) and Kelly (2003).

Dechow, Sloan, and Sloiman (2004) consistent with Cornell (1999) and Campbell and Voulteenaho (2003) argue that low B/M (growth) stocks are long duration stocks and hence are more sensitive to expected returns shocks .This suggests that firms with low B/M ratio are expected to have higher exposure to shocks in economic growth than high B/M firms and vice versa. This expectation finds support in Bagella et al. (2000) finding in the UK that returns of value stock portfolios covariate less with GDP growth than those of glamour stock portfolios.

The goal of this paper is twofold. First, it links the Fama-French factors to shocks in the state variables in order to explore the information content of HML and SMB. Second, we compare the performance of a version of the ICAPM where the factors are shocks to state variables that predict future investment opportunities with both the Fama-French model and the Vassalou (2003) model.

Our study will not be restricted to discover the relationship between HML and SMB and alternative macroeconomic proxies in a simple time-series regressions, but also expanded to test the pricing performance of different asset pricing models constructed on the basis of these proxies in order to examine whether

alternative macroeconomic proxies of HML and SMB explain the cross-sectional variation in returns in the way the HML and SMB do.

The rest of the paper is organised as follows. Section 2 explores the data sample selection. Section 3 discusses the portfolios formation and how the shocks in the state variables are constructed. Section 4 explains the methodology of this study. Section 5 presents the descriptive statistics and contains the results form running different sets of cross-sectional regressions for different sets of testing portfolios. Section 6 summarises and concludes.

2. DATA SAMPLE

The sample covers all UK listed firms (live and dead) for the period from July 1980 to April 2003. For our empirical analysis we use annual accounting data from DataStream (book-to-market and market value data) as well as macroeconomic data. Monthly returns data have been extracted from the London Share Price Database (LSPD). The companies are matched between the two databases by their SEDOL number. Furthermore, we use the London Share Price Database Industrial classification (G17) and the FTSE Industrial Classification Benchmark (ICB) in our construction of the industry portfolios. We *include* in our sample companies that have been de-listed from the exchange due to merger or bankruptcy etc. We *exclude* companies with more than one class of ordinary share, companies with negative book-to-market, and companies that belong to the financial sector (banks, insurance companies, investment funds, unit trusts and property companies).

The proceeds from a delisted stock are distributed among other stocks in the portfolio on the basis of their weights. Moreover, we correct for the delisting bias of Shumway (1997) by adjusting the delisting returns to -100 percent whenever the LSPD death type is liquidation (7), quotation cancelled for reason unknown (14), receiver appointed/liquidation (16), in administration (20), or cancelled and assumed valueless (21). The return on the market portfolio is proxied by the value-weighted return on the financial time all share index while

the yield on three month Treasury bill is used as a proxy for risk-free rate. The distribution of firms across the years is described in Appendix, Table A.

3. PORTFOLIO FORMATION

3.1 Construction of risk factors

Michou, Mouselli and Stark (2007) review different methods used to construct Fama-French factors HML and SMB in the UK. They show that the mainstream of these methods have attempted to apply the letter or the spirit of the Fama and French (1993) methods to the UK situation, with some attempts at adaptation to the differences between the UK and US stock markets.

We follow Gregory, Harris and Michou (2001, 2003), to construct Fama and French factors. That is, at the end of June each year *t* from 1980 to 2003, stocks are allocated to two groups small (S) or big (B) on the basis of the median of the largest 350 firms. Stocks are also allocated in an independent sort to three book to market groups, low (L), medium (M) or high (H), according to the breakpoints of the bottom 30%, middle 40% and top 30% of the values of BM recorded for the largest 350 firms at the end of year *t-1* .Therefore, six size-BM portfolios (S/L, S/M, S/H, B/L, B/M, B/H) are constructed as the intersections of the two size and three BM groups. Then, we calculate the value weighted monthly returns for the six intersected portfolios.

The return on the size factor (SMB) is defined as the monthly difference between the average of the returns on the three small size portfolios (S/L, S/M, S/H) and the average of the returns on the three big size portfolios (B/L,B/M,B/H). However, the return on the book-to-market factor is calculated as the difference between the average of the returns on the two high BM portfolios (B/H,S/H) and the average of the returns on the two low BM portfolios (B/L,S/L).

3.2 Construction of the 16 size-BM intersected portfolios

We construct two sets of testing portfolios to explore the information content of Fama-French factors. The first set is based on sorting stocks by size and the BM ratio. The second set is based on industry sorts.

For the size-BM intersected portfolios, we independently sort stocks into quartiles based on size and the BM ratio at the end of June of each year *t* which results in 16 size-BM intersected portfolio[1]. For the size sort, firm size is measured as the number of stocks outstanding multiplied by the stock price at the end of June. The BM ratio for every stock is measured as the book value of the firm at the end of December of year *t-1* (the equity capital and reserves minus total intangibles) divided by the market value of the firm at the end of December of year *t-1*.

The intersection of these size and BM independent sorts gives us sixteen portfolios each year. For these sixteen portfolios, we then calculate value-weighted returns on the assumption that the portfolios are bought and held for a year. Repeating this process, year by year, results in a time series of portfolio monthly returns from July 1980 to April 2003. The excess returns on these 16 portfolios are the dependent variables in the time-series regressions. Table B in Appendix provides descriptive statistics for the 16 size-BM sorted portfolios.

3.3 Construction of the 20 industry portfolios

We use the London Share Price Database industrial classification codes G17 and the FTSE Industrial Classification Benchmark (ICB) to construct twenty industry portfolios every month from July 1980 to April 2003. We estimate value-weighted monthly returns for these portfolios. Summary statistics for the industry portfolios are reported in Appendix Table C. In constructing the 20 industry

[1] We use 16 instead of 25 size-BM intersected portfolios, despite the fact that explaining the excess returns on the 25 Fama-French testing portfolios continues to be the basic approach in US empirical finance studies, for two reasons. The first reason is the desire to maintain a reasonably large number of firms in each portfolio. It is well known that the number of stocks traded on the London Stock Exchange is lower than those traded on the NYSE, AMEX and NASDAQ. Hence, constructing 25 size-BM intersected portfolios for the UK sample potentially will result in a low number of stocks in some portfolios. Therefore, the average returns of these portfolios could be very sensitive to slight changes in their components. Second, our choice of constructing 16 size-BM sorted portfolios finds support from both Miles and Timmermann (1996) who construct 16 intersected size-BM portfolios to use as testing portfolios in their asset pricing tests.

portfolios, we apply the same criteria we previously used for the construction of the 16 size-BM intersected portfolios.

3.4 The Industrial Production (IP) growth mimicking portfolio

Vassalou (2003) constructs a mimicking portfolio of news related to future GDP growth following Lamont (2001). She regresses future GDP growth on eight base assets (the six size-BM portfolios, which are used to construct HML and SMB factors, in addition to term and default spreads) so the fitted value from the regression will contain the same information as the future GDP growth but this information is expressed now in terms of portfolio returns. In addition to those eight base assets, she adds in to the regression a set of control variables which includes a constant, the yield spread of long-term Treasury bonds minus the Treasury bill yield, the yield spread between long-term corporate bonds and long-term government bonds, the consumption wealth ratio, and the risk-free rate in order to filter the information in the mimicking portfolio so it captures only the innovations in future GDP growth.

In this study, however, we construct a mimicking portfolio for news related to industrial Production (IP) growth instead of GDP growth because GDP data is not available in the UK on a monthly basis in contrast to all the macroeconomic variables we employ. Andreou *et al*. (2000) point out that IP accounts for 26.6% of the UK's GDP in 1995 and 25.9% for the US in 1996.

We follow Vassalou (2003) in constructing a mimicking portfolio of news related to future IP growth by regressing IP growth on eight base assets and a set of control variables. The eight base assets consist of six stock portfolios constructed from the intersection of two MV and three BM portfolios in addition to two fixed-income portfolios which are the returns on default spread (DEFAULT) and term spread (TERM). DEFAULT is defined as the difference between the monthly return of the Financial Times fixed interest securities price index and the Financial Times government securities price index. TERM is the yield difference between a long term government bond and a short term government bond (one year government bond). The data source for TERM and

DEFAULT components is DataStream, apart from the yield on a one year government bond, which is obtained from the Bank of England website.

According to the UK literature on the macroeconomic factors that affect stock returns, our set of control variables includes inflation, unexpected inflation, real money supply, the difference between the yield on long term and three month Treasury bill rate (TERMY), the UK treasury bill rate, the Input Price Index (IPI), and oil prices. We define those control variables as follows:

a) **Real money supply** is the UK money supply M0 deflated by the Consumer Price Index (CPI);
b) **Termy** is the difference between the yield on long term and short term government interest rates. The long-term interest rate is approximated by the yield on the government long-term bond while the short-term interest rate is measured by the three month Treasury bill rate. Both interest rates are converted to their monthly equivalents to be comparable with stock returns;
c) **IPI** is the Input Price Index which refers to fuel and material purchased by manufacturing industries and not seasonally adjusted obtained from the Office for National Statistics;
d) **Oil Prices** is the monthly price of crude petroleum;
e) **Inflation** is the monthly percentage change in the Consumer Price Index;
f) **Unexpected inflation** is the difference between expected inflation and actual inflation measured by the percentage change in the CPI.

In order to construct expected inflation, we follow Brooks (2002) in fitting an ARMA model to the actual series and making a one-period (month) ahead forecast, then rolling the sample forward one period, and re-estimating the parameters, and making another one-step-ahead forecast, and so on. We use two information criteria, namely, the Akaike and Schwarz, in order to determine the order of the model that best captures the dynamic features of the data. We find that ARMA (2,1) produces the lowest values for both the Akaike and Schwarz information criteria -2.47453 and -2.34605 respectively. Moreover, we use static forecasts to construct our expected inflation series.
The regression model is of the form:

$$IP_{t,t+12} = \mathbf{cB_{t-1,t}} + \mathbf{kZ_{t-1,t-2}} + e_{t,t+12} \quad (1)$$

where:

$P_{t,t+12}$ is the annualised IP growth over the next twelve months;

$\mathbf{B_{t-1,t}}$ is a column vector of eight base assets returns – six of them are stock portfolios and two are fixed-income portfolios from the end of period *t-1* to the end of period *t*;

c is a row vector of portfolio weights;

$\mathbf{Z_{t-1,t-2}}$ is a vector of a constant and a set of control variables from the end of period t-2 to the end of period t-1;

k is a row vector of coefficients on control variables;

$e_{t,t+12}$ is the error term, assumed to be uncorrelated with both Bt-1,t and Zt-1,t-2.

The monthly return on the mimicking portfolio of news related to IP growth from the end of period *t-1* to the end of period *t* ($MFTRALL_{t-1,t}$) is then equal to:

$$MFTRALL_{t-1,t} = \hat{\mathbf{c}}\mathbf{B_{t-1,t}} \quad (2)$$

The results from regression (1) are reported in Table 1. It reports the coefficients on the base assets and control variables while the *t*-statistics are reported below the coefficients. The standard errors are corrected for heteroscedasticity and serial correlation up to five lags using the Newey-West (1987) estimator. The individual coefficient estimates of the base assets are hard to interpret because of multicollinearity among them. Moreover, the *t*-statistics for these coefficients reject the null hypothesis that they are individually significantly different from zero in almost all cases. However, the asymptotic *p*-value from the $\chi^2(8)$ test, which examines the hypothesis that the coefficients of the base assets are jointly zero, suggests that the eight base assets jointly contain some information about the future IP growth. This is consistent with Vassalou's (2003) findings for the

US where none of the base assets have coefficients that are significantly different from zero. The coefficients on the base assets are those that will be used in the construction of mimicking portfolio of news related to IP growth as explained above.

Among the control variables, the coefficient on past risk-free rate is positive and significantly different from zero while the coefficients on previous inflation rate, input price index and real money supply are negative but significantly different from zero. This suggests that those four control variables are significant in predicting future IP growth in the UK. Regarding the adjusted-R^2, we can see that is very close to Vassalou's adjusted-R^2 of 38.62%.

Table 01 The ability of size and BM portfolios to predict future IP growth

		Coefficient	t-statistics
Base assets	B/H	-0.0039	-0.0928
	B/M	-0.0717	-1.4734
	B/L	0.0393	0.8903
	S/H	0.0316	0.4288
	S/M	-0.0592	-0.6289
	S/L	0.1089	2.4215
	Def	-0.0788	-0.7528
	Term	5.1488	0.8242
Control variables	Constant	0.1775	2.8030
	Termy	5.3373	1.1089
	TB	4.1947	1.6509
	Inflation	-5.2341	-1.9868
	IPI	-0.0010	-2.5297
	Oil prices	0.0002	0.3579
	Real money	-0.0050	-2.4868
	Unexpected Inflation	-0.0655	-0.0203
Adj R^2		32.7980	
$\chi^2(8)$		29.7944	
p-value		0.0002	

Notes: The table reports the coefficients on the base assets and control variables as well as their t-statistics (reported below the coefficients) and they are corrected for heteroscedasticity and serial correlation, using the Newey-West (1987) estimator with five lags. The base assets include six equity portfolios with different book-to-market (BM) and size (MV) characteristics as well as the return on long-term government bonds minus the return on short term government bonds (Term) and the default spread measured as the difference between the monthly logarithmic returns of the Financial Times fixed interest securities price index and the Financial Times government securities price index. The returns of the six equity portfolios are in excess of the riskless rate. B stands for big MV whereas S stands for small MV. Similarly, H, M, and L denote high, medium, and low B/M respectively. The set of control variables includes a constant, the yield spread of long term government bonds minus the treasury bill yield (TERMY), the risk-free rate (TB), inflation, oil prices, real money supply, unexpected inflation, IPI. The variables TERMY, INFLATION, IPI, oil prices, real money, and unexpected inflation are lagged by one period. The dependent variable is the annualised IP growth over the next twelve months. The regressions use monthly data, and the returns are simple. The chi-square test examines the hypothesis that the coefficients of the base assets are jointly zero. The sample period is from July 1980 to April 2003.

3.5 VAR estimation to construct shock in state variables

To generate shocks in the state variables, care should be taken in the specification of models that are used to provide conditional expectations of the variables concerned. However, relatively little attention has been paid to the econometric modelling of the state variables to derive shocks in the series. For instance, Chan, Chen and Hsieh (1985) and Chen *et al*. (1986) construct the shocks as the changes in, or the rates of growth, of the variables, despite the Chen *et al*. (1986) initial suggestion that a vector autoregressive (VAR) model might be more appropriate.

Brooks (2002) points out that one advantage of using VAR models to extract shocks to the state variable is that it is more flexible than univariate autoregressive (AR) models. The VAR model allows the value of a variable to depend not only on its own lags but on the lags on other variables in the system. Therefore, the VAR model offers a rich structure which enables it to capture more features of the data.

Campbell (1996) extends the application of VAR systems to asset pricing tests. He argues that the variables that enter the vector of state variables, $\mathbf{z}_t$, play a double role in the empirical work. First, these variables are forecasting variables known for their ability to predict stock returns. Second, shocks to these state variables are factors in cross-sectional asset pricing tests. The UK literature on the relation between stock returns and macroeconomic variables confirms that the first role of the forecasting variables is valid in the UK for the risk-free rate (Beenstock and Chan, 1988), default risk (Clare and Thomas, 1994) and term spread risk (Poon and Taylor, 1991), while the second role is what we test.

Campbell (1996) assumes that the vector $\mathbf{z}_t$ follow a first-order VAR:

$$\mathbf{z}_{t+1} = \mathbf{A}\mathbf{z}_t + \mathbf{u}_{t+1} \tag{3}$$

Campbell and Shiller (1988) argue that the first-order VAR is not restrictive since a higher-order VAR model can always be stacked into first-order form. Moreover, Campbell (1996) argues that first-order VAR has the desirable property of generating simple multi-period forecasts of the elements in $\mathbf{z}_t$ by just multiplying $\mathbf{z}_t$ by the $j+1$ power of the matrix **A**:

$$E_t \mathbf{z}_{t+j+1} = \mathbf{A}^{j+1} \mathbf{z}_t \tag{4}$$

The first element of the vector **z** is the excess return on the market while the other elements are term spread (*TERM*), default spread (*DEF*), the risk-free rate (R_f), *HML* and *SMB*, respectively. All these variables are required to be stationary. Hence, all variables are subjected to the augmented Dickey-Fuller (ADF) test. If a unit root is detected in any of the previous variables, then the first difference of this variable will be used in subsequent analysis. Hence, equation (4) can be re-written as:

$$\begin{bmatrix} R_{M,t} \\ Term_t \\ Def_t \\ R_{f\,t} \\ HML_t \\ SMB_t \end{bmatrix} = \mathbf{A} \begin{bmatrix} R_{M,t-1} \\ Term_{t-1} \\ Def_{t-1} \\ R_{f\,t-1} \\ HML_{t-1} \\ SMB_{t-1} \end{bmatrix} + \mathbf{u}_t \tag{5}$$

Brooks (2002) defines a stationary series as one with a constant mean, constant variance and constant autocovariances for each given lag. The concept of stationarity is important because the use of non-stationary data can lead to a spurious regression. In other words, the end result of a regression of two non-stationary variables regressed on each other might look good (significant coefficient estimates and high R^2), but is really misleading as both variables could be totally unrelated. Therefore, all variables in the VAR model are required to be stationary.

One way to test whether a series y is stationary is by performing an ADF test, usually referred to as a unit root test. The basic objective of the test is to examine the null hypothesis that $\psi = 0$ from the following equation where p is the number of lags and υ is the error term;

$$\Delta y_t = c + \psi y_{t-1} + \sum_{i=1}^{P} \lambda_i \Delta y_{t-1} + \upsilon_t \quad (6)$$

Hence, all variables are subjected to an ADF test with twelve lags of the dependent variable in a regression equation (6) on the raw data series of the above mentioned six variables. If the test statistic exceeds the critical value, the null hypothesis of a unit root in the series is rejected. In contrast, if the test statistic does not exceed the critical value, the null hypothesis of a unit root in the series cannot be rejected. The value of the test statistics and the relevant critical values from the DF tables are presented in Table 2.

Table 02 ADF test statistics for variables in the VAR system

Variable	Augmented Dickey-Fuller Test statistic
Excess market return	-3.929156
Term Spread	-2.373685
Default Spread	-4.379773
Risk-free rate	-1.719578
SMB	-4.146458
HML	-4.007449

Dickey-Fuller critical values are:-3.4563 for 1%,-2.8724 for 5%, and -2.5725 for 10%.

It can be noticed from Table 2 that the ADF test statistic is more negative than the critical values (at any level) for all the variables apart from term spread and risk-free rate. Hence, the null hypothesis of a unit root in term spread and risk-free rate cannot be rejected. However, the null hypothesis of a unit root is rejected for the remaining variables.

If the null hypothesis of a unit root cannot be rejected in any of the tested variables, then the first difference of this variable is taken and tested again for a unit root. Hence, we take the first difference of the variables with a unit root, namely, term spread and risk-free rate, and apply the ADF test for the new series.

The augmented Dickey-Fuller test statistics for the new series are -6.979764 and -7.446724 respectively. The null hypothesis of a unit root in the new series (i.e. the first difference of the term spread (DTERM) and the first difference of the risk-free rate (DRF)) is therefore rejected.

We estimate equation (3) where the elements of **z** are now the excess return on the market, the first difference in term spread (DTERM), default spread (DEF), the first difference in risk-free rate (DRF), HML and SMB, respectively. Next, we save the residuals corresponding to DTERM, DEF and DRF from running this VAR system and denote them as u^{Term}, u^{Def} and u^{Rf} respectively. These shocks are possible risk factors in addition to the excess return of the market portfolio, HML and SMB.

4. Research Design

4.1 Relationship between HML and SMB and shocks to state variables

As the first step in testing whether the HML and SMB factor contain information about shocks to state variables, we calculate the correlation coefficients between HML and SMB and news related to future IP growth (*MFTRALL*), shocks to the term spread (u^{Term}), shocks to the default spread (u^{Def}), and shocks to risk-free rate (u^{Rf}).

In the next step we examine the joint distribution of HML and SMB and the *MFTRALL*, u^{Term}, u^{Def}, and u^{Rf}. Therefore, we run the following two time-series regressions:

$$HML_t = c_0 + c_1(R_{mt} - R_{ft}) + c_2 MFTRALL_t + c_3 u_t^{Term} + c_4 u_t^{Def} + c_5 u_t^{Rf} + \varepsilon_{HMLt} \quad (7)$$

Where:

c_0	is the constant term;
c_1, c_2, c_3, c_4, and c_5	is the covariance of HML with $(R_m - R_f)$, *MFTRALL*, u^{Term}, u^{Def}, and u^{Rf} respectively;

ε_{HMLt} is the error term at time t.

and,

$$SMB_t = d_0 + d_1(R_{mt} - R_{ft}) + d_2 MFTRALL_t + d_3 u_t^{Term} + d_4 u_t^{Def} + d_5 u_t^{Rf} + \varepsilon_{SMBt} \quad (8)$$

Where:

d_0 is the constant term;

d_1, d_2, d_3, d_4, and d_5 is the covariance of HML with $(R_m - R_f), MFTRALL$, u^{Term}, u^{Def}, and u^{Rf} respectively;

ε_{SMBt} is the error term at time t.

If HML factor covaries significantly (whether positively or negatively) with any of the above mentioned shocks to state variables, then we can argue that HML factor may contain information about shocks to this state variables. However, if the covariance of HML factor with any of the above mentioned shocks to state variables is insignificantly distinguishable from zero, then we can suggest that HML factor does not contain information about shocks to this state variable. The same argument applies for the SMB factor.

4.2 Asset pricing specification

The CAPM relates the expected return on any asset to its market risk only. Hence, it abstracts from potential changes in the investment opportunities set over time and therefore implicitly assumes that mean-variance efficiency is a time-invariant concept. In response to this critique, Merton (1973) develops an intertemporal version of the CAPM (ICAPM) to incorporate a dynamic structure into the CAPM.

In the ICAPM, investors not only dislike uncertainty about future wealth as in the CAPM, but also dislike uncertainty over future investment opportunities (Fama, 1996). Therefore, investors should be compensated for holding risk linked with the market and for holding risk associated with potential changes of

the investment opportunities set which, in turn, could arise due to changes of some state variables. Fama (1996) also restates this in terms of algebra. He argues that, in the ICAPM, investors aim to minimise the variance of their investment portfolio not only subject to obtaining a desired portfolio expected return and constrained by the asset weights adding to one (as in the CAPM) but also subject to achieving desired betas against S state-variable mimicking portfolios.

Merton (1973) derives an asset pricing formula where the expected excess returns on an individual asset over the risk-free rate depends not only on its correlation with the excess market return but also on its correlation with the excess return on an asset that proxies for intertemporal changes of the investment opportunities set. Likewise, Fama (1996) presents the ICAPM as a simple generalisation of the CAPM model by adding risk premiums for the sensitivities of R_i to the returns R_s, $s = 1,....,S$, on state variable mimicking portfolios:

$$E(R_i) - R_f = \beta_{iM}[E(R_M) - R_f] + \sum_{s=1}^{S} \beta_{is}[E(R_s) - R_f], \forall i \qquad (9)$$

where:

β_{is} is the exposure of portfolio *i* to the excess return on state variable mimicking portfolio *s*.

We assume that asset returns are governed by the discrete time version of the Merton (1973) ICAPM, whereas the shocks in state variables, which are risk factors in the ICAPM, come from a vector autoregressive (VAR) model. Campbell (1996) argues that this linkage has the desirable feature of not biasing the results towards detecting spurious patterns when linking time-series and cross-sectional findings. We assume the following return-generating process:

$$R_{it} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + \sum_{s=1}^{S} (\beta_{is}) u_t^S + \varepsilon_{it}, \ \forall i \qquad (10)$$

where:

u_t^S is the shock to state variable *s* for period *t*;

β_{is} is the exposure of portfolio *i* to the shock in the state variable *s*.

This equation is a form of equation (9) where the market factor and the shocks to the state variables are the relevant risk factors in the ICAPM. The shock is the unexpected component of the variable as only the unexpected part of the state variable should attract a risk premium.

Consequently, the betas from equation (10) will be the inputs in the following general cross-sectional model:

$$R_{it} - R_{ft} = \gamma_{it} + \gamma_{tM}\hat{\beta}_{iM} + \sum_{s=1}^{S}(\gamma_{ts})\hat{\beta}_{is} + \alpha_{it} \quad , \quad \forall t \tag{11}$$

where:

γ_{ts} is the risk premium for the shock to state variable *s* for period t

4.3 The competing asset pricing models

In order to understand the information content of the SMB and HML in a risk-based framework, we decided to compare the performance of the Fama-French model with two other asset pricing models – the Vassalou model and the Macroeconomic model. Each one of these models gives its own risk story for the empirical success of Fama-French model in the US. Then, we put all the possible risk factors together with the Fama-French factors in one model, called the All Factor model, and test the new model to find which factors retain their ability to explain returns. The main aim here is to compare the pricing performance of the first three models and to use the All Factor model to explore the incremental ability of different risk factors in explaining the cross-section of stock returns. We provide a brief description in the following sections of the asset pricing models which we test.

4.3.1 The Fama-French three factor model

Fama and French (1993) propose an asset pricing model which includes, apart from the market factor, a factor related to BM which they call high-minus-low (HML), and a factor related to size, and called small-minus-big (SMB). They

argue that their model does a good job in explaining average stock returns in the US. In a series of papers, Fama and French (1993, 1995, and 1996) argue that their factors, namely HML and SMB, act as state variables in the context of Merton's (1973) ICAPM. If this is true, then these factors should capture information about fundamental risk in the economy which affects the investment opportunity set.

4.3.2 The Vassalou model

Vassalou (2003) finds that a factor capturing news related to future gross domestic product (GDP) is an important factor in explaining the cross-section of returns of portfolios sorted on size and BM ratio. She points out that a model which includes this factor along with the market factor has explanatory power about as high as the Fama-French model. Moreover, she claims that the HML and SMB factors mainly contain information related to future GDP growth. Furthermore, she shows that the HML and SMB factors lose most of their explanatory power in the presence of the GDP news-related factor. This result provides an economic interpretation for the empirical success of HML and SMB in explaining the cross-section of asset returns.

4.3.3 The Macroeconomic model

Petkova (2006) proposes an asset pricing model that includes, in addition to the market factor, shocks to the aggregate dividend yield, shocks to the term spread, shocks to the default spread, and shocks to the risk-free rate. She shows that this model works better than the Fama-French model in explaining average returns of portfolios sorted on size and BM ratio. Furthermore, she argues that changes in the investment opportunity set are not only due to news related to future GDP growth. Moreover, Campbell (1996) indicates that the empirical implementation of the ICAPM model should not be based on choosing important macroeconomic variables. Instead, the factors in the ICAPM should be related to shocks in state variables that predict future investment opportunities. Therefore, Petkova (2006) concentrates on state variables that are found to work as proxies for changes in the investment opportunity set in the cross-sectional asset-pricing literature.

Merton (1973) argues that the changing nature of the interest rate is the prime example against the constant investment opportunities concept. Moreover, Long (1974) states that the yield curve is a relevant part of the investment opportunity set in an economy with a bond market. Litterman and Scheinkman (1991) confirm that the main drivers of the term structure of interest rates are its level and its slope. Therefore, we use the risk-free rate and term spread to capture variation in the yield curve.

Hahn and Lee (2006) argue that shifts in investment opportunity set come also from time-varying risk premia. Jagannathan and Wang (1996) use variations in the default spread as a proxy for time-varying risk premia. Therefore, the default spread is employed to capture the hedging concerns of investors related to variations in risk premia.

Another relevant part of the investment opportunity set that faces investors in the ICAPM is the conditional distribution of asset returns. Many papers confirm that the first moment of asset returns varies over time and suggest proxies for the variation in average returns. Fama and Schwert (1977) show that excess market returns move through time and document that the Treasury bill rate (as a proxy for expected inflation) has explanatory power over the excess market return. Campbell (1987) confirms the time-varying nature of average excess returns on the market and argues that the term structure of interest rate forecasts the market return. Moreover, Fama and French (1989) show that the variation in stock returns can be explained by both the default spread and term spread.

4.3.4 The All Factor model

The All Factor model corresponds to one where all possible risk factors are included. Using this model will enable us to understand the incremental ability of different risk factors in explaining the cross-section of stock returns. Moreover, it shows whether any of these factors will become insignificant in the presence of other factors.

4.4 The empirical methodology for testing asset pricing models

We use the Fama-MacBeth approach to examine and compare the cross-sectional explanatory power of the Fama-French model to three other different models, namely, the Vassalou model, the Macroeconomic model and the All Factor model.

4.4.1 Time series analysis

We report the time-series estimates of the factor loadings computed in the following first-pass time-series regressions corresponding to the Vassalou model, the Fama-French model, the Macroeconomic model, and the All Factor model respectively.

$$R_{it} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{iMFTRALL} MFTRALL_t + \varepsilon_{it}, \forall i \qquad (12)$$

which corresponds to the Vassalou model where:

$MFTRALL_t$	is the return on a mimicking portfolio for news related to industrial production growth for period *t*;
$\beta_{iMFTRALL}$	is the exposure of portfolio *i* to *MFTRALL*;

and

$$R_{it} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{iHML} HML_t + \beta_{iSMB} SMB_t + \varepsilon_{it}, \forall i \qquad (13)$$

which corresponds to the Fama-French model where:

a_i	is the intercept term for portfolio i;
β_{iM}, β_{iHML}, and β_{iSMB}	are the exposures of portfolio i to R_M, *HML*, and *SMB* respectively;
ε_{it}	is an error term for portfolio i for period t.

and

$$R_{it} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{iMFTRALL} MFTRALL_t + \beta_{iDef} u_t^{Def} +$$
$$+ \beta_{iTerm} u_t^{Term} + \beta_{iR_f} u_t^{R_F} + \varepsilon_{it}, \forall i \quad (14)$$

which corresponds to the Macroeconomic model where:

u_t^{Term} is the shock to the term spread for period *t*;

u_t^{Def} is the shock to default spread for period *t*;

$u_t^{R_F}$ is the shock to risk-free rate for period *t*;

$\beta_{iTerm}, \beta_{iDef}$,and β_{iR_f} are the exposures of portfolio *i* to u^{Term}, u^{Def}, and u^{R_F} respectively;

and

$$R_{it} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{iHML} HML_t + \beta_{iSMB} SMB_t + \beta_{iTerm} u_t^{Term} +$$
$$\beta_{iDef} u_t^{Def} + \beta_{iR_f} u_t^{R_F} + \beta_{iMFTRALL} MFTRALL_t + \varepsilon_{it}, \forall i \quad (15)$$

which corresponds to the All Factor model.

Bearing in mind that shocks to state variables are not portfolio excess returns because they are constructed from VAR model, the sample means of these shocks do not correspond to their estimated risk premia. Hence, the pricing error of the model for a given portfolio could not be represented by the intercept in the time-series regression. Therefore, Cochrane (2001) argues that the typical test of the intercept being jointly zero, like the GRS *F*-test, is not strictly applicable in this case.

In order to show which risk factors are relevant on the basis that the testing assets are loading significantly on them, we present the joint test of the significance of the corresponding loadings, computed from the SUR model. Kan and Zhang

(1999) argue that testing the joint significance of the assets' factor loadings is an important step in detecting useless risk factors.

4.4.2 Cross-sectional analysis

The resulting estimates of betas from equations (12) are used as the independent variables in cross-sectional regressions, one regression for every month, with portfolios excess returns being the dependent variables,

$$R_{it} - R_{ft} = \gamma_{it} + \gamma_{tM}\hat{\beta}_{iM} + \gamma_{tMFTRALL}\hat{\beta}_{iMFTRALL} + \alpha_{it}, \forall t \quad (16)$$

where:

γ_{it} is the risk premium of zero-beta portfolio for period *t*;

γ_{tM} is the risk premium of the market factor for period *t*;

$\gamma_{tMFTRALL}$ is the risk premium of *MFTRALL* for period *t*;

The resulting estimates of betas from equation (13) are then used as the independent variables in cross-sectional regressions, one regression for every month, with portfolios excess returns being the dependent variables,

$$R_{it} - R_{ft} = \gamma_{it} + \gamma_{tM}\hat{\beta}_{iM} + \gamma_{tHML}\hat{\beta}_{iHML} + \gamma_{tSMB}\hat{\beta}_{iSMB} + \alpha_{it}, \forall t \quad (17)$$

where:

γ_{it} is the zero-beta risk premium of portfolio i for period t;

$\gamma_{tM}, \gamma_{tHML}, \gamma_{tSMB}$ is the risk premium on the market factor, *HML*, and *SMB* respectively of portfolio i for period t;

α_{it} is the pricing error of portfolio i for period t;

Similarly, the resulting estimates of betas from (14) are used as the independent variables in cross-sectional regressions, one regression for every month, with portfolios excess returns being the dependent variables,

$$R_{it} - R_{ft} = \gamma_{t0} + \gamma_{tM}\hat{\beta}_{im} + \gamma_{tMFTRALL}\hat{\beta}_{iMFTRALL} + \gamma_{tTerm}\hat{\beta}_{Term} + +\gamma_{tDef}\hat{\beta}_{Def} +$$
$$\gamma_{tR_f}\hat{\beta}_{iR_f} + \alpha_{it}, \forall t \qquad (18)$$

Where:

γ_{Term}, γ_{Def} and γ_{R_f} is the risk premium of u^{Term}, u^{Def}, and u^{R_F} respectively for period *t*;

Finally, the resulting estimates of betas from (15) are used as the independent variables in cross-sectional regressions, one regression for every month, with portfolios excess returns being the dependent variables,

$$R_{it} - R_{ft} = \gamma_{t0} + \gamma_{tM}\hat{\beta}_{iM} + \gamma_{tSMB}\hat{\beta}_{iSMB} + \gamma_{tHML}\hat{\beta}_{iHML} + \gamma_{tMFTRALL}\hat{\beta}_{iMFTRALL} +$$
$$\gamma_{tTerm}\hat{\beta}_{Term} + \gamma_{tDef}\hat{\beta}_{iDef} + \gamma_{tR_f}\hat{\beta}_{iR_f} + \alpha_{it}, \forall t \qquad (19)$$

For each model, the time-series and the cross-sectional steps are then repeated each month in the sample, providing for each variable a time series of its associated risk premium. The time series averages of these estimates are then tested by a *t*-test for significant differences from zero. We report both adjusted and unadjusted cross-sectional t-statistics to address Shanken (1992) and Jagannathan and Wang (1998) concerns regarding the precision of the Fama-MacBeth standard errors. Moreover, we use the cross-sectional R^2 measure employed by Jagannathan and Wang (1996) to compare the goodness-of-fit of the competing asset pricing models and the asymptotic chi-square test in order to check if the pricing errors from each model are jointly zero.

Finally, Lewellen *et al*. (2006) argue that the risk premium for any factor portfolio (not shocks) obtained from the cross-sectional regressions should be its expected excess return. Therefore, we compare and contrast the performance of these different models not only on the basis of cross-sectional adjusted R^2 or χ^2 tests but also on the basis of whether the estimated risk premia are reasonable.

5. RESULTS

5.1 Descriptive statistics

Table 3 provides summary statistics for the potential risk factors, namely, excess market return, HML, SMB, news related to future IP growth (*MFTRALL*), shocks to the term spread (u^{Term}), shocks to the default spread (u^{Def}), and shocks to risk-free rate (u^{Rf}). The *t*-statistics, corrected for heteroscedasticity and serial correlation using the Newey-West (1987) estimator indicates the significance of only two risk factors, the excess market return and HML.

The correlation coefficients between the examined risk factors are presented in Table 4. It can be noticed that the correlations between HML and SMB factors and excess market return are in fact low (–11.78% and –11.24% respectively) and only significantly different from zero at 10% level of significance. Therefore, we can use these factors together in one model without having much multicollinearity concerns.

Table 3 Summary Statistics for the Risk Factors

	R_m-R_f	*HML*	*SMB*	*MFTRALL*	u^{Term}	u^{Def}	u^{Rf}
Mean	0.004972	0.00639	-0.0012	0.00064	-2.76E-20	3.25E-19	-9.72E-21
Median	0.009105	0.00554	-0.0024	0.00169	-1.43E-06	0.00021	-6.11E-06
Maximum	0.132757	0.17745	0.11514	0.0184	0.001161	0.02667	0.001969
Minimum	-0.27057	-0.1577	-0.1252	-0.0198	-0.00097	-0.0308	-0.00134
Std. Dev.	0.048269	0.03254	0.03007	0.00753	0.0003	0.00945	0.000413
Skewness	-1.0457	0.30783	-0.0109	-0.3785	0.169051	-0.171	0.882693
Kurtosis	6.788899	9.42972	4.32706	2.53193	4.4734	3.63076	7.773552
T-statistics	1.87**	2.23*	-0.68	0.71	0.00	0.00	0.00
Observations	274	274	274	274	274	274	274

Note: the sample period is from July 1980 to April 2003 and the t-statistics are corrected for heteroscedasticity and serial correlation, using the Newey-West (1987) estimator with four lags.

***** implies the mean factor return is significantly different from zero at the 5% level of significance, using a two-tailed test.

** implies the mean factor return is significantly different from zero at the 10% level of significance, using a two-tailed test.

Table 4 Correlations Matrix between the Risk Factors

	R_m-R_f	*HML*	*SMB*	*MFTRALL*	u^{Term}	u^{Def}	u^{Rf}
R_m-R_f	1.000000	-0.1178**	-0.1124**	0.32629	0.01743	0.03918	-0.2275*
HML		1.000000	-0.1185**	-0.3699*	0.00057	0.05654	-0.0199
SMB			1.000000	0.43182*	0.08352	0.17083*	-0.0102
MFTRALL				1.000000	0.14812*	0.01524	-0.1104**
u^{Term}					1.000000	-0.0774	-0.2705*
u^{Def}						1.000000	0.20628*
u^{Rf}							1.000000

***** implies the correlation coefficient is significantly different from zero at the 5% level of significance, using a two-tailed test.

** implies the correlation coefficient is significantly different from zero at the 10% level of significance, using a two-tailed test.

5.2 Relationship between HML and SMB and shocks to state variable

In this section, we present the results from running the time-series regressions of equations (7) and (8) of SMB and HML on the excess return of the market factor, an industrial production growth mimicking portfolio, shocks to the term spread, shocks to the default spread, and shocks to the risk-free rate. The *t*-statistics are below the coefficients and they are corrected for heteroscedasticity and serial correlation, using the Newey-West (1987) estimator with four lags. The adjusted R-squared is reported in percentage form, and the sample period is from July 1980 to April 2003. We compute shocks to the state variables in a VAR system, as explained in section 3.5.

As can be noticed from Table 5, the return on HML factor covaries negatively and significantly with news related to future IP growth with t-statistic equal to -3.11. This result is consistent with the findings of Cornell (1999) and Dechow *et al*.(2004), which suggest that firms with a low BM ratio are expected to have higher exposure to shocks in economic growth than high BM firms, and *vice versa*. Moreover, it is consistent with the Bagella *et al*. (2000) result for the UK that returns of value stock portfolios covary less with GDP growth than those of glamour stock portfolios. However, HML covaries positively and significantly with shocks to default spread with coefficient of 0.28 and t-statistic of 2.18. This last result contradicts the Fama and French (1992b) argument that firms with high BM ratios (with persistently poor earnings) are hit more heavily by the change in the default risk than firms with low BM ratios. Moreover, neither shocks to the term spread nor shocks to the risk-free rate are significant factors for the variation in HML.

The return on SMB covaries positively and significantly with news related to future IP growth with a coefficient of 2.08 and *t*-statistic of 6.98. This result confirms the Levis and Kalliontzi (1993) evidence for the UK, and the evidence provided by Liew and Vassalou (2000), Vassalou (2003) and Kelly (2003) that small firms tend to underperform in economic contractions and outperform during periods of economic expansions. Moreover, the return on SMB covaries positively and significantly with shocks to the default spread (a coefficient of 0.60 and t-statistic of 3.12), which contradicts the Perez-Quiros and

Timmermann (2000) and Hahn and Lee (2006) evidence for the US of the negative association between shocks to default spread and contemporaneous returns on SMB. Again, neither shocks to term spread nor shocks to risk-free rate are significant factors for the variation in SMB.

Table 5 Time-Series Regressions Showing the Contemporaneous Relations between the HML and SMB Factors and Shocks in State Variables

$$HML_t = c_0 + c_1(R_{mt} - R_{ft}) + c_2 MFTRALL_t + c_3 u_t^{Term} + c_4 u_t^{Def} + c_5 u_t^{Rf} + \varepsilon_{HMLt}$$
$$SMB_t = d_0 + d_1(R_{mt} - R_{ft}) + d_2 MFTRALL_t + d_3 u_t^{Term} + d_4 u_t^{Def} + d_5 u_t^{Rf} + \varepsilon_{SMBt}$$

Dep. Variable	c_0	c_1	c_2	c_3	c_4	c_5	*Adj.* R^2
HML	0.01	-0.01	-1.64	4.85	0.28	-5.48	13.25
	2.66	-0.23	-3.11	0.75	2.18	-1.46	
	d_0	d_1	d_2	d_3	d_4	d_5	*Adj.* R^2
SMB	0.00	-0.19	2.08	1.08	0.60	-4.20	27.90
	-0.87	-5.81	6.98	0.25	3.12	-1.1	

This table presents time-series regressions of SMB and HML on shocks to the excess return on the market factor, industrial production growth mimicking portfolio, and shocks to the term spread, the default spread, the three-months T-bills. Shocks to the state variables are computed in a VAR system. The t-statistics are below the coefficients and they are corrected for heteroscedasticity and serial correlation, using the Newey-West (1987) estimator with four lags. The adjusted R-squared is reported in percentage form. The sample period is from July 1980 to April 2003.

5.3 Asset Pricing Tests

5.3.1 Time-series regressions

In this section, we present estimates of the loadings, and their associated t-statistics, estimated in the first-pass time series regressions (12), (13), (14), and (15) of the excess returns on the sixteen portfolios sorted on size and BM on the four different asset pricing models. We also report joint tests of the significance of the corresponding loadings, computed from a SUR system. We do this in order to show which risk factors are relevant in the sense that the 16 portfolios load significantly on them.

As pointed out in section 4.4.1, Kan and Zhang (1999) suggest testing whether the loadings of the portfolios with respect to a particular factor are jointly significantly different from zero in the first-pass time-series regression before

running the second pass cross-section regression. If the loadings on a certain factor are not jointly significant, then this factor would be a good candidate for a useless factor (Jagannathan and Wang, 1998).

Panel A in Table 6 presents results for the Vassalou model from July 1980 to April 2003. An F-test implies that the 16 loadings on shocks to IP growth ($MFTRALL_t$) are jointly significant, with the corresponding p-value being less than 0.01%. Moreover, portfolios' loadings on $MFTRALL_t$ are inversely related to size. Within each size quartile, the loading decreases monotonically as one moves from smaller size quartiles to larger size quartiles.

Panel B of Table 6 presents results for the Fama-French model over the sample period. The loadings on both HML_t and SMB_t are jointly significant in the sense that the 16 portfolios load significantly on them. Moreover, the slopes on HML factor are systematically related to BM while slopes on SMB factor are systematically related to size.

Similarly, loadings on shocks to IP growth and shocks to term spread (u_t^{Term}) are jointly significant in Panel C of Table 6, with the corresponding *p*-values being less than 0.01%. However, the slopes on shocks to the default spread (u_t^{Def}) and shocks to the risk-free rate (u_t^{Rf}) are jointly insignificant with the corresponding p-values being 0.21% and 0.52% respectively.

It can be noticed that the time-series regressions with the shocks in the state variables (Panel C) produce adjusted R^2s that are smaller than the ones in the regressions with the Fama-French factors (Panel B). This might be attributed to an error-in-variable problem that is more severe in the case of the shocks terms. Hence, the result may be biased against finding significant factor loadings on the shocks to the state variables.

Panel D presents the loadings on the factors from the All factor model. Shocks to state variables show loadings that are jointly significant with the corresponding

p-values being less than 0.01% apart from shocks to default spread (u_t^{Def}) and shocks to risk-free rate (u_t^{Rf}). The loadings on u_t^{Def} and u_t^{Rf} are jointly insignificant with the corresponding *p*-values being 0.72% and 0.52% respectively.

To summarize, the time-series evidence from the 16 intersected size and BM portfolios suggests that shocks to IP growth and shocks to term spread, in addition to Fama and French's three factors, are useful factors in explaining the time-variation in portfolio returns.

Table 6 Loadings from Time-Series Regressions

Panel A: Loadings on the Vassalou Model Factors from Time-Series Regressions

	Low	2	3	High		Low	2	3	High	
	α					t_α				F
Small	0.15	0.30	0.49	1.04		0.31	0.75	1.65	3.68	6.89
2	-0.49	-0.26	-0.04	0.61		-1.42	-0.96	-0.14	2.21	< .01
3	-0.65	-0.06	0.15	0.51		-2.45	-0.28	0.65	1.80	
Big	-0.30	0.15	0.08	0.50		-2.00	1.20	0.46	2.19	
	β_M					t_β				F
Small	0.52	0.57	0.57	0.47		5.82	6.48	9.06	8.89	>100
2	0.65	0.65	0.65	0.65		11.95	11.88	11.81	13.8	< .01
3	0.82	0.78	0.76	0.79		17.62	18.38	14.86	14.82	
Big	0.96	1.00	0.98	1.04		29.83	39.71	29.04	21.81	
	$\beta_{MFTRALL}$					t_β				F
Small	3.65	2.56	2.31	1.85		5.18	4.37	5.94	4.97	10.52
2	3.25	2.22	1.85	1.71		6.77	6.28	5.21	4.41	< .01
3	3.17	1.63	1.28	1.10		6.78	5.14	3.53	2.50	
Big	0.81	-0.54	-0.44	0.01		3.87	-3.00	-1.50	0.01	
Adjusted R^2										
			Low	2		3	High			
Small			35.20	36.70		47.45	43.29			
2			54.93	57.07		57.17	51.28			
3			71.44	68.93		60.12	54.94			
Big			84.52	85.74		79.43	65.12			

Panel B: Loadings on the Fama-French Factors from Time-Series Regressions

	Low	2	3	High		Low	2	3	High	
	α					t_α				F
Small	0.68	0.52	0.63	1.01		1.51	1.47	2.69	5.15	5.70
2	-0.04	-0.05	-0.08	0.48		-0.18	-0.28	-0.56	3.07	< .01
3	-0.18	0.00	-0.02	0.24		-1.76	-0.04	-0.14	1.91	
Big	0.01	0.00	-0.26	0.17		0.15	0.02	-2.28	0.90	

	β_M					t_β				F
Small	0.76	0.77	0.76	0.65		10.75	10.98	12.59	12.61	>100
2	0.87	0.83	0.83	0.83		20.84	18.33	17.05	24.53	< .01
3	1.03	0.93	0.92	0.95		45.31	35.55	22.91	24.12	
Big	0.96	0.98	1.00	1.10		27.55	40.48	38.38	23.89	
	β_{HML}					t_β				F
Small	-0.40	-0.03	0.06	0.26		-2.41	-3.47	-8.26	-9.83	>100
2	-0.32	-0.06	0.29	0.40		-0.22	-0.82	3.08	3.59	< .01
3	-0.37	0.13	0.44	0.58		0.72	6.53	10.41	11.96	
Big	-0.43	0.18	0.48	0.52		4.53	6.68	11.48	8.64	
	β_{SMB}					t_β				F
Small	1.21	1.13	0.96	0.85		8.81	7.45	9.76	9.28	>100
2	1.20	0.96	0.91	0.91		19.40	12.49	16.05	14.35	< .01
3	1.06	0.89	0.88	0.88		21.76	21.88	15.11	16.92	
Big	-0.10	-0.08	0.01	0.24		-2.09	-1.73	0.29	4.00	
Adjusted R^2										
			Low	2		3	High			
Small			53.28	57.17		66.58	65.93			
2			80.24	78.08		80.56	75.62			
3			90.88	89.82		85.64	82.13			
Big			90.22	86.73		88.08	72.95			

Panel C: Loadings on the Macroeconomic Model Factors from Time-Series Regressions

	Low	2	3	High		Low	2	3	High	
	α					t_α				F
Small	0.17	0.28	0.52	1.05		0.35	0.72	1.76	3.80	6.79
2	-0.47	-0.25	-0.02	0.63		-1.39	-0.94	-0.06	2.30	< .01
3	-0.66	-0.04	0.18	0.54		-2.52	-0.23	0.77	1.94	
Big	-0.31	0.15	0.10	0.53		-2.11	1.22	0.55	2.29	
	β_M					t_β				F
Small	0.53	0.57	0.55	0.47		6.26	6.87	9.30	9.32	>100
2	0.65	0.65	0.64	0.65		12.97	12.94	12.79	13.78	< .01
3	0.81	0.77	0.74	0.77		18.12	18.96	14.91	14.93	
Big	0.97	1.00	0.98	1.03		28.24	41.14	27.95	20.47	
	$\beta_{MFTRALL}$					t_β				F
Small	3.70	2.60	2.40	1.85		5.29	4.54	6.07	5.13	10.54
2	3.30	2.19	1.84	1.70		6.87	6.23	5.40	4.43	< .01
3	3.14	1.56	1.22	1.06		6.80	5.09	3.50	2.51	
Big	0.80	-0.60	-0.46	-0.03		3.85	-3.37	-1.56	-0.07	
	β_{TERM}					t_β				F
Small	-3.49	-5.73	-14.45	0.78		-0.34	-0.71	-1.83	0.12	>100
2	-4.80	6.70	2.03	3.71		-0.54	1.01	0.32	0.53	< .01
3	0.89	9.36	6.17	4.34		0.15	1.94	0.93	0.51	
Big	2.13	7.85	3.83	4.04		0.56	1.86	0.76	0.68	
	$\beta_{DEFAULT}$					t_β				F
Small	0.42	0.90	0.81	0.67		1.26	2.59	2.70	2.41	1.27
2	0.84	0.67	0.59	0.61		3.13	2.60	2.47	2.10	0.21
3	0.51	0.44	0.68	0.70		2.40	2.19	2.96	2.83	
Big	-0.10	-0.01	0.09	0.17		-0.94	-0.07	0.73	0.97	

β_{RF}						t_{β}				F
Small	7.99	3.96	-6.52	-2.05		1.15	0.58	-1.17	-0.34	0.94
2	1.95	0.81	-2.45	0.82		0.36	0.15	-0.48	0.13	0.52
3	-3.34	-3.52	-8.12	-7.27		-0.76	-0.88	-1.57	-1.10	
Big	2.19	-3.15	-0.98	-6.62		0.63	-1.10	-0.28	-1.51	
Adjusted R^2										
			Low	2		3	High			
Small			53.28	38.45		49.65	44.65			
2			56.62	58.37		57.99	52.13			
3			71.61	69.45		61.41	56.04			
Big			84.43	85.90		79.34	65.02			

Panel D: Loadings on the All Factor Model Factors from Time-Series Regressions

	Low	2	3	High		Low	2	3	High	
	α					t_{α}				F
Small	0.62	0.45	0.59	0.93		1.35	1.22	2.46	4.85	5.3
2	-0.06	-0.07	-0.14	0.42		-0.25	-0.35	-0.90	2.80	< .01
3	-0.23	0.00	-0.03	0.22		-2.03	-0.02	-0.26	1.73	
Big	-0.03	0.02	-0.30	0.13		-0.29	0.15	-2.40	0.64	
	β_{M}					t_{β}				F
Small	0.74	0.77	0.72	0.61		10.52	12.02	11.53	10.87	>100
2	0.86	0.83	0.81	0.81		18.57	18.39	16.93	21.87	< .01
3	1.00	0.94	0.91	0.93		38.41	35.10	20.95	23.47	
Big	0.94	0.99	0.98	1.07		23.81	37.61	33.65	23.27	
	β_{HML}					t_{β}				F
Small	-0.35	0.01	0.09	0.31		-1.89	0.04	1.06	5.51	>100
2	-0.30	-0.04	0.34	0.45		-2.89	-0.57	6.41	7.84	< .01
3	-0.34	0.13	0.45	0.59		-7.01	3.18	10.10	11.91	
Big	-0.41	0.16	0.51	0.56		-9.45	3.16	13.26	8.33	
	β_{SMB}					t_{β}				F
Small	1.15	1.09	0.88	0.76		6.17	5.80	8.04	7.55	>100
2	1.14	0.93	0.85	0.84		14.77	10.22	14.05	13.79	< .01
3	1.01	0.90	0.85	0.84		18.81	20.11	12.72	14.68	
Big	-0.16	-0.06	-0.04	0.18		-2.92	-1.14	-0.69	2.95	
	$\beta_{MFTRALL}$					t_{β}				F
Small	0.74	0.35	0.72	0.78		1.28	0.75	2.60	2.55	2.20
2	0.42	0.17	0.63	0.69		1.39	0.73	3.03	2.79	0.00
3	0.49	-0.10	0.20	0.28		2.54	-0.71	1.10	1.23	
Big	0.46	-0.21	0.46	0.50		2.59	-1.12	2.41	1.58	
	β_{TERM}					t_{β}				F
Small	-3.03	-6.93	-15.86	-1.54		-0.33	-0.96	-2.39	-0.29	>100
2	-4.59	5.90	-0.52	0.64		-0.78	1.10	-0.11	0.13	< .01
3	1.46	7.74	3.07	0.58		0.43	2.60	0.78	0.10	
Big	4.28	7.11	1.38	1.15		1.33	2.00	0.41	0.22	
	$\beta_{DEFAULT}$					t_{β}				F
Small	-0.17	0.25	0.25	0.13		-0.54	0.89	1.25	0.70	0.77
2	0.23	0.13	-0.01	-0.02		1.81	0.72	-0.11	-0.11	0.72
3	0.00	-0.14	0.05	0.04		-0.02	-1.25	0.37	0.23	

Big	0.11	-0.02	-0.03	-0.10		1.22	-0.15	-0.28	-0.58	
β_{RF}						t_{β}				F
Small	10.89	8.56	-2.31	2.83		1.90	1.46	-0.53	0.56	0.94
2	5.11	4.48	2.96	6.79		1.40	0.91	0.83	1.48	0.52
3	-0.99	0.99	-2.09	-0.51		-0.31	0.40	-0.68	-0.10	
Big	-0.70	-2.50	1.68	-2.80		-0.25	-0.91	0.58	-0.70	
Adjusted R^2										
			Low	2		3	High			
Small			53.49	57.75		67.55	66.76			
2			80.77	78.30		80.90	76.06			
3			91.01	89.90		85.55	81.90			
Big			90.42	86.81		88.17	72.81			

Notes:

(i) This table reports the loadings from time-series regressions on 16 intersected portfolios sorted by size and BM.

(ii) The corresponding t-statistics are also reported and they are corrected for heteroscedasticity and serial correlation, using the Newey-West estimator with five lags.

(iii) The sample period is from July 1980 to April 2003.

(iv) The last column reports F-statistics, and their corresponding p-values, from a Seemingly Unrelated Regression (SUR), testing the joint significance of the loadings.

(v) The intercepts are in percentages.

5.3.2 Cross-sectional regressions

While the previous time-series regression results give a rough idea about which factors help to price assets in the sense that the 16 portfolios load significantly on them, they neither indicate whether the risk factors are themselves priced nor suggest which model performs better than the others in pricing the cross-section of the 16 intersected portfolios. Moreover, shocks to the term spread, the default spread and the risk-free rate are not portfolio excess returns, which implies that their sample means do not correspond to their estimated risk premium. Hence, the intercept computed in the time-series regression does not correspond to the pricing error of the model for a given portfolio (Hahn and Lee, 2006).

If the factors are not portfolio returns, one can estimate the factor risk premia using the Fama-MacBeth (1973) two-pass cross-sectional regression approach. Cochrane (2001) shows that the Fama-MacBeth procedure is practically the same as first-stage generalised method of moments (GMM) when the identity weighting matrix is used. Roll and Ross (1994) and Kandel and Stambaugh (1995) have advocated a type of second-stage GMM with the second-moment of matrix for returns as a weighting matrix.

However, Lettau and Ludvigson (2001) argue that the Fama-MacBeth method, or first stage GMM, is more appropriate than the second stage GMM where an estimated weighting matrix is used. This is because the testing portfolios, sorted according to size and BM ratio, are chosen to represent economically interesting characteristics. When an estimated weighting matrix is employed, testing portfolios will be linear combinations of original portfolios, which will be difficult to find an economical interpretation for and even involve implausible long and short positions in the original portfolios.

Therefore, we use the two stage Fama-MacBeth method to examine four different model specifications – the Vassalou model, the Fama-French model, the Macroeconomic model, and the All Factor model over the period July 1980 to April 2003, first with time-invariant betas and, second, with time-varying betas.

5.3.2.1 Cross-sectional estimation with time invariant-betas

Panels A, B, C and D of Table 7 contain the results of equations (16), (17), (18) and (19) from applying the second step of the Fama-MacBeth (1973) methodology using the excess returns on 16 portfolios sorted by size and BM. Since the dependent variables in the four cross-sectional regressions are excess returns, the intercept, γ_0, of each cross-sectional regression should be zero (Petkova, 2006). Further, Jagannathan and Wang (2007) argue that if the model is correctly specified, the intercept term should be zero because assets with zero betas should only earn the risk-free rate and in other words a risk premium of zero. This hypothesis is strongly rejected for all four models.

The estimates of the risk premium associated with news related to IP growth in both the Vassalou model and the Macroeconomic model of -0.36% and -0.43% respectively per month are significant, but well below the sample mean of 0.06%. It turns insignificant when the Fama-French factors are added in the All Factor model, but becomes closer to the sample mean.

Panels B and D reveal that the estimates of risk premium associated with HML are 0.78% and 0.72% respectively, which are significant and close to the sample

mean of 0.64%, even after correcting for sampling error. Consistent with the sample mean of SMB, the estimated risk premia related to SMB are negative and insignificantly different from zero in the cross-section of portfolio returns in both panels. Further, none of the premia on shocks to the state variables ($\gamma_{\hat{u}^{Term}}$, $\gamma_{\hat{u}^{Def}}$, $\gamma_{\hat{u}^{R_F}}$) seem to be important cross-section determinants of average returns. Under the error-in-variables correction, the *t*-statistics of the prices of risks related to term spread, default spread and the risk-free rate shocks are not individually significant.

The adjusted R^2 measure suggests that the Fama-French model provides the best fit with an adjusted R^2 equal to 66.15%. However, the χ^2 statistic for the Fama-French model, which tests the null hypothesis that the pricing errors from the model are jointly zero, has a p-value of < .01, suggesting the null hypothesis has to be rejected. The adjusted R^2 from the All Factor model is -58.11%, which means that there is more variation in the average residuals than in the average excess returns. The χ^2 statistics for the three remaining models are also large enough to reject the null hypothesis that the pricing errors from the model are equal to zero at any level of significance. Essentially, the cross-sectional results do not support any model with respect to pricing errors.

The four models in Table 7 show that the market beta is an important factor in the cross-section of returns, although the estimate of the market risk premium tends to be negative and far from the sample's mean excess return on the market portfolio of 0.49% per month. These negative estimates of the market risk premium are consistent with Fama and French (1992), Jagannathan and Wang (1996), and Lettau and Ludvigson (2001), using monthly or quarterly data. However, Jagannathan and Wang (2007) argue that the negative sign on the estimated market risk premium and the large intercept term in the cross-sectional regression is due to the near-multicollinearity between the vector of ones and the vector of stock market betas induced by the sixteen market betas being nearly the same. Hence, we re-estimate the competing models with the intercept term restricted to zero.

Table 8 shows the estimation of the risk premium associated with different risk factors when the intercept, γ_0, is restricted to zero. Consistent with the Jagannathan and Wang (2007) conjecture, the estimated risk premia on the market factor in all Panels in Table 8 is positive and close to the sample mean excess return on the market portfolio, although only significant in Vassalou's model. Panels A, C and D in Table 8 show that the risk premium associated with news related to IP growth is now insignificant when it is included in any asset pricing specification.

Panels B and D in Table 8 reveal that the risk premium associated with HML remains a positive and significant factor in the cross-section of the 16 portfolios after restricting the intercept, γ_0, to be zero. The risk premium related to SMB factor remains insignificant in the cross-section of portfolio returns in both panels. However, surprisingly, the premium on shocks to the default spread in Panel C is now positive and significant, but loses its significance when the Fama-French factors are added in Panel D. This last result suggests that HML subsumes the default shock factor and subsequently contains information about default risk, consistent with the Vassalou and Xing (2004) finding that HML contains some default-related information.

The adjusted R^2 measure in Table 8 still favours the Fama-French model, with an adjusted R^2 equalling 29.26%, relative to the other three models. However, the χ^2 statistic for the Fama-French model has a p-value of < .01, suggesting the null hypothesis of zero pricing errors has to be rejected. Moreover, the χ^2 statistics for the three remaining models are also large enough to reject the null hypothesis that the pricing errors from the model are equal to zero at any level of significance. Again, the cross-sectional results do not support any model with respect to pricing errors.

The results for industry portfolios are presented in Table 9 and 10. When industry data are used, the risk premia associated with SMB and HML factors are insignificant in all cases (with and without the intercept, γ_0) and far from their sample mean. Moreover, the estimated market risk premia are close to the sample

mean but only significant at 10% when the cross-sectional regressions are run without intercept.

Perhaps strikingly, the χ^2 test does not reject the null hypothesis that the pricing errors are jointly zero for any of the factor combinations for the industry portfolios. The Fama-French model is no longer the favourite according to the adjusted R^2 measure. This result is similar to those in Lo (2004) and Phalippou (2006), who find that grouping stocks based on different attributes can give different asset pricing answers using the same pool of stocks.

Given the contradictory results concerning pricing errors, in particular, but also the significance of factor risk premia, between the two sets of portfolios, we examine how the factors perform when the 36 portfolio returns (the 16 intersected portfolios based on size and BM and the 20 industry portfolios) are combined in a single set. The results are presented in Tables 11 and 12.

In Table 11, the risk premium associated with HML in Panel B and D of 0.38% and 0.36% are insignificant and far from the sample mean of 0.64%. Moreover, the risk premia associated with news related to IP growth and shocks to state variables are also insignificant in Panel A and C. The Fama-French model produces the highest adjusted R^2 measure. Nonetheless, the χ^2 test strongly rejects the null hypothesis that the pricing errors are jointly zero for all models.

When we restrict the value of the intercept term to be zero in Table 12, the risk premium associated with HML becomes significant in the Fama-French model and closer to the sample mean. Moreover, the market factor risk premium turns significant in the Macroeconomic model. However, the All Factor model has the highest adjusted R^2 measure of 36.39%. Nevertheless, the χ^2 test strongly rejects the null hypothesis that the pricing errors are jointly zero for the all competing models.

It can be noticed from the cross-sectional tests that restrict the intercept to be zero do not come always with the same results. If the model is correctly specified, the zero beta risk premium should equal zero. However, the zero beta

risk premium are positive and significantly different from zero for all models when tested against the 16 portfolios sorted by BM and size and for three out of four of the models when tested against the 36 combined portfolios. The zero beta risk premium is insignificantly different from zero just for the tests on 20 industry portfolios.

Moreover, restricting the intercept to be zero changes the sign of the market risk premium to the more theoretically appealing one and, in many cases, it changes its significance as well. Furthermore, it also increases the model's pricing errors, measured by χ^2, and decreases the explanatory power of the model, measured by adjusted R^2, for the tests on the 16 portfolios sorted by BM and size. However, such a restriction does not always give similar results for the tests on the 20 industry portfolios or the 36 combined portfolios. Hence, we cannot suggest a single model as the best one for pricing assets as it seems to depend not only on the portfolio groupings but also on the model specification.

Table 7 Cross-Sectional Regressions for Different Asset Pricing Models on 16 Intersected Size/Book-to-Market Portfolio Excess Returns (with Intercept)

Panel A: Vassalou's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	3.05	-2.47	-0.36						57.39	52.99	<.01
FM t-stat	5.96	-4.32	-3.94								
SH t- stat	5.08	-3.82	-3.48								
Panel B: Fama-French's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	2.46	-2.01	0.78	-0.20					66.15	48.68	<.01
FM t-stat	5.05	-3.50	3.53	-1.04							
SH t- stat	4.46	-3.18	3.42	-1.02							
Panel C: Macroeconomic's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	3.29	-2.70	-0.34	-0.01	-0.28	-0.02			60.52	29.24	<.01
FM t-stat	5.87	-4.25	-3.61	-1.65	-0.82	-1.31					
SH t- stat	4.04	-3.10	-2.65	-1.15	-0.57	-0.91					
Panel D: All Factor's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	2.53	-2.02	0.72	-0.25	-0.09	-0.02	-0.82	0.00	-58.11	50.37	<.01
FM t-stat	4.42	-3.20	3.19	-1.29	-0.47	-1.68	-1.60	-0.34			
SH t- stat	2.70	-2.10	2.69	-1.19	-0.29	-1.03	-0.98	-0.21			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 16 portfolios sorted by size and BM ratio. The full-sample factor loadings, which are the independent variables in the regressions, are computed in one multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 8 Cross-Sectional Regressions for Different Asset Pricing Models on 16 Intersected Size/Book-to-Market Portfolio Excess Returns (without Intercept)

Panel A: Vassalou's Model										
	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	0.68	0.04						-27.15	107.08	<.01
FM t-stat	2.19	0.45								
SH t- stat	2.19	0.45								
Panel B: Fama-French's Model										
	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.36	0.79	0.25					29.26	93.14	<.01
FM t-stat	1.20	3.58	1.19							
SH t- stat	1.20	3.55	1.18							
Panel C: Macroeconomic's Model										
	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.62	-0.23	-0.02	1.12	0.01			13.09	40.32	<.01
FM t-stat	2.03	-2.53	-1.80	3.63	0.88					
SH t- stat	1.90	-1.68	-1.11	2.24	0.54					
Panel D: All Factor's Model										
	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.35	0.85	-0.03	0.40	-0.01	0.12	0.02	-77.54	76.88	<.01
FM t-stat	1.13	3.80	-0.18	2.39	-1.07	0.28	1.16			
SH t- stat	1.05	3.41	-0.17	1.69	-0.75	0.19	0.81			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 16 portfolios sorted by size and BM ratio. The full-sample factor loadings, which are the independent variables in the regressions, are computed in one multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 9 Cross-Sectional Regressions for Different Asset Pricing Models on 20 Industry Portfolio Excess Returns (with Intercept)

Panel A: Vassalou's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	0.67	-0.09	-0.13						35.98	15.13	0.65
FM t-stat	0.80	-0.09	-1.27								
SH t- stat	0.79	-0.09	-1.25								
Panel B: Fama-French's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.27	0.38	0.13	-0.58					45.67	13.95	0.67
FM t-stat	0.33	0.41	0.44	-1.59							
SH t- stat	0.32	0.41	0.44	-1.57							
Panel C: Macroeconomic's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.43	0.25	-0.06	0.00	-0.58	0.00			69.46	12.83	0.62
FM t-stat	0.54	0.28	-0.58	-0.17	-1.92	0.51					
SH t- stat	0.44	0.23	-0.49	-0.14	-1.60	0.43					
Panel D: All Factor's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.64	-0.01	-0.06	-0.32	-0.07	0.00	-0.84	0.01	77.86	17.26	0.19
FM t-stat	0.79	-0.01	-0.17	-0.92	-0.29	-0.49	-1.97	1.05			
SH t- stat	0.55	0.00	-0.13	-0.69	-0.20	-0.34	-1.38	0.74			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 20 industry portfolios. The full-sample factor loadings, which are the independent variables in the regressions, are computed in one multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv)The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 10 Cross-Sectional Regressions for Different Asset Pricing Models on 20 Industry Portfolio Excess Returns (without Intercept)

Panel A: Vassalou's Model										
	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	$X^{2\,2}$	$p-value$
Estimate	0.59	-0.14						24.30	14.79	0.68
FM t-stat	1.89	-1.33								
SH t- stat	1.88	-1.29								
Panel B: Fama-French's Model										
	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	$X^{2\,2}$	$p-value$
Estimate	0.65	0.13	-0.65					46.00	12.25	0.78
FM t-stat	2.13	0.45	-2.03							
SH t- stat	2.13	0.45	-1.99							
Panel C: Macroeconomic's Model										
	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	$X^{2\,2}$	$p-value$
Estimate	0.68	-0.06	0.00	-0.59	0.00			69.84	5.58	0.99
FM t-stat	2.22	-0.58	-0.26	-1.93	0.20					
SH t- stat	2.16	-0.49	-0.21	-1.59	0.17					
Panel D: All Factor's Model										
	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	$X^{2\,2}$	$p-value$
Estimate	0.64	-0.01	-0.46	-0.01	-0.01	-0.73	0.01	-35.78	7.64	0.87
FM t-stat	2.07	-0.03	-1.39	-0.03	-0.61	-1.89	0.64			
SH t- stat	1.98	-0.03	-1.12	-0.03	-0.46	-1.42	0.49			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 20 industry portfolios. The full-sample factor loadings, which are the independent variables in the regressions, are computed in one multiple time-series regression. The coefficients are expressed as percentages per month. (ii)The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 11 Cross-Sectional Regressions for Different Asset Pricing Models on the Combined Set of 36 Industry Portfolio Excess Returns (with Intercept)

Panel A: Vassalou's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	1.67	-1.08	-0.16						30.53	117.01	<.01
FM t-stat	3.52	-1.96	-1.73								
SH t- stat	3.40	-1.91	-1.69								
Panel B: Fama-French's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	1.42	-0.88	0.38	-0.10					35.88	114.22	<.01
FM t-stat	3.05	-1.57	1.60	-0.50							
SH t- stat	2.99	-1.54	1.59	-0.50							
Panel C: Macroeconomic's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	1.77	-1.14	-0.15	0.00	-0.14	0.01			31.37	110.83	<.01
FM t-stat	3.48	-1.95	-1.57	-0.36	-0.57	0.67					
SH t- stat	3.31	-1.87	-1.51	-0.35	-0.55	0.64					
Panel D: All Factor's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	1.04	-0.48	0.36	-0.13	0.07	-0.01	-0.36	0.01	-17.98	93.27	<.01
FM t-stat	2.10	-0.83	1.49	-0.64	0.41	-1.27	-1.34	1.19			
SH t- stat	1.75	-0.72	1.39	-0.62	0.35	-1.06	-1.12	1.00			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on the combined set of 36 portfolios. The full-sample factor loadings, which are the independent variables in the regressions, are computed in one multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 12 Cross-Sectional Regressions for Different Asset Pricing Models on the Combined Set of 36 Portfolio Excess Returns (without Intercept)

Panel A: Vassalou's Model										
	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	0.60	0.00						-28.86	141.38	<.01
FM t-stat	1.93	0.05								
SH t- stat	1.93	0.05								
Panel B: Fama-French's Model										
	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.46	0.48	0.08					4.95	129.99	<.01
FM t-stat	1.52	2.01	0.42							
SH t- stat	1.51	2.00	0.42							
Panel C: Macroeconomic's Model										
	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.61	-0.04	-0.01	0.19	-0.01			-19.18	108.07	<.01
FM t-stat	2.02	-0.46	-1.41	0.79	-1.00					
SH t- stat	2.00	-0.42	-1.25	0.71	-0.89					
Panel D: All Factor's Model										
	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.52	0.45	-0.05	0.26	-0.02	-0.29	0.01	36.39	76.20	<.01
FM t-stat	1.70	1.85	-0.27	1.74	-2.00	-1.11	0.91			
SH t- stat	1.65	1.65	-0.26	1.34	-1.52	-0.85	0.70			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on the combined set of 36 portfolios. The full-sample factor loadings, which are the independent variables in the regressions, are computed in one multiple time-series regression. The coefficients are expressed as percentages per month. (ii)The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

5.3.2.2 Cross-sectional estimation with time-varying betas

We find that the results from the previous section vary according to the testing portfolios employed and the model specification. One possibility is that the use of time-invariant betas may contribute to these results. Therefore, we re-estimate the cross-sectional regressions using sample factor loadings, which are the independent variables in the regressions, computed in 60 months, rolling, multiple time-series regression.

Panels A, B, C and D of Table 13 contain the results of estimates of equations (16), (17), (18) and (19) from applying the second step of the Fama-MacBeth (1973) methodology on the excess returns of 16 portfolios sorted by BM and size where the sample factor loadings are time-varying. Again, the hypothesis that the intercept, γ_0, of each cross-sectional regression should be zero is strongly rejected for all four models.

The estimates of the risk premia associated with news related to IP growth in both the Vassalou model and the Macroeconomic model of -0.28% and -0.30% respectively per month are significant but well below the sample mean of 0.06%. Moreover, it remains significant when the Fama-French factors are added into the All Factor model, but still well below its sample mean.

Panels B and D reveal that the estimates of the risk premium associated with HML are 0.90% and 0.98% respectively, which are significant even after correcting for the sampling error but higher than the sample mean of 0.64%. Moreover, consistent with the sample mean of SMB factor, the estimated risk premia related to SMB are negative and insignificantly different from zero in the cross-section of portfolio returns in both panels. Further, none of the premia on shocks to state variables ($\gamma_{\hat{u}^{Term}}, \gamma_{\hat{u}^{Def}}, \gamma_{\hat{u}^{R_F}}$) are important cross-sectional determinants of average returns. Under the error-in-variables correction, the *t*-statistics of the prices of risks related to term spread, default spread and risk-free rate shocks are not individually significant.

The adjusted R^2 measure suggests that the All Factor model provides the best fit with an adjusted R^2 equal to 56.03%. However, the χ^2 statistic for the All Factor model, which tests the null hypothesis that the pricing errors from the model are jointly zero, has a p-value of < .01, suggesting the null hypothesis has to be rejected. The adjusted R^2 from the Fama-French model has an Adjusted R^2 of 49.82%. Moreover, the χ^2 statistics for the three remaining models are also large enough to reject the null hypothesis that the pricing errors from the model are equal to zero at any level of significance. As usual, the cross-sectional results do not support any model with respect to pricing errors.

The market beta is an important factor in the cross-section of returns in three out of four models in Table 13 (not in the Macroeconomic model), despite the estimate of the market risk premium tending to be negative and far from the sample mean excess return on the market portfolio of 0.49% per month. Again, these negative estimates of the market risk premium are consistent with Fama and French (1992a), Jagannathan and Wang (1996), and Lettau and Ludvigson (2001), using monthly or quarterly data. Moreover, they are consistent with the results using time-invariant betas in Table 7. As before, however, we re-estimate the competing models with the intercept term restricted to zero.

Table 14 shows the estimation of the risk premia associated with the different risk factors when the intercept, γ_0 , is restricted to zero. Consistent with the Jagannathan and Wang (2007) conjecture, the estimated risk premia on the market factor in all Panels in Table 14 is positive and close to the sample mean excess return on the market portfolio in all the models, apart from the Fama-French model. Panels A, C and D in Table 14 show that the risk premium associated with news related to IP growth is now insignificant when is included in any asset pricing specification.

Panels B and D in Table 14 reveal that the risk premium associated with HML remains positive and significant in the cross-section of the 16 portfolios after restricting the intercept, γ_0 , to be zero. The risk premium related to SMB remains

insignificant in the cross-section of portfolio returns in both panels. Further, the premium on shocks to default spread is insignificant in both Panels C and D.

Restricting the intercept term to be zero in Table 14 reduces the explanatory power of the testing models. Further, the adjusted R^2 measure in Table 14 now favours the Fama-French model, with adjusted R^2 equal to 36.71%, relative to the other three models. However, the χ^2 statistic for the Fama-French model has a p-value of < .01, suggesting the null hypothesis has to be rejected. The χ^2 statistics for the three remaining models are also large enough to reject the null hypothesis that the pricing errors from the model are equal to zero at any level of significance. As usual, the cross-sectional results do not support any model with respect to pricing errors.

The results for industry portfolios are presented in Tables 15 and 16. The main difference with the results with time-invariant betas is that when industry data are used, the risk premium associated with HML are now significant in all cases (with and without the intercept, γ_0) and close to the sample mean. However, the SMB factor remains insignificant. The estimated market risk premium are negative for the specification with intercept and positive when the intercept is restricted to be zero. The χ^2 test does not reject the null hypothesis that the pricing errors are jointly zero for any of the factor combinations for the industry portfolios. Moreover, the Vassalou model is the best model according to the adjusted R^2 measure.

We now examine how the factors perform when the 36 portfolio returns are combined in a single set. The results are presented in Tables 17 and 18. In Table 17, the risk premia associated with HML in Panels B and D of 0.66% and 0.64% respectively are significant and close to the sample mean of 0.64%. Moreover, the risk premium associated with news related to IP growth and shocks to state variables are also insignificant in Panels A and C. The Fama-French model produces the highest adjusted R^2 measure of 26.50%. Nonetheless, the χ^2 test strongly rejects the null hypothesis that the pricing errors are jointly zero for all models.

When we restrict the value of the intercept term to be zero in Table 18, the risk premium associated with HML factor remains significant in the Fama-French model and close to the sample mean. The market factor risk premium turns positive but remains insignificant in all the tested models. The Fama-French model has the highest adjusted R^2 measure of 14.20%. Nevertheless, the χ^2 test strongly rejects the null hypothesis that the pricing errors are jointly zero for the all competing models.

Again, it can be seen from the cross-section tests that restricting the intercept to be zero does not always produce the same results. We find that the zero beta risk premium are positive and significantly different from zero for all models when tested against the 16 portfolios sorted by BM and size and for one out of four of the models when tested against the 36 combined portfolios. The zero beta risk premium are insignificantly different from zero just for the tests on 20 industry portfolios.

Moreover, restricting the intercept to be zero changes the sign of the market risk premium to the more theoretically appealing one, but it becomes insignificant. Furthermore, it also increases the models' pricing errors, measured by χ^2, and decreases the explanatory power of the model, measured by adjusted $R^{2,}$ for the tests on both the 16 portfolios sorted by BM and size and the 36 combined portfolios. However, such a restriction increases the explanatory power of the models for the tests on the 20 industry portfolios but it moves the pricing errors in different directions. Therefore, and similar to the conclusion from the cross-sectional regression on time-invariant betas, we cannot suggest a single model as the best one for pricing assets as it seems to depend not only on the portfolio groupings, as suggested by Lo (2004) and Phalippou (2006), but also on the model's specification itself.

Table 13 Cross-Sectional Regressions for Different Asset Pricing Models on 16 Intersected Size/Book-to-Market Portfolio Excess Returns (with Intercept)

Panel A: Vassalou's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	1.89	-1.52	-0.28						32.95	61.00	<.01
FM t-stat	3.58	-2.71	-3.87								
SH t- stat	3.31	-2.57	-3.73								
Panel B: Fama-French's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	1.75	-1.57	0.90	-0.09					49.82	67.99	<.01
FM t-stat	3.24	-2.60	3.87	-0.43							
SH t- stat	3.00	-2.45	3.79	-0.42							
Panel C: Macroeconomic's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	1.54	-1.16	-0.30	-0.01	-0.03	-0.01			43.16	50.45	<.01
FM t-stat	2.98	-2.05	-3.55	-1.54	-0.15	-1.09					
SH t- stat	2.59	-1.86	-3.25	-1.37	-0.13	-0.96					
Panel D: All Factor's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	1.99	-1.60	0.98	-0.12	-0.31	-0.01	0.07	-0.01	56.03	49.67	<.01
FM t-stat	3.74	-2.76	4.32	-0.53	-2.77	-1.96	0.43	-1.00			
SH t- stat	3.09	-2.41	4.37	-0.54	-2.38	-1.67	0.29	-0.84			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 16 portfolios sorted by size and BM ratio. The sample factor loadings, which are the independent variables in the regressions, are computed in 60 months rolling multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 14 Cross-Sectional Regressions for Different Asset Pricing Models on 16 Intersected Size/Book-to-Market Portfolio Excess Returns (without Intercept)

Panel A: Vassalou's Model										
	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	0.55	-0.06						-18.08	85.68	<.01
FM t-stat	1.46	-0.72								
SH t- stat	1.46	-0.71								
Panel B: Fama-French's Model										
	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.17	0.92	0.18					36.71	83.15	<.01
FM t-stat	0.47	4.04	0.76							
SH t- stat	0.47	3.99	0.74							
Panel C: Macroeconomic's Model										
	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.42	-0.15	-0.01	0.14	-0.01			29.60	78.54	<.01
FM t-stat	1.12	-1.77	-1.19	0.70	-0.14					
SH t- stat	1.11	-1.71	-1.13	0.67	-0.14					
Panel D: All Factor's Model										
	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.41	0.93	0.01	-0.12	-0.01	0.08	-0.01	35.24	71.35	<.01
FM t-stat	1.11	4.09	0.05	-1.12	-2.27	0.39	-0.30			
SH t- stat	1.08	4.11	0.05	-1.01	-2.04	0.35	-0.27			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 16 portfolios sorted by size and BM ratio. The sample factor loadings, which are the independent variables in the regressions, are computed in 60 months rolling multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 15 Cross-Sectional Regressions for Different Asset Pricing Models on 20 Industry Portfolio Excess Returns (with Intercept)

Panel A: Vassalou's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	1.09	-0.71	-0.12						15.89	10.35	0.92
FM t-stat	1.67	-1.10	-1.58								
SH t- stat	1.65	-1.09	-1.57								
Panel B: Fama-French's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.90	-0.62	0.54	0.17					3.36	12.59	0.76
FM t-stat	1.34	-0.93	2.18	0.54							
SH t- stat	1.31	-0.91	2.17	0.53							
Panel C: Macroeconomic's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	1.28	-0.98	-0.05	-0.01	0.04	0.01			-36.39	10.21	0.81
FM t-stat	1.89	-1.43	-0.63	-0.68	0.21	0.54					
SH t- stat	1.84	-1.40	-0.62	-0.67	0.20	0.53					
Panel D: All Factor's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	1.04	-0.81	0.61	0.31	0.16	-0.01	0.03	-0.01	-103.31	10.81	0.63
FM t-stat	1.50	-1.16	2.72	0.97	1.43	-1.69	0.13	-0.03			
SH t- stat	1.32	-1.05	2.76	0.91	1.30	-1.53	0.12	-0.03			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 20 industry portfolios. The sample factor loadings, which are the independent variables in the regressions, are computed in 60 months rolling multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 16 Cross-Sectional Regressions for Different Asset Pricing Models on 20 Industry Portfolio Excess Returns (without Intercept)

Panel A: Vassalou's Model										
	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	0.36	-0.08						40.23	8.46	0.97
FM t-stat	0.99	-1.05								
SH t- stat	0.99	-1.05								
Panel B: Fama-French's Model										
	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.28	0.53	0.04					4.06	13.30	0.72
FM t-stat	0.79	2.13	0.13							
SH t- stat	0.79	2.12	0.13							
Panel C: Macroeconomic's Model										
	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.31	-0.03	-0.01	0.08	-0.01			-3.57	8.16	0.92
FM t-stat	0.85	-0.40	-1.27	0.54	-0.37					
SH t- stat	0.85	-0.40	-1.24	0.53	-0.36					
Panel D: All Factor's Model										
	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.28	0.53	0.13	0.16	-0.01	0.06	-0.01	-76.13	11.72	0.55
FM t-stat	0.79	2.37	0.44	1.41	-1.61	0.32	-0.79			
SH t- stat	0.77	2.40	0.42	1.29	-1.47	0.29	-0.72			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on 20 industry portfolios. The sample factor loadings, which are the independent variables in the regressions, are computed in 60 months rolling multiple time-series regression. The coefficients are expressed as percentages per month. (ii)The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 17 Cross-Sectional Regressions for Different Asset Pricing Models on the Combined Set of 36 Industry Portfolio Excess Returns (with Intercept)

Panel A: Vassalou's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	1.34	-0.94	-0.15						7.77	100.43	<.01
FM t-stat	2.68	-1.79	-2.24								
SH t- stat	2.60	-1.76	-2.22								
Panel B: Fama-French's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.94	-0.67	0.66	-0.01					26.50	100.06	<.01
FM t-stat	1.85	-1.21	2.91	-0.06							
SH t- stat	1.81	-1.20	2.92	-0.06							
Panel C: Macroeconomic's Model											
	γ_0	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.97	-0.61	-0.11	-0.01	0.10	0.01			8.00	98.14	<.01
FM t-stat	1.96	-1.19	-1.65	-1.37	0.78	0.15					
SH t- stat	1.89	-1.17	-1.63	-1.34	0.76	0.14					
Panel D: All Factor's Model											
	γ_0	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.92	-0.62	0.64	-0.05	0.01	-0.01	0.09	0.01	18.88	89.63	<.01
FM t-stat	2.01	-1.34	3.33	-0.23	0.15	-2.06	0.59	0.11			
SH t- stat	1.86	-1.29	3.48	-0.23	0.15	-1.93	0.55	0.11			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on the combined set of 36 portfolios. The sample factor loadings, which are the independent variables in the regressions, are computed in 60 months rolling multiple time-series regression. The coefficients are expressed as percentages per month. (ii) The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

Table 18 Cross-Sectional Regressions for Different Asset Pricing Models on the Combined Set of 36 Portfolio Excess Returns (without Intercept)

Panel A: Vassalou's Model										
	γ_M	$\gamma_{MFTRALL}$						$Adj.R^2$	X^2	$p-value$
Estimate	0.41	-0.04						-17.60	127.76	<.01
FM t-stat	1.13	-0.56								
SH t- stat	1.12	-0.56								
Panel B: Fama-French's Model										
	γ_M	γ_{HML}	γ_{SMB}					$Adj.R^2$	X^2	$p-value$
Estimate	0.22	0.67	0.09					14.20	115.74	<.01
FM t-stat	0.60	2.92	0.39							
SH t- stat	0.59	2.92	0.39							
Panel C: Macroeconomic's Model										
	γ_M	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}			$Adj.R^2$	X^2	$p-value$
Estimate	0.37	-0.04	-0.01	0.20	0.01			-5.67	110.10	<.01
FM t-stat	1.03	-0.67	-1.63	1.45	0.06					
SH t- stat	1.02	-0.66	-1.57	1.39	0.06					
Panel D: All Factor's Model										
	γ_M	γ_{HML}	γ_{SMB}	$\gamma_{MFTRALL}$	γ_{TERM}	$\gamma_{DEFAULT}$	γ_{RF}	$Adj.R^2$	X^2	$p-value$
Estimate	0.31	0.62	-0.01	0.06	-0.01	0.12	-0.01	12.25	99.33	<.01
FM t-stat	0.87	3.25	-0.05	0.77	-2.45	0.80	-0.26			
SH t- stat	0.86	3.43	-0.05	0.74	-2.27	0.74	-0.24			

Notes: (i) This table reports the results of Fama-MacBeth cross-sectional regressions using the excess returns on the combined set of 36 portfolios. The sample factor loadings, which are the independent variables in the regressions, are computed in 60 months rolling multiple time-series regression. The coefficients are expressed as percentages per month. (ii)The adjusted R-squared follows Jagannathan and Wang (1996) and is reported in percentage form. (iii) The t-statistics, indicated by FM t-stat, are the Fama-MacBeth estimate while those indicated by SH t-stat are the Fama-MacBeth estimate adjusted for the Shanken (1992) correction. (iv) The last columns report χ^2 statistics, and their corresponding p-values, for the test that the pricing errors in the model are jointly zero. (v) Each panel examines the sample period from July 1980 to April 2003.

6. CONCLUSION

In the time-series stage of asset pricing tests, we find that the market factor, HML, SMB, shocks to IP growth, and shocks to the term spread are useful factors in explaining the cross section of the sixteen size and BM intersected portfolios, in the sense that their loadings are jointly significant, with the corresponding p-value being less than 0.01%. However, shocks to the default spread and shocks to the risk-free rate appear to be good candidates for useless factors, as suggested by Kan and Zhang (1999).

When we apply the Fama-MacBeth second-stage cross-sectional regressions with time-invariant betas on the sixteen size-BM intersected portfolios, estimated risk premia are consistently positive and significant for the HML factor, while the estimated risk premia for SMB are consistently insignificant. Moreover, we find that the HML factor contains information about default spread in the sense that the risk premia on the default spread surprise factor is significant in the macroeconomic model but turns insignificant in the All Factor model. Hence, these finding sets up some link between a macroeconomic variable and a factor associated with cross-section return predictability. However, tests for asset pricing errors suggest that all models produce pricing errors significantly different from zero.

When the Fama-MacBeth methodology is applied to the 20 industry portfolios, asset pricing tests suggest that the risk premia for the Fama-French factors and shocks to state variables are statistically indistinguishable from zero – but, as in the previous section, the various models produce insignificant pricing errors. This result is consistent with Lo (2004) and Phalippou (2006), who find that grouping stocks based on different attributes can give different asset pricing answers using the same pool of stocks.

When re-running the regressions on the two sets of portfolios combined, those factor risk premia are generally insignificantly different from zero, other than the HML factor in Fama-French model, when the risk premia for HML is significantly positive. Nonetheless, the null hypothesis that the pricing errors are zero can be rejected for all models.

In addition, the results for the sixteen portfolios indicate that the Fama-French model is better than the other three tested models in capturing assets' covariances with time-varying investment opportunities. However, the Fama-French model no longer provides the best fit when we run the cross-sectional tests on the twenty industry portfolios. This result can be attributed to the fact HML and SMB are constructed on the same basis as the sixteen portfolios, and they represent portfolio returns, while shocks to state variables correspond to realisations of factors that explain the time-varying nature of investment opportunity set.

However, when we re-run the Fama-MacBeth second-stage cross-sectional regressions with time-varying betas for the sixteen size-BM intersected portfolios, estimated risk premia remains positive and significant for the HML factor, while the estimated risk premia for SMB are consistently insignificant. The risk premia on the default spread surprise factor is now insignificant.

When the Fama-MacBeth methodology with time-varying betas is applied to the 20 industry portfolios, asset pricing tests suggest that the risk premia for HML is now significant, while those for the remaining Fama-French factors, and shocks to state variables, are still statistically indistinguishable from zero – but, again, the various models continue to produce insignificant pricing errors. Moreover, applying the Fama-MacBeth methodology with time-varying betas on the two sets of portfolios combined gives similar results to those of the 16 intersected portfolios.

To sum up, we find that the HML factor contains information about shocks to default spread, is consistent with Vassalou and Xing (2004) that HML factor contains some default-related information, although this conclusion is only valid for the specification with time-invariant betas without intercept and for the 16 intersected portfolios. The Fama-French model explains the cross-section of average returns on portfolios sorted on size and BM ratio better than a model that includes shocks to the state variables. When loadings on HML and SMB are present in the model, loadings on shocks to the default spread loses its explanatory power for the cross-section of returns. The results provide

economic interpretation for the empirical success of HML factor but contradict the US evidence that shocks to state variables subsume Fama-French factors.

Moreover, given the absence of 'industry standards' for SMB and HML construction in the UK and the evidence of a real difference between the outcomes of applying different sets of factors as shown by Michou *et al*. (2007), caution is needed to be taken when adopting just one of the combinations of Fama-French factors and then drawing inferences accordingly. As a consequence, we suggest that further research is clearly needed before reaching a clear cut inference regarding the economic intuition behind the Fama-French factors.

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APPENDIX

TABLE A

Sample Observations by Year

Year	*Number of Firms by Year*
1980	731
1981	734
1982	759
1983	792
1984	818
1985	884
1986	934
1987	995
1988	1034
1989	1075
1990	1061
1991	988
1992	1041
1993	1020
1994	1044
1995	1061
1996	1051
1997	1212
1998	1280
1999	1180
2000	1081
2001	1066
2002	1070
Total	22911

Table B
Descriptive Statistics for the Portfolios Sorted on Size and Book-to-Market for the Period 1980(7)-2003(4)

Size	Book-to-market equity quartile			
	Low	2	3	High
Average firm size (£millions)				
Small	5.51	5.52	5.42	4.75
2	21.02	20.29	19.36	18.84
3	73.15	74.29	69.87	66.44
Big	1552.88	1274.63	1119.09	707.96
Average book-to-market				
Small	0.23	0.55	0.93	3.45
2	0.24	0.53	0.90	1.84
3	0.23	0.54	0.89	2.30
Big	0.23	0.53	0.88	1.58
Average value-weighted monthly returns (%)				
Small	1.33	1.43	1.60	2.07
2	0.72	0.89	1.09	1.72
3	0.64	1.12	1.30	1.65
Big	0.91	1.29	1.22	1.70
Average of number of firms in each portfolio				
Small	33	42	59	115
2	57	58	66	68
3	76	72	62	40
Big	83	77	63	26

Notes:
In June each year, stocks are independently sorted into size and BM quartiles to form 16 value weighted portfolios on the basis of the intersection between the two groupings. Firm size is measured as the number of shares outstanding multiplied by the stock price at the end of June. BM is measured at the end of December of previous year.

TABLE C

Industry Portfolios' Descriptive Statistics

Industry	*Average Value-Weighted Monthly Returns %*	*Ave. No. of Stocks*	*Average MV*	*Average BM*
1.Oil and Gas	1.04	21	208.94	0.88
2.Chemicals	1.12	32	479.19	1.00
3.Basic Resources	1.20	19	615.89	1.20
4.Construction and Materials	1.15	72	276.22	1.03
5.Aerospace and Defence	1.27	16	410.28	0.82
6.General Industrials	1.37	24	84.32	1.10
7.Electronic and Electrical Equipment	1.06	59	156.96	0.79
8.Industrial Engineering	0.97	102	151.71	1.08
9.Industrial Transportation	1.01	32	260.94	1.16
10.Support Services	0.92	100	136.42	0.72
11.Automobiles and Parts	1.40	24	219.63	1.20
12.Food and Beverages	1.31	51	635.68	0.91
13.Personal and Household Goods	1.60	109	128.28	1.38
14.Healthcare	1.53	36	583.98	0.68
15.Food and Drug Retailers	1.24	37	869.96	1.07
16.General Retailers	1.54	49	325.87	1.01
17.Media	1.36	57	286.68	0.80
18.Travel and Leisure	1.17	70	253.78	0.98
19.Technology	0.52	60	146.88	7.30
20.Utilities	1.39	28	2120.40	1.02

Note:
The portfolios are formed from July 1980 to April 2003 using LSPD G17 codes and FTSE Industrial Classification Benchmark (ICB)[2].

[2] Utilities include Telecommunication, Electricity, Gas, Water and other companies