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# Can book-to-market, size and momentum be risk factors that predict economic growth?☆

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**Abstract**

We test whether the profitability of HML, SMB, and WML can be linked to future Gross Domestic Product (GDP) growth. Using data from ten countries, we find that HML and SMB contain significant information about future GDP growth. This information is to a large degree independent of that in the market factor. Even in the presence of popular business cycle variables, HML and SMB retain their ability to predict future economic growth in some countries. Our results support a risk-based explanation for the performance of HML and SMB. Little evidence is found to support such an explanation in the case of WML. 

*JEL classification:* G11; G12; G15

*Keywords:* Book-to-market; Size; Momentum; GDP growth

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## 1. Introduction

A growing body of research shows that certain empirical anomalies found in the U.S. stock market also exist in international markets. Fama and French (1998) show that a strong value premium exists in global stock markets. Rouwenhorst (1998) finds international evidence for a momentum effect. Studies surveyed in Hawawini and Keim (1995) document the presence of a size effect in several European markets and in Japan. Suggested evidence of an international size effect is also found in Heston et al. (1995). However, researchers have found little evidence of a relation between these three return-based anomalies and intuitive economic risk factors. This paper takes one step in that direction by linking the return-based factors to future growth in the macroeconomy.

We construct return-based factors for ten developed markets. For each market, HML (high minus low) is the return to a portfolio strategy that is long on high book-to-market stocks and short on low book-to-market stocks, holding the other two attributes (size and momentum) constant. Likewise, SMB (small minus big) and WML (winners minus losers) are returns to long-short portfolios constructed using size and momentum information, respectively, holding the other two attributes constant.

The core results of the paper reveal that the HML and SMB portfolios are related to future growth in the real economy. This is documented both by using regression analysis and calculating the returns of the trading strategies during both good and bad states of the business cycle in each country. The predictive power of HML and SMB is not subsumed when the market factor is included in the regression model. Inclusion of other business cycle variables does not eliminate the forecasting ability of HML and SMB either. We find, however, little evidence of a relation between WML and the real economy.

A positive relation exists between the return on the market portfolio and future economic growth. We show that a positive relation also exists between the returns of HML and SMB and future economic growth. The slope coefficients of HML and SMB are of similar magnitude as those of the market portfolio, even though the information contained in HML and SMB is largely independent of the information contained in the returns of the market factor.

Since the performance of HML and SMB is linked to future economic growth, the hypothesis of Fama and French (1992, 1993, 1995, 1998) that they act as state variables in the context of Merton's (1973) intertemporal capital asset pricing model (ICAPM) is supported by our results.

Our analysis also confirms previous findings that the HML, SMB, and WML zero investment portfolios provide positive returns. In most countries these returns are both economically and statistically significant. The HML and SMB strategies generate significantly lower turnover than the WML strategy.

The paper is organized as follows. Section 2 describes the data set and details our portfolio construction procedure. Section 3 briefly summarizes the

performance and characteristics of the three strategies internationally. In Section 4 we present our results on the relation between the return-based factors and the macroeconomy. Section 5 extends the findings for the U.S. sample, using the HML and SMB factors constructed by Fama and French that cover a longer time period than our data. Section 6 briefly discusses the benefits of performing our analysis using international data. We conclude in Section 7 with a summary of our results.

## 2. Data set description and portfolio construction

Our data, obtained from Datastream International, are securities from Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States. We use end-of-month prices, dividend yields, price-to-book ratios, and market capitalization data both for currently trading and defunct securities.[1] We exclude from our database duplicates, cross listings, preferred shares, warrants, and unit trusts.

Table 1 summarizes the number of securities used when the HML, SMB, and WML portfolio strategies are rebalanced annually. It discloses how many stocks are used in the portfolios each year and the length of time during which the trading strategies are performed. Note that for Italy, the Netherlands, and Switzerland, the number of securities is much smaller than for the other countries. Because our portfolio construction procedure results in the creation of 27 portfolios, some of the portfolios for these three countries may contain as few as one to three stocks. Therefore, the results for these countries should be interpreted with caution.

Monthly total returns in local currency are calculated by spreading evenly the monthly dividends throughout each year. This method, which represents the only option we had available, may smooth the series to some extent, but it does not affect the means. All returns in our analysis are reported annualized.

To check the quality of our data, we used our database to construct market capitalization-weighted country indexes. We then compared them with those provided by Morgan Stanley Capital International (MSCI). The results, not reported here, show that the distributional characteristics of the two sets of indexes are very similar. Furthermore, the correlations between the constructed indexes and those of MSCI are of the order of 0.98 in all countries except Japan where it is 0.92. Our data set, however, has an advantage compared with the constituents of the MSCI indexes used in the Fama and French (1998) study. It

[1] The list of defunct securities in the first years of our sample perhaps is not complete. Therefore, some survivorship bias may exist during those years.

Table 1
Number of securities included in the annually rebalanced portfolios

For inclusion in a portfolio, a security must have positive December-end price-to-book values, June-end market capitalization, and 12 months of returns prior to July. Portfolios are held for one year and are rebalanced at the end of June. The data are from Datastream International.

| Year (July) | Australia | Canada | France | Germany | Italy | Japan | Netherlands | Switzerland | United Kingdom | United States |
|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | | 143 | | | | | 27 | | 1145 | 1565 |
| 1979 | | 145 | | | | | 35 | | 1160 | 1615 |
| 1980 | | 150 | | | | | 39 | | 1160 | 1657 |
| 1981 | | 157 | | | | 71 | 41 | | 1198 | 1676 |
| 1982 | | 198 | | | | 85 | 44 | | 1193 | 1743 |
| 1983 | | 213 | 95 | | | 85 | 44 | | 1182 | 1809 |
| 1984 | | 225 | 104 | | | 714 | 43 | | 1194 | 1837 |
| 1985 | 78 | 242 | 106 | | | 761 | 42 | | 1165 | 1884 |
| 1986 | 91 | 248 | 120 | | | 806 | 49 | 48 | 1116 | 1884 |
| 1987 | 101 | 271 | 126 | 131 | 38 | 817 | 50 | 62 | 1061 | 1938 |
| 1988 | 100 | 296 | 133 | 137 | 79 | 824 | 49 | 102 | 1051 | 2014 |
| 1989 | 159 | 294 | 158 | 150 | 85 | 997 | 52 | 119 | 1001 | 1955 |
| 1990 | 161 | 316 | 284 | 310 | 97 | 1047 | 53 | 132 | 942 | 1840 |
| 1991 | 171 | 329 | 293 | 376 | 104 | 1064 | 48 | 136 | 904 | 1772 |
| 1992 | 175 | 354 | 299 | 402 | 111 | 1071 | 55 | 135 | 861 | 1710 |
| 1993 | 168 | 399 | 297 | 399 | 109 | 1068 | 90 | 136 | 828 | 1792 |
| 1994 | 182 | 434 | 293 | 411 | 117 | 1076 | 94 | 140 | 813 | 1957 |
| 1995 | 175 | 414 | 285 | 415 | 125 | 1076 | 100 | 137 | 854 | 1947 |
| 1996 | 175 | 384 | 280 | 441 | 121 | 1087 | 100 | 131 | 834 | 1770 |
| Average | 145 | 274 | 205 | 317 | 99 | 791 | 56 | 116 | 1035 | 1809 |

also includes small capitalization stocks, which makes tests of the SMB strategy possible.

To capture all three empirical anomalies simultaneously, the HML, SMB, and WML portfolios are constructed as follows. For a given country and at each point in time, we use only stocks for which we have the market capitalization (MV), at least twelve monthly observations so as to be able to calculate the momentum, and a positive book-to-market ratio ($B/M$). We consider only the 12-month momentum strategy, and we implement it by calculating the average of past year's returns, excluding the most recent month (ave12).[2]

To construct the portfolios, we sort all stocks that pass the above requirements by $B/M$ and create tritile portfolios. We then take the portfolio of stocks with the highest $B/M$s and re-sort all stocks by MV, thereby creating three MV portfolios within the high $B/M$ group. We repeat the same procedure for the medium $B/M$ and low $B/M$ groups. After sorting for $B/M$ and MV, we have nine portfolios. We then sort the securities in each of these nine portfolios according to ave12 and create tritile portfolios within the nine portfolios. We obtain, in this manner, 27 portfolios.

Table 2 depicts the portfolio construction procedure. 'Losers' are the bottom third of the total stocks with the lowest last year's average return, excluding the most recent month. 'Winners' are the top third of the total stocks with the highest last year's average return, excluding the most recent month. 'Medium' are the remaining third of the stocks.

The three trading strategies are constructed as follows:

$$\begin{aligned}\mathrm{HML} = 1/9*((&P1 - P19) + (P2 - P20) + (P3 - P21) + (P4 - P22)\\ &+ (P5 - P23) + (P6 - P24) + (P7 - P25) + (P8 - P26)\\ &+ (P9 - P27)),\end{aligned}$$

$$\begin{aligned}\mathrm{SMB} = 1/9*((&P1 - P7) + (P2 - P8) + (P3 - P9) + (P10 - P16)\\ &+ (P11 - P17) + (P12 - P18) + (P19 - P25) + (P20 - P26)\\ &+ (P21 - P27)),\end{aligned}$$

$$\begin{aligned}\mathrm{WML} = 1/9*((&P3 - P1) + (P6 - P4) + (P9 - P7) + (P12 - P10)\\ &+ (P15 - P13) + (P18 - P16) + (P21 - P19) + (P24 - P22)\\ &+ (P27 - P25)).\end{aligned}$$

[2] Excluding the most recent month return eliminates problems associated with microstructure issues such as the bid–ask bounce (see Asness, 1995).

Table 2
Portfolio construction procedure.

| Book-to-market | Market capitalization | Past year's returns (ave12) | Portfolio |
|---|---|---|---|
| High | Small | Losers | P1 |
| | | Medium | P2 |
| | | Winners | P3 |
| | Medium | Losers | P4 |
| | | Medium | P5 |
| | | Winners | P6 |
| | Big | Losers | P7 |
| | | Medium | P8 |
| | | Winners | P9 |
| Medium | Small | Losers | P10 |
| | | Medium | P11 |
| | | Winners | P12 |
| | Medium | Losers | P13 |
| | | Medium | P14 |
| | | Winners | P15 |
| | Big | Losers | P16 |
| | | Medium | P17 |
| | | Winners | P18 |
| Low | Small | Losers | P19 |
| | | Medium | P20 |
| | | Winners | P21 |
| | Medium | Losers | P22 |
| | | Medium | P23 |
| | | Winners | P24 |
| | Big | Losers | P25 |
| | | Medium | P26 |
| | | Winners | P27 |

HML represents the return to a portfolio that is long on high $B/M$ stocks and short on low $B/M$ stocks, controlling for the size and momentum effects. In other words, HML is a zero investment strategy that is both size and momentum neutral. Similar interpretations can be given for SMB and WML.

The 27 portfolios are value-weighted at construction. In the presence of small capitalization stocks, value-weighted portfolios result in more realistic returns.

The factor returns are calculated for quarterly, semi-annual, and annual rebalancing frequencies. Independently of the rebalancing frequency, we use six-month prior $B/M$ values to ensure that the information was available to the public before the portfolios were formed. Annually rebalanced portfolios use

December-end $B/M$ values, June-end market capitalization, and past 12 months of returns prior to July. We rebalance semi-annual portfolios at June-end and December-end. Finally, the quarterly sorted portfolios are rebalanced at the end of March, June, September, and December. If a stock does not have returns for any month through the duration of the holding period, we invest that portion of the portfolio into the corresponding country's risk-free asset.

Our portfolio construction procedure differs from the one used in Fama and French (1993), in which two independent sorts created the HML and SMB. We use three sequential sorts. The disadvantage of our approach is that our results may be specific to the sorting order used. We cannot use independent sorts, however, because of the small number of securities we have in some countries. Fortunately, when we reverse the sorting order and repeat our tests, our main results remain qualitatively the same. To avoid repetition, we do not report them here.

## 3. Characteristics and performance of the HML, SMB, and WML strategies internationally

Before we proceed with the main tests of this paper, we examine the performance of HML, SMB, and WML in the markets and time period covered by our data. Table 3 reports the returns of the strategies when the portfolios are rebalanced annually, semi-annually, and quarterly.

Our results confirm those of Fama and French (1998) that the value premium is pervasive. We find that, in general, the returns of HML are higher when the portfolios are rebalanced more frequently. When the portfolios are rebalanced every quarter, HML generates statistically positive returns in nine out of ten countries.

We also confirm the profitability of the momentum strategy. This is consistent with Rouwenhorst's (1998) findings. It appears that momentum is very sensitive to the rebalancing period. Returns to WML decrease significantly as the rebalancing interval increases. Note that the momentum strategy is not reliably profitable in Italy, and it generates negative average returns in Japan.

In addition, we verify the existence of a size premium. SMB produces positive returns in all countries except Switzerland. These returns are also statistically significant in Canada, France, Japan, and the United States. It appears that the size premium is noisier in markets that are smaller, less liquid, and dominated by a few big capitalization stocks.

Finally, the turnover of the HML and SMB portfolios is significantly smaller than that of the WML portfolios. Around 70% of stocks do not exit the HML and SMB portfolios from one year to another, compared with only 30% in the case of WML. Furthermore, around 50% of stocks in the HML and SMB portfolios remain the same in a three-year period. These findings have two

Table 3
Summary of HML, SMB, and WML performance over different rebalancing horizons

HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing stocks of the past year ('losers'), holding the book-to-market and size effects of the portfolio constant. Local currency returns and standard deviations are reported annualized.

| Country | Quarterly rebalancing | | | Semi-annual rebalancing | | | Annual rebalancing | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (%) | Std (%) | *T*-value | Mean (%) | Std (%) | *T*-value | Mean (%) | Std (%) | *T*-value |
| Australia | | | | | | | | | |
| HML | 9.30 | 14.53 | 2.26 | 9.14 | 14.06 | 2.29 | 5.93 | 13.74 | 1.48 |
| SMB | 6.21 | 15.88 | 1.38 | 2.79 | 16.06 | 0.61 | 5.88 | 19.15 | 1.06 |
| WML | 9.60 | 14.98 | 2.26 | 12.56 | 15.35 | 2.88 | 10.68 | 27.05 | 1.36 |
| Canada | | | | | | | | | |
| HML | 7.44 | 11.06 | 2.98 | 8.56 | 10.69 | 3.53 | 8.16 | 10.46 | 3.41 |
| SMB | 4.85 | 10.71 | 2.01 | 6.02 | 10.79 | 2.46 | 5.16 | 10.15 | 2.21 |
| WML | 14.50 | 14.80 | 4.34 | 10.52 | 14.22 | 3.26 | 3.32 | 13.86 | 1.04 |
| France | | | | | | | | | |
| HML | 12.51 | 9.09 | 5.13 | 12.05 | 9.26 | 4.85 | 10.32 | 9.90 | 3.90 |
| SMB | 5.22 | 11.70 | 1.66 | 5.46 | 11.42 | 1.79 | 5.40 | 10.49 | 1.92 |
| WML | 10.17 | 9.49 | 4.00 | 8.57 | 9.14 | 3.50 | 6.31 | 9.67 | 2.43 |
| Germany | | | | | | | | | |
| HML | 5.55 | 6.42 | 2.75 | 3.14 | 5.96 | 1.66 | 4.56 | 5.98 | 2.40 |
| SMB | 2.07 | 9.69 | 0.68 | 0.82 | 9.63 | 0.27 | 0.46 | 9.94 | 0.14 |
| WML | 9.60 | 9.62 | 3.18 | 10.08 | 9.62 | 3.30 | 9.24 | 9.25 | 3.15 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Italy | | | | | | | | | |
| HML | 7.29 | 9.77 | 2.38 | 7.47 | 9.24 | 2.55 | 7.43 | 9.18 | 2.54 |
| SMB | 2.19 | 10.50 | 0.67 | 2.92 | 10.32 | 0.89 | 0.59 | 10.29 | 0.18 |
| WML | 5.17 | 12.56 | 1.31 | 3.24 | 11.89 | 0.86 | 0.65 | 11.93 | 0.17 |
| Japan | | | | | | | | | |
| HML | 8.75 | 10.12 | 3.53 | 6.85 | 9.77 | 2.84 | 7.71 | 9.32 | 3.29 |
| SMB | 6.78 | 15.27 | 1.81 | 6.92 | 15.37 | 1.82 | 6.57 | 14.05 | 1.87 |
| WML | − 1.67 | 11.77 | − 0.58 | − 1.42 | 11.30 | − 0.51 | − 3.60 | 10.70 | − 1.34 |
| Netherlands | | | | | | | | | |
| HML | 0.75 | 11.50 | 0.28 | 0.96 | 11.60 | 0.36 | 0.68 | 11.17 | 0.26 |
| SMB | 2.00 | 12.98 | 0.67 | 1.82 | 12.73 | 0.62 | 2.40 | 11.92 | 0.88 |
| WML | 14.00 | 12.26 | 4.97 | 9.61 | 12.85 | 3.25 | 7.39 | 12.84 | 2.50 |
| Switzerland | | | | | | | | | |
| HML | 8.66 | 10.34 | 2.77 | 7.62 | 10.57 | 2.38 | 8.48 | 9.87 | 2.83 |
| SMB | − 4.13 | 10.81 | − 1.26 | − 3.39 | 11.01 | − 1.02 | − 1.2 | 10.88 | − 0.37 |
| WML | 9.01 | 9.83 | 3.03 | 7.54 | 10.04 | 2.48 | 4.70 | 8.76 | 1.77 |
| United Kingdom | | | | | | | | | |
| HML | 8.33 | 6.09 | 6.06 | 7.45 | 5.90 | 5.56 | 6.91 | 5.84 | 5.14 |
| SMB | 3.37 | 11.15 | 1.33 | 3.02 | 11.09 | 1.20 | 3.17 | 11.00 | 1.25 |
| WML | 15.02 | 7.27 | 9.16 | 13.54 | 6.77 | 8.80 | 9.57 | 6.21 | 6.71 |
| United States | | | | | | | | | |
| HML | 7.99 | 12.24 | 2.89 | 7.98 | 12.12 | 2.90 | 6.74 | 8.64 | 3.39 |
| SMB | 10.73 | 13.65 | 3.48 | 11.46 | 13.93 | 3.62 | 6.45 | 10.57 | 2.65 |
| WML | 15.02 | 12.70 | 5.24 | 13.26 | 12.64 | 4.62 | 5.05 | 9.42 | 2.33 |

implications. First, they indicate that the $B/M$ and size characteristics of stocks tend to be persistent over time, whereas momentum characteristics do not appear to be so. The persistence of $B/M$ and size characteristics of securities supports the hypothesis of a risk-based explanation for the returns of HML and SMB. Second, on a more practical note, HML and SMB strategies are cheaper to implement than WML strategies, because they generate lower transaction costs.

## 4. The relation between the returns on the trading strategies and the macroeconomy

This section examines the relation between the return on HML, SMB, and WML and future economic growth. Our analysis makes use of additional data, which are discussed below.

### *4.1. Country variables*

Apart from individual security returns, we use in each country the return on the market portfolio (MKT), dividend yield (DY), short-term interest rate (TB), term spread (TERM), and growth in the Gross Domestic Product (GDP) and the Industrial Production (IDP).

As a proxy for the market portfolio in each country, we use the MSCI country indexes. For a given country, DY represents the dividend yield index created from our database. The dividend index is the ratio of dividends from a market capitalization-weighted portfolio for the past year to the value of the portfolio at quarter-end. The short-term interest rates and the long-term bond yields are from the International Monetary Fund. For Australia, Canada, Switzerland, the United Kingdom, and the United States we use the three-month Treasury bill (TB). For the remaining countries, we use the Call Money Rate. Both the Treasury bill yield and the money rate are the average of daily rates from the last month of the quarter. We create the variable TERM as the difference between the ten-year government bond yield and the TB for each country. TERM measures the slope of a country's yield curve. The GDP and IDP series are obtained from the Organization for Economic Co-operation and Development (OECD) Main Indicators and the National Government Series. All GDP and IDP series are seasonally adjusted. For Japan we use the Gross National Product series, because GDP data are not available. Returns and growth rates used in the tests are continuously compounded.

### *4.2. Returns on the trading strategies at different states of the macroeconomy*

We examine the returns on HML, SMB, and WML at different states of future economic growth. Using quarterly observations, we associate next year's

growth in GDP with past year's annual return, and we subsequently sort by growth in GDP every quarter. We call 'good states' of the economy those states that exhibit the highest 25% of future GDP growth, and 'bad states' those with the lowest 25% of future GDP growth.

The results are presented in Table 4. They show that the returns on HML and SMB are positively related to future growth in the macroeconomy. High portfolio returns precede periods of high GDP growth. Similarly, low portfolio returns are associated with low future GDP growth. The difference in returns between good and bad states of the economy is positive for HML in seven out of the ten countries. Similarly, the difference is positive in nine out of ten countries for SMB. In several cases, the difference in returns is statistically significant. In contrast, WML produces a positive difference in only two countries, and it is not statistically significant.

### *4.3. The relation between the return on the trading strategies and the macroeconomy using regression analysis*

In this section, we examine the relation between HML, SMB, and WML and future GDP growth using univariate and multivariate regression analysis.

#### *4.3.1. Univariate regressions*

The results of Section 4.2 are confirmed here using regression analysis. Table 4 reports results from univariate regressions of future growth in GDP on past holding period returns in HML, SMB, and WML. The portfolios are rebalanced annually. The regressions use quarterly data and are of the form

$$\mathrm{GDPgrowth}_{(t,t+4)} = a + b{*}\mathrm{FactorRet}_{(t-4,t)} + e_{(t,t+4)}, \tag{1}$$

where GDPgrowth is growth rate for country's GDP; FactorRet is MKT, HML, SMB, or WML; and $e_{(t,t+4)}$ is the residual term of the regression.

GDP growth rates are observed at quarterly frequencies, and therefore, consecutive annual growth rates have three overlapping quarters. This induces serial correlation in the residuals of our regressions. To correct for this, we use the Newey and West (1987) estimator and set the parameter $q$ equal to three.[3]

Fama (1981) documents the presence of a positive and statistically significant relation between the market factor and future economic growth in the United States. Aylward and Glen (1995) extend his analysis using international data. Our results confirm the presence of such a relation. More importantly, we show that a positive and equally strong relation also exists between the performance of HML, SMB, and future economic growth.

[3] Our results remain qualitatively the same when the parameter $q$ in the Newey–West estimator takes the alternative values of 4, 5, or 6.

Table 4
The performance of the HML, SMB, and WML strategies at 'good states' and 'bad states' of the economy

The results are based on the annually rebalanced HML, SMB, and WML portfolios. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing stocks of the past year ('losers'), holding the book-to-market and size effects of the portfolio constant. GDP growth is calculated as the continuously compounded growth rate in a country's Gross Domestic Product, which is seasonally adjusted. For Japan, we use the seasonally adjusted Gross National Product. We characterize as 'good states' of the economy those states that exhibit the highest 25% of future GDP growth, and 'bad states' those with the lowest 25% of future GDP growth. *T*-values are computed for the difference between the return in good states and bad states of the economy. The tests are performed in the local currency of each country.

| Country | Past year return on factor sorted by future GDP growth: quarterly observations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HML | | | | SMB | | | | WML | | | |
| | Good states (%) | Bad states (%) | Difference (%) | *T*-value | Good states (%) | Bad states (%) | Difference (%) | *T*-value | Good states (%) | Bad states (%) | Difference (%) | *T*-value |
| Australia | − 3.81 | 11.92 | − 15.73 | − 1.54 | 22.91 | − 5.74 | 28.65 | 1.70 | 34.60 | − 5.25 | 39.85 | 1.36 |
| Canada | 3.47 | 5.28 | − 1.81 | − 0.24 | 7.44 | 1.73 | 5.71 | 0.92 | − 6.71 | 6.63 | − 13.34 | − 1.20 |
| France | 21.25 | 6.27 | 14.98 | 1.45 | 18.67 | − 2.47 | 21.14 | 1.80 | 0.24 | 3.74 | − 3.50 | − 0.33 |
| Germany | 4.63 | 2.93 | 1.70 | 0.38 | 19.41 | − 4.29 | 23.70 | 1.45 | 7.64 | 8.82 | − 1.18 | − 0.10 |
| Italy | 19.98 | 2.93 | 17.05 | 4.62 | 15.68 | − 13.33 | 29.01 | 2.81 | 0.92 | 1.93 | − 1.01 | − 0.08 |
| Japan | 7.53 | 8.52 | − 0.99 | − 0.16 | 20.29 | 2.20 | 18.09 | 1.86 | − 5.12 | − 3.95 | − 1.17 | − 0.19 |
| Netherlands | 2.54 | − 2.19 | 4.73 | 0.64 | − 1.41 | 2.68 | − 4.09 | − 0.42 | 9.96 | − 0.19 | 10.15 | 0.93 |
| Switzerland | 21.99 | 7.22 | 14.77 | 1.74 | 7.85 | − 12.12 | 19.97 | 2.76 | 0.31 | 6.20 | − 5.89 | − 0.66 |
| United Kingdom | 9.95 | 1.46 | 8.49 | 1.49 | 9.46 | − 9.67 | 19.13 | 1.97 | 5.27 | 14.42 | − 9.15 | − 1.46 |
| United States | 4.32 | 1.18 | 3.14 | 0.47 | 17.85 | − 1.65 | 19.50 | 2.29 | 1.11 | 5.11 | − 4.00 | − 0.67 |

A positive relation would exist, if high returns in HML and SMB are associated with future good states of the economy. That would mean that high $B/M$ and small capitalization stocks are better able to prosper than low $B/M$ and big capitalization stocks when periods of high economic growth are expected. The observed positive relation between HML and SMB and future GDP growth makes sense. Presumably, investors would rather hold stocks whose returns are relatively high when they discover that the economy is in a bad state. They therefore hold low $B/M$ and big capitalization stocks with good growth opportunities and typically low debt ratios.[4]

Table 5 shows that the coefficients are positive in eight of the ten countries for HML, ten for SMB and six for WML. Five coefficients are statistically significant in the case of HML and seven in the case of SMB. Only two coefficients are statistically significant in the case of WML. In general, the returns of the WML strategy appear to contain little, if any, information about future economic growth.

The information contained in the returns of HML and SMB about future economic growth is largely independent of the information contained in the market factor. Results from regressions of HML, SMB, and WML on the market factor, not reported here, show that the beta coefficients are generally small and often statistically insignificant. Therefore, the positive relation between HML, SMB, and future economic growth is unlikely to be induced by the known positive relation between the market factor and future economic growth. This hypothesis is confirmed by the results of the following section.

*4.3.2. Multiple regressions that include the market factor*

In this section we explicitly compare the information content of HML and SMB with that of MKT.

The bivariate regressions we estimate include the market factor and the return on a trading strategy:

$$\mathrm{GDPgrowth}_{(t,t+4)} = a + b^{*}\mathrm{MKT}_{(t-4,t)} + c^{*}\mathrm{FactorRet}_{(t-4,t)} + k_{(t,t+4)}, \tag{2}$$

where MKT is quarterly excess market return over the risk-free rate; FactorRet stands for quarterly returns on HML, SMB, and WML; and $k_{(t,t+4)}$ are the residuals of the regression.

Table 6 reports the results. Even in the presence of the market factor, the coefficients of HML and SMB remain positive, while their magnitude in most countries is largely unchanged. Furthermore, the predictive ability of the market factor remains. HML has a statistically significant coefficient in France, Germany, Italy, the Netherlands, Switzerland, the United Kingdom, and the United

[4] We are thankful to the referee for providing us with this insight.

Table 5
Univariate regressions of GDP growth rates conditional on past four-quarters of factor returns

$$\text{GDPgrowth}_{(t,\,t+4)} = a + b{*}\text{FactorRet}_{(t-4,\,t)} + e_{(t,\,t+4)}$$

In the regression notation, 'FactorRet' stands for MKT, HML, SMB, and WML. MKT is the excess return on the local market index proxied by the Morgan Stanley Capital International index. The regressions use the annually rebalanced HML, SMB, and WML portfolios. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing stocks of the past year ('losers'), holding the book-to-market and size effects of the portfolio constant. GDP growth is calculated as the continuously compounded growth rate in a country's Gross Domestic Product, which is seasonally adjusted. For Japan, we use the seasonally adjusted Gross National Product. All returns are annualized and continuously compounded. All tests are performed in the local currency of each country. *T*-values are corrected for heteroskedasticity and serial correlation, up to three lags, using the Newey and West (1987) estimator.

| Country | Slope coefficients | | | | *T*-values | | | | Coefficients of determination (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MKT | HML | SML | WML | MKT | HML | SMB | WML | MKT | HML | SMB | WML |
| Australia | 0.026 | − 0.002 | 0.050 | 0.022 | 1.40 | − 0.12 | 3.94 | 2.09 | 4.2 | − 2.5 | 37.1 | 8.6 |
| Canada | 0.049 | − 0.025 | 0.075 | 0.016 | 2.48 | − 0.68 | 3.48 | 0.67 | 11.6 | − 0.19 | 9.6 | − 0.2 |
| France | 0.011 | 0.063 | 0.090 | 0.001 | 0.68 | 2.80 | 4.04 | 0.03 | − 0.5 | 20.8 | 30.7 | − 2.1 |
| Germany | 0.054 | 0.266 | 0.082 | 0.002 | 1.10 | 4.04 | 1.64 | 0.01 | 2.8 | − 1.0 | 10.3 | − 4.7 |
| Italy | 0.035 | 0.067 | 0.064 | − 0.022 | 2.91 | 3.01 | 3.07 | − 0.98 | 29.1 | 30.2 | 22.7 | − 0.4 |
| Japan | 0.030 | 0.036 | 0.035 | 0.036 | 1.98 | 1.15 | 1.35 | 1.16 | 12.0 | 0.9 | 3.8 | 1.0 |
| Netherlands | 0.033 | 0.030 | 0.033 | 0.020 | 1.74 | 1.22 | 1.20 | 0.83 | 5.9 | 2.9 | 1.8 | 0.5 |
| Switzerland | − 0.004 | 0.126 | 0.079 | − 0.107 | − 0.14 | 6.54 | 5.78 | − 2.00 | − 2.7 | 52.5 | 35.7 | 9.8 |
| United Kingdom | 0.072 | 0.075 | 0.088 | − 0.083 | 2.96 | 1.90 | 4.51 | − 1.58 | 14.5 | 8.2 | 25.4 | 4.9 |
| United States | 0.059 | 0.046 | 0.056 | − 0.016 | 2.85 | 1.53 | 1.84 | − 0.51 | 12.7 | 3.5 | 9.5 | − 0.9 |

Table 6
Predicting annual Gross Domestic Product (GDP) growth rates conditional on information about the return on the market and HML, SMB, and WML Trading Strategies via bivariate regressions

In $\text{GDPgrowth}_{(t,t+4)} = a + b*\text{MKT}_{(t-4,t)} + c*\text{FactorRet}_{(t-4,t)} + k_{(t,t+4)}$, MKT is the excess return on the local market portfolio and it is proxied by the MSCI country index. 'FactorRet' stands for HML, SMB, and WML. The HML, SMB and WML portfolios are annually rebalanced. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. WML is the return on a portfolio that is long on the best performing stocks of the past year ('winners') and short on the worst performing stocks of the past year ('losers'), holding the book-to-market and size effects of the portfolio constant. GDP growth is calculated as the continuously compounded growth rate in a country's Gross Domestic Product, which is seasonally adjusted. For Japan, we use the seasonally adjusted Gross National Product. All returns are annualized and continuously compounded. The regressions are performed in the local currency of each country. $T$-values are corrected for heteroskedasticity and serial correlation, up to three lags, using the Newey and West (1987) estimator. $R^2$ are adjusted for degrees of freedom.

| Country | MKT | | HML | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|
| | Slope | $T$-value | Slope | $T$-value | |
| Australia | 0.029 | 1.63 | 0.010 | 0.55 | 2.4 |
| Canada | 0.050 | 2.41 | 0.003 | 0.08 | 10.2 |
| France | − 0.007 | − 0.48 | 0.068 | 2.69 | 19.6 |
| Germany | 0.036 | 0.81 | 0.166 | 2.13 | 6.2 |
| Italy | 0.023 | 2.32 | 0.046 | 2.49 | 39.2 |
| Japan | 0.030 | 2.25 | 0.041 | 1.30 | 14.0 |
| Netherlands | 0.046 | 2.73 | 0.048 | 2.01 | 14.5 |
| Switzerland | − 0.030 | − 1.46 | 0.142 | 6.00 | 59.1 |
| United Kingdom | 0.071 | 3.34 | 0.073 | 2.32 | 22.6 |
| United States | 0.080 | 3.73 | 0.083 | 3.05 | 25.5 |

| Country | MKT | | SMB | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|
| | Slope | T-value | Slope | T-value | |
| Australia | 0.002 | 0.18 | 0.049 | 3.89 | 35.5 |
| Canada | 0.055 | 3.09 | 0.086 | 3.42 | 24.7 |
| France | 0.004 | 0.24 | 0.089 | 3.99 | 29.4 |
| Germany | 0.122 | 2.53 | 0.205 | 2.96 | 42.9 |
| Italy | 0.029 | 2.54 | 0.048 | 3.16 | 40.3 |
| Japan | 0.028 | 1.83 | 0.031 | 1.38 | 14.9 |
| Netherlands | 0.044 | 2.78 | 0.054 | 2.69 | 12.7 |
| Switzerland | 0.023 | 0.96 | 0.090 | 5.89 | 38.7 |
| United Kingdom | 0.054 | 2.69 | 0.076 | 4.37 | 32.9 |
| United States | 0.047 | 2.50 | 0.041 | 1.49 | 16.8 |

Table 6 (*continued*)

| Country | MKT | | WML | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|
| | Slope | *T*-value | Slope | *T*-value | |
| Australia | 0.013 | 0.60 | 0.017 | 1.41 | 7.5 |
| Canada | 0.048 | 2.42 | 0.010 | 0.52 | 10.7 |
| France | 0.025 | 1.59 | − 0.098 | − 2.37 | 16.6 |
| Germany | 0.041 | 0.86 | 0.122 | 1.09 | 9.2 |
| Italy | 0.036 | 2.97 | 0.006 | 0.31 | 27.0 |
| Japan | 0.027 | 2.10 | 0.072 | 1.99 | 19.2 |
| Netherlands | 0.031 | 1.67 | 0.007 | 0.33 | 4.7 |
| Switzerland | − 0.009 | − 0.33 | − 0.111 | − 2.33 | 8.0 |
| United Kingdom | 0.071 | 3.22 | − 0.080 | − 1.43 | 19.2 |
| United States | 0.079 | 3.43 | − 0.069 | − 2.44 | 18.3 |

States. The coefficient of SMB is significant in Australia, Canada, France, Germany, Italy, the Netherlands, Switzerland, and the UK. As expected, the adjusted $R^2$ are now larger than those from the univariate regressions of Section 4.3.1 that included only the market factor. Therefore, the returns of HML and SMB contain information about the future state of the macroeconomy, over and above the information contained in the market factor. Once again, WML appears to have limited ability to explain future economic growth.

We now run a horse race between HML and SMB by estimating the following regression model:

$$\text{GDPgrowth}_{(t,t+4)} = a + b*\text{MKT}_{(t-4,t)} + c*\text{HML}_{(t-4,t)} + d*\text{SMB}_{(t-4,t)} + u_{(t,t+4)}, \quad (3)$$

where $u_{(t,t+4)}$ denotes the residuals of the regression.

Table 7 reports the results. A comparison of the coefficients in Tables 5 and 6 reveals that, in most countries, the sign and magnitude of the coefficients remain relatively stable in the presence of both factors. Furthermore, in eight out of the ten countries, either HML or SMB remains statistically significant. However, the information contained in HML and SMB about future economic growth seems to some extent to be country-specific. This is plausible, given that the markets examined differ in terms of their size, average market capitalization, and accounting standards.

*4.3.3. Regressions that include business cycle variables and the market factor*

We now examine how much of the information contained in HML and SMB, regarding future economic growth, is also present in popular business cycle

Table 7
Predicting annual Gross Domestic Product (GDP) growth rates conditional on information about the return on the market, HML, and SMB using multivariate regressions

In $\text{GDPgrowth}_{(t,\,t+4)} = a + b*\text{MKT}_{(t-4,\,t)} + c*\text{HML}_{(t-4,\,t)} + d*\text{SMB}_{(t-4,\,t)} + u_{(t,\,t+4)}$, MKT is the excess return on the local market portfolio, and it is proxied by the Morgan Stanley Capital International country index. The regressions use the annually rebalanced HML and SMB portfolios. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. GDP growth is calculated as the continuously compounded growth rate in a country's Gross Domestic Product, which is seasonally adjusted. For Japan, we use the seasonally adjusted Gross National Product. All returns are continuously compounded and expressed in the local currency of each country. $T$-values are corrected for heteroskedasticity and serial correlation, up to three lags, using the Newey and West (1987) estimator. $R^2$ are adjusted for degrees of freedom.

| Country | MKT | | HML | | SMB | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|---|---|
| | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | |
| Australia | 0.007 | 0.53 | 0.014 | 1.15 | 0.050 | 3.93 | 35.4 |
| Canada | 0.051 | 2.89 | −0.019 | −0.56 | 0.090 | 3.19 | 24.2 |
| France | −0.008 | −0.48 | 0.048 | 1.82 | 0.073 | 3.46 | 38.2 |
| Germany | 0.123 | 2.41 | −0.007 | −0.08 | 0.206 | 2.91 | 41.0 |
| Italy | 0.025 | 2.45 | 0.023 | 0.86 | 0.031 | 1.68 | 39.6 |
| Japan | 0.029 | 2.06 | 0.032 | 1.04 | 0.026 | 1.21 | 15.4 |
| Netherlands | 0.051 | 3.52 | 0.038 | 1.61 | 0.039 | 2.06 | 17.1 |
| Switzerland | −0.015 | −0.67 | 0.116 | 3.72 | 0.029 | 1.54 | 60.3 |
| United Kingdom | 0.055 | 3.04 | 0.048 | 1.67 | 0.067 | 3.35 | 35.8 |
| United States | 0.069 | 3.43 | 0.081 | 3.31 | 0.040 | 1.61 | 29.7 |

variables. The multiple regressions estimated are of the form:

$$\begin{aligned}\text{GDPgrowth}_{(t,t+4)} = {} & a + b*\text{MKT}_{(t-4,t)} + c*\text{FactorRet}_{(t-4,t)} \\ & + d*\text{TB}_{(t)} + f*\text{DY}_{(t)} + g*\text{TERM}_{(t)} \\ & + h*\text{IDPgrowth}_{(t-4,t)} + q_{(t,t+4)}, \end{aligned} \tag{4}$$

where $\text{TB}_{(t)}$ is the Treasury bill yield or Call Money Rate; $\text{DY}_{(t)}$ is dividend yield on country market capitalization index; $\text{TERM}_{(t)}$ is ten-year government yield minus $\text{TB}_{(t)}$; $\text{IDPgrowth}_{(t-4,t)}$ is past one-year growth in country industrial production; and $q_{(t,t+4)}$ are the residuals of the regression.

Table 8 has the results. Even in the presence of business cycle variables in addition to the market factor, HML continues to have a positive relation with

Table 8
The ability of stock market factors to predict annual Gross Domestic Product (GDP) growth in the presence of business cycle variables

In $\text{GDPgrowth}_{(t,\,t+4)} = a + b*\text{MKT}_{(t-4,\,t)} + c*\text{FactorRet}_{(t-4,\,t)} + d*\text{TB}_{(t)} + f*\text{DY}_{(t)} + g*\text{TERM}_{(t)} + h*\text{IDPgrowth}_{(t-4,\,t)} + q_{(t,\,t+4)}$, MKT is the excess return on the local market portfolio, and it is proxied by the Morgan Stanley Capital International country index. In the regression notation, FactorRet stands for HML and SMB. The HML and SMB portfolios are annually rebalanced. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. TB denotes the Treasury bill yield. DY is the dividend yield on a country's market capitalization weighted index. TERM stands for the difference between the yield on a ten-year government bond and the TB rate. Both Industrial Production (IDP) and GDP growth rates are continuously compounded and seasonally adjusted. For Japan, we use the seasonally adjusted Gross National Product. All returns are continuously compounded and expressed in the local currency of each country. $T$-values are corrected for heteroskedasticity and serial correlation, up to three lags, using the Newey and West (1987) estimator. $R^2$ are adjusted for degrees of freedom.

| Country | MKT | | HML | | TB | | DY | | TERM | | IDP growth | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | |
| Australia | − 0.046 | 2.43 | − 0.021 | − 1.43 | 0.024 | 0.35 | − 0.729 | − 5.43 | 0.067 | 0.78 | − 0.204 | − 3.95 | 38.7 |
| Canada | 0.053 | 5.83 | 0.003 | 0.15 | − 0.754 | − 5.31 | 0.224 | 0.79 | 0.359 | 4.21 | − 0.079 | − 1.13 | 46.9 |
| France | − 0.010 | − 0.73 | 0.076 | 4.21 | − 0.428 | − 3.22 | − 0.294 | − 1.86 | 0.091 | 1.06 | − 0.067 | − 0.66 | 39.4 |
| Germany | 0.076 | 1.47 | 0.256 | 1.81 | 0.787 | 1.43 | − 0.233 | − 0.20 | 1.229 | 2.10 | − 0.179 | − 0.94 | 28.6 |
| Italy | 0.016 | 1.58 | 0.029 | 1.19 | − 0.480 | − 4.34 | 0.257 | 1.24 | − 0.145 | − 2.05 | 0.023 | 0.31 | 55.8 |
| Japan | 0.024 | 2.06 | 0.038 | 1.50 | − 0.015 | − 0.08 | − 0.366 | − 0.90 | 0.160 | 0.86 | 0.211 | 3.51 | 50.8 |
| Netherlands | 0.015 | 0.95 | 0.022 | 0.99 | − 0.433 | − 3.72 | 0.064 | 0.62 | − 0.179 | − 1.56 | − 0.004 | − 0.05 | 40.8 |
| Switzerland | − 0.009 | − 0.64 | 0.093 | 6.25 | − 0.331 | − 3.38 | 0.739 | 2.72 | − 0.550 | − 3.94 | 0.017 | 0.38 | 78.7 |
| United Kingdom | 0.050 | 2.63 | 0.050 | 2.25 | − 0.006 | − 0.04 | − 0.213 | − 0.89 | 0.488 | 2.85 | 0.042 | 0.46 | 55.5 |
| United States | 0.070 | 2.96 | 0.004 | 0.11 | − 0.307 | − 1.10 | 0.416 | 1.50 | 0.462 | 1.64 | 0.028 | 0.34 | 43.1 |

| Country | MKT | | SMB | | TB | | DY | | TERM | | IDP growth | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | |
| Australia | − 0.035 | − 2.10 | 0.044 | 3.90 | 0.052 | 0.90 | − 0.481 | − 3.44 | 0.104 | 2.10 | − 0.199 | − 4.83 | 53.8 |
| Canada | 0.055 | 4.76 | 0.029 | 0.93 | − 0.686 | − 3.55 | 0.282 | 1.12 | 0.331 | 3.88 | − 0.054 | − 0.87 | 48.0 |
| France | − 0.009 | − 0.73 | 0.076 | 4.22 | − 0.429 | − 3.22 | − 0.294 | − 1.86 | 0.091 | 1.06 | − 0.067 | − 0.66 | 39.4 |
| Germany | 0.201 | 3.36 | 0.305 | 4.27 | − 0.009 | − 0.03 | 0.115 | 0.12 | 1.375 | 2.99 | − 0.715 | − 3.12 | 61.1 |
| Italy | 0.015 | 1.24 | 0.028 | 1.57 | − 0.434 | − 3.59 | 0.134 | 0.53 | − 0.148 | − 2.27 | 0.012 | 0.151 | 56.4 |
| Japan | 0.025 | 2.38 | − 0.024 | − 1.04 | 0.094 | 0.47 | − 0.581 | − 1.38 | 0.141 | 0.82 | 0.220 | 3.65 | 50.4 |
| Netherlands | 0.017 | 1.42 | 0.033 | 2.19 | − 0.404 | − 3.43 | 0.042 | 0.42 | − 0.186 | − 1.68 | − 0.022 | − 0.29 | 42.0 |
| Switzerland | 0.049 | 2.70 | 0.059 | 3.15 | − 0.305 | − 3.39 | 1.339 | 3.91 | − 0.564 | − 2.32 | 0.100 | 3.06 | 71.6 |
| United Kingdom | 0.044 | 2.29 | 0.020 | 0.85 | 0.135 | 0.69 | − 0.317 | − 1.13 | 0.534 | 2.53 | 0.058 | 0.61 | 53.2 |
| United States | 0.056 | 3.27 | 0.044 | 2.23 | − 0.355 | − 1.21 | 0.443 | 1.66 | 0.433 | 1.53 | 0.017 | 0.22 | 50.2 |

future economic growth in all countries except Australia. Furthermore, this relation is statistically significant in France, Germany, Switzerland, and the United Kingdom (see first panel). The predictive ability of HML is subsumed by the presence of business cycle variables in Italy, the Netherlands, and the United States.

SMB also maintains a positive relation with future economic growth in all countries except Japan, and the relation is statistically significant in Australia, France, Germany, the Netherlands, Switzerland, and the United States. In the case of SMB, business cycle variables subsume its predictive ability in Canada, Italy, and the United Kingdom (see second panel).

Furthermore, we perform regressions that include HML and SMB, as well as the business cycle variables. The results are reported in Table 9. The coefficients of HML and SMB do not change substantially compared with those reported in Table 8. HML has now a reliably positive coefficient in France, Switzerland, and the United Kingdom, and marginally in Japan. In addition, SMB has a positive and significant coefficient in Australia, France, Germany, the Netherlands, and the United States.

Some overlap exists in the information content of HML, SMB, and the business cycle variables. Our aim in this section is not to propose a new model for predicting future economic growth. Instead, we show that HML and SMB contain significant information regarding future growth in the economy. We also show that some of this information is similar in nature to that contained in popular business cycle variables.

Our findings support the Fama and French (1992, 1993, 1995, 1996, 1998) hypothesis. They imply that it is reasonable to consider HML and SMB as state variables in the context of Merton's intertemporal capital asset pricing model, because they can predict future changes in the investment opportunity set.

## 5. HML, SMB, and future economic growth in the United States: 1957–1998

In this section, we extend the evidence for the United States using the HML and SMB factors constructed by Fama and French.[5] The results cover the period from 1957 : 01 to 1998 : 12, which corresponds to the period during which data for all other variables are also available.[6]

[5] We are grateful to Kenneth French for providing the data on the HML, SMB and market factors, as well as the risk-free rate, for this section of our paper. The HML and SMB factors of Fama and French cover the period from 1927 to 1998. Details on the properties of the series are provided in Davis et al. (2000). In the current study, we extend our evidence only back to 1957 because GDP data are unavailable prior to that date.

[6] The multivariate regressions omit the dividend yield variable because of unavailability.

Table 9
The ability of stock market factors to predict annual Gross Domestic Product (GDP) growth in the presence of business cycle variables

In $\text{GDPgrowth}_{(t,t+4)} = a + b*\text{MKT}_{(t-4,t)} + c*\text{HML}_{(t-4,t)} + d*\text{SMB}_{(t-4,t)} + f*\text{TB}_{(t)} + g*\text{DY}_{(t)} + h*\text{TERM}_{(t)} + i*\text{IDPgrowth}_{(t-4,t)} + v_{(t,t+4)}$, MKT is the excess return on the local market portfolio and it is proxied by the Morgan Stanley Capital International country index. We use the annually rebalanced HML and SMB portfolios. HML is the return on a portfolio that is long on high book-to-market stocks and short on low book-to-market stocks, holding the size and momentum characteristics of the portfolio constant. SMB is the return on a portfolio that is long on small capitalization stocks and short on big capitalization stocks, holding the book-to-market and momentum characteristics of the portfolio constant. TB denotes the annual Treasury bill yield. DY is the dividend yield on a country's market capitalization weighted index. TERM stands for the premium on a ten-year government bond minus the TB rate. Both Industrial Production (IDP) and GDP growth rates are continuously compounded and seasonally adjusted. For Japan, we use the seasonally adjusted Gross National Product. All returns are continuously compounded and expressed in the local currency of each country. $T$-values are corrected for heteroskedasticity and serial correlation, up to three lags, using the Newey and West (1987) estimator. $R^2$ are adjusted for degrees of freedom.

| Country | MKT | | HML | | SMB | | TB | | DY | | TERM | | IDP growth | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | |
| Australia | −0.043 | −2.55 | −0.010 | −1.26 | 0.042 | 3.77 | 0.051 | 0.92 | −0.532 | −3.86 | 0.117 | 2.18 | −0.207 | −4.76 | 53.1 |
| Canada | 0.053 | 5.15 | −0.007 | −0.28 | 0.032 | 0.93 | −0.676 | −3.39 | 0.272 | 1.08 | 0.331 | 3.93 | −0.048 | −0.76 | 47.2 |
| France | −0.015 | −1.03 | 0.059 | 3.74 | 0.074 | 4.18 | −0.315 | −2.73 | −0.323 | −2.12 | 0.063 | 0.84 | −0.208 | −2.15 | 52.4 |
| Germany | 0.166 | 2.86 | 0.171 | 1.57 | 0.294 | 4.08 | 0.246 | 0.67 | −0.507 | −0.55 | 1.445 | 3.33 | −0.839 | −3.71 | 62.5 |
| Italy | 0.014 | 1.27 | 0.011 | 0.36 | 0.021 | 1.00 | −0.450 | −3.67 | 0.172 | 0.64 | −0.143 | −2.00 | 0.009 | 0.11 | 54.8 |
| Japan | 0.025 | 2.58 | 0.045 | 1.69 | −0.029 | −1.34 | −0.004 | −0.02 | −0.502 | −1.23 | 0.198 | 1.02 | 0.233 | 4.15 | 52.7 |
| Netherlands | 0.021 | 1.49 | 0.015 | 0.67 | 0.028 | 1.67 | −0.408 | −3.57 | 0.048 | 0.48 | −0.169 | −1.43 | −0.028 | −0.37 | 41.9 |
| Switzerland | −0.001 | −0.05 | 0.085 | 4.77 | 0.010 | 0.42 | −0.333 | −3.50 | 0.835 | 2.66 | −0.519 | −3.02 | 0.022 | 0.56 | 78.1 |
| United Kingdom | 0.049 | 2.54 | 0.052 | 2.38 | 0.023 | 0.97 | −0.058 | −0.32 | −0.135 | −0.51 | 0.388 | 1.89 | 0.012 | 0.12 | 55.8 |
| United States | 0.056 | 3.03 | 0.004 | 0.13 | 0.044 | 2.23 | −0.353 | −1.20 | 0.437 | 1.67 | 0.420 | 1.47 | 0.013 | 0.16 | 49.4 |

HML produces a return of 4.37% in 'good states' of the economy and 2.85% in 'bad states' of the economy. However, the difference in returns is not statistically significant ($t$-value: 0.32). In contrast, SMB delivers a return of 5.96% in 'good states', but a negative return of $-4.61\%$ in 'bad states'. The difference of 10.6 percentage points has a $t$-value of 2.5. These results are similar to those reported for our U.S. sample.

The HML and SMB factors are again 'market neutral'. SMB has a beta with the market of 0.20, whereas HML has a beta of $-0.21$.

Regression results are reported in Table 10. Similar to our previous findings, univariate regressions of future GDP growth on SMB or HML do not produce coefficients that are statistically significant at the 5% level. In the multivariate regressions, the coefficients are always positive. This is consistent with our previous results. In addition, Table 10 shows that one SMB coefficient is marginally statistically significant at the 10% level. This is not the case in our previous tests, where either the HML or SMB coefficient is statistically significant at the 5% level.

The discrepancy in the results can be attributed, to some extent, to the different time period. When we repeat the tests for the 1979Q2–1996Q3 period using the HML and SMB factors constructed by Fama and French, HML has statistically significant coefficients in the multivariate regressions.

## 6. The benefits of using international data

Although the results on the extended U.S. sample are not strong, they do not necessarily weaken our evidence on the relation between HML, SMB, and future economic growth. The advantage of performing the same tests for many countries is that the findings may no longer be sample-specific. The correlations of factors across countries are low, although not zero, and should provide some degree of independence in tests repeated for many countries.

To give an idea of the level of independence of factors across countries, we express all variables in U.S. dollars and regress future GDP growth in each country on the U.S. market, HML and SMB factors. If the factors were practically identical, we would expect to find the same results as those reported earlier, independently of whether we use the local or U.S. factors. That is far from the case. We no longer find a consistently positive relation between the factors and economic growth. The coefficients are often statistically insignificant. When we add in the regressions the local factor, its coefficient is always positive and statistically significant. Given the space limitations, we do not report them here.

The above findings reveal the benefits of providing international evidence on the relation between the return factors and future economic growth. MacKinlay (1995) raises the concern that the Fama and French (1992, 1993) results may stem from data snooping. Given the results we present in this paper, data snooping becomes less of a concern.

Table 10
HML, SMB, and future economic growth in the United States, 1957 : 01 to 1998 : 12

All regressions in this table use the HML and SMB factors constructed by Fama and French. TB denotes the annual Treasury bill yield. TERM stands for the premium on a ten-year government bond minus the TB rate. Both Industrial Production (IDP) and Gross Domestic Product (GDP) growth rates are continuously compounded and seasonally adjusted. All returns are continuously compounded and expressed in U.S. dollars. $T$-values are corrected for heteroskedasticity and serial correlation, up to three lags, using the Newey and West (1987) estimator. $R^2$ are adjusted for degrees of freedom.

| Regressions | MKT | | HML | | SMB | | TB | | TERM | | IDP growth | | Adjusted $R^2$ (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | Slope | $T$-value | |
| Univariate | 0.047 | 3.59 | | | | | | | | | | | 10.6 |
| | | | − 0.008 | − 0.20 | | | | | | | | | 0.11 |
| | | | | | 0.035 | 1.21 | | | | | | | 3.08 |
| Multivariate | 0.052 | 4.10 | 0.024 | 0.81 | | | | | | | | | 10.4 |
| | 0.043 | 3.63 | | | 0.016 | 0.58 | | | | | | | 10.0 |
| | 0.048 | 4.09 | 0.025 | 0.88 | 0.017 | 0.64 | | | | | | | 10.5 |
| | 0.031 | 2.09 | 0.011 | 0.38 | | | − 0.394 | − 3.95 | 0.463 | 1.89 | − 0.057 | − 1.44 | 41.0 |
| | 0.024 | 1.82 | 0.012 | 0.45 | 0.027 | 1.67 | − 0.404 | − 4.05 | 0.463 | 1.91 | − 0.060 | − 1.53 | 42.2 |

## 7. Conclusions

The aim of this study was to investigate the extent to which the profitability of HML, SMB, and WML can be linked to future economic growth.

Using data from ten developed markets, we found that at least HML and SMB contain significant information about future GDP growth. The predictive ability of these return factors is to a large degree independent of any information contained in the market factor. The regression coefficients on HML, SMB, and the market are generally positive and of similar magnitude. Even in the presence of popular business cycle variables, HML and SMB retain their ability to predict future economic growth in some of the countries examined.

The results of this study suggest that a risk-based explanation for the returns of HML and SMB is plausible and likely. Fama and French (1993, 1995, 1996, 1998) argue that HML and SMB are state variables that predict future changes in the investment opportunity set in the context of Merton's (1973) intertemporal asset pricing model. Our findings support this hypothesis. Finally, our analysis reveals little evidence to support a similar explanation for the returns of WML.

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