Are the Fama and French Factors Global or Country Specific?

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This article examines whether country-specific or global versions of Fama and French's three-factor model better explain time-series variation in international stock returns. Regressions for portfolios and individual stocks indicate that domestic factor models explain much more time-series variation in returns and generally have lower pricing errors than the world factor model. In addition, decomposing the world factors into domestic and foreign components demonstrates that the addition of foreign factors to domestic models leads to less accurate in-sample and out-of-sample pricing. Practical applications of the three-factor model, such as cost of capital calculations and performance evaluations, are best performed on a country-specific basis.

The three-factor model of Fama and French (1993) posits that expected returns can be explained by the excess market return, a size factor (*SMB*), and a book-to-market equity factor (*HML*). In a later study, Fama and French (1998) extend the model to a global context and provide evidence that a two-factor model with a world market and world book-to-market equity (*WHML*) factor explains international stock returns better than the world capital asset pricing model (CAPM).

This article provides a comprehensive examination of whether the time-series variation in stock returns is best characterized by country-specific or global versions of these factors. This is an important question, because the choice of a domestic or global model can substantially affect expected return estimates. For example, for U.S. stocks, the average difference between the domestic and global three-factor model expected return estimates is 8.41%

The first group [Lakonishok, Shleifer, and Vishny (1994), Haugen (1995)] argues that the size and book-to-market equity effects are due to investor overreaction rather than compensation for risk bearing. They argue that investors systematically overreact to recent corporate news, unrealistically extrapolating high or low growth into the future. This, in turn, leads to under-foreign factors to domestic three-factor models. Adding foreign factors leads to a statistically significant but economically small increase in explanatory power. Furthermore, country-specific three-factor models have lower in-sample and out-of-sample pricing errors than models that include foreign factors. The findings here indicate that there are no benefits to extending the three-factor model to an international context.

Section 1 presents the world model and distinguishes it from international and country-specific models. Section 2 explains the data and descriptive statistics. In Section 3 we use portfolios to examine the relative performance of domestic, world, and international models. Section 4 uses individual stock returns to analyze the usefulness of these models and Section 5 examines the out-of-sample accuracy of these models. Section 6 examines an alternative formation of global factors, the relative performance of other international factor models, the usefulness of foreign factors, and cross-sectional regression results. Section 7 concludes.

1. Three Empirical Models

Fama and French (1993) propose a three-factor model in which the factors are the market return in excess of the risk-free rate (*MRF*), the difference between the returns on small and large capitalization portfolios (*SMB*, small minus big), and the difference between the returns on high and low book-to-market portfolios (*HML*, high minus low). In an efficient and integrated international capital market, there should be only one set of risk factors that describe expected returns in all countries. The world factor model regression describes the dollar-denominated return on domestic asset i in excess of the dollar-denominated domestic risk-free rate, r_i, as follows:[3]

$$r_{it} = \alpha_i + b_i(WMRF_t) + s_i(WSMB_t) + h_i(WHML_t) + \varepsilon_i, \qquad (1)$$

where b_i, s_i, and h_i are the unconditional sensitivities of the ith asset to the factors.[4]

The world factors are weighted averages of the country-specific components, for example, $WMRF_t = w_{Dt-1}DMRF_t + w_{Ft-1}FMRF_t$, where w_{Dt-1} is the fraction of the total dollar-denominated market capitalization of the countries in the sample attributable to the domestic market in the previous month, and w_{Ft-1} is the fraction of the total market capitalization in the previous

[3] As noted by Solnik (1983), when expressed in the foreign currency, the risk-free rate's stochastic component is equal to the exchange rate movement. Thus, expressing a foreign security's returns in excess of the local market's risk-free rate in dollar denominated terms reduces the influence of systematic exchange rate shocks.

[4] Unconditional time-series approaches are used here. Conditional approaches to testing international pricing models include those by Harvey (1991), Chan, Karolyi, and Stulz (1992), Ferson and Harvey (1993, 1994, 1997), and Bansal, Hsieh, and Viswanathan (1993), among others. Ferson (1995) provides a comprehensive discussion of the advantages and limitations of testing in a conditional context.

period attributable to foreign market capitalization. The world *HML* and *SMB* factors are also weighted averages of their respective country-specific factors.

and Canada, the United Kingdom, and Japan, particularly after 1980.[5] For this reason, for the empirical tests in this article, we use monthly returns from January 1981 to December 1995. In 1995 the sample comprises 1521 firms in Japan, 1234 in the United Kingdom, and 631 in Canada, for a total of 3386 non-U.S. firms. The large cross section of firms allows a firm-level analysis of the validity of size and book-to-market factors. Appendix A gives the sample construction details.

2.2 Explanatory variables and summary statistics

Table 1 displays means, standard deviations, and correlations of the U.S., Japanese, U.K., and Canadian variables. The U.S. excess market return (*UMRF*) has correlations of 0.33, 0.68, and 0.78 with the Japanese, U.K., and Canadian excess market returns, respectively. The world *SMB* and *HML* factors have high correlations with their country counterparts, reflecting that they are constructed from the country components.[6] Among the various *SMB* and *HML* factors, the correlations across countries are low. These findings support those of Hawawini and Keim (1997), who document size and price-to-book effects in France, the United Kingdom, Germany, Japan, and the United States, but also find low correlations among these premia across markets. The low correlations between *SMB* and *HML* factors across countries are interesting, because we would expect these two variables to be highly correlated if size and book-to-market risk in each country represent the same underlying state variables, and if markets are integrated. For our empirical tests, the low correlations mean that we can include both domestic and foreign factors in the same regressions without concerns about collinearity.

3 Time-Series Tests Using BE/ME Sorted Portfolios

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3.1 BE/ME-sorted portfolios

The dependent variables in the factor model regressions are the dollar-denominated low and high book-to-market equity portfolio returns in excess of the local market's dollar-denominated risk-free rate. This allows comparison to Fama and French (1998). Table 2 presents the average return, the intercept, and the adjusted R^2 for each portfolio. Across both high and low *BE/ME* portfolios in the four countries, the average absolute value of the intercept is 0.25 for the world three-factor model and 0.22 for the purely domestic three-factor model. The domestic model leads to slightly more accurate pricing. The domestic model regressions have much higher adjusted R^2s, indicating that they are more useful for explaining time-series variation in these portfolio returns.

Table 2
Regressions of country high and low book-to-market equity excess portfolio returns on domestic, world, and international Fama and French factors

			Domestic		World		International	
BE/ME	Country	Average return	α	Adj. R^2	α	Adj. R^2	α	Adj. R^2
Panel A: Weighted factors								
High	U.S.	0.89	−0.04	0.936	0.12	0.672	−0.08	0.939
High	Japan	2.02	0.61	0.875	0.25	0.559	0.54	0.883
High	U.K.	1.18	0.05	0.948	−0.11	0.473	0.00	0.949
High	Canada	0.48	−0.11	0.814	−0.25	0.452	−0.23	0.826
Low	U.S.	0.58	−0.14	0.950	0.35	0.712	−0.19	0.951
Low	Japan	1.05	0.60	0.875	−0.12	0.479	0.53	0.882
Low	U.K.	0.52	−0.05	0.947	−0.43	0.427	−0.08	0.946
Low	Canada	0.30	−0.16	0.841	−0.34	0.465	−0.30	0.852
Average		0.88	0.22	0.898	0.25	0.530	0.24	0.904
Panel B: Unweighted factors								
High	U.S.	0.89	−0.03	0.983	0.27	0.683	−0.02	0.983
High	Japan	2.02	0.37	0.906	0.33	0.454	0.35	0.906
High	U.K.	1.18	−0.11	0.961	−0.32	0.656	−0.14	0.961
High	Canada	0.48	−0.21	0.850	−0.46	0.590	−0.26	0.858
Low	U.S.	0.58	−0.14	0.984	0.41	0.700	−0.13	0.985
Low	Japan	1.05	0.35	0.915	−0.03	0.396	0.33	0.915
Low	U.K.	0.52	−0.13	0.956	−0.48	0.610	−0.14	0.955
Low	Canada	0.30	−0.21	0.880	−0.16	0.643	−0.26	0.886
Average		0.88	0.19	0.929	0.31	0.592	0.20	0.931

The table gives the average excess returns, regression intercepts, and adjusted R^2s from domestic, world, and international models. Appendix A details the construction of the high and low book-to-market equity portfolios. The average returns for each of these portfolios in excess of their local market risk-free rates are displayed from January 1978 to December 1995. The following time-series factor model regressions are estimated for each portfolio:

$$\textit{Domestic model: } r_{it} = \alpha_i + b_{Di}(w_{Dt-1}\,DMRF_t) + s_{Di}(w_{Dt-1}\,DSMB_t) + h_{Di}(w_{Dt-1}\,DHML_t) + \varepsilon_i$$

$$\textit{World model: } r_{it} = \alpha_i + b_i(WMRF_t) + s_i(WSMB_t) + h_i(WHML_t) + \varepsilon_i$$

$$\textit{International model: } r_{it} = \alpha_i + b_{Di}(w_{Dt-1}\,DMRF_t) + s_{Di}(w_{Dt-1}\,DSMB_t) + h_{Di}(w_{Dt-1}\,DHML_t) + b_{Fi}(w_{Ft-1}\,FMRF_t) + s_{Fi}(w_{Ft-1}\,FSMB_t) + h_{Fi}(w_{Ft-1}\,FHML_t) + \varepsilon_i$$

The definition and construction of the variables are discussed in Appendix A. Panel A presents intercepts and adjusted R^2s for regressions with factors constructed as market value-weighted averages of local dollar-denominated factors. Panel B presents results with factors that are formed as unweighted ($w_D = w_F = 1$) averages of the local dollar-denominated factors.

When examining high and low book-to-market equity portfolios in each country, Fama and French (1998, Table 4) find that the inclusion of a world *HML* factor leads to intercepts closer to zero and higher adjusted R^2s than does a world CAPM. We find the same result. However, we also find that domestic two-factor models (with the domestic *HML* and *MRF* factors) lead to even lower intercepts and higher adjusted R^2s than the world two-factor model.[7]

Regression results for the international six-factor models yield an average pricing error of 0.24, which is actually 0.02 higher than for the purely domestic model. The average adjusted R^2 from the international models is 0.904, as compared to 0.898 with the purely domestic factor model regressions. Thus the international models have slightly higher explanatory power. However, the international models yield higher absolute intercepts, which signals a greater tendency toward model misspecification. As shown in panel B of Table 2, using equal-weighted averages of the individual country factors gives findings quite similar to the value-weighted results in panel A.

3.2 BE/ME- and size-sorted portfolios

In this section, the dependent variables are the excess returns to 25 portfolios within each country, formed from five independent rankings on size and five rankings on *BE/ME*. (For Canadian equities, we form only nine portfolios because of the limited number of firms.) Table 3 gives the raw portfolio return differences between the extreme high-return (small size, high *BE/ME*) and low-return (large size, low *BE/ME*) portfolios. There is substantial cross-sectional variation between average returns in the extreme portfolios which can provide a more powerful approach for distinguishing between competing global and country-specific regression models. Table 3 presents the difference in time-series regression intercepts between the extreme portfolios.[8] Compared to the domestic models, the world model shows smaller differ-

Table 3
Regressions of size and book-to-market equity excess portfolio returns on domestic, world, and international factors

	U.S.	Japan	U.K.	Canada
Panel A: Raw portfolio returns				
H–L ret.	0.98	2.46	1.20	1.50
p-value	0.08	0.00	0.03	0.01
Avg. |ret|	0.71	1.20	0.61	0.68
A^{VW} |ret|	0.69	0.93	0.56	0.30

	U.S.			Japan			U.K.			Canada		
	Dom.	World	Intl.	Dom.	World	Intl.	Dom.	World	Intl.	Dom.	World	Intl.
Panel B: Weighted factor regressions												
H–L α	0.37	−0.30	0.20	0.40	0.89	0.38	0.63	0.51	0.66	0.81	1.37	0.79
p-value	(0.13)	(0.43)	(0.42)	(0.20)	(0.06)	(0.23)	(0.00)	(0.25)	(0.00)	(0.02)	(0.00)	(0.02)
F-statistic	6.27*	5.87*	5.22*	1.40	1.03	1.26	3.50*	3.70*	3.16*	6.01*	6.23*	5.86*
Avg. |α|	0.34	0.42	0.37	0.48	0.29	0.39	0.29	0.45	0.30	0.48	0.61	0.47
A^{VW}. |α|	0.12	0.56	0.17	0.46	0.33	0.37	0.16	0.09	0.15	0.21	0.60	0.34
Adj. R^2	0.804	0.513	0.807	0.809	0.566	0.813	0.822	0.387	0.821	0.601	0.301	0.610
Panel C: Unweighted factor regressions												
H–L α	0.50	−0.14	0.39	0.36	0.82	0.27	0.58	0.12	0.60	0.82	1.04	0.77
p-value	(0.03)	(0.71)	(0.08)	(0.22)	(0.09)	(0.35)	(0.00)	(0.75)	(0.00)	(0.02)	(0.01)	(0.02)
F-statistic	6.70*	5.48*	5.13*	1.12	0.85	0.84	3.15*	3.40*	2.81*	6.18*	5.15*	5.32*
Avg. |α|	0.33	0.45	0.33	0.28	0.29	0.22	0.32	0.50	0.32	0.48	0.58	0.48
A^{VW}. |α|	0.11	0.58	0.14	0.28	0.36	0.20	0.19	0.15	0.19	0.22	0.53	0.31
Adj. R^2	0.836	0.546	0.839	0.832	0.559	0.832	0.833	0.552	0.832	0.615	0.422	0.620

*Denotes significance at the 1% level.

For the United States, Japan, and the United Kingdom, 25 size and book-to-market equity portfolios are formed by five independent sorts on size and five sorts on *BE/ME* each year. (For Canada, nine size and *BE/ME* portfolios are used.) Details on portfolio formation appear in the data appendix. The dollar-denominated returns on each portfolio are in excess of each country's local dollar-denominated risk-free rate over the period January 1981–December 1995. Panel A presents summary statistics for raw excess portfolio returns. The high minus low portfolio return (H–L ret.) is the difference in the average return between the smallest size and highest *BE/ME* portfolio, and the largest size and lowest *BE/ME* portfolio. The table also reports the equal- and value-weighted cross-sectional average of the absolute value of the average return for each portfolio.
The following time-series factor model regressions are estimated for each portfolio:

$$\textit{Domestic model: } r_{it} = \alpha_i + b_{Di}(w_{Dt-1}\,DMRF_t) + s_{Di}(w_{Dt-1}\,DSMB_t) + h_{Di}(w_{Dt-1}\,DHML_t) + \varepsilon_i$$

$$\textit{World model: } r_{it} = \alpha_i + b_i(WMRF_t) + s_i(WSMB_t) + h_i(WHML_t) + \varepsilon_i$$

$$\textit{International model: } r_{it} = \alpha_i + b_{Di}(w_{Dt-1}\,DMRF_t) + s_{Di}(w_{Dt-1}\,DSMB_t) + h_{Di}(w_{Dt-1}\,DHML_t) + b_{Fi}(w_{Ft-1}\,FMRF_t) + s_{Fi}(w_{Ft-1}\,FSMB_t) + h_{Fi}(w_{Ft-1}\,FHML_t) + \varepsilon_i$$

Panel B presents results for regressions with value-weighted factors. Panel C presents unweighted ($w_D = w_F = 1$) factor results. The difference in the alphas is between the high- and low-return portfolios (H–L α). For all portfolios, the table reports the Gibbons, Ross, and Shanken (1989) F-statistic, and equal- and value-weighted averages of the absolute value of the average portfolio intercept and the average adjusted R^2.

F-statistics are used. Except for the Japanese portfolios, the F-statistic strongly rejects the null that the intercepts are jointly equal to zero for all specifications. Based on comparison of the extreme portfolio returns tests and the GRS F-tests, we reject all three model specifications. Furthermore, these criteria do not yield a consistent ranking among the models.

Average absolute values of intercepts are used to compare the ability of the models to explain average portfolio returns. The equal-weighted average absolute intercepts in Table 3 are closer to zero for the domestic models than for the world model in all countries except Japan. Value-weighted average pricing errors are used in an international context by Ferson and Harvey (1994), and advocated as an economic measure of model performance by Kan and Zhang (1995). The value-weighted average absolute intercepts are closer to zero for the domestic models for U.S. and Canadian portfolios, but not for the Japanese and U.K. portfolios. With unweighted factors, domestic models yield lower equal-weighted average absolute intercepts than does the world model in all countries, and lower value-weighted average absolute alphas in all countries except the United Kingdom. Domestic models generally provide more accurate pricing than the world model. A comparison of average intercepts between domestic three-factor and international six-factor models for both weighted and unweighted regressions shows that each model has lower intercepts about half the time. There is little difference in the ability of the domestic and international models to capture the average portfolio returns.

Finally, to examine the ability of the factor models to explain time-series variation in portfolio returns, adjusted R^2s are compared across models. Weighted domestic three-factor models have average adjusted R^2s that are substantially higher than the world three-factor regression R^2s in the United States (0.804 compared to 0.513), Japan (0.809 compared to 0.566), the United Kingdom (0.822 compared to 0.387), and Canada (0.601 compared to 0.301). We also observe large differences in adjusted R^2s for unweighted regressions. The international six-factor model has a slightly higher average adjusted R^2 than does the domestic three-factor model in three of the four countries with weighted factors, but the average adjusted R^2 of the international model is slightly higher in only two countries with unweighted factors.

Overall, these portfolio results show that all models are formally rejected as asset pricing models, as indicated by the large GRS F-statistics and the inability of all models to explain differences in average returns for the extreme portfolios. Domestic factor model regressions yield large increases in factor model explanatory power (higher R^2s) and generally lower pricing errors than the world model. Adding foreign factors to the domestic models yields only small increases in explanatory power (R^2s) and often higher pricing errors, indicating few advantages to the use of foreign factors.

4. Tests with Individual Securities

In this section we focus on the ability of domestic, world, and international factor model regressions to explain individual security returns. Each month, beginning with January 1981, individual security regressions are estimated over 132 rolling 60-month periods. The last period ends in December 1995. By restricting each period to five years of monthly observations, we allow for the possibility that the structural parameters b_i, s_i, and h_i in Equations (1), (2), and (3) change over time.[9]

[9] We also use three-year periods and obtain qualitatively similar results.

Panel A of Table 4 presents results for weighted factor model regressions and panel B presents the unweighted regressions. The alphas evaluate the regressions as asset pricing models. The equal-weighted absolute alphas for the weighted domestic models are 1.25%, 1.22%, 1.31%, and 1.13% per month in the United States, Japan, the United Kingdom, and Canada, respectively, and are 1.58%, 1.27%, 1.41%, and 1.28% for the weighted world model. In all countries, domestic three-factor models deliver more accurate average pricing than the world three-factor model. The domestic models have lower value-weighted average pricing errors than the world model in all countries except Japan. Unweighted factor regressions in panel B show that the domestic models have lower equal- and value-weighted average absolute intercepts than the world model in all countries.

When compared to international six-factor models, domestic three-factor models yield lower average equal- and value-weighted absolute intercepts.

Table 4
Regressions of individual stock excess returns on world, domestic, and international factors

	U.S.			Japan			U.K.			Canada		
Model	$\lvert\alpha\rvert$	$vw\lvert\alpha\rvert$	Adj. R^2	$\lvert\alpha\rvert$	$vw\lvert\alpha\rvert$	Adj. R^2	$\lvert\alpha\rvert$	$vw\lvert\alpha\rvert$	Adj. R^2	$\lvert\alpha\rvert$	$vw\lvert\alpha\rvert$	Adj. R^2
Panel A: Weighted												
January 1981–December 1995												
Domestic 3-factor	1.25	0.69	0.2123	1.22	1.01	0.3212	1.31	0.72	0.2577	1.13	0.83	0.1699
World 3-factor	1.58	1.03	0.1351	1.27	0.95	0.2492	1.41	0.85	0.1239	1.28	1.05	0.0868
Intl. 6-factor	1.48	0.85	0.2160	1.30	1.08	0.3258	1.42	0.82	0.2597	1.27	0.98	0.1747
January 1990–December 1995												
Domestic 3-factor	1.31	0.63	0.1352	0.84	0.76	0.5112	1.17	0.63	0.2360	1.05	0.76	0.1106
World 3-factor	1.88	1.17	0.0600	1.16	0.91	0.4026	1.19	0.77	0.1083	1.05	0.81	0.0401
Intl. 6-factor	1.54	0.78	0.1403	0.98	0.93	0.5125	1.20	0.71	0.2397	1.10	0.83	0.1168
Panel B: Unweighted												
January 1981–December 1995												
Domestic 3-factor	1.26	0.68	0.2158	1.17	0.95	0.3260	1.32	0.73	0.2582	1.15	0.85	0.1716
World 3-factor	1.62	1.07	0.1444	1.43	0.98	0.1930	1.45	0.84	0.1750	1.27	1.01	0.1187
Intl. 6-factor	1.58	0.90	0.2206	1.34	1.02	0.3286	1.45	0.83	0.2606	1.28	0.98	0.1769
January 1990–December 1995												
Domestic 3-factor	1.32	0.62	0.1379	0.79	0.68	0.5131	1.18	0.64	0.2373	1.05	0.76	0.1111
World 3-factor	1.77	1.11	0.0631	1.41	1.05	0.3254	1.25	0.76	0.1438	1.10	0.89	0.0636
Intl. 6-factor	1.51	0.74	0.1427	0.90	0.83	0.5140	1.24	0.71	0.2399	1.10	0.84	0.1163

Each month, beginning in January 1981, individual security regressions are estimated over 132 rolling five-year periods. The last period ends in December 1995. The following regression models are used:

$$\text{Domestic model: } r_{it} = \alpha_i + b_{Di}(w_{Dt-1}\, DMRF_t) + s_{Di}(w_{Dt-1}\, DSMB_t) + h_{Di}(w_{Dt-1}\, DHML_t) + \varepsilon_i$$

$$\text{World model: } r_{it} = \alpha_i + b_i(WMRF_t) + s_i(WSMB_t) + h_i(WHML_t) + \varepsilon_i$$

[illegible]

This result holds for both weighted and unweighted factors. The subperiod of the 1990s is examined separately to see if the importance of foreign factors has increased over time. For both weighted and unweighted factors,

5.1 Is the model choice relevant?

One question related to our findings is whether the choice of domestic or international models has any material effect in practice, such as estimating expected returns used in common applications, for example, calculating the cost of capital. We investigate this question by estimating five-year rolling regressions, every month beginning in 1981, using individual stocks for each of the three main models. We use regressions without intercept terms because this has been shown to generate more accurate expected return estimates by Fama and French (1997) and Simin (2000). Ferson and Locke (1998) show that using the past historical average leads to better forecasts of the market return than a 60-month historical average. Therefore we use the average factor return over the entire data period prior to the forecast to calculate expected factor returns. Fama and French (1997) use the full sample period to calculate average factor returns. However, this approach is not implementable, since future return observations are not known at the time that estimates are made.[10] Multiplying the estimated regression beta coefficients with the realized average factor returns forms expected return estimates for the next month. With weighted factors, the average absolute difference in expected return estimates between the domestic and world models is 8.41%, 6.09%, 9.35%, 9.14% per year for the United States, Japan, the United Kingdom, and Canada, respectively. The choice between a domestic or international factor model shows smaller differences in expected return estimates of 7.14%, 6.43%, 5.33%, 6.25% in the United States, Japan, the United Kingdom, and Canada, respectively. The choice of a domestic, global, or international model

has a substantial impact on expected return estimates.

5.2 Out-of-sample forecast errors

These findings lead to the question of which model yields more accurate forecasts of actual returns. One advantage of out-of-sample evaluation is that it is a helpful way of evaluating the costs of estimation error in factor loadings. For example, even though foreign factors have some in-sample explanatory power, adding foreign factors to a purely domestic model could yield less-accurate expected return estimates if there is substantial estimation error in foreign factor loadings.

For each stock, out-of-sample forecast errors are generated by using next model and 9.90%, 8.89%, 8.16%, and 7.30% with the international six-factor model. The world and international models produce less accurate forecasts than do the domestic three-factor models for all four countries.[11] In addition, the median absolute and root mean square forecast errors are also lower for the domestic models than for the world and international models in all four countries. Unweighted factor models also yield similar conclusions. World and international factor models yield less accurate estimates of future returns than domestic models.

6. Additional Evidence

6.1 Sensitivity to the formation of the world factors

The preceding analysis forms the three world factors (*WMRF*, *WSMB*, and *WHML*) either as a value-weighted average of individual country factors (weighted) or as an equal-weighted average of the individual country factors (unweighted). Another possible way to construct world size and book-to-market factors is to ignore cross-country differences (particularly in accounting conventions) and to form the world factor breakpoints for *BE/ME* and dollar-denominated market value by pooling stocks in all countries. Foreign factors can also be formed in a similar manner by ignoring cross-country differences and forming factors from securities in the other three countries. World and foreign *SMB* and *HML* factors formed in this way are used in regressions for individual stocks (similar to results reported in Table 4). The average adjusted R^2s for these world factor regressions indicate some increase in explanatory power over the previously constructed, weighted world factors. However, in all countries, the domestic three-factor models still have substantially higher average adjusted R^2s than the world model. Forming world and foreign factors without regard to country composition does not impact our conclusions.[12]

6.2 Other international models

In unreported results (available on request), we also consider two other international models: a domestic three-factor model with a foreign-market return and a domestic three-factor model with a foreign-market return and the change in the country's exchange rate with the dollar.[13] In both weighted and unweighted specifications for individual stocks, the domestic three-factor model has lower equal- and value-weighted absolute intercepts than these other two models in all countries. Except for the value-weighted average

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[11] The forecast error results are available on request.

[12] We also examine the impact of the currency of denomination. Local currency returns in excess of local interest rates are regressed on local currency denominated factors for individual stock regressions. These regressions yield similar findings to those in Table 4.

[13] For the United States, the dollar/yen rate is used.

intercept in Japan, equal- and value-weighted average absolute pricing errors are always higher for the world three-factor and international six-factor mod-

els than these other two international models. Among other international models, the Fama and French world and international models perform poorly.

6.3 Usefulness of factors

The time-series tests indicate that foreign factors have little explanatory power. To more thoroughly study the importance of foreign factor loadings, we estimate international six-factor regressions using individual stocks over two-year (or three-year) nonoverlapping periods. The Spearman rank correlations between factor loadings on the foreign *SMB* and *HML* are close to zero and statistically insignificant. There is no evidence that stocks with high foreign *SMB* or *HML* loadings in one period have higher loadings in the next

7. Conclusion

This article examines the usefulness of domestic, world, and international versions of the Fama and French factor model for equity returns. F-tests of the null hypothesis that the portfolio intercepts are jointly equal to zero are rejected for all models. Thus none of the models completely capture average returns when used as asset pricing models. However, country-specific (domestic) versions of the three-factor model are more useful at explaining time-series variation in portfolio and individual stock returns than a world three-factor model. Domestic factor model regressions also generally yield lower average pricing errors than the world model—particularly for individual securities.

We also examine international models that incorporate both foreign and domestic factors. The international models with actual foreign factors produce increases in explanatory power as measured by regression R^2s. However, the economic importance of the increase is trivial. Moreover, in individual secu- [illegible]

factor models, indicating that the inclusion of foreign factors do not reduce the average pricing errors. These findings are robust to alternative ways of forming world and foreign factors and hold up in the 1990s as well. In addition, domestic three-factor models also yield lower out-of-sample pricing errors.

The findings in this article do not support the notion that there are benefits

March 31. All stocks meeting the selection criteria are ranked independently into five groups based on their *BE/ME* and five groups based on their September market capitalization. The intersection of the five *BE/ME* and five market capitalization rankings are used to form the 25 size and book-to-market value-weighted portfolio returns.

The Japanese variables *JHML* and *JSMB* are constructed from rankings on book-to-market equity and market capitalization similar to those above. All PACAP stocks with positive book equity on or before each March 31 fiscal year-end and market capitalizations as of March 31 and September 30 are ranked (independently) according to their size and *BE/ME*. Half of the firms are classified as small market capitalization (S for small) and the other half as large market capitalization stocks (B for big). For the book-to-market classification, the bottom 30% are designated as low *BE/ME* firms (L), the middle 40% as M, and the highest 30% as H. The intersection of the rankings allows for six value-weighted portfolios: *HB*, *MB*, *LB*, *HS*, *MS*, and *LS*. The return variable *JSMB* (Japanese small minus big) $= (HS + MS + LS - HB - MB - LB)/3$, and the return *JHML* (Japanese high minus low) $= (HB + HS - LB - LS)/2$. The low (L) and high (H) *BE/ME* portfolios are formed as $L = LS + LB$ and $H = HS + HB$.

A.2 U.K. data

End-of-the-month data for all nonfinancial London Stock Exchange stocks, exchange rates, a value-weighted market index, and short-term interest rates are from Datastream International. Delisted securities are included to control for survivorship bias. Book-to-market equity is calculated as the inverse of the Datastream market-to-book value. Similar to U.S. firms, many U.K. companies have December fiscal year-ends. Consequently, stocks with book-to-market equity values from the preceding December and market capitalizations as of June 30 are ranked (independently) according to their size and *BE/ME*. The remaining procedure for forming *KHML* and *KSMB* is identical to that described above for Japanese stocks.

A.3 Canadian data

All Canadian data is from Datastream. Thus many of the construction details are similar to those discussed above for the United Kingdom. Canadian nonfinancial common stocks are members of the Toronto Stock Exchange. This is the only Canadian exchange for which Datastream has extensive coverage prior to the late 1980s. Because Datastream do not include delisted securities

prior to 1991, the data prior to this date do suffer from survivorship bias. U.S.-listed Canadian equities are excluded from the sample after the U.S. listing month, because previous research by Jorion and Schwartz (1986) and Mittoo (1992) finds substantial differences between U.S.-listed and non-U.S.-listed Canadian equities. Canadian non-U.S.-listed stocks with market values less than two million 1975 Canadian dollars are excluded from the analysis. Listing dates are obtained by using the first day of coverage by Datastream on a U.S. exchange, and directly from the NYSE, AMEX, and NASDAQ fact books.

values. The selection criteria and portfolio formation procedure closely follow that of Fama and French (1993) and thus is similar to the description above for Japanese data.

[illegible]

Appendix B: A Comparison of Foreign Factors to Simulated Factors

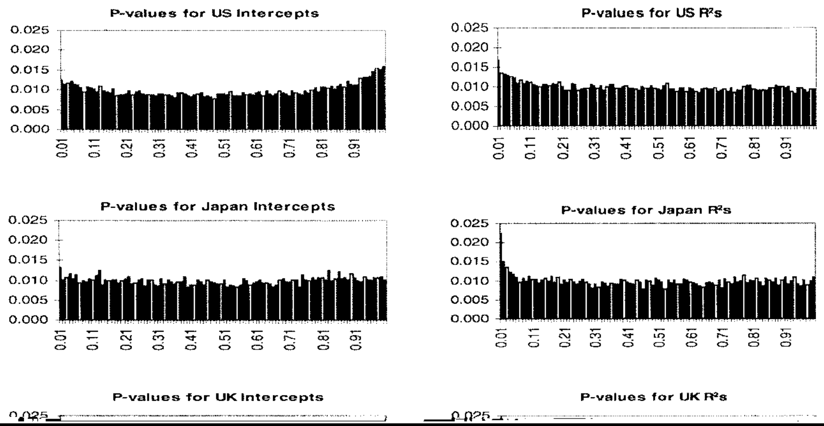
To test the statistical significance of foreign factors, we use empirical distributions from regressions with simulated foreign factors. The simulated foreign factors are generated from a multivariate normal distribution that has the same mean and variance/covariance matrix as the actual weighted foreign factors and the same covariance with domestic factors. Under the null that the foreign factors are not useful in explaining time-series variation in security returns, the simulated foreign factors should only explain domestic stock returns through their covariance with the domestic factors.

For each individual stock regression of the international model, we estimate 500 [illegible]

[illegible]

with the simulated factors. In these regressions the domestic factors are the actual ones and do not change across trials.[17] If foreign factors lead to better pricing, then the regressions with the true foreign factors should have lower intercepts and higher adjusted R^2s than the regressions with random foreign factors. For each regression, the empirical p-value of the R^2 (absolute intercept) is calculated as the fraction of the simulated regressions that have adjusted R^2s (absolute intercepts) greater (smaller) than that obtained from the actual regression. Under the null hypothesis that actual foreign factors perform no better than simulated ones, p-values across regressions should be distributed uniformly between zero and one.

For each country, Figure A.1 displays the distributions of the p-values for both the absolute value of the intercepts and the adjusted R^2s from the weighted six-factor regressions. P-values


P-values for US Intercepts
P-values for US R²s
P-values for Japan Intercepts
P-values for Japan R²s
P-values for UK Intercepts
P-values for UK R²s
0.025
0.020
0.015
0.010
0.005
0.000
0.01
0.11
0.21
0.31
0.41
0.51
0.61
0.71
0.81
0.91

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