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Testing Multi-Factor Models in ADRs: Emerging Market vs. Developed Market

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Abstract
This paper tests whether the Carhart four-factor model and the Fama-French five-factor model can explain variation in returns of 1,230 ADRs originating from six developed markets and five emerging markets. We aim to compare emerging market ADRs with developed market ADRs in terms of traditional risk factors significance, model fitness and the existence of abnormal returns. Overall, we find that substantial variations exist among ADRs by their origin-of-market. First, both models show that most of the positive abnormal returns we document accrue to emerging market ADRs, mainly Chinese ADRs. Among the risk factors, market risk premium is found to be most prevalent in both emerging and developed markets. Although we find some difference in the presence of particular risk factors employed in the four-factor vs. five-factor model, overall, there are no significant differences in the explanation power between the two models. Lastly, the low R^2 values imply that both models do not work very well with the international market ADRs.

Keywords: Carhart Four-Factor Model, Fama-French Five-Factor Model, ADRs, Developed Markets, Emerging Markets.

I. Introduction
American Depositary Receipts (ADRs) are negotiable instruments that represent shares of non-U.S. companies that are held by a U.S. depositary bank outside the United States. Since JPMorgan established the first depositary receipt program in 1927, the ADR markets have gained momentum since the beginning of 2000 and continued to accelerate in growth after the 2007 meltdown. As one example of the fastest growing groups of ADRs, Chinese ADRs have experienced explosive growth in the ADR markets, totaling 323 as of June 2019 compared to less than 100 before 2009 (Morningstar). Globalization has created an entirely new platform for companies to look beyond their home borders to increase their international footprints, expand their investor base and raise capital. There are more than 2000 ADRs, representing companies located in more than 70 countries. ADRs account for 16% of the entire U.S. equity markets (JP Morgan, 2006).

As investing in ADRs has become an attractive investment opportunity to diversify one's portfolio without the high costs of international transactions and to take advantage of potential growth in foreign markets, especially in emerging markets, investors and academic researchers alike try to understand the equity returns of ADRs in order to seek optimal investment strategies. As a result, numerous studies have examined ADR returns (Alhaj-Yaseen *et al.*, 2019 ; Blau, 2017 ; Boubakri *et al.*,

2010 ; Foye, 2018 ; Griffin , 2002 ; Hail & Leuz, 2009 ; Kadiyala & Subrahmanyam , 2004 ; Karolyi , 2006). Given the growing interest in ADRs market, we aim to evaluate whether the traditional factor models can generalize to the ADRs. Specifically, we select the Carhart four-factor model (4FM) and the Fama-French five-factor model (5FM), both of which are the major workhorse models in this area. We further compare emerging market ADRs with developed market ADRs in terms of traditional risk factors significance, model fitness and the existence of abnormal returns. Lastly, by comparing the 4FM with the 5FM, we can show whether the 5FM can better explain the variation in return of ADRs than the 4FM.

The 1,230 ADRs in our sample originate from eleven international markets. The six developed markets include Australia, France, Germany, Hong Kong, Japan, and UK from various continents around the world[i]. The five emerging markets are Brazil, Russia, India, China, and South Africa, known as BRICS, representing about 40% of the world population.

To ensure consistent economic factors throughout the study period, we set our sample period to be from June 2009 to July 2019, which marks the longest expansion period of a business cycle of the post-World War II era after the last contraction from December 2007 to June 2009 according to the National Bureau of Economic Research.

We start by using the ordinary least squares (OLS) model with fixed-effects as the baseline model to estimate the 4FM and the 5FM in the whole sample of ADRs. None of the risk factors is significant in either of the two models. But the *Alpha* of 4FM, measured by the excessive return above the expected return due to market, size, value, momentum risk factors, is positive and significant, suggesting existence of abnormal returns in the ADRs.

Next, we split the sample into developed markets ADRs vs. emerging markets ADRs, and explore whether there is significant difference between the two groups. Results show that none of the 5FM risk factors is significant in either market. However, the *Alpha* of 5FM, measured by the excessive return above the expected return due to market, size, value, profitability and investment risk factor, is found to be positive and significant in the emerging market ADRs, but insignificant in the developed market ADRs. Combined with the previous results, the abnormal returns we documented before accrue mostly to the emerging market ADRs, and there is scant evidence that abnormal return exist in the developed market ADRs. Estimation with the 4FM are similar, except that market risk effect is present in the emerging market ADRs, but not in the developed market ADRs.

Furthermore, we break down ADRs by market-of-origin and examined whether there exists difference among the markets-of-origin. Overall, our results show that substantial variations exist among ADRs originating from the eleven markets. Firstly, both the 5FM and 4FM show that most of the abnormal returns we document previously actually accrue to Chinese ADRs. Both models work the best in Hong Kong with most of risk factors highly significant. Among the risk factors, market risk premium is found to be most prevalent: present in four emerging markets and three developed markets in the 5FM, and in all five emerging markets and the same three developed markets in the 4FM, respectively. We also find presence of other risk factors in some of the individual markets.

This paper, to the best of the authors' knowledge, is the first study of testing both the 4FM and the 5FM using a comprehensive sample consisting of 1,230 ADRs originating from eleven international markets. Also, this paper is the first to compare emerging market ADRs with developed market ADRs and provide strong evidence that substantial variations exist between them, especially that abnormal return exists in emerging market ADRs, mainly Chinese ADRs. Our study has the potential to shed light on the changing landscape of ADRs.

The rest of the paper proceeds as follows. Section 2 reviews the literature on the 4FM and 5FM. Section 3 presents the data source. Section 4 reports the empirical results and Section 5 concludes.

2. Literature Review

In this section we briefly review the literature on the Carhart four-factor model and Fama and French five-factor model.

2.1 Carhart Four-Factor Model (4FM)

Carhart four-factor model is an extension of the (Fama & French, 1998) three-factor model (3FM). The (Fama & French, 2015) 3-factor model (Fama & French, 1992 ; Fama & French, 1993) is an asset pricing model developed in 1992 that expands on the capital asset pricing model (CAPM) by adding size risk and value risk factors to the market risk factor in CAPM. This model considers the fact that value and small-cap stocks outperform markets on a regular basis. Although the 3FM already mitigates average CAPM pricing errors, it is unable to explain the cross-sectional variation in momentum-sorted portfolio returns. Therefore, Carhart (1997) extends the 3FM by adding a fourth factor that captures the (Jegadeesh & Titman, 1993) momentum anomaly. The resulting model is consistent with a market equilibrium model with four risk factors.

Formally, the model can be estimated as:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{Mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 WML_t + \varepsilon_{it} \quad (I)$$

Where R_{it} is the total return of a stock i at time t; R_{ft} is the risk free rate of return at time t; R_{Mt} is the total market portfolio return at time t; $R_{it} - R_{ft}$ is expected excess return; $R_{Mt} - R_{ft}$ is the excess return on the market portfolio (index); SMB_t is the size premium (small minus big), that argues that small-cap companies should outperform the big-cap companies. HML_t is the value premium (high minus low), that argues that companies with high book-to-market ratios outperform those with lower book-to-market values. WML_t is the difference in return between a portfolio of past 12 month winners and a portfolio of past 12month losers at time t. $\beta_{1,2,3,4}$ refer to the factor coefficients. ε_{it} is the residual. The *Alpha* of 4FM (α_{it}) denotes the excessive return above the expected return due to market, size, value, momentum risk factors.

Hong *et al.* (2000); Jegadeesh (1990); Nijman *et al.* (2004) all examined momentum returns of firm size and value. Jegadeesh (1990) investigates the New York Stock Exchange (NYSE) and find that stocks that have performed well over the past few months tend to earn high returns over the next months, while stocks that have performed poorly over the past few months tend to earn low returns over the next months. Hong *et al.* (2000) find that portfolio of stocks with the highest market value does not exhibit momentum effect. Nijman *et al.* (2004) studies the momentum effect on the basis of size and value in the European stock market and find that momentum effect is more pronounced for small growth stocks.

2.2 Fama and French Five-Factor Model (5FM)

In a more recent study, (Fama & French, 2015) introduces a five-factor model by augmenting the 3FM with two mimicking factors that capture the return premiums associated with profitability and investment. This change is motivated by the valuation theory and by recent empirical findings concerning the strong effects of profitability and investment on asset returns. Fama & French (2015) find that the five-factor model outperforms the 3FM in explaining the cross section of stock returns. Fama & French (2015) extended their three-factor model based on dividend discount model as follows:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1\left(R_{Mt} - R_{ft}\right) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_4 CMA_t + \varepsilon_{it} \quad (2)$$

Where RMW_t is the robust-minus-weak profitability factor computed by constructing the size and operating profitability-ranked benchmark portfolios. CMA_t is the conservative-minus-aggressive investment factor computed by constructing size and INV-ranked benchmark portfolios. The *Alpha* of 5FM (α_{it}) denotes the excessive return above the expected return due to market, size, value, profitability and investment risk factors.

Strikingly, (Fama & French, 2015) conclude that the book-to-market factor becomes redundant in the presence of the profitability and investment factors. In line with this argument, (Hou *et al.*, 2015) strongly advocate a four-factor model that includes the market and the mimicking factors of size, profitability, and investment and suggest that it can serve as a new workhorse model in the area.

3. Data

The list of ADRs from the eleven chosen countries are extracted from Morningstar and the ADRs' historical price data between 6/1/2009 and 7/31/2019 are extracted from Yahoo Finance by using the Python package "yfinance." Yahoo Finance was chosen as the data source because "yfinance" allows us to conveniently connect to and download data from the Yahoo's servers. The Fama and French factors and Carhart's momentum factor are obtained from Kenneth R. French's data library[ii]. The website provides data for specific regions around the world. For Fama and French factors, we use the Asia Pacific (excluding Japan) data for Hong Kong and Australia, Japanese data for Japan, European data for France, Germany, and UK, and emerging markets data for Brazil, China, India, Russia and South Africa. The momentum factors are analogously matched with the eleven international markets. Table 1 reports the number of ADRs originated from each of the eleven international markets.

Table 1. Number of ADRs by origin-of-market

Market	Number of ADRs extracted
Brazil	68
China	266
India	13
Russia	19
South Africa	48
Australia	105
France	85
Germany	94
Hong Kong	69

Japan	284
UK	179
Total	1230

Note. This table reports the number of ADRs originated from each of the eleven international markets. The six developed markets include Australia, France, Germany, Hong Kong, Japan, and UK. The five emerging markets are Brazil, China, India, Russia, and South Africa. ADR data is extracted from Yahoo Finance. The sample period is between 6/1/2009 and 7/31/2019.

4. Results

4.1 Baseline Results

In this section, we use the ordinary least squares (OLS) model with fixed-effects as the baseline model to estimate the 5FM and 4FM in the whole sample of ADRs originating from eleven international markets between June 2009 and July 2019.

The results are reported in Table 2. In model 1, we estimate the 5FM (Equation 1) using all observations. None of the five risk factors is significant at any conventional level. Then we turn to model 2 and estimate the 4FM (Equation 2). Consistent with model 1, none of the four risk factors is statistically significant. But the *Alpha* of 4FM, measured by the excessive return above the expected return due to market, size, value, momentum risk factors is positive and significant at 10% level, the coefficient is 125.48 with a t-statistics of 1.65. The result suggests existence of abnormal returns in these international ADRs during our sample period. Furthermore, the R^2 value is 0.009 for both the 5FM and 4FM. There is no difference between the two models, which implies both models may have a similar explanation power on the risk and return pattern of ADRs.

Table 2. Baseline Model

	Fama-French five-factor	Carhart four-factor
	(1)	(2)
Alpha	124.278	125.484*
	(1.56)	(1.65)
$R_{Mt} - R_{ft}$	10.126	10.965
	(0.52)	(0.60)
SMB	44.368	32.789
	(1.00)	(0.78)
HML	66.692	58.955
	(1.26)	(1.51)
RMW	44.089	
	(0.59)	
CMA	-0.349	
	(-0.01)	
WML		25.182
		(0.89)
Observations	103,667	103,667
R^2	0.009	0.009
Fixed effects	F, T	F, T

Note. The table reports the results of OLS estimation with fixed effects of Fama-French five-factor model (Model 1) and Carhart four-factor model (Model 2), where the dependent variable is the excess return of ADRs in eleven international markets between June 2009 and July 2019. *Alpha* of 5FM denotes the excessive return above the expected return due to market, size, value, profitability and investment risk factors. *Alpha* of 4FM denotes the excessive return above the expected return due to market, size, value, momentum risk factors. $R_{Mt} - R_{ft}$ is the excess return on the market portfolio (index). SMB is the size premium (small minus big). HML is the value premium (high minus low). RMW is the robust-minus-weak profitability factor computed by constructing the size and operating profitability-ranked benchmark portfolios. CMA is the conservative-minus-aggressive investment factor computed by constructing size and INV-ranked benchmark portfolios. WML is the premium on

winners minus losers of past 12 months. t-statistics are given in parentheses. F, T denotes firm and time fixed effects, and the symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

4.2 Estimation of 5FM and 4FM in Developed vs. Emerging Market ADRs

In our sample, the eleven international markets that the ADRs originate from can be categorized into two major groups: developed markets and emerging markets. The six developed markets include Australia, France, Germany, Hong Kong, Japan and UK, and the five emerging markets include Brazil, China, India, Russia and South Africa. In this section, we explore whether there is significant difference between developed markets ADRs and emerging markets ADRs

Table 3. Estimation of Fama-French five-factor model in developed vs. emerging market ADRs

	Developed market ADRs	Emerging market ADRs	All
	(1)	(2)	(3)
Alpha	110.386	146.116***	126.868
	(0.97)	(2.75)	(1.58)
$R_{Mt} - R_{ft}$	8.129	17.794	11.055
	(0.29)	(1.19)	(0.28)
$(R_{Mt} - R_{ft}) \times$ *Developed*			-3.005
			(-0.07)
SMB	62.545	1.276	-12.175
	(1.04)	(0.04)	(-0.12)
$SMB \times$ *Developed*			73.824
			(0.68)
HML	77.272	30.311	25.297
	(1.09)	(0.69)	(0.21)
$HML \times$ *Developed*			53.624
			(0.41)
RMW	58.308	46.459	7.539
	(0.58)	(0.75)	(0.05)
$RMW \times$ *Developed*			51.870
			(0.28)
CMA	13.046	-17.462	-11.477
	(0.14)	(-0.33)	(-0.08)
$CMA \times$ *Developed*			23.656
			(0.15)
Observations	69,738	33,929	103,667
R^2	0.008	0.029	0.009
Fixed effects	F, T	F, T	F, T

Note. The table reports the results of OLS estimation with fixed effects of Fama-French five-factor model in developed vs. emerging market ADRs, respectively. The six developed markets (Model 1) are Australia, France, Germany, Hong Kong, Japan and UK, and the five emerging markets (Model 2): Brazil, China, India, Russia and South Africa. The dependent variable is the excess return of ADRs between 2009 and 2019. *Alpha* of 5FM denotes the excessive return above the expected return due to market, size, value, profitability and investment risk factor. $R_{Mt} - R_{ft}$ is the excess return on the market portfolio (index). *Developed* is an indicator variable that equals one if the ADR represents shares of the company that locates in a developed market, and zero otherwise. SMB is the size premium (small minus big). HML is the value premium (high minus low). RMW is the robust-minus-weak profitability factor computed by constructing the size and operating profitability-ranked benchmark portfolios. CMA is the conservative-minus-aggressive investment factor computed by constructing size and INV-ranked benchmark portfolios. *F, T* denotes firm and time fixed effects, and the symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 3 reports the results of estimation of 5FM on ADRs from developed vs. emerging markets. We split the sample into developed market ADRs (Model 1) and emerging market ADRs (Model 2) according to whether the ADR originates from a developed market or an emerging market. Results show that none of the five risk factors is significant at any conventional level in either market. However, the *Alpha* of 5FM is found to be positive and significant at 1% level (the coefficient is 146.12 with an t-statistics of 2.75) in the emerging market ADRs, but insignificant in the developed market ADRs. Combined with the results in Table 2, the abnormal returns we documented in the previous section accrue mostly to the emerging market ADRs, and there is scant evidence that abnormal return exist in the developed market ADRs. In Model 3, we interact each of the five risk factors with an indicator variable, *Developed,* which equals one if the ADR originates from developed market, and zero otherwise. None of the interaction variables is significant at any conventional level, which implies none of the risk factors plays a significantly different role in developed market ADRs than in emerging market ADRs.

Table 4. Estimation of Carhart four-factor model in developed vs. emerging market ADRs

	Developed market ADRs	Emerging market ADRs	All
	(1)	(2)	(3)
Alpha	119.815	138.050***	125.816
	(1.09)	(2.76)	(1.63)
$R_{Mt} - R_{ft}$	7.465	21.840*	16.833
	(0.28)	(1.83)	(0.53)
$(R_{Mt} - R_{ft}) \times$ *Developed*			-9.732
			(-0.26)
SMB	46.873	-7.052	-16.413
	(0.84)	(-0.20)	(-0.17)
$SMB \times$ *Developed*			62.613
			(0.59)
HML	68.027	15.406	28.828
	(1.30)	(0.48)	(0.33)
$HML \times$ *Developed*			39.061
			(0.41)
WML	26.650	27.437	31.934
	(0.70)	(1.21)	(0.52)
$WML \times$ *Developed*			-8.122
			(-0.12)
Observations	69,738	33,929	103,667
R^2	0.008	0.029	0.009
Fixed effects	F, T	F, T	F, T

Notes. The table reports the results of OLS estimation with fixed effects of Carhart four-factor model in developed vs. emerging market ADRs, respectively. The six developed markets (Model 1) are Australia, France, Germany, Hong Kong, Japan and UK, and the five emerging markets (Model 2): Brazil, China, India, Russia and South Africa. The dependent variable is the excess return of ADRs between 2009 and 2019. *Alpha* of 4FM denotes the excessive return above the expected return due to market, size, value, momentum risk factors. $R_{Mt} - R_{ft}$ is the excess return on the market portfolio (index). *Developed* is an indicator variable that equals one if the ADR represents shares of the company that locates in a developed market, and zero otherwise. SMB is the size premium (small minus big). HML is the value premium (high minus low). *WML* is the premium on winners minus losers of past 12 months. *F, T* denotes firm and time fixed effects, and the symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

In Table 4, we estimate 4FM on developed market ADRs (Model 1) vs. emerging market ADRs (Model 2). Results show that the *Alpha* of 4FM and market risk premium ($R_{Mt} - R_{ft}$) are positive and significant in the emerging market ADRs, but none of risk factors is significant in the developed market ADRs. In Model 3, we interact each of the four risk factors with an indicator variable, *Developed.* None of the interaction variables is significant at any conventional level. Overall, the results in Table 4 are consistent with Table 3.

4.3 Estimation of 5FM and 4FM in ADRs by Origin-of-Market

Now we break down ADRs by their origin-of-market and examined whether there exists difference among these markets. We estimate the 5FM in each individual market ADRs, results of the five emerging markets are reported in Panel A of Table 5, and results of the six developed markets in Panel B of Table 5.

Table 5. Estimation of Fama-French five-factor model in ADRs by origin-of-market

Panel A: Emerging market ADRs					
	Brazil	China	India	Russia	South Africa
	(1)	(2)	(3)	(4)	(5)
Alpha	1.950	264.483***	-0.192	0.414	-0.184
	(0.78)	(2.80)	(-0.10)	(0.96)	(-0.63)
$R_{Mt} - R_{ft}$	2.277***	30.660	2.196***	0.992***	1.164***
	(3.27)	(1.15)	(4.25)	(8.24)	(14.23)
SMB	-1.364	3.887	0.911	-0.205	-0.339*
	(-0.81)	(0.06)	(0.73)	(-0.71)	(-1.71)
HML	-1.117	57.173	-0.275	0.739**	-0.786***
	(-0.55)	(0.72)	(-0.18)	(2.11)	(-3.28)
RMW	-1.160	80.445	3.179	-0.931*	-0.520
	(-0.41)	(0.72)	(1.54)	(-1.92)	(-1.55)
CMA	1.756	-36.293	1.299	-0.267	1.565***
	(0.71)	(-0.37)	(0.74)	(-0.64)	(5.40)
Observations	6,792	18,953	1,570	2,003	4,611
R^2	0.029	0.029	0.033	0.162	0.099
Fixed effects	F, T	F, T	F, T	F, T	F, T

Panel B: Developed market ADRs						
	Australia	France	Germany	Hong Kong	Japan	UK
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	15.764	-0.099	-0.082	0.194	244.358	146.518
	(1.07)	(-0.77)	(-0.44)	(1.18)	(0.81)	(0.91)
$R_{Mt} - R_{ft}$	-2.015	1.080***	0.975***	0.787***	-2.821	38.659
	(-0.62)	(31.90)	(19.62)	(21.80)	(-0.03)	(0.89)
SMB	6.955	0.069	0.043	0.084	165.210	-59.552
	(0.99)	(0.83)	(0.34)	(1.09)	(1.08)	(-0.56)
HML	-1.757	0.306***	0.119	0.347***	146.091	-52.352
	(-0.18)	(2.67)	(0.70)	(3.23)	(0.91)	(-0.36)
RMW	6.601	0.208	0.314	-0.358***	15.077	-66.478
	(0.57)	(1.41)	(1.44)	(-2.81)	(0.05)	(-0.35)
CMA	6.375	-0.108	0.054	-0.535***	-42.233	35.369
	(0.58)	(-0.76)	(0.26)	(-4.42)	(-0.19)	(0.19)
Observations	9,036	7,384	7,193	6,164	25,416	14,545
R^2	0.015	0.223	0.103	0.128	0.008	0.011
Fixed effects	F, T	F, T	F, T	F, T	F, T	F, T

Note. The table reports the results of OLS estimation with fixed effects of Fama-French five-factor model in each of the eleven-international market ADRs. The dependent variable is the excess return of ADRs between 2009 and 2019. The eleven markets include five emerging markets (Panel A): Brazil, China, India, Russia and South Africa; and six developed markets (Panel B): Australia, France, Germany, Hong Kong, Japan and UK. *Alpha* of 5FM denotes the excessive return above the expected return

due to market, size, value, profitability and investment risk factor. $R_{Mt} - R_{ft}$ is the excess return on the market portfolio (index). SMB is the size premium (small minus big). HML is the value premium (high minus low). RMW is the robust-minus-weak profitability factor computed by constructing the size and operating profitability-ranked benchmark portfolios. CMA is the conservative-minus-aggressive investment factor computed by constructing size and INV-ranked benchmark portfolios. *F, T* denotes firm and time fixed effects, and the symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

Among the five risk factors, market risk premium ($R_{Mt} - R_{ft}$) are found to be highly significant (less than 1%) in the following seven markets: Brazil, the coefficient is 2.28 with a t-statistics of 3.27; India, the coefficient is 2.20 with a t-statistics of 4.25; Russia, the coefficient is 0.99 with a t-statistics of 8.24; South Africa, the coefficient is 1.16 with a t-statistics of 14.23; France, the coefficient is 1.08 with a t-statistics of 31.90; Germany, the coefficient is 0.975 with a t-statistics of 19.62; and Hong Kong, the coefficient is 0.79 with a t-statistics of 21.80. Size premium (SMB) is significant only in South Africa at 10% level, but the coefficient is negative (-0.34). Value premium (HML) are found to be significantly positive in three market and significantly negative in one market: Russia, the coefficient is 0.74 with a t-statistics of 2.11; South Africa, the coefficient is -0.79 with a t-statistics of -3.28; France, the coefficient is 0.31 with a t-statistics of 2.67; and Hong Kong, the coefficient is 0.35 with a t-statistics of 3.23. These results are consistent with multiple international evidence (Chan, Hamao, and Lakonishok (1991), Capaul, Rowley, and Sharpe (1993), Fama and French (1998) and Liew and Vassalou (2000)) which indicates that size and value effect is not spurious. Profitability premium (RMW) is significantly negative in Russia (the coefficient is -0.93 with a t-statistics of 1.92), and Hong Kong (the coefficient is -0.36 with a t-statistics of -2.81). Finally, investment premium (*CMA*) is significantly positive in South Africa (the coefficient is 1.565 with a t-statistics of 5.40), and significantly negative in Hong Kong (the coefficient is -0.54 with a t-statistics of -4.42). The *Alpha* of 5FM is highly significant in China, which suggests the existence of substantial abnormal return in Chinese ADRs. Moreover, these results also imply that most of the abnormal return we document in Table 3 actually accrue to Chinese ADRs. Overall, 5FM works the best in Hong Kong with four out of five risk factors highly significant. Our results also show that substantial variations exist among these international ADRs when estimating the 5FM.

Table 6. Estimation of Carhart four-factor model in ADRs by origin-of-market

Panel A: Emerging market ADRs

	Brazil	China	India	Russia	South Africa
	(1)	(2)	(3)	(4)	(5)
Alpha	0.891	245.316***	1.655	0.079	0.087
	(0.38)	(2.72)	(0.97)	(0.20)	(0.32)
$R_{Mt} - R_{ft}$	2.227***	39.182*	1.682***	1.083***	0.912***
	(4.03)	(1.81)	(4.16)	(11.45)	(13.96)
SMB	-1.452	-11.774	0.567	-0.081	-0.307
	(-0.87)	(-0.18)	(0.46)	(-0.28)	(-1.57)
HML	0.406	29.474	-0.926	0.919***	-0.038
	(0.27)	(0.53)	(-0.81)	(3.51)	(-0.22)
WML	1.037	51.737	-0.265	-0.121	-0.232*
	(1.01)	(1.22)	(-0.38)	(-0.71)	(-1.90)
Observations	6,792	18,953	1,570	2,003	4,611
R^2	0.029	0.029	0.032	0.160	0.094
Fixed effects	F, T	F, T	F, T	F, T	F, T

Panel B: Developed market ADRs

	Australia	France	Germany	Hong Kong	Japan	UK
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	14.152	-0.023	0.010	0.025	273.307	143.387
	(0.97)	(-0.18)	(0.05)	(0.15)	(0.94)	(0.91)
$R_{Mt} - R_{ft}$	-2.277	1.081***	0.966***	0.846***	-0.737	32.179

	(-0.74)	(34.02)	(20.67)	(24.89)	(-0.01)	(0.79)
SMB	4.082	0.035	-0.013	0.256***	141.413	-51.143
	(0.71)	(0.45)	(-0.11)	(4.03)	(0.90)	(-0.52)
HML	-4.317	0.129*	-0.057	0.477***	177.410	-11.619
	(-0.61)	(1.94)	(-0.58)	(6.15)	(1.30)	(-0.14)
WML	6.413	-0.037	-0.011	-0.102*	68.814	-16.545
	(1.30)	(-0.82)	(-0.17)	(-1.90)	(0.67)	(-0.29)
Observations	9,036	7,384	7,193	6,164	25,416	14,545
R^2	0.016	0.223	0.103	0.124	0.008	0.011
Fixed effects	F, T	F, T	F, T	F, T	F, T	F, T

Note. The table reports the results of OLS estimation with fixed effects of Carhart four-factor model in each of the eleven-international market ADRs. The dependent variable is the excess return of ADRs between 2009 and 2019. The eleven markets include five emerging markets (Panel A): Brazil, China, India, Russia and South Africa; and six developed markets (Panel B): Australia, France, Germany, Hong Kong, Japan and UK. *Alpha* of 4FM denotes the excessive return above the expected return due to market, size, value, momentum risk factors. $R_{Mt} - R_{ft}$ is the excess return on the market portfolio (index). SMB is the size premium (small minus big). HML is the value premium (high minus low). *WML* is the premium on winners minus losers of past 12 months. *F, T* denotes firm and time fixed effects, and the symbols ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

In Table 6, we estimate the 4FM in each individual market ADRs, and report results of the five emerging markets in Panel A and results of the developed markets in Panel B. Market risk premium ($R_{Mt} - R_{ft}$) is found to be significant in eight markets: Brazil, China, India, Russia, South Africa, France, Germany and Hong Kong. The result that market risk premium is significant in all five emerging market ADRs explains why we document a positive loading of market risk premium in emerging market ADRs in Table 4. Size premium (SMB) is highly significant (less than 1%) only in Hong Kong, the coefficient is 0.26 with a t-statistics of 4.03. Value premium (HML) is found to be significantly positive in three markets: Russia, France and Hong Kong. Momentum premium (*WML*) is significantly negative in two markets: South Africa and Hong Kong. The *Alpha* of 4FM is still highly significant in China, the coefficient is 245.32 with a t-statistics of 2.72. Overall, 4FM works the best in Hong Kong with all four risk factors highly significant. Furthermore, there is no significant difference in the R^2 values between the 4FM (Table 6) and 5FM (Table 5), which implies both models may have a similar explanation power in the variations of returns of ADRs.

5. Conclusions

As interest in investing in foreign markets grows, ADRs have become one of the most convenient options to do so. The ADR market is expected to continue to grow as the world becomes more connected through trade and technology. Concurrently an understanding of international investment is needed to navigate the growing ADR markets. Our study examines whether the 4FM and the 5FM can explain variation in returns of 1,230 ADRs originating from six developed markets including Australia, France, Germany, Hong Kong, Japan and UK and five emerging markets known as BRICS: Brazil, Russia, India, China and South Africa. Overall, we find that substantial variations exist among ADRs with respect to their origin-of-market. Both models show that most of the abnormal returns accrue to emerging markets ADRs, mainly Chinese ADRs. Among the risk factors, market risk premium is found to be the most prevalent in both emerging and developed markets with an exception of Chinese ADRs, in which market risk premium is insignificant in the 5FM and slightly significant in the 4FM. Although we find some differences in the presence of particular risk factors employed in the 4FM vs. 5FM among the eleven international markets ADRs, overall, there is no substantial evidence that the 5FM has stronger explanation power than the 4FM in capturing the risk and return patterns of international markets ADRs. For model fitness, both 4FM and 5FM show very low R^2 values, ranging from 0.008 to 0.223. Even in markets like Hong Kong and South Africa in which most risk factors are significant, their R^2 values are still low, 0.128 and 0.099 respectively. This indicates that both models do not work well in international markets ADRs. Further research is needed to explore other risk factors that correlate to equity returns of ADRs.

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Notes

[i] North America does not have representing developed market sample because over 90% of the 2819 Canadian firms are listed in US stock exchanges as ordinary listing (Morningstar). There is no representing developed markets sample available for Africa or South America, either.

[ii] Kenneth R. French's data library can be found at
https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html