The Effect of Extreme Markets on the Benefits of International Portfolio Diversification

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We investigate the effects of bull and bear markets on correlations between developed and emerging country equity returns, and on the benefits of combining international markets in a portfolio. Contrary to most other studies we find that correlations fall in both bull and bear markets, although far more in the former; that emerging markets provide both additional diversification benefits for investors in developed markets and, especially, some protection during bear markets.(JEL: F3, G1, G10, G11, G15)

Keywords: International equity markets, correlations, portfolio choice.

I. Introduction

Portfolio diversification allows investors to increase returns without increasing risk, and, all else equal, the benefits of diversification are greater the lower the correlation between the portfolio's assets. Cross-country portfolio diversification should therefore be more beneficial the lower the degree of correlation between the markets of different countries. Recently, two strands of the finance literature have suggested that (a) emerging markets have improved the scope for diversification (for example, Goetzmann et al (2002)); and (b) cross-country returns are more highly correlated - and hence the benefits

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of diversification are lower - when markets are volatile, particularly in bear markets (see for example, Ang and Bekaert (2002), Campbell et al (2002) and Erb et al (1994)).

Using weekly returns data from 44 countries from July 1994 to October 2003 we present in this paper evidence on both these issues. Specifically, we address the following questions:

Are cross-country returns of developed markets more or less correlated with each other in bull and bear markets than they are overall? Is the same true of correlations between the returns of developed and emerging markets?

Are there clear potential benefits to holding diversified portfolios consisting of pairs of developed markets (*DEV*/*DEV* pairs) in bull, bear and normal markets? Are any such benefits greater or less for portfolios consisting of pairs of developed and emerging markets (*DEV*/*EM* pairs)?[1]

Do such benefits in bull and bear markets depend upon investors foreseeing the changes in the means, the standard deviation of returns and the correlation between them in such markets, and adjusting their portfolios accordingly? Or would they largely accrue anyway to an investor holding a portfolio appropriately diversified for a normal market?

Our results suggest the following.

First, in contrast to most other studies, we find that international equity correlations tend to fall in both bull and bear markets, though the size of the fall is noticeably greater in bull markets. We also find that *DEV*/*DEV* correlations are generally higher than *DEV*/*EM* correlations, although the former tend to fall more than the latter in both bull and bear markets.

Secondly, cross-country diversification is worthwhile in normal market conditions, increasing the certainty-equivalent rate of return by an amount roughly equal to the risk-free rate of interest (for a quadratic utility investor with relative risk aversion rate equal to 2). These benefits are higher for *DEV*/*EM* pairs than for *DEV*/*DEV* pairs. In bull

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1. In what follows we use the term 'diversification' to mean a combination of a risk-free asset and only two risky assets, rather than a multi-asset portfolio. However, we examined these issues both for pairs of markets and for larger groups of markets. While in the case of the larger portfolios there appears to be little to choose between emerging and developed markets during normal market conditions, our central conclusions reported below about emerging markets providing more protection in bear markets remained qualitatively unaltered for the larger portfolios. Because of this we report only the results of testing pairs of markets.

or bear markets that have not been foreseen by the investor, *DEV*/*DEV* portfolios lose the benefits of diversification (in fact, the investor may actually lose by diversifying), while *DEV*/*EM* portfolios do not. So, emerging markets provide not only additional diversification benefits for investors in developed markets under normal market conditions, but those benefits are maintained during unforeseen bull markets and enhanced during unforeseen bear markets. However, these benefits are small relative to the other effects of truncation on portfolio performance.

Finally, a portfolio that is optimal in normal market conditions will miss out on a large proportion of the gains that might be made from correctly-adjusted portfolios in bull markets, and will lead to heavy losses in bear markets.

It is often the convention in the literature on extreme markets to term a set of especially low (high) returns as a bear (bull) market rather than to adopt the more common definition of a bear (bull) market as a period of time during which returns are particularly low (high) - see, for example, Butler and Joaquin (BJ 2002) and Longin and Solnik (2001). We shall follow this convention and will therefore refer to bull and bear markets as 'truncated', since they represent tails of the distribution of returns, and use 'normal' to describe markets that are not truncated. We explain below precisely how we define a truncated distribution.

The paper proceeds as follows. The next section describes our general methodology, in particular how we extend the work of BJ (2002) combined with that of Levy and Sarnat (1970) to obtain a measure of portfolio performance; section 3 explains our data and discusses some empirical issues; section 4 presents descriptive statistics and results relating to some broad averages of countries. Section 5 presents the results of formal tests of whether the effects that bull and bear markets have on correlations between *DEV*/*DEV* pairs and *DEV*/*EM* pairs are different and whether their effects on the benefits of *DEV*/*DEV* and *DEV*/*EM* diversification are different. It also presents tests of the effects of bull and bear markets on the performance of portfolios involving *DEV*/*DEV* pairs and *DEV*/*EM* pairs. Section 6 concludes.

II. Methodology

Our framework is a standard model of portfolio selection in which the investor selects among three assets, two of which are risky. This standard analysis usually assumes the risky assets' returns to be bivariate normal, but the analysis is valid for any distribution of returns if the investor has a quadratic utility function. Since we shall be analysing portfolio selection in truncated markets where bivariate normality clearly does not apply, this is the utility function we shall assume.

In the spirit of BJ (2002)[2] combined with Levy and Sarnat (1970)[3], we can derive an (expected-utility-maximising) optimum portfolio which depends upon the investor's utility function and degree of risk aversion, and on the risk-free rate, the standard deviation of each asset's return, their means, and the correlation between them. We can also derive other portfolios which appear optimal to an investor given the (possibly incorrect) assessment that she makes of those six latter parameters.

Associated with each portfolio and assumed degree of risk aversion is an expected level of utility. From each such expected level of utility it is possible to derive a certainty-equivalent rate of return defined as the riskless rate of return which would deliver to the investor that same level of expected utility. Our measures of both the benefits of diversification and of portfolio performance are in terms of the excess certainty-equivalent rate of return (CERR) over and above the actual risk-free rate of return.[4]

To assess the benefits of diversification we first calculate the following CERRs for diversified portfolios.

R_{NN} = the CERR that would yield the same expected utility that could optimally be achieved in a normal market.

R_{TT} = the CERR that would yield the same expected utility that could optimally be achieved in a truncated market.

R_{NT} = the CERR that would yield the same expected utility that

2. BJ (2002) investigate the loss of returns from a portfolio invested equally in each of a pair of (developed) markets during a bear market. They quantify the loss as the difference between the return achievable from a bivariate normal distribution with the same parameters as the observed distributions of returns, and the observed portfolio returns.

3. They use standard portfolio theory to determine the optimal mix of assets in the portfolio and measure the performance of portfolios in utility per dollar invested rather than as raw returns.

4. We have not used the Sharpe or Sortino ratios as performance measures since their meaning is not clear in cases of negative returns (see, for example, McLeod and van Vuuren, 2004).

would be achieved in a truncated market by an investor who had wrongly assumed that the market characteristics were those of the normal rather than the truncated market.

For each of these we then define a 'plain vanilla' equivalent – i.e. the CERR from a portfolio which consists of the risk-free asset and only one risky asset. We denote these equivalents respectively by VR_{NN}, VR_{TT} and VR_{NT}. The differences between each CERR and its plain vanilla equivalent, denoted DR_{NN}, DR_{TT} and DR_{NT} respectively, provide a measure of the potential benefits of diversification in a normal market, in a truncated market that is foreseen, and in a truncated market that is not foreseen.

To assess the impact of bull and bear markets on the performance of a diversified portfolio, we first calculate ΔM, the difference between R_{NN} and R_{TT}, the maximum gain to be made in a bull market, or the minimum loss in a bear market. We next calculate ΔA, the difference between R_{TT} and R_{NT}. Since any such difference results from the failure of the investor to realise the true nature of market conditions we term this the avoidable effect of operating in a truncated market.

Before presenting results on the interaction of international equity correlations and portfolio performance we analyse certain characteristics of the correlations themselves. We first define the variable *COR* as the correlation between the returns of two markets under normal conditions, and test whether *COR* varies systematically according to the nature of the countries that are paired. We then assess the impact of bull and bear markets on these correlations, defining ΔCOR as the change in correlation between two assets when the markets are truncated.

We start by presenting estimates of *COR*, ΔCOR, VR_{NN}/R_{NN}, VR_{TT}/R_{TT}, VR_{NT}/R_{NT}, ΔM and ΔA, for different broad categories of pairs of markets, for markets truncated at successively higher thresholds in absolute terms. These give an overall view of the behaviour of correlations, of the benefits of diversification, and of how such benefits change in increasingly extreme markets.

We then present a set of regressions from the coefficients of which we assess whether the differences between correlations or CERRs vary according to the investor's home country, or differ for emerging and developed country pairs, and whether they are significantly affected by the value of the threshold itself. Formally we estimate the following sets of regressions:

Model 1: $$\lambda_{i,j} = a + \sum_k d_k THR_k + \varepsilon_{i,j}$$

Model 2: $$\lambda_{i,j} = a + \sum_{i=2}^{3} b_i LD_i + \sum_k d_k THR_k + \varepsilon_{i,j}$$

Model 3: $$\lambda_{i,j} = a + \sum_k d_k THR_k + \sum_k e_k DEVTHR_{k,j} + \varepsilon_{i,j}$$

Model 4: $$\lambda_{i,j} = a + \sum_{i=2}^{3} b_i LD_i + \sum_{i=2}^{3} c_i LDDEV_{i,j} + \sum_k d_k THR_k + \sum_k e_k DEVTHR_{k,j} + \varepsilon_{i,j}$$

Where *i* denotes the first country in the pair and *j* the second;

$$\lambda_{i,j} = \Delta COR_{i,j},\ DR_{TT,i,j},\ DR_{NT,i,j},\ \Delta M_{i,j},\ or\ \Delta A_{i,j}\ ;$$ [5]

LD_i are dummies for three selected 'lead' or 'home' countries which are more fully explained below; $i = 1,\ldots,3$. LD_i takes the value 1 if the lead country is the US and is omitted from the regression in models 2 and 4 since the US is the 'baseline' country; $i = 2$ denotes the UK and $i = 3$ Australia;
THR_k is a dummy that takes the value 1 if the threshold at which the tail is truncated equals k, where $k = -1, -0.5, -0, +0, +0.5, +1, +1.5$ standard deviations from the mean (with the –1.5 threshold forming the 'baseline');
DEV_j is a dummy that takes the value 1 if the second country in the pair is a developed market;

$$DEVTHR_{k,j} \text{ equals } THR_k \times DEV_j; \text{ and}$$

5. When ΔM_{ij} is the dependent variable the models are estimated for positive thresholds only. In almost all cases the optimum decision in a bear market, at any level of truncation, is to invest in the risk-free asset. This means that the reduction in the maximum CERR achievable equals the maximum itself, regardless of the values of the independent variables.

$$LDDEV_{i,j} \text{ equals } LD_i \times DEV_j.$$

We also estimate the following models for the two variables that are unaffected by truncation:

Model 2a: $$\lambda_{i,j} = a + \sum_{i=2}^{3} b_i LD_i + \varepsilon_{i,j}$$

Model 3a: $$\lambda_{i,j} = a + eDEV_j + \varepsilon_{i,j}$$

Model 4a: $$\lambda_{i,j} = a + \sum_{i=2}^{3} b_i LD_i + \sum_{i=1}^{3} c_i LDDEV_{i,j} + \varepsilon_{i,j}$$

Where $\lambda_{i,j} = DR_{NN,i,j}$ or $COR_{i,j}$.

All these tests require a precise empirical definition of a truncated market. We discuss this issue and our data in the next section.

III. Data Availability And Empirical Issues

Because of timing issues there are problems when using daily returns data on international markets. However, the use of monthly data would severely limit the number of observations. We therefore base all our results on weekly returns.

We select four 'lead' countries, US, UK, Japan and Australia, one from each of the main trading areas, and pair these with each other and with the non-lead ('subsidiary') countries for which we have data. The 44 countries available are shown in table 1.

For each country we obtain weekly US$-denominated log returns from Datastream, using Datastream code 'TOTMKT'. The returns are adjusted for re-invested dividends (Datastream item 'RI'). In our tests we classified non-lead countries into three main regions: Latin America, Asia (which consists of S.E. Asia, the Far East and India), and Europe (S. and N. Europe, Scandinavia, Russia and Turkey).

Our proxy for the risk-free rate of interest is the three-month US Treasury bill weekly yield. Since we are using dollar-denominated

TABLE 1. Countries available

Emerging		Developed	
Region	Country	Region	Country
Latin America	Argentina	N. America	Canada
	Brazil		US (Lead country)
	Chile	Far East	Hong Kong
	Mexico		Japan (Lead country)
	Peru	SE Asia	Singapore
	Venezuela	Scandinavia	Denmark
Far East	China		Finland
	Korea		Norway
	Taiwan		Sweden
SE Asia	Malaysia	S. Europe	Spain
	Philippines		Greece
	Thailand		Italy
N. Europe	Czech Republic		Portugal
	Hungary	N. Europe	Germany
	Poland		Belgium
Europe	Russia		France
	Turkey		Ireland
Asia	India		Luxemburg
Other	Israel		Netherlands
	S. Africa		Austria
			Switzerland
			UK (Lead country)
		Australasia	Australia (Lead country)
			New Zealand
Total:	20 countries		24 countries

returns we need a dollar interest rate, and under interest parity we should get the same result whether we use US interest rates, or domestic interest rates adjusted for exchange rate movements.[6]

The 'youngest' market in our sample is Brazil, which came into existence in July 1994, so we restrict our samples to the period from July 1994 to October 2003, a total of 484 observations.

Subject to a qualification concerning Japan discussed below, we assume that this sample provides an accurate representation of the complete distribution of returns. It therefore allows us to calculate

6. Interest parity does not always hold but variations in interest rates are small in comparison with the other parameters.

conventionally the means and standard deviations of any pair of asset returns and the correlations between them in normal market conditions. And from these, again conventionally, we can calculate for any pair the portfolio that would maximise expected utility.[7]

To measure the equivalent parameters of pairs of markets in extreme conditions we need to decide (a) whether to condition on one or both of the asset returns when truncating the distributions; and (b) how the thresholds should be expressed (in absolute terms or in terms of standard deviations) and how high they should go.

A. Conditioning

Some researchers condition on both returns - double truncation - but an investor is likely to be interested in the behaviour of a foreign market when the behaviour of the domestic market is extreme, rather than in the behaviour of the two markets when they are both extreme. Consequently we set our thresholds in terms of only one return (single truncation), using the lead market as the conditioning variable. So, for example, for the US/Argentina pair, observations used to estimate the portfolio parameters are all those US observations that lie in the appropriate tail and the associated Argentinean observations.

B. Thresholds

We set our thresholds at 1.5, 1, 0.5 and 0 standard deviations around the mean (in terms of weekly returns of the lead market). We do not go to higher extremes because the number of observations would then be so small that any estimates derived for them would, as noted by other authors such as Bae et al (2003), be unreliable, and also of rather limited practical importance.

Table 2 shows the numbers of observations used for estimation at different degrees of truncation. This table shows that there is some skewness in the distributions, with more observations above the mean (threshold +0), than below it (threshold –0), except for Japan, which, we will see below, has many other unusual characteristics.

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7. In doing so we are, of course, abstracting from the practical problems of implementing any particular investment strategy, such as cost or the absence of suitable investment vehicles, both of which might be especially acute in emerging markets.

TABLE 2. Average number of observations in the tails

	Threshold in terms of standard deviations around mean							
	–1.5	–1	–0.05	–0	+0	0.5	1	1.5
Lead country								
US	29	68	127	225	259	138	61	24
Japan	26	62	148	249	235	124	70	36
UK	29	66	125	223	261	144	64	26
Australia	27	63	144	236	248	142	69	31

IV. Descriptive Statistics; Correlations and Portfolio Performance in Normal and Truncated Markets

Table 3 shows dollar-denominated means, medians and standard deviations for weekly returns of the whole sample of country markets and for the upper and lower halves of the distributions. The data for the four lead countries are shown separately, while, to save space, data for the remaining countries are grouped into regions and a simple average calculated.

Of the lead countries, Japan was in a recession throughout the sample period. Furthermore, its median return is considerably lower than its mean, while all developed regions and most emerging ones have the opposite relationship. Whilst this is useful in that it presents us with data on unusual markets, it does question our assumption that the sample period represents the complete distribution of returns. We therefore deal with Japan separately in all the statistics presented below and exclude it from our regressions.

For all the countries, standard deviations in the tails are lower than overall standard deviations. For all but Japan and Asian emerging markets the standard deviation of the top half of the distribution is lower than that in the lower half.

Table 4 shows the correlations between the weekly returns of each lead country and each of the other three, and the average of correlations between each of the four lead countries and selected other groups of countries. Correlations are shown for the whole sample and for the upper and lower tails of the distribution. They suggest, very broadly, that correlations between emerging markets and the developed ones are lower than correlations between developed markets (although again Japan is something of an exception); and that correlations in both tails are lower than the overall correlation, a phenomenon that we explore more fully below.

TABLE 3. Summary statistics: Weekly returns

	Overall			Tail below the mean			Tail above the mean		
	Mean %	Median %	SD %	Mean %	Median %	SD %	Mean %	Median %	SD %
US	0.2178	0.3970	2.6463	–1.9044	–1.4734	1.9370	2.0614	1.6848	1.5854
Japan	–0.0746	–0.2348	3.4248	–2.6085	–2.1391	1.9803	2.6103	1.8018	2.4459
UK	0.1668	0.3347	2.3117	–1.7248	–1.2413	1.7126	1.7830	1.5011	1.3162
Australia	0.1818	0.2264	2.4835	–1.7553	–1.5058	1.6721	2.0251	1.6742	1.5504
Asia Developed	0.0545	0.0778	4.0414	–2.8224	–1.9474	3.0577	2.9077	2.0668	2.6215
Europe Developed	0.1782	0.2864	3.0556	–2.1774	–1.5262	2.2322	2.3795	1.9461	1.8333
Latin America Emerging	–0.0066	0.1170	4.3669	–3.5771	–2.6048	3.2712	2.8446	2.0320	2.8275
Asia Emerging	–0.0467	–0.0363	5.5235	–3.5947	–2.1319	3.9261	4.1501	2.9329	4.0333
Europe Emerging	0.2350	0.2093	5.6557	–3.7060	–2.7032	3.9832	4.6111	3.6543	3.6812

TABLE 4. Correlation coefficients

	Overall				Tail below the mean				Tail above the mean			
Lead:	US	Japan	UK	Au	US	Japan	UK	Au	US	Japan	UK	Au
US	1.0000	0.2860	0.6233	0.4947	1.0000	0.2352	0.4676	0.4710	1.0000	0.0316	0.4405	0.1894
Japan	0.2860	1.0000	0.3431	0.4258	0.1724	1.0000	0.2533	0.2049	0.1576	1.0000	0.2662	0.2815
UK	0.6233	0.3431	1.0000	0.5129	0.5322	0.1954	1.0000	0.4051	0.4035	0.1127	1.0000	0.2366
Australia	0.4947	0.4258	0.5129	1.0000	0.4199	0.3116	0.4019	1.0000	0.2797	0.3973	0.3660	1.0000
Asia Developed	0.4532	0.4443	0.4999	0.5614	0.3114	0.3070	0.3573	0.5497	0.2550	0.4062	0.3075	0.4135
Europe Developed	0.4388	0.2696	0.5637	0.4018	0.3675	0.1937	0.5013	0.3501	0.2051	0.1833	0.3147	0.1989
Latin Amer Emerging	0.3078	0.1314	0.2741	0.2628	0.2702	0.1410	0.2710	0.2999	0.1184	0.0250	0.1338	0.1174
Asia Emerging	0.2617	0.2935	0.2672	0.3720	0.2063	0.1611	0.1820	0.3566	0.0836	0.2858	0.1741	0.2633
Europe Emerging	0.2685	0.1742	0.3186	0.2908	0.2540	0.1172	0.2960	0.2825	0.0959	0.0942	0.1755	0.1818

Note: The correlations between lead countries in the tails are not symmetric, since in each case the distribution is truncated around the mean of the lead country.

Table 5 presents estimates of average weekly CERRs generated by plain vanilla and diversified portfolios in normal markets, unexpectedly truncated markets and correctly predicted bull markets:[8] R_{NN} and VR_{NN}; R_{NT} and VR_{NT}; and R_{TT} and VR_{TT}. In the table Japan is treated separately but other lead countries are grouped together, so the results presented there give only a very broad picture of the benefits of diversification. They are also calculated for a particular degree of risk aversion parameter, viz. 2, though we have repeated all the tests and summaries for parameter values 0.5, 1, 1.5, 2.5 and 3 and there were no qualitative differences.[9]

The first column of table 5 suggests that combining two international markets in a diversified portfolio under normal market conditions yields significant but modest benefits. The average weekly risk-free rate over the sample period was in the region of 0.075%. So, for lead countries other than Japan, domestic diversification (investing in a single market) yielded approximately double this in CERR terms for an investor with relative risk aversion of 2, while combining two markets added an extra 0.05% - 0.07% on average. Note that a positive CERR is achievable when holding Japan as the only risky asset, even though Japan was in recession over the sample period, because the optimum mix involves shorting the market to invest in the risk-free asset. Combining Japan with other countries generates the highest CERR in a normal market because of the low correlation between Japan and the other lead markets, combined with the ability to short Japan.

The CERR figures in the last four columns suggest that in correctly anticipated bull markets there are still rewards to diversification, but that they are very small in relation to the overall returns. It is worth pointing out that the very high figures that appear here are caused by short-selling. Clearly, an investor who knows that the market is about to enter a bull period will borrow heavily (short the risk-free asset) and invest in the market; if the investor is correct, as assumed in these columns, high rewards will ensue. An interesting extension of this paper would be to investigate how a restriction on short-selling would affect the results.

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8. For our data and sample period, correctly predicted bear markets always generate zero CERRs, since, as mentioned above, the optimal decision is to invest only in the risk-free asset for all pairs and at all levels of truncation.

9. The CERRs at different levels of risk aversion are inversely proportionate to $\delta \equiv \lambda/2(1+\lambda)$, where λ is the rate of relative risk aversion (RRA). So, for example, the CERRs with RRA 0.5 are twice those with RRA of 2. Therefore regression results at all levels of risk aversion have the same standard errors, although the coefficient values vary proportionately.

TABLE 5. Effects of international diversification (risk aversion parameter 2)

	Overall CERR %	CERR in unexpectedly truncated market (%)							
	VR_{NN} or R_{NN}	VR_{NT} or R_{NT}							
		–1.5	–1	–0.5	–0	+0	+0.5	+1	+1.5
Lead countries other than Japan									
1. Alone	0.1477	–14.3594	–10.6389	–7.6847	–5.0409	4.9237	7.4893	10.3671	13.6313
2. Paired with Japan	0.4568	–13.8792	–9.8609	–6.7516	–4.4504	4.9936	7.5360	10.6872	14.5430
3. Paired with other lead countries	0.1988	–14.6102	–10.8233	–7.8631	–4.9956	4.9787	7.4721	10.2243	12.9924
4. Paired with non-leads	0.2164	–14.2370	–10.5922	–7.6337	–5.0065	5.0272	7.5425	10.3036	13.4259
Japan									
5. Alone	0.1501	13.4406	10.6378	7.4698	5.2082	–5.0298	–8.2577	–11.0285	–13.7067
6. Paired with other lead countries	0.4568	12.8504	10.8702	7.1508	5.2650	–4.4754	–7.5696	–11.3405	–14.4919
7. Paired with non-leads	0.4221	12.0744	10.3325	7.1205	5.4568	–4.7347	–7.6511	–11.1586	–14.9639

(*Continued*)

TABLE 5. (Continued)

	Overall CERR %	CERR in anticipated truncated market (%)			
	VR_{NN} or R_{NN}	VR_{TT} or R_{TT}			
		+0	+0.5	+1	+1.5
Lead countries other than Japan					
1. Alone	0.1477	56.9836	85.5688	102.6779	116.3167
2. Paired with Japan	0.4568	57.7775	86.4362	103.0221	116.4190
3. Paired with other lead countries	0.1988	57.3204	86.2380	103.1368	116.6708
4. Paired with non-leads	0.2164	57.3395	86.1350	103.1241	117.1133
Japan					
5. Alone	0.1501	45.7665	77.6148	96.3523	105.0492
6. Paired with other lead countries	0.4568	46.3451	78.6385	96.7757	106.4109
7. Paired with non-leads	0.4221	46.0617	78.5365	97.1157	105.8419

Note: The table shows the excess CERRs generated by various portfolios. The column headed 'overall' CERR shows the maximum CERR available under normal market conditions, VR_{NN} with a 'plain vanilla' portfolio and R_{NN} with a diversified one. The other columns show the CERR generated when the market is truncated as shown, with truncation thresholds in terms of standard deviations of lead country returns around their mean. VR_{NT} and R_{NT} are CERRs generated by the portfolio that is appropriate for normal market conditions; VR_{TT} and R_{TT} are CERRs generated by the portfolio that is optimal for the truncated market. Only positive thresholds are shown in this case, as the optimum portfolio in a bear market is always 100% in the risk-free asset, generating zero CERRs. The figures in lines 1- 4, 6 and 7 are means across the categories shown.

TABLE 6. Effects of truncation on CERRs (risk aversion parameter 2); lead countries other than Japan

All in %	Effect of truncation: optimal outcome			'Avoidable' loss caused by sub-optimal portfolio	Total CERR
	Best CERR achievable in normal market (R_{NN})	Max gain / Min loss (ΔM)	Best CERR achievable in truncated market (R_{TT})	ΔA	(Table 5 col 8) R_{NT}
A. Threshold 1 standard deviation above the mean					
Paired with Japan					
Mean	0.4568	102.5654	103.0222	–92.3350	10.6872
Paired with other leads					
Mean	0.1989	102.9379	103.1368	–92.9125	10.2243
Median	0.2095	102.6926	102.8861	–93.1188	
Std dev	0.0335	2.2379	2.2246	3.8401	
Other pairs					
Number	120	120	120	120	
Mean	0.2164	102.9077	103.1241	–92.8205	10.3036
Median	0.2045	102.5133	102.7185	–93.0989	
Std dev	0.1045	2.2879	2.2482	3.7927	

(*Continued*)

TABLE 6. (Continued)

	Effect of truncation: optimal outcome			'Avoidable' loss caused by sub-optimal portfolio	Total CERR
	Best CERR achievable in normal market (R_{NN})	Max gain / Min loss (ΔM)	Best CERR achievable in truncated market (R_{TT})	ΔA	(Table 5 col 3) R_{NT}
B. Threshold 1 standard deviation below the mean					
Paired with Japan					
Mean	0.4568	–0.4568	0.0000	–9.8609	–9.8609
Paired with other leads					
Mean	0.1988	–0.1988	0.0000	–10.8233	–10.8233
Median	0.2095	–0.2095	0.0000	–10.1194	
Std dev	0.0335	0.0335	0.0000	1.5239	
Other pairs					
Number	120	120	120	120	
Mean	0.2164	–0.2164	0.0000	–10.5922	–10.5922
Median	0.2045	–0.2045	0.0000	–9.9649	
Std dev	0.1045	0.1045	0.0000	1.5627	

Note: The table shows beneficial (+) and harmful (–) effects of truncation on the CERR achieved in bull and bear markets. The first three columns show how the best achievable CERR in normal market conditions (R_{NN}) would be increased in a bull market (Panel A) or decreased in a bear market (Panel B) by an investor holding the portfolio that is optimal for the truncated market (R_{TT}). Column 4 shows how this optimum is reduced by mis-predicting the market and therefore mistakenly holding a portfolio based on parameters of the complete distribution (ΔA). Column 5 repeats figures in columns 8 and 3 of table 5, for clarity, showing the breakdown of these figures, namely R_{TT}+ΔA.

Finally, when the lead market is unexpectedly truncated so that the investor is holding the portfolio which is appropriate for a normal market, table 5 suggests that the benefits of diversification are less clear-cut for both bear and bull markets: the CERR on a diversified portfolio is generally higher on average than the CERR on a 'plain vanilla' portfolio but this is by no means always the case.[10] However, in all cases the benefits of diversification per se are very small relative to the overall returns.

These results suggest that, in general, cross-country diversification is worthwhile in normal markets, but that it may not provide much extra protection nor offer greater opportunities in periods of market turbulence. On the other hand, it is not clear from these very general results whether benefits of diversification are actually lost during bull or bear markets. The tests below address this issue formally.

Panels A and B of table 6 focus on the effect of truncation on diversified portfolios, elaborating on some of the figures in table 5. For the sake of space we show only figures for one standard deviation above and below the mean. The figures for other tails had similar patterns. Panel A refers to a bull market, panel B to a bear market. The top left-hand figure in panel A (0.46%) is the CERR for an optimal portfolio that combines the risk-free asset, Japan, and a lead country other than Japan, in normal market conditions. The figure immediately to its right shows that if the market were a bull market then the optimal portfolio in such a market would increase that CERR by 102.57% to 103.02%, the figure in the third column. However, of this additional 102.57%, 92.33% (column 4) would be lost if the portfolio were not adjusted to take account of market conditions, resulting in a final CERR of 10.69% (column 5).

The equivalent figures for the bear market are shown in row one of panel B. Here the CERR for an optimal portfolio in normal market conditions is 0.46% as before. The maximum achievable CERR in the truncated market is now zero, since with almost any degree of truncation the optimal portfolio in a bear market consists entirely of the risk-free asset. The minimum loss resulting from the market truncation is therefore 0.46%. The additional loss that would result from not re-arranging the portfolio given the market conditions is shown in column 4 as –9.86%.

Overall, the results in table 6 indicate that appropriate

10. With Japan-led portfolios, the optimum portfolio mix under normal conditions involves short-selling Japan so that when it is in a deeper recession than expected, the CERRs increase, and the opposite applies in a boom.

re-arrangement of portfolios is required to achieve the large potential gains offered by bull markets and to avoid the large losses in bear markets: holding a portfolio that is optimally diversified for normal market conditions will do neither.

V. Formal Tests

A. Correlations

Table 7 presents the results of estimating models 2(a) – 4(a) with $\lambda_{i,j} = COR_{i,j}$ and models 1-4 with $\lambda_{i,j} = \Delta COR_{i,j}$ and figure 1 illustrates some of the results graphically, using the predicted values from the estimates of models 3(a) and 3.[11] Estimates of models 2(a)-4(a) suggest that, as one might expect, *DEV*/*DEV* correlations are significantly higher (by about 0.2) than *DEV*/*EM* pairs, though this varies somewhat with the lead country. Estimates of models 1-4 suggest a marked and significant tendency for correlations to decline as the bull or bear market becomes more extreme. The base case in these columns is the most extreme bear market, which has a strongly significant negative coefficient. All other joint coefficients (that is, base case + appropriate dummy) are negative. The last two columns of coefficients suggest that this tendency is significantly more marked in *DEV*/*DEV* pairs. In fact, figure 1 emphasises that, although the reduction in correlations is greater for *DEV*/*DEV* pairs, the overall correlation for such pairs is sufficiently high to mean that *DEV*/*DEV* correlations are still higher than *DEV*/*EM* ones in truncated markets. The fall in correlations as the absolute value of the threshold increases is contrary to the findings of other studies (for example, Longin and Solnik (2001)), most of which suggest that international correlations increase with the severity of the bear market. Our results suggest that this is not true of our data period for any of the lead countries.[12]

B. Benefits of International Diversification

Table 8 and table 9 present the results of the regressions involving international diversification benefits in normal markets and in truncated

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11. As explained above, from this point onwards data relating to Japan are omitted.

12. To check whether our results differ from other researchers' because we are using single truncation, we examined correlations in tails of doubly-truncated distributions. Our results were qualitatively unaltered.

TABLE 7. Analysis of correlations

	Dep var: $Cor_{i,j}$ (overall correl)			Dep var: $\Delta Cor_{i,j}$ (correlation change)			
Model:	2a	3a	4a	1	2	3	4
Constant	0.3826	0.3066	0.2977	–0.1202	–0.1320	–0.0759	–0.1044
	(16.83)**	(20.08)**	(11.60)**	(–9.82)**	(–10.05)**	(–4.46)**	(–5.77)**
LD_{UK}	0.0477		0.0005		–0.0293		0.0000
	(1.48)		(0.02)		(–2.88)**		(0.00)
LD_{Au}	0.0039		0.0263		0.0644		0.0855
	(0.12)		(0.72)		(6.33)**		(6.10)**
DEV		0.1779					
		(8.43)**					
$LDDEV_{US}$			0.1621				
			(4.57)**				
$LDDEV_{UK}$			0.2520				–0.0559
			(7.11)**				(–2.89)**
$LDDEV_{Au}$			0.1195				–0.0402
			(3.37)**				(–2.08)*
–1				0.0345	0.0345	0.0502	0.0502
				(2.00)*	(2.08)*	(2.09)*	(2.19)*
–0.5				0.0581	0.0581	0.0529	0.0529
				(3.36)**	(3.50)**	(2.20)*	(2.31)*
–0				0.0739	0.0739	0.0536	0.0536
				(4.27)**	(4.45)**	(2.23)*	(2.34)*

(*Continued*)

TABLE 7. (Continued)

	Dep var: $Cor_{i,j}$ (overall correl)			Dep var: $\Delta Cor_{i,j}$ (correlation change)			
Model:	2a	3a	4a	1	2	3	4
+0				–0.0715	–0.0715	–0.0792	–0.0792
				(–4.13)**	(–4.31)**	(–3.29)**	(–3.46)**
+0.5				–0.1419	–0.1419	–0.1383	–0.1383
				(–8.20)**	(–8.54)**	(–5.75)**	(–6.04)**
+1				–0.1564	–0.1564	–0.1676	–0.1676
				(–9.03)**	(–9.42)**	(–6.97)**	(–7.32)**
+1.5				–0.2055	–0.2055	–0.2030	–0.2030
				(–11.87)**	(–12.38)**	(–8.44)**	(–8.87)**
–1.5*DEV*						–0.0847	–0.0527
						(–3.61)**	(–2.11)*
–1*DEV*						–0.1146	–0.0825
						(–4.88)**	(–3.30)**
–0.5*DEV*						–0.0747	–0.0426
						(–3.18)**	(–1.70)
–0*DEV*						–0.0459	–0.0138
						(–1.95)	(–0.55)
+0*DEV*						–0.0702	–0.0381
						(–2.99)**	(–1.52)
+0.5*DEV*						–0.0915	–0.0595
						(–3.89)**	(–2.38)*

(*Continued*)

TABLE 7. (Continued)

	Dep var: $Cor_{i,j}$ (overall correl)			Dep var: $\Delta Cor_{i,j}$ (correlation change)			
Model:	2a	3a	4a	1	2	3	4
+1*DEV*						–0.0633	–0.0313
						(–2.69)**	(–1.25)
+1.5*DEV*						–0.0896	–0.0575
						(–3.81)**	(–2.30)*
Adjusted R sq	0.0056	0.3593	0.3969	0.3466	0.3988	0.3998	0.4564
NOBS	126	126	126	1,008	1,008	1,008	1,008

Note: The table shows the results of estimating the following regression equations.
See model 2a, model 3a, model 4a, model 1, model 2, model 3, model 4 on text.
where $\lambda_{i,j} = COR_{i,j}$ for models 2a-4a and $\Delta COR_{i,j}$ for models 1-4;
$\Delta COR_{i,j}$ = the correlation in the relevant tail minus the overall correlation;
LD_i are lead country dummies distinguishing between the US (i = 1), UK (i = 2) and Australia (i = 3);
THR_k is a dummy that takes the value 1 if the threshold equals k, k = –1, –0.5, –0, +0, +0.5, +1, +1.5 standard deviations around the lead country's mean;
DEV_j is a dummy that takes the value 1 if the second country in the pair is a developed market;
$DEVTHR_{k,j}$ equals $THR_k \times DEV_j$; and
$LDDEV_{i,j}$ equals $LD_i \times DEV_j$
t-statistics are shown in parentheses and indicate statistical significance at 5% (*) and 1% (**), two-tailed tests.

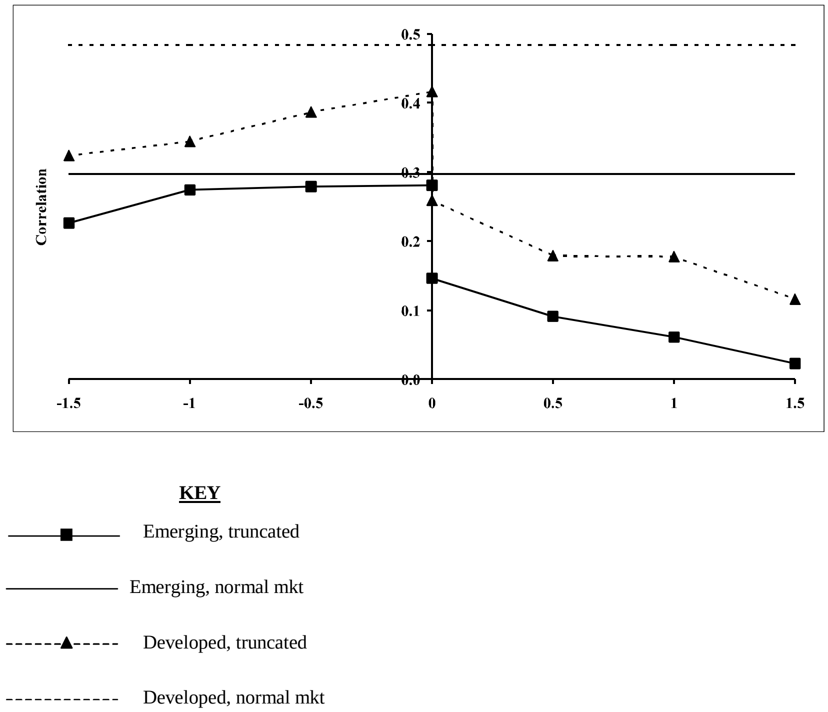


FIGURE 1.— Correlations in Normal and Truncated Markets

Note: The figure shows the joint coefficients from the regression results of models 3 and 3a in table 7.

markets, both predicted and unpredicted. Table 8 shows the results of estimating models 2(a)-4(a) with $\lambda_{i,j}$ = $DR_{NN,i,j}$ (diversification with normal markets), and table 9 the results of estimating models 1-4 with $\lambda_{i,j}$ = $DR_{TT,i,j}$ or $DR_{NT,i,j}$ (diversification with truncated markets). Figure 2 uses the results from estimates of model 3(a) and model 3 to illustrate their overall pattern graphically.

The constant in model 2(a) in table 8 confirms our earlier suggestion that the benefits of diversification in normal markets are roughly equal to a doubling of the risk-free rate of interest (for an investor with relative risk aversion of 2). But models 3(a) and 4(a) suggest that the benefits for portfolios involving *DEV*/*DEV* pairs are about half that of *DEV*/*EM* pairs, with US-led pairs suffering the most. The results in table 9, which are illustrated in the left-hand section of figure 2, suggest that in unexpectedly truncated markets *DEV*/*DEV* portfolios lose the

TABLE 8. Benefits of diversification in normal market (DR_{NN}) (risk aversion 2)

Model:	2a	3a	4a
Constant	0.0636	0.0884	0.0922
	(12.44)**	(21.13)**	(12.74)**
LD_{UK}	0.0017		–0.0135
	(0.23)		(–1.32)
LD_{Au}	0.0111		0.0023
	(1.54)		(0.22)
DEV		–0.0393	
		(–6.79)**	
$LDDEV_{US}$			–0.0546
			(–5.46)**
$LDDEV_{UK}$			–0.0256
			(–2.56)*
$LDDEV_{Au}$			–0.0377
			(–3.77)**
Adj R sq	0.0008	0.0429	0.0459
NOBS	1,008	1,008	1,008

Note: The table shows the results of estimating the following regression equations. See model 2a, model 3a, model 4a on text.
where $\lambda_{i,j} = DR_{NN,i,j}$;
LD_i are lead country dummies distinguishing between the US (i = 1), UK (i = 2) and Australia (i = 3);
THR_k is a dummy that takes the value 1 if the threshold equals k, k = –1, –0.5, –0, +0, +0.5, +1, +1.5 standard deviations around the lead country's mean;
DEV_j is a dummy that takes the value 1 if the second country in the pair is a developed market;
$DEVTHR_{k,j}$ equals $THR_k \times DEV_j$; and
$LDDEV_{i,j}$ equals $LD_i \times DEV_j$
T-statistics are shown in parentheses and indicate statistical significance at 5% (*) and 1% (**), two-tailed tests.

benefits of diversification, while *DEV*/*EM* portfolios do not. For *DEV*/*DEV* portfolios the benefits fall with the degree of truncation (both in bull and bear markets); indeed they fall to such an extent that they rapidly become negative. For *DEV*/*EM* portfolios, diversification in bull markets yields much the same benefit as in normal markets, while the benefits tend to increase in bear markets. However, as noted earlier, the benefits in truncated markets are minor when compared to the other effects of truncation.

Finally, if a bull market is correctly predicted (right-hand section of of table 9),[13] benefits of diversification are higher than in normal

13. See also footnote 5.

TABLE 9. Benefits of diversification in truncated markets (risk aversion 2)

	Unpredicted truncated market (dep var DR_{NT})				Predicted truncated market (dep var DR_{TT})			
Model:	1	2	3	4	1	2	3	4
Constant	0.1047	0.1403	0.3437	0.4029	0.0710	0.5654	0.2411	0.4876
	(1.92)	(2.30)*	(4.50)**	(4.73)**	(3.54)**	(7.63)**	(2.70)**	(4.58)**
LD_{UK}		–0.0800		–0.1556		–0.2815		–0.4340
		(–1.70)		(–2.36)*		(–3.80)**		(–4.08)**
LD_{Au}		–0.0268		–0.0222		–0.3496		–0.3057
		(–0.57)		(–0.34)		(–4.72)**		(–2.87)**
$LDDEV_{UK}$				0.1443				0.2911
				(1.58)				(1.98)*
$LDDEV_{Au}$				–0.0088				–0.0839
				(–0.10)				(–0.57)
–1	–0.0690	–0.0690	–0.1136	–0.1136				
	(–0.90)	(–0.90)	(–1.05)	(–1.05)				
–0.5	–0.0646	–0.0646	–0.1732	–0.1732				
	(–0.84)	(–0.84)	(–1.60)	(–1.61)				
–0	–0.0698	–0.0698	–0.2999	–0.2999				
	(–0.91)	(–0.91)	(–2.78)**	(–2.78)**				
+0	–0.0035	–0.0035	–0.2096	–0.2096				
	(–0.05)	(–0.05)	(–1.94)	(–1.94)				

(Continued)

TABLE 9. (Continued)

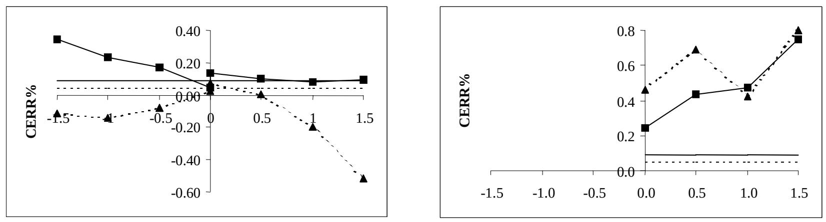
	Unpredicted truncated market (dep var DR_{NT})				Predicted truncated market (dep var DR_{TT})			
Model:	1	2	3	4	1	2	3	4
+0.5	–0.0549	–0.0549	–0.2423	–0.2423	0.5001	0.2161	0.1954	0.1954
	(–0.71)	(–0.71)	(–2.24)*	(–2.25)*	(10.19)**	(2.53)*	(1.55)	(1.59)
+1	–0.1719	–0.1723	–0.2657	–0.2657	0.3759	0.0919	0.2354	0.2354
	(–2.23)*	(–2.23)*	(–2.46)*	(–2.46)*	(7.66)**	(1.07)	(1.86)	(1.92)
+1.5	–0.3307	–0.3307	–0.2520	–0.2520	0.7045	0.4205	0.5105	0.5105
	(–4.29)**	(–4.29)**	(–2.33)*	(–2.34)*	(14.35)**	(4.91)**	(4.04)**	(4.16)**
–1.5*DEV*			–0.4563	–0.5014				
			(–4.33)**	(–4.26)**				
–1*DEV*			–0.3710	–0.4162				
			(–3.52)**	(–3.53)**				
–0.5*DEV*			–0.2490	–0.2941				
			(–2.36)*	(–2.50)*				
–0*DEV*			–0.0171	–0.0623				
			(–0.16)	(–0.53)				
+0*DEV*			–0.0628	–0.1080			0.2175	0.1484
			(–0.60)	(–0.92)			(1.76)	(1.01)
+0.5*DEV*			–0.0984	–0.1435			0.2572	0.1881
			(–0.93)	(–1.22)			(2.08)*	(1.28)

(*Continued*)

TABLE 9. (Continued)

	Unpredicted truncated market (dep var DR_{NT})				Predicted truncated market (dep var DR_{TT})			
Model:	1	2	3	4	1	2	3	4
+1*DEV*			–0.2774	–0.3226			–0.0566	–0.1257
			(–2.63)**	(–2.74)**			(–0.46)	(–0.85)
+1.5*DEV*			–0.6065	–0.6517			0.04583	–0.0234
			(–5.75)**	(–5.53)**			(0.37)	(–0.16)
Adj R sq	0.0203	0.0213	0.0843	0.0868	0.2197	0.0857	0.0508	0.1026
NOBS	1,008	1,008	1,008	1,008	1,008	504	504	504

Note: The table shows the results of estimating the following regression equations.
See model 1, model 2, model 3, model 4 on text.
where $\lambda_{i,j} = DR_{NT,i,j}$ or $DR_{TT,i,j}$;
LD_i are lead country dummies distinguishing between the US (i = 1), UK (i = 2) and Australia (i = 3);
THR_k is a dummy that takes the value 1 if the threshold equals k, k = –1, –0.5, –0, +0, +0.5, +1, +1.5 standard deviations around the lead country's mean;
DEV_j is a dummy that takes the value 1 if the second country in the pair is a developed market;
$DEVTHR_{k,j}$ equals $THR_k \times DEV_j$; and
$LDDEV_{i,j}$ equals $LD_i \times DEV_j$
T-statistics are shown in parentheses and indicate statistical significance at 5% (*) and 1% (**), two-tailed tests.



Unpredicted truncated market vs normal market

Predicted truncated market (upper tails) vs normal market

KEY

Emerging, truncated

Emerging, normal mkt

Developed, truncated

Developed, normal mkt

FIGURE 2.— Diversification Benefits (risk aversion 2)

Note: The figures show the diversification benefits achievable in normal markets and in truncated markets, in terms of the change in CERRs produced by diversifying internationally. They are constructed from the joint coefficients of the regression results of models 3 and 3a in tables 8 and 9. The left-hand panel shows the results of regressions with DR_{NT} as the dependent variable and the right- hand panel shows the results of regressions with DR_{TT} as the dependent variable.

markets, and increase with truncation. Other than at a threshold 0.5 standard deviations above the mean, which has a significant coefficient on the +0.5*DEV* dummy, there is no significant difference between *DEV*/*DEV* and *DEV*/*EM* pairs in this respect.

C. Effects of Truncation on Internationally Diversified Portfolios

Table 10 shows the results of estimating models 1-4 for $\lambda_{i,j} = \Delta A_{i,j}$ and table 11 shows the results of $\Delta M_{i,j}$. In the case of $\Delta A_{i,j}$, the 'avoidable' loss caused by holding a sub-optimal portfolio in a truncated market, we present separate estimates for the upper and lower tails because of the highly skewed nature of the distribution, as explained in the discussion of table 6. In the case of $\Delta M_{i,j}$ we present estimates only for the upper tail, i.e., for the maximum gain achievable in a bull market (see note 5).

The results for $\Delta A_{i,j}$ in table 10 suggest first that the failure to predict

TABLE 10. Regression tests of effect of truncation on CERR of diversified portfolios in unpredicted truncated market (risk aversion 2)

	ΔA, upper tails				ΔA, lower tails			
Model:	1	2	3	4	1	2	3	4
Constant	–103.6869	–100.5240	–103.3453	–100.1713	–14.2548	–16.0653	–14.0158	–15.8262
	(–334.41)**	(–526.51)**	(–229.48)**	(–362.53)**	(–105.60)**	(–183.11)**	(–71.76)**	(–126.36)**
LD_{UK}		–7.1907		–7.1513		2.7106		2.6726
		(–37.66)**		(–25.88)**		(30.90)**		(21.34)**
LD_{Au}		–2.2980		–2.3705		2.7210		2.7587
		(–12.04)**		(–8.57)**		(31.01)**		(22.03)**
$LDDEV_{UK}$				–0.0751				0.0726
				(–0.20)				(0.42)
$LDDEV_{Au}$				0.1383				–0.0721
				(0.36)				(–0.42)
-1					3.6516	3.6516	3.6070	3.6070
					(19.13)**	(36.04)**	(13.06)**	(24.94)**
-0.5					6.6101	6.6101	6.5016	6.5016
					(34.62)**	(65.25)**	(23.54)**	(44.95)**
-0					9.2487	9.2487	9.0187	9.0187
					(48.45)**	(91.29)**	(32.65)**	(62.36)**
+0	51.3733	51.3733	51.1785	51.1785				
	(117.16)**	(233.03)**	(80.36)**	(160.40)**				
+0.5	25.0861	25.0861	24.9307	24.9307				
	(57.21)**	(113.79)**	(39.15)**	(78.14)**				

(*Continued*)

TABLE 10. (Continued)

	ΔA, upper tails				ΔA, lower tails			
Model:	1	2	3	4	1	2	3	4
+1	10.8620	10.8620	10.6361	10.6361				
	(24.77)**	(49.27)**	(16.70)**	(33.34)**				
–1.5*DEV*							–0.4563	–0.4564
							(–1.69)	(–2.64)**
–1*DEV*							–0.3710	–0.3712
							(–1.37)	(–2.14)*
–0.5*DEV*							–0.2490	–0.2491
							(–0.92)	(–1.44)
–0*DEV*							–0.0171	–0.0173
							(–0.06)	(–0.10)
+0*DEV*			–0.2803	–0.3014				
			(–0.45)	(–0.79)				
+0.5*DEV*			–0.3555	–0.3766				
			(–0.57)	(–0.99)				
+1*DEV*			–0.2208	–0.2419				
			(–0.35)	(–0.63)				
+1.5*DEV*			–0.6522	–0.6733				
			(–1.05)	(–1.76)				
Adj R sq	0.9684	0.9920	0.9682	0.9920	0.8378	0.9543	0.8383	0.9557
NOBS	504	504	504	504	504	504	504	504

(*Continued*)

TABLE 10. (Continued)

Note: The table shows the results of estimating the following regression equations.
See model 1, model 2, model 3, model 4 on text.
where $\lambda_{i,j} = \Delta A_{i,j}$;
LD_i are lead country dummies distinguishing between the US (i = 1), UK (i = 2) and Australia (i = 3);
THR_k is a dummy that takes the value 1 if the threshold equals k, k = –1, –0.5, –0, +0, +0.5, +1, +1.5 standard deviations around the lead country's mean;
DEV_j is a dummy that takes the value 1 if the second country in the pair is a developed market;
$DEVTHR_{k,j}$ equals $THR_k \times DEV_j$; and
$LDDEV_{i,j}$ equals $LD_i \times DEV_j$
T-statistics are shown in parentheses and indicate statistical significance at 5% (*) and 1% (**), two-tailed tests.

TABLE 11. Regression tests of effect of truncation on CERR of diversified portfolios in predicted truncated market (risk aversion 2)

	ΔM (Upper tails only)			
Model:	1	2	3	4
Constant	11.2522	55.8970	56.9885	55.7906
	(15.48)**	(330.74)**	(181.83)**	(227.19)**
LD_{UK}		3.8471		3.7097
		(22.76)**		(15.11)**
LD_{Au}		–0.1691		–0.1163
		(–1.00)		(–0.47)
$LDDEV_{\mathrm{UK}}$				0.2621
				(0.77)
$LDDEV_{\mathrm{Au}}$				–0.1007
				(–0.30)
+0.5	74.6722	28.8014	28.7806	28.7806
	(41.93)**	(147.59)**	(64.93)**	(101.50)**
+1	91.6570	45.7862	45.9298	45.9298
	(51.47)**	(234.62)**	(103.62)**	(161.98)**
+1.5	105.6245	59.7537	59.8437	59.8437
	(59.31)**	(306.20)**	(135.01)**	(211.04)**
+0*DEV*			0.2568	0.2030
			(0.59)	(0.60)
+0.5*DEV*			0.2965	0.2427
			(0.68)	(0.72)
+1*DEV*			–0.0173	–0.0711
			(–0.04)	(–0.21)
+1.5*DEV*			0.0850	0.0312
			(0.20)	(0.09)
Adj R sq	0.8565	0.9952	0.9883	0.9952
NOBS	1,008	504	504	504

Note: The table shows the results of estimating the following regression equations. See model 1, model 2, model 3, model 4 on text.
where $\lambda_{i,j} = \Delta M_{i,j}$;
LD_i are lead country dummies distinguishing between the US ($i = 1$), UK ($i = 2$) and Australia ($i = 3$);
THR_k is a dummy that takes the value 1 if the threshold equals k, $k = –1, –0.5, –0, +0, +0.5, +1, +1.5$ standard deviations around the lead country's mean;
DEV_j is a dummy that takes the value 1 if the second country in the pair is a developed market;
$DEVTHR_{k,j}$ equals $THR_k \times DEV_j$; and
$LDDEV_{i,j}$ equals $LD_i \times DEV_j$
T-statistics are shown in parentheses and indicate statistical significance at 5% (*) and 1% (**), two-tailed tests.

the nature of the market and appropriately change one's diversified portfolio imposes heavy opportunity costs on investors, costs which in terms of CERRs range from around 50 to 100 percentage points in a bull market (for example, the joint coefficient on the +0 dummy in model 1 is –103.69 + 51.37 = –52.32) and 4 to 16 percentage points in a bear market (for investors with risk aversion 2). These clearly dwarf any losses or benefits from holding a plain vanilla rather than diversified portfolio that we have discussed so far. The size of these losses appears to be largely independent of whether the portfolio involves *DEV*/*DEV* or *DEV*/*EM* pairs of assets.

The results for $\Delta M_{i,j}$ in table 11 confirm the large potential gains from a positively truncated market and that they are negligibly affected by whether the portfolio involves *DEV*/*DEV* or *DEV*/*EM* pairs of assets.

VI. Conclusions

In this paper we have used weekly returns data from 44 countries between July 1994 and October 2003 to examine the effects of bull and bear markets on certain market variables and portfolio characteristics. In particular, we have investigated the behaviour of cross-country correlations, benefits of international diversification and the effects of truncation on the performance of diversified portfolios.

Our conclusions are as follows.

Correlations between pairs of developed countries (*DEV*/*DEV* pairs) are significantly higher (by about 0.2) than correlations between pairs of developed and emerging countries (*DEV*/*EM* pairs). Contrary to other work in this field we find that for all types of portfolio correlations tend to fall in both bull and bear markets, although they fall considerably more in bull markets. The fall in correlations is greater for *DEV*/*DEV* pairs, but the overall correlation for such pairs is sufficiently high to mean that *DEV*/*DEV* correlations are still higher than *DEV*/*EM* ones in truncated markets.

Cross-country diversification is worthwhile in normal markets, increasing the certainty-equivalent rate of return by an amount roughly equal to the risk-free rate of interest (for an investor with relative risk aversion of 2). The benefits for an investor in a developed market of diversifying into an emerging market are higher than this, while the benefits of diversifying into a developed market are somewhat lower. Furthermore, in unexpectedly truncated markets *DEV*/*DEV* portfolios lose the benefits of diversification, while *DEV*/*EM* portfolios do not. For *DEV*/*DEV* portfolios the benefits fall with the degree of truncation (both in bull and bear markets); indeed they fall to such an extent that they rapidly become negative. For *DEV*/*EM* portfolios, diversification in bull markets yields much the same benefit as in normal markets, while the benefits tend to increase in bear markets. So emerging markets not only provide additional diversification benefits, but the benefits are not eroded in bull markets and are enhanced in bear markets. Nevertheless, the benefits in truncated markets are relatively small compared with the other effects of truncation.

As discussed above, our results abstract from certain practical problems, such as the unavailability of index futures, options and Exchange Traded Funds for certain emerging markets which makes the assumption of the possibility of short-selling in all stocks at all levels problematic. The thinness of markets might also put practical limits on an investor's ability to engage in *DEV*/*EM* diversification. Further useful research would consider the extent to which the potential benefits of *DEV*/*EM* diversification that we have identified are reduced by such practical difficulties.

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