Accepted Manuscript

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Authors: Jenny Berrill, Colm Kearney

PII: S0148-6195(10)00013-5
DOI: doi:10.1016/j.jeconbus.2010.02.002
Reference: JEB 5544

To appear in: *Journal of Economics and Business*

Received date: 21-3-2009
Revised date: 20-2-2010
Accepted date: 22-2-2010

Please cite this article as: Berrill, J., & Kearney, C., Firm-level internationalisation and the home bias puzzle, *Journal of Economics and Business* (2008), doi:10.1016/j.jeconbus.2010.02.002

Firm-level internationalisation and the home bias puzzle

Abstract

The extent to which internationalising MNEs create value, and the extent to which investors can reap the benefits of firm-level internationalisation remain controversial issues. Using a multi-country dataset with over 3 million observations, we classify 1,143 firms listed on the exchanges of the G7 countries according to the geographical spread of their sales and subsidiaries. We show that more internationalised firms provide greater diversification benefits. By investing in home-based internationalised firms, investors can 'free ride' the costs and risks associated with internationalisation at the level of the firm and exhibit home bias while availing of international diversification benefits.

Keywords

International diversification, home bias, mean variance spanning.

JEL Classification

F21, F23, G11

1 Introduction

Enhanced integration throughout the world's commodity, industrial and service sectors has created expanding opportunities for firms and investors to reap the synergistic gains from internationalisation. Firms have responded by internationalising their activities across greater geographical and cultural distances through trading, forming alliances, licensing, joint venturing and foreign direct investment (FDI). The extent to which they create value by internationalisation remains a controversial issue, with divergent results across many studies. Investors have responded to greater international integration by holding more geographically and culturally distant foreign assets in their portfolios. The extent to which they diversify internationally, however, remains significantly less than what many analysts and researchers believe should be observable. This is the so-called 'international diversification puzzle' or 'home-bias puzzle'. It arises because although the benefits of international portfolio diversification are significant, and although the costs and risks associated with achieving them appear small relative to those associated with internationalising at the level of the firm, investors continue to hold the majority of their equity portfolios in domestic rather than foreign-based firms.

The home bias literature offers a number of explanations for the phenomenon, including currency and political risk, information asymmetries, transaction costs, taxes, legal restrictions and other controls. Tesar & Werner (1995), for example, show that geographical proximity, language compatibility and trade links are more important than correlation structures for international investors. Baxter & Jermann (1997) argue that because labour income is highly correlated with the return on physical capital, investors should hold short positions in home-based firms. Hasan & Simaan (2000) and Ahearne, Griever & Warnock (2004) show how home bias results from costly or asymmetric information, and Fidora, Fratzscher & Thimann (2007) show that exchange rate volatility is a contributory factor. Overall, it is widely agreed that home bias continues to exist despite the well-understood benefits of international diversification, and that it results from investor preferences as much as from market imperfections (Lewis, 1999; Wei, 2000; Karolyi & Stulz, 2002; Portes & Rey, 2005; Aurelio, 2006; and French, 2008).

In this paper, we provide a different perspective on the home bias puzzle. Combining the resources of *Datastream*, Dun and Bradstreet's *Who Owns Whom*, and *Worldscope*, we construct a sample of 1,143 firms from the G7 countries: Canada, France, Germany, Italy, Japan, the UK and the US. Our sample comprises the constituent firms of these countries' main stock indexes for which we have the full set of data. We measure firm-level and market performance using daily returns from January 1999 to June 2007. We classify the degree of multinationality of these firms' operations from the geographical spread of their sales and subsidiaries as either domestic (*D*), regional (*R*), trans-regional (*T*) or global (*G*). Our analysis yields several novel findings. *First*, we show that the greater the firm's international reach, the more diversification benefits it can provide. Abstracting from country effects, firms that are more internationalised in their activities tend to provide greater diversification benefits to investors in every country in our sample. *Second*, we show that investors in each country can gain international diversification without having to invest in foreign-based firms. By investing in internationalised firms listed in their home countries, investors can 'free ride' the costs and risks associated with internationalisation at the level of the firm. We suggest that the contradictory findings in prior studies of this issue may be due to inconsistent definitions of 'multinational' or 'international' firms. When differences in firm-level internationalisation are carefully considered, it is clear that investors can benefit from international diversification while exhibiting 'home bias'.

Our *third* novel finding relates to how investors can obtain the greatest international diversification benefits. This can be achieved by combining a portfolio of home-based domestic firms with a portfolio of foreign-based domestic, regional, trans-regional and/or global firms. The bulk of the gains from this strategy, however, can be captured by the simple strategy of combining home-based domestic firms with foreign-based domestic firms. This is intuitive because foreign-based internationalised firms are likely to have exposures back to the investor's home country. A US-based investor, for example, investing in a UK-based global firm would be investing in a firm with exposure to the US economy. A portfolio comprising domestic firms from all over the world would clearly involve lower correlations and therefore yield greater diversification benefits.

Our paper exhibits several other innovative features. Our firm-level classification provides a new perspective on the construction of empirical samples of multinational enterprises (MNEs). Multinationality is a key dimension of the international business, economics and finance disciplines that spans all theoretical frameworks, levels of empirical analysis and domains of investigation. In empirical studies of MNEs, however, there is no widely accepted measure of the degree of firm-level multinationality. Membership of a particular data set or company list is often used to qualify firms as multinational. This has the effect of combining different kinds of firm into a broad category labelled 'MNE', and the resulting sample is used to test hypotheses about the nature, objectives, strategies and performance of MNEs. This issue is also discussed in Pantzalis (2001) and Choi and Jiang (2009). We overcome this problem by introducing a classification system for the degree of firm-level multinationality.

By classifying firms as 'domestic', 'regional', 'trans-regional' or 'global', we are able to establish and test a richer set of hypotheses about the benefits of diversification at different degrees of firm-level multinationality than has been investigated by previous researchers. Following Rowland & Tesar (2004), we apply our methodology to the perspective of investors in each of the G7 countries using a significantly larger dataset. Existing studies of the diversification benefits of investing in MNEs (such as Huberman & Kandel, 1987; Bekaert & Urias, 1996; and Errunza, Hogan & Hung, 1999) typically examine the question from a US perspective. The US has one of the most diversified economies and stock markets in the world, and results obtained using US data will not necessarily apply in other countries. Lastly, using mean variance spanning (MVS) tests to calculate the statistical significance of differences in firm-level diversification benefits, and using Sharpe ratios to measure their economic significance, we consider in turn the case in which investors can short sell without costs, and the case with short selling constraints.

The remainder of our paper is structured as follows. In section 2, we provide the contextual background to our study by reviewing previous related research. In section 3, we describe our data, introduce our firm-level classification methodology, and describe the MVS tests. Our hypotheses and results are presented and discussed in section 4. In section 5, we present our robustness analysis for size effects, industry effects, short sales constraints, and alternative specifications of our classification of firms. The final section summarises our paper and draws together our conclusions.

2 Previous related research

If capital markets were perfectly developed, and if international capital mobility was unimpeded, the returns on stocks in each country would include only the value of their contribution to the risk of the fully diversified world portfolio. In such a world, international diversification at the level of the firm would be inconsequential. In reality, however, no country has perfect capital markets, and there are substantial barriers, costs and risks associated with international portfolio investment. Because of this, investors are only partially diversified internationally, and they tend to hold a limited number of stocks (Barberis & Thaler, 2003). In addition, internationalisation of the firm can potentially raise firm value, and investors can obtain at least part of their desired degree of international diversification by investing in home-based internationalised firms. This raises two related questions: how does the degree of internationalisation affect firm performance, and to what extent can investors obtain the benefits of international diversification by investing in home-based internationalised firms?

Does the degree of internationalisation affect firm performance? The main theories of internationalisation, including Johanson & Vahlne's (1977) experiential learning model, Dunning's (1980, 1988) eclectic paradigm, Kogut & Zander's (1993) knowledge-based view and Oviatt & McDougall's (1994) international new venture theory, emphasize different aspects of the internationalisation process. Collectively, however, they suggest that given their financial, knowledge and management resources and the external constraints and opportunities that confront them, firms choose the patterns of internationalisation that maximize their risk-adjusted expected returns net of expected costs. The benefits to internationalisation include larger markets in which to apply their specialist knowledge and management skills, scale economies in production, and rents from imperfectly competitive factor and product markets. In addition to the initial investment, the costs include higher coordination and management expenses over geographical and cultural distances, enforcement of contracts, protection of patents, and the risks associated with foreign exchange, taxation, and political factors. The many possible patterns of firm-level internationalisation imply alternative combinations of benefits and costs, and following the early work of Errunza & Senbet (1981, 1984), an extensive empirical literature has sought to identify and measure them. The issue, however, remains unsettled. Douglas & Craig (1983), Lecraw (1983), Grant (1987), Allen & Pantzalis (1996) and Brouthers, Werner & Matulich (2000) have found that the degree of internationalisation is positively associated with profitability. In contrast, Mishra & Gobeli (1998) found that greater internationalisation by itself does not deliver greater value, and Berry (2006) found that the benefits depend on the location and industrial patterns of internationalisation relative to the firm's experience. Gomes & Ramaswamy (1999) concluded that greater internationalisation brings benefits up to a point beyond which they cease, and Kotabe, Srinivasan & Aulakh (2002) found that the benefits are moderated by R&D and marketing capabilities. Doukas & Lang (2003) showed that firms create (destroy) value when they internationalise from their core (non-core) activities. Overviews of the literature on this issue are provided by Annavarjula & Beldona (2000), Majocchi & Zuchella (2003) and Li (2007).

Can home-based firms yield international diversification benefits? Early research by Hughes, Logue & Sweeney (1975), Agmon & Lessard (1977), Mikhail & Shawky (1979) and Logue (1982) concluded that investing in home-based MNEs does indeed yield international diversification benefits, and more recent work by Errunza, Hogan & Hung (1999) and Cai & Warnock (2004) supports the earlier findings. Errunza, Hogan & Hung (1999), for example, show that US investors can mimic foreign market index returns using US domestically traded assets including MNEs, closed-end country funds and American Depositary Receipts (ADRs). The issue is far from settled, however, because Jacquillat & Solnik (1978), Senchak & Beedles (1980), Brewer (1981), Fatemi (1984), Michel & Shaked (1986), Kim & Lyn (1990), Mathur, Singh & Gleason (2001), Salehizadeh (2003) and Rowland & Tesar (2004) all found that investing in home-based MNEs does not yield significant international diversification benefits.

Research on the question of the extent to which investing in multinational firms can substitute for investing internationally has been hampered by the multiplicity of approaches that have been used to gather samples of 'MNEs'. We provide three examples to illustrate the diversity of MNE samples. Lecraw's (1983) sample comprises 153 MNE subsidiaries spread across five countries and six industries that have substantial FDI. He found that MNEs' profitability rises with market share, advertising R&D and tariffs. Lecraw used the multinationality of the industry to classify firms as MNEs, but scant information is provided on the individual firms. With no further information on the criteria for sample selection, we know little about the depth or breadth of the multinationality of these firms. Michel & Shaked (1986) examined *Fortune 500* firms in the manufacturing sector, classifying them as MNEs if at least 20 percent of their total sales were foreign and if they had direct investment in at least six countries. The firms were classified as domestic if they had less than 10 percent of their sales, profits and assets abroad. These thresholds are problematic. A firm with 20 percent foreign sales to one country in its home region would be grouped with another firm with 60 percent foreign sales to three continents. Another firm with 15 percent foreign sales spread over six countries in all continents would be classified as neither multinational nor domestic. Errunza, Hogan & Hung (1999) used a sample of the 30 largest US firms from the *Fortune 100* list. Because it is based on total sales without considering their international spread, the sample probably includes firms with very different degrees of multinationality.

As illustrated by these examples, the absence of an agreed approach to operationally defining, measuring or classifying the degree of firm-level multinationality has seen researchers adopt pragmatic approaches to operationally defining MNEs and to creating their MNE samples on the basis of characteristics such as the level (or percentage relative to total) of foreign sales and subsidiaries. This has led to different sample selection methodologies being used in the same business sub-discipline, even when studying the same research question. This has impeded comparisons between related studies, and it has hindered the ability to generalise, replicate and draw conclusions on particular topics. This in turn has curtailed the process of validating, refining and rejecting prevailing theory, which is necessary for advancement of the discipline (Kuhn, (1962); Popper, (1978)). We suggest that research agendas could progress more effectively by the adoption of a common or at least a more carefully considered approach to operationally defining and measuring the degree of firm-level multinationality.

3 Data and methodology

We began our data collection by identifying all 1,289 firms that comprise the main stock indexes in the G7 countries: the Canadian *TSX 60*, the French *SBF 120*, the German *HDAX 110*, the Italian *MIB-SGI* 174, the Japanese *Nikkei 22*5, the UK *FTSE 100* and the US *S&P 500*. We measure performance using 2,217 observations of daily firm-level and market-level returns from 1 January 1999 to 30 June 2007, and our proxy for the risk-free rate is the 3-month treasury bill rate for each country. We obtained the geographical breakdown of each firm's sales from *Worldscope* using company accounts for December 2005, and of each firm's subsidiaries from Dun and Bradstreet's *Who Owns Whom* 2005/06. All stock price, market index, exchange rate and treasury bill rate data were sourced from *Datastream*. After removing firms for which these data were not available, our sample comprises 1,143 firms.

We define the degree of multinationality of a firm's operations along two dimensions: *breadth* and *depth*. To implement the *breadth* dimension, we use four categories of multinationality – domestic, regional, trans-regional and global – and we divide the world into 6 regions based on the inhabited continents: Africa, Asia, Europe, North America, Oceania and South America. An activity associated with a firm that takes place entirely within the home country is referred to as domestic (*D*), and if it takes place in the region in which the firm is headquartered it is referred to as regional (*R*). An activity associated with a firm that takes place in more than one region (but not fully global) is defined as trans-regional (*T*), and an activity that takes place in all six regions of the world is classified as 'global' (*G*). To implement the *depth* dimension, we use two categories:

sales and investments. Investments, such as joint ventures and subsidiaries, entail a deeper engagement with foreign markets and higher exposures to foreign business, economic and political risks than sales. We combine the *breadth* and *depth* dimensions to form our matrix of multinationality below.

	Breadth of Geographical Spread			
Depth of Engagement	Domestic	Regional	Trans-regional	Global
Trading	*TD*	*TR*	*TT*	*TG*
Investments	*ID*	*IR*	*IT*	*IG*

Taking both dimensions together, there 16 different types of firm, ranging from purely domestic firms (*TD-ID*) that conduct their trading activities and investments entirely within their home countries, to deeply global MNEs (*TG-IG*) that have trading activities and subsidiaries in all regions of the world. These are presented in Table 1, which describes eight types of regional and trans-regional firm (numbered 2 to 9) and seven types of global corporation (numbered 10 to 16). Looking first at the eight regional and trans-regional firms numbered 2 to 9, we can differentiate between firms that have increasingly broad but shallow patterns of geographical spread (firms 2–3), and those that are more deeply engaged with foreign markets (firms 4–9). One would not expect a type 4 firm (*TD-IR*) with domestic trading and regional investments to deliver the same international diversification benefits as a type 9 firm (*TT-IT*) with trans-regional sales and subsidiaries. But this is precisely what many researchers assume when they combine such firms to form their 'MNE' data sets – along with purely domestic (*TD-ID*) and deeply global firms (*TG-IG*)! Looking next at the seven global firms numbered 10 to 16 in the Table, they can be global in their trading (firms 10–12), their investments (firms 13–15), or both (firm 16). Firm 10 (*TG-ID*) is shallowly global and deeply domestic, whereas firm 12 (*TG-IT*) is shallowly global and deeply trans-regional.

Using our classification system for the degree of firm-level multinationality, we construct two sets of indexes using the value-weighting methodology that is used to compile the

FTSE 100 and the *S&P 500*.[1] *First*, we generate several country-specific indexes. For each country, we create indexes of domestic (*D*), regional (*R*), trans-regional (*T*) and global (*G*) firms, using sales data to classify the firms. We then repeat this using subsidiaries to classify the firms. This potentially yields 8 indexes for each country or 56 indexes in total. The resulting number of country-specific indexes is in fact 51 rather than 56, because Canada and Japan have no firms with global (*G*) sales, Germany and Japan have no firms with regional (*R*) sales, and Canada has no firms classified as regional (*R*) in subsidiaries. *Second*, we construct 8 cross-country indexes that include all of the domestic (*D*), regional (*R*), trans-regional (*T*) and global (*G*) firms in our 7-country sample, using the sales and then the subsidiaries data. We examine the robustness of our results to currency denomination, by using daily bilateral exchange rates to convert all 59 indexes into each of the five currencies of the *G7* countries – the Canadian dollar, the Euro (France, Germany and Italy), the Japanese Yen and the US dollar. Together with the market index and the risk free rate for each country, we have over 3 million (2,534,031 firm-level and 696,138 market and index-level) observations for our analysis.

The sources of international firm-level diversification

Errunza, Hogan & Hung (1999) introduced the concept of home-based international diversification (*HID*) that is achieved by holding claims on foreign assets that trade only in the investor's home country, and foreign-based international diversification (*FID*) from holding foreign assets that trade only in foreign markets. Recognising that *HID* can achieve some of the benefits of *FID*, they note that this is consistent with observed home bias in investors' portfolios. We adapt these concepts and apply them to our firm-level analysis by using *HID* and *FID* to denote the international diversification benefits available to investors in each country by investing in home-based and foreign-based firms respectively. Thus, while the market index in any country comprises home-based domestic firms (*D*), it also comprises home-based internationalised firms (*R*, *T* and *G*) through which domestic investors can obtain *HID*. Equation (1) describes the return on the market index in country i, R_m^i, as the sum of the returns on home-based domestic firms multiplied by their value weights, $\omega_D^i R_D^i$, plus the returns on home-based internationalised firms multiplied by their value weights, $\omega_{HID}^i R_{HID}^i$. R_{HID}^i is described in equation (2) as comprising the returns on all home-based regional (*R*), trans-regional (*T*) and global (*G*) firms in the index.

$$R_m^i = \omega_D^i R_D^i + \omega_{HID}^i R_{HID}^i \qquad \text{with} \quad \omega_D^i + \omega_{HID}^i = 1 \tag{1}$$

$$R_{HID}^i = \omega_R^i R_R^i + \omega_T^i R_T^i + \omega_G^i R_G^i \qquad \text{with} \quad \omega_R^i + \omega_T^i + \omega_G^i = \omega_{HID}^i \tag{2}$$

In Table 2, we detail the number of domestic, regional, trans-regional and global firms classified by the geographical spread of their sales (with percentages in brackets) in each country. Of the 1,143 firms in our sample, 229 (20 percent) are domestic, and this ranges from 30 percent in Italy to 5 percent in Germany. Although the relative sizes of the domestic and international sub-components vary considerably, the vast majority of firms have sales beyond their home regions. Putting this another way, the potential for *HID* arises in 80 percent of firms overall; it arises in more than 70 percent of firms in each country, and in over 90 percent of firms in France, Germany, Japan and the UK. The size of the US economy explains the large size of its domestic sector, which in turn implies that the potential benefits of *HID* are less than in other countries. Of the international firms, 835 (73 percent) are trans-regional, 40 (4 percent) are regional, and 39 (3 percent) are global. The market indexes in every country in our sample are dominated by trans-regional firms to a greater or lesser extent, and these numbers are similar when we use the subsidiary data. The small number of truly global firms is broadly consistent with Rugman & Verbeke (2007, 2008) and Osegowitsch and Sammartino (2008), who use different regional definitions and methodologies.

Correlation analysis

We begin our analysis by examining the correlations between each category of firm in each country – domestic (*D*), regional (*R*), trans-regional (*T*) and global (*G*) – and the market indexes.[2] Our rationale for this preliminary analysis is to cast light on the extent to which firm-level internationalisation provides diversification benefits. Table 3 presents average correlation coefficients, denominated in each country's currency. By taking within-country averages, we condense what would be a large set of correlation matrixes into a small summary table. The first column, *Market*, gives the average correlation for each stock market with the other 6 stock market indexes. For example, the average correlation of the US stock market with the other 6 stock market indexes is 0.347. Columns [2] to [5] headed *D*, *R*, *T* and *G* show average correlations between the indexes of domestic, regional, trans-regional and global firms in each country with the 6 foreign stock markets. For example, in column [2] we can see that our index of Canadian domestic firms has an average correlation of 0.185 with the 6 foreign (non-Canadian) stock markets. Looking at the inter-stock market correlations in the first column, the Japanese stock market is the least correlated with the other markets, suggesting that Japanese investors would benefit most from diversification by investing in stocks from the other G7 countries. Investors from mainland Europe would benefit least from international diversification; the French and German stock markets have the highest average correlations with the other G7 stock markets, 0.608 and 0.583 respectively.

The correlations summarised in columns [2] to [5] give some preliminary insight into the extent to which the degree of firm-level multinationality might provide diversification benefits to foreign investors. As expected, domestic (*D*) firms in most countries have the lowest correlation with foreign markets, with an average correlation coefficient of 0.247, and regional firms are slightly more highly correlated at 0.295. The trans-regional firms in all of the G7 countries are most highly correlated with foreign markets, with an average correlation coefficient of 0.441, and the corresponding figure for global firms is 0.387. These figures suggest that for investors holding a portfolio of home-based firms, the greatest diversification benefits would be gained by investing in foreign-based domestic (*D*) firms, closely followed by foreign-based regional (*R*) firms.

Mean Variance Spanning

Several methods are available to measure the extent to which MNEs provide international portfolio diversification benefits. These include using the international market model to investigate the influence of domestic and foreign market indexes on individual shares (Hughes, Logue and Sweeney (1976), Agmon and Lessard (1977) and Brewer (1981));

comparing the risk adjusted performance of MNEs and domestic firms; comparing firms on the basis of returns, standard deviations, betas, coefficient of variation and performance measures, such as the Sharpe, Treynor and Jensen measures (Jacquillat and Solnik (1978), Mikhail and Shawky (1979), Senchack and Beedles (1980), Fatemi (1984) and Michel and Shaked (1986)); and more recently, MVS tests (Errunza, Hogan and Hung (1999), Rowland and Tesar (2004)). We use the latter methodology because of its analytical rigour in facilitating a series of related tests of the statistical significance of diversification benefits using consistent benchmark portfolios, and we accompany these with Sharpe ratio measures of their economic benefits.

Following the methodology of Huberman and Kandel (1987), De Roon and Nijman (2001) and Kan and Zhou (2001), we apply our MVS tests to examine whether adding international assets can improve the efficient risk-return frontier that confronts investors who hold only domestic assets. In the spanning literature parlance, we consider a set of *K* 'benchmark' (domestic) assets and *N* 'test' (international) assets, and we investigate whether, conditional on the *K* benchmark assets, the addition of the *N* test assets can shift the mean variance efficient frontier. Alternatively, conditional on the *K*+*N* benchmark and test assets, can the subset of *K* benchmark assets yield the same diversification benefits? In other words, we are interested in whether the *K* benchmark assets 'span' the extended set of *K*+*N* assets. To do this, we define $R_{1,t}$ as the $K\times 1$ vector of returns on the *K* benchmark assets and $R_{2,t}$ as the $N\times 1$ returns on the *N* test assets at time *t*, and we combine $R_{1,t}$ and $R_{2,t}$ in the *K*+*N* vector $R_t = [R_{1,t}', R_{2,t}']'$. The MVS test proceeds by regressing the *N* test asset returns on the *K* benchmark returns as below,

$$R_{2,t} = \alpha + \beta R_{1,t} + \varepsilon_t \tag{3}$$

with $\varepsilon_t \sim N(0,\Sigma)$, $\alpha = E[R_{2,t}] - \beta E[R_{1,t}] = \mu_2 - \beta\mu_1$, and $\beta = V_{21}V_{11}^{-1}$.

Testing whether the *K* benchmark assets span the broader set of *K*+*N* assets amounts to testing the joint hypothesis that $\alpha = 0$ and $\beta = 1$. If this hypothesis is upheld, it implies that for every test asset, we can obtain a portfolio of the *K* benchmark assets that has the same expected return (because $\alpha = 0$ and $\beta = 1$) and a lower variance (because $R_{1,t}$ and ε_t are uncorrelated while $Var(\varepsilon_t)$ is positive definite). Details of implementing this test are provided in the Appendix.

The null hypothesis is that the benchmark portfolio spans the extended portfolio comprising the benchmark assets and the test assets, implying that the mean variance frontiers coincide at all points. We estimate equation (3) using ordinary least squares OLS. We test the spanning restrictions using Kan & Zhou's (2001) suggested two-step Wald tests, whereby we first test whether $\alpha = 0$, and we then test whether $\beta = 1$ conditional on $\alpha = 0$. If we reject the null hypothesis of spanning due to the first test the tangency portfolios are different, and if we reject due to the second test, the global minimum-variance portfolios are different. The OLS tests assume that the error terms are normally distributed and homoskedastic, and to check the robustness of our results, we repeat all tests using the generalised method of moments (GMM) which does not require information about the exact distribution of the error terms[3]. If the null hypothesis of spanning is rejected, we measure the economic significance of the diversification benefits by changes in the Sharpe ratios between the *K* benchmark assets and the *K + N* assets. Different Sharpe ratios indicate that investors can improve their risk-return tradeoffs by investing in the additional assets[4].

4 Tests and results

We conduct four tests of the extent to which investors can gain the benefits of international diversification by investing in firms of differing degrees of multinationality. In our first test, we use the domestic market index as the benchmark portfolio and the remaining G7 market indices as the extended set. We next use our cross-country index of all domestic firms as the benchmark portfolio and our cross country regional, trans-regional and global indices as the extended sets. In our third test, we use all home based domestic firms as the benchmark portfolio and home-based regional, trans-regional and global firms as the extended sets. Finally, in test 4, the benchmark portfolios comprise home-based domestic firms, and foreign-based firms form the extended sets.

Test 1: Replicating conventional tests of the benefits of international portfolio diversification

Our first test replicates conventional tests of the benefits of international portfolio diversification. To implement this, we set each country's aggregate market index as the 'benchmark' portfolio of *K* assets, we set the optimally weighted portfolio of the remaining G7 countries' market indexes converted to the home country's currency as the extended 'test' portfolio of *N* international assets, and we conduct MVS tests equivalent to equation (3) as in (4), testing the joint null hypothesis that $\alpha^i = 0$ and $\beta^i = 1$.

$$R^j_{m,t} = \alpha^i + \beta^i R^i_{m,t} + \varepsilon^i_{m,t} \quad \text{with } i = \text{countries } 1 \ldots 7. \tag{4}$$

The results of these tests are presented in Table 4. The Wald tests indicate that spanning is rejected in all countries. The step-down Wald tests of $\beta = 1$ indicate that the minimum variance portfolios of the extended and benchmark assets are statistically different in each country, and the step-down Wald tests of $\alpha = 0$ indicate that the tangency portfolios are also statistically different in every country except Canada. The latter result is not surprising, because the Sharpe ratio of the benchmark domestic index in Canada, at 4.047, shows that this market performed the best amongst all countries over the sample period. The percentage increase in the Sharpe ratios average 147 percent, ranging from 14 percent for Canada to 289 percent for the United States. Overall, this test confirms the usefulness of our methodology to replicate conventional measures of the statistically and economically significant benefits of international portfolio diversification.

Test 2: International diversification and the degree of firm-level multinationality

In our second test, we abstract from country effects and use all 1,143 firms to examine whether the degree of firm-level multinationality determines the magnitude of potential diversification benefits. Our 'benchmark' asset for this test is the portfolio of all domestic

(D) firms, and our 'test' assets are the portfolios of all regional (R), trans-regional (T) and global (G) firms. The returns on these four 'world' portfolios are, respectively, R_D^W, R_R^W, R_T^W and R_G^W. We therefore conduct three MVS tests equivalent to equation (3) as in equations (5a) – (5c).

$$R_{R,t}^{W} = \alpha^{R} + \beta^{R} R_{D,t}^{W} + \varepsilon_{m,t}^{R} \tag{5a}$$

$$R_{T,t}^{W} = \alpha^{T} + \beta^{T} R_{D,t}^{W} + \varepsilon_{m,t}^{T} \tag{5b}$$

$$R_{G,t}^{W} = \alpha^{G} + \beta^{G} R_{D,t}^{W} + \varepsilon_{m,t}^{G} \tag{5c}$$

In (5a), we test whether the mean-variance efficient frontier of all domestic firms spans the frontier of all regional firms, and in (5b) and (5c) we do likewise for all trans-regional and global firms. We let h = R, T and G, and test the joint null hypothesis that $\alpha^h = 0$ and $\beta^h = 1$ in each case. To ensure that our findings are robust to the choice of currency, we provide the results converted to the home currencies of each country. This is a novel test that we have not seen in prior research, and it is enabled by our classification of the degree of firm-level multinationality.

The results are presented in Table 5. The Wald tests indicate that spanning is rejected in all cases. The step-down Wald tests of β = 1 indicate that the minimum variance portfolios of the extended sets of regional, trans-regional and global firms are statistically different from the benchmark portfolios of domestic firms regardless of what currency we use. In contrast to this, the step-down Wald tests of $\alpha = 0$ indicate that none of the tangency portfolios are statistically different. As we move from domestic to regional firms, the percentage increase in the Sharpe ratios varies from 2 percent when measured in Japanese yen to 39 percent when we use the Canadian dollar, with an average gain of 13 percent. When we move from domestic to trans-regional firms, the percentage increases in the Sharpe ratios are broadly similar, with an average gain of 8 percent.

Moving from domestic to global firms, however, the results are more striking. The percentage increase in the Sharpe ratios varies from 29 percent when measured in Japanese yen to 160 percent when we use the Canadian dollar, with an average gain of 84 percent. Overall, therefore, this test confirms that when firms are combined across countries and classified by degree of multinationality, the most internationalised firms tend to provide the greatest diversification benefits to investors. We find that global firms provide the greatest increase in Sharpe ratios regardless of the currency in which we conduct the tests, and this is followed by regional and trans-regional firms, which are broadly similar.

Test 3: International diversification with home-based firms (HID)

In our third test, we examine the extent to which investors in each country can gain home-based international diversification *(HID)* benefits by investing in home-based internationalised (*R*, *T* and *G*) firms. Our 'benchmark' asset comprises the portfolio of all home-based domestic (*D*) firms, and our extended 'test' assets are optimal portfolios of home-based regional, trans-regional and global (*R*, *T* and *G*) firms. In our single country analysis in this and the next test, we combine the latter three categories because, as shown in Table 2, there are relatively few regional and global firms. We therefore conduct the following MVS tests equivalent to equation (3) as presented in equation (6), and we test the joint null hypothesis that $\alpha^i = 0$ and $\beta^i = 1$.

$$R^i_{HID,t} = \alpha^i + \beta^i R^i_{D,t} + \varepsilon^i_t \qquad (6)$$

The results in local currency for each country are presented in Table 6. The Wald tests indicate that we reject spanning in all cases. The step-down Wald tests of $\beta = 1$ indicate that the minimum variance portfolios of the extended sets of home-based regional, trans-regional and global firms are statistically different from the benchmark of domestic firms in all countries, and the step-down Wald tests of $\alpha = 0$ indicate that the tangency portfolios are statistically different in two countries – France and the UK. As we move from home-based domestic to home-based internationalised (*R*, *T* and *G*) firms, the percentage increase in the Sharpe ratios vary from 8 percent in Canada to 96 percent in Japan, with an average increase of 36 percent. Interestingly, the most internationalised firms are included in the optimal portfolios of *HID* in all countries. Our results confirm that there are statistically and economically significant benefits to *HID* in every country. They are greatest in the UK, the US, Italy and Japan, and they are smallest in Canada, Germany and France. Overall, the average *HID* across all countries of 36 percent – measured by the average percentage increase in the Sharpe ratios as we move from home-based domestic to home-based internationalised firms – is equal to one quarter of the 142 percent average increase in the Sharpe ratios as we move from home-based domestic to foreign-based internationalised firms. These findings shed light on one explanation for home bias – investors in each country can gain part of the total benefits available to international investment by investing in home-based internationalised firms.

Test 4: International diversification with foreign-based firms (FID)

In our fourth test, we examine the extent to which investors in each country can gain foreign-based international diversification *(FID)* benefits by investing in foreign-based firms with varying degrees of multinationality. The benchmark portfolios comprise all home-based domestic (*D*) firms in each country, and the test assets are: *first*, optimal portfolios of foreign-based domestic (*D*) firms; *second*, optimal portfolios of foreign-based internationalised (*R*, *T*, and *G*) firms; and *third*, optimal portfolios of all foreign-based firms (*D, R, T* and *G*). We consequently conduct three MVS tests equivalent to equation (3) as in equations (7a) – (7c),

$$R^{j}_{D,t} = \alpha^{D} + \beta^{D} R^{i}_{D,t} + \varepsilon^{D}_{t} \qquad (j \neq i = 1 \ldots 6) \qquad (7a)$$

$$R^{j}_{RTG,t} = \alpha^{RTG} + \beta^{RTG} R^{i}_{D,t} + \varepsilon^{RTG}_{t} \qquad (j \neq i = 1 \ldots 6) \qquad (7b)$$

$$R^{j}_{DRTG,t} = \alpha^{DRTG} + \beta^{DRTG} R^{i}_{D,t} + \varepsilon^{DRTG}_{t} \qquad (j \neq i = 1 \ldots 6) \qquad (7c)$$

In these three sets of tests, we alternatively let *h = D, RTG and DRTG*, and we test the joint null hypothesis that $\alpha^h = 0$ and $\beta^h = 1$ in each case. As before, we provide the results converted to the home currencies of each country to ensure that our findings are robust to the choice of currency.

The results are presented in Table 7. The Wald tests indicate that we reject spanning in all 21 cases. Furthermore, the step-down Wald tests of $\alpha = 0$ and $\beta = 1$ indicate that both the tangency and the minimum variance portfolios of the extended sets are statistically different from the benchmark domestic firms in all cases. This is a strong result, confirming that when we perform a 'clean' test of the benefits of foreign-based firm-level diversification in which the benchmark portfolio comprises only home-based domestic firms, there are strongly significant statistical improvements in the mean-variance frontiers at all levels of risk. These differences are also economically significant. As we move from the benchmark home-based domestic firms to foreign-based domestic (*D*) firms, the Sharpe ratios rise by 148 percent on average, ranging from 37 percent for Canada to 247 for Japan. As we move from the same benchmark of home-based domestic firms to foreign-based internationalised (*R*, *T* and *G*) firms, the Sharpe ratios rise by similar amounts: 142 percent on average, ranging from 36 percent for Canada to 242 percent for Japan. Finally, when all foreign-based (*D*, *R*, *T* and *G*) firms form the extended set, the Sharpe ratios rise by 174 percent on average, ranging from 49 percent for France to 281 percent for Japan.

Our methodology for classifying firms by their degree of multinationality provides insights on the benefits available to investors by investing in home-based firms that are themselves internationalised (Test 3 for *HID*) rather than investing in foreign-based firms. Test 3 shows that investors can achieve an average Sharpe ratio increase of 36 percent by extending their benchmark portfolios of home-based domestic firms to home-based internationalised firms. Test 4 shows that investors would reap greater benefits – an average Sharpe ratio increase of 174 percent – by extending their portfolios of home-based domestic firms to include foreign-based domestic, regional, trans-regional or global firms. Most of these gains, however, can be captured by investing in foreign-based domestic firms – an increase in the Sharpe ratio relative to the purely domestic benchmark of 148 percent.

These findings are consistent with our correlation analysis (in section 3) that showed domestic firms in each country having the lowest correlation with foreign stock markets. This result can be illustrated with an example from Table 7, which shows that a United States investor has a Sharpe ratio of 2.83 on his/her portfolio of home-based domestic (*D*) firms. By extending this to include foreign-based domestic (*D*) firms, he/she can raise the Sharpe ratio by 223 percent to 9.14. By investing in an efficient portfolio of *all* foreign-based firms (*D*, *R*, *T* and *G*), the investor can increase his/her Sharpe ratio only by a further 1 percent, to 10.11. The reason why investing in all foreign-based firms yields such a small increment relative to investing only in foreign-based domestic (*D*) firms is that the foreign-based internationalised firms (*R*, *T* and *G*) are likely to have exposures back to the United States. Including foreign-based internationalised firms, therefore, does not yield substantially greater diversification benefits than those available from investing in foreign-based domestic firms.

Our finding that internationalising by investing in foreign-based domestic firms yields similar benefits to diversifying by investing in foreign-based internationalised firms was anticipated more than 30 years ago by Hughes, Logue & Sweeney (1975). 'If international capital markets are perfectly integrated, if transactions costs are low, and if investors are rational and risk averse, then there are no diversification benefits inherent to multinational firms that could not be obtained by investors making direct portfolio investments in the countries in which the multinational firms would otherwise operate. That is, in the case of perfect financial market integration there is no systematic advantage to owning shares in a multinational firm versus holding shares in a number of *domestic firms in different countries*.' (1975: 628, our italics). Although there is imperfect financial market integration across the G7 countries, they are substantially free of cross-border capital controls.

5 Robustness analysis

Reliance on sales and other accounting data to measure the degree of firm-level multinationality can be problematic insofar as firms use a variety of geographical groupings to describe their international operations. For example, many firms use the category 'Other' or 'Rest of the World' as a catch-all to locate their less important international operations, and the countries and regions within these catch-all categories vary from firm to firm. To overcome this, we have conducted all our tests using subsidiary data in addition to sales data, and the results are similar. In this section, we further address this potential bias by re-estimating using variations of our classification system.

Fama and French (1992) show that a firm's relative size within the local market portfolio is a priced factor. Our sample firms are drawn from each country's main stock market index, so they are the largest listed firms in each country. However, as average firm size can differ considerably between countries, we test the robustness of our findings to firm size. We next divide all firms into four broad industrial sectors and test the robustness of our results to industry effects. Lastly, we test whether the introduction of short sales constraints, whereby only positive quantities of any stock can be held, affects our results.

Classification of Firms

Table 2 shows that just 3 percent of firms in our data set are classified as global and 73 percent are classified as trans-regional. To test the robustness of the results to our classification of firms, we perform two additional robustness tests. We first relax the requirement on firms to have operations in all 6 regions of the world in order to be classified as global. We initially include firms classified as T5 in our global category and then allow firms classified as T4 and T5 to be considered global. The results from these tests confirm that the global category provides the greatest diversification benefits in all countries. In our second set of tests, we segregate the trans-regional category in two – firms classified as T2 and T3, and firms categorised as T4 and T5. Results show that firms classified as T4 and T5 provide greater benefits than firms classified as T2 and T3 in all countries. We therefore conclude that our results are robust to our classification of firms, and that firms with greater global reach provide greater international diversification benefits.

Firm Size

We measure the size of each firm using 2005 sales figures in US dollars. The average size of the firms in our sample is $13,958 billions, and we segregate them into two categories – small (sales below average) and large (sales above average). Within each category, we replicate the MVS and Sharpe ratio tests of our second test, in which we use the domestic firms as the benchmark portfolio, and the regional, trans-regional and global firms as the extended sets. We continue to reject spanning in all tests. Once again, global firms in each size category provide the greatest benefits to diversification across all countries. This is followed by regional and trans-regional firms, confirming that our previous results are robust to firm size. It would be interesting to extend our sample to smaller firms, and this is a topic for further research.

Industry Effects

We next investigate the robustness of our results by examining whether they vary across industry groups. Following Rowland and Tesar (2004), we use four industrial categories as defined in Datastream; *consumer goods and services*, *energy and utilities*, *finance and real estate* and *industrials*. The first category has most firms, and the second has fewest overall and in all countries except Canada. We then replicate test 2 for each industry group, with domestic firms being the benchmark and regional, trans-regional and global firms forming the extended sets. We perform these tests first for the United States market and then using aggregate indexes combined across all 7 countries (expressed in US dollars). We reject spanning in all 12 tests in the United States market. Using the aggregate indexes, we reject spanning in all 12 tests with one exception – the *finance and real estate* industry, where domestic firms are the benchmark and global firms are the extended set. Global firms provide the largest increase in Sharpe ratios in 3 of the 4 industry groups in the United States (*finance and real estate* being the exception) and in 3 of 4 industries overall (*energy and utilities* being the exception). We conclude that our results are quite robust to industry effects, and as before, this is a future research project for an extended sample.

Short Sales Constraints

To introduce short selling constraints, we follow De Roon, Nijman and Werker (2001) by running the same regressions, but with inequality constraints[5]. The elimination of short sales does not significantly affect our results. We arrive at very similar conclusions in relation to the benefits from both *HID* and *FID*. We also find that when we combine all firms across all countries as in test 2, firms with global sales provide the best international diversification benefits.

6 Summary and conclusions

Although multinationality is a key dimension within the disciplines of international business, economics and finance, there is no widely accepted measure of the degree of firm-level multinationality. This has led to the use of a multiplicity of operational definitions that has hindered the ability of researchers to replicate and refine prior studies, and to draw definitive conclusions about what is known and what remains to be discovered. In this paper, we have shown how a more careful analysis of the degree of firm-level multinationality provides a new perspective and new insights on the home bias puzzle. Using a multi-country firm-level sample of 1,143 firms from the G7 countries, we classified the multinationality of their operations from the geographical spread of their sales and their subsidiaries. We used mean variance spanning and Sharpe ratio tests to show how firm-level multinationality provides diversification benefits to investors. We also showed how investors can obtain international diversification benefits by investing in home-based firms that have international operations.

We conducted four sets of tests. In our first test, we replicated the standard approach to measuring the benefits of international diversification using market-level data from the aggregate stock market indices in each country. We then classified all firms across all countries in our sample into four different categories of multinationality – domestic, regional, trans-regional and global. In a novel test, we showed that abstracting from country effects, firms with more global operations tend to provide more international diversification benefits. In our third test, we reintroduced country effects and showed how investors in each country can obtain international diversification without having to invest abroad. By investing in internationalised firms that are listed on the exchanges in their home countries, investors can 'free ride' some of the costs and risks associated with internationalisation at the level of the firm by reaping a portion of the benefits of international diversification directly from home-based internationalised firms. It follows that the 'home-bias puzzle' in international portfolio analysis is overstated.

In our final set of tests, we showed how investors can maximise their international diversification benefits by combining portfolios of home-based domestic firms with portfolios of foreign-based firms with differing degrees of international exposure. We showed that foreign-based domestic firms yield similar diversification benefits to foreign-based internationalised firms in all countries, and that most of the available diversification benefits can be obtained by combining home-based domestic firms with foreign-based domestic firms. Finally, we subjected all our firm-level tests to a set of robustness checks including variations in our firm-level classification system; classifying firms based on their subsidiaries as well as their sales; using alternative estimation strategies; controlling for size and industry effects; and allowing short sales constraints on portfolio optimisation.

We conclude by pointing to the many advantages that international business, economics and finance researchers can obtain by adopting a common – or at least a more carefully considered – approach to operationally defining and measuring the degree of firm-level multinationality. This will become increasingly important as existing and new firm-level databases are developed that will make it possible to work with MNE samples that are many times larger than what we have been accustomed to until now.

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Table 1
Classifying firm-level internationalisation

	Symbol	MNE type
		Purely domestic firm
1	*TD-ID*	Domestic trading, domestic investments
		Regional and trans-regional firms
2	*TR-ID*	Regional trading, domestic investments
3	*TT-ID*	Trans-regional trading, domestic investments
4	*TD-IR*	Domestic trading, regional investments
5	*TR-IR*	Regional trading, regional investments
6	*TT-IR*	Trans-regional trading, regional investments
7	*TD-IT*	Domestic trading, trans-regional investments
8	*TR-IT*	Regional trading, trans-regional investments
9	*TT-IT*	Trans-regional trading, trans-regional investments
		Global firms
10	*TG-ID*	Global trading, domestic investments
11	*TG-IR*	Global trading, regional investments
12	*TG-IT*	Global trading, trans-regional investments
13	*TD-IG*	Domestic trading, global investments
14	*TR-IG*	Regional trading, global investments
15	*TT-IG*	Trans-regional trading, global investments
16	*TG-IG*	Global trading, global investments

***Notes*.** The Table describes 16 types of MNE, ranging from a purely domestic firm to a fully global corporation. It describes two depths of engagement, trading (*T*) and investments (*I*). By combining the three 'within-region' decompositions (*R1*, *R2* and *R3*) and the 4 trans-regional groups (*T2*, *T3*, *T4* and *T5*), the breadth categories are reduced from 9 to 4: domestic (*D*), regional (*R*), trans-regional (*T*) and global (*G*).

Table 2
International Classification of Firms

	Canada	France	Germany	Italy	Japan	UK	US	Sum
D	13 (23)	6 (6)	5 (5)	46 (30)	16 (9)	7 (8)	136 (29)	229 (20)
R	7 (12)	8 (7)	3 (3)	7 (5)		5 (6)	10 (2)	40 (4)
T	37 (65)	87 (81)	84 (85)	90 (59)	152 (91)	71 (78)	314 (67)	835 (73)
G		6 (6)	7 (7)	9 (6)		7 (8)	10 (2)	39 (3)
Total	57	107	99	152	168	90	470	1,143

Notes. This Table shows the number of firms in each country that are classified as domestic (D), regional (R), trans-regional (T) and global (G) based on the geographical spread of their sales data. Figures in parentheses are the within-country percentage of firms in each category.

Table 3
Correlation Structures

	[1] **Market**	[2] ***D***	[3] ***R***	[4] ***T***	[5] ***G***
Canada	0.362	0.185	0.190	0.341	
France	0.608	0.194	0.203	0.586	0.486
Germany	0.583	0.237		0.574	0.451
Italy	0.504	0.383	0.491	0.528	0.359
Japan	0.202	0.132		0.220	
UK	0.536	0.331	0.362	0.498	0.341
US	0.347	0.270	0.228	0.341	0.296
Average	0.449	0.247	0.295	0.441	0.387

Notes. This Table shows the average correlation coefficients (in local currencies) between each stock market and the other 6 stock markets (the column headed 'market'), and between our four categories of firm – domestic (D), regional (R), trans-regional (T) and global (G) – and each foreign stock market. For example, the average correlation of the US stock market with the other 6 stock market indexes is 0.347, and the average correlation of US-based domestic (*D*) firms with the other 6 market indexes is 0.270. The bottom row presents the average correlation of each category of firm with all foreign market indexes. For example, the average correlation of *D* firms in all countries with foreign market indexes is 0.247. Where the field is blank, no firms exist in that particular category.

Table 4
Conventional tests of the benefits of international diversification

	Canada	**France**	**Germany**	**Italy**	**Japan**	**UK**	**US**
Wald	564.74 (0.00)	1241.20 (0.00)	1226.08 (0.00)	555.69 (0.00)	674.52 (0.00)	260.36 (0.00)	542.98 (0.00)
$\alpha = 0$	2.06 (0.15)	6.55 (0.01)	7.41 (0.01)	5.33 (0.02)	8.40 (0.00)	10.28 (0.00)	9.45 (0.00)
$\beta = 1$	1126.90 (0.00)	2469.66 (0.00)	2437.71 (0.00)	1103.90 (0.00)	1336.18 (0.00)	508.23 (0.00)	1072.43 (0.00)
SR Benchmark	4.047	2.896	1.698	3.274	3.570	1.680	1.587
SR Extended Set	4.602	5.613	5.400	5.541	7.306	5.752	6.168
SR Change	0.555	2.717	3.702	2.267	3.736	4.072	4.580
SR Change (%)	13.72	93.81	218.07	69.25	104.64	242.44	288.54

Notes. This table shows the results from test 1 which replicates conventional international diversification tests. The local market index is used as the benchmark portfolio and an optimally weighted portfolio of the remaining 6 of the G7 market indexes is used as the extended set. Firms are classified based on sales data and short sales are allowed. Results are presented from the point of view of investors in each country. All results are in local currencies. The F-statistics are from the Wald test of the joint hypothesis that $\alpha = 0$ and $\beta = 1$, and the results from the step down Wald tests for each country. The p-values from each test are in parentheses. We also show the increase in the Sharpe ratios of the optimal portfolios.

Table 5
Diversification benefits of internationalised firms

	Canadian Dollar	Euro	Japanese Yen	UK Pound	US Dollar
			Regional (R) firms		
Wald	66.83	43.27	22.49	41.55	79866.77
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\alpha = 0$	0.18	0.15	0.13	0.16	0.07
	(0.67)	(0.70)	(0.72)	(0.69)	(0.79)
$\beta = 1$	133.52	86.42	44.87	82.98	72.90
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SR benchmark	1.174	2.184	3.898	1.647	3.099
SR test	1.637	2.395	3.972	1.969	3.190
SR change	0.463	0.211	0.074	0.321	0.091
SR change (%)	39.47	9.67	1.91	19.51	2.92
			Trans-regional (T) firms		
Wald	95.01	53.20	60.38	61.67	77266.38
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\alpha = 0$	0.092	0.06	0.02	0.05	0.003
	(0.76)	(0.81)	(0.89)	(0.82)	(0.95)
$\beta = 1$	190.00	106.39	120.78	123.34	151.20
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SR benchmark	1.174	2.184	3.898	1.647	3.099
SR test	1.500	2.287	3.910	1.820	3.123
SR change	0.326	0.103	0.012	0.172	0.024
SR change (%)	27.76	4.710	0.310	10.45	0.790
			Global (G) firms		
Wald	99.78	105.09	42.62	94.17	104854.6
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\alpha = 0$	2.14	2.74	2.28	2.66	2.65
	(0.14)	(0.10)	(0.13)	(0.10)	(0.10)
$\beta = 1$	197.32	207.29	82.91	185.54	129.75
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SR benchmark	1.174	2.184	3.898	1.647	3.099
SR test	3.048	3.942	5.044	3.522	4.471
SR change	1.874	1.758	1.146	1.875	1.372
SR change (%)	159.59	80.5	29.4	113.82	44.26

Notes. This Table shows the MVS results for test 2 on all 1,143 firms across all countries and grouped into *D*, *R*, *T* and *G* firms. The benchmark portfolio comprises all domestic firms in the G7 countries, and the remaining aggregate indexes are used as the extended sets. Firms are classified based on sales data and short sales are allowed. Results are presented from the point of view of investors in each currency. All results are in local currencies.

Table 6
The benefits of home-based international diversification

	Canada	**France**	**Germany**	**Italy**	**Japan**	**UK**	**US**
Wald	439.50 (0.00)	718.08 (0.00)	2289.54 (0.00)	289.78 (0.00)	274.02 (0.00)	472.01 (0.00)	1.07 (0.34)
α = 0	1.93 (0.17)	5.11 (0.02)	1.46 (0.23)	1.37 (0.24)	1.25 (0.26)	4.15 (0.04)	0.72 (0.40)
β = 1	876.70 (0.00)	1428.39 (0.00)	4576.65 (0.00)	578.10 (0.00)	546.74 (0.00)	938.54 (0.00)	1.42 (0.23)
SR benchmark	5.762	6.597	3.778	3.774	2.809	4.115	2.828
SR test	6.231	7.935	4.393	5.193	3.662	8.085	4.090
SR change	0.469	1.338	0.615	1.419	0.854	3.970	1.262
SR change (%)	8.14	20.29	16.28	37.62	30.39	96.45	44.61

Notes. This table shows the MVS results for test 3 when home-based domestic (*D*) firms are the benchmark portfolio. The test assets are optimal portfolios of home-based regional (*R*), trans-regional (*T*) and global (*G*) firms). All results are in local currencies. Firms are classified based on sales data and short sales are allowed. The format is identical to Tables 4 and 5.

Table 7
The benefits of foreign-based international diversification

	Canada	France	Germany	Italy	Japan	UK	US
			Foreign-based domestic firms (D)				
Wald	529.56	943.55	6193.66	1013.28	1276.88	2368.91	820.89
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
α = 0	8.11	10.88	18.96	18.33	19.47	18.73	19.76
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β = 1	1047.63	1867.90	12268.86	1992.64	2513.31	4681.64	87.15
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SR benchmark	5.762	6.597	3.778	3.774	2.809	4.115	2.828
SR test	7.916	9.184	9.217	9.255	9.755	12.321	9.144
SR change	2.154	2.587	5.439	5.482	6.946	8.205	6.316
SR percentage	37.38	39.22	143.96	145.26	247.31	199.38	223.34
			Foreign-based internationalised firms (RTG)				
Wald	837.25	941.17	6116.66	1025.62	1508.29	2243.01	997.55
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
α = 0	8.30	10.12	17.78	14.75	18.90	19.81	19.03
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β = 1	1660.72	1864.53	12123.68	2023.92	2973.62	4428.62	1960.11
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SR benchmark	5.762	6.597	3.778	3.774	2.809	4.115	2.828
SR test	7.850	9.013	8.956	8.404	9.618	12.613	8.902
SR change	2.088	2.417	5.178	4.630	6.809	8.498	6.074
SR percentage	36.23	36.64	137.05	122.7	242.44	206.48	214.79
			Foreign-based domestic and internationalised (DRTG)				
Wald	969.47	1195.83	8232.22	1428.77	1671.55	2878.38	1143.34
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
α = 0	11.92	13.31	24.99	23.23	23.64	24.45	24.81
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β = 1	1917.57	2365.20	16263.30	2806.14	3285.85	5672.25	2237.81
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SR benchmark	5.762	6.597	3.778	3.774	2.809	4.115	2.828
SR test	8.800	9.805	10.399	10.206	10.690	13.617	10.105
SR change	3.038	3.208	6.620	6.433	7.881	9.502	7.277
SR percentage	52.72	48.64	175.23	170.47	280.61	230.89	257.34

Notes. This table shows the MVS results when home-based domestic firms are the benchmark portfolio and the extended sets are optimal portfolios of foreign-based domestic firms, optimal portfolios of foreign-based regional, trans-regional and global firms and optimal portfolios of all foreign listed firms (domestic, regional trans-regional and global). Firms are classified based on sales data and short sales are allowed. All results are in local currencies. The format is identical to Tables 4-6.

Appendix
Derivation of the mean variance spanning tests

To construct our MVS tests, we follow Huberman and Kandel (1987), De Roon and Nijman (2001) and Kan and Zhou (2001) by considering a set of *K* benchmark assets and *N* test assets and investigate whether, conditional on the *K* benchmark assets, the addition of the *N* test assets can shift the mean variance efficient frontier. Alternatively, conditional on the *K+N* benchmark and test assets, can the subset of *K* benchmark assets yield the same diversification benefits? In common parlance, we are interested in whether the *K* benchmark assets span the extended set of *K+N* assets. We begin by defining $R_{1,t}$ as the $K\times 1$ vector of returns on the *K* benchmark assets at time *t*, we define $R_{2,t}$ as the $N\times 1$ returns on the *N* test assets at time *t*, and we combine $R_{1,t}$ and $R_{2,t}$ in the *K+N* vector $R_t = [R_{1,t}^{'}, R_{2,t}^{'}]^{'}$. The expected returns $E[R_t]$ and the variances $Var[R_t]$ on these *K+N* assets can be written as

$$E[R_t] = \mu = \begin{vmatrix} \mu_1 \\ \mu_2 \end{vmatrix} \qquad\qquad Var[R_t] = V = \begin{vmatrix} V_{11} & V_{12} \\ V_{21} & V_{22} \end{vmatrix} \tag{A1}$$

The MVS test proceeds by estimating the following model, which regresses the *N* test asset returns on the *K* benchmark asset returns,

$$R_{2,t} = \alpha + \beta R_{1,t} + \varepsilon_t \tag{A2}$$

with $\varepsilon_t \sim N(0,\Sigma)$, $\alpha = E\left[R_{2,t}\right] - \beta E\left[R_{1,t}\right] = \mu_2 - \beta\mu_1$ and $\beta = V_{21}V_{11}^{-1}$.

Testing whether the set of *K* benchmark assets spans the broader set of *K+N* assets amounts to testing the joint hypothesis that $\alpha = 0$ and $\beta = 1$. If this hypothesis is upheld, it implies that for every test asset, we can obtain a portfolio of the *K* benchmark assets that has the same expected return (because $\alpha = 0$ and $\beta = 1$) and a lower variance (because $R_{1,t}$ and ε_t are uncorrelated while $Var(\varepsilon_t)$ is positive definite.

To derive the form of the MVS test, we rewrite equation (A2) in matrix notation as

$$R = X\beta + \Sigma \tag{A3}$$

with the unconstrained maximum likelihood estimates of β and Σ being determined as usual by

$$\hat{\beta} = (X'X)^{-1}(X'R) \text{ and } \hat{\Sigma} = \frac{1}{T}\left(R - X\hat{\beta}\right)'\left(R - X\hat{\beta}\right) \tag{A4}$$

To derive the tests of spanning and to facilitate their geometric presentation, we define $\hat{\mu} = \sum_{t=1}^{T} R_t / T$ and $\hat{V} = \sum_{t=1}^{T} (R_t - \hat{\mu})(R_t - \hat{\mu})'$, and we define three constants *a, b, c* and *d* that are important determinants of the location and shape of the efficient frontier. We do this for the efficient frontiers with *K* and with *K+N* assets. For *K* assets, we have $\hat{a}_K = \hat{\mu}_K' \hat{V}_{11}^{-1} \hat{\mu}_K$, $\hat{b}_K = \hat{\mu}_K' \hat{V}_{11}^{-1} 1_K$, $\hat{c}_K = \hat{1}_K' \hat{V}_{11}^{-1} 1_K$ and $\hat{d}_K = \hat{a}_K \hat{c}_K - \hat{b}_K^2$. The equivalent for *K+N* assets is $\hat{a}_{K+N} = \hat{\mu}_{K+N}' \hat{V}^{-1} \hat{\mu}_{K+N}$, $\hat{b}_{K+N} = \hat{\mu}_{K+N}' \hat{V}^{-1} 1_{K+N}$, $\hat{c}_{K+N} = \hat{1}_{K+N}' \hat{V}^{-1} 1_{K+N}$ and $\hat{d}_{K+N} = \hat{a}_{K+N} \hat{c}_{K+N} - \hat{b}_{K+N}^2$. As we move from the frontier with *K* benchmark assets to the more general frontier with *K+N* assets, these constants will change by $\Delta\hat{a} = \hat{a}_{K+N} - \hat{a}_K$, $\Delta\hat{b} = \hat{b}_{K+N} - \hat{b}_K$ and $\Delta\hat{c} = \hat{c}_{K+N} - \hat{c}_K$. We can now form the following two matrices, the latter of which is termed the marginal information matrix (see Jobson and Korkie (1989)).

$$\hat{G} = \begin{vmatrix} 1 + \hat{a}_K & \hat{b}_K \\ \hat{b}_K & \hat{c}_K \end{vmatrix} \text{ and } \hat{H} = \begin{vmatrix} \Delta\hat{a} & \Delta\hat{b} \\ \Delta\hat{b} & \Delta\hat{c} \end{vmatrix} \tag{A5}$$

Combining the $\hat{G}$ and $\hat{H}$ matrices in (A5), recalling that $\hat{\Sigma}$ denotes the unconstrained (with *K+N* assets) maximum likelihood estimate of Σ in (A4), denoting the constrained (with *K* assets) maximum likelihood estimate of Σ in (A4) as $\tilde{\Sigma}$, and letting

$U = \left|\hat{\Sigma}\tilde{\Sigma}^{-1}\right|$, the likelihood ratio test of whether the *K* benchmark assets span the *K+N* benchmark and test assets is:

$$LR = -T\ln(U) \tag{A6}$$

where

$$U = \left|\hat{\Sigma}\tilde{\Sigma}^{-1}\right| = \frac{\left|\hat{G}\right|}{\left|\hat{G}+\hat{H}\right|} = \frac{(1+\hat{a}_K)\hat{c}_K - \hat{b}_K^2}{(1+\hat{a}_{K+N})\hat{c}_{K+N} - \hat{b}_{K+N}^2} = \left(\frac{\hat{c}_K}{\hat{c}_{K+N}}\right)\left(\frac{1+\frac{\hat{d}_K}{\hat{c}_K}}{1+\frac{\hat{d}_{K+N}}{\hat{c}_{K+N}}}\right)$$

Huberman and Kendel (1987) and Jobson and Korkie (1989) show that the distribution of the likelihood ratio test under the null is distributed as

$$F = \left(\frac{T-K-N}{N}\right)\left(U^{-\frac{1}{2}}-1\right) = \left(\frac{T-K-N}{N}\right)\left[\left(\frac{\sqrt{\hat{c}_{K+N}}}{\sqrt{\hat{c}_K}}\right)\left(\frac{\sqrt{1+\frac{\hat{d}_{K+N}}{\hat{c}_{K+N}}}}{\sqrt{1+\frac{\hat{d}_K}{\hat{c}_K}}}\right)-1\right] \tag{A7}$$

We know that the standard deviations of the minimum variance portfolios of the *K* benchmark assets and the *K+N* benchmark and test assets are $1/\sqrt{\hat{c}_K}$ and $1/\sqrt{\hat{c}_{K+N}}$, so the first ratio on the right hand side of (A7) is their ratio, which is always greater than one. Kan and Zhou (2001) also show that the second ratio is the length of the asymptote from to the *K+N* efficient frontier benchmark divided by its equivalent to the restricted frontier of the *K* benchmark assets, and this ratio is also greater than one. Diagrammatically, Kan and Zhou (2001) show that the likelihood ratio test, the Wald test and the Lagrange multiplier test are closely related tests of MVS as shown in Figure 1.

In our tests, we focus on the Wald test for the case of *N = 1*. Kan and Zhou (2001) show that although the power of the three spanning tests is difficult to gauge when *N > 1*, the likelihood ratio test is generally not the most powerful. They also show that for the case of *N = 1*, differences in the minimum variance portfolio are more important that differences in the tangent portfolio, and the Wald test is the most powerful of the three. We estimate equation (A2) using OLS and the *2n* restrictions in equation (A3) are tested using a Wald test. The distribution of the asymptotic Wald test statistic of the null hypothesis is:

$$W = T\left(\lambda_1 + \lambda_2\right) \sim \chi^2_{2n} \tag{A8}$$

Kan and Zhou (2001) outline a procedure whereby mean-variance spanning tests can be decomposed into two parts: the spanning of the global minimum-variance portfolio and the spanning of the tangency portfolio. In this case, we can re-write the Wald test statistic as:

$$W = T\left(\frac{\left(\hat{\sigma}_{R_1}\right)^2}{\left(\hat{\sigma}_R\right)^2} - 1\right) + T\left(\frac{1+\hat{\theta}_R\left(R_1^{GMV}\right)^2}{1+\hat{\theta}_{R_1}\left(R_1^{GMV}\right)^2} - 1\right) \tag{A9}$$

where $(\hat{\sigma}_{R1})^2$ and $(\hat{\sigma}_R)^2$ are the global minimum-variance of the benchmark assets and benchmark plus the extended assets respectively. $\hat{\theta}_{R1}(R_1^{GMV})$ is the slope of the asymptote of the mean-variance frontier for the benchmark assets, and $\hat{\theta}_R(R_1^{GMV})$ is the slope of the tangency line of the mean-variance frontier for the benchmark portfolio plus the extended set (based on the return of global minimum-variance portfolio for the benchmark assets, R_1^{GMV}). The first term measures the change of the global minimum-variance portfolios due to the addition of the new asset. The second term measures whether there is an improvement of the squared tangency slope when the extended set of assets is added to the benchmark asset.

Kan and Zhou (2001) show that the asymptotic tests have very good power for test assets that can reduce the variance of the global minimum-variance portfolio, but have little power against test assets that can only improve the tangency portfolio. They therefore suggest a step-down procedure, whereby they first test $\alpha = 0$ and then test $\beta = 1$ conditional on α = 0. The step-down asymptotic Wald tests can then be written as:

$$W_1 = T(\lambda_3) \sim \chi_n^2, \quad W_2 = T(\lambda_4) \sim \chi_n^2 \tag{A10}$$

If we reject the hypothesis due to the first test, the tangency portfolios are different, and if we reject due to the second test, the global minimum-variance portfolios are very different.

The OLS tests above assume the error terms are normally distributed and homoskedastic. In order to test the robustness of this assumption, we also perform all tests using the Generalised Method of Moments (GMM) approach. The GMM approach has the advantage that it does not require information on the exact distribution of the error terms. We use the following GMM Wald test:

$$W_a = T \times vec\left(\hat{\Theta}'\right)' \left[\left(A_T \otimes I_N\right) S_T \left(A_T' \otimes I_N\right) \right]^{-1} vec\left(\hat{\Theta}'\right) \sim \chi_{2N}^2 \tag{A11}$$

where the moment condition is

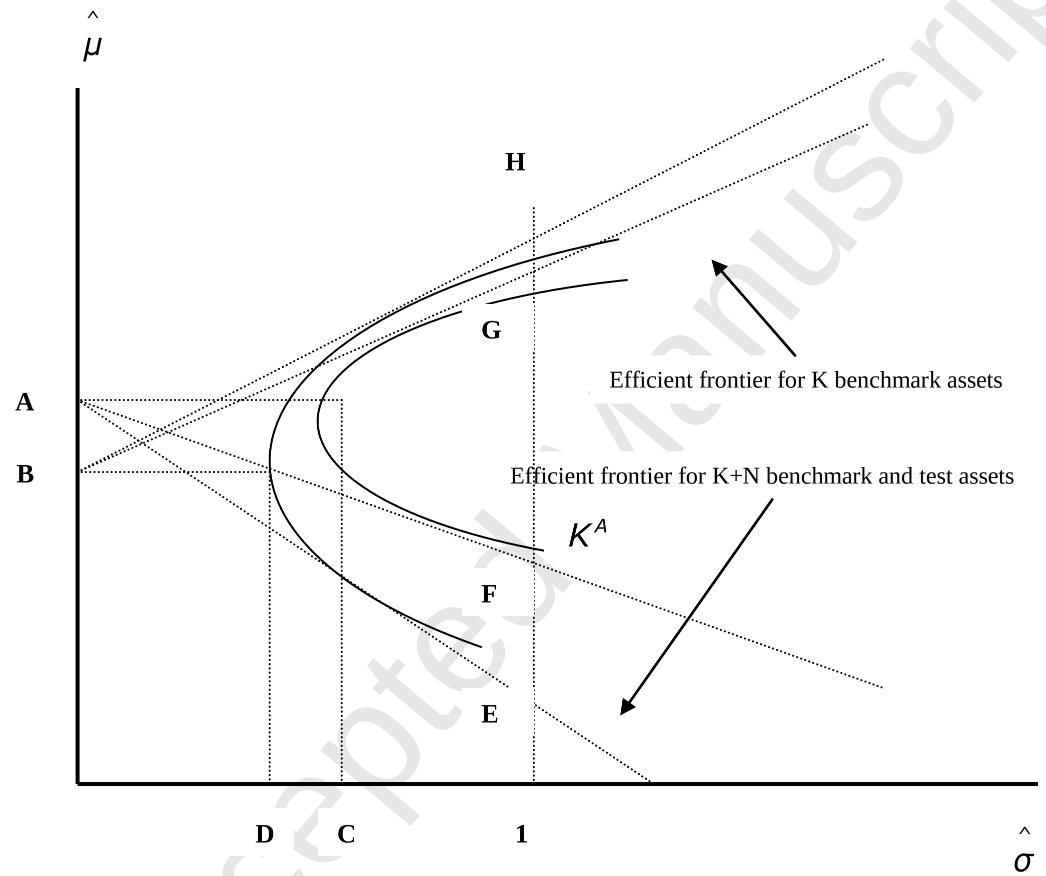
$$E[g_t] = E(X \otimes E) = 0_{n(1+k)}' \tag{A12}$$

$$S_T = E\left[g_t' g_t\right] \tag{A13}$$

$$A_T = \begin{bmatrix} 1 + \hat{a}_1 & -\hat{\mu}_1' \hat{V}_{11}^{-1} \\ \hat{b}_1 & -1_k' \hat{V}_{11}^{-1} \end{bmatrix} \tag{A14}$$

We also conduct step-down GMM Wald tests to disentangle the two sources of spanning. The step-down GMM Wald test statistics are distributed as chi-square with N degrees of freedom.

Figure 1
Testing for mean variance spanning



Notes. Derived from Kan and Zhou (2001). In this figure, the geometry of the likelihood ratio (LR) test, the Wald test and the Lagrange multiplier (LM) tests for spanning are as follows.

LR = (OC/OD)(BH/AF) –1

Wald = $(OC/OD)^2 - 1 + (AE/AF)^2 - 1$

LM = $1 - (OD/OC)^2 + 1 - (BG/BH)^2$

Acknowledgements

Previous versions of this paper were presented at research seminars at the Manchester Business School, February 2008, at the Sydney University School of Economics and Business, August 2008, and at the annual conferences of the European Financial Management Association, Athens, June 2008, and the Academy of International Business, Milan, June 2008. We are grateful to many participants for helpful suggestions, and we are especially indebted to Michael Adler, Don Breedon, J.J Choi, Raj Aggarwal and Elaine Hutson for insightful comments, and to two anonymous referees.

Endnotes

[1] The value of the index each day is calculated using the following formula:

$$IndexValue = \frac{\sum_{i=1}^{n} MV_{it}}{\sum_{i=1}^{n} MV_{ib}} \times 100$$

where MV_{it} is the market value of firm *i* at time *t*, MV_{ib} is the market value of firm *i* at the base year and *n* is the number of firms in the index.

[2] Our analysis in this section and in the results section are obtained using the sales data. All our tests have also been conducted using subsidiary data, and similar results have been obtained. These results are not presented here, but are available on request from the authors.

[3] These results are not presented, but are available on request from the authors.

[4] Tobin (1958) has shown that the composition of the tangency portfolio is independent of investors' preferences.

[5] With short selling constraints, the power of MVS tests may be low in small samples. We use 8.5 years of daily data to minimise these small sample problems.