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Abstract: We explore the link between international stock market comovement and the degree to which firms operate globally. Using stock returns and balance sheet data for companies in twenty countries, we estimate a factor model that decomposes stock returns into global, country- and industry-specific shocks. We find a large and highly significant link: a firm raising its international sales by 10 percent raises the exposure of its stock return to global shocks by 2 percent and reduces its exposure to country-specific shocks by 1.5 percent. This link has grown stronger over time since the mid-1980s.

JEL classification: G11, G15

Key words: diversification, risk, international financial markets, industrial structure

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1. Introduction

There is mounting evidence that firms around the world are becoming more global. For example, the World Investment Report (WIR) by UNCTAD (United Nations Conference on Trade and Development) reports that the global stock of FDI has gone from 5 to 16 percent of world GDP in the last two decades, while international production has increased from about 5 to 10 percent of world output over the same period. Indeed, the pace at which companies have been diversifying internationally accelerated in the late 1990s, when the value of cross-border mergers and acquisitions (M&A) rose sharply. According to the WIR, cross-border M&A as a share of world GDP rose from around 0.5 percent in 1994 to around 2.4 percent in 1999. With this surge in the globalization of businesses, one of the most pronounced empirical regularities in international finance—the low degree of comovement across national stock markets—has broken down. For example, the correlation coefficient of U.S. stock returns with equity returns in other developed markets has risen from a relatively stable level of around 0.4 from the mid-1980s through the mid-1990s to close to 0.9 more recently.[1]

Against this background, we investigate the empirical link between international stock market comovement and the degree to which firms operate internationally. We collect stock returns and balance sheet data for 1,239 firms in 20 developed and emerging markets from 1985

[1] To compute these correlation coefficients, we use U.S. dollar-denominated monthly returns from the DataStream Global Equity indices. The developed markets index excluding the US comprises the United Kingdom, France, Germany, Italy, Japan, Canada, Australia, Austria, Belgium, Denmark, Hong Kong, Ireland, the Netherlands, New Zealand, Norway, Spain, Portugal, Sweden, Switzerland, Finland, Luxembourg and Singapore.

to 2002 and estimate a factor model that decomposes international stock returns into global, country- and industry-specific factors. The model differs in an important respect from the prevailing approach in the international portfolio diversification literature. Earlier work, such as Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998), assumes that country and industry shocks affect all stocks within a given country or industry in the same way. In contrast, our model estimates separate exposures to the global, country- and industry-specific shocks for each stock in our sample.[2] We use these firm-level exposures, called betas below, to investigate the link between stock market comovement and the degree to which firms are international. Is it the case, for example, that global sources of return variation are more important for stocks where the underlying company is highly international? Are country-specific shocks less important for such stocks? And if there is such a link, is it quantitatively important?

Before we turn to our results, a more basic question arises: how to measure the degree to which firms operate internationally? The existing literature in this area, consisting of Cavaglia, Cho and Singer (2001), Diermeier and Solnik (2001) and Lombard, Roulet and Solnik (1999), relies primarily on the percentage of sales from firms' operations in foreign countries as a measure. We broaden our focus to include the percentage of assets associated with companies' foreign operations and the fraction of operating income generated by their operations abroad. But

[2] This model was developed in Brooks and Del Negro (2002c) who show how it can be estimated for large cross-sections and find that the firm-level exposures provide useful information for international diversification strategies. They also test the restriction implicit in earlier papers, that country and industry shocks affect all stocks within a given country or industry in the same way, and find that it is strongly rejected by the data.

all of these measures have an important shortcoming, as they are likely measured with substantial error. In addition, sometimes these measures fail to capture the importance of exports as a channel through which firms operate internationally. To address this deficiency, we estimate our factor model for the annual growth rates of total sales for the firms in our sample. The resulting factor exposures, called "sales betas" below, capture the degree of international exposure of the company, whether it is coming from exports, sales from operations abroad, or overall sensitivity of the business to the world business cycle. Our sales betas thus address a key measurement problem in the existing literature.

Our results suggest that global shocks are a more important source of return variation for stocks whose underlying company is globally diversified, according to our various measures of firm-level globalization. We also find that country-specific shocks are less important for such stocks. Most important, we find that this link is large and highly statistically significant. For example, a company that raises the international component of its sales by 10 percent raises the exposure of its stock return to the global shock by 2 percent and reduces its exposure to country-specific shocks by 1.5 percent. A similar economically and statistically significant relationship exists for our other measures of firm-level globalization, notably our sales betas.

We next investigate whether the importance of this link has changed over our sample period. To this end, we estimate a more general specification of the model, in which we allow the variances of the global, country- and industry-specific factors to change over time. We find that the positive link between firms' exposure to the global stock market factor and the international component of their sales has more than doubled in magnitude from the late 1980s to the late 1990s. Over the same period, the link between firms' stock market country betas and their international sales ratio has gone from positive to negative. These changes are driven by a large

rise in the importance of the global factor and a decline in the importance of country-specific shocks. When we investigate the driving forces behind these changes, we find that the declining importance of country factors is more pronounced for countries in which companies are highly international, according to their international sales. We also find that the decline is more pronounced for more financially open countries and countries with fewer capital account restrictions, although the association here is weaker than for our firm-level variable. Because we lack a similar cross-country dimension for the global factor, there are insufficient observations to relate its evolution over time to firm-level and macroeconomic measures of openness.[3]

We extend the literature in several ways. First, as noted above, we improve on measuring the extent to which firms operate globally. Second, our factor model yields estimates of the stock market betas that are more precise, both from conceptual and statistical perspectives, than those in earlier papers. Our model—unlike that in Diermeier and Solnik (2001)—extracts global, country- and industry-specific factors that are orthogonal on each other. This means that our stock market betas have unambiguous interpretations, namely that they capture global, country- or industry-specific exposures.[4] Cavaglia et al. (2001) use an empirical model very similar to ours, but their betas are estimated using the iterative approach of Marsh and Pfleiderer (1997), while we use maximum likelihood estimation. The latter estimates are consistent and

[3] Forbes and Chinn (2003) find a positive link across countries between comovement in stock returns and bilateral trade linkages and that the strength of this link has increased in recent years.

[4] In contrast, Diermeier and Solnik (2001) note that their "domestic factor is to some extent correlated with international factors." This means that their domestic stock market betas capture both domestic and international exposure, leaving their results hard to interpret.

asymptotically efficient while, to our knowledge, there is no evidence that their estimator enjoys such properties. Third, the existing literature has recognized the possibility of measurement error in firm-level measures of globalization, such as international sales. We are, to our knowledge, the first to address this problem. Following Fama and MacBeth (1973), we examine the link between the stock market betas and our firm-level diversification measures using sorted portfolios. This increases our estimate of this link by an order of magnitude, relative to our estimate using the same data for individual firms. We see this as a strong indication that measurement error in the regressors is a quantitatively important problem and has likely biased downward similar estimates in the existing literature. Fourth and finally, we are the first to find that the magnitude and significance of the link between stock market comovement and the degree to which firms are international has increased substantially over time. The existing literature fails to find any systematic change over time.

The paper is organized as follows. Section 2 discusses our empirical approach, while Section 3 reviews our data. Section 4 presents the results. Finally, section 5 concludes.

2. The Model

This section briefly outlines the factor model used to extract firms' betas with respect to the global, country- and industry-specific shocks. The model is more extensively described in Brooks and Del Negro (2002c). Let us denote by R_{nt} the excess return on stock n in period t over the riskless rate, where n goes from 1 to N and t goes from 1 to T. We index countries with the letter c (c = 1,..,C) and industries with the letter i (i = 1,..,I). The model is described by the following equation:

$$R_{nt} = \mu_i + \beta_n^G f_t^g + \sum_{c=1}^{C} \beta_{nc}^C f_t^c + \sum_{i=1}^{I} \beta_{ni}^I f_t^i + \varepsilon_{nt} \qquad (1)$$

where f_t^g, f_t^c and f_t^i denote the global factor, the country-specific factor *c* and the industry-specific factor *i*, respectively, and ε_{nt} represents the idiosyncratic shock to the return on stock *n*, all in period *t*. The factors are unobservables, as in the latent factor models employed for instance in the APT literature. A key innovation of this model relative to that literature, however, is that here the factors are "identified." The identification arises from the fact that we impose a very natural set of zero restriction on the betas: We restrict β^C_{nc} and β^I_{ni} to zero if stock *n* does not belong to country *c* or industry *i*. For example, if stock *n* is a U.S. chemical company, we restrict the loadings of stock *n* on any country factor other than that for the U.S. and on any industry factor other than the chemical industry factor to be zero. In absence of these zero restrictions, the factors could be rotated arbitrarily and thus could not be identified separately. In our model, the zero restrictions pin down the rotation matrix and give an economic interpretation to the factors, allowing us to characterize them as global, country- or industry-specific factors.

Brooks and Del Negro (2002c) show that the Lehman and Modest (1985) EM algorithm can be used to obtain maximum likelihood estimates of the betas in model (1) and that this approach is computationally feasible even for large cross-sections.[5] In order to estimate (1) via maximum likelihood, we need to make distributional assumptions however. Specifically, we assume—as in much of the APT literature that uses maximum likelihood estimation—that i) both

[5] Convergence is reached whenever the mean squared gradient is less than 10^{-4}. Lehman and Modest (1985) adopt a slightly tighter criterion, namely that the sum of the squared gradients is less than 10^{-4}. Given that the EM algorithm is notoriously slow to converge close to the summit of the likelihood and that our results do not change as long as the mean squared gradient is less than 10^{-2}, we adopt a slightly looser convergence criterion.

the factors and the idiosyncratic shocks are normally distributed *i.i.d.* random variables, uncorrelated with each other:

$$f_t^g,\ f_t^c,\ f_t^i \xrightarrow{d} N(0,1) \text{ all } g,\ c,\ i \tag{2.1}$$

$$\varepsilon_{nt} \xrightarrow{d} N\left(0,\sigma_n^2\right) \text{ all } n \tag{2.2}$$

$$E_{t-1}\left[f_t^k f_t^m\right] = 0 \text{ for } k \neq m,\ E_{t-1}\left[f_t^k \varepsilon_{nt}\right] = 0 \text{ all } k,n \tag{2.3}$$

for all *t*, where the assumption of a unit variance is purely a normalization assumption, and ii) the idiosyncratic shocks are cross-sectionally uncorrelated:

$$E_{t-1}\left[\varepsilon_{nt}\varepsilon_{mt}\right] = 0 \tag{3}$$

for all *t*, *n* and *m*. In the remainder of the paper we will show results that are based on variance decomposition of returns for individual stocks. These are obtained as follows. From equation (1) it follows that the variance of excess returns for stock *n* can be decomposed as the sum of the variances attributed to global, country, and industry shocks and the idiosyncratic component:

$$Var(R_{nt}) = \left(\beta_n^G\right)^2 + \left(\beta_{nc}^C\right)^2 + \left(\beta_{ni}^I\right)^2 + \sigma_n^2 \tag{4}$$

where *c* and *i* denote the country and the industry that stock *n* belongs to. This variance decomposition is exact—in the sense that the impact of country shock can be perfectly separated from that of an industry shock--because it makes use of assumption (2.3). Of course, even if the factors are *ex ante* orthogonal, *ex post* they may not be. However, we find that the average *ex post* correlation coefficient between the global, country and industry factors is virtually zero.

3. The Data

We use data constructed by Brooks and Del Negro (2002a).[6] Their data cover monthly total U.S. dollar-denominated stock returns from January 1985 to February 2002 for 9,679 companies.[7] They cover all constituent firms in the Datastream country indices for 42 developed

[6] Brooks and Del Negro (2002a) investigate the recent rise in the importance of global industry effects in international stock returns and find that it is driven by a small set of industries at the heart of the recent stock market bubble. Their approach follows Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998) in assuming that firms within a given country or industry have the same exposure to country or industry shocks. Brooks and Del Negro (2002b) extend this work to investigate the evolution of country-specific shocks over time by region. They find that only for Europe has the importance of such shocks declined since the mid-1980s and that this decline appears linked to the lifting of capital account restrictions and the introduction of EMU.

[7] We follow much of the literature in using U.S. dollar-denominated returns. L'Her et al. (2002) and Griffin and Karolyi (1998) most recently use this approach for samples that, like ours, span many countries. Using U.S. dollar-denominated returns has the effect of lumping nominal currency influences into country-specific shocks in international stock returns. Brooks and Del Negro (2002a) investigate the magnitude of this bias by redoing their estimations using returns denominated in local currencies and find it to be negligible. This matches Hentschel and Long (2002), Griffin and Stulz (2001) and Heston and Rouwenhorst (1994) who find that exchange rates play only a minor role in explaining international return variation. One explanation for the absence of such a link could be that firms hedge exchange rate risk, consistent with Dominguez and Tesar (2001) who report that exchange rate exposure in stock returns is actually lower for firms with substantial international trade.

and emerging markets as of March 2002 and augment this list with active and inactive stocks for each market from Worldscope. Each stock belongs to one of 39 Level 4 Datastream Global Equity industries, a set of industry assignments that has been used most recently by Griffin and Stulz (2001). Table 1 in Brooks and Del Negro (2002a) lists these industries.

Our sample represents a subset of that in Brooks and Del Negro (2002a) because we use data only for those firms for which a continuous series for U.S. dollar-denominated total sales at fiscal year-end is available from Worldscope.[8] The cross-section of firms for which stock returns and total U.S. dollar sales data are continuously available from January 1985 to February 2002 amounts to 1,239 companies in 20 developed and emerging markets. This sample is balanced over time—there are no changes in composition driving any of our results. The country composition of this sample, and the number of firms in each market, are: Australia (26), Austria (4), Belgium (6), Canada (57), Denmark (9), France (14), Germany (25), Hong Kong (21), Ireland (10), Italy (8), Japan (467), Malaysia (8), the Netherlands (8), Norway (5), Singapore (14), South Africa (13), Sweden (11), Switzerland (7), the UK (150) and the US (376).[9] Our data set includes firms in 34 (out of 39) Level 4 industries. Following Griffin and Karolyi (1998) and Griffin and Stulz (2001), we also distinguish between traded and non-traded goods industries. In

[8] The Worldscope variable we use for total sales is called *SalesUSD*, which is the net sales or revenues of a company converted to U.S. dollars using the fiscal year end exchange rate, according to the Worldscope data definitions guide.

[9] In addition, when a factor (either country and industry) contains only one or two companies, we eliminate the factor and the corresponding firms from the analysis. This is because we cannot in this case identify the idiosyncratic component separately from the country or industry factor.

this dimension, our dataset has 611 traded and 628 non-traded goods firms.[10] Our data coverage compares favorably to that in other papers that use firm-level international stock returns. For example, Heston and Rouwenhorst (1994) examine data on 829 stocks in 12 European countries. Griffin and Karolyi (1998) collect data on 2,400 firms in 25 developed and emerging markets.

We follow standard practice in the literature—see Ferson and Harvey (1994), Dumas and Solnik (1995), Heston et al. (1995) and De Santis and Gerard (1997)—in estimating our factor model over excess U.S. dollar-denominated stock returns, which we compute by subtracting the monthly total return for a 3-month U.S. Treasury Bill from the individual stock returns. Over the full sample, the monthly U.S. dollar-denominated excess return averages 0.3 percent per month, while the average variance across stocks is 114.34 percent-squared. The average annual growth rate for total sales across all the firms in our sample amounts to 8.06 percent. The average variance across firms of the growth rate of annual sales is 477.41 percent-squared.[11]

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[10] Following Griffin and Karolyi (1998) and Griffin and Stulz (2001), we treat the following industries as tradable goods sectors: AUTMB, OILGS, FSTPA, PHARM, CHMCL, INFOH, ELTNC, SFTCS, HHOLD, MNING, STLOM, TOBAC, FOODS, ENGEN, PERSH. See Table 1 in Brooks and Del Negro (2002a) for an explanation of these abbreviations.

[11] We compute monthly total returns for the 3-month Treasury Bill using the Merrill Lynch 3-month Treasury Bill Index. The 3-month US Treasury Bill Index is comprised of a single issue purchased at the beginning of the month and held for a full month. At the end of the month, that issue is sold and rolled into a newly selected issue. The issue selected at each month-end re-balancing is the outstanding Treasury Bill that matures closest to, but not beyond 3 months from the re-balancing date. To qualify for selection, an issue must have settled on or before the re-

(continued)

Finally, we collect annual Worldscope data from 1985 to 2001 for each firm on the share of total sales generated abroad, the fraction of total assets held overseas and the fraction of total income generated abroad.[12] 1,170 firms in our sample have data on the international component of total sales at some point over our sample. This number is 1,071 for international assets and 1,059 for international income. Firms in traded goods industries are on average more open, according to these balance sheet variables, than firms in non-traded goods industries. The international sales ratio for traded goods firms averages 28.49 percent over our sample, while it is 16.00 percent for non-traded goods firms. The corresponding ratios for international assets are 19.30 percent and 10.81 percent, and 22.75 percent and 13.57 percent for international income.

4. The Results

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balancing (month-end) date. While the index will often hold the Treasury Bill issued at the most recent or prior 3-month auction, it is also possible for a seasoned 6-month or 1-Year Bill to be selected.

[12] The Worldscope variable that measures the percentage of international sales in total sales is called *ForeignSalesPctSales*. This variable captures sales generated by operations in foreign countries and therefore omits export sales. The Worldscope variable for the share of international assets in total assets is *ForeignAssetsPctTotalAssets*. This variable captures total or identifiable assets of foreign operations before adjustments and eliminations. Finally, the Worldscope variable for the international income share is *ForeignIncomePctTotalIncome,* which measures the importance of international operating income in total income. International operating income represents operating income generated from operations in foreign countries before adjustments and eliminations.

This section reports the estimation results for model (1) with one global factor, 20 country factors (one for each country) and 34 industry factors (one for each industry). It has two sub-sections. Section 4.1 quantifies the empirical link between international stock market comovement and the degree to which firms operate internationally. We call this the cross-sectional link because it holds across firms for the full sample period. Section 4.2 then asks whether this cross-sectional link has changed over our sample period, using a more general specification in which we allow the factor variances to change over time.

4.1 The Cross-Sectional Link

This section explores the importance of the link between international stock market comovement and firm-level diversification across countries. Our basic strategy is to relate the estimated stock market betas for each firm to different measures of the extent to which firms are international. The first measure we consider is whether a firm belongs to a traded or non-traded goods industry, in recognition of the fact that some industries are more global than others. This notion is tested explicitly in Griffin and Karolyi (1998) who find that global industry effects are more important relative to country effects for traded than for non-traded goods industries. But there are limitations to this industry-level analysis. First, though firms may nominally belong to a traded goods industry, their true exposure to stock market shocks may be different. Think of Spanish banks, nominally part of a non-traded goods sector, that are heavily exposed to the crisis in Argentina. Second, there may be heterogeneity across sectors in the exposure to global shocks—some traded goods industries may be more global than others. Third, there may be substantial heterogeneity within countries and industries in the exposure of firms to shocks.

Following Cavaglia et al. (2001), Lombard, Roulet, and Solnik (1999) and Diermeier and Solnik (2001), we consider a second measure, namely balance sheet data on the global exposure

of firms through the international component of their sales, income, or assets (the above-mentioned authors consider primarily international sales). One advantage of this approach is that it exploits firm-level information and hence takes firm-level heterogeneity into account. The main disadvantage is that these variables may be measured with error, as noted by Diermeier and Solnik (2001). In addition, these variables sometimes do not capture firms' exposure to global shocks through exports.

An important added value of this paper is that it provides a third approach to measuring the extent to which firms operate internationally. We estimate the factor model described in section 2 for the annual U.S. dollar-denominated growth rates of total sales for our panel of firms. This gives us the exposure to global, country- and industry-specific shocks in annual sales growth for each firm in our data. These "sales betas" are measured in U.S. dollars to be consistent with our stock market betas.[13] We expect to find that the global shock is more important, and the country-specific shock less important, for more international firms. The advantage of these sales betas is that they capture international exposure not reflected in international sales, which only reflects sales by foreign affiliates and thus ignores export sales, an additional channel through which firms may be exposed to global shocks. The downside of the

[13] The intuition behind these sales betas is straightforward. U.S. dollar sales growth for a Brazilian multinational, for example, will be less affected by a devaluation of the Brazilian Real, a country-specific shock, than the U.S. dollar-denominated sales growth of a Brazilian firm that operates only domestically.

sales betas is twofold: i) the underlying model to estimate them may not be correct[14] and ii) even if the model is correct, the estimated betas will have sampling error.

Our task now is to determine whether there is a relationship between firms' stock market betas and the degree to which firms are international, as measured by these three approaches. We expect that firms that are more international on the real side have, *ceteris paribus*, a higher stock market exposure to global shocks and a lower exposure to country-specific shocks. Of course, there are other determinants of stock market exposure, most importantly the pricing kernel at which dividends are discounted. In principle, a domestic firm whose stock is traded in an open stock market (where the marginal investor is international) may be more exposed to global shocks, and less exposed to country-specific shocks, than an international firm whose stock is traded in a closed market. We directly address this possibility toward the end of this section.

First, we look for a qualitative link between the stock market and sales growth betas and the balance sheet variables that measure the international component in sales, assets and income. We sort the sample according to our accounting measures and compare the average variance decomposition for the top quartile of our sample (the most international) with that for the bottom quartile (the least international firms). Table 1 shows that, both for stock returns and sales growth, the global factor is more important and the country factor less important for firms in the

[14] As in the stock market model we assume that all the shocks are *iid* over time. While this assumption is more unpalatable when applied to the sales growth rates than for the stock returns data, we find that the one-lag correlation for the sales growth data is on average very low, about 0.1. In addition, given that T=16 for the annual sales data, more complicated models with serially correlated factors would be very hard to estimate precisely.

top quartile based on international sales, asset and income ratios. Comovement in both real and financial variables is therefore greater for firms that operate globally than for firms that do not. Next we group firms by whether they belong to traded or non-traded goods industries. Here, the qualitative link goes the right way for stock returns but not for sales growth. Finally, we rank firms by their global and country sales betas. For the former, we find that the global factor is on average more important in explaining international return variation for the top quartile (high sales betas) than for the average stock, but that this holds even more so for the bottom quartile (low sales betas). Similarly, we find that country-specific shocks are more important on average for the top quartile than for the bottom quartile. These results go against our intuition and point to some inaccuracy in the measurement of the global sales betas. In contrast, the variance decompositions for sales growth are more in line with our expectations. Turning to the variance decompositions based on our country sales betas, we find that the results are as expected. Firms with high (low) real-side exposure to country shocks have a lower (higher) than average exposure to the global factor and a higher (lower) than average exposure to country shocks. This is true both for the stock market and the sales betas.

Table 1 thus establishes a qualitative link between firm-level integration and international stock market comovement. But how important is this link quantitatively? In order to investigate this issue, we regress the stock market betas (in percent) on an array of measures of real side exposure: the international sales, asset and income ratios, the respective sales betas and a dummy variable equal to one if a firm belongs to a traded goods sector and zero otherwise.[15] We focus

[15] For each firm we use the full sample average over time for the international sales, asset and income ratios, whenever these variables are available.

only on the global and country stock market betas on the grounds that: i) from Table 1 there is no apparent link between industry betas and firm-level measures of globalization, ii) it is not clear from theory that any such link should *a priori* exist.

All of these regressors, for the reasons discussed before, likely contain measurement error, which leads to a downward bias in the coefficients. In order address this problem, we adopt an approach similar to Fama and MacBeth (1973). We: i) sort firms according to the dependent variable, ii) construct N portfolios containing n/N firms (where n is the total number of firms in the sample), iii) use as data the N within-portfolio averages for the dependent and explanatory variables.[16] If measurement error in the regressors is not too correlated within each portfolio, this averaging should reduce the bias due to the law of large numbers.[17]

[16] An important difference with Fama and MacBeth is that they sort firms according to their *independent* variable. Therefore, the betas in their sorted portfolio are still measured with error. For this reason, they sort firms by the betas estimated in a previous sub-period—assuming that the measurement error in the two sub-periods is independent. In contrast, we sort firms according to the *dependent* variable and hence do not encounter the same problem: our dependent variable is still likely to be measured with error, but this does not bias our estimates.

[17] Of course, the sorting is done according to the dependent variable *only*. We use N=20 portfolios for the bivariate regressions. There is a trade-off between bias and degrees of freedom in the regressions. The higher is N, the higher the degrees of freedom, but the higher also the bias because averaging occurs among n/N firms. Increasing N to 30 reduces the coefficients somewhat, but not sizably. The number of portfolios is 40 for the regressions with more than 2

(continued)

Table 2 presents the results of bivariate portfolio-level regressions of the stock market betas (in percent) on each of the regressors (and a constant). The t-ratios are computed using robust standard errors (White 1980) and reported in parentheses. The coefficients largely have the expected sign: an increase in the extent to which firms operate globally raises their exposure to global stock market shocks and reduces their exposure to country-specific shocks. An increase in the real-side exposure of firms to global and country shocks—as measured by our sales betas—is associated with an increase in stock market exposure to global and country shocks. More surprising, our estimates are highly significant, whereas those in Cavaglia, Cho, and Singer (2001), the most similar paper in terms of methodology, are mostly insignificant. Most important, though, the effects are economically large, again in contrast to Cavaglia, Cho, and Singer (2001): a 10 percent increase in the international sales ratio increases firms' exposure to global stock market shocks by 2 percent and reduces their exposure to country-specific shocks by 1.5 percent. If for individual stocks a change in the exposure of 2 percent may not seem large (the average stock in the sample has a standard deviation of about 10 percent), for portfolios these numbers are considerable: the equally-weighted world market portfolio has an in-sample standard deviation of 4.6 percent. Our results are therefore important for portfolio managers. The respective sales betas (also measured in percent) have a ¾ to one percent impact on the stock market betas. Taking into account that the sales betas are measured on an annual basis and the

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variables (shown in the appendix), given that more degrees of freedom are needed when there are more regressors. The multivariate regression results are virtually unchanged for N=30.

stock market betas on a monthly basis, one should multiply this number by $\sqrt{12} \approx 3.5$.[18] Again, the impact of real-side exposure on stock market exposure is therefore estimated to be large.

Why do our results differ from the existing literature? First, we use portfolios to reduce measurement error in our variables. Second, our measure of firms' exposures to stock market shocks is different. Diermeier and Solnik (2001) do not account for country- or industry-specific shocks, nor are their factors orthogonal. And though Cavaglia et al. (2001) use an empirical model very similar to ours, their betas are estimated using the iterative approach of Marsh and Pfleiderer (1997), while we use maximum likelihood methods.[19] The latter estimator is consistent and asymptotically efficient while, to our knowledge, there is no evidence that their estimator enjoys such properties.

We also run firm-level cross-sectional regressions, without the within-portfolio averaging (the results are shown in the appendix). It is reassuring to observe that none of the coefficients changes sign under this alternative procedure. In addition, most of the coefficients that are significant at the five percent level using the portfolio-level regressions are also significant at the

[18] Since the model assumes *i.i.d.* shocks, the annual variance is 12 times the monthly variance. Hence the annualized stock market betas are roughly $\sqrt{12}$ times the monthly betas.

[19] Marsh and Pfleiderer (1997) propose an iterative approach, which involves i) estimating the β's by OLS given the factors and ii) estimating the factors by OLS given the β's. They propose this approach on the ground that "with the large cross-section of stocks…we know of no feasible way to estimate the restricted factor model by maximum likelihood methods" (p. 9). A value-added of Brooks and Del Negro (2002c) is that they provide such a method.

five percent level at the firm level. As expected, the difference between the two procedures lies in the size of the coefficient. Within-portfolio averaging generally increases the coefficients by one order of magnitude, suggesting that bias in the firm-level regressions is considerable.

Finally, we check the robustness of our results to alternative specifications. In particular, we demean within each country both the dependent and the independent variables. As discussed above, cross-country differences in the stock market exposures of firms could be due to the fact that the marginal investor—and hence the pricing kernel—may be different across countries. By demeaning the stock market betas by country we remove these cross-country differences and exploit only within-country information. The results based on the demeaned regressions (also in the appendix) suggest that our results are robust. The sign of the coefficients is unchanged, most of the coefficients are still significant, and the magnitude is if anything larger in the demeaned regressions. The only exception is the regression of the country stock market betas on the accounting variables: the coefficients have the expected negative sign but are smaller than in Table 2 and no longer significant in the portfolio regressions (the coefficients are still significant in the regressions without averaging however). In interpreting these results one should bear in mind that our sample covers mostly developed markets that had liberalized their capital accounts by the start of our sample period. Moreover, the demeaning prevents us from using relevant cross-country information: in some countries firms are more international than in others.

4.2. The Cross-Sectional Link over Time

So far we have investigated the link between financial and real integration in a cross-sectional sense. We have asked if the global factor in international stock returns is on average more important, and the country factor less important, for firms that are more international. There is evidence, however, that the relative importance of global, country and industry shocks

in international stock returns may be changing, as L'Her et al. (2002) argue. In this section we modify the model to accommodate this evidence. We then ask if the cross-sectional link between international stock market comovement and firm-level international diversification found in the previous section is robust, and how it has evolved over time.

To this end, we estimate a more general specification of the model in Section 2, one that allows for the importance of the global, country and industry factors to vary across exogenously pre-specified sub-periods of the data. In our baseline specification, the factors in every period are drawn from the same distribution, as described in equation (2.1). Now we allow for these distributions to evolve over time. Assumption (2.1) is therefore replaced with:

$$f_t^g \xrightarrow{d} N\left(0, \xi_l^g\right),\ f_t^c \xrightarrow{d} N\left(0, \xi_l^c\right),\ f_t^i \xrightarrow{d} N\left(0, \xi_l^i\right) \text{ for } t_{l-1}+1 \le t \le t_l \text{ and l=1,..,L} \qquad (4)$$

where t_0=1 and t_L=*T*. Assumption (4) says that our sample period is divided into *L* periods, each starting at time t_{l-1}+1 and ending at time t_l, In each period, we let the variance and therefore the importance of our factors change. For normalization purposes, we still constrain the variance in the first sub-period to be one for all factors. Hence ξ_l^g can be interpreted as the variance of the global factor relative to its variance in the first period. The variance of excess returns for stock *n* in period *l* can therefore be decomposed as follows:

$$Var(R_{nt}) = \left(\beta_n^G\right)^2 \xi_l^g + \left(\beta_{nc}^C\right)^2 \xi_l^c + \left(\beta_{ni}^I\right)^2 \xi_l^i + \sigma_n^2 \qquad (6)$$

for $t_{l-1}+1 \le t \le t_l$. As the ξs change over time, the relative importance of the global, country- and industry-specific shocks in explaining variation in stock returns can also change.

Before examing our results, a discussion of our modelling choices is in order. The model we estimate is a compomise between the baseline model described in section 2 and a model where the βs—the factor exposures—change independently across firms and over time. The latter model is attractive because it would allow us to analyze the link between the evolution of

the βs and the evolution of the international sales ratio at the firm level. However, since the cross-section (N=1239) and hence the number of estimated parameters ($4\times N$) is large, it would be hard to estimate these βs with any precision. Hence we opt for a more parsimonious representation, where the number of additional parameters to be estimated relative to the baseline model is only K (the number of factors) × L-1 (the number of periods-1). Second, the choice as to the number and timing of sub-periods is somewhat arbitrary. We therefore allow for two through eight equally-spaced sub-periods and systematically test for the increase in explanatory power relative to our baseline model with fixed factor variances. Our results below are qualitatively robust across specifications. However, since the model with four sub-periods has the highest BIC (Bayesian Information Criterion), we present the results for that specification only.

Table 3 shows the variance decompositions over time for international stock returns, based on the model with four sub-periods. As in Table 1, we show the variance decomposition for the average across all firms, for firms in the top quartile according to the international sales ratio (the most international firms) and for firms in the bottom quartile (the least international firms). Let us first focus on the variance decompositions for the full sample. The results suggest that the importance of the global factor has grown from 4.26 percent in the first sub-period to 16.49 percent in the last sub-period. However, this rise is confined almost entirely to the last sub-period. Over the four sub-periods, the global factor actually describes a U-shape, decreasing between the first and the second period and then rising sharply at the end of our sample. The importance of the industry factors has been approximately constant over time. The country shocks are the most important source of return variation in all four periods, although their importance has declined relative to that of the global factor in the last period. Is this pattern the same across all firms? The answer from the comparison of the variance decompositions for high

and low international sales firms is no. Note that in the first sub-period, country shocks are more important for high international sales firms than for low international sales firms. This pattern is reversed in all subsequent periods. In the last period, country-specific shocks are less important for high than for low international sales firms. Notably, for high international sales firms, the global shock is the most important source of return variation in the last period.

Table 4 takes a different look at the same phenomenon. It explores the evolution over time of the cross-sectional link between stock market comovement and firm-level international diversification. Note that in each period the exposure of firm *n* to world, country- and industry-specific shocks is given by the expressions $\beta_n^g \xi_l^g$, $\beta_n^c \xi_l^c$, and $\beta_n^i \xi_l^i$. We regress these exposures on within-period measures of firm-level integration, such as the international sales ratio and the sales betas, using within-portfolio averages to reduce the impact of measurement error on our estimates. For each sub-period, Table 4 presents the estimated slope coefficient on the within-period average international sales ratio. We use White (1980) robust standard errors. ** denotes significance at the 5 percent level and * denotes significance at the 10 percent level. Table 4 suggests that the cross-sectional link between the global stock market betas and the international sales ratio has increased by a factor of 2.3 from the first to the last sub-period. Meanwhile, the coefficient on the international sales ratio in the country beta regressions has switched from 0.181 in the first sub-period (consistent with the greater importance of the country factor for highly international firms than for the average firm in Table 3) to -0.191 in the last sub-period. The coefficients in the regressions of the stock market betas on the respective sales betas always have the expected positive sign: an increase (decrease) in real-side exposure to global (country) shocks maps into an increase (decrease) in stock market exposure.

It is important to bear in mind that our model does not allow for time-varying exposures at the firm level, but only for a change in the variances of the factors. It is apparent for instance that the change in the coefficients for the regressions featuring the global stock market betas on the left hand side is merely a reflection of the fact that the importance of the global shocks, ξ_I^g, has changed over time. The change in the coefficients in the country beta regressions is not as mechanical. In this case compositional effects play an important role. The results suggest that country shocks have fallen in importance more for countries where firms are more international.

We now focus on trying to explain the changing country factor variances over time. The cross-country dimension of the data allows us to use regression analysis to link the evolution of these factor variances to country averages of our firm-level international sales variable and to macroeconomic data on capital account and trade openness (because we lack the same cross-sectional dimension for the global factor, we do not perform similar analysis for it). Is it the case, for example, that the importance of country-specific stock market shocks has declined more in countries where firms are on average more international? Or is it the case that macroeconomic measures of openness are more successful in explaining the evolution of the country factor variances? Table 5 presents bivariate cross-sectional regressions for each period (except the first period when the country factor variances are normalized to one) of the country factor variance parameters on the full sample averages for the following variables: the country-level averages for the international sales ratio, the country-level averages for the global and country sales betas, the capital account openness measure (CA Open) of Lane and Milesi-Ferretti (2001) who compute the ratio of foreign assets and liabilities to GDP annually for each country in our sample, the Chinn and Ito (2002) measure of capital account restrictions (CA Restrict) that is based on the IMF's annual measure of capital account restrictions that takes a value of one if restrictions exist

and zero otherwise, and the annual ratio of trade to GDP for each country in our sample from the World Bank's World Development Indicators. Table 5 shows that firm-level diversification across countries is on average negatively associated with the evolution of the country factor variances. This suggests that the more international is a country's average firm, as measured by the international sales ratio, the higher the decline in the importance of its country-specific stock market factor over time. More important, this link has become progressively stronger and more significant over time. This suggests that the rise in the importance of the cross-sectional link between international stock market comovement and firm-level trade integration is not entirely spurious, at least as far as the changing importance of the country factors is concerned. Finally, it does not appear that macroeconomic measures of openness rival our firm-level international sales measure in explaining the evolution of the country factors over time. The capital account openness measure of Lane and Milesi-Ferretti (2001) comes closest, but here is seems that the relationship has weakened over time.

5. Conclusion

We investigate the empirical link between international stock market comovement and the degree to which firms operate internationally. Using stock returns and balance sheet data for companies in 20 countries, we measure the betas of stock returns with respect to global, country- and industry-specific shocks. In contrast to earlier papers, we find a strong and highly significant link between these betas and firm-level variables that measure international diversification. For example, a firm raising its international sales by 10 percent raises the exposure of its stock return to global shocks by two percent and reduces its exposure to the country shocks by 1.5 percent.

We also estimate a more general version of our model, in which we allow the variances of the global, country- and industry-specific factors to vary over time. Using this specification,

we find that the link between international stock market comovement and the degree to which firms operate internationally has grown substantially since the mid-1980s.

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Table 1. Variance Decompositions for International Stock Returns and Sales Growth (in %) by Different Measures of Firm-Level Diversification Across Countries.

Panel A. Stock Market Betas

All Firms	Global	Country	Industry
All Firms	6.92	32.24	7.01

Sorted by International Sales Ratios	Global	Country	Industry
Top Quartile	11.32	25.59	6.70
Bottom Quartile	3.91	34.34	7.15

Sorted by International Asset Ratios	Global	Country	Industry
Top Quartile	10.04	26.26	8.36
Bottom Quartile	4.07	35.85	6.55

Sorted by International Income Ratios	Global	Country	Industry
Top Quartile	10.99	25.58	7.35
Bottom Quartile	4.08	34.85	6.85

Sorted by Traded/Non-Traded Industry	Global	Country	Industry
Traded	8.49	30.36	7.74
Non-Traded	5.11	34.41	6.16

Sorted by Global Sales Betas	Global	Country	Industry
Top Quartile	7.25	33.58	4.92
Bottom Quartile	7.68	25.57	9.62

Sorted by Country Sales Betas	Global	Country	Industry
Top Quartile	6.83	33.57	6.02
Bottom Quartile	7.82	25.03	7.82

Panel B. Sales Betas

All Firms	Global	Country	Industry
All Firms	10.42	16.58	13.52

Sorted by International Sales Ratios	Global	Country	Industry
Top Quartile	13.20	14.60	16.07
Bottom Quartile	11.17	17.15	14.44

Sorted by International Asset Ratios	Global	Country	Industry
Top Quartile	13.22	14.72	15.20
Bottom Quartile	9.97	17.52	12.80

Sorted by International Income Ratios	Global	Country	Industry
Top Quartile	15.14	15.97	11.05
Bottom Quartile	10.21	17.84	13.35

Sorted by Traded/Non-Traded Industry	Global	Country	Industry
Traded	8.78	16.51	16.51
Non-Traded	11.87	16.64	10.89

Sorted by Global Sales Betas	Global	Country	Industry
Top Quartile	20.21	14.48	10.41
Bottom Quartile	6.74	16.24	17.34

Sorted by Country Sales Betas	Global	Country	Industry
Top Quartile	9.93	30.60	9.22
Bottom Quartile	11.66	5.61	20.93

Table 1 shows the qualitative link between stock return and sales betas and the degree to which firms operate globally. The variance for stock returns (Panel A) and sales growth rates (Panel B) for each firm in our sample can be decomposed into the contributions from global, country- and industry-specific factors according to $\mathrm{Var}(R_{nt}) = (\beta_n^G)^2 + (\beta_{nc}^C)^2 + (\beta_{ni}^I)^2 + \sigma_n^2$. The table shows simple averages across firms for these variance decompositions. The top and bottom quartiles represent the most and least international firms in our sample, sorting according to our different firm-level measures of international diversification: the international sales, international asset and international income ratios, the traded goods industry dummy and the sales betas.

Table 2. Cross-sectional Regressions of the Stock Market Betas on Firm-Level Measures of International Diversification.

	Global Stock Market Betas	Country Stock Market Betas
International Sales Ratio	0.191 (8.89)	-0.151 (-2.55)
Adjusted R2	0.859	0.263
International Asset Ratio	0.297 (9.343)	-0.274 (-2.82)
Adjusted R2	0.864	0.301
International Income Ratio	0.217 (14.426)	-0.138 (-1.44)
Adjusted R2	0.897	0.167
Traded Goods Dummy	9.352 (5.468)	13.75 (2.471)
Adjusted R2	0.609	0.234
Respective Sales Betas	0.768 (6.62)	0.722 (11.55)
Adjusted R2	0.507	0.803

Table 2 shows cross-sectional regression results of the stock market global and country betas on the full sample averages of the international sales ratio, international asset ratio and international income ratio, in addition to the traded goods industry dummy and the respective sales betas. All variables are measured in percent. T-ratios are computed using robust standard errors as in White (1980) and shown in parentheses. Because of the possibility of measurement error in the regressors, these regressions are performed on within-portfolio averages for $N = 20$ portfolios. We construct these portfolios by i) sorting firms according to the dependent variable, ii) constructing N portfolios containing n/N firms (where n is the total number of firms in the sample), iii) using as observations the N within-portfolio averages for the dependent and explanatory variables.

Table 3. Variance Decompositions of International Stock Returns (in %) Over Time.

Variance Decomposition (in %) of International Stock Returns

	All Firms			Top Quartile: Int'l Sales			Bottom Quartile: Int'l Sales		
	Global	Country	Industry	Global	Country	Industry	Global	Country	Industry
1985:1 to 1989:3	4.26	29.61	9.57	6.56	34.33	5.19	3.17	26.67	10.47
1989:4 to 1993:7	2.02	41.97	4.27	3.39	30.56	4.05	1.17	45.16	4.41
1993:8 to 1997:10	2.72	30.90	5.41	4.62	21.42	6.17	1.54	35.40	5.47
1997:11 to 2002:02	16.49	29.46	8.73	24.17	21.34	8.22	10.98	31.98	9.15

Table 3 is constructed is the same manner as Table 1. It is based on an extended version of our model in which the variances of the global, country- and industry-specific factors are allowed to vary across exogenously specified sub-periods in our sample. The variance decomposition for each stock is now given by $\text{Var}(R_{nt}) = (\beta_n^G)^2 \zeta_l^G + (\beta_{nc}^C)^2 \zeta_l^C + (\beta_{ni}^I)^2 \zeta_l^I + \sigma_n^2$, where the index l denotes the sub-period and ζ_l^G, ζ_l^C and ζ_l^I scale the factor variances of the global, country- and industry-specific factors in the l'th sub-period relative to their variances in the first sub-period.

Table 4. Cross-sectional Regressions of the Stock Market Betas on the International Sales Ratio and the Respective Sales Betas Over Time.

Global Stock Market Betas		
	International Sales Ratio	Global Sales Betas
1985:1 – 1989:3	0.123**	0.634**
1989:4 – 1993:7	0.088**	0.430**
1993:8 – 1997:10	0.079**	0.403**
1997:11 – 2002:02	0.280**	1.440**

Country Stock Market Betas		
	International Sales Ratio	Country Sales Betas
1985:1 – 1989:3	0.181**	0.794**
1989:4 – 1993:7	-0.154*	1.050**
1993:8 – 1997:10	-0.123**	0.628**
1997:11 – 2002:02	-0.191**	0.911**

Table 4 is constructed analogously to Table 2. The only difference is that the international sales ratio now represents an average for the relevant period. All variables are measured in percent. T-ratios are computed using robust standard errors as in White (1980). ** denotes significance at the 5 percent level, * denotes significance at the 10 percent level. Because of the possibility of measurement error in the regressors, the regressions for each sub-period are performed on the within-portfolio averages for $N = 20$ portfolios. We construct these portfolios by i) sorting firms according to the dependent variable, ii) constructing N portfolios containing n/N firms (where n is the total number of firms in the sample), iii) using as observations the N within-portfolio averages for the dependent and explanatory variables. See the appendix for detailed results for each sub-period.

Table 5. Explaining the Changing Importance of Country Factors in International Stock Returns.

	Int'l Sales Ratio	Global Sales Betas	Country Sales Betas	CA Open	CA Restrict	Trade Open
1989:4 – 1993:7	-0.0001	-1.394	-1.1163	-0.2722	0.0591	-0.0026*
1993:8 – 1997:10	-0.0114**	0.7543	1.0476	-0.2878**	-0.0337	0.0004
1997:11 – 2002:2	-0.0168**	-9.900**	3.8162	-0.0115	-0.0147	0.0033**

Table 5 shows the slope coefficients for period by period bivariate cross-country regressions of the variance scale parameters for the country factors, ζ_l^C, on full sample averages of firm-level and macroeconomic measures of openness (and a constant): country-level averages for the international sales ratio, country-level averages for the global and country sales betas, the capital account openness measure (CA Open) of Lane and Milesi-Ferretti (2001) who compute the ratio of foreign assets and liabilities to GDP annually for each country in our sample, the Chinn and Ito (2002) measure of capital account restrictions (CA Restrict) that is based on the IMF's annual measure of capital account restrictions that takes a value of one if restrictions exist and zero otherwise, and the annual ratio of trade to GDP for each country in our sample from the World Bank's World Development Indicators. ** denotes significance at the 5 percent level, * denotes significance at the 10 percent level. All variables are measured in percent. We use White (1980) robust standard errors to compute the T-ratios.

APPENDIX

Table A1. Cross-Sectional Regressions of the Stock Market Betas on Firm-Level Measures of International Diversification: Full Sample (January 1985 – February 2002).

Panel A: Portfolio-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.191					0.126	0.217
	(8.886)					(4.982)	(1.851)
International Assets		0.297					-0.110
		(9.343)					(-0.663)
International Income			0.217				0.038
			(14.426)				(0.474)
Traded/Non-Traded				9.352		3.368	
				(5.468)		(2.876)	
Respective Sales Beta					0.768	0.056	
					(6.620)	(0.523)	
Adjusted R2	0.859	0.864	0.897	0.609	0.507	0.826	0.783

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.151					-0.091	-0.068
	(-2.549)					(-3.618)	(-0.749)
International Assets		-0.274					-0.334
		(-2.821)					(-1.933)
International Income			-0.138				0.170
			(-1.438)				(2.018)
Traded/Non-Traded				13.750		2.952	
				(2.471)		(1.921)	
Respective Sales Beta					0.722	0.529	
					(11.548)	(7.939)	
Adjusted R2	0.263	0.301	0.167	0.234	0.803	0.777	0.320

Panel B: Firm-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.027					0.021	0.029
	(11.916)					(9.383)	(4.399)
International Assets		0.033					-0.011
		(9.329)					(-1.568)
International Income			0.029				0.011
			(10.594)				(2.174)
Traded/Non-Traded				0.968		0.739	
				(8.989)		(7.192)	
Respective Sales Beta					0.040	0.036	
					(4.080)	(4.008)	
Adjusted R2	0.113	0.082	0.104	0.062	0.018	0.155	0.129

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.012					-0.016	-0.008
	(-5.301)					(-7.039)	(-1.201)
International Assets		-0.016					-0.013
		(-4.679)					(-1.699)
International Income			-0.010				0.005
			(-3.937)				(0.779)
Traded/Non-Traded				0.158		0.342	
				(1.311)		(2.808)	
Respective Sales Beta					0.097	0.098	
					(9.341)	(8.787)	
Adjusted R2	0.019	0.018	0.012	0.002	0.098	0.130	0.023

Panel C: Portfolio-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.217					0.139	0.242
	(13.684)					(6.599)	(2.106)
International Assets		0.310					-0.087
		(9.304)					(-0.597)
International Income			0.227				0.002
			(12.466)				(0.041)
Traded/Non-Traded				8.527		2.848	
				(6.526)		(2.355)	
Respective Sales Beta					0.877	0.090	
					(5.188)	(0.815)	
Adjusted R2	0.895	0.873	0.870	0.719	0.377	0.846	0.763

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.106					-0.077	-0.154
	(-1.101)					(-1.579)	(-1.189)
International Assets		-0.098					-0.008
		(-0.694)					(-0.071)
International Income			-0.029				0.120
			(-0.290)				(1.151)
Traded/Non-Traded				-6.423		-0.979	
				(-1.442)		(-0.458)	
Respective Sales Beta					1.095	0.599	
					(4.966)	(4.082)	
Adjusted R2	0.137	0.085	0.056	0.161	0.442	0.352	0.165

Panel D: Firm-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.033					0.025	0.032
	(11.710)					(9.134)	(4.678)
International Assets		0.036					-0.011
		(9.550)					(-1.446)
International Income			0.030				0.010
			(10.192)				(1.884)
Traded/Non-Traded				1.153		0.825	
				(11.158)		(8.197)	
Respective Sales Beta					0.028	0.034	
					(2.657)	(3.597)	
Adjusted R2	0.126	0.089	0.101	0.008	0.093	0.175	0.132

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.006					-0.006	-0.010
	(-2.782)					(-2.620)	(-1.745)
International Assets		-0.005					-0.003
		(-1.825)					(-0.479)
International Income			-0.003				0.008
			(-1.296)				(1.617)
Traded/Non-Traded				-0.180		-0.074	
				(-2.047)		(-0.773)	
Respective Sales Beta					0.024	0.027	
					(3.294)	(3.379)	
Adjusted R2	0.008	0.004	0.002	0.004	0.010	0.020	0.011

Panel A shows bivariate portfolio-level regression results (reported in Table 2) of stock market betas on firm-level measures of international diversification (and a constant). It also shows multi-variate regression results that show that the various diversification measures are complementary. Panel B shows the same estimates for firm-level data, which are an order of magnitude smaller, a sign that measurement error in the regressors is important. Panels C and D show analogous regression results where the underlying data have been demeaned by country, to control for differences across countries in the interest rate at which future earnings are discounted. These results show that our results are robust to segmented markets. All variables measured in percent. T-ratios computed using robust standard errors as in White (1980) and shown in parentheses.

APPENDIX

Table A2. Cross-Sectional Regressions of the Stock Market Betas on Firm-Level Measures of International Diversification: First Sub-Sample (January 1985 – March 1989).

Panel A: Portfolio-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.123					0.049	0.083
	(6.617)					(2.880)	(1.679)
International Assets		0.221					-0.093
		(7.992)					(-1.649)
International Income			0.172				0.133
			(6.400)				(5.139)
Traded/Non-Traded				8.250		2.101	
				(4.607)		(1.890)	
Respective Sales Beta					0.634	0.161	
					(5.232)	(1.988)	
Adjusted R2	0.708	0.720	0.736	0.552	0.420	0.666	0.696

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	0.181					0.070	-0.059
	(4.051)					(2.523)	(-0.435)
International Assets		0.204					0.126
		(1.631)					(0.603)
International Income			0.235				0.024
			(4.329)				(0.207)
Traded/Non-Traded				-9.056		-0.285	
				(-2.292)		(-0.218)	
Respective Sales Beta					0.794	0.426	
					(6.959)	(4.290)	
Adjusted R2	0.335	0.178	0.470	0.232	0.630	0.526	0.131

Panel B: Firm-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.017					0.012	0.023
	(9.071)					(6.035)	(2.158)
International Assets		0.026					-0.032
		(6.507)					(-2.655)
International Income			0.020				0.032
			(6.533)				(4.206)
Traded/Non-Traded				0.586		0.568	
				(7.017)		(5.584)	
Respective Sales Beta					0.024	0.034	
					(3.166)	(4.399)	
Adjusted R2	0.080	0.071	0.079	0.039	0.011	0.131	0.136

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	0.008					0.010	0.010
	(3.376)					(4.052)	(0.631)
International Assets		0.006					-0.006
		(1.329)					(-0.352)
International Income			0.012				0.002
			(3.995)				(0.245)
Traded/Non-Traded				-0.317		-0.480	
				(-3.179)		(-3.703)	
Respective Sales Beta					0.046	0.049	
					(5.643)	(5.089)	
Adjusted R2	0.013	0.005	0.022	0.009	0.033	0.063	0.011

Panel C: Portfolio-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.172					0.070	0.040
	(11.232)					(5.804)	(0.603)
International Assets		0.233					-0.007
		(5.326)					(-0.120)
International Income			0.182				0.104
			(8.845)				(2.204)
Traded/Non-Traded				6.655		2.349	
				(6.135)		(3.045)	
Respective Sales Beta					0.484	0.128	
					(5.642)	(2.514)	
Adjusted R2	0.875	0.657	0.726	0.724	0.297	0.769	0.635

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	0.073					-0.009	0.101
	(0.632)					(-0.169)	(1.341)
International Assets		0.136					-0.255
		(1.994)					(-2.426)
International Income			0.172				0.202
			(3.038)				(2.043)
Traded/Non-Traded				2.096		1.902	
				(0.450)		(1.171)	
Respective Sales Beta					0.952	0.392	
					(5.189)	(3.197)	
Adjusted R2	0.075	0.149	0.320	0.061	0.492	0.280	0.353

Panel D: Firm-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.020					0.014	0.014
	(8.932)					(6.177)	(1.775)
International Assets		0.025					-0.014
		(5.861)					(-1.589)
International Income			0.020				0.021
			(6.133)				(2.782)
Traded/Non-Traded				0.812		0.694	
				(10.570)		(7.416)	
Respective Sales Beta					0.023	0.041	
					(3.008)	(5.151)	
Adjusted R2	0.092	0.062	0.072	0.084	0.010	0.172	0.107

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	0.000					0.000	0.012
	(0.163)					(0.142)	(1.393)
International Assets		0.005					-0.019
		(1.365)					(-2.147)
International Income			0.009				0.011
			(3.248)				(1.504)
Traded/Non-Traded				-0.029		-0.037	
				(-0.352)		(-0.347)	
Respective Sales Beta					0.027	0.028	
					(3.567)	(2.995)	
Adjusted R2	0.001	0.004	0.014	0.001	0.013	0.017	0.025

Panel A shows bivariate portfolio-level regression results of the stock market betas on firm-level measures of international diversification (and a constant). It also shows multi-variate regression results that show that the various diversification measures are complementary. Panel B shows the same estimates for firm-level data, which are an order of magnitude smaller, a sign that measurement error in the regressors is important. Panels C and D show analogous regression results where the underlying data have been demeaned by country, to control for differences across countries in the interest rate at which future earnings are discounted. These results show that our results are robust to segmented markets. All variables measured in percent. T-ratios computed using robust standard errors as in White (1980) and shown in parentheses.

APPENDIX

Table A3. Cross-Sectional Regressions of the Stock Market Betas on Firm-Level Measures of International Diversification: Second Sub-Sample (April 1989 – July 1993).

Panel A: Portfolio-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.088					0.060	-0.025
	(6.983)					(4.041)	(-0.873)
International Assets		0.114					0.089
		(7.410)					(2.008)
International Income			0.092				0.034
			(8.587)				(1.305)
Traded/Non-Traded				5.593		1.966	
				(4.607)		(2.292)	
Respective Sales Beta					0.430	-0.017	
					(5.232)	(-0.228)	
Adjusted R2	0.731	0.784	0.822	0.552	0.420	0.695	0.706

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.154					-0.076	0.156
	(-1.676)					(-2.579)	(2.105)
International Assets		-0.255					-0.409
		(-4.241)					(-5.002)
International Income			-0.125				0.030
			(-1.706)				(0.414)
Traded/Non-Traded				24.282		6.828	
				(5.920)		(3.625)	
Respective Sales Beta					1.050	0.599	
					(8.941)	(6.942)	
Adjusted R2	0.218	0.474	0.223	0.613	0.781	0.794	0.443

Panel B: Firm-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.012					0.010	0.011
	(9.878)					(7.942)	(2.502)
International Assets		0.020					0.005
		(9.315)					(0.967)
International Income			0.013				0.002
			(8.042)				(0.706)
Traded/Non-Traded				0.397		0.301	
				(7.017)		(5.237)	
Respective Sales Beta					0.016	0.016	
					(3.166)	(2.982)	
Adjusted R2	0.090	0.115	0.093	0.039	0.011	0.118	0.138

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.017					-0.025	0.009
	(-5.352)					(-7.692)	(1.545)
International Assets		-0.045					-0.064
		(-9.675)					(-8.980)
International Income			-0.021				0.005
			(-6.246)				(1.113)
Traded/Non-Traded				0.812		1.256	
				(4.837)		(7.132)	
Respective Sales Beta					0.130	0.135	
					(8.884)	(8.023)	
Adjusted R2	0.021	0.079	0.035	0.019	0.090	0.172	0.088

Panel C: Portfolio-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.114					0.065	0.018
	(16.266)					(6.056)	(0.556)
International Assets		0.154					0.078
		(13.480)					(1.741)
International Income			0.108				0.003
			(6.897)				(0.106)
Traded/Non-Traded				4.511		1.770	
				(6.135)		(3.536)	
Respective Sales Beta					0.328	0.063	
					(5.642)	(1.657)	
Adjusted R2	0.897	0.864	0.714	0.724	0.297	0.858	0.600

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.019					-0.032	0.005
	(-0.149)					(-0.550)	(0.083)
International Assets		0.122					-0.012
		(1.822)					(-0.116)
International Income			0.129				0.082
			(3.924)				(1.623)
Traded/Non-Traded				-2.752		0.537	
				(-0.382)		(0.197)	
Respective Sales Beta					1.207	0.472	
					(4.385)	(3.346)	
Adjusted R2	0.055	0.161	0.266	0.070	0.477	0.236	0.222

Panel D: Firm-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.014					0.011	0.013
	(9.748)					(7.539)	(3.319)
International Assets		0.018					0.002
		(7.756)					(0.460)
International Income			0.011				0.001
			(6.394)				(0.260)
Traded/Non-Traded				0.550		0.439	
				(10.570)		(8.146)	
Respective Sales Beta					0.016	0.018	
					(3.008)	(3.385)	
Adjusted R2	0.103	0.088	0.065	0.084	0.010	0.159	0.113

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.003					-0.004	-0.011
	(-1.192)					(-1.568)	(-1.904)
International Assets		0.005					0.008
		(1.692)					(1.336)
International Income			0.006				0.012
			(3.016)				(2.716)
Traded/Non-Traded				-0.044		0.081	
				(-0.461)		(0.754)	
Respective Sales Beta					0.024	0.026	
					(3.318)	(3.082)	
Adjusted R2	0.002	0.004	0.008	0.001	0.009	0.013	0.020

Panel A shows bivariate portfolio-level regression results of the stock market betas on firm-level measures of international diversification (and a constant). It also shows multi-variate regression results that show that the various diversification measures are complementary. Panel B shows the same estimates for firm-level data, which are an order of magnitude smaller, a sign that measurement error in the regressors is important. Panels C and D show analogous regression results where the underlying data have been demeaned by country, to control for differences across countries in the interest rate at which future earnings are discounted. These results show that our results are robust to segmented markets. All variables measured in percent. T-ratios computed using robust standard errors as in White (1980) and shown in parentheses.

APPENDIX

Table A4. Cross-Sectional Regressions of the Stock Market Betas on Firm-Level Measures of International Diversification: Third Sub-Sample (August 1993 – October 1997).

Panel A: Portfolio-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.079					0.063	-0.006
	(7.286)					(5.700)	(-0.182)
International Assets		0.118					0.056
		(7.669)					(1.868)
International Income			0.087				0.040
			(9.609)				(1.627)
Traded/Non-Traded				5.251		1.581	
				(4.607)		(2.244)	
Respective Sales Beta					0.403	-0.027	
					(5.232)	(-0.565)	
Adjusted R2	0.786	0.799	0.820	0.552	0.420	0.765	0.750

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.123					-0.067	0.310
	(-2.480)					(-4.435)	(3.337)
International Assets		-0.242					-0.608
		(-3.604)					(-5.626)
International Income			-0.156				0.013
			(-2.969)				(0.174)
Traded/Non-Traded				22.158		5.481	
				(11.034)		(5.055)	
Respective Sales Beta					0.628	0.357	
					(8.972)	(6.166)	
Adjusted R2	0.298	0.472	0.380	0.755	0.698	0.820	0.551

Panel B: Firm-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.012					0.010	0.011
	(10.820)					(9.122)	(3.232)
International Assets		0.017					0.002
		(10.225)					(0.578)
International Income			0.013				0.003
			(9.836)				(1.074)
Traded/Non-Traded				0.373		0.268	
				(7.017)		(5.014)	
Respective Sales Beta					0.015	0.011	
					(3.166)	(2.184)	
Adjusted R2	0.107	0.110	0.108	0.039	0.011	0.129	0.141

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.015					-0.020	0.004
	(-6.437)					(-8.579)	(0.609)
International Assets		-0.026					-0.026
		(-7.660)					(-3.847)
International Income			-0.018				-0.006
			(-6.879)				(-1.106)
Traded/Non-Traded				0.516		0.818	
				(4.095)		(6.274)	
Respective Sales Beta					0.107	0.113	
					(9.244)	(8.746)	
Adjusted R2	0.032	0.049	0.041	0.014	0.108	0.191	0.058

Panel C: Portfolio-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.096					0.062	0.029
	(14.790)					(6.895)	(1.049)
International Assets		0.137					0.050
		(10.111)					(1.670)
International Income			0.098				0.018
			(13.527)				(0.728)
Traded/Non-Traded				4.235		1.272	
				(6.135)		(3.262)	
Respective Sales Beta					0.308	0.063	
					(5.642)	(1.974)	
Adjusted R2	0.891	0.889	0.865	0.724	0.297	0.868	0.790

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.025					-0.058	-0.131
	(-0.290)					(-1.392)	(-1.517)
International Assets		-0.016					0.070
		(-0.197)					(1.012)
International Income			-0.005				0.089
			(-0.071)				(1.510)
Traded/Non-Traded				-1.290		1.339	
				(-0.282)		(0.709)	
Respective Sales Beta					0.729	0.485	
					(4.174)	(3.912)	
Adjusted R2	0.061	0.055	0.053	0.063	0.390	0.353	0.174

Panel D: Firm-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.015					0.012	0.014
	(11.044)					(8.747)	(3.983)
International Assets		0.018					-0.000
		(10.003)					(-0.103)
International Income			0.014				0.003
			(9.454)				(0.972)
Traded/Non-Traded				0.517		0.395	
				(10.570)		(7.914)	
Respective Sales Beta					0.015	0.014	
					(3.008)	(2.952)	
Adjusted R2	0.128	0.107	0.109	0.084	0.010	0.177	0.142

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.002					-0.003	-0.011
	(-1.385)					(-1.734)	(-2.471)
International Assets		-0.002					0.005
		(-0.881)					(1.257)
International Income			-0.001				0.005
			(-1.043)				(1.720)
Traded/Non-Traded				-0.047		0.048	
				(-0.723)		(0.641)	
Respective Sales Beta					0.015	0.020	
					(2.852)	(3.039)	
Adjusted R2	0.003	0.002	0.002	0.001	0.007	0.015	0.012

Panel A shows bivariate portfolio-level regression results of the stock market betas on firm-level measures of international diversification (and a constant). It also shows multi-variate regression results that show that the various diversification measures are complementary. Panel B shows the same estimates for firm-level data, which are an order of magnitude smaller, a sign that measurement error in the regressors is important. Panels C and D show analogous regression results where the underlying data have been demeaned by country, to control for differences across countries in the interest rate at which future earnings are discounted. These results show that our results are robust to segmented markets. All variables measured in percent. T-ratios computed using robust standard errors as in White (1980) and shown in parentheses.

APPENDIX

Table A5. Cross-Sectional Regressions of the Stock Market Betas on Firm-Level Measures of International Diversification: Fourth Sub-Sample (November 1997 – February 2002).

Panel A: Portfolio-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.280					0.211	0.250
	(9.378)					(6.268)	(2.753)
International Assets		0.443					-0.171
		(7.211)					(-1.908)
International Income			0.373				0.131
			(11.861)				(1.426)
Traded/Non-Traded				18.755		4.422	
				(4.607)		(1.436)	
Respective Sales Beta					1.440	-0.052	
					(5.232)	(-0.221)	
Adjusted R2	0.825	0.729	0.881	0.552	0.420	0.732	0.819

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.191					-0.099	-0.200
	(-5.604)					(-5.740)	(-2.396)
International Assets		-0.270					0.078
		(-3.212)					(0.502)
International Income			-0.168				0.063
			(-1.826)				(0.793)
Traded/Non-Traded				13.827		3.897	
				(4.240)		(2.795)	
Respective Sales Beta					0.911	0.381	
					(8.159)	(4.222)	
Adjusted R2	0.517	0.382	0.239	0.363	0.789	0.764	0.281

Panel B: Firm-Level Regressions

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.041					0.035	0.060
	(10.879)					(9.125)	(6.057)
International Assets		0.044					-0.034
		(7.516)					(-2.776)
International Income			0.044				0.012
			(9.460)				(1.440)
Traded/Non-Traded				1.333		0.878	
				(7.017)		(4.549)	
Respective Sales Beta					0.053	0.040	
					(3.166)	(2.352)	
Adjusted R2	0.104	0.054	0.094	0.039	0.011	0.124	0.144

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.015					-0.019	-0.017
	(-6.453)					(-8.061)	(-3.220)
International Assets		-0.013					0.007
		(-3.625)					(0.976)
International Income			-0.009				0.002
			(-3.342)				(0.385)
Traded/Non-Traded				0.198		0.455	
				(1.519)		(3.223)	
Respective Sales Beta					0.088	0.094	
					(7.842)	(7.613)	
Adjusted R2	0.030	0.013	0.011	0.003	0.069	0.126	0.022

Panel C: Portfolio-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.322					0.225	0.270
	(12.468)					(6.905)	(3.657)
International Assets		0.518					-0.117
		(7.795)					(-1.092)
International Income			0.386				0.082
			(12.435)				(1.141)
Traded/Non-Traded				15.127		2.279	
				(6.135)		(1.161)	
Respective Sales Beta					1.100	0.316	
					(5.642)	(3.138)	
Adjusted R2	0.896	0.826	0.889	0.724	0.297	0.839	0.808

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.118					-0.028	-0.128
	(-0.911)					(-0.713)	(-1.281)
International Assets		-0.087					-0.064
		(-0.541)					(-0.542)
International Income			0.031				0.192
			(0.300)				(2.226)
Traded/Non-Traded				-0.441		0.098	
				(-0.052)		(0.033)	
Respective Sales Beta					1.147	0.562	
					(5.131)	(3.724)	
Adjusted R2	0.121	0.080	0.056	0.053	0.440	0.333	0.177

Panel D: Firm-Level Regressions Demeaned

	Global Stock Market Betas						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
International Sales	0.050					0.039	0.061
	(11.232)					(8.837)	(6.484)
International Assets		0.048					-0.037
		(7.645)					(-2.930)
International Income			0.046				0.015
			(9.328)				(1.830)
Traded/Non-Traded				1.846		1.310	
				(10.570)		(7.281)	
Respective Sales Beta					0.053	0.061	
					(3.008)	(3.639)	
Adjusted R2	0.126	0.059	0.097	0.084	0.010	0.171	0.150

	Country Stock Market Betas						
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
International Sales	-0.004					-0.005	-0.006
	(-1.645)					(-1.996)	(-1.228)
International Assets		-0.004					-0.005
		(-1.281)					(-0.827)
International Income			0.000				0.008
			(0.170)				(1.875)
Traded/Non-Traded				-0.042		0.051	
				(-0.432)		(0.463)	
Respective Sales Beta					0.028	0.035	
					(3.340)	(3.696)	
Adjusted R2	0.004	0.003	0.001	0.001	0.011	0.021	0.008

Panel A shows bivariate portfolio-level regression results of the stock market betas on firm-level measures of international diversification (and a constant). It also shows multi-variate regression results that show that the various diversification measures are complementary. Panel B shows the same estimates for firm-level data, which are an order of magnitude smaller, a sign that measurement error in the regressors is important. Panels C and D show analogous regression results where the underlying data have been demeaned by country, to control for differences across countries in the interest rate at which future earnings are discounted. These results show that our results are robust to segmented markets. All variables measured in percent. T-ratios computed using robust standard errors as in White (1980) and shown in parentheses.