Firm-Level Evidence on International Stock Market Comovement

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July 2004

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JEL Classification Numbers: G11, G15

Keywords: Diversification; Risk; International financial markets; Industrial structure.

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We explore the link between international stock market comovement and the extent to which firms operate globally. Using stock returns and balance sheet data for companies in 20 countries, we estimate a factor model that decomposes stock returns into global, country- and industry-specific shocks. We find a large and statistically significant link: 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 country-specific shocks by 1.5 percent. We also find that this link has grown stronger over time since the mid-1980s.

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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 (2000) 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 World Investment Report, cross-border M&A as a share of world GDP rose from around 0.5 percent in the mid-1990s to around 2.5 percent in 1999. With this rise 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. As Brooks and Del Negro (forthcoming) show, 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 (see also Longin and Solnik (1995) and Goetzmann et al. (forthcoming)).

We investigate the empirical link between comovement in international stock returns and the extent to which firms operate across countries. Using data for 1,239 firms in 20 developed and emerging markets from 1985 to 2002, we estimate a latent factor model for international stock returns, which yields firm-level exposures on (i) a global factor common to all stocks; (ii) country-specific factors that capture common variation within countries; (iii) industry-specific factors that capture common variation within industries; and (iv) a component that captures idiosyncratic variation in each stock. 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. 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 shocks account for more return variation for stocks where the underlying company is highly international? Do country-specific shocks account for less return variation for such stocks? And if there is such a link, is it economically 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.[1] 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. These measures have an important shortcoming: they fail to capture the importance of exports as a channel through which firms operate across countries. 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 both through exports and through sales from operations abroad. They also capture foreign exposure of firms that are purely domestic in terms of sales, but are nonetheless exposed to global shocks through foreign competition. 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 operates globally, 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 economically and 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. Finally, consistent with the recent wave of cross-border M&A, we find that the economic and statistical importance of the link between return comovement and the extent to which firms operate globally has grown dramatically in recent years.

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. 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:

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

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 widely in the

Aribitrage Pricing Theory literature. However, unlike that literature, our focus is on modeling covariation in stock returns, rather than on modeling excess returns. We therefore model excess returns in the simplest possible way: μ_i is simply the average excess return on stock i over the sample. This means that we demean excess returns before estimating our model.

Our main innovation is in how we model comovement. Unlike the Asset Pricing Theory literature, we decompose returns into factors that are "identified." The identification arises from the fact that we impose a set of zero restrictions 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-specific or industry-specific factors.[2]

Our approach bridges two extremes in the factor model literature. One extreme, see Cho et al. (1986) and Heston et al. (1995), uses latent factor models to decompose returns into common shocks. This approach has the advantage that it captures a substantial amount of covariation, but since the factors are unidentified, it yields little information on their economic interpretation. The other extreme, see Chen et al. (1986), relates stock returns to pre-specified variables. This approach has the advantage that the factors are identified, but their choice is somewhat arbitrary. Our approach is grounded in the latent factor approach, but imposes restrictions on the variance-covariance matrix such that the latent factors are identified as global, country, industry and other factors.

We use the EM algorithm to obtain maximum likelihood estimates of the betas in model (1), as in Lehman and Modest (1985). In order to estimate (1) via maximum likelihood, we make the following distributional assumptions: i) both the factors and the idiosyncratic shocks are normally distributed independent and identically distributed (*i.i.d.)* random variables, uncorrelated with each other:

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

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

$$E[f_t^k f_t^m] = 0 \text{ for } k \neq m,\ E[f_t^k \varepsilon_{nt}] = 0 \text{ all } k,n \tag{2.3}$$

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

$$E[\varepsilon_{nt}\varepsilon_{mt}] = 0 \tag{3}$$

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:

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

where c and i denote the country and the industry that stock n belongs to. This variance decomposition is exact—it makes use of assumption (2.3)—so that in that the impact of country shocks can be perfectly separated from that of industry shocks.

Brooks and Del Negro (2002) develop and extensively describe the methodology used to estimate this model for large cross sections. In this paper, we use their approach to investigate an economically meaningful question: is there a link between stock market comovement and the degree to which firms operate internationally?

3. The Data

We use data constructed by Brooks and Del Negro (forthcoming). Their data cover monthly U.S. dollar-denominated stock returns from January 1985 to February 2002 for 9,679 companies.[3] We download the country and industry affiliation for each stock from Datastream International. With regard to industry affiliation, Datastream has six levels of disaggregation. At each level, there are more disaggregated industry definitions, up to the most disaggregated classification, level 6. We report results based on level 4. The results are qualitatively unchanged using higher levels of disaggregation.

Our sample is a subset of that in Brooks and Del Negro (forthcoming) because we use data only for those firms for which a continuous series for U.S. dollar-denominated sales is available from Worldscope. 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. Table 1 in Appendix I describes the country and industry composition of our data and compares it to the original sample in Brooks and Del Negro (forthcoming). It gives a similar breakdown from the S&P Stock Market Factbook (2001). This comparison shows that coverage *across* countries and industries is reasonably representative, although balancing shrinks coverage *within* countries and industries.

We follow common practice in the literature, see Ferson and Harvey (1994) and Heston et al. (1995), and estimate our model for excess returns. We compute these as the difference between individual stock returns and the return on a three month U.S. Treasury Bill, which we obtain from Datastream International. Although our balanced sample covers fewer stocks than the original data by Brooks and Del Negro (forthcoming), Table 2 in Appendix I shows that our sample is comparable in terms of the means and standard deviations of the equal-weighted excess return across all stocks. In particular, there is little indication of a systematic bias in the standard deviation of excess returns, which is important because we focus on return variability and comovement.

Following Griffin and Karolyi (1998) and Griffin and Stulz (2001), we also distinguish between traded and non-traded goods industries. In this dimension, our dataset has 611 traded and 628 non-traded goods firms. 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.

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. 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. Table 3 in Appendix I gives the exact variable definitions for the Worldscope data we use.

4. The Results

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". 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 for time-variation in the relative importance of the different factors (global, country and industry).

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. 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. One advantage of this approach is that it exploits firm-level information and hence takes firm-level heterogeneity into account. However, an important disadvantage is that these variables only capture operations of foreign subsidiaries. They do not account for exports. We provide an additional approach to measuring the extent to which firms are international. 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. 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 may also capture international exposure via export sales, an additional channel through which firms are exposed to global shocks.

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). Table 1 shows that, both for stock returns (Panel A) and sales growth (Panel B), the global factor is more important and the country factor less important for firms in the 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 (Panel A), but not for sales growth (Panel B) where the global factor is less important for traded than for non-traded goods firms. Finally, we rank firms by their global and country sales betas. Our variance decompositions for stock returns (Panel A) point to some inaccuracy in the measurement of the global sales betas: the global factor is on average more important for the bottom quartile (low global sales betas) than for the top quartile (high global sales betas). Similarly, country-specific shocks are more important on average for the top quartile than for the bottom quartile. However, measurement of the country sales betas is more accurate: firms with high country sales betas have a lower exposure to the global stock market factor and a higher exposure to country-specific stock market shocks. The variance decompositions for sales growth with respect to the global and country sales betas (Panel B) are as expected.

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.[4] We focus 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 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.[5] 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.[6]

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—leads is associated with an increase in stock market exposure to global and country shocks. More surprising, our estimates are highly significant. Most important, though, the effects are economically large: 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. Again, the impact of real-side exposure on stock market exposure is therefore estimated to be large.

We also run firm-level cross-sectional regressions, without the within-portfolio averaging (the results are shown in the Appendix II). 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 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

We now modify our model to allow the importance of global, country and industry shocks in international returns to change over time, motivated by Goetzmann et al. (forthcoming) and Longin and Solnik (1995) who report that comovement in international equity returns is time varying and L'Her et al. (2002) who find that country shocks have fallen in importance in recent years. We use this expanded approach to 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 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 $t_{l-1}+1 \leq t \leq t_l$. 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.[7]

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. Importantly, this pattern is not the same across all companies, as can be gauged from the comparison of the variance decompositions for high and low international sales firms. 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 this 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, along with the t-ratio and the adjusted r-squared. We again use White (1980) robust standard errors. 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. Meanwhile, the coefficient on the international sales ratio in the country beta regressions has switched from 0.181 in the first 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 most recent 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, because the cross-country dimension of the data allows us to use regression analysis to link the evolution of these factors 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 scale 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 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 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 respective 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 international sales ratio, international asset ratio, international income ratio, 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. If measurement error in the regressors is not too correlated within each portfolio, this averaging should considerably reduce the bias because of the law of large numbers. We find that our portfolio-level regressions yield an estimate of the cross-sectional link an order of magnitude larger than that for the firm-level regressions reported in the appendix, a sign that measurement error in the regressors is quantitatively important.

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 $\mathrm{Var}(R_{nt}) = (\beta_n^{G})^2\, \zeta_l^{G} + (\beta_{nc}^{C})^2\, \zeta_l^{C} + (\beta_{ni}^{I})^2\, \zeta_l^{I} + \sigma_n^{2}$, 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. The number and timing of sub-periods is somewhat arbitrary. We therefore allowed for two through eight equally-spaced sub-periods and systematically tested 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 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. 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. If the measurement error in the regressors is not too correlated within each portfolio, this averaging should reduce the bias because of the law of large numbers. 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 – 1997:1	-0.0114**	0.7543	1.0476	-0.2878**	-0.0337	0.0004
1997:11 – 2002	-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.

APPENDIX I

Table 1. Comparing Our Balanced Data to Brooks and Del Negro (forthcoming) and Reality

	Balanced Sample			Brooks and Del Negro (forthcoming)			S&P Stock Market Factbook 2001		
	No. of Firms	Mkt Cap (Bill	Share (%)	No. of Firms	Mkt Cap (Bill.	Share (%)	No. of Firms	Mkt Cap (Bill.	Share (%)
World	1239	11187328	100.00	8969	31486	100.00	37188	31852	100.00
United States	376	6671900	59.64	1309	15577	49.47	7524	15104	47.42
United Kingdom	150	808743	7.23	986	3114	9.89	1904	2577	8.09
France	14	187281	1.67	363	1438	4.57	808	1447	4.54
Germany	25	315951	2.82	404	1043	3.31	1022	1270	3.99
Italy	8	81593	0.73	219	750	2.38	291	768	2.41
Japan	467	1974602	17.65	1189	3052	9.69	2561	3157	9.91
Canada	57	358991	3.21	424	792	2.52	3977	841	2.64
Australia	26	143472	1.28	207	323	1.02	1330	373	1.17
Austria	4	3141	0.03	82	33	0.11	97	30	0.09
Belgium	6	15486	0.14	127	131	0.41	174	182	0.57
Denmark	9	19090	0.17	109	116	0.37	225	108	0.34
Hong Kong	21	88806	0.79	208	669	2.13	779	623	1.96
Ireland	10	31546	0.28	79	81	0.26	76	82	0.26
Netherlands	8	199974	1.79	183	688	2.18	234	640	2.01
Norway	5	16862	0.15	103	69	0.22	191	65	0.20
Sweden	11	46761	0.42	145	305	0.97	292	328	1.03
Switzerland	7	167945	1.50	185	830	2.64	252	792	2.49
Korea	0	0	0.00	168	136	0.43	1308	172	0.54
Malaysia	8	6641	0.06	168	97	0.31	795	117	0.37
Singapore	14	27467	0.25	164	164	0.52	418	153	0.48
South Africa	13	21074	0.19	189	153	0.49	616	205	0.64
Philippines	0	0	0.00	71	24	0.08	230	52	0.16
Luxembourg	0	0	0.00	31	41	0.13	54	34	0.11
New Zealand	0	0	0.00	69	23	0.07	144	19	0.06
Spain	0	0	0.00	135	387	1.23	1019	504	1.58
Finland	0	0	0.00	106	250	0.79	154	294	0.92
Thailand	0	0	0.00	78	29	0.09	381	29	0.09
Taiwan	0	0	0.00	165	270	0.86	531	248	0.78
Argentina	0	0	0.00	73	51	0.16	127	166	0.52
Greece	0	0	0.00	109	86	0.27	329	111	0.35
Mexico	0	0	0.00	117	106	0.34	179	125	0.39
Portugal	0	0	0.00	59	76	0.24	109	61	0.19
Turkey	0	0	0.00	72	223	0.71	315	70	0.22
Chile	0	0	0.00	92	54	0.17	258	60	0.19
Brazil	0	0	0.00	189	102	0.32	459	226	0.71
India	0	0	0.00	153	110	0.35	5937	148	0.46
Indonesia	0	0	0.00	77	6	0.02	290	27	0.08
China	0	0	0.00	152	48	0.15	1086	581	1.82
Peru	0	0	0.00	60	4	0.01	230	11	0.03
Poland	0	0	0.00	60	18	0.06	225	31	0.10
Colombia	0	0	0.00	31	3	0.01	126	10	0.03
Czech Republic	0	0	0.00	59	13	0.04	131	11	0.03
Basic Industries	210	664141	5.94	1059	1254	3.98			
General Industries	217	1620263	14.48	1140	2838	9.01			
Cyclical Consumer G	87	472653	4.22	457	853	2.71			
Non-Cyclical Consur	162	2784319	24.89	990	4558	14.48			
Cyclical Services	203	1346887	12.04	1455	3724	11.83			
Non-Cyclical Service	29	701701	6.27	376	2891	9.18			
Itilities	69	434491	3.88	345	1107	3.52			
Information Technolo	58	1167270	10.43	815	4933	15.67			
Financials	151	1298311	11.61	1925	7414	23.55			
Resource Industries	53	697292	6.23	407	1915	6.08			

Table 1 shows by country and by Datastream International level 3 industry the number of stocks, the market capitalization in billions of U.S. dollars, and the capitalization share in percent of the sample total as of December 2000 for the balanced panel used in this paper, for the full sample of Brooks and Del Negro (forthcoming), and the S&P Stock Market 2001 Factbook.

APPENDIX I

Table 2. Excess Returns in Our Balanced Data and Brooks and Del Negro (forthcoming): Descriptive Statistics for Equal-Weighted Excess Return Across Stocks (in % per month).

	Balanced Sample	Brooks and Del Negro (forthcoming)
Time-Series Mean	0.30	0.30
Standard Deviation	4.38	4.32

Table 2 shows the mean and standard deviation of the equal-weighted excess return across all stocks in our balanced sample. It shows the same descriptive statistics for the dataset by Brooks and Del Negro (forthcoming). The comparison shows that our sample is comparable to the original data in terms of the means and standard deviations of international excess returns. In particular, there is little indication of a systematic bias in the standard deviation of excess returns, which is important because we focus on return variability and comovement.

APPENDIX I

Table 3. Worldscope Variable Definitions

Variable	**Worldscope Code**	**Definition**
Total Sales in U.S. Dollars	SalesUSD	Net sales or revenues of a company converted to U.S. dollars using the fiscal year end exchange rate.
International Sales	ForeignSalesPctSales	Sales generated by operations in foreign countries in percent of total sales (omits export sales).
International Assets	ForeignAssetsPctTotalAssets	Total or identifiable assets of foreign operations before adjustments and eliminations, in percent of total assets.
International Income	ForeignIncomePctTotalIncome	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.

APPENDIX II

Table 1. 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 multivariate 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 II

Table 2. 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 (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 II

Table 3. 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 (reported in Table 2) of stock market betas on firm-level measures of international diversification (and a constant). It also shows multivariate 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 II

Table 4. 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 (reported in Table 2) of stock market betas on firm-level measures of international diversification (and a constant). It also shows multivariate 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 II

Table 5. 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 (reported in Table 2) of stock market betas on firm-level measures of international diversification (and a constant). It also shows multivariate 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.

[1] Diermeier and Solnik (2001) use foreign revenues as their measure of international operations of companies. They note that this measure includes foreign and export sales, when such data are available.

[2] In contrast, Diermeier and Solnik (2001) note that their domestic factor is correlated with international factors, making their results hard to interpret. 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 asymptotically efficient while, to our knowledge, there is no evidence that their estimator enjoys such properties.

[3] Using U.S. dollar-denominated returns has the effect of lumping nominal currency influences into country-specific shocks in international stock returns. However, Griffin and Stulz (2001) and Heston and Rouwenhorst (1994) find that exchange rates play only a minor role in explaining international return variation.

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

[5] A difference with Fama and MacBeth is that they sort firms according to their *independent* variable. Thus, the betas in their sorted portfolio are still measured with error. Hence, 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.

[6] 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 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.

[7] An alternative approach would be to estimate our original model for different sub-periods of the data. However, because of the large number of parameters we estimate, this severely reduces the efficiency of our estimates.