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Stock Market Co-Movement at the Disaggregated Level: Individual Stock Integration

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Abstract

This paper investigates the international stock market integration phenomenon at the disaggregated level. By using Geweke (1982) feedback measures, we measure the world market integration levels of individual companies. The results confirm the presence of individual stock integration since each company is integrated with the world market at different levels of strength. By using firm-specific and industry-level variables, we then explain the year-to-year changes in integration levels to identify the determinants of "individual stock integration". The results of panel data analysis show that it is possible to explain those differences at individual integration levels with both company-specific variables and industry performance-related

1. Introduction

Markowitz (1952) indicates that maximizing a portfolio return by minimizing a portfolio risk can be successfully done by forming a portfolio with low correlated assets. Grubel (1968) extends this concept to the international markets and suggests that the same kind of low-risk portfolios can be formed by diversifying internationally as long as national stock markets are not correlated or do exhibit a low level of co-movement. By following this main principle, international stock market integration has traditionally been widely studied at the country level. Some scholars[1] have investigated the aggregate-level integrations between national stock markets and, in cases where two national markets demonstrate strong interrelationships within the same day or across days, they have concluded that diversifying a portfolio between those countries does not provide additional advantages to investors, such as reduced risk or increased returns.

However, these scholars have recently started to ask whether the evidence of country-level integration necessarily implies the integration of all equity market segments within countries. In other words, they have undertaken to determine whether an integrated market means complete integration of all the segments or groups of companies without any exception.[2] Empirical results commonly suggest that cross-country stock market correlations vary for different segments and industry sectors. Stocks that have overseas listings or international sales, for instance, tend to display greater co-movements than stocks that are not international.[3] This body of empirical work thus provides evidence regarding the existence of partial segmentation even though in an overall assessment a given market is integrated with other national markets.

[1] See Voronkova (2004), Egert and Kočenda (2007) and Kucukcolak (2008), among others.

[2] Examples of recent empirical studies include the works of Carrieri *et al.* (2004), Claessens and Schmukler (2007) and Lucey and Zhang (2010).

[3] See Federov and Sarkissian (2000).

Although the current empirical literature offers useful insights on the semi-disaggregated level of integration, it does not provide a contribution on how extensive stock market integration is and how deep it reaches at the fully disaggregated level. For instance, those studies do not tell how many firms from a specific country are actively participating in the integration process (Claessens and Schmukler, 2007). In this paper, we complement the existing literature by studying the extent of the disaggregated level of international stock market integration and analyzing firm-level participation in that process.

With respect to this, we introduce the concept of "individual stock integration" and define it as co-movement of a specific stock with a foreign national stock market. Our hypothesis is that the extent of stock market integration may depend upon certain microeconomic factors that in fact cause every individual stock to be integrated with international markets at different levels of strength. To investigate this hypothesis, we employ a two-step procedure. By using Geweke feedback measures, we first examine how co-movement in daily returns for a given individual stock/world market pair varies over time. Second, we seek an answer for why this interdependence varies for different pairs. For this step, we incorporate a set of microeconomic variables which are potentially the most relevant sources of variation in the degree of individual integration in a panel data model. We are thereby able to address the following important questions: Does the integrated stock market mean that all firms on that specific stock market are integrated with the world market at the same level? How extensive is this firm-level integration process? Which firm-specific and industry-level variables significantly affect the degree of individual stock integration?

The remainder of the paper is organized as follows: Section 2 presents the models used to estimate the Geweke feedback measures and individual stock integration. Section 3 discusses the data and Section 4 provides analysis of the estimated Geweke measures. Section 5 presents the regression models that describe the microeconomic determinants of individual stock integration and robustness tests. Finally, Section 6 summarizes and concludes the paper.

2. Geweke Feedback Measures and Individual Stock Integration Model

2.1 Geweke Feedback Measures

Geweke feedback measures are based on log likelihood ratio statistics and provide cardinal measures of the degree of co-movements. Therefore "an increase (decrease) in a Geweke measure, from year to year, reflects the magnitude of increase (decrease) of stock market integration for that pair of countries" (Johnson and Soenen, 2009, p. 209). The measures are non-negative and zero only when feedback (causality) between series is absent (Calderon and Liu, 2002).

To obtain the feedback measures, Geweke (1982) first considers two types of linear projections of stationary time series x_t and y_t, as suggested for Granger causality:

The restricted form where x_t depends only on its own past return:

$$x_t = \sum_{i=1}^{\infty} a_{1i} x_{t-i} + u_{1t}, \qquad E\left(u_{1t}\right) = 0 \quad \text{and} \quad Var\left(u_{1t}\right) = \sigma_{u_1}^2 \tag{1}$$

The unrestricted form where x_t depends on both its own past return and the past return of the variable y_t :

$$x_t = \sum_{i=1}^{\infty} a_{2i} x_{t-i} + \sum_{i=1}^{\infty} b_{2i} y_{t-i} + u_{2t}, \qquad E(u_{2t}) = 0 \text{ and } Var(u_{2t}) = \sigma_{u_2}^2 \tag{2}$$

The value of $\sigma_{u_1}^2$ measures the accuracy of the autoregressive prediction of x_t based on its previous values, whereas the value of $\sigma_{u_2}^2$ represents the accuracy of predicting the present value of x_t based on the previous values of both x_t and y_t.

The same linear projections can be done for the variable *y* too:

The restricted form, where y_t depends only on its own past return:

$$y_t = \sum_{i=1}^{\infty} c_{1i} y_{t-i} + v_{1t}, \qquad E(v_{1t}) = 0 \text{ and } Var(v_{1t}) = \sigma_{v_1}^2 \tag{3}$$

The unrestricted form, where y_t depends on both its own past return and the past return of the variable x_t ;

$$y_t = \sum_{i=1}^{\infty} c_{2i} y_{t-i} + \sum_{i=1}^{\infty} d_{2i} x_{t-i} + v_{2t}, \qquad E(v_{2t}) = 0 \text{ and } Var(v_{2t}) = \sigma_{v_2}^2 \tag{4}$$

The value of $\sigma_{v_1}^2$ measures the accuracy of the autoregressive prediction of y_t based on its previous values, whereas the value of $\sigma_{v_2}^2$ represents the accuracy of predicting the present value of y_t based on the previous values of both x_t and y_t.

Next, Geweke (1982) jointly considers equations (1) and (3) and equations (2) and (4) to obtain the systems of Seemingly Unrelated Regressions (SUR) and to get the following Geweke measures:

$$\begin{aligned} F_{y\to x} &= \ln\left[\frac{\sigma_{u_1}^2}{\sigma_{u_2}^2}\right] \\ F_{x\to y} &= \ln\left[\frac{\sigma_{v_1}^2}{\sigma_{v_2}^2}\right] \end{aligned} \tag{5}$$

The first measure gives the magnitude of the causality from *y* to *x*, while the second measure gives the magnitude of the causality from *x* to *y*. If *y* does not Granger-cause *x*, the first measure should be zero and $b_{2i} = 0$ for all *i* in equation (2), and if *x* does not Granger-cause *y*, the second measure should equal zero and $d_{2i} = 0$ for all *i* in equation (4).

The contemporaneous relationship between the two series can be computed with a similar process by using the contemporaneous covariance matrix $\left(\sum\right)$:

$$Cov(u_2 v_2) = \begin{pmatrix} \sigma_{u_2}^2 & \sigma_{u_2 v_2} \\ \sigma_{u_2 v_2} & \sigma_{v_2}^2 \end{pmatrix} \tag{6}$$

Assuming u_2 and v_2 are serially uncorrelated, the contemporaneous Geweke feedback measure can be calculated as follows:

$$F_{x.y} = \ln\left(\frac{\sigma_{u_1}^2 * \sigma_{v_1}^2}{|\Sigma|} \right) \tag{7}$$

2.2 Individual Stock Integration Model

In the model, we consider the dynamic interrelationships between daily returns of the individual stocks from the sample countries, r_{1t}, and the MSCI World Index, r_{2t}. We assume that each individual company's daily stock return varies over time in a manner that reflects sensitivity to i) sources of information that also influence the world market, ii) sources of information that do not affect the world market, and iii) noise.[4] We specify the following three null hypotheses:

H$_1$: There is no contemporaneous relationship between r_{1t} and r_{2t} on the same day.
H$_2$: The r_{2t} does not lead r_{1t} across days.
H$_3$: The r_{1t} does not lead r_{2t} across days.

These interdependences can be modeled with the following system of two seemingly unrelated regressions:

$$r_{1t} = a_0 + \sum_{i=1}^{M_2} a_i r_{2t-i} + \sum_{i=1}^{M_1} b_i r_{1t-i} + \varepsilon_{1t} \tag{8}$$

$$r_{2t} = c_0 + \sum_{i=1}^{M_2} c_i r_{1t-i} + \sum_{i=1}^{M_1} d_i r_{2t-i} + \varepsilon_{2t} \tag{9}$$

with $Cov\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} = \begin{bmatrix} \sigma_{\varepsilon_1}^2 & \sigma_{\varepsilon_1 \varepsilon_2} \\ \sigma_{\varepsilon_1 \varepsilon_2} & \sigma_{\varepsilon 2}^2 \end{bmatrix} = Y$

where r_{1t} is the return of an individual company and r_{2t} is the return of the world market. The coefficient a_i reflects how the world market leads the individual stock, b_i displays how the the individual stock's own past return affects its return, c_i reflects how the individual stock leads the world market, d_i displays how the world market's own past return affects the its return, and ε_{1t} and ε_{2t} are error terms.

[4] "The extent of integration between a given pair of national equity markets should, theoretically, depend upon the sensitivity of each market to common sources of information, (i), and in relation to the variation within each market that is not systematically associated with the other market, (ii) and (iii)" (Bracker *et al.*, 1999, p. 3).

To be able to calculate the Geweke feedback measures, we need to estimate the restricted forms of the equations that are constructed only with the past returns of the variables.

$$r_{1t} = a_0^{'} + \sum_{i=1}^{M1} b_i^{'} r_{1t-i} + \mu_{1t}, \qquad Var\left(\mu_{1t}\right) = \sigma_{\mu 1}^2 \tag{10}$$

$$r_{2t} = c_0^{'} + \sum_{i=1}^{M1} d_i^{'} r_{2t-i} + \mu_{2t}, \qquad Var\left(\mu_{2t}\right) = \sigma_{\mu 2}^2 \tag{11}$$

with $Cov\left(\mu_{1t}, \mu_{2t}\right) = 0$

We can now investigate hypotheses H_1 through H_3 with the following Geweke measures of feedback statistics:

$$\begin{aligned} (n)\hat{F}_{1.2} &= (n)\ln\left[\left(\hat{\sigma}_{\mu 1}^2 * \hat{\sigma}_{\mu 2}^2\right) / \left|\hat{Y}\right|\right] \sim \chi_1^2 && \text{under } H_1 \\ (n)\hat{F}_{2\to 1} &= (n)\ln\left(\hat{\sigma}_{\mu 1}^2 / \hat{\sigma}_{\varepsilon 1}^2\right) \sim \chi_{M_2}^2 && \text{under } H_2 \\ (n)\hat{F}_{1\to 2} &= (n)\ln\left(\hat{\sigma}_{\mu 2}^2 / \hat{\sigma}_{\varepsilon 2}^2\right) \sim \chi_{M_2}^2 && \text{under } H_3 \end{aligned} \tag{12}$$

where n is the sample size and $\left|\hat{Y}\right|$ is the determinant of $\hat{Y}$; each measure has an asymptotic χ^2 distribution under each respective null hypothesis.[5]

The Geweke feedback measures are simply the log likelihood ratio statistics. Since the asymptotic distribution of each Geweke feedback measure is known under the alternative hypothesis that feedback is present, this approach enables use of the Wald *F*-test. In this case, as Kawaller *et al.* (1993) suggest, the asymptotic distribution of each feedback measure under its alternative hypothesis is approximately non-central chi-square as follows:

$$(n)\hat{F}_{1.2} \sim \chi^{'2}\left(1; (n)F_{1.2}\right) \tag{13}$$

$$(n)\hat{F}_{2\to 1} \sim \chi^{'2}\left(M_2; (n)F_{2\to 1}\right) \tag{14}$$

$$(n)\hat{F}_{1\to 2} \sim \chi^{'2}\left(M_2; (n)F_{1\to 2}\right) \tag{15}$$

Any non-central chi-square statistic can be manipulated with a nonlinear monotonic transformation. Geweke (1982) suggests the following transformation to get a normal approximate distribution:

If $X \sim \chi^{'2}\left(r;\lambda\right)$, where r is the degree of freedom and λ is the non-centrality parameter, then

$$\left(X - (r-1)/3\right)^{1/2} \sim N\left[\lambda + \left(2r+1\right)^{1/2}, 1\right] \tag{16}$$

[5] The Geweke measures are always positive (or equal zero in the case of no feedback) since the numerator is always larger than the denominator due to the increasing number of regressors, i.e. decreasing variance of errors.

3. Data

In order to be able to investigate the co-movement $\left(\hat{F}_{1.2}\right)$ in daily returns of individual stocks and the world market (MSCI World Index), we collect daily data of 355 individual companies from emerging European countries (classified according to Morgan Stanley's Capital International). Although we intended to construct our data set with the daily closing prices of every available stock from January 1, 1994 to December 31, 2014 from the main indices of those countries' stock markets—the PX of the Prague Stock Exchange (the Czech Republic), the BUX of the Budapest Stock Exchange (Hungary), the WIG20 of the Warsaw Stock Exchange (Poland), the RTS Index of the Russian Trading System Stock Exchange (Russia) and the XU30 of the Istanbul Stock Exchange (Turkey)—we are faced with two major issues. The first one is the availability of data. Although most of the emerging European countries started to develop between the late 1990s and the mid-2000s, balance sheet data are not available for a significant number of the companies. Second, there is significantly thin trading and a constant price problem especially during the very early years of the stock exchanges. Jorion and Schwartz (1986) clearly express that the thin-trading phenomenon may lead to false rejection of significant integration. We cleanse our data according to these problems. We exclude companies that do not have sufficient balance sheet data or that have unchanged stock prices for at least 30 consecutive days or zero returns for at least 120 days in a single year.[6] And we include only the companies that are listed in the stock indices for at least three consecutive years, as we need at least three annual Geweke feedback measures to investigate the annual changes in the integration levels.

The daily stock market returns are calculated by taking the first difference of the natural log of the daily closing prices:

$$R_{i,t} = \ln\left(I_{i,t}\right) - \ln\left(I_{i,t-1}\right) \tag{17}$$

In the second step, company characteristics and industry performance-based variables are employed as independent variables to explain the changes in the Geweke feedback measures. In the first model, the dependent variable side of the panel data set is constructed by pooling observations on a cross-section of the annual Geweke contemporaneous feedback measure $\left(\hat{F}_{1.2}\right)$ of all 355 companies over the time period from 1994 to 2014, while size, book-to-market ratio, price-to-earnings ratio, price-to-cash flow ratio, current ratio and gearing ratio constitute the explanatory variable side of the first panel model. In the second model, the following industry performance-based variables (along with the firm-specific variables) are included in the group

[6] Jorion and Schwartz (1986) empirically show that thin trading causes a bias in integration vs. segmentation studies and they conclude that "thin trading is important enough to warrant formal incorporation into the empirical methodology, because this phenomenon may lead us to falsely reject integration" (p. 608). For that reason, they first weed out companies with less than 60 months of consecutive data and then replace the single regression with a multiple regression with one lead and one lag added. On the other hand, Serra (2000) removes all the firms that do not show any price changes for ten or more consecutive weeks. Therefore, we tailored this main principal according to our own data sample and weed out companies according to the criteria set forth above. However, we did not incorporate thin trading into the empirical methodology as Jorion and Schwartz (1986) suggest, as our methodology already dictates the estimation of the multiple regression with a 5 to 10 lead/lag length.

of explanatory variables: lagged industrial return, change in the proportion of global industry capitalization with respect to world market capitalization, and the global industry price-to-earnings ratio.

4. Geweke Feedback Measures of Individual Stock Integration

We first ranked the companies alphabetically for each year. For this reason, company *x*, for instance, is called comp1 for a specific year, while it may possibly be called comp3 for the next year and comp5 for the year after that year due to new entries on the list. We used this kind of naming because it was necessary for the E-views program. We estimated annual contemporaneous feedback measures for each of the 355 pairs of an individual company and the MSCI World Index. For every pair, we generated a time series of a minimum of three and maximum of 21 annual measures depending on the life of the company, which gives us 2,267 Geweke feedback measures in total.[7] Before we calculated the Geweke feedback measures, we prepared separate name and number lists for each year, as the given numbers for each company continuously changed from year to year due to new entries and exits. After we obtained the Geweke feedback measures, we matched the real names and numbered names for each year to enable analysis. As expected, the final table clearly expressed variations in the integration levels from company to company and year to year.[8]

The variations by industries are presented in *Table 1*, which reports the industry averages of individual Geweke contemporaneous feedback measures. According to *Table 1*, the oil and gas industry has the highest average and the household goods industry has the lowest average. Therefore, while companies in the oil and gas industry are the most strongly integrated with the world market and follow similar same-day trends with the MSCI World Index, companies in the household goods industry are the most separated from the world market. These results are not surprising since the oil and gas industry is expected to be strongly integrated with the world market, as it is highly speculative and dependent on the international news and investors, while the household goods industry is expected to be separated from the world market, as is a more stable and domestic-oriented industry. The analysis reveals that the banking and financial services industries are, respectively, the second and third most strongly integrated with the world market.

One of the interesting results of the industry-based analysis is the following: Although the media, real estate investment and services industries mostly target domestic markets and consumers (and as non-tradable industries, they are likely to have exposure to local risk), they rank among the top five industries in the average Geweke contemporaneous feedback measure list. In other words, the analysis shows that individual companies operating in those industries strongly follow the MSCI World Index on the same day.

[7] We calculate Geweke measures for companies that are listed for at least three consecutive years. Therefore, we have at least three annual Geweke measures for each company. Likewise, since our dataset covers 21 years, we have a maximum of 21 annual Geweke measures for companies that are listed during the whole of that period. For other companies, the calculated measures vary according to the number of years for which they are listed.

[8] The full table of annual Geweke feedback estimations for each stock is available upon request from the author.

Table 1 Industry Averages of Individual Geweke Contemporaneous Feedback Measures

Industry	$GCFM_{w.i}$
Automobiles and parts	34.4905***
Banks	54.7364***
Construction and materials	33.0418***
Chemicals	45.4188***
Electricity	35.6630***
Electronic and electrical equipment	33.3290***
Financial Services	50.9385***
Food Producers	28.7568***
Gas, water and multi-utilities	35.4214***
Household goods	24.3721***
Media	46.2124***
Oil and gas producers	59.4118***
Personal goods	35.2121***
Real estate investment and services	46.4673***
Retailers	26.4190***
Software and computer services	40.6679***
Telecommunications	41.9238***
Travel and Leisure	38.6919***

Notes: This table presents the industry averages of Geweke contemporaneous feedback measures for the period from 1994 to 2014. Each statistic has an approximate χ^2 distribution with one degree of freedom under the null hypothesis of no contemporaneous relationship.

The critical value is 2.71, 3.84 and 6.63 at the 10%, 5% and 1% levels of significance, respectively.

Rejection of the null hypothesis is represented by *, ** and *** for the 10%, 5% and 1% levels of significance, respectively.

Finally, the integration levels of the rest of the industries are too close to each other to be of statistical importance. These results lead us to conclude that no significant differences in the integration levels of individual companies occur due to the characteristics of specific industries. Thus, it is fair to say that, except for a few surprising results such as strong integrations of the media and real estate sectors and strong segmentation of the food industry (and obvious expected results such as strong integrations of the oil and gas industry and the banking and financial services industries and strong segmentation of the household goods and retail industries), the "industry" as such is not a main driver of the global integrations of individual companies. While one may be able to anticipate the possible integration of a specific company in the financial services industry or the oil and gas industry, or the possible segmentation of a company that is in the household goods industry, the name of the industry is not decisive for companies in other sectors.

In stage two of our analysis, we scrutinize the variation in individual stock integrations in order to determine why different stocks experience changing degrees of world market integration over time.

5. Microeconomic Determinants of Individual Stock Integration

We suggest that the degree of a stock's international integration depends on its microeconomic conditions (firm-specific variables and industry performance-based variables).

$$GCFM_{i,t} = \alpha + \beta_1 Size_{i,t} + \beta_2 BtoM_{i,t} + \beta_3 PtoCF_{i,t} + \beta_4 PtoE_{i,t} + \beta_5 Liq_{i,t} + \\ + \beta_6 Lev_{i,t} + \varepsilon_i + v_{it} \quad (18)$$

$$GCFM_{i,t} = \alpha + \beta_1 Size_{i,t} + \beta_2 BtoM_{i,t} + \beta_3 PtoCF_{i,t} + \beta_4 PtoE_{i,t} + \\ + \beta_5 Liq_{i,t} + \beta_6 Lev_{i,t} + \beta_4 InR_{i,t} + \beta_5 ICtoWC_{i,t} + \beta_6 InPtoE_{i,t} + \varepsilon_i + v_{it} \quad (19)$$

The dependent variable $GCFM_{i,t}$ is the Geweke contemporaneous feedback measure for company *i* for period *t; Size* is the size of the company for period *t*; *BtoM* is the book-to-market ratio of the company for period *t*; *PtoCF* is the price-to-cash-flow ratio of the company for period *t*; *PtoE* is the price-to-earnings ratio of the company for period *t*; *Liq* is the liquidity of the company for period *t*; *Lev* is the leverage of the company for period *t*; *InR* is the lagged industrial return for period *t*; *ICtoWC* is the change in the proportion of global industry capitalization with respect to world market capitalization for period *t*; and *InPtoE* is the industry average price-to-earnings ratio for period *t*[9] α and βs are parameters, $\varepsilon_i \sim IID\left(0, \sigma_\varepsilon^2\right)$ is the unobserved random effect[10] that varies across companies but not over time, and $v_{it} \sim IID\left(0, \sigma_v^2\right)$ is an idiosyncratic error term $i = 1, \ldots, N$, $t = 1, \ldots, T$.

5.1 Firm-Specific Variables

Table 2 reports the results of the panel data model, which is constructed with only the firm-specific variables over the 21-year sample period for 355 individual companies. The model explains over 19% of the variation in the same-day co-movement between the world market and individual stocks. That means our model constructed with firm-specific variables (size, book-to-market ratio, price-to-cash flow ratio, price-to-earnings ratio, current ratio and gearing ratio) is able to explain 19.67% of the changes in the strength of individual stock integration.

Three out of six of the tested firm-specific variables significantly explain the changes in individual integration; size and leverage are significant at the 99% confidence level, the book-to-market ratio is significant at the 95% confidence level.

The positive and significant size coefficient shows that size has a positive effect on individual stock integration. The same-day co-movement between large stocks and the world market is higher than the same-day co-movement between small stocks and the world market. Therefore, one can say that large stocks, in terms

[9] The calculation methods are presented in the *Appendix, Table 1A*.

[10] While we were constructing the model, a model that allows for company-specific effects or time-specific effects (fixed-effects approach) could have been preferable, but it was ruled out on the grounds that there are many more companies than time periods and thus it would have been necessary to estimate too many parameters. The Hausman test also reveals that the random-effects model is the most appropriate model for our panel dataset.

Table 2 Results of the Pooled Regression Analysis with Firm-Specific Variables

Explanatory variable	*t*-stat
Size	14.7533***
Book to market	-2.1968**
Price to cash flow	0.3095
Price to earnings	0.1197
Liquidity (current ratio)	1.5175
Leverage (gearing ratio)	-3.6786***
Adjusted R^2	0.1967
F-statistic	63.4120

Notes: This table presents the GLS regression results of the panel data model constructed with only firm-specific variables.

The significance of the *t*-test is represented by *, **, and *** for the 10%, 5% and 1% levels, respectively.

of the total market capitalization of the given company, are more strongly integrated with the world market. We can list a few practical causes for the significance of the size effect. It is a widely known fact that large-cap stocks have greater international operations and thus, as Huang (2007) states, this creates greater exposure to global risk. Furthermore, since large-cap stocks are more likely to be cross-listed in international stock markets and international investors tend to concentrate on those stocks, large-cap stocks have greater investor recognition and face fewer direct or indirect investment barriers. On the other hand, since small stocks are less accessible by international investors due to the high transaction costs associated with their limited liquidity and information ability, they are likely to be priced according to their local or idiosyncratic risk, which leads those stocks to be segmented from other international markets.

Leverage is also significant at the 99% confidence level. The negative sign of the leverage coefficient shows that the companies with lower leverage ratios are more strongly integrated with the world market compared to those with high leverage ratios. In fact, several papers empirically[11] show that firms tend to de-leverage with increasing financial integration. Decreasing leverage with increasing international integration can be justified by the effect of decreasing cost of capital. Lucey and Zhang (2010) empirically show that due to beneficial outcomes of financial integration such as risk sharing, diversification opportunities, increased competition and efficiency of financial markets and institutions, enhanced corporate governance and an improved information environment, the cost of capital decreases with increasing financial integration. Therefore, firms adjust their use of debt and equity financing at a reduced cost and prefer issuing equity as long-term financing instead of using long-term debt.

The final significant variable is the book-to-market ratio. The negative sign of the factor indicates that stocks with lower book-to-market ratios tend to be more strongly integrated with the world market compared to those with high book-to-

[11] See Chaplinsky and Ramchand (2000), Schmukler and Vesperoni (2006) and Claessens and Schmukler (2007).

Table 3 Results of the Pooled Regression Analysis with Firm-Specific and Industry Performance-Based Variables

Explanatory variable	*t*-stat
Size	13.9383***
Book to market	-2.3793**
Price to cash flow	0.2939
Price to earnings	1.1301
Liquidity (current ratio)	1.2792
Leverage (gearing ratio)	-3.4008***
Lagged industrial return	31.0274***
Change in the proportion of a global industry capitalization with respect to the world market capitalization	3.9957***
Global industry price-to-earnings ratio	0.2177
Adjusted R^2	0.3597
F-statistic	96.4133

Notes: This table presents the GLS regression results of the panel data model constructed with both firm-specific and industry performance-based variables.

The significance of the *t*-test is represented by *, ** and *** for the 10%, 5% and 1% levels, respectively.

market ratios. Chaplinsky and Ramchand (2000) empirically show that international companies (companies that are financially integrated with the world market) tend to grow faster compared to segmented companies. As Fama and French (1993) classify firms with low book-to-market ratios as growth companies, we can associate faster-growing firms with low book-to-market ratios (growth stocks). Chen and Zhao (2006) also support the hypothesis that firms with higher growth rates tend to have lower book-to-market ratios. Therefore, it is fair to say that our result that companies with lower book-to-market ratios are more integrated with the world market is strengthened by the findings in the literature that firms with low book-to-market ratios have higher growth rates.

5.2 Firm-Specific Variables and Industry Performance-Based Variables

In the second regression analysis, we include to our model industry-level variables which are directly related to the performance of the given industry. As *Table 3* shows, the model with six firm-level factors and three industry-level factors is now able to explain approximately 36% of the variation in the cotemporaneous relationship between the world market and individual firms. The significance of two of the three tested industry performance-based factors and the nearly 100% increase in the adjusted R^2 due to the inclusion of the variables indicate the importance of industry impact (general performance of industry) on the individual stock integration process.

Table 3 shows that the same firm-level variables (size and leverage, and book-to-market ratio) remain significant at the 99% and 95% confidence levels, respectively. Among the three newly added industry-level variables, the lagged industrial return and change in the proportion of global industry capitalization with respect to world market capitalization are significant at the 99% confidence level.

The positive and significant lagged industrial return coefficient shows that an increasing (decreasing) return of global industry causes the contemporaneous relationship between the world market and individual stocks in that industry to also increase (decrease). Thus, one can expect that a stock in an industry having a globally increasing return trend will be more strongly integrated with the world market as compared to a stock in an industry that shows a globally decreasing return trend.

The results reveal that the tested variable "change in the proportion of global industry capitalization with respect to world market capitalization" is also significant in explaining the changes in individual stock integrations. Carrieri *et al.* (2004) use that specific variable as a proxy for the growth rate of a given industry. Hence, a negative change in the ratio of capitalization of a global industry to the market capitalization of the entire world shows the declining share of that particular industry while a positive change is proof of an expanding industry. In this case, the significance of the *ICtoWC* factor indicates that an individual stock integration is significantly affected by the expansion or contraction of the industry that stock belongs to. Furthermore, the positive sign indicates that a positive change, namely an expanding industry, causes the stocks in that industry to be more strongly integrated into the world market, while a negative change in that ratio, namely a contracting industry, means weakening of the individual stock integration.

The insignificance of the *industry P/E* confirmed the results of the first-step analysis (it is not possible to interpret the strength or weakness of the integration levels of an individual company by looking at its industry) and revealed that an industry sector (here *industry P/E* is used as a proxy to differentiate the industries) does not create significant differences in individual integration levels.

5.3 Robustness

As our study is constructed as a two-step procedure, we implemented the robustness tests for each of the steps separately. For the first step, we wanted to make sure of the robustness of the integration levels and thus of the feedback measures. "In implementing the Geweke method, the forecast equations must be estimated with stationary time series; otherwise, the forecasts may be subject to spurious correlation" (Fuess and Millea, 2002, p. 5). Therefore, for each of the individual companies (355 time series) and the MSCI World Index, we first ran both ADF and PP tests to investigate the presence of a unit root. Since we had already taken the first differences of the price series for each company and the world market, the null hypothesis of non-stationarity was rejected for all returns. On the other hand, we did not need to worry about any possible heteroscedasticity or autocorrelation problems of our return series because, as a VAR system, the Geweke technique "requires no such restrictions to be imposed" (Brooks, 2008, p. 291). We then tested a number of alternative specifications of our empirical model in order to verify the robustness of our results. Although we included trend and day-of-the-week dummy variables in our model and added longer lead/lag lengths, the results show that for most of the world market-individual company pairs, dummy variables are statistically insignificant and the results are robust even if those variables are omitted from the model and lead/lag lengths over 5/10 do not improve the results.

To ensure the robustness of the second step, where we identify the significant microeconomic variables, we followed three steps. In the first step, we ensured

Table 4 Unit Root Test Results for Geweke Contemporaneous Feedback Measures and Microeconomic Variables

Variables	ADF	PP
Geweke measures	-3.7588*	-4.0968*
Size	-10.0997*	-17.2946*
Book to market	-17.4845*	-35.8916*
Price to cash flow	-21.6562*	-29.4801*
Price to earnings	-10.2191*	-24.8436*
Liquidity (current ratio)	-31.0379*	-31.3551*
Leverage (gearing ratio)	-11.4336*	-16.2832*
Lagged industrial return	-4.5449*	-4.7725*
Change in the proportion of a global industry capitalization with respect to the world market capitalization	-14.2480*	-14.1159*
Global industry price-to-earnings ratio	-28.0175*	-28.8576*

Notes: The critical value for the ADF and PP test statistics is 3.4344 at the 1% significance level.
* denotes the rejection of the null hypothesis at the 1% level.

the robustness of the data. Berry and Feldman (1985, p. 77) clearly state that "[…] with heteroscedasticity (or autocorrelation), the Generalised Least Squares (GLS) estimation technique produces the estimators that are BLUE". Therefore, we did not need to test the potential heteroscedasticity and autocorrelation problems for our dependent and independent series, as we estimated our panel data models with the GLS technique. However, since stationarity is still crucial, we used both ADF and PP tests to investigate the presence of a unit root for the dependent variable (Geweke feedback measures) and the independent variables (nine microeconomic variables). The null hypothesis of non-stationarity is rejected for all variables.

In the second step, we further investigated the robustness of our results by examining various sub-samples. We divided our dataset into four different time periods[12] and investigated the individual integrations of the companies by grouping according to their countries. We thus repeated our regressions 20 times in total for groups of individual companies from each country separately—not as a group of emerging European countries—and for different time periods. Most of the regressions with different countries and different time periods ended up with almost the same statistically significant microeconomic variables.

Finally, we employed the dynamic factor model methodology of Stock and Watson (2002) in order to estimate and forecast individual stock integrations conditioned by the microeconomic variables that were used in our analysis. More explicitly, the microeconomic variables that were used in the second step of our study are now used to compute forecasts for the series of Geweke measures to enable us to see the preponderance of each factor.

Table 5 presents the R^2 of the forecast results of the Geweke contemporaneous feedback measures with a single variable included in the dataset. According to that,

[12] In this part of the study, our overall time period is investigated in four sub-periods: from 1994 to 1998, from 1999 to 2003, from 2004 to 2008, and from 2009 to 2014.

Table 5 R^2 of the Regressions with Each Variable for the Forecast of Geweke Measures

Variables	R^2
Size	0.19
Book to market	0.12
Price to cash flow	0.11
Price to earnings	0.06
Liquidity (current ratio)	
Leverage (gearing ratio)	0.14
Lagged industrial return	0.23
Change in the proportion of a global industry capitalization with respect to the world market capitalization	0.16
Global industry price-to-earnings ratio	0.05

Note: This table presents the results of dynamic factor models by following Stock and Wtason (2002)

the forecast results reveal that, while the lagged industrial return has the greatest power in terms of explaining the variation in individual stock integration, the size of the company and change in the proportion of global industry capitalization with respect to world market capitalization are in second and third place, respectively. In the analysis part, we showed that the explanatory power of the microeconomic model was doubled with the inclusion of the industry performance-based factors. The results here clearly revealed that the main factors behind the individual stock integration are indeed industry performance-based variables, while the size of the company is equally as important as those factors.

6. Summary and Conclusions

Investigating international stock market integration at the fully disaggregated level is particularly important. For instance, if the national stock market of an emerging country does not show significant integration with the stock market of a developed country, we do not know whether investors from those countries can diversify their portfolios with any stocks with confidence because it is not known whether the segmentation of those national markets means every single stock from those markets is also not integrated. In other words, what can we say when the national stock markets are not integrated but some of the stocks, depending on their industries or other characteristics, are significantly integrated into other countries? Therefore, the primary motive of this paper was to determine the depth of international integration of national stock markets and whether particular characteristics of firms affect groups of stocks differently in that process.

In the first step, we used Geweke feedback measures to calculate contemporaneous co-movements between the MSCI World Index and 355 individual stocks from emerging European countries. This first step of the study showed us that individual stocks are indeed integrated with the world market at significantly different levels. Industry-based analysis has shown that while one may be able to anticipate the possible integration of a specific company that is in the financial services industry or oil and gas industry or the possible segmentation of a company that is in the household goods industry, the industry is not decisive for companies in other sectors.

In the second step, we investigated the micro-level determinants of individual stock integration. The first panel model, which was constructed with only firm-specific variables, was able to explain 19.67% of the changes in the Geweke contemporaneous feedback measures, while the tested firm-specific variables size and leverage were significant at the 99% confidence level and the book-to-market ratio was significant at the 95% confidence level. On the other hand, the second model, which was constructed with six firm-specific factors and three industry performance-based factors, was able to explain approximately 36% of the variation in the contemporaneous relationship between the world market and individual firms from emerging European countries. As in the first model, size and leverage and the book-to-market ratio were significant at the 99% and 95% confidence levels, respectively, and among newly added industry-level variables lagged industrial return and change in the proportion of global industry capitalization with respect to world market capitalization were significant at the 99% confidence level. The analysis of the industry-level variables showed that while the global condition of an industry, return performance and capital expansion are significant determinants of individual stock integration, it is not possible to group the strength level of individual stocks as weak or strong according to their industries, as the insignificant global industry P/E ratio indicates that there is no significant difference between the industries based on that specific factor.

Therefore, all of these findings clearly imply that when forming an internationally diversified portfolio in order to improve portfolio performance, investors should also use an individual company selection mechanism and cross-industry diversification strategies in addition to cross-country diversification. Although "individual company selection mechanism" is a new term for the literature and is thus open to further research, the advantages of diversifying a portfolio across industries is a technique that is already widely studied and accepted by scholars. Griffin and Karolyi (1998) and Carrieri *et al.* (2004) empirically show that international investors can have better risk-return characteristics by diversifying their portfolios across industries. There are some other scholars, such as Guisa *et al.* (2004a), Claessens and Schmukler (2007) and Lucey and Zhang (2010), who investigate stock market integration at the disaggregated level and reach findings that support the use of the individual company selection mechanism in forming an internationally diversified portfolio. For instance, Huang (2007) empirically investigates the impacts of the size of individual stocks in the international integration process and finds that large-cap stocks involve significantly stronger co-movements across countries compared to small-cap stocks. Therefore, Huang (2007, p. 1,336) clearly states that "if countries' large-cap stocks are exposed to global risk factors, then the prices of such stocks are likely to be driven by common fundamental factors and, in turn, the diversification gains from holding foreign large-cap stocks are likely to fall". In this paper, we have shown the significant impacts of other micro-level characteristics besides the size effect on the co-movements of stocks with other national stock markets and thus their possible impacts on international portfolio diversification strategies.

APPENDIX

Table 1A Definitions and Calculations of Microeconomic Variables

Variable	Definition	Calculation
S	Size	*Number of outstanding shares * price of shares*
BtoM	Book to market equity	$\frac{\textit{Book Value of Equity}}{\textit{Market Value of Equity}}$
PtoCF	Price to cash flow ratio	$\frac{\textit{Price}}{\textit{CashFlow}}$
PtoE	Price to earnings ratio	$\frac{\textit{Price}}{\textit{Earnings per share}}$
Liq	Liquidity (current ratio)	$\frac{\textit{Current Assets}}{\textit{Current Liabilities}}$
Lev	Leverage (gearing ratio)	$\frac{\textit{Total Debt}}{\textit{Total Equity}}$
InR	Lagged global industry return	$\ln(R_{It} / R_{It\text{-}1})$
ICtoWC	Change in the proportion of local industry capitalization to world market capitalization	$\Delta \frac{\textit{Local Industry Capitalization}}{\textit{World Market Capitalization}}$
InPtoE	Industry price to earnings ratio	$\frac{\textit{Industry Price}}{\textit{Industry Earnings}}$

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