Cross-Sectional Variations in the Degree of Global Integration: The Case of Russian Equities

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ABSTRACT

While there is a significant amount of research on integration differences across countries, the integration variations across industry or market capitalization groups within a single country have been largely unexplored. The degree of integration, however, varies widely cross-sectionally. In this paper, we analyze the degree of integration of Russian stocks grouped into five size and five industry portfolios using the GMM methodology and conditional asset pricing model. In line with economic intuition, the estimates of average degrees of integration show a noticeable downward trend with a decrease in the portfolio size and are also smaller for less diversified industries. The strength of integration is higher for those portfolios that have more firms which cross-list their stocks on foreign exchanges and/or sell their output internationally.

Keywords: Conditional asset pricing; Average degree of integration; Portfolio diversification
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1. Introduction

There has been a fair amount of research on capital market integration. The primary goal of these studies has been to provide economic and statistical evidence for integration or segmentation among world financial markets. Some authors, most notably Errunza, Losq and Padmanabhan (1992) assume mild segmentation of capital markets, in effect, precluding both full integration and complete segmentation. Bekaert and Harvey (1995) also abandon the assumptions of full integration or segmentation but argue that the degree of integration is time varying and may not only increase but also decrease through time. The most common feature of previous studies is that they analyze either the integration between two specific markets, one of which is usually the U.S. equity market (e.g., see Jorion and Schwartz (1986)), or cross-country differences in the levels of integration (e.g., Bekaert and Harvey (1995), Hardouvelis, Malliaropulos and Priestley (1999)).

This paper, to the best of our knowledge, makes the first attempt to understand and quantify the differences in integration processes across various industry sectors and market capitalization groups within a single country. We accomplish that by studying the newly emerged Russian equity market.[1] Our choice for the analysis of this emerging market in particular is driven by the following two considerations. Firstly, due to its recent appearance, the Russian financial market has been largely unexplored. Secondly, and more importantly, we think that the Russian equity market differs substantially from many other emerging and developed markets by its more profound cross-industry and market capitalization differences that may ultimately be more detectable in empirical work.[2] As an example, there are more different types of Russian stocks traded in the United States as American Depository Receipts (ADRs) than, say Korean, but most of the actively traded

[1] In the summer of 1997, the total market capitalization of the Russian equity market was in excess of $150bn or about 35% of the country's GDP.

[2] Rouwenhorst (1999) argues that, in general, the relative segmentation of emerging markets gives a researcher an excellent ground to examine the cross-sectional differences in their stock returns.

shares are issued by large oil & gas firms.[3] Along with these companies, the market capitalization of which reaches billions of U.S. dollars, there are also smaller manufacturing and other firms with "dubious" accounting disclosure standards that are nevertheless fairly actively traded in the domestic Russian market. This motivates a study of cross-sectional differences in integration across various sectors of the Russian economy.

We analyze cross-sectional differences in integration using a conditional asset pricing framework. The conditional expected returns in our model are affected by their covariances with global and local risk factors. Due to the small sample size, we have to restrict the number of both global and local risk factors to one. These factors are the world market return and the value-weighted return of Russian stocks respectively. In our study, we do not claim that any specific portfolio of Russian equities is fully integrated with or segmented from the world markets. Moreover, unlike Bekaert and Harvey (1995), we are not particularly interested in the details of the time series properties of integration. We conduct a cross-sectional analysis with the goal of finding the average differences in the degrees of integration with the world markets across five size and five industry portfolios of Russian stocks.

To estimate the level of integration, we use a time-varying integration coefficient which is essentially a weight showing the relative contribution of global and local risk factors in predicting current returns. Due to the short period of observation (26 months) relative to the usual duration of the business cycle, we assume that the prices of risk factors are constant. Such a specification allows us to estimate degrees of integration simultaneously for all size or industry portfolios. Our estimation results show that the level of integration is, in general, declining from the largest to the smallest market capitalization portfolio, and is lower for less diversified sectors of the Russian industry such as

[3] As of December 1997, there were 16 different Korean ADRs (common shares) listed on NYSE, or traded as 144A or OTC securities. The corresponding number of Russian ADRs was 22, out of which 5 were in oil & gas sector. This information is based on publicly available data provided by the Bank of New York.

manufacturing. Subsequent diagnostic tests provide no evidence of misspecification for our model.

What are the primary conditions for firms or industries to have a higher or lower degree of integration with the world markets? Griffin and Stulz (1998) find that industries producing internationally traded goods are more sensitive to both exchange rate and world wide industry shocks. Therefore, we expect the portfolios of stocks with a large proportion of firms that sell their output internationally to be more integrated. Companies can also achieve a higher integration through listings of their shares on foreign exchanges (e.g., see Foerster and Karolyi (1999) for extensive evidence). This implies that if stocks in a given portfolio are extensively represented abroad then we should expect that portfolio to be more integrated.[4]

Thus, our results are consistent with the above findings since the most highly integrated sectors of the Russian economy include many firms that are either actively traded on oversees exchanges (e.g., communications), or sell a significant part of their output on world markets (e.g., metallurgy), or both (oil & gas industry). Our results also contribute to the growing research on the benefits of industrial as opposed to market-wide diversification.[5] Another innovation in our paper is the development of a new liquidity criterion for securities that are traded frequently during some periods of time but remain essentially idle during others.

The remainder of the paper is organized as follows. Section 2 specifies our conditional asset pricing model and outlines econometric methodology. Section 3 gives the data description and details on the construction of size and industry portfolios of Russian stocks. Section 4 contains the empirical results. In this section, we also conduct diagnostic

[4] The impact on integration of a stock's cross-listing can be measured by such attributes as the quality of exchange, trading volume, number of exchanges where the stock is represented, etc.

[5] See papers by Roll (1992), Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998) among others.

tests on the misspecification of the model and discuss the implications of our results for global portfolio diversification. Section 5 concludes.

2. Methodology

We employ a multifactor asset pricing model with constant price of risk based on seminal papers of Merton (1973) and Ross (1976). However, we formulate a *k*-factor asset pricing relation in the conditional setting. Let

$$E\left[r_{i,t} | \boldsymbol{Z}_{t-1}\right] = \boldsymbol{\lambda}\,\mathrm{Cov}\left[r_{i,t}, \boldsymbol{F}_t | \boldsymbol{Z}_{t-1}\right], \tag{1}$$

where $r_{i,t}$ is the excess return on portfolio *i* at time *t*, $\boldsymbol{F}_t$ are the *k* risk factors observed at time *t*, $\boldsymbol{\lambda}$ is the size *k* vector of prices of covariance risk between excess returns and risk factors, and $\boldsymbol{Z}_{t-1}$ is the size *l* information set observable to investor at time *t*-1. Even though numerous studies have rejected international asset pricing models with constant prices of risk, we define the prices of risk to be time-invariant. We feel that taking into account a short time period of observation (26 months) relative to the duration of the world business cycle, one can present a stronger argument in favor of the constant price of risk. However, restricting the price of risk to be time-invariant, cannot significantly impact our major inferences about differences in integration across portfolios of Russian stocks because our prices of risk are portfolio-invariant measures and therefore affect the entire cross-section of portfolio returns in a similar way. [6]

The methodology used in our paper is derived from Harvey (1989, 1991) and Ferson and Harvey (1993). Unlike those authors however, we assume that the local equity market

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[6] To see this, notice that Bekaert and Harvey (1995) deal with both country-invariant (world) prices of covariance risk and country-specific prices of variance risk. We instead focus on the differences in global integration for portfolios of stocks in a single country and, therefore, deal only with the prices of covariance risk. Thus, in our setting, the prices of risk are portfolio-invariant measures. Consequently, at any given point in time, the time-varying prices of risk would have a proportional impact on the entire spectrum of portfolio returns.

is not perfectly integrated with the world capital markets. Under this assumption, we decompose risk factors into global, $\boldsymbol{F}_t^{gl}$, and local, $\boldsymbol{F}_t^{lc}$. This allows us then to assume that the conditional expectation of global factors is linear in *only* global information variables, while that for local factors is linear in *both* global and local information variables, i.e., $E\left[\boldsymbol{F}_t^{gl} | \boldsymbol{Z}_{t-1}^{gl}\right] = \boldsymbol{\gamma}^{gl} \boldsymbol{Z}_{t-1}^{gl}$ and $E\left[\boldsymbol{F}_t^{lc} | \boldsymbol{Z}_{t-1}\right] = \boldsymbol{\gamma} \boldsymbol{Z}_{t-1}$, where $\boldsymbol{\gamma}^{gl}$ and $\boldsymbol{\gamma}$ are the coefficient vectors and $\boldsymbol{\gamma}^{gl}$ is a subset of $\boldsymbol{\gamma}$. In similar spirit, the return on each portfolio i may have a different exposure to global and local information variables. Assuming a linear projection of returns on the information set of an investor, the expected return on portfolio i is modeled as a linear combination of projections on global and local information variables, namely:

$$E\left[r_{i,t} | \boldsymbol{Z}_{t-1}\right] = \varphi_{i,t-1} \boldsymbol{\delta}_i^{gl} \boldsymbol{Z}_{t-1}^{gl} + \left(1 - \varphi_{i,t-1}\right) \boldsymbol{\delta}_i^{lc} \boldsymbol{Z}_{t-1}^{lc}, \tag{2}$$

where $\boldsymbol{\delta}_i^{gl}$ and $\boldsymbol{\delta}_i^{lc}$ are the vectors of coefficients. The scalar $\varphi_{i,t-1}$ denotes the relative importance of global information variables for predicting the return on portfolio i as in Bekaert and Harvey (1995, 1997) but is defined through conditional probability as a simple logistic function:

$$\varphi_{i,t-1} = \Pr\left(Q_{i,t} = 1 \middle| \boldsymbol{Z}_{i,t-1}^{in}\right) = \frac{1}{1 + \exp\left(-\eta_i \boldsymbol{Z}_{i,t-1}^{in}\right)}, \tag{3}$$

where $Q_{i,t}$ is the unobserved state variable that takes the value of one if portfolio i is fully integrated with the world market at time t and zero otherwise, $\boldsymbol{Z}_{i,t-1}^{in}$ is the portfolio specific information set available to an investor at time t-1 that proxies for the degree of integration between portfolio i and the world market, and η_i is the portfolio specific vector of coefficients.

The estimation of the model parameters using Hansen's Generalized Method of Moments (GMM) (see Hansen (1982)) separately for each portfolio will necessarily lead to the loss of the tractability of point estimates and overall statistical inference since coefficients γ and λ must in theory be the same for all returns. Therefore, we estimate the model jointly for all portfolios by defining the following three error terms expressed below in the vector form:

$$\begin{aligned} \boldsymbol{u}1_t &= \left[\boldsymbol{r}_t - \left(\varphi_{t-1}\boldsymbol{\delta}^{gl}\boldsymbol{Z}^{gl}_{t-1} + (1-\varphi_{t-1})\boldsymbol{\delta}^{lc}\boldsymbol{Z}^{lc}_{t-1}\right)\right] \\ \boldsymbol{u}2_t &= \begin{bmatrix} \boldsymbol{F}^{gl}_t - \boldsymbol{\gamma}^{gl}\boldsymbol{Z}^{gl}_{t-1} \\ \boldsymbol{F}^{lc}_t - \boldsymbol{\gamma}\boldsymbol{Z}_{t-1} \end{bmatrix} \\ \boldsymbol{u}3_t &= \left[\boldsymbol{r}_t - \boldsymbol{u}2_t\,\boldsymbol{\lambda} \otimes \boldsymbol{u}1_t\right] \end{aligned} \quad , \qquad (4)$$

where $\otimes$ denotes the row-wise Kroneker product. Restricting the vector $\boldsymbol{\lambda}$, $\boldsymbol{\lambda} = [\lambda^{gl}, \lambda^{lc}]'$, to be constant as well as partitioning risk factors into global and local, allows us to “free” some moment conditions in the GMM estimation. These moment conditions are needed to achieve the goal of the paper – the evaluation of the degree of integration for the cross-section of the Russian equity market: without such a provision, the system of equations (4) will be underidentified. However, model (4) in our specification is always overidentified. Indeed, for n portfolio returns, there are $l(2n+k)$ orthogonality conditions and $l(n+k)+n$ parameters to be estimated. This results in $n(l-1)$ degrees of freedom – a number which is always greater than zero as long as the instrument set $\boldsymbol{Z}$ contains at least one component (excluding a constant).

3. Data and Summary Statistics

3.1. Portfolio Construction

In this paper, we analyze 112 weekly returns from the first Friday of October, 1995, to the last Friday of November, 1997, on 125 common stocks (22 in the very beginning of the sample) traded on the Russian Trading System (RTS) and its subsystem for less liquid issues, RTS-2.[7] The data are from the Russian Skate Press Agency. Quotations on the RTS

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[7] The RTS, which is a NASDAQ-type inter-regional real-time trading system, has established itself as Russia’s principal market for equities. Originally brought into existence in June of 1995, the average daily trading

are carried in U.S. dollars; therefore, no currency translation is needed. Weekly returns are defined as holding period returns on the common stock from the last trading day of the previous week to the last trading day of the current week. In case of public holidays, the last day of the working week is defined as the day directly preceding the beginning of holidays.[8]

The choice of the RTS as the primary source of pricing information exposes us to two principal problems. The first issue is whether prices on the RTS are representative of those prevailing on the market. There is a controversy surrounding the estimation of the share of transactions on the Russian stock market carried through the RTS. According to the AK&M, a reputable financial information agency, the RTS represents only 20% of the total market turnover, whereas RINACO Plus, a brokerage, estimates this share to be about 50-70%. Although these numbers differ, we think that even the conservative estimates allow us to consider the RTS as the major marketplace of Russian equities and therefore use its quotes as proxies for the actual market prices.

The second limitation is that according to the RTS disclosure rules, reporting of transactions is mandatory only for members of the National Association of Participants of the Stock Market (NAUFOR) but is voluntary for transactions with the clients. Hence, a limited number of transactions might cause the price quoted on the RTS to deviate from the actual non-RTS price on the secondary market. We recognize this danger and overcome this problem by employing in our analysis a new *floating turnover criterion*. In doing so, we consider only those prices which are supported by a certain volume of trading as a percentage of the market capitalization of the company in a given week. However, in the early period of trading on the RTS, weekly volumes were not an adequate indicator of the

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volumes on the RTS in November of 1997 was approximately $50 million with a total market capitalization of around $100 billion. The earliest pricing information on the RTS is available starting September 1995.

[8] During the examined time period, only a very limited number of Russian stocks were paying dividends. The information on dividend payments as well as stock repurchases by most of the analyzed companies is not readily available. However, we think that the inclusion of dividend payments will not qualitatively change the major findings of our paper.

level of liquidity for a particular issue. Even though no transactions were undertaken in a certain week, a market-maker could update his quote based on the price changes on the non-RTS secondary market. Hence, the problem is how to disregard prices on the highly illiquid stocks and yet keep in our sample stocks with moderate level of trading where pricing is adjusted at the discretion of the market-maker. To alleviate this problem we take the one-month "moving window" of trading volume and market capitalization for each stock. Thus, to make a decision on whether a certain issue passes the criterion in a given week, we look at the total trading volume for a four-week period ending this week as a percentage of the average market capitalization of the company in the calendar month which embeds the week in consideration. Choosing the threshold value of the total monthly trading volume to the average monthly market cap is a subjective decision; after investigating several alternative values, we have chosen the threshold of 10 basis points. This level represents approximately 10% of the ratio of the median trading volume during a four-week window ($368,171,980) over the median market capitalization ($36,730,649,729). We can represent the logic more formally as:

$$I_{j,t} = \begin{cases} 1 \quad \text{if} \quad \sum_{k=0}^{3} V_{j,t-k} \Big/ MkCap_{j,t} > 0.001 \\ 0 \qquad\qquad \text{otherwise} \end{cases},$$

where $I_{j,t}$ is the indicator variable and $V_{j,t}$ is the trading volume for stock *j* at time *t* respectively, while $MkCap_{j,t}$ is the average market capitalization of company *j* in the month of observation *t*. That is, if $I_{j,t}$ for some stock *j* at time *t* equals zero, then the price of stock *j* at time *t*, $P_{j,t}$, is dropped in the calculation of returns. The selection of the threshold level is motivated by the two opposing reasons: (i) the liquidity concerns, and (ii) the necessity to have a reasonable pool of stocks throughout the entire period of observation. Indeed, if a portfolio includes many illiquid stocks, its return characteristics will not be representative.

Likewise, if too many stocks are classified as illiquid, a portfolio may end up consisting of only a few stocks, which will again cast doubts on the validity of its return characteristics.

We study the Russian equity market by forming five size and five industry portfolios. The size portfolios are formed as follows. For the issues that satisfy our floating turnover criterion, in a given week, we rank the stocks based on the market capitalization of the respective companies at the end of the previous week and divide them into five portfolios. We adopt the Russian Skate Press Agency classification scheme by allocating the stocks to the following industrial sectors: communications, manufacturing, metallurgy, oil & gas, and utilities. Then, for each size (industry) quintile we determine the value-weighted (equally-weighted) rate of return on these portfolios and consequently derive the excess rate of return by subtracting the weekly rate of return on the three-month U.S. Treasury bill.

3.2. Risk Factors and Instruments

In the selection of potential economic risk factors and instruments we face two problems. First of all, given the low frequency at which major economic variables are observed and a short period of observation, we have to choose the proxies for economic risk factors among financial variables which are observed with at least weekly frequency. Secondly, because of small sample size, it is important to keep the number of risk factors and instruments relatively small to achieve a better performance of the estimation procedure.

As we mentioned above, the assumption that the Russian capital market is not fully integrated with the world motivates us to differentiate between global and local risk factors and global and local instruments. The sole global risk factor that we choose is the world weekly excess market return (WDR), which is defined as holding period return on the world index from Friday of the previous week to Friday of the current week less the weekly rate of return on the three-month U.S. Treasury bill.[9] Our sole local factor is the excess return on the Russian equity index as reported by the RTS (RUR). The contemporaneous correlation between WDR and RUR is only 0.37, which effectively allows us to use both these factors simultaneously in the estimation of model (4). In our study, we use three global instruments -- a subset of those variables used previously by other researchers. They are: the lagged weekly excess return on the world index, the weekly yield on the three-month U.S. Treasury bill (USTb), and the weekly spread between the U.S. Government long term aggregate bond yield and the seven-day Eurodollar deposit rate (Gdiff). The local instruments that we employ are the lagged weekly excess return on the Russian stock market index and the seven-day Moscow inter-bank rate (7dIBR). All data except that on the Russian stock market are from *Datastream*. As an illustration, Figure 1 provides plots of the value-weighted index of Russian equities based on the RTS quotations as well as the world market index.

Finally, we need to choose information variables that may serve as proxies for the degree of integration. Bekaert and Harvey (1997) study countries' integration with the world markets. The ratios of market capitalization to GDP and export plus import to GDP that they use are reasonable proxies for integration because they are country specific. Contrary to that, we are interested in different portfolios' integration with the world markets for stocks from a single country. Therefore, we need portfolio specific rather than country specific integration proxies. This means that in a single country case the above ratios cannot become integration proxies because they are exactly the same for all size and industry portfolios. One possible proxy could have been the proportion of exports from a given industry or market capitalization group to total exports. However, these data are not available. We attempt to solve this issue by creating a plausible integration proxy for each

[9] The world index is the U.S. dollar denominated index of equities from 35 countries. The weighting of the equity market share of each country in the world index is determined by the market capitalization of the constituent countries relative to the world. The information on the exact composition of the world index can be found in the *Datastream Definitions Manual*, August 1995.

portfolio *i*, a dispersion vector, DIS_i. Our dispersion measure is the absolute difference between the returns on portfolio *i* of Russian stocks and world index, i.e.:

$$\text{DIS}_{i,t} = \left| r_{i,t} - \text{WDR}_t \right|.$$

In making our selection for the integration proxy – a dispersion-based measure, we used the following logic.[10] If a particular sector of a country's economy becomes more integrated with the world (through increases in exports, trading on foreign exchanges, etc.), then the returns on that sector may become more aligned with those of the world index. The higher correlation of returns should in general imply a lower cross-sectional variance between the returns on the given sector and the world index. Therefore, if our *a priori* assumption is that Russia's oil & gas industry (Ol) is more integrated with the world than, say its manufacturing sector (Mn), then we should observe that $mean(\text{DIS}_{\text{Ol},t}) < mean(\text{DIS}_{\text{Mn},t})$. The data below support our reasoning.[11] However, a note of caution is warranted here. The integration proxy we use should not be interpreted in a way as to assume that the degree of integration between different sections of the Russian stock market and the world changes on the weekly basis.

3.3. Summary Statistics

Table 1 shows the mean, standard deviation and autocorrelations for size and industry portfolio returns, risk factors, instruments, and our integration proxies – the cross-sectional

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[10] Dispersion or the cross-sectional volatility of stock returns, unlike the second moment of stock returns, has not been widely used or examined in the finance literature. Recently, Campbell and Lettau (1999) show that dispersion is an important leading indicator for the business cycle.

[11] We agree with the referee who has pointed out that the lower correlation between variables does not necessarily imply lower cross-sectional variance since the correlation has to do with changes, while the dispersion with levels of the variables. However, our intuition is based solely on the fact that returns on the portfolios of Russian stocks and the world market index are of comparable magnitude. Therefore, if the levels of the variables are similar (which is generally the case for returns series), one may indeed observe that more highly correlated series exhibit less cross-sectional variability.

standard deviations between each portfolio return and the world market return. We report weekly, bi-weekly, monthly and quarterly autocorrelations. As with the U.S. data, there is almost a steady increase in the mean return and volatility from the largest size portfolio (1st quintile) to the lowest size portfolio (5th quintile). Among industry portfolios, the mean return is higher for communications, oil & gas, and utilities, while that for manufacturing and metallurgy is much lower. Standard deviations, however, do not in general match the mean return pattern across size and especially industry portfolios. Weekly autocorrelations of all portfolio returns are very low but bi-weekly and monthly autocorrelations are markedly larger. The mean values of the integration proxies for size portfolios increase almost steadily from the largest to the smallest portfolio quintile, with the second quintile having the lowest mean dispersion. This pattern suggests that larger size portfolios are, in general, more aligned with the world market than smaller size portfolios. The mean values of the integration proxies for industry portfolios confirm our intuition once again: these dispersion measures are the lowest for oil & gas and communication sectors of the Russian economy while substantially higher for manufacturing, metallurgy, and utilities.

Table 2 depicts the unconditional cross-correlations of portfolio returns with the risk factors and variables entering the information set of an investor. Panel A shows the results for size portfolios. As expected, the correlation of size portfolio returns with the world and local market returns decreases from the largest to the smallest quintile. Panel B shows that across industry groups oil and gas and utilities have the highest correlation with both the world and local markets, while manufacturing has the lowest correlation. The lagged USTb has a moderate negative correlation with all portfolio returns. The lagged Gdiff has a moderate positive correlation with all returns but this relation is much weaker for returns on metallurgy portfolio. The lagged WRD, however, has the highest correlation with metallurgy. The data therefore suggest that manufacturing may be one of the least integrated with the world sectors of the Russian economy.

4. Empirical Results

4.1. The Cross-Sectional Analysis of Integration

We first determine the joint significance of selected instruments for excess returns on each portfolio by estimating the heteroskedasticity consistent Wald test statistics. We regress the excess portfolio returns first on all lagged instruments and then on global instruments only. The null hypothesis in both cases is that all slope coefficients are zero. Table 3 presents the outcome of these tests for five size portfolios (panel A) and five industry portfolios (panel B) of Russian stocks. The table shows that global and local information variables taken together are jointly significant for the utilities industry and all but the largest market capitalization quintiles. Qualitatively, the results do not change when we test for the joint significance of global instruments only. This implies that local information variables contribute a small portion to the expected component of returns on Russian stocks.

Table 4 shows the main results of the paper based on the estimation of the system of equations (4).[12] It shows the average integration coefficient $\overline{\varphi}_i$, $\overline{\varphi}_i = mean(\varphi_{i,t})$, the average and root mean squared pricing errors, $\overline{e}_i$ and $\overline{e}_i^2$ respectively, for each size (panel A) and industry (panel B) portfolio. The pricing errors are computed from the first disturbance terms of model (4), namely:

$$\overline{e}_i = \frac{1}{T}\sum_{t=1}^{T} u1_{i,t} \text{ and } \overline{e}_i^2 = \sqrt{\frac{1}{T}\sum_{t=1}^{T} u1_{i,t}^2} ,$$

where T is the number of observations. It also gives Hansen's J-statistics with the corresponding *p*-values. Remarkably, the model is not rejected even though we set the prices of global and local risks to be time-invariant. Thus, we are tempted to claim that

[12] Due to high dimensionality of the optimizing function (72 orthogonality conditions and 47 parameters to be estimated), different initial values in our GMM estimation lead to different parameter estimates (i.e., we reach different local minimums). The results reported in Table 4 correspond to those initial values that lead to the smallest value of the optimizing function. We use the iterative version of the GMM parameter estimation (see Ferson and Forester (1994)) because it produces more consistent estimates in small samples.

modeling prices of risk as time-varying coefficients is more important for longer observation periods which embrace several regimes of the world economy such as recessions and expansions. Finally, since our integration coefficients, φ_i, are composite and time-varying, we also report the estimated values of our portfolio specific scalars η_i and their *t*-statistics. Even though the *t*-statistics show that statistically most of the coefficients η_i are not significant, within the scope of our paper one should not overestimate the economic importance of this result.[13]

We can easily observe high variation in the average degrees of integration across size and industry portfolio groups. Consistent with economic intuition, we find that, in general, larger size portfolios have higher degree of integration with the world capital markets than smaller size portfolios. Nevertheless, the largest market capitalization portfolio is not the most highly integrated with the world. At first, this finding seems to be surprising. However, this portfolio of Russian stocks includes many utility companies such as the giant United Energy System and others. The operations of this type of companies are limited to the internal Russian market. Therefore, based on the findings of Griffin and Stulz (1998), we should indeed expect these firms to be weakly integrated with the world.

The situation with industry groups is again consistent with intuition: we see that oil & gas or communications sectors of the Russian economy show a higher average integration with the world than manufacturing or utilities. The relatively high integration coefficient for the Russian's communications sector is consistent with the fact that many companies in this

[13] At the recommendation of the referee, we have also tested model (4) with Russian stock market returns "truncated" at the threshold level of 0 basis points, i.e., constructed without our floating turnover criteria. The results of the integration tests were, to some extent, similar to the ones reported in Table 4, although the integration coefficient for the smallest size portfolio was relatively high and the Hansen's J-statistic was high too. However, there are substantial qualitative differences in the sample statistics between the two sets of portfolio returns. For example, the well-known empirical evidence from both developed and emerging equity markets that average returns increase from large market capitalization stocks to small ones (e.g., see Rouwenhorst (1999)), is severely distorted for the size portfolios formed on the 0 basis points threshold. These results are available upon request.

group are quite actively traded in oversees markets.[14] However, at first glance, it is somewhat surprising to see that the estimated degree of integration for the metallurgy sector is the highest. We think that this result is driven by the fact that this portfolio includes the world largest producer of nickel – the Norilsk Nickel Plant, as well as several other large metal producing plants. Since a large proportion of the output of these companies is sold abroad, we must expect this industry group to have a high degree of integration. Notice finally that since the largest size portfolio of Russian stocks include primarily oil & gas and utility companies, our finding that its average degree of integration (0.43) is between those for oil & gas and utility industries (0.63 and 0.04 respectively) underscores the validity of the estimation procedure. We would like to warn the reader however that the reported integration estimates across different portfolios should not be interpreted in absolute terms.

Average pricing errors, especially root mean squared, provide additional information about the overall fit of the model. Panel A shows that both the average and root mean squared pricing errors are the highest for the smallest size portfolio. In fact, $\bar{e}_i^2$ increases almost monotonically from the smallest to the largest size quintile. This outcome is likely to be the result of both the differences in the standard deviation of returns across portfolios as well as the fact that our floating turnover criterion affects larger size firms less frequently than smaller ones. The latter reason may lead to the introduction of more noise to the constructed series of returns on smaller size portfolios. Panel B highlights that the Russian industry sectors such as manufacturing and utilities which are perceived to be less integrated with the world markets display higher root mean squared pricing errors than more integrated sectors such as communications and oil & gas. A relatively small average pricing error but large root mean squared error for metallurgy indirectly confirms our earlier idea that the return dynamics in this industry group of Russian stocks is largely determined by one

[14] For example, the first overseas listing of a Russian firm on the NYSE was from Vimpelcom – a communications company, the first cross-listing is from another communications company – Rostelecom (listed in February 1998).

company. Notice that the correspondence between root mean squared pricing errors and standard deviations is very profound for industry-based portfolios: unlike size portfolios, here the relation between these two characteristics is one-to-one.

Figure 2 visualizes the time variation of integration coefficients for all five size and five industry portfolios of Russian stocks. The overall level of integration coefficients for the second and third market capitalization as well as metallurgy portfolios is markedly higher than that for other size or industry portfolios. The plots essentially reveal three possible types for the degree of integration: high, moderate, and low. Therefore, one can say that metallurgy and sizes 2 and 3 portfolios have high degree of integration; communications, oil & gas, and sizes 1, 4, and 5 portfolios – moderate; manufacturing and utilities portfolio – low.

4.2. Diagnostic Tests

It is important to provide some information on whether our model can be supported by diagnostic tests on the estimated residuals. Table 5 shows the results of these tests, which consist of regressing the residuals for each portfolio *i* at time *t*, $u1_{i,t}$, on three sets of lagged instruments: global, $\boldsymbol{Z}_{t-1}^{gl}$, local, $\boldsymbol{Z}_{t-1}^{lc}$, and their combination, $\boldsymbol{Z}_{t-1} = \left[\boldsymbol{Z}_{t-1}^{gl}, \boldsymbol{Z}_{t-1}^{lc}\right]$. We report the adjusted *R*-squares and heteroskedasticity consistent Wald test statistics with their *p*-values. If model (4) is correctly specified, then these test statistics should provide no evidence of significant explanatory power of instruments in predicting the errors terms for any size or industry portfolio of Russian stocks. Both, the small magnitude of the estimated *R*-squares and large *p*-values of the Wald test statistics indicate that the model is not misspecified for all portfolios. The *R*-squares from regressions of the error terms separately on $\boldsymbol{Z}_{t-1}^{gl}$ and $\boldsymbol{Z}_{t-1}^{lc}$ are particularly small and mainly negative. The maximum adjusted *R*-square of 2.85% from the regression of residuals for the communications industry portfolio on all instruments is still small enough, while the *p*-value of the corresponding Wald statistic of 0.32 supports the model statistically even in this case.

4.3. Implications for Global Portfolio Diversification

At present, there are two competing views on the usefulness of international diversification. The lifting of many legal restrictions to international investments, liberalization of economies, and advance of information technology in the last two decades have greatly increased the interdependence of world capital markets, thus, reducing the potential benefits of global diversification. For example, Odier and Solnik (1993) and Longin, and Solnik (1995) among others provide empirical evidence that downturns in the financial market of the United States quickly propagate to other countries.[15] They argue that benefits of global diversification decrease or may even completely disappear at the time of bearish markets. Nevertheless, the consensus among researchers is that the market price of risk differs across countries and asset returns are less correlated at the international level than domestic. Therefore, global investing is still beneficial.

What are the implications of our findings for international portfolio diversification? Our results suggest that due to significant cross-sectional variability in the levels of integration for different size and industry portfolios from a given country, an investor is better off by investing money into specific types of assets for such country rather than putting it directly into that country's fund. In other words, we recommend that portfolio managers use *both* cross-country and cross-industry or market capitalization diversification as a means to decrease the global systematic risk of their portfolios. The most important thing here is to understand that if a given industry or size portfolio from one country does not show a high degree of integration, it does not imply that the same portfolio type in all other countries will also exhibit weak integration with the world markets. In light of this,

[15] Several other papers address the issue of cross-country stock return correlations and their changes through time. For example, Karolyi and Stulz (1996) investigate the integration between the U.S. and Japanese equity markets and find that return correlations change primarily due to large shocks to broad market indices. Ramchand and Susmel (1998) provide empirical evidence on time-varying correlations across equity markets using the international capital asset pricing model with time and state varying beta.

our paper complements the findings of Heston and Rouwenhorst (1994) who argue in favor of diversification across countries within an industry but are quite skeptical with regard to industry diversification alone.

5. Conclusions

In this paper, using the Generalized Method of Moments and conditional two factor asset pricing model, we analyze 112 weekly returns on five size and five industry portfolios of Russian stocks with the main goal to quantify the average degree of integration across these portfolios. Due to the short period of observation, in our paper we use only two risk factors: one global – the value-weighted return on the world market index, and one local – the value-weighted return on the Russian equity index. We are also constrained in our choice of the instrumental variables. However, even in this simplified setting, the test results are in line with economic intuition: the estimates of average degrees of integration show a noticeable downward trend with a decrease in the portfolio size and are also smaller for less diversified industries. The strength of integration is higher for those industries the stocks of which are extensively traded on foreign exchanges, as in the case of communication sector, and those which widely sell their output internationally, as in the case of oil & gas and metallurgy sectors. The implication of our findings for global portfolio diversification lies in the understanding of the importance of cross-industry diversification potential across countries. This potential may be greater for other emerging economies with significant cross-sectional differences in their national equity markets such as those of other large and/or natural resources driven economies of Brazil, Indonesia or Venezuela.

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Table 1

Summary Statistics

	Mean	S.D.	ρ_1	ρ_2	ρ_4	ρ_{12}
			Size portfolios			
Size 1 (largest)	0.0169	0.0824	0.010	0.208	0.111	-0.042
Size 2	0.0145	0.0817	-0.095	0.289	0.244	0.063
Size 3	0.0175	0.0803	0.072	0.080	0.255	0.014
Size 4	0.0230	0.0806	0.143	0.349	0.340	-0.043
Size 5 (smallest)	0.0388	0.1043	0.184	0.185	0.093	-0.030
			Industry portfolios			
Communications	0.0165	0.0788	-0.135	0.323	0.192	0.035
Manufacturing	0.0080	0.0866	0.035	0.205	0.101	0.015
Metallurgy	0.0089	0.0904	0.005	0.254	0.179	-0.083
Oil & Gas	0.0136	0.0807	0.007	0.145	0.075	-0.060
Utilities	0.0231	0.0932	0.023	0.280	0.257	0.029
			Risk factors			
WDR	0.0012	0.0137	-0.068	0.248	-0.047	-0.189
RUR	0.0143	0.0806	-0.057	0.266	0.130	-0.074
			Instruments			
WDR(-1)	0.0012	0.0137	-0.068	0.248	-0.047	-0.189
USTb(-1)	0.0997	0.0026	0.835	0.688	0.414	-0.419
Gdiff(-1)	0.0181	0.0093	0.906	0.863	0.812	0.398
RUR(-1)	0.0148	0.0798	-0.012	0.219	0.090	-0.066
7dIBR(-1)	0.0074	0.0034	0.623	0.596	0.510	0.570
			Integration proxies			
DIS_1	0.0551	0.0554	-0.011	0.187	0.093	-0.142
DIS_2	0.0520	0.0571	0.259	0.420	0.198	-0.022
DIS_3	0.0551	0.0533	0.016	0.183	0.131	-0.056
DIS_4	0.0581	0.0531	-0.000	0.199	0.321	-0.039
DIS_5	0.0806	0.0736	0.120	0.053	0.024	-0.022
DIS_{Cm}	0.0534	0.0539	-0.024	0.293	0.163	0.036
DIS_{Mf}	0.0607	0.0566	0.093	0.198	-0.088	-0.135
DIS_{Ml}	0.0623	0.0581	-0.021	0.180	0.071	-0.024
DIS_{Ol}	0.0547	0.0529	0.017	0.117	0.083	-0.130
DIS_{Ut}	0.0606	0.0677	0.040	0.287	0.218	-0.090

Notes.

The mean (Mean), standard deviation (S.D.), first-, second-, fourth-, and twelve-order autocorrelations (ρ_1, ρ_2, ρ_4, and ρ_{12}) are for five size and five industry excess portfolio returns on the Russian equity market, risk factors and instruments, and world integration proxies. The sample includes 112 weekly observations from the first Friday of October, 1995, to the last Friday of November, 1997. WDR and RUR are the weekly excess returns on the world and Russian index respectively, USTb is the weekly yield on the three-month U.S. Treasury bill, Gdiff is the weekly spread between the U.S. Government long term aggregate bond yield and the seven-day Eurodollar deposit rate, and 7dIBR is the seven-day Moscow interbank rate. DIS_i is a vector of size 112 where each component *t* is the absolute difference between the returns on given size or industry portfolio *i* and the world index observed at time *t*. The means and standard deviations for USTb and Gdiff are given in percentage points.

Table 2

Unconditional Cross-Correlations

Panel A: Size portfolios					
	Size 1	Size 2	Size 3	Size 4	Size 5
Size 1	1	0.833	0.802	0.586	0.412
Size 2		1	0.811	0.603	0.427
Size 3			1	0.628	0.445
Size 4				1	0.475
Size 5					1
WDR	0.416	0.374	0.400	0.294	0.174
RUR	0.951	0.871	0.804	0.641	0.440
WRD(-1)	0.084	0.068	0.105	0.224	0.121
USTb(-1)	-0.127	-0.115	-0.154	-0.138	-0.136
Gdiff(-1)	0.170	0.286	0.197	0.237	0.201
RUR(-1)	-0.003	-0.073	0.037	0.128	0.021
7dIBR(-1)	0.089	0.067	-0.014	-0.098	-0.116
Panel B: Industry portfolios					
	Comm.	Manuf.	Metall.	Oil	Util.
Communications	1	0.580	0.755	0.815	0.876
Manufacturing		1	0.611	0.607	0.572
Metallurgy			1	0.791	0.801
Oil & Gas				1	0.840
Utilities					1
WDR	0.327	0.234	0.359	0.420	0.368
RUR	0.881	0.602	0.854	0.917	0.921
WRD(-1)	0.078	-0.042	0.139	0.067	0.085
USTb(-1)	-0.098	-0.106	-0.124	-0.125	-0.118
Gdiff(-1)	0.232	0.163	0.093	0.151	0.246
RUR(-1)	-0.023	-0.054	0.031	-0.024	0.025
7dIBR(-1)	0.119	-0.078	-0.047	0.067	0.128

Notes.

The unconditional cross-correlations between excess portfolio returns on Russian stocks, risk factors, and instruments. (-1) denotes the lag. The remaining abbreviations are as in Table 1.

Table 3

The Wald Tests

Panel A: Size portfolios					
	Size 1	Size 2	Size 3	Size 4	Size 5
All Instruments	6.07 (0.299)	17.64 (0.003)	10.00 (0.075)	19.81 (0.001)	13.13 (0.022)
Global Instruments	5.21 (0.157)	14.70 (0.002)	8.30 (0.040)	15.94 (0.001)	10.25 (0.017)

Panel B: Industry portfolios					
	Comm.	Manuf.	Metall.	Oil & Gas	Utilities
All Instruments	9.21 (0.101)	7.34 (0.196)	5.21 (0.390)	5.05 (0.410)	10.69 (0.058)
Global Instruments	6.69 (0.082)	4.31 (0.230)	4.59 (0.204)	4.07 (0.254)	9.11 (0.028)

Notes.

The excess returns on each size and industry portfolio of Russian stocks are regressed separately on the sets of all instruments and then global instruments only. The global instruments are: WDR, USTb, and Gdiff. The local instruments are: RUR and 7dIBR. The abbreviations are as in Table 1. The numbers shown are the chi-square test statistics with the corresponding *p*-values given in parentheses.

Table 4

Tests on Integration of the Russian Equity Market (see Eq. (4))

Panel A: Size portfolios						
	Size 1	Size 2	Size 3	Size 4	Size 5	J-stat.
η	-5.01 (-1.86)	330.62 (0.28)	395.88 (2.09)	16.48 (0.50)	7.11 (0.22)	17.85 (0.85)
$\overline{\varphi}$	0.43	0.97	0.98	0.70	0.63	
$\overline{e}$	-0.0028	-0.0033	-0.0026	0.0046	0.0125	
$\overline{e}^2$	0.0897	0.0961	0.1046	0.0976	0.1073	

Panel B: Industry portfolios						
	Comm.	Manuf.	Metall.	Oil & Gas	Utilities	J-stat.
η	-4.93 (-0.02)	-177.77 (-1.04)	131.67 (0.92)	10.59 (0.26)	-285.87 (-1.21)	15.86 (0.92)
$\overline{\varphi}$	0.44	0.05	0.95	0.63	0.04	
$\overline{e}$	-0.0017	-0.0092	-0.0037	-0.0042	0.0049	
$\overline{e}^2$	0.0770	0.1330	0.1661	0.0810	0.1235	

Notes.

For each size and industry portfolio of Russian stocks, η is the estimated integration proxy (with its *t*-statistic in paranthesis), $\overline{\varphi}$ is the average degree of integration, $\overline{e}$ is the average pricing error, and $\overline{e}^2$ is the root mean squared pricing error. The pricing errors are computed from the first disturbance term of model (4). J-stat. is the Hansen's goodness-of-fit J-statistic (with its *p*-value in parentheses).

Table 5

Diagnostic Regressions

Portfolio	Global Instruments $AdjR^2$	Global Instruments W	Local Instruments $AdjR^2$	Local Instruments W	All Instruments $AdjR^2$	All Instruments W
Size 1	-0.0121	0.51	-0.0064	0.65	0.0025	1.01
		(0.92)		(0.72)		(0.96)
Size 2	-0.0172	0.24	-0.0152	0.27	-0.0127	0.74
		(0.97)		(0.87)		(0.98)
Size 3	-0.0030	1.54	-0.0040	1.45	0.0070	2.93
		(0.67)		(0.48)		(0.71)
Size 4	-0.0145	0.35	-0.0156	0.43	-0.0114	1.39
		(0.95)		(0.81)		(0.93)
Size 5	-0.0015	2.37	-0.0094	1.48	0.0079	4.29
		(0.50)		(0.48)		(0.51)
Communications	0.0037	2.32	-0.0044	1.46	0.0285	5.8414
		(0.51)		(0.48)		(0.32)
Manufacturing	-0.0176	0.14	-0.0119	0.77	-0.0103	1.0032
		(0.99)		(0.68)		(0.96)
Metallurgy	-0.0149	0.36	-0.0041	1.12	0.0040	1.7299
		(0.95)		(0.57)		(0.86)
Oil & Gas	0.0039	2.98	-0.0038	1.52	0.0326	5.5034
		(0.39)		(0.48)		(0.36)
Utilities	-0.0149	0.44	-0.0066	1.80	-0.0018	2.8065
		(0.93)		(0.41)		(0.73)

Notes.

For each size and industry portfolio of Russian stocks, the residuals $u1_{i,t}$ from estimating model (4) are regressed separately on the sets of global instruments, local instruments, and then all instruments. The global instruments are: WDR, USTb, and Gdiff. The local instruments are: RUR and 7dIBR. The abbreviations are as in Table 1. $AdjR^2$ is the R-square adjusted for the degrees of freedom, W is the heteroskedasticity consistent Wald statistic (with its p-value given in parentheses) of the joint significance of regressors.

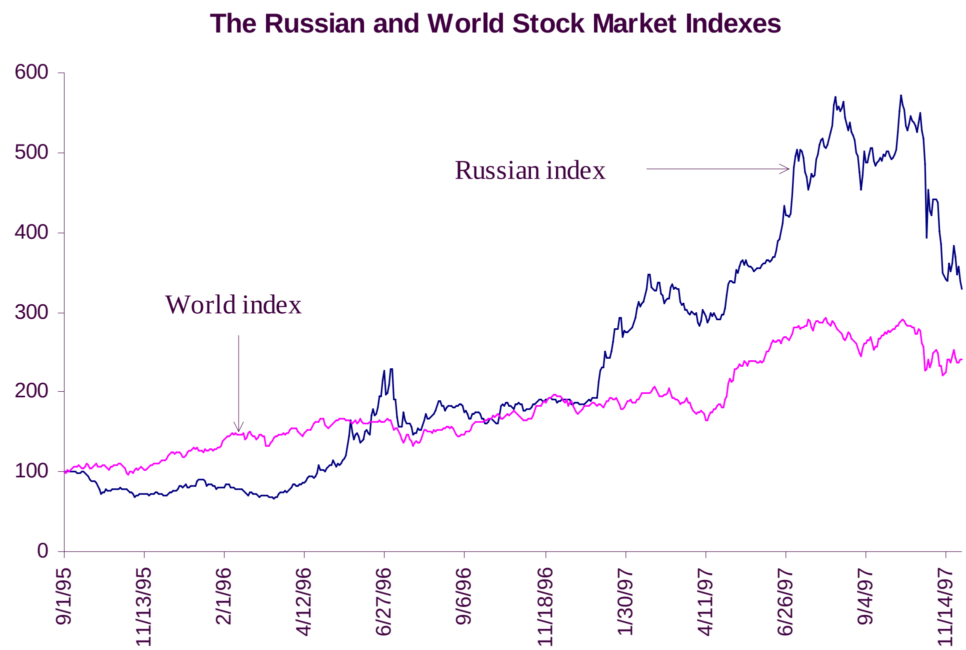

Fig. 1. The Russian and World Stock Market Indexes. The plot shows the Russian and world stock market indexes from September 1, 1995, to November 28, 1997. The Russian index is based on the Russian Trading System quotations. Both series are normalized to 100 on September 1, 1995.

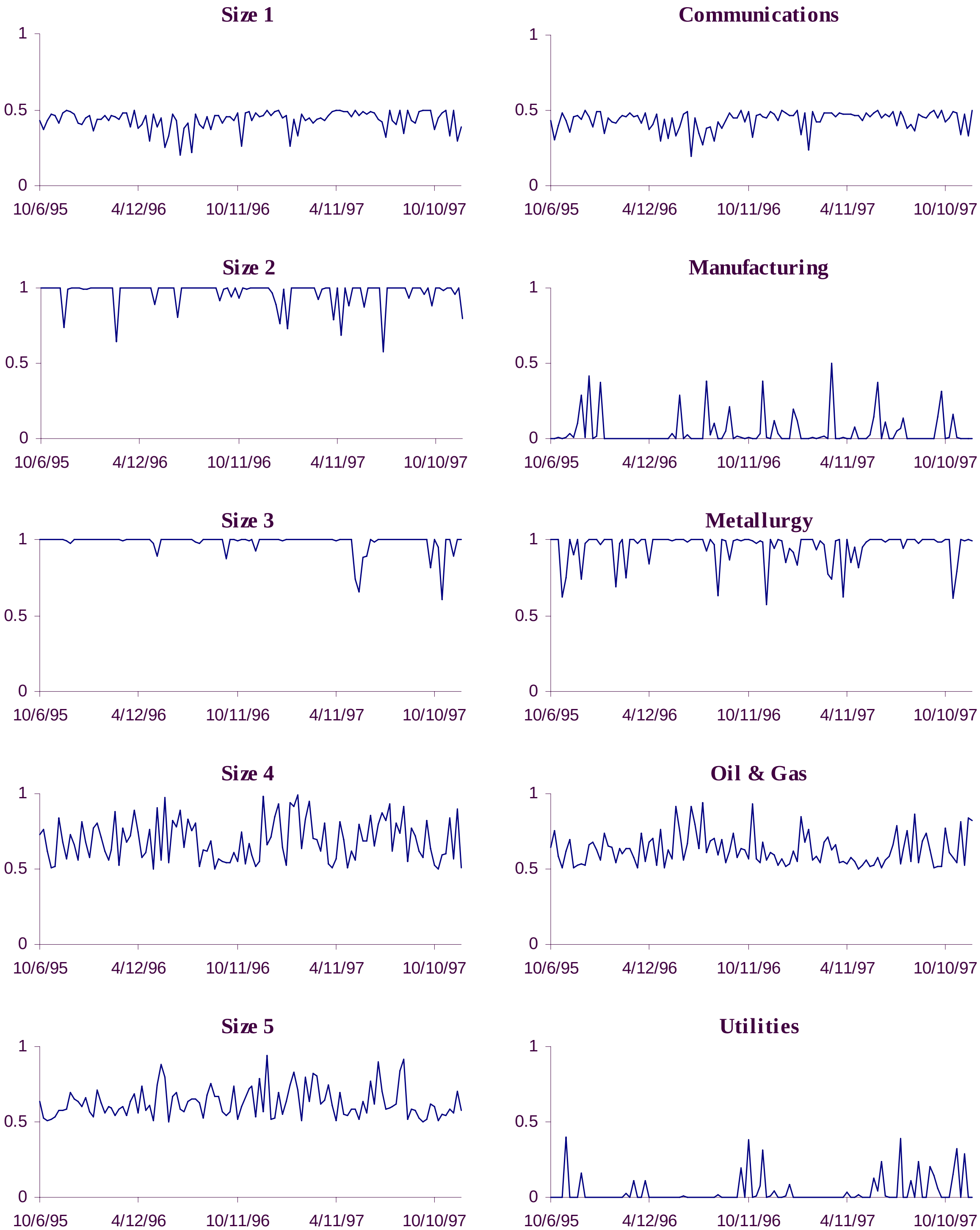

Fig. 2. The Time-Series of Integration Coefficients. The plots show the time variation of the integration coefficients for five size and five industry portfolios of the Russian equity market.