A factor analysis of global stock market integration

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1 INTRODUCTION

Most international studies in the field of financial market integration focus on stock markets, while the literature on bond markets and currency markets are more limited. Most international studies on the stock market integration focus on a specific region, like Europe, East Asia or Latin America; or an economic grouping, like emerging market countries or the OECD. Apart from this study, there are to best of our knowledge only two empirical studies that covered a global sample – see Bruner, Li, Kritzman, Myrgren and Page (2008); and Pukthuanthong and Roll (2009.)

Most of the studies confirm an increasing trend in integration or alternatively highlight the time-varying nature of integration[3]. One exception to this trend is a study by Ibrahim (2006). He concludes that during the period 1988 – 2003 the ASEAN countries became less integrated and more driven by country-specific factors. Bruner et al (2008) also report lower levels of integration – this time for emerging markets during the period 1994 – 2004.

The aim of this paper is to determine the level of stock market integration for a global sample of 49 countries. In doing so, two further methodological issues are addressed, first whether the number of stock market indices have an impact on the integration measure and secondly if the frequency of the data has an impact on the measure. The time-varying nature of integration is assessed by means of rolling regressions and finally an attempt is made to identify possible economic determinants of stock market integration.

2 LITERATURE REVIEW

2.1 Integration

According to Bekaert and Harvey (2003), financial markets are integrated when assets with identical risk yield the same return regardless of their domicile. During the integration process, emerging market stocks, with diversification potential, are bought by foreign investors, leading to higher prices. At the same time, both local and international investors stop investing in inefficient sectors. Sutherland (1996:522) describes financial market

[3] See Frijns, Tourani-Rad & Indriawan (2012); Yang, Kolari & Min (2003); Jawadi, Million & Arouri (2009); Lucey & Voronkova (2006); and Lin (2005)

integration as a process in which countries converge, and are faced by the same shocks. In addition, the hedging properties of their assets also converge.

Many studies use various versions of correlation coefficients to measure co-movement between financial assets. The literature is in agreement that correlations between the indices in levels are not appropriate. Either first differences or percentage returns are employed. However, correlation coefficients serve as a first indication of co-movement. In addition, correlation accounts only for bivariate analysis between two variables. The analysis weakens when the number of variables increases.

Raj and Dhal (2008) provide a comprehensive summary of the use of cointegration analysis in determining the presence of financial market integration. The presence of a single long-run relationship between a group of markets indicates that these markets are treated as single-asset countries by investors and that specific shocks affect investor sentiment towards the region (or group) as a whole (Voronkova, 2004: 639). While some authors report only on the outcomes of test statistics and the number of cointegrating vectors present, Voronkova (2004: 645) stresses that the statistical significance of the error correction term strengthens evidence in favour of integration. Like most other vector autoregressive (VAR) analysis, cointegration analysis can accommodate only a limited number of variables with the risk of running out of degrees of freedom where the number of coefficients exceeds the number of observations.

Other studies involve more than one empirical technique. See, for example, Lucey and Voronkova (2006), who tested the integration of the Russian stock market employing the Johansen multivariate cointegration approach, the Gregory-Hansen residual based cointegration test and a DCC-GARCH model. Pukthuanthong and Roll (2009) argue that correlation across indices is a poor measure of integration, and that the explanatory power (R-square) of a multi-factor model provides a better indicator of integration. This study follows closely the latter approach, that is, factor analysis which contains a large panel of global stock market returns.

2.2 Factor analysis

Following Emiris (2000), Brooks and DelNegro (2004), Kabundi and Mouchili (2009) and Pukthuanthong and Roll (2009) this study measures stock market integration as the

explanatory power (or the R-square) of a multi-factor model. Following the APT of asset returns, common sources of global systematic risk are identified for the global stock market. Using exploratory factor analysis, the appropriate number of latent factors is extracted through the principal components estimation technique. Once the latent factors/ common factors/ global factors of systematic risk have been identified, they are used as explanatory variables in a regression explaining returns on the various emerging stock market indices representative of the overall market (or all share). The R-square from these regressions is an indication of the proportion of the country's returns that are explained by global forces – and thus the level of the particular country's integration into global markets.

The use of cointegration analysis to test for integration is limited, when more than two series are involved. Factor analysis, the empirical technique employed in this study, is much more suitable to handle a large cross-section of time series data without having to deal with the loss of degrees of freedom – as would be the case when using cointegration. Factor analysis therefore is able to transform the "curse of dimensionality" into a blessing – see Bellman (1961), Donoho (2000) and Lam and Yao (2011) While cointegration analysis and VAR analysis are not able to handle the large panels of data and experience problems with degrees of freedom, factor analysis is designed to deal with large panels.

3 EMPIRICAL RESULTS

3.1 Data description

The stock market data is from the Datastream data base of Thompson Reuters[4]. The aim is to compile the largest possible sample of available stock market price indices that could be deemed representative of the global stock market. For that reason the sample includes the share indices of all the countries, as well as the different equity sub sectors available per country. Datastream provides indices for the all share (total market) per country as well as the following sub sectors: Oil and Gas; Basic Materials (Chemicals and Resources); Industrial; Consumer goods; Health care; Consumer services; Telecom; Utilities; Financial; and Technology. The following countries are included in the sample: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Cyprus, Czech Republic,

[4] See Thompson Reuters (2008) for a description of how the indices are compiled.

Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, United States and Venezuela,

Datastream provides index values since 1973. In 1973 data for only 17 countries are available. Since stock market data on most emerging markets is only available from the 1990s, and data on the Russian Federation only since February 1998 (and the Finance subsector of Russia only from 20 April), the time period for the study start on 18 May 1998 (the starting date for data on the Oil and Gas subsector of China). The sample therefore includes stock market data for 18 emerging market countries – all of them being classified as "emerging" according to the FTSE classification – as well as 31 other countries some of which are classified as "developed" and some classified as "economies in transition".

The raw data is in daily format and converted into either weekly observations by taking the average of the five observations of each week or monthly observations by taking the average of the daily observations for the specific month. Weekly/ monthly returns are calculated as the log difference of consecutive weekly/ monthly averages. These calculated returns are stationary, a prerequisite of the factor analysis that follows in section 3.2. A total of 691 weekly observations/ 159 monthly observations is included spanning the period May 1998 (week starting 18 May 1998) until August 2011 (week starting 8 August 2011). These 691 observations span across 49 countries and a total of 451 stock market indices. The market capitalisation of the listed companies in these 49 countries together accounted for 95.98% of the world market capitalisation, measured in US dollars, in 2010 – thus a truly global sample.

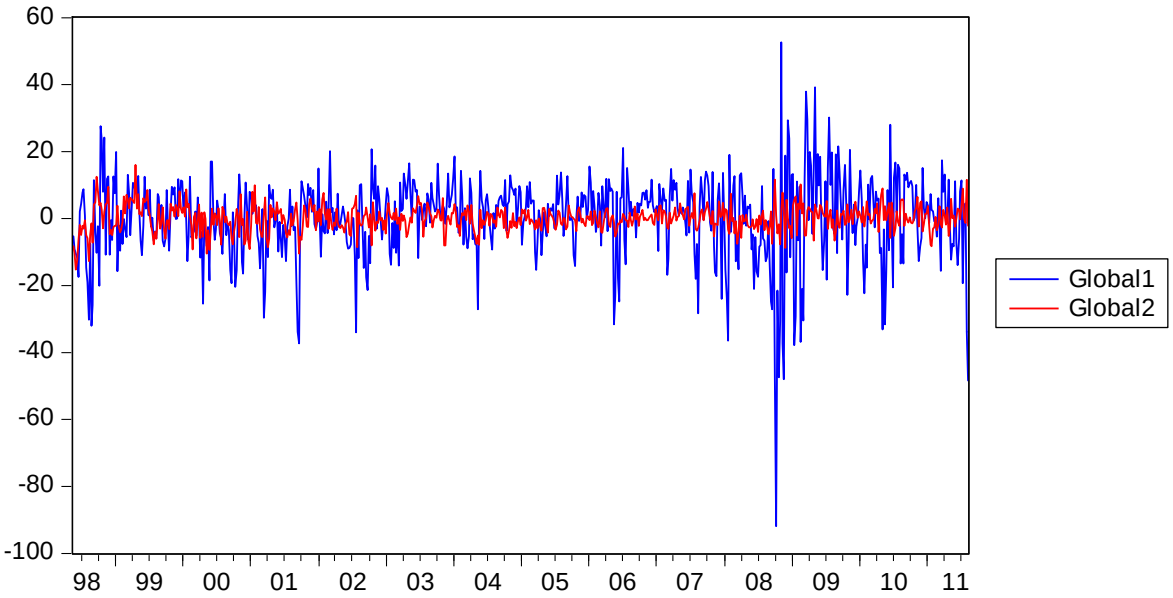
3.2 Common factors

Bai and Ng (2002) propose the use of panel criteria to statistically determine the number of factors needed to approximate a large number of related time series. No formal critical values were available before this 2002 publication and researchers had to make assumptions about the appropriate number of factors in their empirical studies. Unfortunately none of the PC or IP values indicate fewer than 10 factors. Considering the cumulative variance, the first factor

explains the highest share of variance: 34.7%. The second factor displays an eigenvalue of less than 0.05. Apart from considering the critical values, it is practice to add additional factors until the last factor adds 5% to total variation. Since the PC and IP values do not indicate less than 10 common factors, two factors are extracted. This is in line with previous empirical studies.

Moranara and Beltratti (2008) find one factor sufficient to explain changes in stock market returns and two factors for volatility. Lin (2005) employs a two factor model for the period 1985-1999. In one of the oldest stock market studies Ripley (1973) extracts four common factors from a sample of 19 developed markets – of which the first one explains more than half of common movements between 1960 and 1970. Employing principal component analysis two common factors are extracted from the global sample of stock market returns – see Figure 1.

Figure 1: Common factors extracted from global sample



The first factor (Global1 in Figure 1) is clearly more volatile than the second factor, also with a higher maximum and lower minimum. These common/ latent factors driving global stock markets (depicted in Figure 1) have no intuitive economic meaning.

3.3 Level of integration

After the above identification of the common factors driving the global stock market, the focus now shifts to the individual countries and their respective levels of stock market integration. The specific question is: to what extent are the stock markets of the world integrated into the global stock market? As discussed in section 2.2 the R^2 (or variance share) of a regression of the standardised return of each country's all share index on the two global factors serves as an indication of the level of integration.

Table 1 summarises the various variance shares for the 49 countries across four different samples.

Table 1: Comparing variance share across countries

	Weekly sample		Monthly sample	
Country	Sectors	All Share	Sectors	All Share
Argentina	0.327321	0.332861	0.372238	0.391787
Australia	0.781786	0.773345	0.838842	0.836449
Austria	0.751744	0.715708	0.784771	0.753787
Belgium	0.773904	0.766963	0.813966	0.774091
Brazil	0.573877	0.57905	0.691958	0.699227
Canada	0.736861	0.744622	0.793492	0.802021
Chile	0.498232	0.499811	0.644225	0.645293
China A	0.147443	0.122533	0.134176	0.113176
Colombia	0.194219	0.21848	0.377618	0.391356
Cyprus	0.279072	0.279632	0.338722	0.366561
Czech Republic	0.544884	0.54741	0.591125	0.605118
Denmark	0.742078	0.730727	0.797237	0.791196
Finland	0.528751	0.569526	0.512941	0.556552
France	0.893003	0.915148	0.909374	0.933534
Germany	0.832526	0.851812	0.863703	0.882032
Greece	0.566464	0.565889	0.662977	0.662651
Hong Kong	0.688358	0.657874	0.726464	0.712758
Hungary	0.595221	0.592754	0.714617	0.715124
India	0.459705	0.444956	0.551242	0.533767
Ireland	0.67779	0.67801	0.765525	0.756246
Israel	0.412081	0.400902	0.465106	0.481358
Italy	0.842545	0.854323	0.852633	0.8718
Japan	0.382727	0.365248	0.445828	0.443753
Korea South	0.456228	0.443641	0.597176	0.600035
Luxembourgh	0.464994	0.460773	0.578676	0.592135
Malaysia	0.350049	0.324	0.450937	0.407904

Mexico	0.599193	0.608477	0.713226	0.726326
Netherlands	0.882114	0.886915	0.925138	0.924959
New Zealand	0.586403	0.581774	0.673169	0.673212
Norway	0.73754	0.720624	0.80112	0.784122
Pakistan	0.069703	0.066564	0.212157	0.1962
Peru	0.344875	0.393125	0.493732	0.518217
Philippines	0.502839	0.530033	0.630826	0.670113
Poland	0.583314	0.587373	0.672945	0.691432
Portugal	0.68053	0.684736	0.774697	0.781741
Romania	0.283461	0.280945	0.484488	0.483676
Russian Federation	0.430368	0.452921	0.523788	0.554668
Singapore	0.723365	0.701773	0.804638	0.79856
South Africa	0.6205	0.625426	0.668037	0.667505
Spain	0.804964	0.818609	0.806959	0.814134
Sri Lanka	0.056976	0.083734	0.185975	0.2059
Sweden	0.760869	0.786252	0.796616	0.827441
Switzerland	0.767192	0.769086	0.837981	0.828404
Taiwan	0.505635	0.484374	0.633725	0.627402
Thailand	0.602328	0.593287	0.657339	0.680374
Turkey	0.385457	0.374771	0.498227	0.494998
UK	0.826481	0.835678	0.882917	0.880185
US	0.654393	0.663584	0.745594	0.761655
Venezuela	0.028775	0.033389	0.1134	0.124635
Average	*0.549778*	*0.551009*	*0.628822*	*0.633379*

Daily data is converted into weekly data by taking the average closing price of the five weekdays and average of daily values for the month – hence the weekly and monthly samples. In a second step the included stock market indices are also split into two groups: in the first instance (called sectors) all the available stock market indices available for each country are included in the sample – see discussion of the indices in Section 3.1. In a smaller sample only the All Share indices of the 49 countries are included. This is an attempt to determine if the frequency of the data has an impact on the calculated level of integration and also if the addition of sub-sector indices adds to the explanatory power of the extracted common factors.

Although the results differ between countries, the general observation is that the level of integration is higher in the samples compiled from monthly data as well as the smaller sample of indices only including the movement in prices of the total market or all share index. The

empirical results indicate the difference between common factors from the two sub-samples; and that stock markets from developed countries are generally more integrated into the global stock market than stock markets from emerging market countries. Focusing on individual countries, France and the Netherlands are among the developed stock markets with the highest variance share (highest level of stock market integration) – while South Korea and Japan report the lowest levels of integration. From the emerging markets group, South Africa and Thailand are the most integrated into the global stock market – with China and Pakistan the two countries with the lowest level of stock market integration. The stock markets of France and the Netherlands are therefore mainly driven by global factors while South Korea and Japan are driven by idiosyncratic or country specific factors.

Since the variance shares (as absolute measure of integration) vary across the different samples in Table 1, an attempt is made to see if the rankings of countries would be influenced by the choice of sample. Table 2 indicates the ranking of each country (starting from highest variance share to lowest variance share) in each of the four samples.

Table 2: Comparing rankings across samples

	Weekly sample		**Monthly sample**	
Country	Sectors	All Share	Sectors	All Share
France	1	1	2	1
Netherlands	2	2	1	2
Italy	3	3	5	5
Germany	4	4	4	3
UK	5	5	3	4
Spain	6	6	9	9
Australia	7	8	6	6
Belgium	8	10	8	15
Switzerland	9	9	7	7
Sweden	10	7	13	8
Austria	11	14	15	18
Denmark	12	12	12	12
Norway	13	13	11	13
Canada	14	11	14	10
Singapore	15	15	10	11
Hong Kong	16	19	19	21
Portugal	17	16	16	14
Ireland	18	17	17	17
US	19	18	18	16
South Africa	20	20	25	27

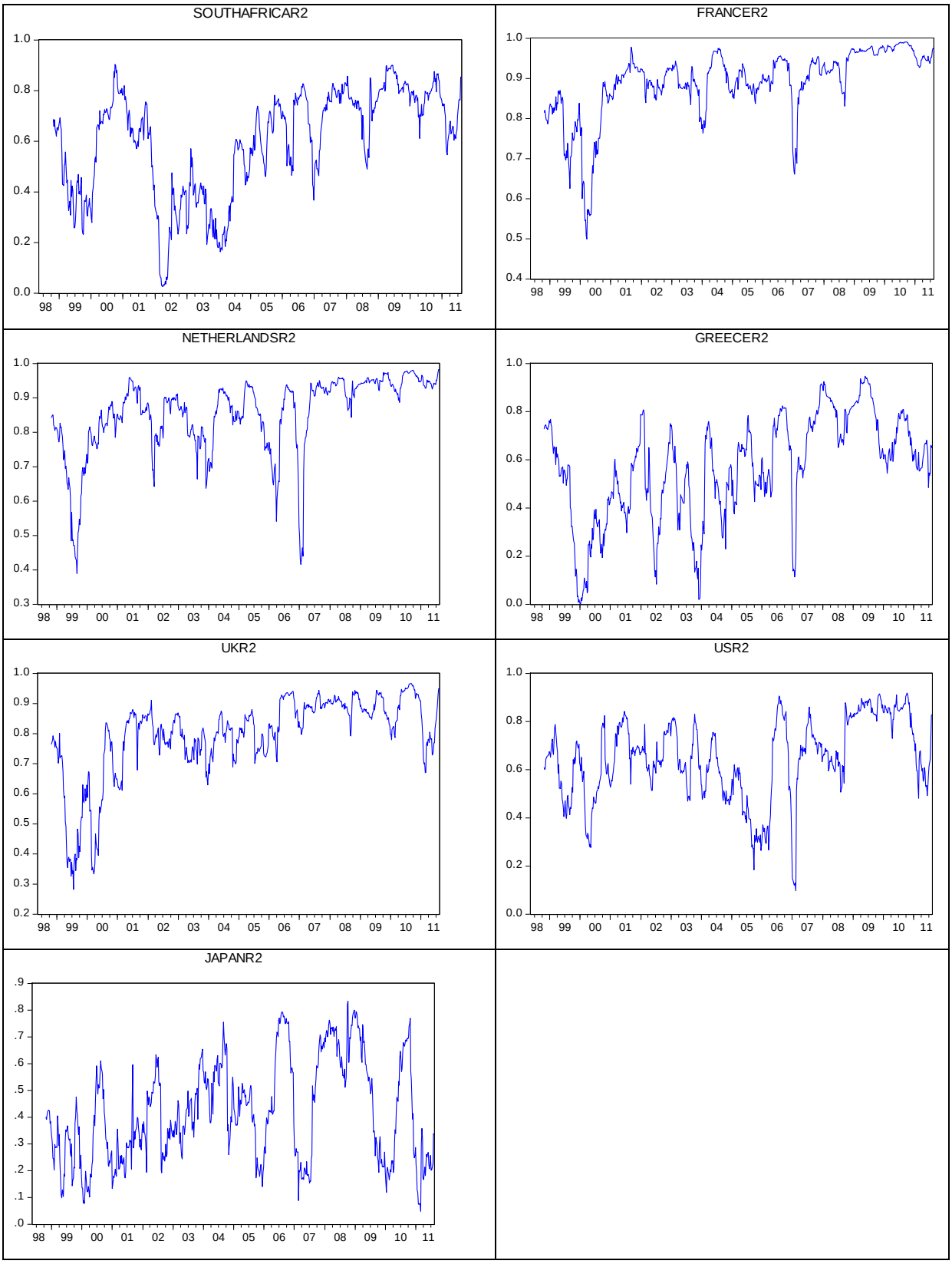
Thailand	21	22	27	24
Mexico	22	21	21	19
Hungary	23	23	20	20
New Zealand	24	25	23	25
Poland	25	24	24	23
Brazil	26	26	22	22
Greece	27	28	26	28
Czech Republic	28	29	32	31
Finland	29	27	36	34
Taiwan	30	32	29	30
Philippines	31	30	30	26
Chile	32	31	28	29
Luxembourgh	33	33	33	33
India	34	35	34	36
Korea South	35	36	31	32
Russian Federation	36	34	35	35
Israel	37	37	40	40
Turkey	38	39	37	38
Japan	39	40	42	41
Malaysia	40	42	41	42
Peru	41	38	38	37
Argentina	42	41	44	43
Romania	43	43	39	39
Cyprus	44	44	45	45
Colombia	45	45	43	44
China A	46	46	48	49
Pakistan	47	48	46	47
Sri Lanka	48	47	47	46
Venezuela	49	49	49	48

Even though the rankings seem to be quite similar across the four samples, in some cases like Belgium, the ranking can vary as much as between 8th and 15th. These rankings should therefore be interpreted with care.

3.4 Time-varying integration

As stated before, the variance share reported in Table 1 is the R^2 of a regression of each country's standardised stock market return on the two global common factors over the whole sample period. In an attempt to investigate the possible changing level of integration, 24-week rolling regressions are run using the same variables.

Figure 2: Time varying integration of selected markets



From Figure 2 a general high level of integration is observed for France, the Netherlands and UK. Greece displayed increasing levels of integration until 2009 when concerns were raised about debt levels. Japan display high volatility in integration and a decline towards the end – indicative of how country specific forces are driving their stock market.

The JSE also deviates from global stock markets from time to time – as is evident from lower variance shares obtained from the rolling regressions. Especially during the initial part of the study sample, certain country-specific factors are identified. Relaxed exchange controls led to an outflow of portfolio investments through the selling of South African shares and the purchase of foreign shares. This led to lower share prices – something that was not mirrored elsewhere in the world. Political uncertainty related to the second round of democratic elections in the country also had an impact on the JSE that could not be explained by global factors. The subsequent depreciation of the rand was not observed in other emerging market economies. Later in the study period the dependency on/sensitivity to movements in the share prices of resources led to lower levels of integration. The JSE would therefore react relatively more to developments in resource prices than global markets. During the last part of the study period weaknesses in developed stock markets (Lehman Brothers collapse, debt crisis in Europe to a lesser extent) resulted in foreigners preferring to buy emerging markets stocks. This also led to lower levels of integration with developed markets and greater synchronisation with emerging stock markets.

Appendix A contains the graphical results for some emerging market countries. The general trend observed from Appendix A is that of increasing levels of integration for emerging markets over time – however it is not true for China, Pakistan, Peru, Thailand and Turkey. Although still volatile the levels of integration generally increased since 2006 (see for instance the graphs of Hungary, Malaysia, Mexico, Poland and South Africa). The sample period does not include the full Russian/Asian crisis of 1997-98, but it does cover the global financial crisis. Frijns et al (2012) observe that the start of a crisis usually reduces the level of integration. This is evident from Appendix A as all the variance shares significantly lower during 2008. Although not to the same extend, a general lower level of integration is evident during 2010 and 2011 at the same level coinciding with the Euro debt crisis.

3.5 Determinants of integration

Various studies have linked the level of financial integration with specific economic variables (see for instance Arfaoui and Abaoub (2010) Forbes and Chinn (2004)). The variables identified by the literature as determinants of financial integration include: economic growth, local inflation, trade openness, local investment as % of GDP, budget surplus/ deficit, market capitalization to GDP, domestic bank credit to GDP, domestic institutional and legal environment and world interest rates. In an attempt to look for a possible link between stock market integration of the 49 countries and macroeconomic variables, certain macroeconomic variables were obtained from the World Bank and Global Competitiveness Report. Initial results (not reported here) including the full sample of 49 countries did not render any statistically significant results. The focus then shifted to the 18 emerging markets in the sample, of which South Africa is one.

Table 3: Stock market characteristics

Country	Market Cap	Data commence	Regulate	Restrict
South Africa	129.5	1/1/1973	6.0	3.9
Thailand	77.7	12/29/1986	4.8	4.4
Mexico	34.9	1/4/1988	3.8	4.9
Hungary	13.7	6/17/1991	4.5	5.2
Poland	26.8	2/28/1994	5.0	4.5
Brazil	49.6	7/4/1994	5.7	4.4
Czech Republic	17.8	11/8/1993	4.6	5.2
Taiwan	140.2	9/7/1987	5.2	3.8
Philippines	73.8	9/7/1987	4.1	4.5
Chile	107.6	7/3/1989	3.7	5.4
India	54.0	1/1/1990	5.3	4.4
Russian Federation	41.8	1/26/1998	3.3	3.4
Turkey	26.0	1/4/1988	4.6	5.0
Malaysia	136.6	12/30/1985	5.2	4.4
Peru	46.5	1/3/1994	3.4	5.3
Colombia	60.0	12/30/1991	3.5	3.8
China	46.3	8/26/1991	4.4	3.3
Pakistan	15.3	7/13/1992	4.0	4.2

Market Cap: Market capitalization as % of GDP (Source: World Bank)
Data Commence: The starting date of Datastream data – indication of age of stock market
Regulate: Global Competitiveness 2011 score for regulation of securities exchange (higher value indicates better regulation)
Restrict: Global Competitiveness 2011 score for the restrictiveness of capital flows to the country (higher value indicates fewer restrictions)

In looking for explanations for the varying levels of emerging stock market integration, Table 3 contains stock market indicators for the 18 countries. Market capitalization refers to the total value of shares listed on the stock market of the country as a % of the country's GDP. "Data commence" indicates the date from which onwards stock market data for the specific country is available on Datastream database. This serves as a proxy for the age of the stock market. The last two indicators are taken from the 2011 Global Competitiveness Report. "Regulate" represents the score regarding the question to assess the regulation and supervision of securities exchanges in the country (A score of 1: Ineffective; and 7: Effective). "Restrict" measures the restrictiveness of regulations related to international capital flows (1: Highly restrictive; 7: Not restrictive at all).

With the exception of Pakistan, countries like Hungary, Poland and the Czech Republic (with relative young market economies) display the lowest levels of market capitalization and some of the highest variance shares. Taiwan and Malaysia with some of the highest market capitalization percentages are ranked somewhere in the middle of the 18 countries, while the highest ranked South Africa is also among the countries with the highest market capitalization.

Spearman rank correlations are calculated in a more formal approach to explain the varying levels of integration among emerging markets. The integration ranking is compared to rankings regarding the four characteristics in Table 4. Only two of the four rank correlation coefficients are marginally significant. The rank correlation between integration and age is 0.323 (t value of 1.2) and between integration and regulate 0.447 (t value of 1.6). There seems to be some evidence that the older and better regulated emerging stock markets are the ones who are more integrated into the global stock market.

Building on the mentioned rank correlations OLS estimates are provided in Table 4.

Table4: OLS results for emerging markets

Dependent variable: Integration		
Explanatory variable	**Estimated coefficient**	**Probability**

Openness	0.0005	0.4931
Budget balance	0.0339	0.0295
Restrict	0.0293	0.5201
Regulate	0.1612	0.0007
C	-0.3903	0.1324
Observations	18	
Adjusted R^2	0.5159	

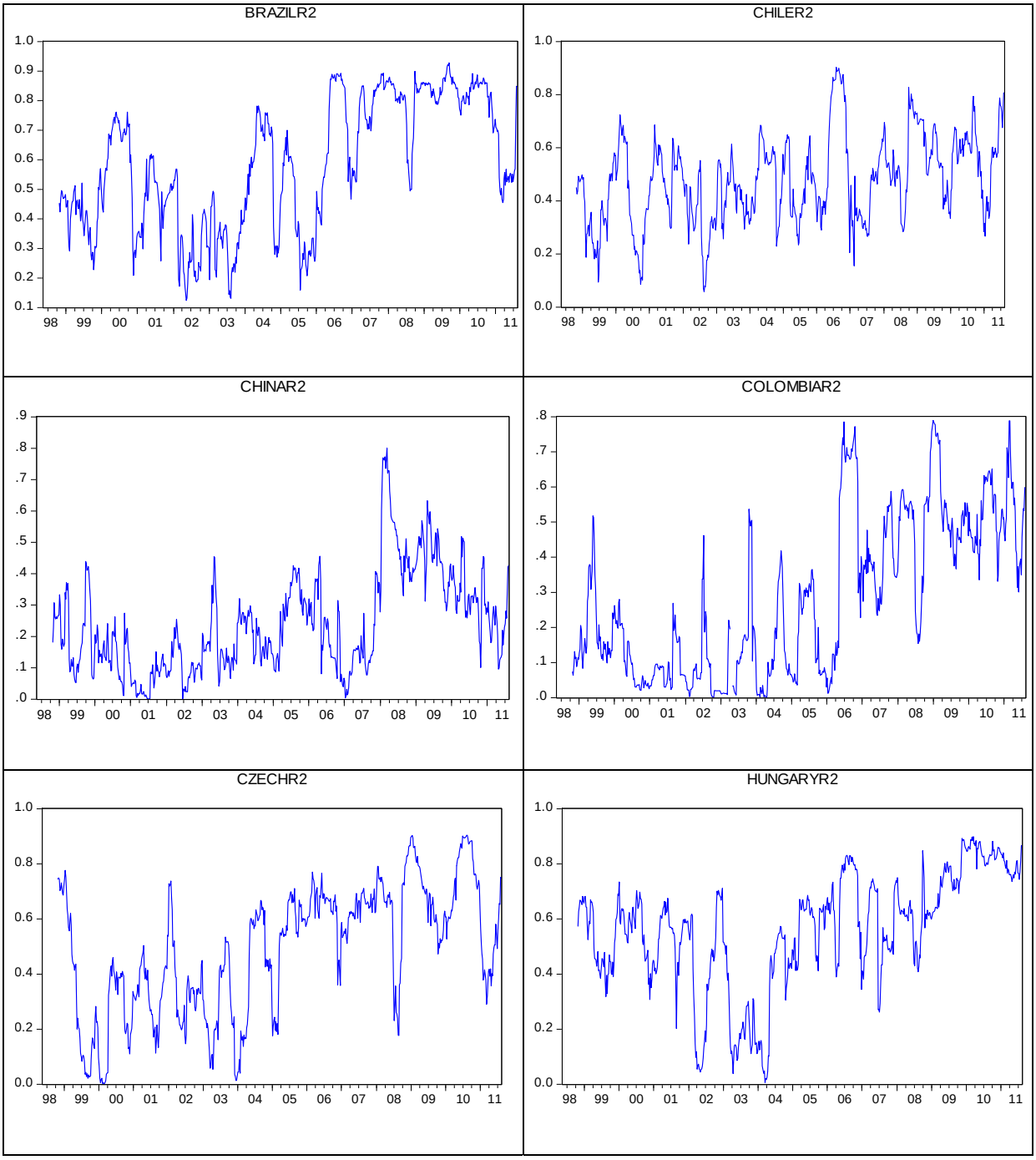
* Estimated with White-Heteroskedasticity-consistent standard errors and covariance

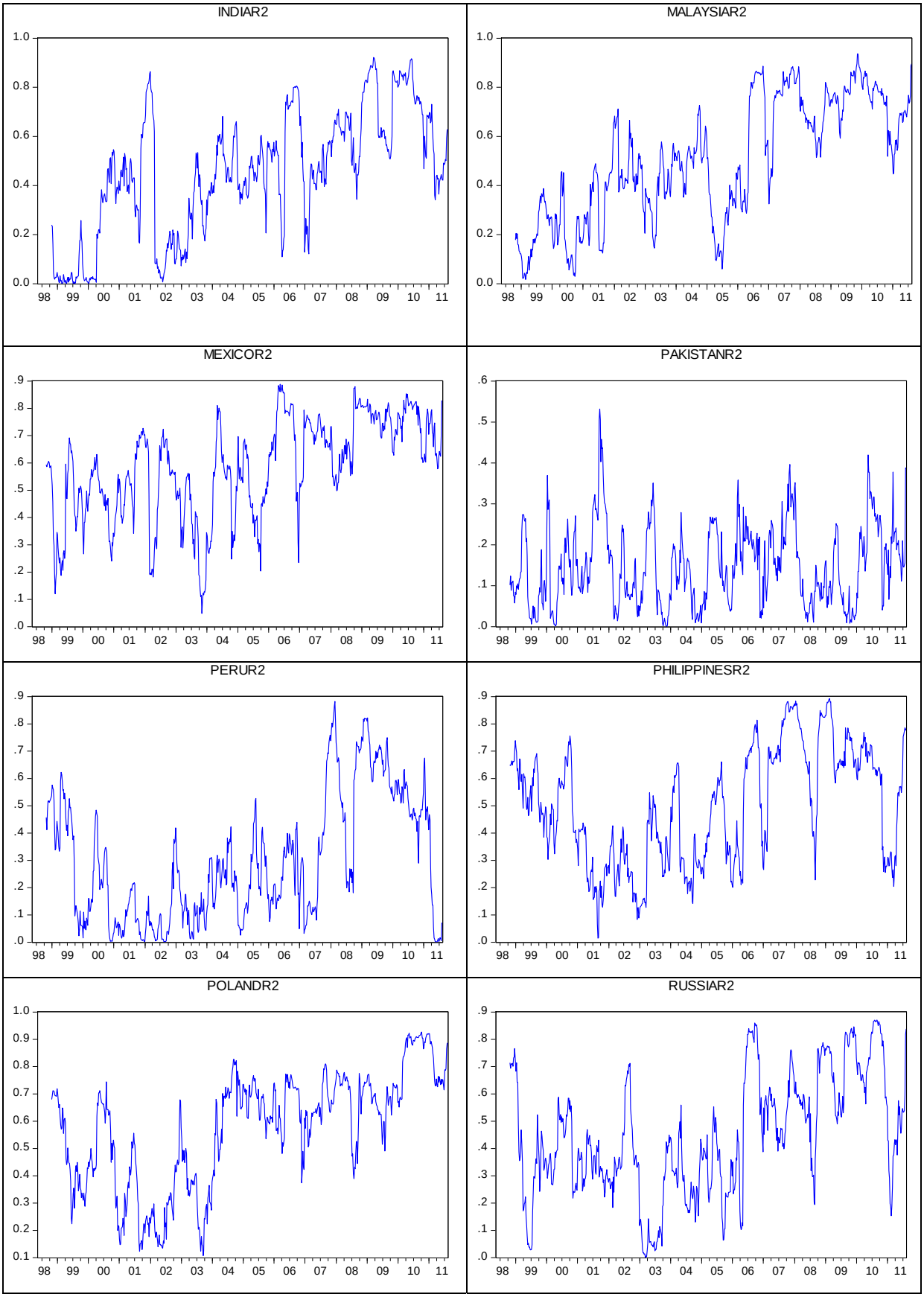
Despite the low number of observations, the estimates render two statistically significant determinants. The surplus/ deficit of the budget as well as the strictness, with which the stock exchange is regulated, have a statistically significant impact on the level of stock market integration. However, further analysis of the determinants over the full global sample of countries is needed in order to make valid conclusions. For instance, panel data analysis can be employed where annual measures of integration are combined with macroeconomic variables in annual frequency. This should render more refined results than the current analysis of one value for the entire 21 year sample period.

4. CONCLUSION

Spanning over a global sample of stock markets this is one of the most comprehensive studies on stock market integration to date. The empirical results confirm that two common factors drive global stock market returns – confirming the applicability of the APT. The methodological question of whether the sample choice matters is answered in varying levels of integration being indicated by four different samples. The larger samples, spanning weekly observations and including more stock market indices, render lower levels of integration. Analysis over rolling periods indicates the varying nature of integration for most countries. During periods of financial crises changing levels of integration are observed in general and across most countries. Finally there is some evidence that the age of the stock market, the country's fiscal balance, and level of regulation of the specific stock market have an impact on the level of stock market integration.

Appendix A: R^2s (variance shares) from 24-week rolling regressions

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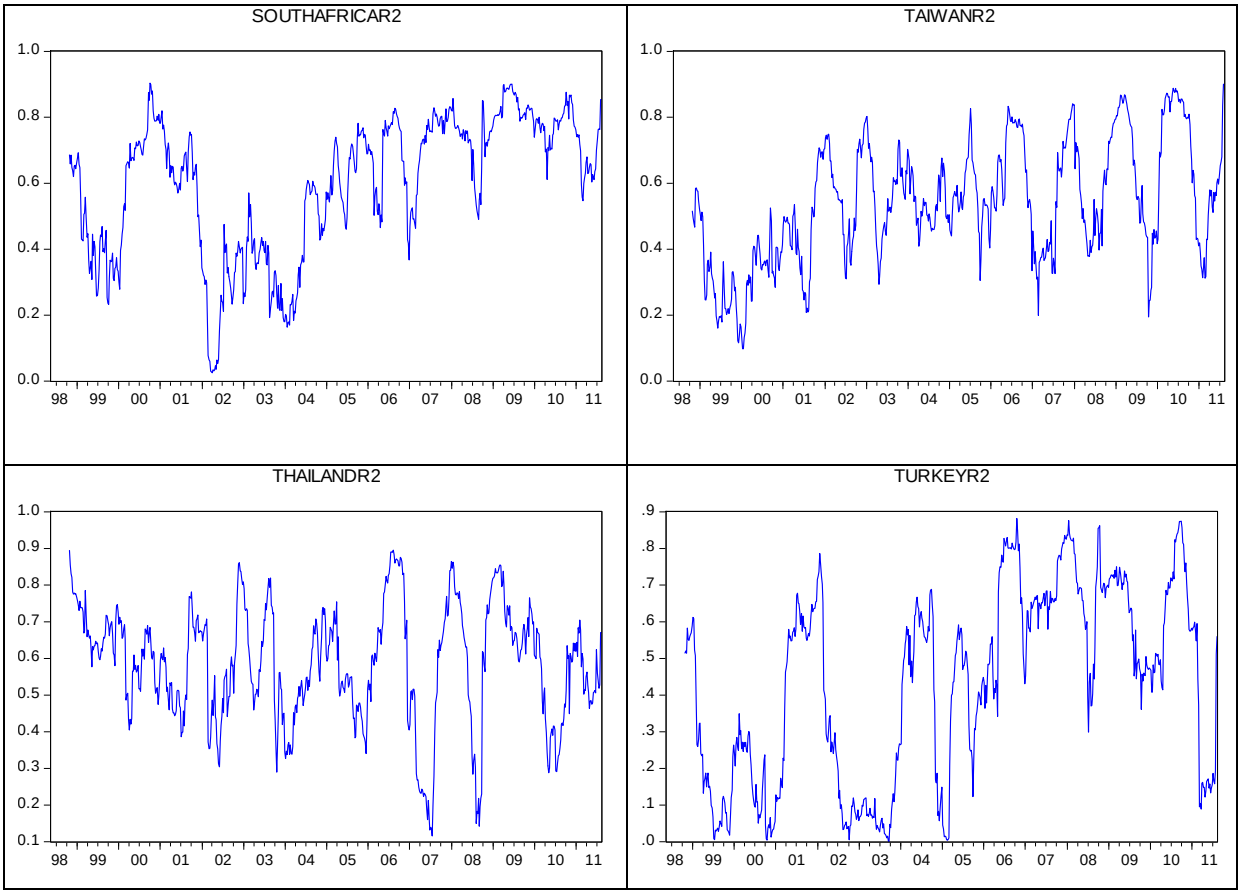
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