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Analysing the Effect of Portfolio Concentration Index and Stock Market Correlation (*Menganalisis Kesan Indeks Kepekatan Portfolio Terhadap Korelasi Pasaran Saham*)

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ABSTRACT

The objective of this research was to test the effect of portfolio concentration on market correlation. The relationship between stock market linkages and portfolio concentration was investigated to gain a better understanding of the vulnerability that a country is subjected to during a global financial crisis. The portfolio concentration index of a country reflects its portfolio investment strategy and design, whether it prefers to concentrate its portfolio of stocks in a handful of target markets or to geographically diversify its investments. It was found that countries that had invested disproportionate weights in selected financial markets were significantly different from those countries that held less concentrated portfolios in terms of their effect on financial market integration. The portfolio concentration index, real interest rate differential, industrial production growth differential, and stock market size differential were statistically significant in influencing the correlation in stock returns when a fixed effects model was employed for a sample of 25 investing and 27 investee countries from 2001 to 2014. This study implied that although portfolio allocation affects financial market integration, it is not significantly related to financial spill-overs during crisis periods. The findings may shed light for investors regarding portfolio designs and allocation decisions.

Keywords: Portfolio concentration; stock return correlation; stock market co-movement

ABSTRAK

Objektif kajian ini adalah untuk menguji kesan kepekatan portfolio terhadap korelasi pasaran saham. Hubungan antara rangkaian pasaran saham dan kepekatan portfolio akan diselidik untuk lebih memahami kelemahan negara yang tertakluk dalam jangkamasa krisis kewangan sejagat. Indeks kepekatan portfolio negara mencerminkan strategi dan reka bentuk pelaburan portfolionya, sama ada mereka memilih menumpukan portfolio saham mereka dalam beberapa pasaran sasaran atau mempelbagaikan pelaburan mereka secara geografi. Negara-negara yang melaburkan berat tidak seimbang ke pasaran kewangan terpilih didapati jauh berbeza daripada negara-negara yang memegang portfolio kurang tertumpu dalam mempengaruhi integrasi pasaran kewangan. Indeks kepekatan portfolio, kadar faedah sebenar pengkamiran, hasil perindustrian pengkamiran pertumbuhan, dan saiz pasaran saham pengkamiran adalah penting dari segi statistik dalam mempengaruhi korelasi pulangan saham dengan meggunakan model kesan tetap untuk sampel 25 negara pelaburan dan 27 negara penerima pelaburan dari tahun 2001 hingga 2014. Kajian ini menyiratkan peruntukan portfolio walaupun mempengaruhi integrasi pasaran kewangan tetapi tidak ketara berkaitan dengan penyebaran kewangan semasa krisis. Penemuan ini mungkin memberi penerangan kepada pelabur mengenai keputusan portfolio dan peruntukan portfolio.

Kata Kunci: Kepekatan portfolio; korelasi pulangan saham; pergerakan pasaran saham

INTRODUCTION

Cross-border capital investment is rapidly gaining prominence as the transaction value of cross-border capital has been surpassing the value of direct investments in recent years. Also, it has been observed that international capital flows have

increased substantially among regional partners. On the one hand, investing in foreign stock markets that are less correlated with the domestic market generates higher potential returns with lower portfolio risks. On the other hand, greater correlation among stock markets may increase the risk of spill-overs in times of market turmoil. A financial crisis can be extended to neighbouring countries and regional partners that are maintaining close financial linkages (Azman-Saini et al. 2002; Tong & Wei 2011; Rijanto 2017).

Apparently, a fully-closed economy has a lower risk of financial spill-overs, but the economy may experience sluggish growth due to lower international integration. Bhagwati (1998) asserted that foreign capital flows create panic, and can potentially bring about a destabilizing effect on the domestic stock bourse. The benefits of an international portfolio diversification are unappreciated by domestic investors as financial contagion and volatility spill-overs negate the benefits of holding diversified international portfolios.

The traditional asset pricing theory asserts that investors should hold world market portfolios by fully diversifying their investments. However, theories based on the advantages of information, as suggested by van Nieuwerburgh & Veldkamp (2009) predict portfolios that are home-biased and concentrated in selected markets, and financial securities can be optimal. The suggestion by van Nieuwerburgh and Veldkamp (2009) that investors assign disproportionate weights to particular financial markets and securities is, in fact, a rational choice and a reflection that investors hold a superior and initial information advantage in selected foreign markets.

The role of portfolio concentration has been gaining more attention in recent works (Choi et al. 2017). Portfolio concentration measures the extent to which the value of the equity portfolio of a home country that is being held in a particular host country deviates from the average share of the equity portfolio investment of the host markets. The portfolio concentration index of a country reflects its portfolio investment strategies and design, whether it prefers to concentrate its portfolio of stocks in a handful of target markets or geographically diversify its investments. A high-concentration country may differ from a low-concentration one with regard to the extent of financial market integration and co-movements in market returns during crisis periods.

Nevertheless, the existing research focused on the relationship between the under-diversification of international portfolios to the optimal world market portfolios and abnormal returns (Choi et al. 2017; Fjesme, in press; Fulkerson & Riley 2019) and the sources of abnormal portfolio returns (Karolyi et al. 2019). Since increased stock market correlations may lift the risk of spill-overs, an investigation into the link between the portfolio holdings concentration and stock market correlations may help in understanding the mechanisms responsible for the propagation of external shocks during a financial crisis. This paper attempted to assess whether a country with a higher concentration of international portfolio investments will lead to non-fundamental co-movements in stock market returns. It would be interesting to investigate which type of country investors increase cross-market linkages. The present work contributes towards an understanding of the effect of portfolio concentration strategies on stock market connectedness and the driving factors of the market integration process. Understanding the relationship between optimal foreign portfolio investments and the returning co-movement may help to improve market resilience and economic growth. Equity market integration is a central issue in finance as it has critical implications on portfolio risk management and asset pricing.

Table 1 exhibits the equity portfolio concentration index by home countries in a sample of 27 host countries over a period of 14 years (2001-2014). Norway held the most concentrated equity portfolio, followed by the Netherlands. Russia had the most geographically diversified external portfolio equity liabilities, and an equity portfolio with the lowest concentration, while Malaysia held a less concentrated equity portfolio in international financial markets.

The remainder of this research paper is structured as follows: Empirical reviews with regard to the influence of a country's concentration on the interdependence of equity markets are presented for consideration along with the traditional determining factors of co-movements in stock returns in Section 2. Section 3 describes the sample selection procedure, data sources and research methodology. Section 4 discusses the results of the stock market synchronization using a static panel model and fixed-effect instrumental variable estimation. Section 5 presents the conclusion for the paper.

TABLE 1. Average concentration portfolio index by home country over the period 2001-2014

Home country	Portfolio concentration index (%)
Norway	10.03
Netherlands	8.64
Cyprus	8.05
Austria	3.91
Denmark	3.19
Canada	2.89
Canada	2.89
Sweden	2.21
Argentina	1.97
Belgium	1.76
UK	1.28
UK	1.28
Italy	0.84
Switzerland	0.7
Germany	0.56
Japan	0.39
France	0.34
Portugal	0.3
Czech republic	0.3
Hungary	0.27
Hong Kong	0.23
US	0.17
US	0.17
Greece	0.06
South Korea	0.06
Malaysia	0.03
Brazil	0.00
Russia	0.00

Notes: The concentration index of a home country is measured by the sum of the squared sum of the squared deviations of the foreign equity portfolio investment of country i in country j from the underlying optimal portfolio. The higher the percentage index, the higher is the extent of the portfolio concentration.
Source: Coordinated Portfolio Investment Survey and the author's own calculations.

LITERATURE REVIEW

Two countries with a similar macroeconomic performance should yield more or less a co-movement in stock markets (Pretorius 2002). Changes in economic fundamentals such as growth rates in consumer price indices, interest rates and industrial productions affect stock market interdependence. A larger difference in these economic indicators between two countries suggests a smaller correlation in their stock market performances.

In investigating 10 stock markets between 1972 and 1993, Bracker et al. (1999) reported a negative effect of the real interest rate differential on the return co-movement. In contrast, a short-term interest rate differential does not factor significantly in determining the return co-movement of European stock (Büttner & Hayo 2009). Pretorius (2002) found that the interest rate differential and inflation differential do not play a role in driving stock market correlations. However, stock prices between two countries converge when their industrial production growth exhibits a similar trend (Pretorius 2002).

Aside from that, the GDP growth differential appeared to be statistically significant in explaining the integration of the stock market for a sample of 20 country pairs based on the Geweke Measure of Feedback method (Bracker et al. 1999). Albeit, Beine and Candelon (2011) suggested that the output growth between two countries poorly explains the co-movement in stock prices. Further, stock market developments exert an influence on co-movements in equity returns between two countries. The equity market development, transaction cost, and information cost are similar for stock markets that have more or less the same size. A larger discrepancy in size, as measured by the market capitalization of domestic listed companies, will cause a lower interdependence between the markets (Bracker et al. 1999; Johnson & Soenen 2003; Lucey & Zhang 2010; Pretorius 2002).

In a more recent study, Brushko and Hashimoto (2014) analysed the impact of a country's concentration on changes in its foreign portfolio investments before and after the global financial crisis. They found that countries with high and low investment concentration indices differed in their response to changes in macroeconomic variables such as the Consumer Price Index, unemployment rate and income growth. They suggested that the risk tolerance level for high-concentration countries is greater. On the other hand, a home country that invests more evenly in destination countries

(low investment concentration) may withdraw capital from crisis-originating countries for reasons that are unrelated to economic fundamentals in response to changes in general macroeconomic factors.

Vermeulen (2013) showed that investors tilt their equity investments toward foreign markets that are less correlated with their home market during times of stock market turbulence. Vermeulen (2013) concluded that portfolio diversification enhances financial stability when stock markets crash. Countries with a more diversified portfolio will experience less volatility in their equity portfolios (Vermeulen 2013).

A concentrated equity holdings pattern affects bilateral correlations in stock returns. Investment concentration can be a channel of shock transmission. Shinagawa (2014) stated that a country with a higher concentration in international equity portfolios is able to contain a spill-over risk if the returns generated from the subset of foreign countries are high. The returns earned from the concentrated investments serve as a cushion for financial spill-overs measured by the correlation coefficients. On the other hand, a country with a more diversified international portfolio may face a lower risk of financial spill-overs. This may be due to the greater capacity of the investing country to withstand common financial shocks (Shinagawa 2014).

The information advantage theory (van Nieuwerburgh & Veldkamp 2009) infers that a deviation from world market portfolios by concentrating investment in a particular country is in fact a rational choice driven by the initial comparative information advantage possessed by international investors. Many empirics show that international investor portfolios are less well-diversified across international markets and are concentrated only in a handful of foreign countries. The fact as to whether portfolio concentration is due to some behavioural bias or a rational portfolio choice has yet to be substantiated by extant literature. Brushko and Hashimoto (2014) proposed that investing countries with a higher concentration of international portfolio holdings responded differently compared to low-concentration countries to changes in macroeconomic variables before and during the 2007-2010 financial crisis. Utilizing a sample of 42 countries over the period 2001-2012, Shinagawa (2014) provided mixed evidence of countries with a concentration on bilateral co-movements in stock returns, as measured by adjusted correlation coefficients. The effect of the interaction term between a crisis dummy and a country's concentration on financial spill-overs for the full sample was significantly negative, but the variable turned positive and became insignificant for the sample of advanced economies using the difference GMM estimator.

In more recent works, foreign portfolio concentrations on abnormal portfolio returns are gaining the interest and attention of researchers (e.g. Choi et al. 2017; Fjesme in press; Fulkerson & Riley 2019). Choi et al. (2017) lent support to the information endowment theory of van Nieuwerburgh and Veldkamp (2009) by finding a positive significant relationship between foreign portfolio concentration, home concentration and global industry concentration on excess returns. They explained that institutional investors are rational in their decision making, and possess superior information on those assets, and hence, opt to invest in the selected stock markets that they are more informed of. Narrowing the sample to emerging markets, Karolyi et al. (2019) determined the sources of excess stock portfolio concentrations, and found that institutional investors tend to hold more concentrated portfolios in target countries in which their headquarters or subsidiaries are located. Karolyi et al. (2019) suggested that concentrated foreign portfolios are associated with selected familiar foreign markets, thereby providing evidence to the information advantage hypothesis.

Earlier researches emphasized the effect of macroeconomic fundamentals and stock market characteristics on market correlations (Pretorius 2002), while more recent researches focused on the relationship between portfolio concentration and excess returns (Choi et al. 2017; Fjesme in press; Fulkerson & Riley 2019), thus leaving a gap in the literature concerning the link between portfolio concentration on equity market connectedness. It is interesting to ascertain whether a country with a more geographically concentrated portfolio experiences a significant change in cross-market linkages in times of market upheaval. Expanding the research to a global setting could provide insights into the role of a country's concentration on co-movements in asset prices worldwide with the utilization of a greater breadth of data in the study.

DATA AND RESEARCH METHODOLOGY

MEASURING PORTFOLIO CONCENTRATION

This research measured high and low equity concentrations across countries following the method by Brushko and Hashimoto (2014). The concentration index in Equation 1 below shows the sum of the squared deviations of the foreign equity portfolio investments of country i in country j from the benchmark portfolio. The benchmark portfolio is defined as the average share of foreign equity portfolio investments for all samples in the host country, j. The construction of the portfolio concentration index was employed because of the time-varying properties of the optimal equity investment calculated from the CPIS data. Secondly, the index took into account the attractiveness of the host country, since a more favourable country receives a greater portfolio equity investment (Brushko & Hashimoto 2014).

The home country's portfolio concentration index took the following form:

$$CI_{it} = \sum_{j}^{N} \left(W_{ijt} - W_{jt}^{*}\right)^{2} \quad (1)$$

where CI= country concentration index; W_{ijt} = foreign portfolio equity invested by home country i into host country j; W_{jt}^{*}= average foreign portfolio equity invested in country j.

MEASURING STOCK MARKET CORRELATIONS

Correlation coefficients were employed to gauge the degree of equity and bond market co-movements across countries. This direct approach to measure the interdependence of stock markets is common and was widely adopted in prior empirical researches (Bracker et al. 1999; Bunda et al. 2009; Pretorius 2002; Wälti 2011). Following Wälti (2011), Pearson's correlation coefficient (ρ), which is not normally distributed, was transformed using the following formula:

$$Adjusted\ \rho_{ijt} = ln\left(\frac{1+\rho_{ijt}}{1-\rho_{ijt}}\right) \quad (2)$$

MODEL SPECIFICATIONS

The following model was adapted from Pretorius (2002), and was extended to include the concentration index of a country, as proposed by Brushko and Hashimoto (2014), to determine the stock market linkages. Accordingly, the model was specified in the following form:

$$W_{ijt} = \beta_0 + \beta_1 CI_{ijt} + \beta_2 CI_i \times CRISIS_{ijt} + \beta_3 \prod\_DIFF_{ijt} + \beta_4 R\_DIFF_{ijt} + \beta_5 IPG\_DIFF_{ijt} + \beta_6 SIZE\_DIFF_{ijt} + \beta_7 RGDPG\_DIFF_{ijt} + \varepsilon_{ijt} + \mu_{ij} \quad (3)$$

where the subscripts of i, j, and t denote the home country, host country, and time, respectively; μ_{ij}= unobserved country-specific effect between countries i and j such as their historical, cultural and social differences; ε_{ijt}= error term that is assumed to be normally distributed with mean 0 and variance σ^2; W = market correlation; CI= concentration index; π_DIFF = absolute difference in the annual percentage change in CPI between country i and country j; R_DIFF= absolute value of the difference in the short-term real interest rate; IPG_DIFF= absolute value of the difference in the industrial production growth; $SIZE\_DIFF$ is the absolute difference in the ratio of the stock market capitalization to GDP, and $RGDPG\_DIFF$ is the absolute value of the difference in the real GDP growth

β1 and β2 were expected to carry a positive sign as a higher country concentration would indicate stronger financial links between two countries and thus, a greater extent of stock market co-movements. β3, β4, β5, β6, and β7 were expected to carry a negative sign because a larger difference in these macroeconomic indicators between two countries would suggest a smaller correlation in their stock market performances.

A fixed effects regression model was chosen to investigate the interdependence of international equity markets in this study. The selection of a fixed effects model was determined by the Hausman specification test. The selection criterion was based on the correlation between the unobserved heterogeneity and the independent variables. If the country-specific effect is uncorrelated with the regressors, a random effects model will provide unbiased and efficient estimators. If the Hausman test rejects the null value of the regressor-effect independence, the regression should be estimated using the fixed effects model.

DATA AND SAMPLE SELECTION

Table 2 describes the independent variables that were included in the model specifications and records their sources. The bilateral foreign assets and foreign liabilities, which were used to derive the country's concentration index, were collected from the CPIS of the IMF.

The stock market correlation was deployed as the proxy for the stock market interdependence. It could also be an indirect measure of stock market integration. The stock market indices that were used to derive the return correlations were sourced from Datastream. The annual country-pair correlations were computed using the monthly returns on stock market indices to derive the time-varying values. To capture the macroeconomic similarities between the home and host countries, the absolute difference in the inflation rate between the home country and host country was calculated. The same method was applied to the other economic variables such as the real interest rate, industrial production growth, stock market size, and real GDP per capita growth.

Financial centres such as the Bahamas, Luxembourg and Ireland were excluded from the sample, as in Fidora et al. (2007). Furthermore, countries for which the foreign liabilities, foreign assets and market value of equities were missing and confidential, as reported in the CPIS and WDI, were filtered out, leaving a final sample of 25 home countries and 27 host countries over a 14-year sample period of between 2001 and 2014. The home and host markets that were included in the model of the stock market interdependence are exhibited in Table 3.

TABLE 2. Variables and sources

Variable	Definition	Source
CI	$\sum_{j}^{N}(W_{ijt} - W_{jt}^{*})$	Coordinated Portfolio Investment Survey conducted by International Monetary Fund
∏_DIFF	$\lvert\Delta_{\%}\mathrm{CPI}_i - \Delta_{\%}\mathrm{CPI}_j\rvert$	World Bank
R_DIFF	$\lvert(I-\prod)_i - (I-\prod)_j\rvert$	Datastream, World Bank
IPG_DIFF	$\lvert\mathrm{IPG}_i - \mathrm{IPG}_j\rvert$	Datastream
SIZE_DIFF	$\lvert\mathrm{MarketCAP}_i - \mathrm{MarketCAP}_j\rvert$	World Development Indicators, World Federation of Exchange, European Central System, Datastream.
RGDPG_DIFF	$\lvert\mathrm{RGDPG}_i - \mathrm{RGDPG}_j\rvert$	Penn World Tables 8.0 and 8.1

Notes: CI= concentration index; ∏_DIFF= absolute difference in the annual percentage change in CPI between country i and country j; R_DIFF= absolute value of the differences in short-term real interest rate between country i and country j; IPG_DIFF= absolute value of the difference in industrial production growth between country i and country j; SIZE_DIFF is absolute difference in the ratio of the stock market capitalization to GDP between country i and country j and RGDPG_DIFF is absolute value of difference in real GDP growth between country i and country j.

TABLE 3. Sample countries

Number	Home country	Host country
1	United States	Argentina
2	United Kingdom	Australia
3	Canada	Austria
4	Germany	Belgium
5	Italy	Brazil
6	Sweden	Canada
7	France	China P.R. Hong Kong
8	Switzerland	Cyprus
9	Austria	Czech Republic
10	Belgium	Denmark
11	Denmark	Finland
12	Greece	France
13	Norway	Germany
14	Portugal	Greece
15	Netherland	Hungary
16	Japan	Italy
17	China P.R. Hong Kong	Japan
18	Malaysia	South Korea
19	Brazil	Malaysia
20	Argentina	Norway
21	Cyprus	Netherlands
22	Czech Republic	Portugal
23	Hungary	Russia
24	Russia	Sweden
25	South Korea	Switzerland
26		United Kingdom
27		United States

EMPIRICAL ANALYSIS

DESCRIPTIVE STATISTICS

Table 4 summarizes the descriptive statistics, including the mean, minimum value, maximum value and variation over time and between countries. The absolute difference in inflation (∏_DIFF) was 2.27% on average for the home and host markets, with a minimum value of 0% and a maximum value of 23.12%, respectively. The interest rates were the same across member states in the Euro area, with the lowest value being 0% for the Eurozone and the highest being 41.27%.

The differential industrial production growth (IPG_DIFF) ranged from 0% to 22.68%, with an average value of 4.21%. At the same time, the mean of the absolute difference in the market value of the listed companies as a percentage of the GDP (SIZE_DIFF) between country i and country j was 80.30%. The mean of the per capita income growth differential (RGDPG_DIFF) was 3.44%, with a range of 17%.

The overall variance for the dependent variable, i.e. the adjusted stock market correlation, was 0.8023, of which the within variance was 0.5705. The 'within variance' of the adjusted market correlation contributed to 71% of the overall variance. As with the correlation variable, the within variance for the interest rate differential, industrial production growth differential, and real GDP growth differential dominated the total variance. These variables varied more over time for each country. On the other hand, the concentration index, inflation differential and country size differential had a larger between variance than within variance.

TABLE 4. Summary statistics

Variable	Mean	Overall standard deviation	Between standard deviation	Within standard deviation	Minimum	Maximum
ADJUSTED ρ	1.49	0.90	0.48	0.76	-1.39	4.85
CI	0.02	0.04	0.03	0.03	0.00	0.31
∏_DIFF	2.27	2.81	2.26	1.69	0.00	23.12
R_DIFF	1.71	1.82	1.16	1.40	0.00	16.17
IPG_DIFF	4.20	3.49	1.53	3.17	0.00	22.68
SIZE_DIFF	80.30	129.80	107.85	70.32	0.01	1115.88
RGDPG_DIFF	0.03	0.03	0.02	0.02	0.00	0.17

Notes: ADJUSTED ρ= adjusted stock market correlation; CI= concentration index; ∏_DIFF= absolute difference in the annual percentage change in CPI between country i and country j; R_DIFF= absolute value of the differences in short-term real interest rate between country i and country j; IPG_DIFF= absolute value of the difference in industrial production growth between country i and country j; SIZE_DIFF is absolute difference in the ratio of the stock market capitalization to GDP between country i and country j and RGDPG_DIFF is absolute value of difference in real GDP growth between country i and country j.

DIAGNOSTIC TESTS

This study employed a fixed effects model to examine whether the stock return correlation depended on a country's concentration index. However, the fixed effects regression assumes that the error terms are independently and identically distributed. The coefficient estimates would be inefficient despite remaining consistent and unbiased if the assumption is violated. Hence, a series of diagnostic tests were performed for the residuals, as reported in Table 5.

TABLE 5. Diagnostic statistics

Test	Test statistic
Doornik-Hansen $\chi 2$ statistic	27011.03***
Breusch-Pagan test for heteroskedasticity	9.97***
Wooldridge test for autocorrelation	15.32***

Note: *** indicates statistically significant at 1% level.

The multivariate tests for normality indicated that the distribution of the residuals was abnormal. Therefore, 117 outlying observations with studentized residuals greater than two in absolute values were dropped from the analyses. The Breusch-Pagan test for heteroscedasticity tested the null hypothesis that the residuals were constant across observations. The Chi-squared statistic was significant, thereby rejecting the null hypothesis of homoscedasticity. Besides, the F-statistic for the Wooldridge autocorrelation test shown in Table 4 was statistically significant, which led to the rejection of a no

serial correlation in the residuals based on the first difference estimator. The heteroscedasticity and autocorrelation problem were then corrected with robust clustered standard errors in all the regressions.

Table 6 presents the correlation matrix for all regressors. There was no high pairwise correlation exceeding 0.8 between the independent variables. As expected, the country's concentration and the interaction term of concentration index and financial crisis dummy were positively correlated with the stock return co-movement, while the other variables such as the inflation differential, interest rate differential, industrial production growth differential, market size differential, and growth differential between the home and host countries were indeed inversely correlated with the adjusted stock market correlation.

TABLE 6. Pairwise correlation for stock market correlation

	ADJUSTED ρ	CI	∏	R	IPG	SIZE	RGDPG
ADJUSTED ρ	1.00						
CI	0.17	1.00					
∏_DIFF	-0.31	-0.11	1.00				
R_DIFF	-0.22	-0.04	0.53	1.00			
IPG_DIFF	-0.14	0.05	0.06	0.05	1.00		
SIZE_DIFF	-0.06	-0.10	-0.08	-0.06	0.00	1.00	
RGDPG_DIFF	-0.19	-0.01	0.45	0.39	0.13	-0.03	1.00

Notes: Adjusted ρ= adjusted stock market correlation; CI= concentration index; ∏_DIFF= absolute difference in the annual percentage change in CPI between country i and country j; R_DIFF= absolute value of the differences in short-term real interest rate between country i and country j; IPG_DIFF= absolute value of the difference in industrial production growth between country i and country j; SIZE_DIFF is absolute difference in the ratio of the stock market capitalization to GDP between country i and country j and RGDPG_DIFF is absolute value of difference in real GDP growth between country i and country j.

STATIC PANEL MODEL

Table 7 contains the estimates of the adjusted stock market correlation. First, Models 1 to 3 consisted of all the variables and were estimated using the pooled OLS, random effects and fixed effects regression models, respectively. The Hausman test, shown at the bottom of Table 7, suggested the use of a fixed effects rather than random effects estimation.

Model 3 was the main model comprising all the predictors and the interaction terms using a fixed effects regression. The estimated results of Model 3 were used to make inferences. The Chi-squared statistic was significant at the level of 1%, thereby leading to the rejection of the null hypothesis of the regressor-effect independence. Therefore, the subsequent Models 4 to 6 were estimated using the fixed effects model by excluding the interaction effect between a country's concentration index and crisis dummy, the concentration index and both the concentration indicator and crisis dummy, respectively, for consistency checking.

Generally, the directions and magnitudes of the independent variables were very similar for the fixed effects model. The positive and statistical significance of the country's concentration index was robust to the exclusion of the interaction effect in Model 4. The coefficients of the real interest rate differential, industrial production growth differential and market size differential were very identical in terms of their size and magnitude across the fixed effects regression.

Accessing the hypothesis of the interest directly, the country's concentration index (CI) had a positive and significant coefficient in Model 3. An increase of one standard deviation in the portfolio concentration index or 0.04 corresponded to a rise of about 0.33 in the market correlation measure. It was highly significant at the level of 1%. The results implied that countries with a high concentration in portfolio investments (concentrated investments in a subset of foreign destinations) have higher bilateral stock market co-movements. Their stock markets are more financially integrated and their diversification opportunities are reduced because of the high return correlations between them. On the other hand, low-concentration countries holding a more diversified portfolio have lower stock return co-movements with other financial markets. Therefore, opportunities for risk reduction are higher. In summary, a country with a lower concentration index will have increasing market segmentation. As a country's concentration index goes up, the correlations also rise.

The interaction term entered between crisis and country concentration (CI*CRISIS) was negative and statistically significant at the level of 1%. It appeared that an increase of one standard deviation in the interaction term was associated with a reduction of around 3.33 in market correlations. The results indicated that the impact of a country's concentration on stock market correlation was less in bad times. Put differently, countries with a high foreign portfolio equity concentration did not experience an increase in stock market linkages during the crisis period. The negative coefficient on the interaction term may be explained by the fact that investment returns gained from the concentrated portfolio may have helped the home countries to mitigate the risk of spill-overs during the global financial crisis. Consistent with the assertion in Brushko and Hashimoto (2014), high-concentration countries are more tolerant to risk, so they may not engage in panic selling, which potentially gives rise to financial spill-overs. Chin and Azali (2010) pointed out that for financial markets that are highly correlated; a financial shock in one country is more likely to spill over into another country.

TABLE 7. Country concentration and stock market interdependence

	(1)	(2)	(3)	(4)	(5)	(6)
	Pooled OLS	RE	FE	FE	FE	FE
Constant	2.13***	2.13***	1.91***	1.93***	2.04***	2.04***
	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)
CI	5.77***	5.77***	8.51***	7.09***		
	(0.76)	(0.76)	(1.00)	(0.91)		
CI*CRISIS	-2.61**	-2.61***	-3.35***		-0.57	
	(1.01)	(1.01)	(1.01)		(0.90)	
∏_DIFF	-0.05***	-0.05***	-0.00	-0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R_DIFF	-0.04***	-0.04***	-0.03*	-0.03*	-0.03*	-0.03*
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
IPG_DIFF	-0.03***	-0.03***	-0.02***	-0.02***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SIZE_DIFF	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RGDPG_DIFF	-1.25**	-1.25**	0.12	0.08	0.21	0.19
	(0.58)	(0.58)	(0.64)	(0.64)	(0.65)	(0.64)
Breusch-Pagan	88.61***					
Hausman test		131.32***				
Observation	2621	2621	2621	2621	2621	2621

Notes: The dependent variable is stock market correlation, W. CI= concentration index; CI*CRISIS= interaction term of concentration index and crisis dummy; ∏_DIFF= absolute difference in the annual percentage change in CPI between country i and country j; R_DIFF= absolute value of the differences in short-term real interest rate between country i and country j; IPG_DIFF= absolute value of the difference in industrial production growth between country i and country j; SIZE_DIFF is absolute difference in the ratio of the stock market capitalization to GDP between country i and country j and RGDPG_DIFF is absolute value of difference in real GDP growth between country i and country j.*** and ** indicate statistical significance at 1% and 5%, respectively. Robust clustered standard errors are reported in the parentheses.

With regard to the control variables, the coefficient on the size differential (SIZE_DIFF) was economically significant at the level of 1%, and this was consistent with the findings by Bracker et al. (1999), Pretorius (2002), and Mobarek et al. (2016). A smaller disparity in market sizes reflected the similarity between two stock markets in terms of their market liquidity, transaction cost and information cost. Moreover, countries that showed a similar growth in industrial output (IPG_DIFF) were more correlated in terms of their stock market returns.

Additionally, since interest rates are inversely related to stock prices due to the denominator effect of the discount rate in the dividend valuation model, the interest rate differential is expected to be negatively associated with the stock return correlation between two countries. When two countries have dissimilar monetary policies, their interest rates will deviate from each other and their stock price performance will diverge. As predicted, the estimated coefficient on the real interest rate differential (R_DIFF) was statistically significant at the level of 10%. When the difference in the short-term real interest rates between the home and host markets went up by one standard deviation, or 1.82, the market correlation declined by 0.05 units.

Besides that, the stock returns reacted negatively to an increase in inflation, as evidenced by the negative coefficient on the inflation differential. However, the variable was found to be insignificant. A possible explanation for this is that the real interest rate differential takes into account inflation, making the inflation differential variable not statistically significant at the conventional level.

The real GDP growth differential (RGDPG_DIFF) did not provide any significant explanation as to the stock co-movements based on Model 3. There was no evidence that the stock returns correlation was higher for countries with a similar level of economic development. Due to the interconnectedness through the holding of shares in multinational corporations, there was an increasing market correlation between developing countries and industrialized countries. This was a possible explanation for the insignificant result obtained for the per capita real GDP differential between two countries. The result was congruent with that of Beine and Candelon (2011).

ROBUSTNESS ANALYSIS

A robustness analysis was also carried out by employing an alternative research method to test the extent to which the estimates on stock market correlation were robust. It was suspected that the concentration index of the countries was endogenous as it could be affected by stock market correlations. A country's concentration index is potentially endogenous because investors may choose to diversify in stock markets whose returns are negatively correlated with their own markets to reap a return differential. Hence, the concentration index may be higher if the average market correlation for the home country is smaller.

To address the endogeneity issue, the concentration index of the country was instrumented with its own lags for the time periods t-3 and t-4, since lagged values were less likely to be impacted by current shocks. The first stage analysis uncovered that the excluded instruments (in other words, the instrumental variables) were jointly significant at the 1% level based on the F-statistic, thus suggesting that the instruments were relevant. Table 8 reports the results of the second stage of the analysis of the fixed effects instrumental variable approach.

The positive coefficient and its significance on the concentration index of the country were qualitatively similar to the standard fixed effects estimates presented in Table 8. The degree of stock market interdependence was higher when the countries diversified less and concentrated more of their investments in certain foreign stock markets. The interaction term of the financial crisis dummy and concentration index, however, was insignificant.

TABLE 8. Fixed-effects instrumental variables result for stock return correlation

Variable	FE IV
CI	6.84***
	(1.61)
CI*CRISIS	-0.52
	(0.89)
∏_DIFF	-0.01
	(0.01)
R_DIFF	0.04**
	(0.02)
IPG_DIFF	-0.01*
	(0.01)
SIZE_DIFF	-0.01***
	(0.00)
RGDPG_DIFF	-1.80**
	(0.80)
R^2	0.10
F-statistics	15.64***
Kleibergen-Paap rk LM statistic	32.33***
(underidentification test)	
Kleibergen-Paap rk Wald F statistic	143.08***
(weak identification test)	
Hansen-J statistic	0.606
Endogeneity test	2.072
Observations	1462

Notes: The dependent variable is stock market correlation, W. CI= concentration index; CI*CRISIS= interaction term of concentration index and crisis dummy; ∏_DIFF= absolute difference in the annual percentage change in CPI between country i and country j; R_DIFF= absolute value of the differences in short-term real interest rate between country i and country j; IPG_DIFF= absolute value of the difference in industrial production growth between country i and country j; SIZE_DIFF is absolute difference in the ratio of the stock market capitalization to GDP between country i and country j and RGDPG_DIFF is absolute value of difference in real GDP growth between country i and country j.***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively. Robust clustered standard errors are reported in the parentheses.

The negative coefficient and its significance on the industrial production growth differential and market size differential were maintained when the fixed effects instrumental approach was deployed. This confirmed that similar-sized stock markets, as measured by the market value of shares, tend to have higher cross-country co-movements in stock

returns. The industrial production growth is regarded as a coincidental indicator. A change in industrial outputs reflects a similar change in the GDP growth of a country. In other respects, equity markets with a similar size and economic fundamentals tend to move together.

The null hypothesis that the equation was under-identified was rejected based on the Kleibergen and Paap Lagrange Multiplier test, thereby confirming that the model was identified. The instrument was correlated with the endogenous variable at the level of 1%. Moreover, the Kleibergen-Paap Wald F-statistic was greater than the critical values provided by Stock and Yogo (2005), thus, rejecting the null hypothesis of a weak correlation between the instrument and the endogenous variable. In other words, the lagged concentration index was relevant and was a strong instrument.

In addition, the Hansen J-statistic failed to reject the null hypothesis that the endogenous variable (lagged concentration index) was uncorrelated with the residuals, providing evidence that the instrument was exogenous. Overall, the post-estimation tests indicated that the instrument was valid and satisfied the exogeneity.

Based on the endogeneity test, a country's concentration index can actually be treated as exogenous, indicating the fixed effects estimator was consistent with the fixed effects instrumental variable estimation. The results required a thorough examination of the presumption of endogeneity of a country's concentration index.

CONCLUDING REMARKS

This study examined whether the concentration of an investor's holdings in a foreign country has an influence over the return correlations among stock markets. This paper empirically analysed how portfolio construction influences return correlations in stock markets. Based on the study sample, the host countries did not experience a significant elevation in return co-movements during a financial crisis. The concentration of equity investments in a handful of target markets did not lead to financial spill-overs and market co-movements during the period of a global financial crisis. Portfolio investments appeared to be one of the potent channels of spill-overs. High-concentration countries that consolidated their investments in certain foreign countries did not experience a spill-over during a crisis period as the coefficient estimate on the interaction term of the concentration index and crisis dummy was significantly negative in the full model. By way of explanation, the influence of a country's concentration on correlations in equity returns was lesser during a global financial meltdown.

Other than that, countries with a similar growth of industrial production and which adopted a similar monetary policy exhibited a higher co-movement in stock returns. Furthermore, the return correlations increased when two stock markets were identical in size. Although international stock market linkages were on the rise, there was still room for international diversification gains, as indicated by the correlation coefficients between the country-pairs.

It is useful for global investors seeking to diversify their portfolio investment to monitor changes in macroeconomic fundamentals. A concentration of portfolios led to an upward movement in asset prices in the host countries. As a result, there were more return co-movements between the domestic and foreign stock bourses. These findings may shed light for investors regarding portfolio designs and allocation decisions. It remains an empirical question whether stock market integration diminishes excess portfolio returns generated from foreign concentrated portfolios, as shown in previous literature, and this can be further examined in future researches.

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