

The Socioeconomic Determinants of Correlations Between Stock Market Returns as Revealed by a Gravity Model

Danni Yang

A Thesis in the John Molson School of Business

Presented in Partial Fulfillment of the Requirements

for the Degree of Master of Science (Administration) at

Concordia University

Montreal, Quebec, Canada

September, 2009

© Danni Yang, 2009



Library and Archives
Canada

Published Heritage
Branch

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque et
Archives Canada

Direction du
Patrimoine de l'édition

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence
ISBN: 978-0-494-63078-5
Our file Notre référence
ISBN: 978-0-494-63078-5

NOTICE:

The author has granted a non-exclusive license allowing Library and Archives Canada to reproduce, publish, archive, preserve, conserve, communicate to the public by telecommunication or on the Internet, loan, distribute and sell theses worldwide, for commercial or non-commercial purposes, in microform, paper, electronic and/or any other formats.

The author retains copyright ownership and moral rights in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

AVIS:

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque et Archives Canada de reproduire, publier, archiver, sauvegarder, conserver, transmettre au public par télécommunication ou par l'Internet, prêter, distribuer et vendre des thèses partout dans le monde, à des fins commerciales ou autres, sur support microforme, papier, électronique et/ou autres formats.

L'auteur conserve la propriété du droit d'auteur et des droits moraux qui protègent cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

In compliance with the Canadian Privacy Act some supporting forms may have been removed from this thesis.

While these forms may be included in the document page count, their removal does not represent any loss of content from the thesis.

Conformément à la loi canadienne sur la protection de la vie privée, quelques formulaires secondaires ont été enlevés de cette thèse.

Bien que ces formulaires aient inclus dans la pagination, il n'y aura aucun contenu manquant.


Canada

CONCORDIA UNIVERSITY

School of Graduate Studies

This is to certify that the thesis prepared

By: Danni Yang

Entitled: The Socioeconomic Determinants of Correlations Between Stock Market Returns as Revealed by a Gravity Model

and submitted in partial fulfillment of the requirements for the degree of

Master of Science (Administration)

complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final examining committee:

_____ Chair

_____ Examiner

_____ Examiner

_____ Supervisor

Approved by

Chair of Department or Graduate Program Director

_____ 20 _____

Dean of Faculty

Abstract

The Socioeconomic Determinants of Correlations Between Stock Market Returns as Revealed by a Gravity Model

Danni Yang

Economic variants of Newton's law of universal gravitation have been used to model the flow of trade between two countries as proportional to the attraction created by measures of their economic masses and dampened by their distance from one another. More business will likely take place between big economies that are close to one another. This study uses that same gravity analogy to explore the long-term, or perhaps more accurately, stable determinants of the correlation of stock markets, where in its simplest form, financial mass is represented by the joint market size of two countries and financial distance by the overlap in trading hours of their stock exchanges. Stock market correlations are found to be positively related to these variables and negatively related to joint trading volume. If distance is expanded to include the relative similarity in culture and legal institutions, it is found that correlations are positively related to the disparity in religious pluralism, negatively related to differences in economic freedom, and positively related to the sharing of a common legal system. In all, the gravity models estimated explain almost 11 percent of the cross-sectional variation in the correlations of stock markets, with the incremental influence of the cultural and legal variables being many times greater than that of the financial variables.

Acknowledgments

I would like to express my gratitude to all those who gave me the opportunity to complete this thesis. I am deeply indebted to my supervisor, Dr. Gregory Lypny, Department of Finance, John Molson School of Business, whose direction, stimulating suggestions and encouragement helped me through the research and writing. I would especially like to express thanks to my mom whose patience, care and love enabled me to complete this work.

Table of Contents

List of Figures	vi
List of Tables	vii
1. Introduction.....	1
2. Background.....	2
3. Data and Methods	5
3.1 Base gravity model	5
3.2 Extended gravity model	14
3.3 An alternative version of the extended gravity model.....	18
3.4 Summary of hypotheses.....	20
4. Results and discussion	20
4.1 Base gravity model	21
4.2 Extended gravity model	22
4.3 Alternative extended gravity model.....	24
4.4 Robustness to a measure of economic development.....	26
4.5 What lies behind the home equity bias	28
4.6 Stock market openness and correlation: the case of China.....	31
5. Conclusion	33
References.....	34
Appendix.....	38

List of Figures

Figure 1—Flying hours pair-wise-----	6
Figure 2—Great circle distance-----	8
Figure 3—Home bias ratio-----	31

List of Tables

Table 1—Distances-----	7
Table 2—Common borders-----	10
Table 3—Legal origins-----	11
Table 4—Descriptive statistics on markets-----	13
Table 5—Overlapping trading hours-----	15
Table 6—Trading Hours-----	16
Table 7—Pluralism and economic freedom indices-----	18
Table 8—Security law index-----	19
Table 9—OLS estimates (Base gravity model)-----	21
Table 10—OLS estimates (Extended gravity model)-----	23
Table 11—OLS estimates (Alternative extended gravity model) -----	25
Table 12—Internet penetration rate-----	26
Table 13—OLS estimates (Robustness)-----	27
Table 14 — Foreign and domestic holdings of equity-----	30
Table 15—Schedule of liberalization of stock markets-----	32

1. Introduction

What characteristics of countries explain the co-movement of returns in their stock markets? In Newtonian physics, the gravitational attraction between two objects is positively related to their masses, or more specifically, the product of their masses, and negatively related to their distance from one another. Economists borrowed Newton's law of universal gravitation in the 1960s, among them Tinbergen (1962), Poyhonen (1963) and Linnemann (1966), to model trade flows, using measures such as aggregate income to represent economic mass, and geographic distance to represent physical distance. Subsequent studies eventually came to include variables about culture, or those which can be connected to culture — borders, language, legal origin — ostensibly refining the notion of distance and turning it into a continuum of similarity to dissimilarity. A small number have also looked at stock market linkages, but the finance literature has generally not paid much attention to uncovering the more stable or long-term determinants of the correlation of stock markets of different countries, and has instead concerned itself with studying the time-varying properties of return covariances using relatively high frequency data.

This study explores the association between gravity factors and the stock market correlations of 18 Asia-Pacific countries. The motivation is to complement the research on the short-run, time-varying properties of return covariances by providing a sense of the factors that are tied to long-term differences in level or that may result in more permanent shifts when they change. We find that overlapping stock market trading hours are a good proxy for distance narrowly defined. Joint trading volume and religious diversity also play a part, as does legal origin and economic freedom.

2. Background

Research using gravity models to explain bilateral trade flows, with GDP standing in for mass and geographic distance for the physical distance between countries, can be found in Bergstrand (1985) and Feenstra, Markusen and Rose (2001). Bergstrand (1985) found that GDP deflators improve the explanatory power of the models, pointing to the need for measuring mass appropriately through the incorporation of real values. Feenstra, Markusen, and Rose (2001) found evidence of reciprocal dumping in assessing the "home market effect" in separate gravity equations for differentiated and homogeneous goods. The home market effect is present for differentiated goods but not homogeneous goods. Their result is consistent with the theoretical predictions of reciprocal dumping playing a role in homogeneous markets. McCallum (1995) introduced the common border as an alternative distance measure to explain the regional trade patterns between the US and Canada and found that borders have a significant association with trade patterns. Rauch (2001) found that cultural ties based on ethnicity or religion are associated with the correlations of economic activity.

Financial economics has tended to focus less on the long-term determinants of correlations and more on the time-varying properties of stock market linkages as exemplified in studies using GARCH estimations. The motivation for this is that if investors can forecast changes in joint distributions of returns, then they will be able to make better portfolio investment and risk management decisions. Longin and Solnik (1995) used a bivariate GARCH model to capture the conditional covariance structure of monthly international equity returns from 1960 to 1990 and found significant time-variation. Har-

vey (1995) used a one-factor asset pricing model to estimate time-varying capital market correlation. Ramchand and Susmel (1998) used an SW-ARCH model to show that correlations were both time- and state-dependent and that the covariance structure between markets changes over time, with implications for portfolio diversification strategies. Bordart and Reding (1999) also used a bivariate GARCH model to examine the impact of exchange rate variability on international correlations, while Groenan and Franses (2000) used a graphing technique to investigate stock market correlations and their evolution over time. It is now well accepted that the volatility and correlation of rates of return of many financial assets varies over time.

Only recently has attention turned to the longer-term determinants of international securities correlations, and as physical transportation is generally not a fundamental variable in financial markets, the door was opened to exploring alternatives, such as measures of socioeconomic and cultural similarity, to geographical distance in gravity models in addition to conventional financial variables. Portes and Rey (2002) studied the bilateral equity flows of 14 OECD countries from 1989 to 1996 and uncovered a geographical pattern of international asset transactions. Distance can proxy information costs and other variables that represent differences in information, transaction timeliness and technology. Distance enters in the equation as a proxy for information asymmetries and other variables which plausibly represent international information flows (telephone traffic, number of bank branches, index of insider trading were also significant). They interpret their findings as financial markets segmented by such informational asymmetries or familiarity. This, in turn, provides a possible reason for the home equity bias. Flavin, Harley and Rousseou (2002) used a gravity model to explain the stock market correlations in 27 in-

dustrial countries using 1999 data, and found that overlapping stock market opening hours and a common border, in particular, tend to be associated with stock market correlation. The number of non-overlapping trading hours restricts the ability of investors in different markets to react to 'global news' simultaneously (or with shorter time lags), and discourages them from venturing from home. Huang (2006) used a gravity model to measure stock market correlations for 20 emerging industrial countries from 1995 to 2002, and found that distance, market size and legal system similarity are significantly related to stock market correlations.

The correlatedness of returns across stock markets can be thought as the degree to which markets are integrated. Research has documented an increase in international economic and financial integration. Heaney et al (2002), using monthly US dollar stock returns from 1985 to 2001, found that Latin American stock markets have become more integrated. Their finding reflects the growing cooperation between Latin American countries since the liberalization of their stock markets in the early 1990s. Prior to liberalization, equity markets tended to be more correlated with the world market portfolio than regionally. Morgado and Tavares (2006) found that stock markets have become more correlated, and that this increase in correlation is associated with bilateral economic integration and segmentation factors such as mutual participation in a trade agreement.

3. Data and Methods

3.1 Base gravity model

A gravity model as applied to trade flows, F , poses a positive relation to the economic mass of two countries, M_i and M_j , measured, for example, by GDP, and a negative relation to their geographic distance D_{ij} as in

$$F_{ij} = k \frac{M_i M_j}{D_{ij}}$$

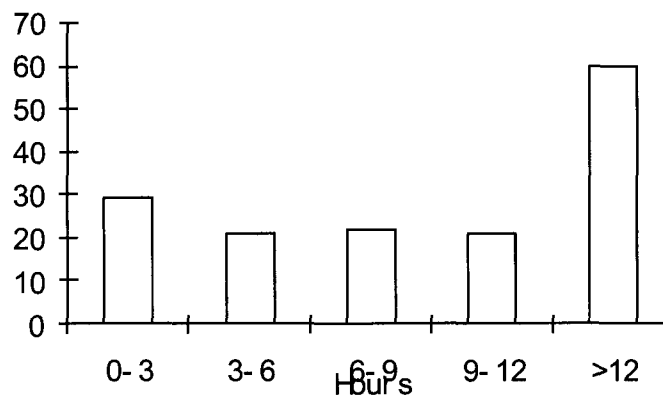
where k is a constant. The model is linearized by taking the natural logarithm of each side. Holding M_i and D_{ij} constant, the bigger M_j , the bigger the trade flows between two countries. In financial markets, this mass-distance analogy is melded into similarity-dissimilarity. The base model used in this study is

$$\begin{aligned} \rho_{ijt} = & \beta_0 + \beta_1 \ln(GCD) + \beta_2 Border \\ & + \beta_3 \ln(CMC_{it} \cdot CMC_{jt}) + \beta_4 \ln(Volume_{it} \cdot Volume_{jt}) + \beta_5 Legal_{ij} + \varepsilon_{ijt} \end{aligned} \quad (1)$$

The dependent variable is the Pearson correlation coefficient for the total monthly returns on the major stock market indices of country i and j , sampled from 2002 to 2007 for 18 Asia-Pacific Economic Cooperation (APEC) members: Australia, Canada, Chile, China, Hong Kong, Indonesia, Japan, Malaysia, Mexico, New Zealand, Peru, Philippines, Russia, Singapore, South Korea, Taiwan, Thailand, and the United States. The 72 return observations for each country are collected from Bloomberg. The error term is assumed to be normally distributed with a zero mean and standard deviation equal to one. The model is estimated by ordinary least squares. The independent variables discussed below capture geographic and socioeconomic similarity.

The first independent variable, *GCD*, is the natural logarithm of geographic distance between the financial centers of two countries as measured by the great circle between them. The great circle distance is obtained from Direct-line Distance by Fitzpatrick and Modlin (1986). It is defined as the shortest distance between two points on a spheroid, and can be estimated by air flight duration. With proximity comes more frequent contact, familiarity, exchange of ideas, intermingling of values, and I hypothesize, greater similarity in financial behavior, which in turn implies more highly correlated stock markets. Figure 1 shows a histogram of the flight durations for the 153 different trips that could be taken between the 18 countries in the sample. The figure shows that there is enough variation in flight durations to justify inclusion of *GCD* as an explanatory variable. One-half of the trips can be made in a working day and one-fifth in three hours or less. I predict that the correlations will be higher between these countries, all things being equal. Table 1 reports the great circle distances in kilometers, and Figure 2 shows selected “flight paths” between financial centres in Canada, China, Australia and Chile as a visual representation of great circle distances.

Figure 1 — Flight durations



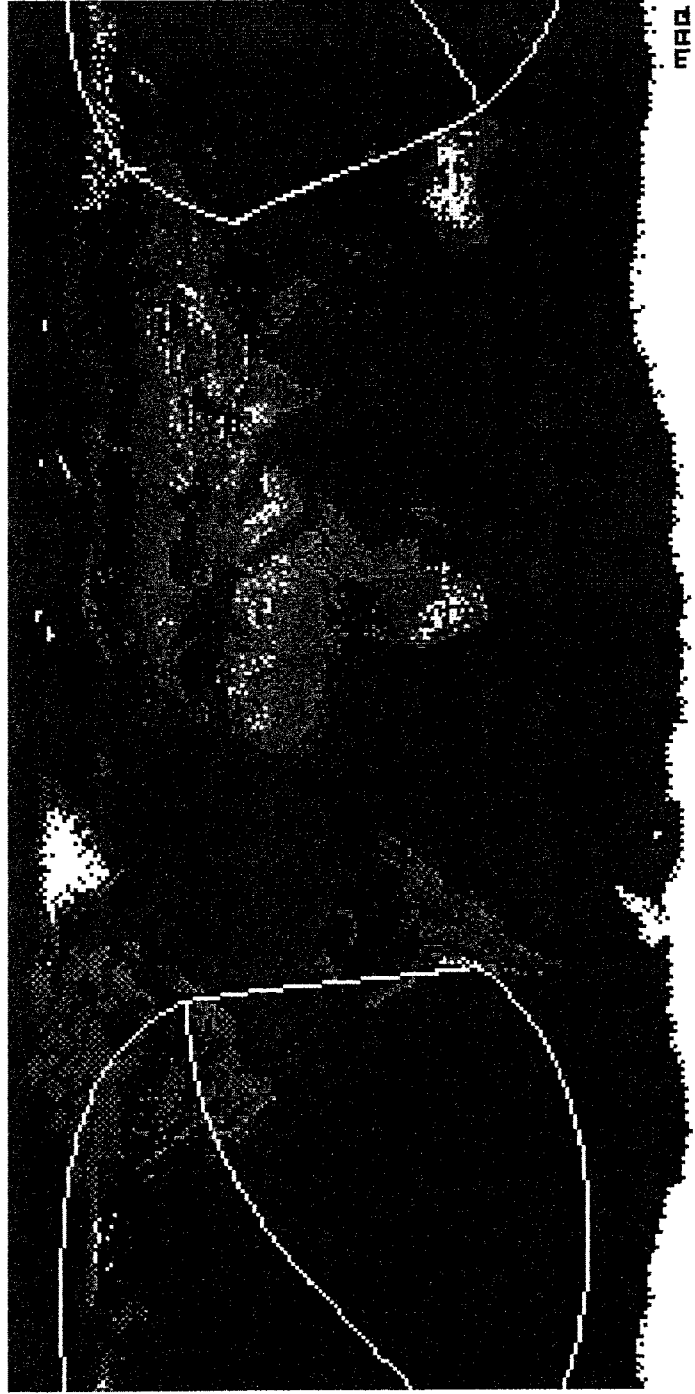
The flight durations between the 153 different trips that could be made between the 18 countries in the sample

Table 1 — Great Circle Distance between financial centers (in kilometers)

	New York	Tokyo	Hong Kong	Shanghai	Taipei	Singapore	Bangkok	Manila	Seoul	Sydney	Wellington	Jakarta	Kuala Lumpur	Moscow	Toronto	Mexico City	Santiago	Lima
New York	0	10870	12984	11897	12551	15349	13949	13692	11078	15990	14395	16177	15127	7530	553	3362	8218	5849
Tokyo	10870	0	2893	1782	2110	5317	4610	2997	1160	7794	9246	5776	5319	7502	10367	11319	17234	15493
Hong Kong	12984	2893	0	1215	810	2575	1723	1114	2097	7348	9408	3244	2504	7158	12577	14155	18649	18379
Shanghai	11897	1782	1215	0	672	3783	2871	1831	883	7847	9715	4408	3720	6837	11460	12945	18865	17182
Taipei	12551	2110	810	672	0	3243	2529	1160	1483	7240	9173	3803	3220	7370	12104	13418	18517	17599
Singapore	15349	5317	2575	3783	3243	0	1427	2392	4666	6293	8524	887	317	8426	15015	16623	16399	18810
Bangkok	13949	4610	1723	2871	2529	1427	0	2213	3720	7523	9739	2309	1178	7070	13647	15760	17651	19702
Manila	13692	2997	1114	1831	1160	2392	2213	0	2615	6247	8295	2779	2467	8269	13232	14237	17612	18061
Seoul	11078	1160	2097	883	1483	4666	3720	2615	0	8298	9994	5276	4601	6626	10624	12071	18361	16311
Sydney	15990	7794	7348	7847	7240	6293	7523	6247	8298	0	2231	5502	6610	14487	15566	12972	11369	12815
Wellington	14395	9246	9408	9715	9173	8524	9739	8295	9994	2231	0	7726	8841	16543	14127	11092	9369	10603
Jakarta	16177	5776	3244	4408	3803	887	2309	2779	5276	5502	7726	0	1178	9298	15806	16862	15612	17947
Kuala Lumpur	15127	5319	2504	3720	3220	317	1178	2467	4601	6610	8841	1178	0	8122	14816	16637	16561	19013
Moscow	7530	7502	7158	6837	7370	8426	7070	8269	6626	14487	16543	9298	8122	0	7504	10740	14116	12641
Toronto	553	10367	12577	11460	12104	15015	13647	13232	10624	15566	14127	15806	14816	7504	0	3262	8585	6174
Mexico City	3362	11319	14155	12945	13418	16623	15760	14237	12071	12972	11092	16862	16637	10740	3262	0	6585	4240
Santiago	8218	17234	18649	18865	18517	16399	17651	17612	18361	11369	9369	15612	16561	14116	8585	6585	0	2458
Lima	5849	15493	18379	17182	17599	18810	19702	18061	16311	12815	10603	17947	19013	12641	6174	4240	2458	0

The great circle, also known as the Riemannian circle, is the path with the smallest curvature, and hence, an arc (or an orthodrome) of a great circle is the shortest path between two points on the surface. Flight durations can therefore often be approximated to the great-circle distance between two airports.

Figure 2 — Great Circle Distance



Source: <http://gc.kls2.com/> . The great circle distances between Ontario, Shanghai, Sydney and Santiago.

The variable *Border* flags whether two countries are neighbours, taking the value 1 if they share a common border or strait and 0 otherwise. Eighteen pairs of countries share at least one border or strait, while Indonesia and Malaysia share as many as four with other countries. The stock markets of countries with a common border or strait are expected to be more highly correlated. Table 2 reports which countries are neighbours.

Table 2 — Common borders

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Japan	0		0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Hong Kong	0	0		1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
China	0	0	1		1	0	0	0	0	0	0	0	0	1	0	0	0	0
Taiwan	0	1	1	1		0	0	0	1	0	0	0	0	0	0	0	0	0
Singapore	0	0	0	0	0		0	0	0	0	0	1	1	0	0	0	0	0
Thailand	0	0	0	0	0	0		0	0	0	0	1	1	0	0	0	0	0
Philippines	0	0	0	0	0	0	0		0	0	0	1	1	0	0	0	0	0
South Korea	0	1	0	0	1	0	0	0		0	0	0	0	0	0	0	0	0
Australia	0	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	0
New Zealand	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	0
Indonesia	0	0	0	0	0	1	1	1	0	0	0		1	0	0	0	0	0
Malaysia	0	0	0	0	0	1	1	1	0	0	0	1		0	0	0	0	0
Russia	0	0	0	1	0	0	0	0	0	0	0	0	0		0	0	0	0
Canada	1	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Mexico	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
Chile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
Peru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

A 1 indicates that two countries share a border.

Legal is a dummy variable equal to one if the two countries' legal systems have the same historical origin and zero otherwise. La Porta et al. (1998) argue that most modern legal systems can be traced back to one of four major families of law: English common law, French civil law, German civil law, or Scandinavian civil law. Table 3 reports the origin of the legal system of each country in our sample.

Table 3 — Legal origins

English common law	French civil law	German civil law	Scandinavian civil law
US	Philippines	Japan	
Hong Kong	Indonesia	Taiwan	
Singapore	Mexico	South Korea	
Thailand	Chile		
Australia	Peru		
New Zealand			
Malaysia			
Canada			

Legal systems are classified as four major families of law: English common law, French civil law, German civil law, or Scandinavian civil law. China (Socialist origin) and Russia (Russian origin) do not belong to any of these four legal origins.

I predict that the stock markets of countries whose current legal systems have the same origin will be more highly correlated, all things being equal. This is because similar legal systems are more likely to produce similar regulatory environments, rules of corporate governance, and even investment climates, which in turn reduces contracting costs and information asymmetries between them and also implies that they are more likely to face similar systematic risks. Legal rules protecting investors vary systematically among legal origins. Common law countries are more protective of outside investors than civil law countries and particularly French civil law countries. The popular press—Legal Affairs has attributed the differences in the economic success of Malaysia and Indonesia and the effectiveness of their individual responses to financial crises to specific

actions and contemporary institutions but these can be traced back to Malaysia's British common law heritage and Indonesia's in Dutch French civil law.

Two purely financial variables are included in the model, both of which were obtained from Bloomberg. *CMC* is the joint annual current market capitalization in Canadian dollars of two countries on a monthly average basis from year 2002 to 2007. *Volume* is their joint total trading volume. Both of these mass variables enter the empirical model as the product of the levels for the corresponding countries. Table 4 reports these numbers. The larger the joint market capitalization, the more highly correlated the stock markets are expected to be because market capitalization is a proxy for the level of advancement of the economies. But somewhat ambiguously, a financial market being active individually with respect to trading volume means that there may be enough variety at home that investors needn't need to look elsewhere (despite being rational to do so), resulting in a home bias; so we expect that joint volume is negatively related to the stock market correlations.

Table 4—Descriptive statistics on markets

	2002			2003			2004			2005			2006			2007		
	CMC	Volume	CMC	Volume	CMC	Volume	CMC	Volume	CMC	Volume	CMC	Volume	CMC	Volume	CMC	Volume	CMC	Volume
US	13919453	431035738944	12132571	325037702816	13460998	287921110784	13438848	317866140544	13754883	351863161696	14398881	319038435776						
Japan	3541288	183401940464	3285759	278769761312	4172146	327084967232	4460340	473433201472	5156468	443953300736	4934514	512978140224						
Hong Kong	576448	58366241360	555630	64960255216	668094	77646399704	701587	81978233376	861197	135995144224	1428042	483448400768						
China	517732	178375529760	477762	273363193216	467184	365582169728	347004	424159239168	521767	1153833963648	2187989	2543400777472						
Taiwan	496244	845221882752	476676	911182660992	525598	985651386752	533029	654913142528	580534	723274680320	684343	874396415232						
Singapore	180918	1485810900	157234	1948236200	193652	1800550200	212908	1986593100	242484	2413755800	322498	3675825500						
Thailand	67913	128464931088	90031	370030947536	131838	443607394176	138150	495745424192	148753	583593574912	203392	448035718912						
Philippines	25505	17242300672	21560	19222756976	26025	31100786602	30864	34408331322	41882	126351954684	67237	113159895976						
South Korea	353275	217276435200	315212	141492085408	408471	97185955904	578415	120974318288	769686	71684551984	965156	90437977936						
Australia	556851	91693908584	578640	105618129920	736260	115488400328	852724	116097022816	924019	136612054864	1260785	173951811888						
New Zealand	31614	7122312878	36806	6698308662	46267	8141766217	49786	8262101980	42356	9008321284	49816	8944186140						
Indonesia	48514	151503976544	55226	180454378032	79271	352384432768	90003	323983853184	116085	364918723680	170594	960215334400						
Malaysia	126261	12066596792	125651	15894559664	144231	18685230312	147758	17628847964	162553	29288807088	224208	57089738792						
Russia	2883	14088402634	3633	12265727210	4529	6802648503	4860	5401378656	20530	4799204028	26712	21705299787						
Canada	775616	29928270796	792657	30256897004	993894	32239896269	1189275	31821464974	1511036	46008369912	1660745	53211177528						
Mexico	143425	19182760984	115775	16915775664	148071	21895872192	194707	22890551884	262804	29300809492	308604	32934633942						
Chile	50432	20303610125	60590	34785534656	84471	127206525880	102893	116405506808	116857	135465893680	153790	166155877496						
Peru	9841	1169915473	319236	1914592697	141963	3867179383	126087	1527962676	151455	2406354972	141595	2870198666						

CMC is current market capitalization denominated in millions of Canadian dollars, using exchange rates from www.bankofcanada.ca.

3.2 Extended gravity model

A different version of the base model, shown in (2), is also considered.

$$\begin{aligned} \rho_{ijt} = & \beta_0 + \beta_1 OLOH + \beta_2 \ln(CMC_{it} \cdot CMC_{jt}) + \beta_3 \ln(Volume_{it} \cdot Volume_{jt}) \\ & + \beta_4 \frac{PI_i}{PI_j} + \beta_5 Legal_{ij} + \beta_6 \frac{EFI_{it}}{EFI_{jt}} + \varepsilon_{ijt} \quad (2) \\ & PI_i > PI_j, EFI_{it} > EFI_{jt} \end{aligned}$$

The physical measures of distance, GCD , and a common border are replaced by a financial measure of distance, overlapping (stock market) opening hours, $OLOH$. Cities that are far from one another may still be in the same time zone and therefore have largely overlapping trading hours; $OLOH$ captures the fact that their financial distance may be small in this respect. Markets with overlapping opening hours may react synchronously to global events, implying a tighter co-movement of their markets' returns. Data on overlapping stock market opening hours were collected from the websites of the individual exchanges (see Table 5) and trading hours in local and Hong Kong time are summarized in Table 6 below. The United States, Canada, Mexico, Chile and Peru overlap considerably, while Australia and New Zealand overlap the most.

Table 5-Overlapping opening hours

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.5	6.5	6	7
Japan	0		1	1.5	3	2	2	1	4.5	4.5	3.25	0	2	0	0	0	0	0
Hong Kong	0	1		2	2.5	4	2	2	2.5	2.5	2.75	4	4	1	0	0	0	0
China	0	1.5	2		2.5	3	1	2	3	3	2	1.5	2.5	1	0	0	0	0
Taiwan	0	3	2.5	2.5		3.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0	0	0	0	0
Singapore	0	2	4	3	3.5		3	2.5	2.5	2.5	2.5	4.5	5	1.5	0	0	0	0
Thailand	0	2	2	1	2.5	3		1	2	2.5	2.5	3.5	3.5	2	0	0	0	0
Philippines	0	1	2	2	2.5	2.5	1		2.5	2.5	2.5	1.5	2.5	0	0	0	0	0
Korea	0	4.5	2.5	3	2.5	2.5	2	2.5		6	4.25	2.5	3.5	0	0	0	0	0
Australia	0	4.5	2.5	3	2.5	2.5	2.5	2.5	6		4.75	2.5	3.5	0	0	0	0	0
New Zealand	0	3.25	2.75	2	2.5	2.5	2.5	2.5	4.25	4.75		2.25	3.5	0	0	0	0	0
Indonesia	0	0	4	1.5	2.5	4.5	3.5	1.5	2.5	2.5	2.25		4.5	1.5	0	0	0	0
Malaysia	0	2	4	2.5	2.5	5	3.5	2.5	3.5	3.5	3.5	4.5		1.5	0	0	0	0
Russia	0	0	1	1	0	1.5	2	0	0	0	0	1.5	1.5		0	0.5	0.5	0
Canada	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0		6.5	5.5	7.5
Mexico	6.5	0	0	0	0	0	0	0	0	0	0	0	0	0.5	6.5		6.5	5.5
Chile	6	0	0	0	0	0	0	0	0	0	0	0	0	0.5	5.5	6.5		6.5
Peru	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7.5	5.5	6.5	

The figure indicators how many overlapping trading hours there are between two countries' stock exchange.

Table 6—Trading hours

Country	Exchange	Trading Hours (Mon to Fri)	Trading Hours (Mon to Fri)
		(Local Time)	(Hong Kong Time)
US	AMEX, Nasdaq, NYSE	9:30-16:00 (6.5hrs)	22:30-5:00
Japan	Tokyo Stock Exchange	9:00-11:00, 12:30-15:00(4.5hrs)	8:00-10:00, 11:30-14:00
Hong Kong	Hong Kong Stock Exchange	10:00-12:30, 14:30-16:00 (4hrs)	10:00-12:30, 14:30-16:00
China	Shanghai SE, Shenzhen SE	9:30-11:30, 13:00-15:00 (4hrs)	9:30-11:30, 13:00-15:00
Taiwan	Taiwan Stock Exchange	9:00-13:30 (4.5hrs)	9:00-13:30
Singapore	Singapore Exchange	9:00-12:30, 14:00-17:00(6.5hrs)	9:00-12:30, 14:00-17:00
Thailand	Thailand Stock Exchange	9:55-12:30, 14:25-16:30(4.5hrs)	10:55-13:30, 15:25-17:30
Philippines	Philippines Stock Exchange	9:30-12:00 (2.5hrs)	9:30-12:00
South Korea	Korea Stock Exchange	9:00-15:00 (6hrs)	8:00-14:00
Australia	Australia Stock Exchange	10:00-16:00 (6hrs)	8:00-14:00
New Zealand	New Zealand Stock Exchange	10:00-16:45 (6.75hrs)	6:00-12:45
Indonesia	Jakarta Stock Exchange	9:30-12:00, 13:30-16:00 (5 hrs)	10:30-13:00, 14:30-17:00
Malaysia	Kuala Lumpur Stock Exchange	9:00-12:30, 14:30-17:00 (6 hrs)	9:00-12:30, 14:30-17:00
Russia	RTS Stock Exchange	10:30-18:00 (7.5hrs)	14:30-22:00
Canada	Montreal SE, Toronto SE	9:30-16:00 (6.5hrs)	22:30-5:00
Mexico	Mexican Stock Exchange	8:30-15:00 (6.5hrs)	21:30-4:00
Chile	Santiago Stock Exchange	9:30-16:30 (7hrs)	21:30-5:30
Peru	Lima Stock Exchange	9:30-16:00 (6.5hrs)	22:30-5:00

Source: Each country's stock market website

PI is the pluralism index of a country, a measure of its religious diversity. The pluralism index, calculated according to *World Christian Encyclopedia 1982*, is one minus the Herfindahl index of adherents in 2000 to nine major religions, among persons expressing adherence to some religion. The religions are Buddhism, Catholicism, Hinduism, Islam, Judaism, Protestantism, Orthodox, other eastern religions, and a catch-all. These data are from Barrett (1982). I grouped data on religious adherence into the above nine categories. The Herfindahl index in this case is the sum of the squares of the fraction of the population belonging to each religion, and therefore a high pluralism index value is indicative of greater religious diversity, and can be interpreted as the probability that any two randomly selected persons in a country do not belong to the same religion. A pluralistic society is one in which numerous distinct ethnic, religious, or cultural groups coex-

ist amiably. People from different countries may have cultural ties from their religions, which influences their economic and financial behaviour. My empirical model uses the ratio of pluralism indexes of two countries, effectively making it an odds ratio of the diversity of one country to another; for example, an observed pluralism index ratio of 3 would suggest that one country is three times as likely as the other to be diverse in the sense implied by the calculation of the Herfindahl index. I hypothesize that the stock markets of countries that are more pluralistic will be more highly correlated with those that are less so because the diversity of the former increases the likelihood of religious ties to those in the latter.

EFI is a country's economic freedom index as compiled by the Heritage Foundation for the years 2002 to 2007. The index is a grade from 0 to 100 assigned to each country from scores assessed for freedom enjoyed by or pertaining to business, trade, fiscal matters, investment, finance, labour, size of government, monetary policy, property rights, and freedom from corruption, all weighted equally. In 2007, Hong Kong maintained its status as the world's freest economy, a position it has held for more than 10 consecutive years. It was the only economy to score more than 90 on the 100-point economic freedom scale. Singapore remains close, ranked as the world's second freest economy. Carlsson and Lundstrom (2002) found that GDP growth bears a positive and robust relationship to a number of index variables, notably, legal structure, private ownership, and freedom to use an alternative currency in commerce. As with the pluralism index, I use the ratio of two countries' economic freedom indexes as a measure of their difference in economic freedom. A country that enjoys greater economic freedom is more open and attractive to foreign investors and thus suggests higher correlations with other countries. I therefore hypothesize an inverse relationship between the discrepancy in economic freedom and the correlation between markets. The pluralism and economic freedom indices are summarized in Table 7.

Table 7 — Pluralism and economic freedom indices

Country	Pluralism Index	Economic Freedom Index						Average
		2007	2006	2005	2004	2003	2002	
Australia	0.51	81.0	79.4	78.5	77.9	77.4	77.3	78.6
Canada	0.56	78.1	77.5	75.8	75.3	74.8	74.6	76.0
Chile	0.22	79.0	79.3	79.1	76.9	76.0	77.8	78.0
China	0.46	51.8	53.4	53.5	52.5	52.6	52.8	52.8
Hong Kong	0.60	90.6	89.3	90.2	90.0	89.8	89.4	89.9
Indonesia	0.64	53.9	52.7	53.6	52.1	55.8	54.8	53.8
Japan	0.46	72.2	72.8	66.7	64.3	67.6	66.7	68.4
South Korea	0.33	67.2	66.9	65.7	67.8	68.3	69.5	67.6
Malaysia	0.68	64.5	62.3	62.5	59.9	61.1	60.1	61.7
Mexico	0.05	66.3	64.9	65.5	66.0	65.3	63.0	65.2
New Zealand	0.37	81.0	81.7	81.9	81.5	81.1	80.7	81.3
Peru	0.09	62.5	60.3	61.1	64.7	64.6	64.8	63.0
Philippines	0.28	56.9	57.2	55.7	59.1	61.3	60.7	58.5
Russia	0.51	52.5	52.7	51.6	52.8	50.8	48.7	51.5
Singapore	0.63	87.2	89.1	89.7	88.9	88.2	87.4	88.4
Taiwan	0.58	70.2	70.4	71.9	69.6	71.7	71.3	70.9
Thailand	0.14	64.8	64.5	63.8	63.7	65.8	69.1	65.3
United States	0.64	80.9	81.1	79.7	78.7	78.2	78.4	79.5

Source: *World Christian Encyclopedia 1982* (pluralism) and Heritage Foundation (economic freedom)

3.3 An alternative version of the extended gravity model

The model in (3) below replaces legal origin and economic freedom with a security law index, *SLI*, proposed by La Porta et al (2006), to create a more parsimonious version of the model in (2).

$$\rho_{ijt} = \beta_0 + \beta_1 OLOH + \beta_2 \ln(CMC_{it} \cdot CMC_{jt}) + \beta_3 \ln(Volume_{it} \cdot Volume_{jt}) + \beta_4 \frac{PI_i}{PI_j} + \beta_5 \frac{SLI_i}{SLI_j} + \varepsilon_{ijt} \quad (3)$$

$$PI_i > PI_j, SLI_i > SLI_j$$

The security law index covers disclosure requirements, liability standards, and public enforcement, which itself encompasses liability standards, supervisor characteristics, rule making powers, investigative powers, orders and criminal sanctions. The data was obtained from Table II of La Porta et al (2006) and the index is computed as the average of the above three areas. Table 8 provides the details.

Table 8—Security law index

Country	Disclosure Requirements	Liability Standard	Public Enforcement	Security Law Index
USA	1	1	0.9	0.97
Japan	0.75	0.66	0	0.47
Hong Kong	0.92	0.66	0.87	0.82
China	0.33	0	0.33	0.22
Taiwan	0.75	0.66	0.52	0.64
Singapore	1	0.66	0.87	0.84
Thailand	0.92	0.22	0.72	0.62
Philippines	0.83	1	0.83	0.89
South Korea	0.75	0.66	0.25	0.55
Australia	0.75	0.66	0.9	0.77
New Zealand	0.67	0.44	0.33	0.48
Indonesia	0.5	0.66	0.62	0.59
Malaysia	0.92	0.66	0.77	0.78
Russia	0	0.11	0.57	0.23
Canada	0.92	1	0.8	0.91
Mexico	0.58	0.11	0.35	0.35
Chile	0.58	0.33	0.6	0.50
Peru	0.33	0.66	0.78	0.59

The table classifies countries showing the securities law variables for each country covering the equal weighting area of (1) disclosure requirements, (2) Liability standard, (3) Public enforcement

The security law index may subsume economic freedom and legal origin. The law regulates the stock market and measures the development of the stock market, including market openness and other relevant characteristics. The security law index, like economic freedom, is applied here as the ratio of the indexes of two countries, so it measures the discrepancy in security law between two countries. A higher security law index will lead to a higher-level development of stock market and thus increases the correlations with other stock markets. So we hypothesize an inverse relationship between the discrepancy in security law and the correlation between markets.

3.4 Summary of hypotheses

Nine hypotheses were posed in this section: (1) Greater similarity in financial behavior, which in turn implies more highly correlated stock markets. (2) Countries with a common border or strait are expected to have more highly correlated stock markets. (3) Stock markets of countries whose current legal systems have the same origin will be more highly correlated. (4) Larger markets are more highly correlated. (5) Active markets are less correlated. (6) The more that trading hours overlap, the higher the correlation between markets. (7) The greater the discrepancy in religious pluralism, the higher the correlation between stock markets. (8) The greater the discrepancy in economic freedom, the lower the correlation between stock markets. (9) The greater the discrepancy in security law, the lower the correlation between stock markets.

4. Results and discussion

Regression results for the base gravity model and the two extended gravity models is reported in this part, followed by a discussion of how the results are relevant to the home bias anomaly and the liberalization of China's stock market. Throughout the discussion,

reference is made to specific examples of stock market correlation coefficients. These numbers are reported in the appendix for each year of the sample.

4.1 Base gravity model

The results for the base gravity model, which includes the geographical distance variables, is presented in Table 9.

Table 9—Ordinary Least Squares Estimation of the Base Gravity Model

	<i>Variable</i>	<i>Coefficient</i>	<i>t-statistic</i>
β_0	Intercept	0.39772	1.72*
β_1	Great circle distance	0.01060	0.83
β_2	Common border	0.07322	2.04**
β_3	Joint market capitalization	0.02906	6.72***
β_4	Joint volume	-0.01746	-4.05***
β_5	Legal origin	0.07848	3.69***

N=918, Adjusted R-square=0.0748

Geographical distance, as measured by the great circle distance, is not statistically significant, but having a common border is, and it is associated with a seven percentage point increase in the correlation of market returns. The size variable, represented by the product of current market capitalizations, is positive and statistically significant at 99%. The larger the market, the more correlated it is with other markets. Larger markets tend to be more diversified across industrial sectors and thus co-move more closely in response to common or global events. This result is consistent with Flavin, Hurley, and Rousseau (2002) and Huang (2006). In 2002, the highest correlation is between the US and Australia, whose joint market capitalization is much bigger than that of the US and Indonesia whose correlation is -0.0164. The CMC of Australia is ten times larger than the CMC of Indonesia. But the product of trading volume, an indicator of joint market activeness, is statistically significant at 99% confidence level with a negative sign. The

more active one market is, the less it need turn to or be concerned with other markets; in other words, I interpret an active market is more independent, all things being equal. From 2002 to 2007, China and Japan are two typical countries with relatively higher trading volumes, but their correlation with other markets are very low. In 2006, China's trading volume was as high as 1.2 trillion and ranked first among all countries, but its average correlation of 0.1179 with other countries is the lowest of all. As stated before, an active market may mean that there is enough variety and enough going on at home that people from that country don't need to look elsewhere for investments, resulting in a home bias. This assumes selective attention and informational asymmetries and thus leads to a lower correlation with other markets.

Sharing a common legal heritage is significantly related to the correlation between markets, enough so to be associated with a correlation that is eight percentage points higher on average. In my sample, eight countries have an English common law heritage, and their markets have higher correlations with each other, but lower correlations with German civil law origin countries. In 2002, the US and Australia, which have the same legal origin, had a correlation as 0.8769, whereas the US and Japan, whose legal origins differ, had a correlation of 0.2883. La Porta et al (1997) examined the influence of legal rules on capital markets across 49 countries and found strong evidence that countries with different legal origins provide different rights and protection of their investors. Levine (2005) found that, at a broader lever, there is some evidence that legal systems that embrace jurisprudence have better property rights and, in turn, better financial systems.

4.2 Extended gravity model

Ordinary least squares estimates for the extended model in (2) are reported in Table 10.

Table 10—Ordinary Least Squares Estimation of the Extended Gravity Model

	<i>Variable</i>	<i>Coefficient</i>	<i>t-statistic</i>
β_0	Intercept	0.49504	2.44*
β_1	Overlapping opening hours	0.01292	2.69***
β_2	Joint market capitalization	0.02565	5.96***
β_3	Joint volume	-0.01371	-3.22***
β_4	Pluralism	0.01090	3.33***
β_5	Legal origin	0.08007	3.75***
β_6	Economic freedom	-0.12163	-2.28**

N=918, Adjusted R-square=0.1071

All variables are significant and of the predicted sign; and notably, the magnitude of those carried over from the base model, joint volume, joint market capitalization and legal origin, are unaffected in the presence of the new variables, overlapping operating hours, pluralism, and economic freedom.

Overlapping operating hours is associated with a significant, although modest, heightened correlation, consistent with fewer informational asymmetries. The religious diversity variable, applied by quotient of pluralism index of two countries, is statistically significant at 99% confidence level with a positive sign. The larger the distance between pluralism indexes of two countries, the more correlated their markets. This is not intuitive. Suppose the world has five religions, A, B, C, D, and E. The most plural country, I, is represented by all of them. There is a country, II, of median pluralism which has two religions, C and E. There are also two mono-religion countries, III and IV, one with A and the other with C. Country I, which is the most plural country, has religious ties with all the other countries, but country II only has religious ties with country I and IV. Comparatively speaking, a more plural country has more cultural ties with other countries than a less plural one, thus the more cultural ties indirectly increase the financial market correlations. Claims that religion affects economic and financial behaviors can be found in Hun-

tington (1996), Landes (1999), and Inglehart and Baker (2000) who argued that explanations for economic growth should go further to incorporate cultural factors. Religion is an important aspect of culture and Barro and McCleary (2003) who found that pluralism indirectly but significantly affected economic growth. They found that greater religious pluralism was associated with higher church attendance and stronger religious belief. For given church attendance, stronger adherence to some beliefs, notably in Heaven, Hell, and an after-life—were associated with higher economic growth.

Economic freedom, like pluralism, is applied here as the ratio of the indexes of two countries, so it measures the discrepancy in freedom. Here the result is opposite to that of pluralism, where the coefficient has a negative sign: the bigger the discrepancy in economic freedom, the lower the correlation of the two markets. And that coefficient is the largest: -0.12. Marshall (2005) reviewed previous research on the relationship between economic freedom and equity markets and found that cross-country equity returns were directly related to increases in economic freedom. For investors seeking superior investment returns, countries likely to experience an increase in economic freedom should be selected for investment. The countries with higher economic freedom like Hong Kong and Singapore are more open and attractive to foreign investors and thus lead to a positive impact on market correlation. In contrast, countries with lower economic freedom like Russia are not open and less attractive to foreign investors. The correlation of Hong Kong and Singapore in 2003 is 0.6499, while the correlation of Hong Kong and Russia is 0.1181. The economic freedom index of Hong Kong and Singapore is very close, so the discrepancy is much smaller than that of Hong Kong and Russia.

4.3 Alternative extended gravity model

Ordinary least squares estimates for the extended model using security law index in (3) to

replace legal origin and economic freedom is reported in Table 11. All of the independent variables are significant as before.

Table 11—Ordinary least squares estimates for the alternative extended model
using Security law index

	<i>Variable</i>	<i>Coefficient</i>	<i>t-statistic</i>
β_0	Intercept	0.53089	2.99***
β_1	Overlapping opening hours	0.01227	2.58**
β_2	Joint market capitalization	0.02684	6.36***
β_3	Joint volume	-0.01516	-3.66***
β_4	Pluralism	0.01054	3.31***
β_5	Security law index	-0.06821	-6.09***

N=918, adjusted R-square=0.1071

Here the result of security law index is the same as economic freedom, where the coefficient has a negative sign: the bigger the discrepancy in security law, the lower the correlation of the two markets. Similarity in the security law system is associated with higher financial market correlations and discrepancy in the security law system associated with lower correlations. La Porta et. al (2006) showed that security laws, especially laws mandating disclosure and facilitating private enforcement through liability rules, benefit the development of stock markets. A higher security law index will accompany if not lead to higher-level development of a stock market and thus increase the correlation with like markets. When one market is poorly protected, there is indicative of market segmentation as Bartram and Dufey (2001) market segmentation is “caused by barriers that are difficult for the investors to overcome, such as legal restrictions on international investment, thus the correlation with the other markets is low. The issue of stock market openness will be especially addressed in the next section.

4.4 Robustness to a measure of economic development

It can be argued that the variables studied might lose their significance in the presence of fundamental economic variables that gauge similarities in the level of economic development or the prosperity of the countries considered. The question of which fundamentals are most appropriate to include is beyond the scope of this study. However, to provide a non-rigorous sense of the robustness of the results, I include, somewhat arbitrarily, the rate of Internet penetration as a measure of the level of economic advancement of the countries. This rate, obtained from the International Telecommunication Union, corresponds to the percentage of the total population of a given country or region that uses the Internet. Table 12 reports the details, and shows that penetration rates have been increasing over time, and that there is variation between countries.

Table 12—Internet penetration rate (%)

	2002	2003	2004	2005	2006	2007
US	59.63	62.61	65.73	69	70	72.5
Japan	46.44	48.26	62.13	66.59	68.27	68.85
Hong Kong	42.9	46.67	49.98	50.08	52.97	54.97
China	4.57	6.12	7.19	8.5	10.5	16
Taiwan	47.6	51.94	53.81	58.01	63.68	64.45
Singapore	49.59	53	62	61	59.61	69.99
Thailand	7.67	9.5	10.94	15.43	17.62	21
Philippines	4.45	4.99	5.39	5.56	5.92	6.03
South Korea	59.4	65.5	70.2	72.8	74.8	76.3
Australia	58	60	62	63	52.05	53.99
New Zealand	60	62	63	64	69	70
Indonesia	2.1	2.35	2.56	3.54	8.87	10.79
Malaysia	32.71	35.37	42.73	49.18	52.24	55.67
Russia	4.13	8.3	12.86	15.22	18.02	21.05
Canada	61.6	64	66	68	70.5	73

Mexico	13.27	14.74	16.36	18.17	18.98	20.75
Chile	19.06	20.31	19.36	21.55	25.48	30.95
Peru	8.97	10.49	11.68	16.45	22.89	27.37

Source : www.itu.int

The model in (3) is re-estimated with the ratio of Internet penetration rates between countries and the results reported in Table 13. All of the original independent variables remain significant as before and the R-squared is increased by approximately two percentage points.

Table 13—Ordinary least squares estimates for the alternative extended model
using Security law index and Internet penetration rate

	<i>Variable</i>	<i>Coefficient</i>	<i>t-statistic</i>
β_0	Intercept	0.51097	2.89***
β_1	Overlapping opening hours	0.01254	2.65***
β_2	Joint market capitalization	0.02316	5.35***
β_3	Joint volume	-0.01230	-2.93***
β_4	Pluralism	0.00969	3.05***
β_5	Security law index	-0.06773	-6.08***
β_6	Internet penetration	-0.00645	-3.51***

N=918, adjusted R-square=0.1238

The interpretation of Internet penetration is the same as that for the security law index in the sense of gauging discrepancies in the level of sophistication and advancement of the economies. From Table 14, we can see US and Canada are the two countries with the highest internet penetration rates in our sample while Indonesia is the lowest. The market correlation in 2002 for the US and Canada is .83 but for the US and Indonesia it is -0.016.

4.5 What lies behind the home equity bias

The tendency of investors to allocate a disproportionate share of their wealth to domestic securities or, more often, to ignore foreign securities entirely, is in violation of the principles of portfolio theory and theories of market equilibrium such as the Capital Asset Pricing Model, and has been studied for some time. This study suggests that the variables that are associated with the correlation of stock markets bear some relevance to home bias, namely that those countries that display low correlations with others also tend to have the biggest home bias. It is natural to suggest that investors simply shy away from companies with which they are presumably unfamiliar, particularly those domiciled in countries with unfamiliar laws and cultures. Distance, in every sense of the word, would seem to matter in portfolio selection and thus be an essential part of the study of financial market segmentation and integration. Lewis (1999), Srong and Xu (2003), and Karolyi and Stulz (2003), among others, explain that the bias can be explained by explicit barriers to international investments, which were regulations, costs, information asymmetry, insider benefits, hedging motives and behavioral traits. But globalization has removed many barriers to international investment, especially in developed markets. Information too is more widely available and rapidly disseminated, especially for the multi-national firms that make up the much of world market capitalization. Interest has therefore turned to behavioural explanations for the persistence of the bias.

Given that gravity models make use of what might be considered behavioral variables, there is an opportunity to see whether the countries that display the strongest home bias are also the ones whose stock markets are least correlated with those of others, which in turn may be explained by gravity model variables. Data from the International Monetary Fund's Coordinated Investment Portfolio Survey (CIPS) is used here to calibrate a home bias ratio for each country along the lines of Solnik (2005). CIPS provides

detailed statistics on the geographical breakdown of investment and foreign equity holdings for each country at the end of 2007. All the 18 countries are covered in IMF's statistics. The ratio of foreign to world market capitalization and foreign holdings within equity portfolios is computed in Table 12. According to Kho and Warnock (2006), the home bias ratio (HBR) is one minus the ratio of the weights of foreign stocks in the investors' portfolio and in the world portfolio as in (4):

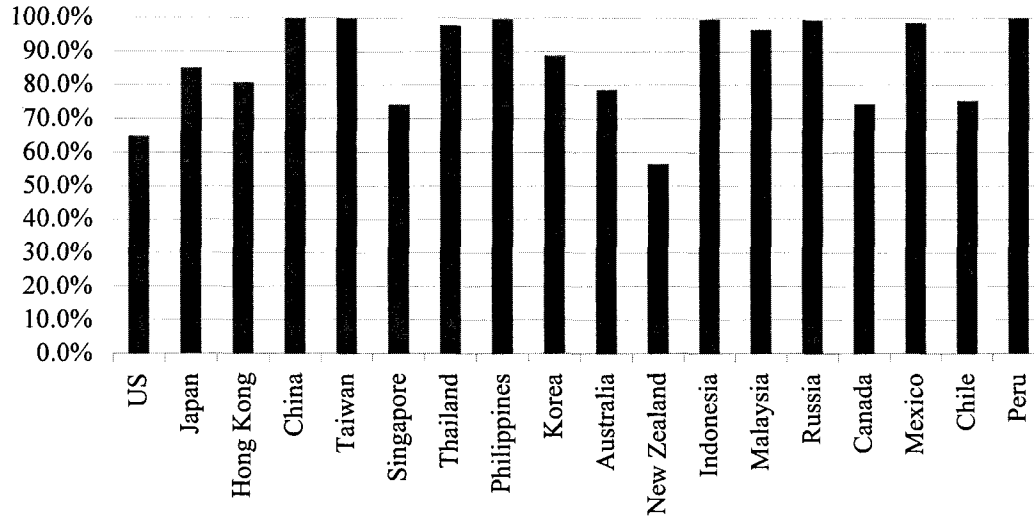
$$HBR = 1 - \frac{\alpha / w}{m_i / W} \quad (4)$$

Here, α refers to the holdings of international stocks by domestic investors and w indicates domestic equity holdings. m_i refers to the domestic market capital and W indicates total world market capital. This ratio is zero if there is no home bias and one if no foreign assets are owned (complete home bias). Table 14 and Figure 3 report the variables.

Table 14— Foreign and domestic holdings of equity

Notation	Holdings of international stocks by domestic investors	alpha	Holdings of domestic stocks by international investors	beta	m	International market cap.	Domestic equity holdings	International equity holdings	Foreign Market Cap.	Foreign Holdings	Home bias Ratio
						m_i	w	w_i	m/W	α/w	$1-(m/W)/(\alpha/w)$
US	5,247,983		2,889,037		19,922,280	40,952,119	22,281,226	38,593,173	67.3%	23.6%	65.0%
Japan	573,469		1,040,927		4,663,778	56,210,621	4,196,320	56,678,079	92.3%	13.7%	85.2%
Hong Kong	518,717		326,384		2,654,416	58,219,983	2,846,749	58,027,650	95.6%	18.2%	80.9%
China	0		387,920		4,478,867	56,395,532	4,090,947	56,783,452	92.6%	0.0%	100.0%
Taiwan	0		153,761		663,716	60,210,683	509,955	60,364,444	98.9%	0.0%	100.0%
Singapore	140,553		127,920		539,177	60,335,222	551,810	60,322,589	99.1%	25.5%	74.3%
Thailand	3,237		46,611		197,129	60,677,270	153,755	60,720,644	99.7%	2.1%	97.9%
Philippines	186		18,908		103,007	60,771,392	84,285	60,790,114	99.8%	0.2%	99.8%
Korea	106,110		257,405		1,122,606	59,751,793	971,311	59,903,088	98.2%	10.9%	88.9%
Australia	262,081		301,646		1,298,315	59,576,084	1,258,750	59,615,649	97.9%	20.8%	78.7%
New Zealand	27,411		11,641		47,486	60,826,913	63,256	60,811,143	99.9%	43.3%	56.6%
Indonesia	511		38,989		211,693	60,662,706	173,215	60,701,184	99.7%	0.3%	99.7%
Malaysia	9,422		53,496		325,290	60,549,109	281,216	60,593,183	99.5%	3.4%	96.6%
Russia	4,081		182,113		995,000	59,879,399	816,968	60,057,431	98.4%	0.5%	99.5%
Canada	563,661		465,155		2,186,550	58,687,849	2,285,056	58,589,343	96.4%	24.7%	74.4%
Mexico	3,672		120,981		397,725	60,476,674	280,416	60,593,983	99.3%	1.3%	98.7%
Chile	65,057		11,747		212,910	60,661,489	266,220	60,608,179	99.7%	24.4%	75.5%
Peru	0		3,281		69,386	60,805,013	66,105	60,808,294	99.9%	0.0%	100.0%
World market cap. (W)							60,874,399				

Figure 3—Home bias Ratio



A value less than US\$ 500,000 is indicated as a zero value. Holdings of international stocks by domestic investors and holdings of domestic stocks by international investors are obtained from CIPS of IMF. Domestic market cap and world market cap are obtained from The World Federation of Exchanges.

The home bias ratio for New Zealand and US at the end of 2007 is 56.6% and 65.0% respectively. Compared with that of other countries, equity home bias is not prevalent in these two developed countries. But investors from all the other countries exhibit a large degree of home bias (greater than 70%). Home bias is extreme in the emerging markets where the bias ratio exceeds 95%, except for Chile which is 75.5%.

Our gravity model shows the developed markets are those markets with large size, free and advanced economies, so the correlation is higher between each other, while the emerging markets are the opposite. This is consistent with the home bias ratio results.

4.6 Stock market openness and correlation: the case of China

Opening stock markets to foreign portfolio investment is a key step in world market inte-

gration, which is beneficial for the developing economy. All of the developing countries in the sample have undergone official liberalization or cross-listing or country fund listing since the late 1980s (Table 15). Data of Official liberalization events (I), cross-listing or country fund listing events (II), and deliberalization events (III) is given by Bae et al. (2006) and Bekaert et al. (2002).

Table 15—Schedule of liberalization of stock markets

Country	Official liberalization	Cross-listing or country fund listing	De-liberalization
Chile	01/1992	-	07/1995
China	03/2003	03/1997	-
Indonesia	-	10/1994	-
Korea	01/1992	10/1994	-
Malaysia	12/1988	02/1990	02/1994
Mexico	05/1989	-	05/1990
Peru	-	09/1994	-
Philippines	06/1991	10/1994	-
Russia	-	11/1996	05/1997
Taiwan	01/1991	04/1995	-
Thailand	09/1987	-	06/1997

Consider the case of China, whose official liberalization took place between 2002 and 2007. This allows us to examine the associations between stock market openness and correlation. The reform of the Chinese financial system continued from 1997 to 2007. In March 2003, investment quota for the QFII Scheme was started to allocate to qualified financial institutions. A capital injection of 45 billion USD into the Bank of China and China Construction Bank was announced in an effort to recapitalize the banks. This reform was the key standard that the Chinese stock market is officially liberalized. In the year of 2006, Qualified Domestic Institutional Investors (QDII) Scheme was introduced. It refined the interbank money market and introduced flexibility to the exchange rate sys-

tems. Whether the degree of market openness has something to do with market correlation is an important question of this study. We can refer to Appendix for details. In the year 2002, except for Hong Kong and Malaysia, China has a negatively low correlation with all other markets with average correlation of -0.1975, while in the year of 2004, after its official liberalization, China has a positive correlation with almost all other markets with average correlation of 0.2311. In the year of 2007, after the introduction of QDII Scheme, its average market correlation is increased to 0.2905. Clearly, liberalization and other acts of opening to foreign equity investors have a positive impact on stock market correlation, so the market openness indicator should act as an important factor included in the gravity model in this paper.

5. Conclusion

Gravity factors have long been used to explain economic correlations between goods markets. Our analysis shows that the gravity model with extended attraction factors is also applicable to the regional financial asset market. The alternative home bias measure--overlapping opening hours may be acting as a proxy for information asymmetries in a regional study. We also find market size, legal origin influence cross-country correlation which is consistent with former empirical studies. The new introduction of market activeness factor--trading volume and the extended unphysical distance variables such as religious diversity, economic freedom, security law index play an important role too. The robustness test introduces the internet penetration rate, which is also robust in the cross-country correlation.

References

Bae Kee-Hong, Bailey, Warren and Mao, Connie X. (2006), Stock market liberalization and the information environment, *Journal of International Money and Finance*, Vol. 25 (2006) 404-428.

Barro, Robert and McCleary, Rachel (2003), Religion and economic growth across countries, Harvard University, *American Sociological Review*, 2003, vol.68.

Bartram, Sohnke and Wang, Yaw-Huei (2005), Another look at the relationship between cross-market correlation and volatility, *Finance Research Letters*, Vol. 2, No. 2, pp.75-88.

Bergstrand, Jeffrey H. (1985), The Gravity Equation in International Trade: some Micro-economic Foundations and Empirical Evidence, *Review of Economics and Statistics*, 67, August, 474-481.

Feenstra, Robert C., James R. Markusen, and Andrew K. Rose (2001), Using the Gravity Equation to Differentiate among Alternative Theories of Trade, *The Canadian Journal of Economics*, Vol. 34, No. 2. (May, 2001), pp. 43.

Fitzpatrick. G. L. & M. J. Modlin (1986), *Direct-line distance* (International Edition), Metuchen, NJ: Scarecrow Press.

Flavin, T. J., M. J. Hurley and F. Rousseau (2002). Explaining stock market correlation: a gravity model approach. *The Manchester School*, 70(1), 87-106.

Forbes, K. J., Rigobon, R., (2002), No contagion, only interdependence: measuring stock market co-movements, *Journal of Finance* 57(5): 2223-2261.

Fredrik, Carlsson & Susanna, Economic freedom and growth: Decomposing the effects, *Public Choice* 112: 335–344, 2002.

Heaney, Richard, Hooper, Vince and Jaugietis, Martin (2002), Regional Integration of Stock Markets in the Latin America, *Journal of Economic Integration*, 17(4), pp.745-760.

Huang, Jui-Chi, Aysegul Ates & Tantatope Brahmasrene (2006), Measuring emerging stock market correlation utilizing the gravity model. *Journal of Economics and Economic Education Research*, 7,3, ABI/INFORM Global.

La Porta, R., Lopez-de-Silanes, F., Shlieufer, A. and Vishny, R. (1998), Law and Finance, *Journal of Political Economy*, Vol. 106, pp. 1113-1155.

La Porta, R., Lopez-de-Silanes and F., Shlieufer, A.(2006), What works in security laws?, *The Journal of Finance*, Vol. Lxi, No.1.

Lee, Jess and Wong, Alfred (2009), Impact of financial liberalization on stock market liquidity: Experience of China, Working paper, Hong Kong Monetary Authority.

Levine, Ross (2005), Law, Endowments and Property Rights, *Journal of Economic Perspectives*, Vol.19, No.3, pp61-88.

McCallum, John (1995), National Borders Matter: Canada-U.S. Regional Trade Patterns, *The American Economic Review*, Vol. 85, No. 3 (Jun., 1995), pp. 615-623.

Morgado P. and Tavares J.(2006), Economic Integration and the Correlation of Stock Returns, Working Paper, Social Science Research Network.

Portes, R. H. Rey (2004), The determinants of cross-border equity flows, *Journal of International Economics*, 65 (2005) 269– 296.

Ramchand, Latha and Susmel, Raul (1998), Volatility and cross correlation across major stock markets, *Journal of Empirical Finance*, 1998.397–416.

Solnik, Bruno, Boucrelle, Cyril, and Yann, Le Fur (1996), International Market Correlation and Volatility, *Financial Analysts Journal*, Vol. 52, No. 5:17-34.

Solnik, Bruno (2008), Equity home bias and regret: an international equilibrium model, Working Paper, Social Science Research Network.

Stocker, Marshall L. (2005), Equity returns and economic freedom, *Cato Journal*, Vol. 25, No. 3 (Fall 2005).

Appendix

National Stock Index

Country	National Index
US	S&P 500 Index
Japan	TOPIX Index
Hong Kong	Hang Seng Index
China	Shanghai SE Composite Index
Taiwan	Taiwan Taix Index
Singapore	Straits Times Index
Thailand	Stock Exchange of Tailand
Philippines	Philippines SE Index
South Korea	Kospi Index
Australia	S&P/ASX 200 Index
New Zealand	NEX All Index
Indonesia	Jakarta Composite Index
Malaysia	Kuala Lumpur Comp Index
Russia	Russian Traded Index
Canada	S&P/TSX Composite Index
Mexico	Mexico Bolsa Index
Chile	Chile Stock Mkt Select
Peru	Peru Lima General Index

Stock Market Correlations

Year 2002

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	1.0000	0.2883	0.7468	-0.1482	0.7980	0.6246	0.5464	0.0194	0.7121	0.8769	0.3883	-0.0164	0.3197	0.5320	0.8263	0.6815	0.5653	0.6807
Japan	0.2883	1.0000	0.5468	-0.0122	0.1159	-0.1500	0.2541	0.1656	0.4194	0.2527	0.0636	0.3108	-0.0811	0.3943	0.5228	0.1933	0.0337	0.0730
Hong Kong	0.7468	0.5468	1.0000	0.1110	0.6633	0.3074	0.2745	-0.1974	0.5808	0.5503	-0.0077	0.1000	0.4124	0.5538	0.6341	0.5435	0.4883	0.4300
China	-0.1482	-0.0122	0.1110	1.0000	-0.1482	-0.2789	-0.4066	-0.5448	0.0174	-0.3936	-0.4084	-0.1103	0.2287	-0.1223	-0.2330	-0.1165	-0.1846	-0.6073
Taiwan	0.7980	0.1159	0.6633	-0.1482	1.0000	0.8821	0.5510	0.2669	0.6903	0.7452	0.2667	0.2688	0.7282	0.7540	0.6541	0.8828	0.6647	0.6893
Singapore	0.6246	-0.1500	0.3074	-0.2789	0.8821	1.0000	0.6182	0.4160	0.5393	0.7216	0.5140	0.1999	0.6550	0.6855	0.4258	0.7856	0.4907	0.5795
Thailand	0.5464	0.2541	0.2745	-0.4066	0.5510	0.6182	1.0000	0.4653	0.5583	0.6877	0.5463	0.2817	0.2282	0.3871	0.5002	0.3994	0.2896	0.4877
Philippines	0.0194	0.1656	0.2669	0.4653	0.2669	0.4160	0.4653	1.0000	0.4205	0.2825	0.3104	0.5651	0.0338	0.3504	0.2140	0.4358	-0.0867	0.4740
South Korea	0.7121	0.4194	0.5808	0.0174	0.6903	0.5393	0.5583	0.4205	1.0000	0.6003	0.1231	0.2007	0.2983	0.4174	0.6059	0.6516	0.3160	0.6314
Australia	0.8769	0.2527	0.5503	-0.3936	0.7452	0.7216	0.6877	0.2825	0.6003	1.0000	0.7362	0.2019	0.3437	0.6275	0.8208	0.7490	0.5095	0.6906
New Zealand	0.3883	0.0636	-0.0077	-0.4084	0.2667	0.5140	0.5463	0.3104	0.1231	0.7362	1.0000	0.1992	0.1120	0.4381	0.4281	0.4013	0.1048	0.2045
Indonesia	-0.0164	0.3108	0.1000	-0.1103	0.2688	0.1999	0.2817	0.5651	0.2007	0.2019	0.1992	1.0000	0.4119	0.4618	0.4141	0.5289	0.1271	0.1974
Malaysia	0.3197	-0.0811	0.4124	0.2287	0.7282	0.6550	0.2282	0.0338	0.2983	0.3437	0.1120	0.4119	1.0000	0.5938	0.3072	0.6960	0.6645	0.2121
Russia	0.5320	0.3943	0.5538	-0.1223	0.7540	0.6855	0.3871	0.3504	0.4174	0.6275	0.4381	0.4618	0.5938	1.0000	0.5659	0.8291	0.2846	0.3099
Canada	0.8263	0.5228	0.6341	-0.2330	0.6541	0.4258	0.5002	0.2140	0.6059	0.8208	0.4281	0.4141	0.3072	0.5659	1.0000	0.7266	0.5842	0.6439
Mexico	0.6815	0.1933	0.5435	-0.1165	0.8828	0.7856	0.3994	0.4358	0.6516	0.7490	0.4013	0.5289	0.6960	0.8291	0.7266	1.0000	0.5183	0.6285
Chile	0.5653	0.0337	0.4883	-0.1846	0.6647	0.4907	0.2896	-0.0867	0.3160	0.5095	0.1048	0.1271	0.6645	0.2846	0.5842	0.5183	1.0000	0.5771
Peru	0.6807	0.0730	0.4300	-0.6073	0.6893	0.5795	0.4877	0.4740	0.6314	0.6906	0.2045	0.1974	0.2121	0.3099	0.6439	0.6285	0.5771	1.0000

Year 2003

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	1.0000	0.3634	0.4342	-0.0379	0.0829	0.4546	0.3666	0.1649	0.7877	0.7121	0.4831	0.6348	0.4005	0.3326	0.7551	0.6644	0.6644	0.4765
Japan	0.3634	1.0000	0.6415	-0.4585	0.4554	0.7940	0.7395	0.4187	0.5291	0.3645	0.3856	0.4453	0.5482	0.3363	0.6491	0.3035	0.3160	-0.0263
Hong Kong	0.4342	0.6415	1.0000	-0.2032	0.5557	0.6499	0.4457	0.0036	0.6311	0.2797	0.2733	0.3306	0.7308	0.1181	0.7750	0.2733	0.3956	-0.0177
China	-0.0379	-0.4585	-0.2032	1.0000	0.1294	-0.5340	-0.1057	-0.1825	-0.2374	-0.1725	-0.0771	-0.2732	-0.0656	-0.1423	-0.0032	-0.3786	-0.1802	0.5028
Taiwan	0.0829	0.4554	0.5557	0.1294	1.0000	0.4582	0.4940	0.3456	0.2630	0.3523	0.3427	-0.2410	0.7732	-0.3402	0.3797	-0.1586	0.0771	-0.0003
Singapore	0.4546	0.7940	0.6499	-0.5340	0.4582	1.0000	0.5702	0.4364	0.6175	0.4840	0.2166	0.3404	0.6212	-0.0580	0.6387	0.4339	0.3182	-0.2270
Thailand	0.3666	0.7395	0.4457	-0.1057	0.4940	0.5702	1.0000	0.6687	0.3102	0.4763	0.5131	0.3953	0.5081	0.0694	0.5446	0.1549	0.0102	0.2927
Philippines	0.1649	0.4187	0.0036	-0.1825	0.3456	0.4364	0.6687	1.0000	0.0372	0.3502	0.3898	0.2877	0.3763	-0.1785	0.0971	0.0583	0.0956	0.3013
Korea	0.7877	0.5291	0.6311	-0.2374	0.2630	0.6175	0.3102	0.0372	1.0000	0.5263	0.3174	0.2908	0.5559	0.2692	0.8764	0.6825	0.5800	0.2113
Australia	0.7121	0.3645	0.2797	-0.1725	0.3523	0.4840	0.4763	0.3502	0.5263	1.0000	0.3301	0.3525	0.4371	-0.1210	0.4925	0.4074	0.5396	0.3359
New Zealand	0.4831	0.3856	0.2733	-0.0771	0.3427	0.2166	0.5131	0.3898	0.3174	0.3301	1.0000	0.4171	0.2282	0.4898	0.2893	0.4462	0.2081	0.2847
Indonesia	0.6348	0.4453	0.3306	-0.2732	-0.2410	0.3404	0.3953	0.2877	0.2908	0.3525	0.4171	1.0000	0.0422	0.5791	0.4226	0.5331	0.5862	0.3955
Malaysia	0.4005	0.5482	0.7308	-0.0656	0.7732	0.6212	0.5081	0.3763	0.5559	0.4371	0.2282	0.0422	1.0000	-0.2820	0.6108	-0.0692	0.3014	0.0706
Russia	0.3326	0.3363	0.1181	-0.1423	-0.3402	-0.0580	0.0694	-0.1785	0.2692	-0.1210	0.4898	0.5791	-0.2820	1.0000	0.2639	0.4997	0.3370	0.2413
Canada	0.7551	0.6491	0.7750	-0.0032	0.3797	0.6387	0.5446	0.0971	0.8764	0.4925	0.2893	0.4226	0.6108	0.2639	1.0000	0.5329	0.5224	0.3598
Mexico	0.6644	0.3035	0.2733	-0.3786	-0.1586	0.4339	0.1549	0.0583	0.6825	0.4074	0.4462	0.5331	-0.0692	0.4997	0.5329	1.0000	0.5388	0.2088
Chile	0.6644	0.3160	0.3956	-0.1802	0.0771	0.3182	0.0102	0.0956	0.5800	0.5396	0.2081	0.5862	0.3014	0.3370	0.5224	0.5388	1.0000	0.4593
Peru	0.4765	-0.0263	-0.0177	0.5028	-0.0003	-0.2270	0.2927	0.3013	0.2113	0.3359	0.2847	0.3955	0.0706	0.2413	0.3598	0.2088	0.4593	1.0000

Year 2004

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	1.0000	0.1573	0.6512	0.0105	0.6421	0.2495	0.3827	-0.0138	0.4548	0.6300	0.0515	0.2916	0.3245	0.0601	0.7274	0.6240	0.1421	0.2262
Japan	0.1573	1.0000	-0.3652	0.0452	0.1550	-0.0658	-0.2270	-0.2992	0.2117	0.1925	0.2861	-0.1790	0.2234	0.3573	-0.1603	0.3377	-0.2653	0.0381
Hong Kong	0.6512	-0.3652	1.0000	0.2771	0.7129	0.5721	0.3909	-0.0243	0.5192	0.2406	-0.1079	0.3723	0.4756	0.0481	0.6926	0.3725	0.4560	0.0782
China	0.0105	0.0452	0.2771	1.0000	0.4435	0.3154	-0.2795	-0.1658	0.3736	0.0317	0.0313	0.2133	0.6819	0.5119	0.3549	0.5505	-0.0936	0.6269
Taiwan	0.6421	0.1550	0.7129	0.4435	1.0000	0.5001	0.0170	-0.1051	0.8223	0.1361	-0.2336	0.2063	0.4324	0.4900	0.5998	0.6634	0.2226	0.3429
Singapore	0.2495	-0.0658	0.5721	0.3154	0.5001	1.0000	0.1543	0.3702	0.4625	-0.0270	0.4072	0.6034	0.5393	0.1935	0.4731	0.3884	0.2377	0.1815
Thailand	0.3827	-0.2270	0.3909	-0.2795	0.0170	0.1543	1.0000	0.2451	0.0790	0.5948	0.1395	0.2829	0.0755	-0.3939	0.2296	-0.1021	0.6447	-0.4005
Philippines	-0.0138	-0.2992	-0.0243	-0.1658	-0.1051	0.3702	0.2451	1.0000	0.1019	-0.1206	0.2468	0.5945	-0.2330	-0.1839	0.0593	-0.1324	0.0184	0.1165
Korea	0.4548	0.2117	0.5192	0.3736	0.8223	0.4625	0.0790	0.1019	1.0000	0.1732	-0.0943	0.4204	0.4232	0.5280	0.2646	0.5120	0.2926	0.2979
Australia	0.6300	0.1925	0.2406	0.0317	0.1361	-0.0270	0.5948	-0.1206	0.1732	1.0000	0.1563	0.1298	0.4605	0.1405	0.4941	0.5412	0.3827	0.2242
New Zealand and	0.0515	0.2861	-0.1079	0.0313	-0.2336	0.4072	0.1395	0.2468	-0.0943	0.1563	1.0000	0.5199	0.2360	-0.2949	-0.0921	0.0444	-0.3781	0.0063
Indonesia	0.2916	-0.1790	0.3723	0.2133	0.2063	0.6034	0.2829	0.5945	0.4204	0.1298	0.5199	1.0000	0.3185	-0.2290	0.2131	0.1674	-0.0446	0.1371
Malaysia	0.3245	0.2234	0.4756	0.6819	0.4324	0.5393	0.0755	-0.2330	0.4232	0.4605	0.2360	0.3185	1.0000	0.4993	0.5351	0.6818	0.2961	0.3869
Russia	0.0601	0.3573	0.0481	0.5119	0.4900	0.1935	-0.3939	-0.1839	0.5280	0.1405	-0.2949	-0.2290	0.4993	1.0000	0.2989	0.6831	0.2118	0.6583
Canada	0.7274	-0.1603	0.6926	0.3549	0.5998	0.4731	0.2296	0.0593	0.2646	0.4941	-0.0921	0.2131	0.5351	0.2989	1.0000	0.7633	0.2789	0.5223
Mexico	0.6240	0.3377	0.3725	0.5505	0.6634	0.3884	-0.1021	-0.1324	0.5120	0.5412	0.0444	0.1674	0.6818	0.6831	0.7633	1.0000	0.0477	0.7658
Chile	0.1421	-0.2653	0.4560	-0.0936	0.2226	0.2377	0.6447	0.0184	0.2926	0.3827	-0.3781	-0.0446	0.2961	0.2118	0.2789	0.0477	1.0000	-0.2434
Peru	0.2262	0.0381	0.0782	0.6269	0.3429	0.1815	-0.4005	0.1165	0.2979	0.2242	0.0063	0.1371	0.3869	0.6583	0.5223	0.7658	-0.2434	1.0000

Year 2005

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	1.0000	0.3521	0.6596	0.2282	0.7435	0.6787	0.1935	0.4085	0.7855	0.6439	0.5682	0.4807	0.2523	0.4576	0.7442	0.6829	0.3057	0.2497
Japan	0.3521	1.0000	0.2571	0.4237	0.4435	0.1252	0.4277	0.1029	0.6064	0.6359	0.3206	0.1488	0.0363	0.5890	0.5231	0.6781	-0.1302	0.4751
Hong Kong	0.6596	0.2571	1.0000	0.5588	0.6047	0.5647	0.3615	0.0870	0.6398	0.5969	0.6812	0.1243	0.5492	0.7758	0.7351	0.6592	0.4044	0.4350
China	0.2282	0.4237	0.5588	1.0000	0.3530	0.0077	0.6162	-0.0572	0.2969	0.3455	0.5060	-0.2129	0.2083	0.7235	0.5771	0.3683	-0.0554	0.3311
Taiwan	0.7435	0.4435	0.6047	0.3530	1.0000	0.6966	0.4230	0.3890	0.8026	0.7837	0.6798	0.6459	0.2382	0.4251	0.7815	0.7051	0.2047	0.1250
Singapore	0.6787	0.1252	0.5647	0.0077	0.6966	1.0000	0.1805	0.4346	0.7363	0.6401	0.6086	0.7488	0.5786	0.2680	0.6944	0.5345	0.6036	0.2159
Thailand	0.1935	0.4277	0.3615	0.6162	0.4230	0.1805	1.0000	0.4029	0.5506	0.6232	0.6924	0.2521	0.3205	0.6998	0.6007	0.6259	0.0285	0.3298
Philippines	0.4085	0.1029	0.0870	-0.0572	0.3890	0.4346	0.4029	1.0000	0.6147	0.4385	0.4261	0.5707	0.2480	0.2608	0.2658	0.4899	0.0490	0.1991
Korea	0.7855	0.6064	0.6398	0.2969	0.8026	0.7363	0.5506	0.6147	1.0000	0.8610	0.7366	0.6627	0.4271	0.6729	0.8078	0.9238	0.3655	0.4722
Australia	0.6439	0.6359	0.5969	0.3455	0.7837	0.6401	0.6232	0.4385	0.8610	1.0000	0.8001	0.4909	0.3694	0.6918	0.8649	0.8111	0.2957	0.5694
New Zealand	0.5682	0.3206	0.6812	0.5060	0.6798	0.6086	0.6924	0.4261	0.7366	0.8001	1.0000	0.5081	0.6950	0.6729	0.7622	0.7616	0.4954	0.3386
Indonesia	0.4807	0.1488	0.1243	-0.2129	0.6459	0.7488	0.2521	0.5707	0.6627	0.4909	0.5081	1.0000	0.3839	-0.0367	0.3955	0.5327	0.4555	-0.1451
Malaysia	0.2523	0.0363	0.5492	0.2083	0.2382	0.5786	0.3205	0.2480	0.4271	0.3694	0.6950	0.3839	1.0000	0.4208	0.3372	0.5138	0.4985	0.1025
Russia	0.4576	0.5890	0.7758	0.7235	0.4251	0.2680	0.6998	0.2608	0.6729	0.6918	0.6729	-0.0367	0.4208	1.0000	0.7158	0.7519	0.1461	0.7170
Canada	0.7442	0.5231	0.7351	0.5771	0.7815	0.6944	0.6007	0.2658	0.8078	0.8649	0.7622	0.3955	0.3372	0.7158	1.0000	0.6941	0.3902	0.5411
Mexico	0.6829	0.6781	0.6592	0.3683	0.7051	0.5345	0.6259	0.4899	0.9238	0.8111	0.7616	0.5327	0.5138	0.7519	0.6941	1.0000	0.2442	0.3849
Chile	0.3057	-0.1302	0.4044	-0.0554	0.2047	0.6036	0.0285	0.0490	0.3655	0.2957	0.4954	0.4555	0.4985	0.1461	0.3902	0.2442	1.0000	0.3249
Peru	0.2497	0.4751	0.4350	0.3311	0.1250	0.2159	0.3298	0.1991	0.4722	0.5694	0.3386	-0.1451	0.1025	0.7170	0.5411	0.3849	0.3249	1.0000

Year 2006

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	1.0000	0.6851	0.6997	-0.0939	0.5596	0.8358	0.6696	0.3064	0.7350	0.8197	0.5197	0.7896	0.4717	0.4653	0.6817	0.8435	0.7193	0.2097
Japan	0.6851	1.0000	0.5997	0.0400	0.2709	0.6473	0.2225	0.0017	0.5279	0.8503	0.5062	0.6312	0.1460	0.3971	0.6835	0.7004	0.4864	0.2804
Hong Kong	0.6997	0.5997	1.0000	0.1267	0.4404	0.7562	0.5862	0.2044	0.6874	0.6185	0.2957	0.6342	0.4817	0.7200	0.6235	0.8645	0.5805	0.7220
China	-0.0939	0.0400	0.1267	1.0000	0.3797	0.0677	-0.3617	0.1369	0.0263	0.0622	0.0856	0.0201	0.1753	-0.0621	-0.0718	0.0299	0.3691	0.1932
Taiwan	0.5596	0.2709	0.4404	0.3797	1.0000	0.6503	0.3572	0.1658	0.7866	0.5404	0.5010	0.7882	0.6695	0.4076	0.2289	0.6564	0.5255	0.2836
Singapore	0.8358	0.6473	0.7562	0.0677	0.6503	1.0000	0.4242	0.2065	0.6844	0.8099	0.6779	0.7510	0.5488	0.5498	0.5130	0.8600	0.6441	0.2850
Thailand	0.6696	0.2225	0.5862	-0.3617	0.3572	0.4242	1.0000	0.1938	0.6048	0.4360	0.1394	0.5898	0.4832	0.6978	0.6847	0.6086	0.4669	0.3286
Philippines	0.3064	0.0017	0.2044	0.1369	0.1658	0.2065	0.1938	1.0000	0.1110	0.0108	0.4679	0.3416	0.1778	-0.1347	0.1298	0.2870	0.2201	-0.2047
Korea	0.7350	0.5279	0.6874	0.0263	0.7866	0.6844	0.6048	0.1110	1.0000	0.5764	0.3073	0.8951	0.7425	0.5690	0.4983	0.8844	0.5973	0.5076
Australia	0.8197	0.8503	0.6185	0.0622	0.5404	0.8099	0.4360	0.0108	0.5764	1.0000	0.6779	0.7154	0.2733	0.5226	0.7248	0.7461	0.5629	0.1998
New Zealand	0.5197	0.5062	0.2957	0.0856	0.5010	0.6779	0.1394	0.4679	0.3073	0.6779	1.0000	0.6251	0.2550	0.1604	0.4068	0.5360	0.2597	-0.2568
Indonesia	0.7896	0.6312	0.6342	0.0201	0.7882	0.7510	0.5898	0.3416	0.8951	0.7154	0.6251	1.0000	0.5933	0.5694	0.5614	0.8909	0.5645	0.3220
Malaysia	0.4717	0.1460	0.4817	0.1753	0.6695	0.5488	0.4832	0.1778	0.7425	0.2733	0.2550	0.5933	1.0000	0.4134	0.4443	0.6453	0.6877	0.1854
Russia	0.4653	0.3971	0.7200	-0.0621	0.4076	0.5498	0.6978	-0.1347	0.5690	0.5226	0.1604	0.5694	0.4134	1.0000	0.5660	0.6121	0.4670	0.6827
Canada	0.6817	0.6835	0.6235	-0.0718	0.2289	0.5130	0.6847	0.1298	0.4983	0.7248	0.4068	0.5614	0.4443	0.5660	1.0000	0.6711	0.6276	0.1611
Mexico	0.8435	0.7004	0.8645	0.0299	0.6564	0.8600	0.6086	0.2870	0.8844	0.7461	0.5360	0.8909	0.6453	0.6121	0.6711	1.0000	0.6341	0.4715
Chile	0.7193	0.4864	0.5805	0.3691	0.5255	0.6441	0.4669	0.2201	0.5973	0.5629	0.2597	0.5645	0.6877	0.4670	0.6276	0.6341	1.0000	0.2214
Peru	0.2097	0.2804	0.7220	0.1932	0.2836	0.2850	0.3286	-0.2047	0.5076	0.1998	-0.2568	0.3220	0.1854	0.6827	0.1611	0.4715	0.2214	1.0000

Year 2007

	US	Japan	Hong Kong	China	Taiwan	Singapore	Thailand	Philippines	South Korea	Australia	New Zealand	Indonesia	Malaysia	Russia	Canada	Mexico	Chile	Peru
US	1.0000	0.4319	0.4677	0.5591	0.2467	0.7393	0.0936	0.6431	0.2850	0.8515	0.6817	0.2000	0.4035	-0.1896	0.7657	0.6332	0.6253	0.3279
Japan	0.4319	1.0000	0.2886	-0.0459	0.5873	0.6952	0.3883	0.6580	0.3809	0.5307	0.5367	0.1358	0.5592	-0.1381	0.6476	0.4802	0.5990	0.5068
Hong Kong	0.4677	0.2886	1.0000	0.3856	0.6545	0.5992	0.5985	0.4361	0.5159	0.5950	0.2757	0.5546	0.2708	0.5762	0.6127	0.2685	0.3920	0.2381
China	0.5591	-0.0459	0.3856	1.0000	0.2859	0.3702	0.3464	0.0268	0.5183	0.4185	0.2879	0.2182	0.1203	-0.1154	0.5580	0.3406	0.2777	0.3861
Taiwan	0.2467	0.5873	0.6545	0.2859	1.0000	0.6215	0.8070	0.4077	0.7181	0.3509	0.3040	0.3741	0.2379	0.4142	0.6144	0.2538	0.3671	0.5764
Singapore	0.7393	0.6952	0.5992	0.3702	0.6215	1.0000	0.4470	0.7907	0.4871	0.7704	0.8656	0.4516	0.7239	0.1650	0.8246	0.6285	0.5815	0.6148
Thailand	0.0936	0.3883	0.5985	0.3464	0.8070	0.4470	1.0000	0.1501	0.9180	0.1263	0.2713	0.7349	0.3027	0.4178	0.5779	0.1558	0.1818	0.4615
Philippines	0.6431	0.6580	0.4361	0.0268	0.4077	0.7907	0.1501	1.0000	0.1216	0.5547	0.7307	0.2427	0.6882	0.1145	0.6503	0.7301	0.7298	0.3275
Korea	0.2850	0.3809	0.5159	0.5183	0.7181	0.4871	0.9180	0.1216	1.0000	0.2962	0.3632	0.6765	0.2085	0.1822	0.6655	0.3448	0.2275	0.4646
Australia	0.8515	0.5307	0.5950	0.4185	0.3509	0.7704	0.1263	0.5547	0.2962	1.0000	0.5357	0.1897	0.3471	0.0107	0.6844	0.5623	0.5801	0.4176
New Zealand	0.6817	0.5367	0.2757	0.2879	0.3040	0.8656	0.2713	0.7307	0.3632	0.5357	1.0000	0.4252	0.7475	-0.1098	0.6855	0.6189	0.4221	0.4114
Indonesia	0.2000	0.1358	0.5546	0.2182	0.3741	0.4516	0.7349	0.2427	0.6765	0.1897	0.4252	1.0000	0.5268	0.5387	0.4419	0.2153	0.2031	0.3547
Malaysia	0.4035	0.5592	0.2708	0.1203	0.2379	0.7239	0.3027	0.6882	0.2085	0.3471	0.7475	0.5268	1.0000	0.1363	0.5545	0.4612	0.5185	0.5464
Russia	-0.1896	-0.1381	0.5762	-0.1154	0.4142	0.1650	0.4178	0.1145	0.1822	0.0107	-0.1098	0.5387	0.1363	1.0000	0.0399	-0.1333	-0.0705	0.1474
Canada	0.7657	0.6476	0.6127	0.5580	0.6144	0.8246	0.5779	0.6503	0.6655	0.6844	0.6855	0.4419	0.5545	0.0399	1.0000	0.6998	0.5281	0.4057
Mexico	0.6332	0.4802	0.2685	0.3406	0.2538	0.6285	0.1558	0.7301	0.3448	0.5623	0.6189	0.2153	0.4612	-0.1333	0.6998	1.0000	0.6770	0.2688
Chile	0.6253	0.5990	0.3920	0.2777	0.3671	0.5815	0.1818	0.7298	0.2275	0.5801	0.4221	0.2031	0.5185	-0.0705	0.5281	0.6770	1.0000	0.5813
Peru	0.3279	0.5068	0.2381	0.3861	0.5764	0.6148	0.4615	0.3275	0.4646	0.4176	0.4114	0.3547	0.5464	0.1474	0.4057	0.2688	0.5813	1.0000