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CULTURAL AND LINGUISTIC DISTANCE AS FORCES IN GRAVITY MODELSOF BILATERAL TRADE AND INVESTMENT: THE CASE OF JAPAN

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ABSTRACT

Academic disciplines often benefit from borrowing and adapting good ideas in one endeavor to better understand another, seemingly different problem. So it is that the gravitational model of physics has become a workhorse in explaining the forces that compel countries to enter into economic exchanges by considering the economic mass of each economy, tempered by the distance between them. This paper considers the possibility that, at least for some countries some of the time, other factors may contribute more than physical distance to its perception of isolation or tendency to seek out partners that are "nearby" in some sense other than physical space. Two seemingly reasonable candidates are considered in some detail: cultural distance and linguistic distance. Multiple constructs are considered for each. The working hypothesis is that there may be circumstances in which results from the standard gravity model may improve by substituting alternative measure(s) of distance. Empirical support for the hypothesis is derived from consideration of trade and investment data from bilateral relations Japan has with each of 65 countries around the world. Japan is an ideal candidate because it is an island-nation, far removed geographically from most of the world's primary markets, with deeply engrained cultural roots in a highly homogenized society, and almost uniformly speaking a language that has not been adopted by other nations. Statistical findings reject the null hypothesis that physical distance matters (at least in terms of statistically significant explanatory power) in economic relations involving Japan, and support the alternative hypothesis that cultural and/or linguistic distance (in this instance, linguistic) is a statistically significant alternative measure of distance.

Keywords: Trade, Foreign Direct Investment, Linguistic Distance, Cultural Distance, Gravity Model, Japan

INTRODUCTION

Global Trade and Foreign Direct Investment

Throughout the two-thirds of a century since the end of World War II, but especially since 1980, there has been steady and dramatic growth in global productivity and trade, and explosive growth in global (FDI) foreign direct investment (see Appendix). There are several theories and models to justify and motivate such activity, usually based on the seminal works of Adam Smith, David Ricardo, and various 20th-century economists. There also are several models to measure and explain levels and variations in such activity between countries, such as the gravity model discussed in the next section. More recently, attention has focused on explaining the differing incentives for export *v.* outward FDI (and conversely, import *v.* inward FDI), and in determining conditions under which these are substitute or complementary activities.

The searches for universal principles may obscure significant idiosyncratic factors that help explain the level and nature of trade between any two specific countries. This seems all the more likely to the extent that one of the countries is "very different" from other(s). For example, the United States and Japan are the two countries that rank near the top on all three criteria of GDP, GDP per capita, and population. It also is the case that they are among the lowest in levels of trade and FDI as a percent of GDP (see Appendix). However, the two countries are dramatically different in several ways thought to influence global partnerships. In distinct contrast to the United States, Japan seems a densely populated island nation with homogeneity of culture and language, and a strong preference for insularity from outside influences. It seems only natural to suggest that such distinctiveness and homogeneity might hamper global commerce. Yet appearances and stereotypes can mislead, and Japan today maintains trade relations with more than 60 countries. How can this be explained?

Standard Gravity Models

A simple conceptual framework for explaining the level of bilateral trade and investment activity between two countries is the gravity model, based on the landmark observation by Sir Isaac Newton (in his *Principia*, 1687):

> *Every particle of matter in the universe attracts every other particle with a force that is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them.*

The mathematical representation of Newton's insight expresses force as a function of gravitational pull, which is positively influenced by mass of the two objects, but negatively influenced by the distance between them:

$$F_{i,j} = g \frac{m_i \, m_j}{d^2}$$

The empirical model to implement this model estimates parameters β, subject to errorε:

$$F_{i,j} = \alpha \left(m_i{}^{\beta_i} m_j{}^{\beta_j} / d_{i,j}^{\beta^k} \right) \varepsilon_{i,j}$$

Social scientists have adapted and modified the model to fit other circumstances, such as the so-called Huff Model (incorporated into ArcGIS software) to predict potential customer attraction to alternative new retail site locations. For present purposes, the base model is:

$$T_{i,j} = \alpha \frac{GDP_i \;\; GDP_j}{{d_{i,j}}^2}$$

Econometric implementation and estimation takes the following form:

$$ln\left(T_{1,2}\right) = \beta_0 + \beta_1 ln(GDP_1) + \beta_2 ln(GDP_2) - \beta_3 ln\left(d_{1,2}\right) + \epsilon_{1,2}$$

Since this is a standard multiple linear regression framework, it is easily modified to consider additional predictors not anticipated by Newton. Indeed, several studies have augmented the gravity model of international trade to consider the impact of such additional binary predictors as contiguity (a shared boundary), isolation (an island), or common language. However, existing literature does not provide more than superficial attention to alternative measures and depictions of linguistic or cultural similarity between countries, and do not explicitly consider alternatives to the merely physical definition of distance.

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Reconsidering Distance Measures

So, the workhorse model in consideration of bilateral trade assumes that "mass" can be represented by respective national GDP levels (perhaps adjusted for population), and "distance" can be represented by separation (in miles or kilometers) between nearest national borders, respective capital cities, or some similar geographic measure. In the case of the United States, for example, geographic distance may determine whether goods can be driven into Canada or Mexico or must be shipped overseas – with corresponding different cost structures and convenience. By contrast, Japan cannot load a truck to drive goods to any bilateral partner, and almost all its trading targets are sufficiently far from Japan to make variability in geographic distance less dominant a consideration. A more powerful predictor of trade as a function of distance could emerge from considering non-geographic measures.

"Cultural distance" has been the subject of intense scrutiny in the social sciences. Within economics and business, the two most cited studies and databases are those of Hofstede and, more recently, Minkov. Following decades of study, measurement, and adjustment, Hofstede presents six constructs to culture, with estimates of average scores within each country:

Construct 1:	Power Distance	Degree of acceptance of social inequality
Construct 2:	Uncertainty Avoidance	Degree of tolerance for ambiguity
Construct 3:	Individualism	Degree of integration into groups or collectivity
Construct 4:	Masculinity	Degree of acceptance of traditional gender roles
Construct 5:	Long-Term Orientation	Degree of respect for past and focus on tradition
Construct 6:	Restraint	Degree of indulgence and seeking gratification

Not surprisingly, there are various criticisms and recognized shortcomings to this data, ranging from biases in sample selection to the presumption of a single score to represent any construct of any population of millions of individuals. Nonetheless, there is reason to attach some credibility to a database that generates results such as the following (from Hofstede):

Scale ~ [0, 100]	**Japan**	**v.**	**United States**
Individualism	46		91
Uncertainty Avoidance	92		46
Masculinity	95		62

"Linguistic distance" would seem another candidate to supplement or supplant geographic and/or cultural distance. One simplistic is to include an indicator variable to identify countries with a common primary language. More ambitious attempts to capture language similarities and linguistic-based notions of fractionalization, polarization, and disenfranchisement are discussed in Desmet. Et al, and measured for five well-defined constructs, by country:

Construct A:	Greenberg Index	A measure of linguistic homogeneity

Construct B:	Ethno-linguistic Fractionalization	A slight variation of GI to generate ELF
Construct C	Esteban-Rey Index	A measure of social effective antagonism
Construct D:	Reynal-Querol Index	A measure of polarization
Construct E:	Peripheral Diversity Index	Apartitioning into linguistic groups

Of these, the Greenberg index is the most well-known, perhaps due to its simple intuitive interpretation as the probability that any two randomly selected individuals in a nation would speak the same language. Other measures consider, at least implicitly, the common roots among branches of language families, as well as perceived social disenfranchisement resulting from language biases. Does any of this impact global trade and investment?

THE CASE OF JAPAN

Japan had trade and/or FDI relations with 65 countries during 2011. The leading partners are:

CTRY	Exports	Share
CHN	$127,583.67	19%
USA	$116,017.33	17%
KOR	$ 56,095.67	8%
TWN	$ 44,780.33	7%
HKG	$ 38,000.33	6%
THA	$ 28,533.00	4%
SGP	$ 24,089.00	4%
DEU	$ 20,233.00	3%
NLD	$ 16,908.67	2%
MYS	$ 15,587.67	2%
AUS	$ 15,051.33	2%
GBR	$ 14,104.67	2%
PAN	$ 13,024.67	2%
IDN	$ 12,567.00	2%
other	$139,135.99	20%
	$681,712.33	100%

CTRY	Imports	Share
CHN	$139,227.67	22%
USA	$ 67,744.33	11%
AUS	$ 42,354.33	7%
SAU	$ 38,478.67	6%
ARE	$ 32,775.00	5%
IDN	$ 27,422.33	4%
KOR	$ 26,595.67	4%
QAT	$ 21,266.67	3%
TWN	$ 20,989.33	3%
MYS	$ 20,803.67	3%
THA	$ 19,205.33	3%
DEU	$ 18,897.67	3%
IRN	$ 12,847.00	2%
RUS	$ 12,743.67	2%
KWT	$ 11,456.00	2%
CAN	$ 10,920.67	2%
other	$117,475.67	18%
	$641,203.68	100%

CTRY	FDIoutFlow	Share
USA	$ 21,509.00	25%
CYM	$ 11,201.67	13%
CHN	$ 6,882.33	8%
AUS	$ 6,246.33	7%
NLD	$ 5,500.00	6%
GBR	$ 4,498.00	5%
BRA	$ 4,480.00	5%
IND	$ 4,026.33	5%
SGP	$ 2,605.00	3%
THA	$ 1,965.33	2%
DEU	$ 1,891.00	2%
HKG	$ 1,665.33	2%
KOR	$ 1,510.33	2%
LUX	$ 1,232.67	1%
FRA	$ 1,138.33	1%
other	$ 8,766.00	10%
	$ 85,117.65	100%

CTRY	FDIinFlow	Share
USA	$ 5,528.00	48%
GBR	$ 3,052.33	26%
CYM	$ 1,724.33	15%
SGP	$ 1,682.33	15%
DEU	$ 1,260.00	11%
other	$ (1,661.03)	-14%
	$11,585.96	100%

CTRY	FDIoutStock	Share
USA	$236,454.67	33%
NLD	$ 75,212.33	10%
CYM	$ 63,169.00	9%
CHN	$ 56,841.67	8%
GBR	$ 33,938.00	5%
AUS	$ 30,506.67	4%
THA	$ 23,688.67	3%
SGP	$ 23,540.33	3%
BRA	$ 21,622.33	3%
FRA	$ 15,981.00	2%
BEL	$ 14,210.67	2%
DEU	$ 14,134.67	2%
HKG	$ 13,435.33	2%
KOR	$ 13,275.33	2%
IND	$ 10,660.00	1%
other	$ 74,173.31	10%
	$720,843.98	100%

CTRY	FDIinStock	Share
USA	$ 73,948.00	38%
NLD	$ 36,478.00	19%
CYM	$ 17,704.00	9%
FRA	$ 16,878.00	9%
SGP	$ 11,526.67	6%
DEU	$ 7,922.33	4%
GBR	$ 7,818.00	4%
CHE	$ 5,778.00	3%
LUX	$ 4,368.00	2%
HKG	$ 3,301.00	2%
TWN	$ 2,048.67	1%
KOR	$ 1,537.33	1%
CAN	$ 1,306.67	1%
other	$ 4,610.35	2%
	$195,225.02	100%

Fig 1: Leading Partners

Overall, the ten leading partners are AUS, CHN, GBR, HKG, IDN, KOR, NLD, THA, TWN and USA. These selections exclude SAU and ARE, because Japanese relations with Saudi Arabia and the United Arab Emirate are based almost solely on the import of oil, a natural resource that has a physical location and demand curve for Japan which trumps all consideration of distance(s).

Of the ten most substantial trade and investment partners with Japan, only one (KOR) is less than a 1,000 miles away from Japanese shoreline, three (TWN, CHN and HKG) are between 1,000 and 2,000 miles away, two (THA and IDN) are between 2,000 and 4,000 miles away, and the remaining four (AUS, GBR, NLD and USA) are more than 4,000 miles away. The standard formulation of gravity models results in suppressed expectations for Japanese trade and investment in most bilateral partnerships, due to the denominator of "distance-squared".

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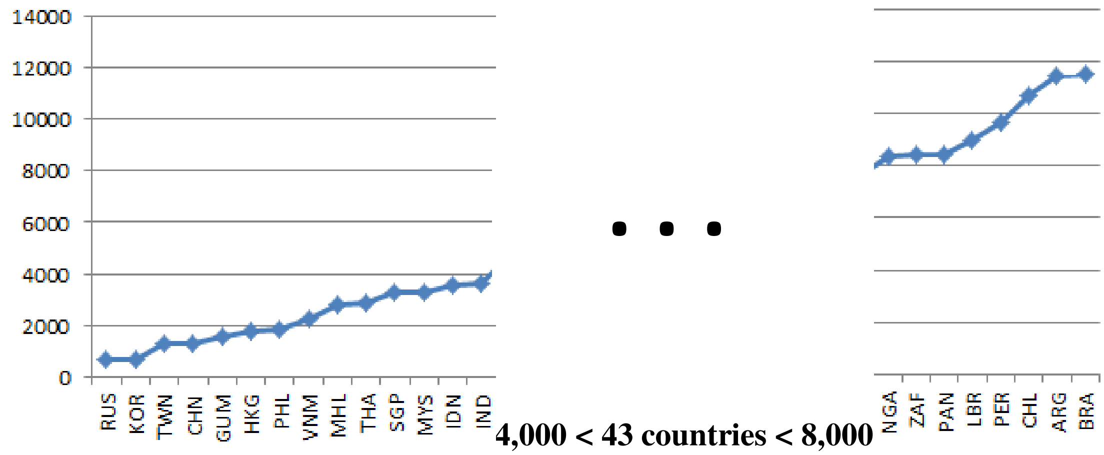

Fig 2: Geographic Distance (in Miles to Nearest Border)

Alternative distance measures discussed earlier are various measures of cultural distance and linguistic distance. For the 65 trade partners, the various measures are highly correlated:

	PDI	IDV	MAS	UAI	LTO	IVR
PDI	1.000					
IDV	-.683	1.000				
MAS	.115	.142	1.000			
UAI	.209	-.187	.034	1.000		
LTO	.147	-.153	.150	.038	1.000	
IVR	-.439	.354	-.122	-.187	-.402	1.000

± .242	critical value .05 (two-tail)
± .315	critical value .01 (two-tail)

Fig 3: Cultural Distances

	GI	ELF	ER	RQ	PH
GI	1.000				
ELF	.633	1.000			
ER	.826	.283	1.000		
RQ	.463	.675	.485	1.000	
PH	.903	.396	.969	.496	1.000

± .242	critical value .05 (two-tail)
± .315	critical value .01 (two-tail)

Fig4: Linguistic Distances

Rather than incorporate multiple measures of each, thereby risking redundancy through multicollinearity, a principal component analysis has been applied to the multiple measures of each set, based on measured distances from Japan of each of the 65 countries. The first principal component has an eigenvalue that captures 37% of the total variability among the six measures of cultural distance (compared to the 16.7% expected if constructs were orthogonal), and explains 70% of the total variability among the five measures of linguistic distance.

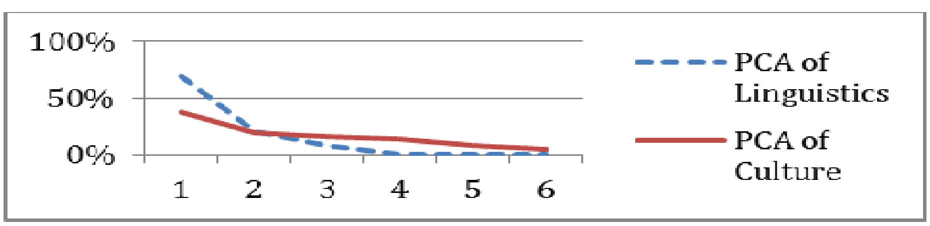

Fig5: Proportion of Total Variability Captured by Each Principal Component

Accordingly, the first principal component is selected as a proxy measure of cultural and linguistic distance, respectively. The culture distances range [0.10, 4.52], while the linguistic distances range [0.02, 7.23], so combined distance measures can range [0.12, 11.75].

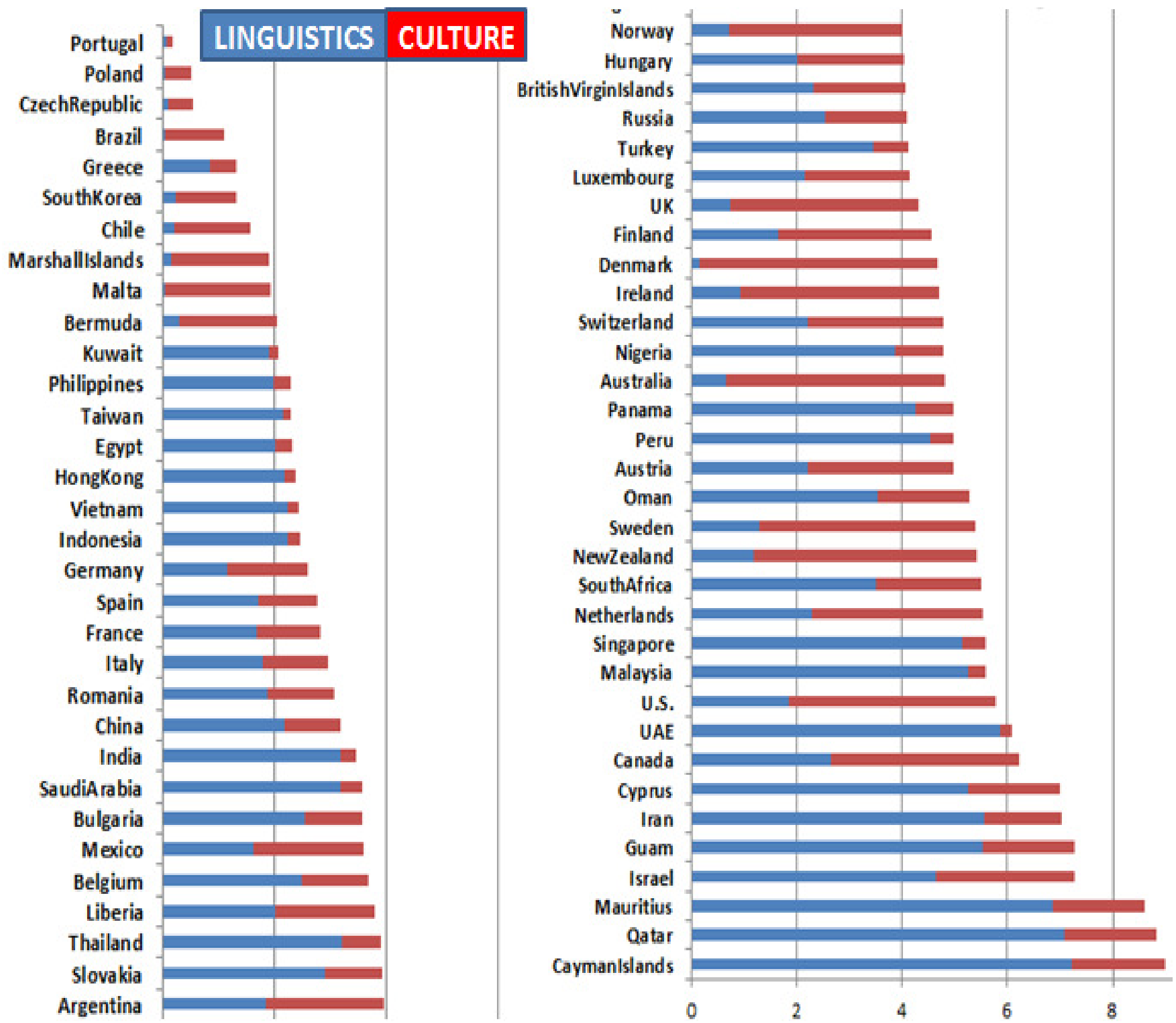

Fig 6: Cultural and Linguistic Distances from Japan

It is interesting to observe that Portugal is closest to Japan based on combined cultural and linguistic distance, perhaps reflecting historical precedent from "Nanban trade" with the Portuguese from the 16th century (note also Brazil, where Portuguese is the dominant language). Among the ten primary trade partners today, Japan exhibits strong linguistic proximity to South Korea (KOR), substantial linguistic proximity to Australia (AUS) and the United Kingdom (GBR), strong cultural proximity to Taiwan (TWN), Hong Kong (HKG), and Indonesia (IDN), and substantial cultural proximity to China (CHN), Thailand (THA). Only the Netherlands (NLD) and United States (USA) are not in either cultural or linguistic proximity to Japan, but of course neither are they in geographic proximity to Japan. It also is noteworthy that the two excluded strong import partners, Saudi Arabia (SAU) and the United Arab Republic (ARE) both are in very strong cultural proximity to Japan, as are other significant trade partners such as Malaysia, Singapore and India.

Based on these results, there is reason to believe that measures of cultural and linguistic distance may outperform the standard measure of geographic distance in explaining trade levels through a gravity model. The next section provides empirical support for such a claim.

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Testing the Gravity Model

Japan has different economic relations and interactions with different parts of the world. For example, roughly half its exports and imports are within Asia, whereas the home region accounts for only one-quarter of aggregate outward FDI and one-tenth of inward FDI.

Region	Exports	Imports	FDIoutFlow	FDIinFlow	FDIoutStock	FDIinStock
Africa	1%	1%	0%	0%	0%	0%
Asia	55%	44%	26%	22%	25%	10%
Central&SoAmerica	4%	3%	20%	-9%	12%	9%
Europe	14%	11%	19%	38%	23%	42%
MiddleEast	4%	19%	0%	0%	1%	0%
NorthAmerica	18%	12%	26%	48%	34%	39%
Oceania	2%	7%	8%	1%	4%	1%
RussiaCIS	1%	2%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

Fig 7: Japan Trade and Investment by Region of the World

The goal is to explain these variations over space, at the country level rather than by region. Rather than separately modeling each of the six trade and investment variables, or combining them in ways that compromise economic realities, a principal component analysis also was conducted on these alternative measures of bilateral economic activity. The first principal component captured 72% of total variability, so serves as a reasonable proxy measure.

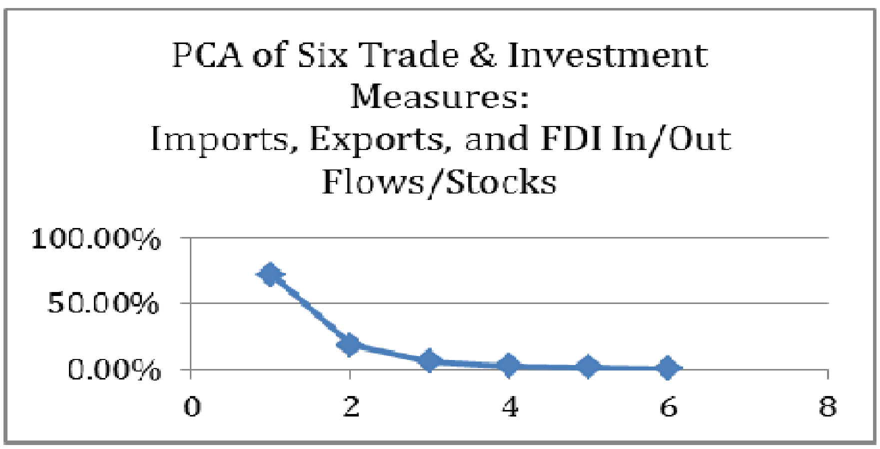

Fig 8: Proportion of Total Variability Captured by Each Principal Component

The primary principal component for trade and investment now can be regressed on country gross domestic product (standardized GDP), geographic distance (scaled), and the primary principal component for each of cultural and linguistic distance. The hypothesis is that cultural and/or linguistic distance variables provide significant incremental value to a base regression of trade and investment on GDP and geographic distance. Full model results are:

Summary

R^2	0.847	n	65
Adjusted R^2	0.836	k	4
R	0.920	Dep. Var.	**TradePCA**
Std. Error	0.840		

ANOVA table

Source	*SS*	*df*	*MS*	*F*	*p-value*
Regression	233.7974	4	58.4494	82.82	9.82E-24
Residual	42.3466	60	0.7058		
Total	276.1440	64			

Regression output *confidence interval*

variables	*coefficients*	*std. error*	*t (df=60)*	*p-value*	*95% lower*	*95% upper*
Intercept	-0.5255	0.2445	-2.149	.0357	-1.0146	-0.0363
GDPs	1.8826	0.1089	17.293	5.48E-25	1.6649	2.1004
GeogDs	-0.1618	0.1069	-1.513	.1355	-0.3757	0.0521
PC1D_LING	-0.1524	0.0587	-2.595	.0119	-0.2700	-0.0349
PC1D_CULT	-0.0961	0.0916	-1.048	.2986	-0.2793	0.0872

Fig 9: Gravity Model Regression Results, with Three Alternative Measures of Distance

The model explains about 84% of the variability in bilateral trade and investment (or at least the 72% of such variability captured by the primary principal component). As expected from the gravity model, the coefficient for GDP is positive, and for geographic distance is negative. However, whereas the GDP coefficient is statistically significant (p-value << 0.05), the coefficient for geographic distance is not significant. This might be a surprising result for many countries, or for different periods of history, but for reasons already discussed is less so for Japan or for today. What is intriguing is the statistical significance of linguistic distance.

Following is a comparison of the full model with two restricted subsets of the full model:

	GDP		Geographic Distance		Linguistic Distance		Cultural Distance			Adjusted
Model	Coefficient	p-Value	Coefficient	p-Value	Coefficient	p-Value	Coefficient	p-Value	R-square	R-square
I	1.88	0.00	-0.17	0.14	-0.15	0.01	-0.10	0.30	84.7%	83.6%
II	1.90	0.00			-0.16	0.01	-0.08	0.41	84.1%	83.3%
III	1.92	0.00			-0.15	0.01			83.9%	83.4%

Fig 10: Summary of Regression Models with Varying Distance Measures

For Japan, the geographic distance measure commonly employed in gravity models of trade and investment is of no significant predictive power, whereas the linguistic-based measure of distance has statistically significant explanatory power (at the 0.01 level). Regression diagnostics of the recommended Model III indicate only minor issues among the 65 countries:

High Leverage:	Cayman Islands, China, Mauritius, Qatar, USA
Studentized Residual:	Cayman Islands, Netherlands, Singapore
Studentized Deleted Residual:	Cayman Islands, Italy, Mexico, Netherlands, Singapore

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CONCLUSION

The gravity model herein considered postulates that bilateral trade and investment is a positive function of the product of the country gross domestic product (GDP) and a negative function of distance between the countries. While traditional measurements and implementations often work to satisfaction, this study shows that, at least for Japan in 2011, linguistic distance between countries (as broadly defined, to include similarities in degrees of homogeneity, antagonism and polarization, rather than merely commonality of base language or linguistic family root) is significantly more important than geographic distance.

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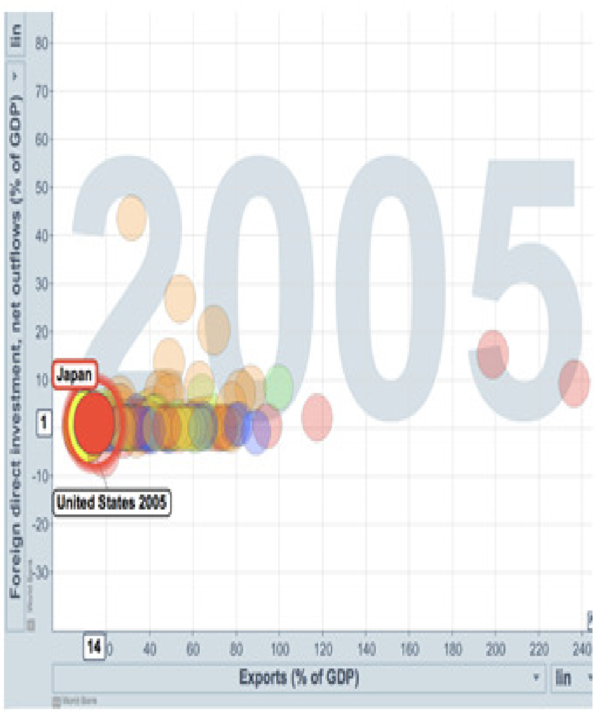
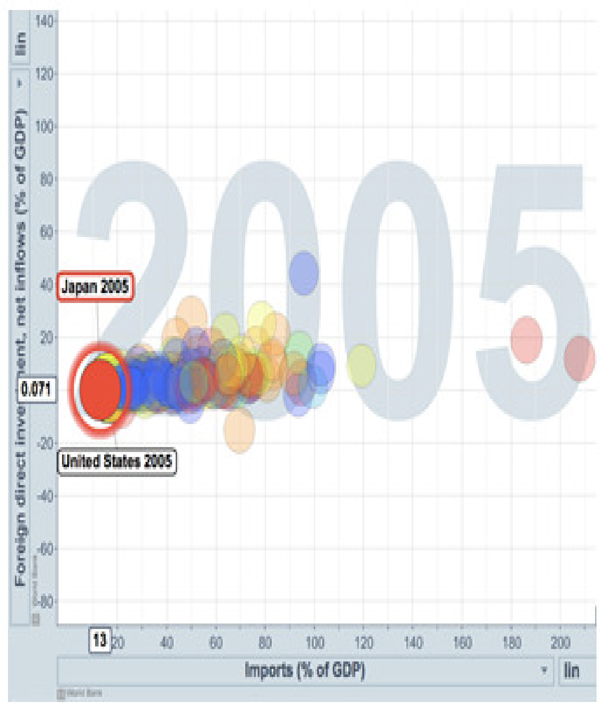
Appendix A

Japan (& United States) areamong the lowest countries (as % of GDP) with regard to (pre-Recession):





(i) Exportsand(ii) FDI Outflows **(iii) Imports and(iv) FDI Inflows**

Source: http://www.gapminder.org

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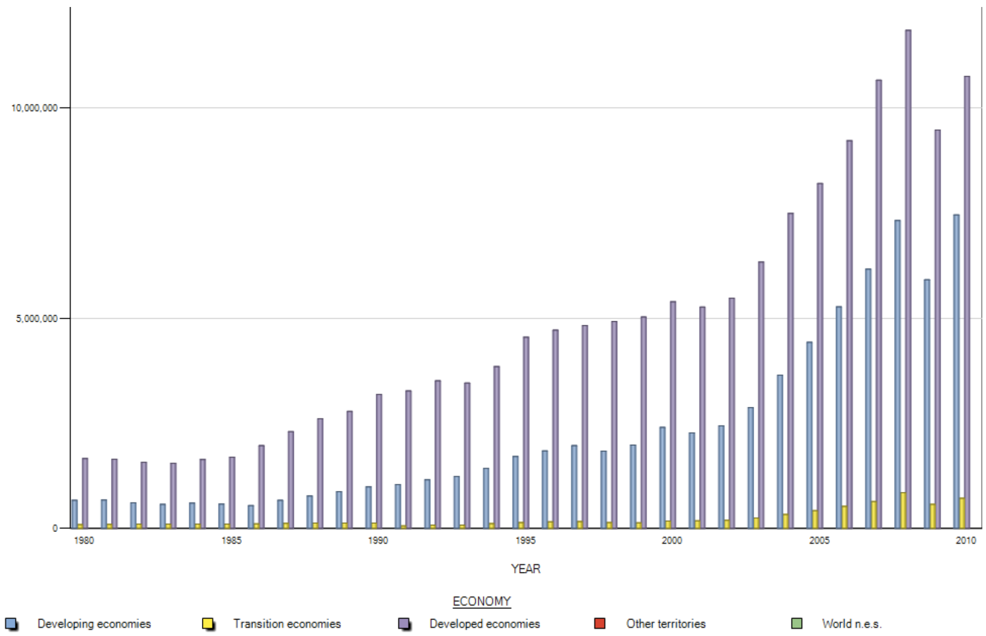
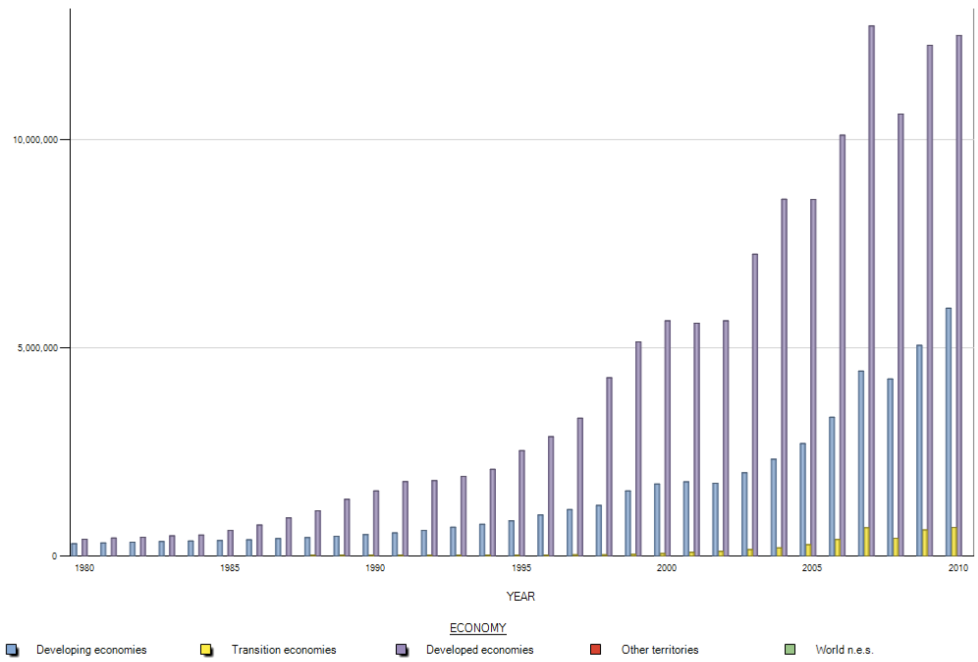
Appendix B

Trends in Global Trade and Foreign Direct Investment



Global Exports (in U.S. $millions)



Global FDI Stock (in U.S. $millions)

Source: U.N. Conference on Trade and Development,http://unctadstat.unctad.org/TableViewer/chartView.aspx