East Asian Integration and Shared Growth: Some Preliminary Results of a Center-Of-Buoyancy Approach*

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Abstract

We apply a Center-Of-Buoyancy (COB) approach to the issue of East Asian integration and shared growth (efficiency + equity). Our COB approach is inspired by the Center-Of-Gravity (COG) approach, as well, as ship stability analysis of the naval architecture. We derive two hypotheses using our COB approach, using variations of de-trended nominal GDP as a measure of regional instability. Firstly, regional instability is negatively related to the variation about the economic COB, which is taken to be the income-weighted average of the location of the capital cities of a set of East Asian economies. Secondly, regional instability is positively related to the computed "vertical distance" between the economic COB and the economic COG, which is computed as a simple arithmetic mean (one-country, one-vote) of the location of the capital cities of a set of East Asian economies, and is taken as the Center of Shared Growth (COSG). Using OLS estimation on a repeated sampling of ten East Asian economies in the 1980s, we find preliminary evidence to support these two hypotheses.

Keywords: Center of Gravity, Center of Buoyancy, Shared Growth
JEL: R11, R12

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1. Introduction

Each of the past three decades has brought with it a financial tsunami that generally had severe repercussions on developing economies. In the 1980s, there was the external debt crisis, which caused that decade to be dubbed the lost decade of growth especially for developing countries. In the 1990s, there was the East Asian financial crisis. This was followed in the 2000s by the sub-prime crisis or more commonly known as the "Lehman Shock" in Japan.

Despite the surge in post-crisis efforts to prevent their recurrence, such crises appear to have developed a tendency to be regular as well as increasingly destructive with each occurrence. The 1980 crisis was largely a crisis that hit developing countries that were already in a precarious situation to start with. The 1990 crisis seemed to have come out from nowhere erupting from one of the most vibrant economy, Thailand, or region, East Asia, in the world. Moreover, the crisis spread beyond its initial sphere of damage leading to emergence of terms such as "contagion" and "reforming the international financial architecture." The latest crisis of the first decade of the 21st century was even more unforeseen as it erupted from the strongest economy from the world, the U.S., and with alarming speed spread across the global economy.

In this paper, we examine such crises from the perspective of East Asian integration and a type of development called "shared growth."[3] In doing so, we shall attempt to investigate the possibility of how regional integration could contribute to the attenuation of the destabilizing effects of a world-class financial tsunami. We intend to do this by adopting a Center-Of-Buoyancy (COB) approach that takes its inspiration from the Center-Of-Gravity (COG) approach.[4] We use this approach in the context of stability of floating objects, thus, giving us a convenient analytical framework for analyzing East Asian integration and its relation to economic stability. We discuss this framework in more detail in Section II. This is followed by the formulation of hypotheses in Section III. We discuss the results and its implications in Section IV and end with some possible future research work in Section V.

2. Analytical Framework

[3] Shared growth research is a major research thrust of the authors. For example, see Maquito and Carbonel (2010), Maquito and Hirakawa (forthcoming)

[4] One of the authors has been involved in COG research. For example, see Hirakawa (2009, 2010)

2.1. The COG Approach

The COG approach, from which this paper derives one of its inspirations, treats a country as an "economic mass" with its centroid located exactly on the longitude-latitude coordinates of the country's capital (at sea level). Economic mass is usually based on national income. The geographical coordinates for the COG of a group of countries is computed as the weighted average of the coordinates of the capitals of the constituent countries. The computed COG therefore gives an idea of the location of a center of economic activity of a group of countries.

By definition, the COG in itself is a point of balance. It is, however, essentially the product of a one-dollar-one-vote algorithm. This implies that countries (or individuals) that have more income find their selves closer to the center of gravity, while those with less income tend to be located in the periphery.

We consider the COG, therefore, as not necessarily reflecting a shared growth type of income distribution. As the term implies, shared growth refers to a state of affairs that combines rapid income growth with significant improvements in the distribution of income. Two possible candidates for a Center of Shared Growth (COSG) are as follows: a) COSG1 (One-Person-One-Vote Center), wherein the coordinates are calculated using the share of a country's population to the total population of the group of countries being considered; b) COSG2 (One-Country-One-Vote Center), wherein the coordinates are calculated using as weights one divided by the number of countries in the group being considered.COSG1 defines shared growth as a situation wherein each person in the group being considered has the same income. COSG2 defines shared growth as a situation wherein each country in the group being considered has the same income.

The above conception of centers coincides closely with those used by Grether and Mathys (2008). They refer to the COG as the Economic COG, the COSG1 as the Demographic COG, and the COSG2 as the Geographic COG. In addition to tracking the movement of the various COGs, Grether and Mathys (2008) ranks the sample cities according to their distance to the COGs and computes a distance ratio equal to the city's distance to the World Economic COG divided by the city's distance to the World Geographic COG.

Despite the recognition of the Demographic and Geographic COG as benchmarks, such analyses imply a value judgment which puts a premium on proximity to the World Economic COG. Countries that are closer to the World Economic COG are ranked more highly. Such analyses imply a value judgment which effectively puts a premium on efficiency.

This also appears to be the preoccupation in the related but non-identical literature on gravity models, wherein distances between countries are considered as sources of inefficiencies, thereby dampening trade between these two countries.

2.2. COG and Ship Stability: From Gravity to Buoyancy

In this paper, we attempt to go one step further by investigating two of the aforementioned three COGs, i.e., the economic COG (one-dollar, one-vote center) and the geographic COG (one-country, one-vote center) or simply COSG (Center of Shared Growth). For our analysis, we derive further inspiration from ship stability theory.[5] We shall see that this will suggest a reversal in perspective in one of the COGs.

A floating vessel's instability is largely determined by the relationship of two centers: the center of gravity through which the ship's mass and weight are assumed to act; and the center of buoyancy through which the countervailing buoyancy force is assumed to act. Ship instability could be taken in at least two senses.

The first sense of instability (rolling instability) is related to the ship's rolling motion wherein the ship is assumed to still retain the ability to right itself after the application of a heeling force. In this sense, higher rolling frequencies could be associated with higher ship instability. This is shown in Figure 1. Theoretically, the upward force, which represents the buoyancy force acts through the center of mass of the displaced water. It can be observed that the center of buoyancy tends to move from one side to another as the center of mass of the displaced water moves from one side to another as the ship rolls from one side to another, prompting the rolling of the ship. The arched arrows indicate the righting moment which is acts opposite to the direction of heeling of the ship, prompting the ship to return to its upright position.

The second sense of instability (capsizing instability) refers to a situation where the ship faces the risk of capsizing due to a complete loss of the ability to recover from a heeling force. Whether the ship is unstable or not would depend on the relative positions of the buoyancy and weight forces. Figure 1 shows a stable situation wherein the buoyancy force always acts as a righting force that could arrest further heeling of the ship. Figure 2 shows a Figure 1 which has been modified so as that the buoyancy force does not provide a righting force and in fact could lead to the ship heeling further (in the direction

[5] For example see Rhodes (2003). Tupper (2004)

of the arched arrows), and possibly capsizing the ship.

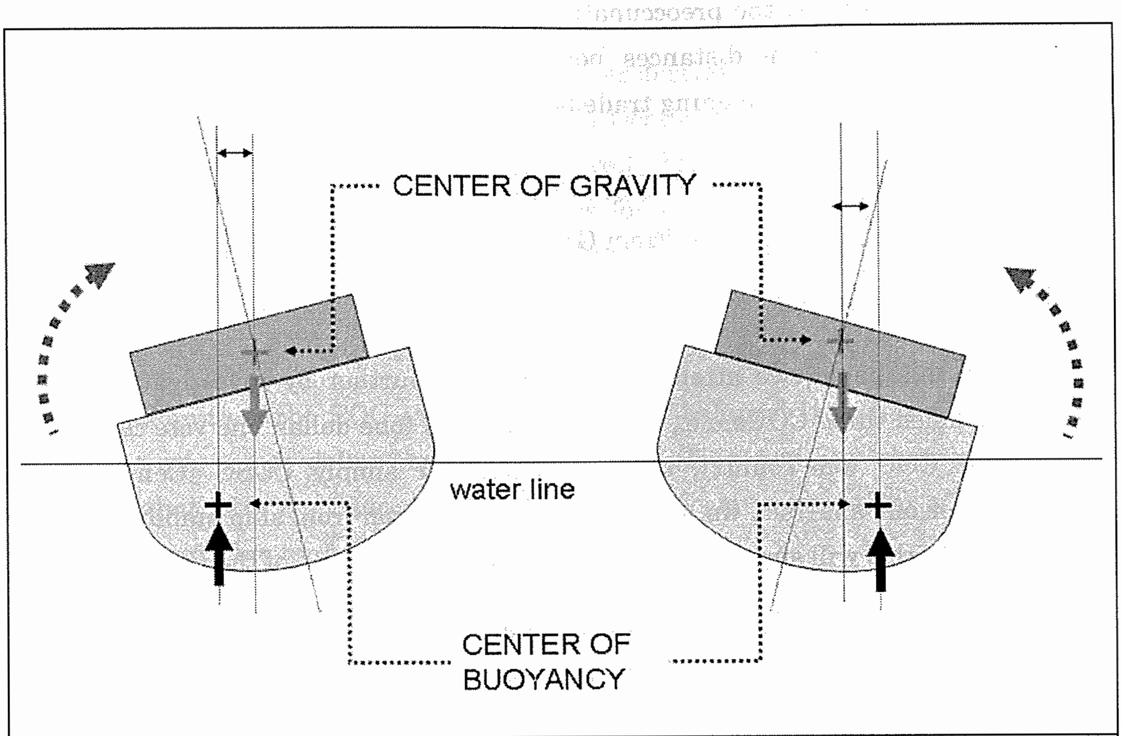


Figure 1. Rolling Instability

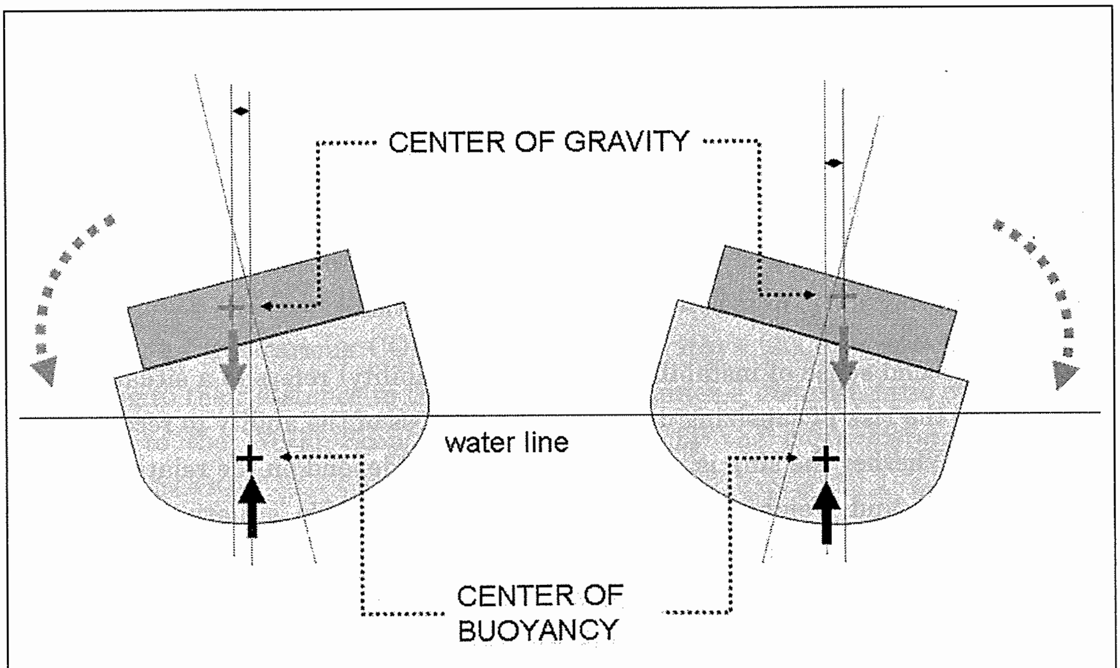


Figure 2. Capsizing Instability

The application of this theory to an economic analysis suggests an interesting reversal in our initial conceptions. It could be readily observed from Figure 1 and even Figure 2 that the center of gravity of the ship is relatively at a fixed position, while the center of buoyancy is constantly shifting about the center line of the vessel, as the ship rolls from one extreme heeling position to another.

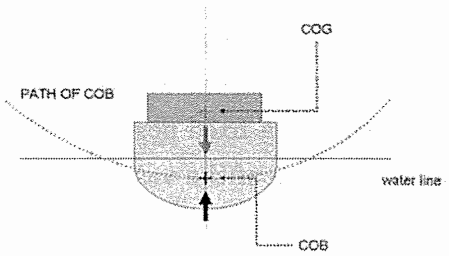
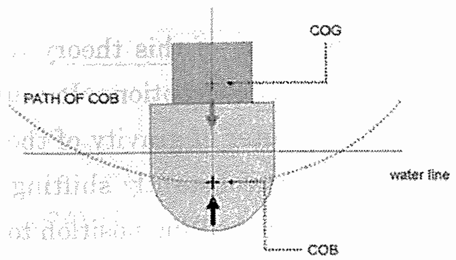
In our economic analysis, the relatively fixed center of gravity would correspond to the geographic COG, while the economic COB would tend to be in constant motion. This is fortuitously closer to the general perception that it is economic activity which "buoys up" a society, but is certainly completely opposite to the common perception in economic COG analysis, which treats economic activity as weights, or forces that weigh down rather than buoy up.

In our paper, therefore, we treat economies as sources of buoyancy forces, akin to ballast tanks in a ship, providing a variable amount of buoyancy. The sum of the buoyancy force provided by each economic ballast tank acts through the center of buoyancy. The buoyancy force provided by each proportional to the mass of the water displaced in the ballast tanks.

3. Hypothesis Formulation and Testing

In this paper, we just focus on the first sense of ship instability, the rolling instability. This conforms to the common perception that economies generally go through periods of extreme movements in economic activity, but given enough time are always able to recover. This is precisely what is taken place when a ship rolls, as suggested in Figure 1.

In its simplest form, ship stability theory indicates that a ship will be more stable, in the sense of less rolling, if it has a wide and low structural profile. This is shown in Figure 3, where the left panel shows a low and wide ship profile that is more stable with respect to rolling than the high and narrow ship profile shown in the right panel.

	
Low and Wide Ship Profile (More Stable)	High and Narrow Ship Profile (Less Stable)
Figure 3. Ship Profiles and Ship Stability	

From this theory, we derive two implications which guide our economic analysis in this paper. These two implications become our two major hypotheses in this paper.

Hypothesis #1: Economic instability of a group of countries is negatively positively related to the instability of the economic COB. From Figure 3, we note that the path of the ship's COB is limited by the width of the ship. A wider path of COB corresponds to a more stable ship profile. Rolling frequency tends to be lower.

Hypothesis #2: Economic instability of a group of countries is positively related to the geographical distance between the COSG and the economic COB. From Figure 3, we note that the vertical distance between the ship's COG and COB is smaller for the more stable ship profile.

3.1. Economic Instability

Economic instability is measured as the variance of the de-trended total Nominal Gross Domestic Product (GDP) of a group of countries being studied. A linear trend is estimated over the years covered. In effect, we are measuring economic instability using the instability of the "buoyancy force" as an indicator.

As a first approximation, we carry out the analysis for the period 1980 to 1989, using annual Nominal GDP data. Since our interest is on the East Asian region, we chose the following 10 economies as the subject of our preliminary analysis given in Table 1, showing the respective arbitrary letter designations that will be used for the analysis.

Designation	Economy
A	Japan
B	South Korea
C	Singapore
D	China
E	Indonesia
F	Malaysia
G	Myanmar
H	Philippines
I	Thailand
J	Vietnam

Table 1. Economy Coverage

In order for us to undertake a statistical analysis that would provide some basis for the acceptance or rejection of the above hypotheses, we generate a repeated sample of economies from the population of economies in Table 1. This is achieved by taking all the possible distinct combinations of eight economies from the population of ten economies. This gives a manageable set of 45 such combinations.

The Nominal GDP values, the corresponding linear trend values, and the de-trended values are shown in Appendix 1. The de-trended value is computed as the Nominal GDP values minus the de-trended values. The trend values are considered as average values about which the GDP values would oscillate with some frequency. Mathematically, this is given by the following relationships, which is calculated for each economy for each year.

$$Y_{DETREND} = Y_{ACTUAL} - Y_{TREND} \quad (1)$$

where

$Y_{DETREND}$ is the de-trended Nominal GDP

Y_{ACTUAL} is the actual Nominal GDP[6]

Y_{TREND} is the estimated real trend value for Real GDP = a + b YEAR (a and b are estimated coefficients using the LINEST function of MS EXCEL).[7]

For each of the 45 distinct combinations, the following three variables are computed, yielding 45 observations that are used in an OLS analysis. The variance of the de-trended values is computed using the VAR function of MS EXCEL. This constitutes the observations for the explained variable in the OLS analysis. The two explanatory variables corresponding to the variables postulated to have a positive relationship with the explained variable, as given in the two hypotheses above. These variables are the variance of the economic COB (computed using the VAR function of MS EXCEL), and the vertical distance between COSG and the average economic COB. COSG is computed as the arithmetic average of the latitude and longitude of the capitals of the economies included in the given sample of eight economies.

3.2. Instability of Economic COB

The variance of the economic COB is our proxy variable to indicate the instability of the economic COB. For each 8-country combination and for each year, the shares of nominal GDP of each country to the total GDP of the 8 countries were calculated. These shares were then applied as weights to the latitude and longitude coordinates of the capitals of the 8 countries in order to arrive at the coordinates for the economic COB for each year. The coordinates for the average economic COB was derived using the average shares, for the period from 1980 to 1989, of the nominal GDP of each country to the total GDP .The variance of economic COB coordinates was taken as the arithmetic mean of the variance of the latitude and the variance of the longitude of the economic COB for the period 1980 to 1989.

3.3. COSG and Average Economic COB Vertical Distance

Measuring the vertical distance between the COSG and the average economic COB is not as straightforward as that suggested in Figure 3. While the up and down

[6] See Appendix
[7] See Appendix

directions are very clear in ship theory, this is not the case for a group of countries scattered across the face of the earth. As it turns out, it is not simply a matter of connecting the average economic COB to the COSG.

One of the observations we made regarding most of the eight-country combinations, however, provides us with one solution to this orientation problem. There appears to be a strong linear relationship between the latitude and longitude coordinates of the economic COB over the period being studied. We use this observation to arrive at an indicator for the vertical distance between the COSG and average economic COB, as suggested by the ship stability theory we are considering in this paper. The geometry of the problem is shown in Figure 4, which shows three points of concern in geographical space: the position of the average economic COB, as indicated by "Economic COB_{AVE}"; the position of the COSG; and the position of a reference economic COB, which is of the same latitude as the COSG. The latitude and longitude coordinates of each point is given in parentheses.

The vertical distance we are looking for as indicated in Figure 4 is the distance between two parallel lines: the fitted economic COB path, and the line that passes through COSG parallel to the fitted economic COB path. Translating back to the ship metaphor, the COG is effectively at the other end of the "vertical distance" double-edge arrow, just across the average Economic COB.

The fitted economic COB path was derived for each eight-country combination using the LINEST function of MS Excel and the computed values of the economic COB. The vertical distance was then computed based on the trigonometric relationships implied in Figure 4.

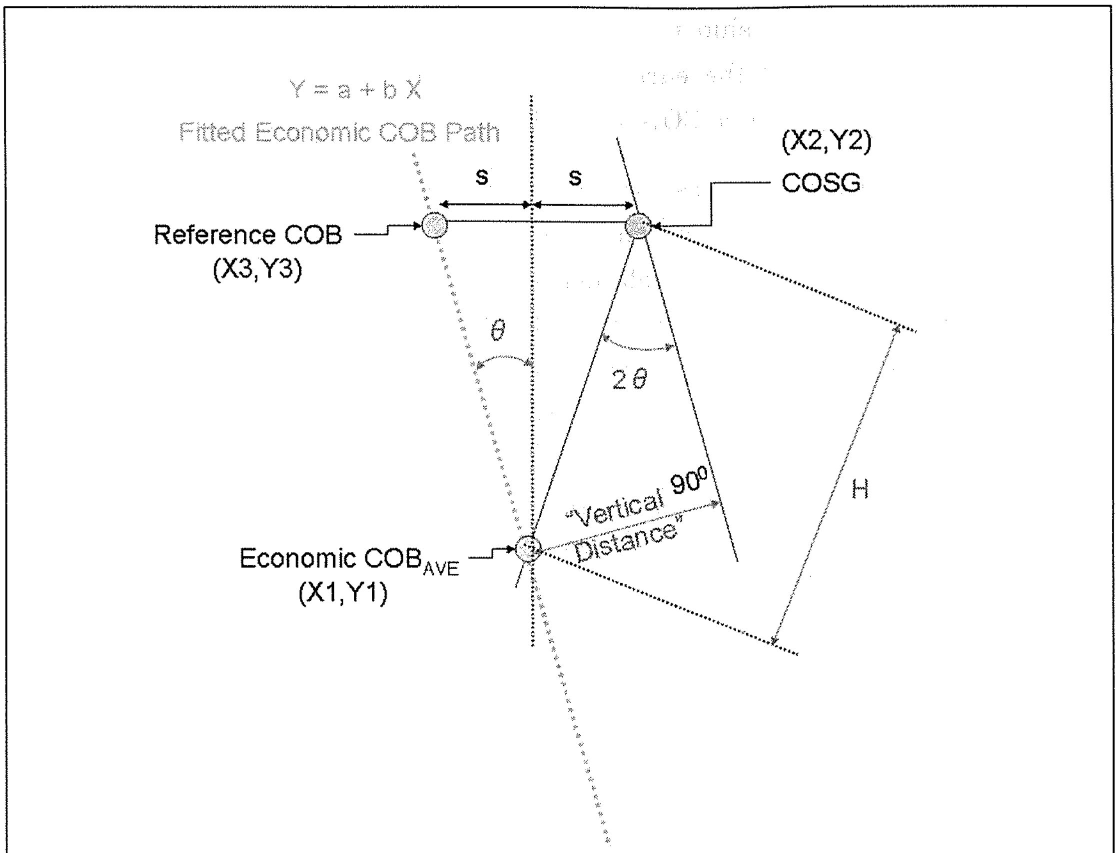


Figure 4 A General Geometrical Representation of Economic COB and COSG

4. Results of the Analysis and Its Implications

From left to right, Table 2 tabulates the results of the computations for the vertical distance, the variance of the economic COB, and the variance of the de-trended GDP for each of the 45 distinct 8-country combinations, indicated by their letters as given in Table 1.

Observation Number	8-Country Combinations	Vertical Distance	Variance Economic COB	Variance De-trended GDP
1	ABCDEFGH	2.0050933	1.32082385	796907.364

2	ABCDEFGI	2.0044546	1.31050286	814758.939
3	ABCDEFGJ	2.0047023	1.3490171	789561.552
4	ABCDEFHI	2.0054171	1.41882448	811545.422
5	ABCDEFHJ	2.0057662	1.46216331	786360.131
6	ABCDEFIJ	2.0050082	1.44960458	804115.018
7	ABCDEGHI	2.0054629	1.23276052	812686.011
8	ABCDEGHJ	2.0058019	1.26619923	787456.772
9	ABCDEGIJ	2.005003	1.25676092	805211.118
10	ABCDEHIJ	2.0062214	1.36359869	801985.916
11	ABCDFGHI	2.004896	0.67745113	819830.109
12	ABCDFGHJ	2.0051686	0.70788006	794661.376
13	ABCDFGIJ	2.0044901	0.73110219	812508.645
14	ABCDFHIJ	2.0055501	0.79588796	809244.109
15	ABCDGHIJ	2.005514	0.65931491	810347.226
16	ABCEFGHI	2.0037052	1.25640147	734060.594
17	ABCEFGHJ	2.0038743	1.27404923	710586.55
18	ABCEFGIJ	2.0034469	1.25625563	727420.133
19	ABCEFHIJ	2.004133	1.41865707	724307.79
20	ABCEGHIJ	2.0041099	1.1601946	725360.76
21	ABCFGHIJ	2.0036498	0.36781436	732438.315
22	ABDEFGHI	2.0055438	1.36528052	809828.808
23	ABDEFGHJ	2.0058898	1.4062582	784662.877
24	ABDEFGIJ	2.0050644	1.39374736	802391.554
25	ABDEFHIJ	2.006321	1.50328237	799169.008
26	ABDEGHIJ	2.0063079	1.31082691	800275.042

27	ABDFGHIJ	2.0055914	0.75450033	807520.461
28	ABEFGHIJ	2.0041722	1.33683169	722675.893
29	ACDEFGHI	2.003808	1.56098143	721728.587
30	ACDEFGHJ	2.0040042	1.61299095	698239.241
31	ACDEFGIJ	2.003555	1.59716956	714930.77
32	ACDEFHIJ	2.0042372	1.71440719	711874.507
33	ACDEGHIJ	2.0042583	1.50298698	712928.828
34	ACDFGHIJ	2.0038507	0.88724441	719872.556
35	ACEFGHIJ	2.0030131	1.58068939	640337.666
36	ADEFGHIJ	2.0043153	1.65426244	710267.91
37	BCDEFGHI	2.0187622	0.7787582	19828.0088
38	BCDEFGHJ	2.01959	1.06570723	15421.9171
39	BCDEFGIJ	2.0181084	0.84213816	17970.3271
40	BCDEFHIJ	2.0224518	0.90594757	17585.435
41	BCDEGHIJ	2.0235643	0.79405813	4771.00173
42	BCDFGHIJ	2.0136679	0.22512246	4423.49411
43	BCEFGHIJ	2.1259062	4.31311879	7055.15295
44	BDEFGHIJ	2.0260945	0.92533879	17304.8384
45	CDEFGHIJ	2.0196987	0.35137804	6544.45196

Table 2 Observations Used in OLS Analysis

The correlation coefficient between the two explanatory variables was calculated to be equal to 0.642, which, although a bit high, should not give cause for concern about multicollinearity problems.

The OLS estimation results are given in Table 3 below.

$$VAR_Y = 34624931 + 368078.7598\ VD - 17142866.82\ VAR_{COB}$$

SE		3941442		61769.59669			1984612.284	
R-squared		0.640734557						
DF		42						
F-stat		37.45260221						

Table 3 Estimation Results (Note: all explanatory variables are statistically significant to the 5% level)

VAR_Y is the variance of the de-trended Nominal GDP,

VD is the vertical distance, and

VAR_{COB} is the variance of the economic COB.

The preliminary analysis indicates that the two hypotheses proposed above appear to have validity. A higher instability in the de-trended nominal GDP of a group of countries in East Asia appears to be associated with lower variance in the economic COB and higher distance between the economic COB and the COSG.

As mentioned in the opening remarks of this paper, one of the problems that confront the global economy is the increasing instability brought about mainly by recurring financial crises. It stands to reason, therefore, that stabilization of economic activity should be given a high priority.

In this respect, the results above could be seen as having important implications. The first hypothesis implies that greater variance in the economic COB would contribute to greater stability in the movements of de-trended nominal GDP. This would also imply that clustering of economic activity, which leads to less variance in the economic COB, risk greater instability. The second hypothesis implies that reduction in the distance between the COSG and the economic COB would contribute to greater stability in economic activity. Together with the first hypothesis, this would recommend against clustering in areas far off from the COSG.

In short, the two hypotheses could be seen as advocating a shared growth type of regional development. Such development would be characterized by a more balanced distribution of economic activity, where there is minimal clustering of economic activity away from the COSG. Beyond satisfying the two economic goals of efficiency and equity, shared growth takes on an additional economic merit. It enables a region to achieve greater stability in economic activity.

5. Future Research

This paper reports a first attempt to apply a Center of Buoyancy Approach to an economic analysis of a region. The results are preliminary but promises to unearth further insights related to a geographical analysis of economic activity. The work here could be extended in various ways in the future.

We could investigate the applicability of these hypotheses to: other cases of regional economic integration such the EU and NAFTA; other time periods, such as the 1990s and the 2000s; other regional economic integration based on concrete strategies for division of labor in East Asia, namely, Brand-to-Brand Complementation (BBC) and the ASEAN Industrial Cooperation (AICO) strategies; particular industries and their division of labor; and other measures of economic activity, such as net foreign direct investment and net exports. Moreover, we could also include the demographic COG (one-person, one-vote center) in future research work, as well as develop a theoretical foundation for the findings, which indicate that imbalances in economic activity among a set of East Asian economies lead to greater instability in the economic activity of the group as a whole.

References

Grether, Jean-Marie and Nicole Mathys (2008) "Is the World's Economic Center of Gravity Already in Asia?" *Cahiers de Recherches Economiques du Département d'Econométrie et d'Economie politique (DEEP),* Université de Lausanne, Faculté des HEC No. 08.03, August 2008

Hirakawa, Hitoshi (2009) Chikiki Kyoryoku no Jidai (An Age of Regionalism), in H.Hirakawa, N. Kobayashi, and M. Morimoto eds., Higashi Ajia Chiiki Kyoryoku no Kyodo Sekkei (Co-design for Regional Cooperation in East Asia), Tokyo: Nishida Shoten

Hirakawa, Hitoshi (2010) East Asia's Structural Change from NIEs to Potentially Bigger Market Economies (PoBMEs) and Regional Cooperation: Implications for a Small Country, Paper presented at the Second Annual Conference of the Academic Network for Development in Asia (ANDA), January 8-10, Phnom Penh, Cambodia.

Maquito, Ferdinand and Henrietta Carbonel (2010) "Redicscovering Japan's Leadership in "Shared Growth" Management *Rikkyo Business Review* No. 3, July 2010, 20-38

Rhodes, Martin (2003) *Ship Stability for Mates/Masters* Glasgow: Seamanship International Ltd

Tupper, Eric Charles (2004) *Introduction to Naval Architecture*, New York: Elsevier

APPENDIX

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Japan	1070.996	1183.790	1100.410	1200.187	1275.563	1364.164	2020.887	2448.675	2971.033	2972.667
Korea	66.545	74.504	79.454	88.099	97.170	100.722	116.031	145.951	195.406	240.261
Singapore	11.730	13.904	15.293	17.414	18.824	17.742	18.007	20.571	25.421	30.117
China	309.266	292.608	281.283	301.806	310.688	307.016	297.591	323.973	404.148	451.311
Indonesia	95.375	106.470	109.305	99.075	101.456	101.139	92.728	87.865	97.551	111.467
Malaysia	24.938	25.463	27.288	30.519	34.566	31.772	28.243	32.182	35.272	38.845
Myanmar	6.255	6.296	6.355	6.557	6.695	7.333	8.854	11.275	12.621	19.876
Philippines	32.450	35.647	37.140	33.212	31.408	30.734	29.868	33.196	37.885	42.647
Thailand	32.353	34.848	36.591	40.043	41.799	38.900	43.097	50.535	61.667	72.251
Vietnam	27.847	13.875	18.405	27.726	48.177	14.999	33.873	42.045	23.234	6.293

GDP at current prices

Source: IMF World Economic Outlook Database 2009

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Japan	371.552	248.481	(70.764)	(206.852)	(367.342)	(514.606)	(93.748)	98.175	384.667	150.436
Korea	23.301	14.111	1.912	(6.592)	(14.670)	(28.267)	(30.107)	(17.336)	14.970	42.676
Singapore	0.278	0.797	0.530	0.995	0.750	(1.988)	(3.379)	(2.471)	0.724	3.764
China	42.833	12.500	(12.499)	(5.651)	(10.444)	(27.790)	(50.890)	(38.183)	28.318	61.806
Indonesia	(6.073)	5.290	8.393	(1.570)	1.079	1.030	(7.114)	(11.709)	(1.755)	12.428
Malaysia	(0.280)	(1.019)	(0.459)	1.507	4.290	0.231	(4.563)	(1.889)	(0.063)	2.245
Myanmar	2.470	1.305	0.158	(0.846)	(1.914)	(2.482)	(2.167)	(0.952)	(0.812)	5.237
Philippines	0.132	2.862	3.888	(0.507)	(2.777)	(3.918)	(5.251)	(2.390)	1.833	6.128
Thailand	4.130	2.850	0.819	0.496	(1.522)	(8.196)	(7.773)	(4.110)	3.248	10.057
Vietnam	1.518	(12.303)	(7.621)	1.851	22.454	(10.573)	8.453	16.777	(1.883)	(18.672)

De-trended Nominal GDP