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A Measure of Trade Intensity and Country Market Potential

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ABSTRACT

Trade is important in driving a country's economic growth. It has also become essential to go beyond own soil as the infrastructures and communications across countries are becoming better every year. Hence it is of great importance for policy makers to be able to measure the trade intensity of a country to identify market potential. A simple ratio between export and import of trade activities demonstrates imbalanced characteristics which add up to drawbacks in term of scaling, proportionality and symmetry issues of the existing Trade Intensity (TI) measurements. As such the analysis could potentially be erroneous due to biased and skewed characteristics. In addition, the existing TI measurements focus on bilateral trade activities between countries which do not explicitly address country market potential dimension for export opportunities that change throughout times. Thus we propose an innovative new measure of trade intensity focusing on precision trade between change in import and export elements which we named as "TI Index". It is geometrically symmetrical, proportional and scale invariant to the changes in market potential of all products and across the world market. The pinnacle of this paper is the design and construction of an innovative new TI index for possible use in measuring country market potential. The design and construction of the TI index is geometrically illustrated using a newly constructed Geometric Trade Intensity Space Box (GTISB). This TI index provides a single number that is easy to calculate, comparable and change sensitive across all products/countries combinations globally.

JEL Classification: F17, F40

Keywords: Trade intensity index, market potential, easy, comparable, change, symmetrical, proportional, scale invariant

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INTRODUCTION

Trade is one of the key drivers of a country economy. Countries across the world perform trades for various reasons and factors. Some countries do trades due to competitive advantage while others do it to satisfy domestic market demands. Along the way, trade also opens up opportunities for countries to do business and increase their economic growth. As such it is an advantage for a country policy maker who is able to identify market potential in advance. Existing Trade Intensity (TI) measurements such as Cho and Doblas-Madrid (2014), World Integrated Trade Solution (WITS) software by World Bank, The Asia-Pacific Research and Training Network on Trade (ARTNeT) and Sundar Raj and Ambrose (2014) widely used the Balassa's Revealed Comparative Advantage (BRCA) foundation in measuring export share ratio as indicator in bilateral TI perspectives. However there are concerns on the scaling, proportionality and symmetry characteristics of these methodologies due to ratios being naturally biased and unbalanced as variables in numerator and denominator experience changes particularly as the changes approaches zero that lead to disproportionate scaling. As such consistent interpretation through space of time could not be accomplished that could lead to mismeasurement and therefore to biased and/or erroneous conclusions. Furthermore the existing TI measurements do not really lead to market potential insights of a country as they do not consider change in flow of imports and exports directions across period of time as this could signal a contraction or expansion of a product or an industry. With that, it is the objective of this paper to propose an innovative new TI index to measure the TI of a country as well as its market potential for export opportunities by means of precision trade mechanism which we call the "TI Index" that can be geometrically illustrated and a country's market potential is able to be interpreted and derived from it. This TI index comes with symmetrical, proportional and scale invariant features that are able to capture changes in market potential of all products/countries combination across the globe within the span period of analysis. In this way the TI index produce a single number that is comparable and change sensitive.

LITERATURE REVIEW

This section is to review the literature on S index by Azhar and Elliott (2003) in Marginal Intra Industry Trade (MIIT) as well as literatures on existing TI measurements proposed by scholars and practised by researchers. The purpose of reviewing S index in MIIT is purely because of its fundamental concept of symmetrical, proportional and scale invariant in measuring change of trade flows in MIIT is to be reviewed and applied into TI measurement scenario. The new interpretation shall be done concurrently whilst reviewing whereas the innovation part is to be discussed in Section Three. The structures and methods of the existing TI indices will be studied and systematically reviewed too. This includes; for example, the functional forms of the parameters used by the existing TI index in measuring TI. From the observations and gaps found in the literatures, this paper will then propose a new TI index that can measure a country TI as well as supply insights of the country market potentials.

S Index in MIIT Scenario and New Interpretation in TI and Country Market Potential Context

Azhar and Elliott (2003) developed the Trade Adjustment Space (TAS) and derived the S index. The purpose was to measure MIIT in explaining the Smooth Adjustment Hypothesis (SAH) of the adjustment costs associated with changes in trade patterns. The S index is as per equation (1) below:

$$S_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}, -1 \leq S_i \leq 1 \qquad (1)$$

where for home country of product i, ΔX is the changes for export value and ΔM is the changes for import value from start year to end year during the period. From equation (1), when $\Delta X_i > \Delta M_i$ then $0 < S_i \leq 1$, when

$\Delta M_i > \Delta X_i$ then $-1 \leq S_i < 0$ and when $\Delta M_i = \Delta X_i$ then $S_i = 0$. The calculated S index can be visualised inside TAS which could help and enhance the comprehension of trade flow evolution. The associated TAS geometrical diagram of volume induced adjustment space for S indices from the perspective of home country is shown in Figure 1.

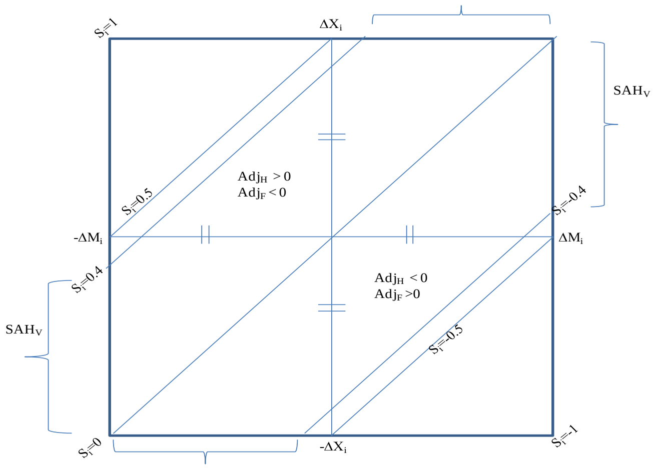

Figure 1: The industry Trade Adjustment Space (TAS) diagram
(Source: Azhar and Elliott, 2003)

Base on Figure 1, the TAS is a square two dimensional spaces that captures all changes in ΔX and ΔM either positive, negative or zero for a period of time of a product i. The important feature is the length of each side of TAS is set to twice the maximum of either |ΔX| or |ΔM|, whichever is the maximum. Change in export is represented on vertical axis (+/-ΔX) and change in import is represented in horizontal axis (+/-ΔM). Each TAS depicts the relationship between home (H) and foreign (F) country. The adjustment effect is positive towards the home country when S > 0 ($Adj_H > 0$) and the extent of the adjustment implication increases as S indices value increases. On the other hand the adjustment effect is negative towards the home country when S < 0 ($Adj_H < 0$) and the extent of the adjustment implication increases as S indices value decreases. Relatively the implication is reverse for foreign country. The cut-off of S indices for volume Smooth Adjustment Hypothesis (SAH_V) is between range [-0.4, 0.4].

In terms of home country market potential from foreign country point of view, if home country change in imports is dominating for product i (ΔM > ΔX), it indicates that home country is importing more of product i against exporting it. From equation (1), ΔM > ΔX occurs when the S index is less than zero (S < 0) which signalling the home country is possessing market potential for foreign country to export product i into home country. The home country market potential intensity is positive towards foreign country and the extent of it increases as S index value decreases. Reversely if home country change in exports is dominating for product i (ΔX > ΔM), it indicates that home country is exporting more of product i against importing it. From equation (1), ΔX > ΔM occurs when the S index is more than zero (S > 0) which signalling the home country is possessing niche market potential for foreign country to export product i into home country. The home country market potential intensity is negative towards foreign country and the extent of it increases as S index value increases. Note that when ΔX > ΔM, its implying that home county does still importing of product i but in lesser volume thus explaining the niche market condition. From Equation (1), when ΔX = ΔM, then S = 0 indicating equivalent change in export and import activity. In this situation the home market potential is regarded in equilibrium condition. As such, the relationship between S index and home country market potential can be regarded as inversely proportionate i.e. $S \propto \frac{1}{\text{market potential}}$ from foreign country point of view.

Next Azhar and Elliott (2008) extent the concept of S index in analysing the quality changes of product i by employing the Marginal Quality (MQ) index as given as follows:

$$MQ = \frac{(\Delta UV_X - \Delta UV_M)}{2\max\{|\Delta UV_X|, |\Delta UV_M|\}}, -1 \leq MQ \leq 1 \quad (2)$$

where for product i, ΔUV_X is the changes for unit export value and ΔUV_M is the changes for unit import value from start year to end year during the period. From equation (2), when $\Delta UV_X > \Delta UV_M$ then $0 < MQ \leq 1$, when $\Delta UV_X < \Delta UV_M$ then $-1 \leq MQ < 0$ and when $\Delta UV_X = \Delta UV_M$ then $MQ = 0$. The Product Quality Space (PQS) for MQ index is given in Figure 2. The PQS was developed by Azhar and Elliott (2006) which is a square box scaled by the maximum of either export unit value (UV_X) or import unit value (UV_M) so that the dimensions of each axis are defined by the maximum value of either UV_X or UV_M in the analysis. Referring to Figure 2 it can be seen that it is fairly similar to Figure 1. The difference is the change in export unit value is represented on vertical axis (+/-ΔUV_X) and change in import unit value is represented in horizontal axis (+/-ΔUV_M). Thus MQ index is similar to S index but translated for use in unit value space (UVS) in measuring changes of trade flows of quality differentiated products. Azhar and Elliott (2006) highlighted that the ground for using unit value in measuring quality is based on Stiglitz (1987) which pointed that products of a higher quality should charge a higher price so that price can be considered an (albeit imperfect) indicator of quality. The cut-off of MQ indices for quality Smooth Adjustment Hypothesis (SAH_Q) is between range [-0.4, 0.4]. In term of market potential, the same explanation as equation (1) could be derived from equation (2) as they used the same basic structure and principal, substituting only volume with quality. As such, the relationship, from foreign country point of view would be $MQ \propto \frac{1}{\text{market potential (quality)}}$

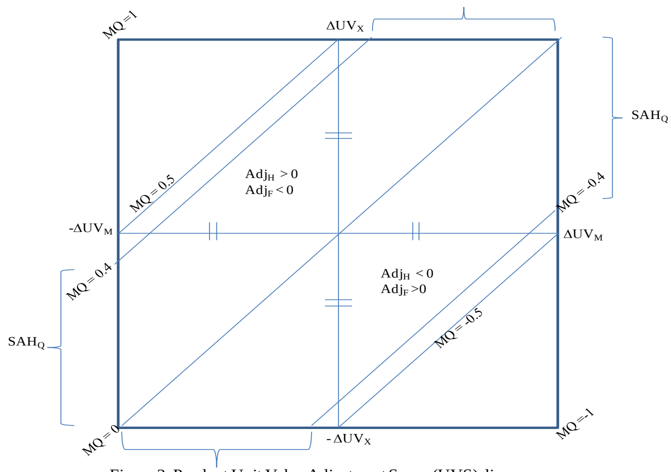

Figure 2: Product Unit Value Adjustment Space (UVS) diagram
(Source: Azhar and Elliot, 2008)

In addition Azhar and Elliott (2011) suggested extra extension procedure where both volume and quality induced adjustment measures are integrated by adding both of them together. According to Azhar and Elliott (2011), existing literatures examined volume and quality separately. The volume literatures examined on the Intra Industry Trade (IIT) trade flows and the associated adjustment costs in debating on Smooth Adjustment Hypothesis (SAH) that hypothesises that trade changes in IIT will experience trade induced adjustment costs that are less severe than the costs associated with inter-industry changes. The quality literatures examined the extent to which products are differentiated in terms of quality within matched trade flows. Azhar and Elliott (2011) highlighted that quality has become important up to the point where Cabral et al. (2006) split the IIT into horizontal and vertical IIT in examining the quality implications and demonstrated that the adjustment implications differs which has important implications for the SAH. Thus, Azhar and Elliott (2011) purpose was to produce an index that can visualise both changes in volume and quality simultaneously, a gap that they found missing in the family of static and dynamic trade measures. Their proposed equation is as follows:

$$VQ = S + MQ, \quad -2 < VQ < 2 \tag{3}$$
$$MQ = -S + VQ \quad -2 < VQ < 2 \tag{4}$$

Hence the straight line should go down from left to right across the MQ and S plane. There is a fall in change of MQ while change of S run across. This shall produce negative gradient, hence indicating decrease rate of change, which is at the same constant rate. Thus, the associated diagrammatic representation of VQ isoclines is depicted in following Quality Adjusted Trade Adjustment Space (QTAS) diagram as shown in Figure 3 below.

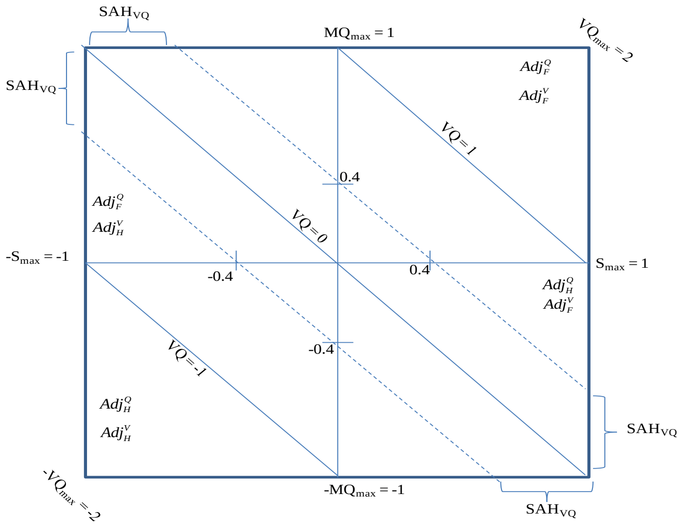

Figure 3: Product Quality Adjusted Trade Adjustment Space (QTAS) diagram
(Source: Azhar and Elliott (2011)

From Figure 3, the S index is represented on horizontal axis and MQ index is represented on vertical axis. Any change in volume and/or quality in trade flows changes is captured by the QTAS. The diagonal lines represent lines of equal VQ indices. The cut-off of VQ indices for volume and quality Smooth Adjustment Hypothesis (SAH_{VQ}) is between range [-0.4, 0.4]. Referring to QTAS in Figure 3, within the SAH_{VQ} strip where VQ [-0.4, 0.4], the combined adjustment pressure for both home and foreign country are considered benign. A combined adjustment pressure of volume and quality occur outside the cut-off strip as indicated in Figure 3 as:

Adj_F^Q = quality induced adjustment in foreign country
Adj_F^V = volume induced adjustment in foreign country
Adj_H^Q = quality induced adjustment in home country
Adj_F^V = volume induced adjustment in foreign country
Adj_F^Q = quality induced adjustment in foreign country
Adj_H^V = volume induced adjustment in home country

The combined adjustment pressure of volume and quality analysis is further explained in Table 1 below as indicated in Figure 3 for the home and foreign country by using QTAS and the calculated S, MQ and VQ indices.

For example, in the region of 0.4 < VQ < 1, there shall be multiple combinations of adjustment pressure depending on the value of S and MQ. In situation where S < 0 and MQ > 0, the home country shall have volume induced adjustment while foreign country shall have quality induced adjustment. If within the period of study is divided into several phases, the analysis of Table 1 can be repeated for several phases accordingly.

Table 1 Analysis of volume and quality induced adjustment pressure for home and foreign country by using QTAS and the calculated S, MQ and VQ indices.

	VQ		S	MQ	Home	Foreign
1	1 < VQ < 2		> 0	> 0		F_V, F_Q
		(a)	< 0	> 0	H_V	F_Q
2	0.4 < VQ < 1	(b)	> 0	> 0		F_V, F_Q
		(c)	> 0	< 0	H_Q	F_V
		(a)	< 0	> 0	H_V	F_Q
3	0 < VQ < 0.4	(b)	> 0	> 0		F_V, F_Q
		(c)	> 0	< 0	H_Q	F_V
		(a)	< 0	> 0	H_V	F_Q
4	-0.4 < VQ < 0	(b)	< 0	< 0	H_V, H_Q	
		(c)	> 0	< 0	H_Q	F_V
		(a)	<0	>0	H_V	F_Q
5	-0.4 < VQ < -1	(b)	<0	<0	H_V, H_Q	
		(c)	>0	<0	H_Q	F_V
6	-2 < VQ < -1		<0	<0	H_V, H_Q	

Note: H_V and H_Q are the volume and quality induced adjustment in home country, F_V and F_Q are the volume and quality induced adjustment in foreign country.

After reviewing the S index, next the existing TI measurements available in literatures shall be reviewed.

Existing Trade Intensity Measurements

Prior to reviewing existing TI measurements, let review the Balassa (1965) Revealed Comparative Advantage (RCA) index first. This is because Balassa (1965) had popularised the Balassa Index, the concept of share ratio through actual export trade flows in revealing a country strong sectors, thus it is also known as the RCA index. The RCA index is as per equation (5) below:

$$RCA_{ij} = (x_{ij}/X_{it}) / (x_{wj}/X_{wt}) \qquad (5)$$

where x_{ij} is the values of country i's exports of product j, x_{wj} is the values of world exports of product j, X_{it} is the country i's total exports, X_{wt} is the world total exports. When a value of RCA is less than unity implies that the country i has a revealed comparative disadvantage in the product j. Likewise, if the RCA value exceeds unity, the country i is said to have a revealed comparative advantage in the product j. The RCA concept has set forth the foundation for existing TI measurements.

In reference to Cho and Doblas-Madrid (2014), they measured TI by the following equation:

$$\text{tradeint}^{\max}_{X,Y,t} = \max\left\{ \frac{\text{export}_{X,Y,t} + \text{export}_{Y,X,t}}{\sum_{all}\text{export}_{X,i,t} + \sum_{all}\text{export}_{i,X,t}}, \frac{\text{export}_{X,Y,t} + \text{export}_{Y,X,t}}{\sum_{all}\text{export}_{Y,i,t} + \sum_{all}\text{export}_{i,Y,t}} \right\} \qquad (6)$$

Where $\text{export}_{X,Y,t}$ is the exports from country X to country Y at year t. According to equation (6), TI only needs to be high for one of the two countries in the bilateral trade relationship. Cho and Doblas-Madrid (2014) also defined $\text{tradeint}^{\text{avg}}_{X,Y,t}$ as an alternative measure to equation (6). Instead of choosing the highest and disposing the lowest percentage, equation (7) takes both percentages into account.

$$\text{tradeint}_{X,Y,t}^{\text{avg}} = avg\left\{\frac{\exp ort_{X,Y,t} + \exp ort_{Y,X,t}}{\sum_{all}\exp ort_{X,i,t} + \sum_{all}\exp ort_{i,X,t}}, \frac{\exp ort_{X,Y,t} + \exp ort_{Y,X,t}}{\sum_{all}\exp ort_{Y,i,t} + \sum_{all}\exp ort_{i,Y,t}}\right\} \quad (7)$$

Thus, equation (7) averages the two functions in the bilateral trade affiliation.

The World Bank via its World Integrated Trade Solution (WITS) software defined TI as below:

$$\mathrm{T}_{\mathrm{i,j}} = (x_{\mathrm{ij}} / X_{it}) / (x_{wj} / X_{wt}) \quad (8)$$

where x_{ij} is the values of country i's exports to country j, x_{wj} is the values of world exports to country j, X_{it} is the country i's total exports and X_{wt} is the total world exports. The equation (8) is used to determine whether the value of trade between two countries is greater or smaller than would be expected on the basis of their importance in world trade. From equation (8) it can be seen defined as the share of one country's exports going to a partner divided by the share of world exports going to the partner. Thus an index of $T_{ij} > 1$ indicates a bilateral trade flow that is larger than expected, given the partner country's importance in world trade while $T_{ij} < 1$ indicates a bilateral trade flow that is smaller than expected, given the partner country's importance in world trade.

A quick look at The Asia-Pacific Research and Training Network on Trade (ARTNeT), they also used similar definition as the WITS as follow:

$$\text{Trade Intensity} = \frac{\sum_{sd} X_{sd} / \sum_{sw} X_{sw}}{\sum_{wd} X_{wd} / \sum_{wy} X_{wy}} \quad (9)$$

where s is the set of countries in the source, d is the destination countries, w is the countries in the world, y is the countries in the world and X is the bilateral flow of total exports. In essence equation (9), the numerator is the export share of the source region to the destination while the denominator is export share of the world to the destination. Equation (9) Trade Intensity shall takes a value between zero and $+\infty$. Trade Intensity > 1 indicates an 'intense' trade relationship. Thus equation (8) and (9) are indeed the same whereby they can be interpreted as an export share.

Sundar Raj and Ambrose (2014) used below equations in analysing the bilateral trade intensity between India and Japan:

$$XII_{ijt} = [X_{ij} / X_i] / [M_j / (M_w - M_i)]*100 \quad (10)$$

$$MII_{ijt} = [M_{ij} / M_i] / [X_j / (X_w - X_i)] * 100 \quad (11)$$

$$XII_{jit} = [X_{ji} / X_j] / [M_i / (M_w - M_j)] * 100 \quad (12)$$

$$MII_{jit} = [M_{ji} / M_j] / [X_i / (X_w - X_j)] * 100 \quad (13)$$

where XII_{ijt} and XII_{jit} is the Export Intensity Index of trade India with Japan and Japan with India, MII_{ijt} and MII_{jit} is Import Intensity Index of trade India with Japan and Japan with India, X_{ij} and X_{ji} is exports of India to Japan and Japan to India, X_i is total exports of India, X_j is total exports of Japan, X_w is total world exports, M_{ij} and M_{ji} is imports of India from Japan and Japan from India, M_j is total imports of Japan, M_i is total imports of India, M_w is total world imports and *t* is year.

The value of TI index ranges from 0 to 1 (0 to 100 when multiplied with 100). If TI is zero this implies that there is no trade relationship between partner countries. If TI is one this implies high trade relations. If Import Intensity Index is more (or less) than 100, it indicates that India is importing more (or less) from Japan than might be expected from that country's share in total world trade. The same goes for export too, if the value is zero it implies export link between these two countries is negligible and if the value is nearer to 100 it indicates that performance is significant and if it exceeds 100 it indicates that India is exporting more to Japan than might be expected from that country's share in world trade.

Thus, comparing equations (6), (7), (8) and (9) with equation (5), their fundamental can be regarded as actually derived from RCA foundation which is measuring a country export share. The RCA equation is measuring in the perspective of country/product while the TI equations are measuring the bilateral trade intensity between countries. Nevertheless their fundamental concepts are similar. However Azhar and Elliott (2006) highlighted that the RCA index is having issues in term of scaling, proportionality and symmetry characteristics. This issue can be seen at the functional form of a ratio as illustrated by Azhar ad Elliott (2006) through an example. Referring to their paper, an example shown in Table 2 below provides two cases, A and B, consist of two equal but opposite pairs of unit value (UV). Consider the equal but opposite changes in r over four periods as shown in column 6. Note that the Δr values are generated from different changes in UV_X and UV_M. For example in case A, in period 1, Δr = -0.50 is associated with ΔUV_M = 0.50 in column 8. However for same period 1, in case B, Δr = 0.50 is associated with ΔUV_X = 0.88 in column 7. Azhar ad Elliott (2006) indicated that for any two equal but opposite UV_X and UV_M coordinates, as in example of cases A and B, an equal but opposite change in value of Δr should be associated with an equal but opposite increase in UV_X in case B and UV_M in Case A. However as demonstrated in Table 2, r exhibit disproportionate scaling with respects to ΔUV_M and ΔUV_X. Due to this issue there is possibility implication on misinterpretation of result in analysis.

Table 2 The disproportionate scaling characteristic of the UV ratio r

1	2 Period	3 UV_X	4 UV_M	5 $r = UV_X/UV_M$	6 Δr	7 ΔUV_X from period 0	8 ΔUV_M from period 0
A	0	1.50	1.00	1.50	-	-	-
	1	1.50	1.50	1.00	-0.50	0	0.50
	2	1.50	1.75	0.86	-0.64	0	0.75
	3	1.50	2.00	0.75	-0.75	0	1.00
B	0	1.00	1.50	0.75	-	-	-
	1	1.88	1.50	1.25	+0.50	0.88	0
	2	2.09	1.50	1.39	+0.64	1.09	0
	3	2.25	1.50	1.50	+0.75	1.25	0

The equations (9), (10), (11) and (12) did deviate to some extend from RCA concept by introducing import element in measuring bilateral trade intensity perspective. Nonetheless Azhar et al. (2016) highlighted that simple ratio is naturally unbalanced. Perhaps this issue can be analysed from the range perspective of equation (5) as an example. According to Balassa (1965), when $0 < RCA < 1$, a country i has no comparative advantage in product j while when $1 < RCA < \infty$, a country i has comparative advantage in product j. Note that the range to distinguish between those two is imbalanced; no comparative advantage range is very much smaller as compared to comparative advantage range. Thus the results of any analysis could be regarded as asymmetrical and skewed.

In addition from observation of all the existing equations above, there is lack of consideration on the concept of change. By considering change, gaps can be identified and their strengths can be analysed to infer useful information. Fertő and Soós (2008) pointed out that in MIIT the structure of the change in flows of goods affect the adjustment rather than the trading pattern in any given time period in IIT. The MIIT is used in measuring adjustment costs which is dynamic in nature. In the same connotation, it is suggesting to apply this concept in measuring trade intensity by considering they are dynamic too. Another point to note is that by considering change there is possibility to do cross-sectional analysis which could possibly show the evolution and trend of trade intensity. With that in below section the methodological framework of the new proposed TI index shall be detailed out. This index can be considered new since as reviewed above, the existing trade intensity measurements do not take into account the change element and this index is an attempt to apply MIIT concept in measuring trade intensity. The innovative element of the new TI index in the context of country market potential would be elaborated, particularly focusing on the symmetrical, proportionality and scale invariant aspects while in parallel introducing a change concept.

A METHODOLOGICAL INNOVATION

This section shall deliberate the methodological derivation and foundation of the new proposed TI index and its representation in a geometrical Trade Intensity Space (TIS) square box. Its innovation from an intuitive of an index of a simple ratio between change in export and import towards an index of a ratio that addressed the scale invariant, proportionality and symmetrical issues shall be elaborated and discussed. The dynamic measurement of TI index and its properties inside a geometrical square box as well as its possible extension in measuring a country market potential shall also be illustrated accordingly.

TI Index Derivations and GTISB Foundations

Consider trade activity of host country A for a period of time (t, t + Δ) of product i as shown in Figure 4 below.

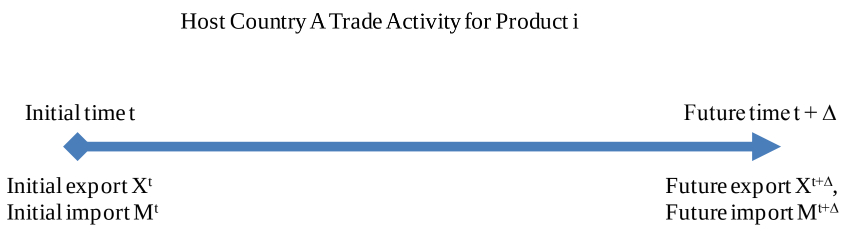

Figure 4: Country A Trade Activity

From Figure 4 above, there is a trade intensity activity occurs between time interval (t, t + Δ) for country A for a product i. There would be change in export as well as change in import occurs. It is to note that in dynamic setting, the ΔX_i and ΔM_i over time interval (t, t + Δ) where Δ > 0 can be in day, week, month, quarter or year. Thus an export and import changes would be measured as $\Delta X_i = X_i^{t+\Delta} - X_i^t$ and $\Delta M_i = M_i^{t+\Delta} - M_i^t$ respectively. Thus, the pillar definitions of the dynamic components of trade intensity, over a time interval:

1. $\Delta TTI = \Delta X_i + \Delta M_i$ is the change in total trade intensity of product i
2. $\Delta NTI = \Delta X_i - \Delta M_i$ is the change in net trade intensity of product i

where ΔTTI is change in Total Trade Intensity and ΔNTI is change in Net Trade Intensity.

From Figure 4 and literatures review, an intuitive impetus to suggest that a simple ratio of ΔX/ΔM can be used to create an index to measure the Trade Intensity (TI) of product i as shown in equation (14):

$$TI_i = \frac{\Delta X_i}{\Delta M_i} \tag{14}$$

However Azhar et al. (2016) highlighted that ratios are naturally biased and unstable. This concern could be explained through an example of a simple functional ratio as follows. Consider a functional form of a ratio y/x = λ or y = λ.x. For this ratio to produce consistent interpretation across all parameters where λ is a constant, strict proportionality must be controlled and adhered regardless of the change in the values of y and x. However in the presence of an intercept: $y = \lambda . x + k$ or $\lambda = y/x - k/x$ the strict proportionality is deviated. This deviation occurs when there are very small variables, the value of x will be small enough for the intercept, k, to impact the relationship between x and y but with a bias toward x. Thus, control on strict proportionality is not adhered and results of any analysis could be biased. Consider $TI_i = f(\Delta X_i, \Delta M_i) = \frac{\Delta X_i}{\Delta M_i}$ for product i.

$$TI_i = f(\Delta X_i, \Delta M_i) = \frac{\Delta X_i}{\Delta M_i} = \Delta X_i.(\Delta M_i)^{-1}.$$

The behaviours of when TI_i changes with respect to ΔX_i and ΔM_i can be summarised and compared as in Table 3 below.

Table 3 Summarisation of mathematical behaviour of TI_i functional ratio

Differentiation	Limit
When TI_i changes with respect to ΔX_i; $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right]_{\Delta Xi} = \Delta X_i.[-1.(\Delta M_i)^{-2}] = -\frac{\Delta X_i}{(\Delta M_i)^2}$	As $\Delta M_i \to 0$, $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right] \to -\infty$
When TI_i changes with respect to ΔM_i; $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right]_{\Delta Mi} = \frac{1}{\Delta M_i}$	As $\Delta X_i \to 0$, $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right] \to \frac{1}{\Delta M_i}$.

As can be seen from the Table 3 above, the rate of changes of TI_i with respect to ΔX_i and ΔM_i are not similar. A major methodological issue occurs when ΔX_i and ΔM_i approaches zero. The rate of change for the numerator is disproportionately higher than the denominator (as $\Delta M_i \to 0$) while the rate of change remains constant (as $\Delta X_i \to 0$). Additionally, consider a scenario where an intercept exist for a straight line equation in a Cartesian plane of ΔX_i and ΔM_i as Y-axis and X-axis respectively. The equation would be $\Delta X_i = TI_i.\Delta M_i + k$ or $\frac{\Delta X_i}{\Delta M_i} = TI_i + \frac{k}{\Delta M_i}$. When ΔM_i has very small value, the impact of k to the relationship between ΔX_i and ΔM_i can be negligible however still bias toward ΔM_i. Therefore, as pointed by Azhar et al. (2016), strict proportionality is not adhered and results of any analysis could be biased and skewed. In deduction, the equation (14) as a ratio exhibits disproportionate scaling. This leads to mismeasurement, biased and/or erroneous conclusions. With that, in the below section we will discuss an innovation of the ratio formula in order to overcome this disproportionate and bias issues.

TI Index Innovations

Consider again the $\Delta NTI = \Delta X_i - \Delta M_i$ for interval of time. This equation would measure the gap of both changes for an interval of time. The gap would be referred back to either ΔX_i or ΔM_i indicating which is dominant. Thus if the gap is relative back to the dominant, a percentage trade intensity can be calculated. This is suggesting equation (14) can be rewritten as below:

$$TI_i = \frac{\Delta X_i - \Delta M_i}{\max(|\Delta X_i|, |\Delta M_i|)} \tag{15}$$

By adding a scaling factor of two in the denominator, it would allow this index to possess a scaling factor, i.e., scaling by the largest value for a given time scale. Thus:

$$TI_i = \frac{\Delta X_i - \Delta M_i}{2\{\max(|\Delta X_i|, |\Delta M_i|)\}}, -1 \le TI_i \le 1 \tag{16}$$

Now consider situations when either $|\Delta X_i|$ or $|\Delta M_i|$ is the highest and TI_i changes with respect to ΔX_i and ΔM_i as summarised and compared in Table 4 below. From Table 3, it looks like this equation has scale feature but does not have the symmetrical and proportionality features. However when innovatively set the highest value of both $|\Delta X_i|$ and $|\Delta M_i|$ as the same value, according to which ever is the highest, the symmetrical and proportionality features can be materialised. In other word, the TI index is scaled to the highest value of either $|\Delta X_i|$ or $|\Delta M_i|$ for a given period of time. This will ensure when $|\Delta X_i|$ or $|\Delta M_i|$ approaching zero, both $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right] \rightarrow -\frac{1}{2\Delta X_i}$ and $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right] \rightarrow \frac{1}{2\Delta M_i}$ has the same value but opposite. Hence scale, symmetrical and proportionality features are achieved.

Table 4 Summarisation of the innovated TI index mathematical behaviour

Situation	Differentiation	Limit
$|\Delta X_i|$ the highest	$TI_i = \frac{\Delta X_i}{2\Delta X_i} - \frac{\Delta M_i}{2\Delta X_i}$ $TI_i = \frac{1}{2} - \frac{\Delta M_i}{2\Delta X_i}$ $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right]_{\Delta X_i} = -\frac{1}{2\Delta X_i}$	As $\Delta M_i \rightarrow 0$, $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right] \rightarrow -\frac{1}{2\Delta X_i}$
	$TI_i = \frac{\Delta X_i}{2\Delta X_i} - \frac{\Delta M_i}{2\Delta X_i}$ $TI_i = \frac{1}{2} - \frac{\Delta M_i}{2\Delta X_i}$ $TI_i = \frac{1}{2} - \frac{1}{2}.\Delta M_i.(\Delta X_i)^{-1}$ $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right]_{\Delta M_i} = -\frac{1}{2}.\Delta M_i.[-1.(\Delta X_i)^{-2}] = \frac{\Delta M_i}{2(\Delta X_i)^2}$	As $\Delta X_i \rightarrow 0$, $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right] \rightarrow \infty$.
$|\Delta M_i|$ the highest	$TI_i = \frac{\Delta X_i}{2\Delta M_i} - \frac{\Delta M_i}{2\Delta M_i}$ $TI_i = \frac{\Delta X_i}{2\Delta M_i} - \frac{1}{2}$ $TI_i = \frac{1}{2}.\Delta X_i.(\Delta M_i)^{-1} - \frac{1}{2}$ $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right]_{\Delta X_i} = \frac{1}{2}.\Delta X_i[-1.(\Delta M_i)^{-2}] = -\frac{\Delta X_i}{2(\Delta M_i)^2}$	As $\Delta M_i \rightarrow 0$, $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right] \rightarrow -\infty$
	$TI_i = \frac{\Delta X_i}{2\Delta M_i} - \frac{\Delta M_i}{2\Delta M_i}$ $TI_i = \frac{\Delta X_i}{2\Delta M_i} - \frac{1}{2}$ $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right]_{\Delta M_i} = \frac{1}{2\Delta M_i}$	As $\Delta X_i \rightarrow 0$, $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right] \rightarrow \frac{1}{2\Delta M_i}$.

Comparing to the simple ratio of $\Delta X/\Delta M$, the limiting behaviour is asymmetrical and disproportionate between both positive and negative sides. As such the result interpretation for the innovated TI index would show holistic and monotonous scenarios across changes. In parallel, symmetrical issues is tackled too along the way as consistency of behaviour is obtained on both positive and negative sides. This implies control is achieved. Perhaps the proportionality, scaling and symmetrical discussion can be visualised clearer when geometrically discuss in below section.

The Geometrical Model Structure of TI Index (The GTISB)

The geometrical model structure of the TI index is graphically shown in Figure 5 below.

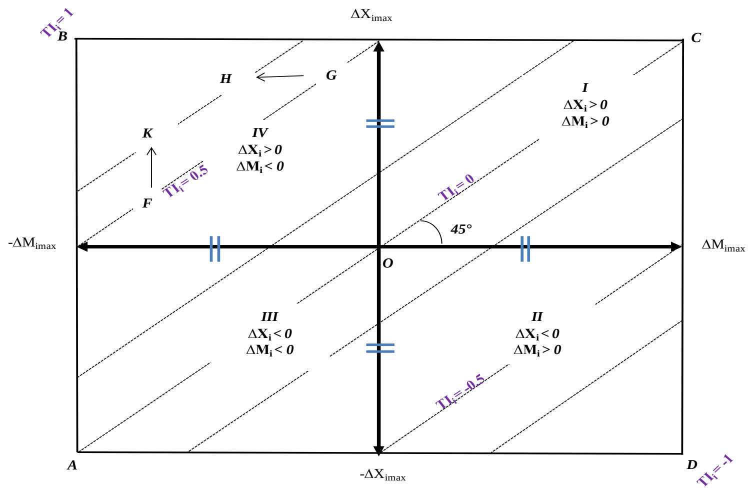

Figure 5: Geometric Trade Intensity Space Box (G*TISB*)
(Adapted: Azhar and Elliott, 2003)

As can be seen from Figure 5 above, the dynamic measurement of TI index is through the relationships between ΔX_i and ΔM_i of product i over multiple time periods. The proposal is that the Trade Intensity Space (*TIS*) to measure how *TI* evolves over time. The relationship is disentangled via a Cartesian plane which is divided into four quadrants (*I, II, III* and *IV*) to accommodate all possible positive and negative changes in values of ΔX_i and ΔM_i. This will create a host country TIS box which enables the measurement of host country TI evolves over time. Thus this TIS box is to be named as Geometric Trade Intensity Space Box (GTISB).

The assumption is that for product i over n years (or quarters) for all t, n = 1, 2, 3, ….., n. The space dimensions of the GTISB on all four sides are determined by the maximum of ΔX_i or ΔM_i. The length (L) of any of the four sides is determined by twice the maximum of the highest absolute change value of the denominator of equation (16) whichever the highest during the span period of consideration t. Hence, the total area of the GTISB for i is an element of t ($i \in t$) is $2 \times \max|\Delta X_i| = 2L$ or $2 \times \max|\Delta M_i| = 2L$. This is the key innovation whereby it enable this index to possess a scaling factor for a given time scale. In a way, it also enables the space to have a shape of a square box. With that, any changes within the square box should be symmetrical, scale invariant and proportional within the span period of times.

As can be seen in Figure 6 below, the square box is divided into two triangles, lower triangle ADC and upper triangle ABC. The triangle ADC is defined as the Net TI for M_i (NTIM) while the triangle ABC is defined as the Net TI for X_i (NTIX). The origin O represents the unique case where the coordinate $(\Delta X_i, \Delta M_i) = (0, 0)$. The AOC line is a line representing perfectly matched TI changes or balance TI where $\Delta X_i = \Delta M_i$ and TI = 0. All other lines parallel to the AOC line are defined as equi-TI lines. Hence when TI > 0 (means trade intensity $\Delta X > \Delta M$) as the value of TI increasing positively towards TI = 1 the host market potential is decreasing.

Likewise when TI < 0 (means trade intensity $\Delta X < \Delta M$) as the value of TI decreasing negatively towards TI = -1 the host market potential is increasing.

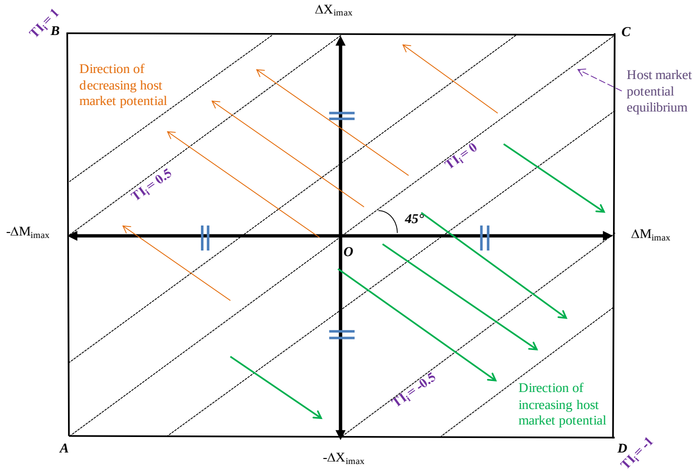

Figure 6: Direction of increasing and decreasing of host market potential in GTISB
(Adapted: Azhar and Elliott, 2003)

Referring back to Figure 5, point F and point G that are on the same dynamic TI line share same TI values. Point H that located on a higher equi-TI line has higher TI value than point F and G. For example, consider the transition from point G to point H, when the value of ΔM_i rises while the value of ΔX_i remain the same, the equi-TI line move towards the North-West direction further away from the AOC equi-TI line of balance TI value. Similarly, the transition from point F to point K where there is no net changes.

In essence, the GTISB measure the changes in the balance of TI ($\Delta NTI = \Delta X_i - \Delta M_i$) over a multiple time period. Dynamically measuring the ΔNTI is more appropriate as opposed to measuring changes in total TI ($\Delta TTI = \Delta X_i + \Delta M_i$) due to ΔTTI is invariant to ΔX_i or ΔM_i. The ΔTTI line is in fact parallel to BOD line although not indicated in the figure. Mathematically it can be shown via the straight line equation Y = mX + C as follows: $\Delta TTI = \Delta X_i + \Delta M_i$; $\Delta X_i = -\Delta M_i + \Delta TTI$ which is line parallel to BOD line with m = -1. This is because due to its summation equation ΔTTI will always appear higher due to increase or decrease in either or both ΔX_i and ΔM_i. Larger positive ΔX_i while desirable theoretically may show higher TTI which may lead to erroneous interpretation that TI is increasing. Thus, ΔNTI would show the correct evolution of TI due to ΔX_i and ΔM_i. Due to its design, the TI index is scaled and has a ranking ability factor that shows how ranked TI changes over time and whether the direction of change is positive or negative.

The Dynamic Measurement of TI Index in GTISB

From Figure 5, assuming that changes are monotonically increasing, the TI value satisfy TI = 0 when $\Delta X_i = \Delta M_i$, the measure of dynamic TIS that possess values that satisfies criteria I-IV of each quadrant for n years (or quarters) for t periods = 1, 2, 3, …n and i product for I = 1, 2, 3, …m is given by the TI index as depicted by equation (16).

Since Figure 5 is a square box, hence the point B and D would have coordinate of ($-\Delta M_i$, ΔX_i) and (ΔM_i, $-\Delta X_i$) accordingly. At these two points B and D, the value of ΔX_i is equal to the value of ΔM_i but with opposite sign. These two points are the farthest points. Hence, consider Table 5 below.

Table 5 The GTISB space boundary

At point B	At point D
$TI_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{\|\Delta X_i\|,\|\Delta M_i\|\})}$	$TI_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{\|\Delta X_i\|,\|\Delta M_i\|\})}$
$TI_i = \frac{\Delta X_i - (-\Delta X_i)}{2\Delta X_i}$	$TI_i = \frac{-\Delta M_i - \Delta M_i}{2\Delta M_i}$
$TI_i = \frac{2\Delta X_i}{2\Delta X_i}$	$TI_i = \frac{-2\Delta M_i}{2\Delta M_i}$
$TI_i = 1$	$TI_i = -1$

As shown in Table 5 above, the GTISB space boundary will take values from -1 < TI_i < 1. This measurement is theoretically justified in describing the dynamic relationship between ΔX_i and ΔM_i over different time periods. If $\Delta X_i > \Delta M_i$, the TI_i will take values in the range of 0 < TI < 1, the upper triangle ABC. In this case host country is experiencing greater change in export activity against change in import activity. This is signalling host country is having increasing demand and competitive advantage of product i from foreign countries while in the same time is importing lesser quantity of product i to cater niche host market. When $\Delta X_i < \Delta M_i$, the TI_i will take values in the range of -1 < TI_i < 0, the lower triangle ADC. In this case host country is experiencing greater change in import activity against change in export activity. This is signalling host country is having less demand and losing competitive advantage of product i from foreign countries while at the same time it is importing increasing quantity of product i to cater increasing host market demand.

The Properties of TI Index in GTISB

After introducing the TI index as per equation (16), this section will propose four theorems that describe the desirable properties of the TI index.

Theorem 1

For every TI_i index, a unique straight line with constant gradient m =1 and an intercept of Y-axis exists. Hence, the TI_i index values will be the same for every point (ΔX_i , ΔM_i) along the same iso-line. This can be proven as below:

$$TI_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}$$

$$2(\max\{|\Delta X_i|,|\Delta M_i|\}).TI_i = \Delta X_i - \Delta M_i$$

$$\Delta X_i = \Delta M_i + 2(\max\{|\Delta X_i|,|\Delta M_i|\}).TI_i$$

This is analogous to straight line equation Y = mX + C where m = 1 while C = $2(\max\{|\Delta X_i|,|\Delta M_i|\}).TI_i$

Theorem 2

The TI_i index is symmetrical about the diagonal $-\Delta X_i = \Delta M_i$ for each $\Delta X_i = \Delta M_i$. This can be proven as below:

$TI_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}$ is a function of positive values of ΔX_i and ΔM_i, *f*(ΔX_i , ΔM_i). For the case of *f*($-\Delta X_i$, $-\Delta M_i$):

$$f(-\Delta X_i, -\Delta M_i) = \frac{(-\Delta X_i + \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}$$

$$f(-\Delta X_i, -\Delta M_i) = -\frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}$$

$$f(\Delta X_i, \Delta M_i) = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}$$

Theorem 3

The TI_i index is scaled to the largest value of either ΔX_i or ΔM_i for a given time period. It is therefore a proportionately scaled symmetrical measurement that allows the observation of how TI_i would evolve over time across all countries/products combination without any further assumptions. This is proven as per derivation shown in section TI Index Innovations above. In either case ΔX_i is highest or ΔM_i is highest the same and opposite symmetrical proportionality limiting behaviour is observed.

Theorem 4
The space dimension of the GTISB is perfectly divided into symmetrical half by the equation of straight line $\Delta X_i = \Delta M_i$. This can be proven as below:

$$TI_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})}$$
$$0 = \Delta X_i - \Delta M_i$$
$$\Delta X_i = \Delta M_i$$

Since the space dimension of the GTISB is a square box, thus the $\Delta X_i = \Delta M_i$ is symmetrically dividing the space of GTISB into half when $TI_i = 0$

Supplementary Consideration
Consider equation (16) to be in below form instead:

$$TI_i = \frac{(\Delta X_i + \Delta M_i)}{2(\max\{|\Delta X_i|,|\Delta M_i|\})} \tag{17}$$

$TI_i = 0$ when $\Delta X_i = -\Delta M_i$ and $-\Delta X_i = \Delta M_i$. This is the BOD line of the GTISB diagram in Figure 5. Since Figure 5 is a square box, hence the point A and C would have coordinate of ($-\Delta M_i$, $-\Delta X_i$) and (ΔM_i, ΔX_i) accordingly. At points A and C, the value of ΔX_i is equal to the value of ΔM_i with both will have same signs. These two points are the farthest points of the GTISB space. Hence consider Table 6 below.

Table 6 The GTISB space boundary (supplementary consideration)

At point A	At point C
$TI_i = \frac{(\Delta X_i + \Delta M_i)}{2(\max\{\|\Delta X_i\|,\|\Delta M_i\|\})}$ $TI_i = \frac{-\Delta X_i - \Delta M_i}{2\Delta X_i}$ $TI_i = \frac{-\Delta X_i - \Delta X_i}{2\Delta X_i}$ $TI_i = \frac{-2\Delta X_i}{2\Delta X_i}$ $TI_i = -1$	$TI_i = \frac{(\Delta X_i + \Delta M_i)}{2(\max\{\|\Delta X_i\|,\|\Delta M_i\|\})}$ $TI_i = \frac{\Delta M_i + \Delta M_i}{2\Delta M_i}$ $TI_i = \frac{2\Delta M_i}{2\Delta M_i}$ $TI_i = 1$

As can be seen from Table 6 above, the boundary is still $-1 \leq TI_i \leq 1$. However the limiting behaviour is not the same. Consider Table 7 below which shows the limiting behaviour of equation (17). From Table 7 it can be seen that the constant limiting behaviours are on the positive side only while the infinity limiting behaviours are on the negative side only for both situations. It is asymmetrical which lead to imbalanced analysis. Thus, there is no symmetrical proportionality that can be obtained from equation (17). The analysis would produce bias result. Hence the rational for not choosing the total change of TI ($\Delta TTI = \Delta X_i + \Delta M_i$) due to its invariant to ΔX_i or ΔM_i changes.

Table 7 Summarisation of the equation (17) mathematical behaviour

Situation	Differentiation	Limit
$\lvert\Delta X_i\rvert$ the highest	$TI_i = \frac{\Delta X_i}{2\Delta X_i} + \frac{\Delta M_i}{2\Delta X_i}$ $TI_i = \frac{1}{2} + \frac{\Delta M_i}{2\Delta X_i}$ $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right]_{\Delta X_i} = \frac{1}{2\Delta X_i}$	As $\Delta M_i \to 0$, $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right] \to \frac{1}{2\Delta X_i}$
	$TI_i = \frac{\Delta X_i}{2\Delta X_i} + \frac{\Delta M_i}{2\Delta X_i}$ $TI_i = \frac{1}{2} + \frac{\Delta M_i}{2\Delta X_i}$ $TI_i = \frac{1}{2} + \frac{1}{2}.\Delta M_i.(\Delta X_i)^{-1}$ $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right]_{\Delta M_i} = \frac{1}{2}.\Delta M_i.[-1.(\Delta X_i)^{-2}] = -\frac{\Delta M_i}{2(\Delta X_i)^2}$	As $\Delta X_i \to 0$, $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right] \to -\infty$.
$\lvert\Delta M_i\rvert$ the highest	$TI_i = \frac{\Delta X_i}{2\Delta M_i} + \frac{\Delta M_i}{2\Delta M_i}$ $TI_i = \frac{\Delta X_i}{2\Delta M_i} + \frac{1}{2}$ $TI_i = \frac{1}{2}.\Delta X_i.(\Delta M_i)^{-1} + \frac{1}{2}$ $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right]_{\Delta X_i} = \frac{1}{2}.\Delta X_i[-1.(\Delta M_i)^{-2}] = -\frac{\Delta X_i}{2(\Delta M_i)^2}$	As $\Delta M_i \to 0$, $\left[\frac{\partial TI_i}{\partial \Delta M_i}\right] \to -\infty$
	$TI_i = \frac{\Delta X_i}{2\Delta M_i} + \frac{\Delta M_i}{2\Delta M_i}$ $TI_i = \frac{\Delta X_i}{2\Delta M_i} + \frac{1}{2}$ $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right]_{\Delta M_i} = \frac{1}{2\Delta M_i}$	As $\Delta X_i \to 0$, $\left[\frac{\partial TI_i}{\partial \Delta X_i}\right] \to \frac{1}{2\Delta M_i}$.

TI Index and GTISB Extension

The host country A trade activity from Figure 4 can be broken down to two categories, volume and quality. Thus the TI_i index of equation (16) can be extended to measure both categories. For the volume category:

$$V_i = \frac{(\Delta X_i - \Delta M_i)}{2(\max\{|\Delta X_i|, |\Delta M_i|\})}, -1 \le V_i \le 1 \tag{18}$$

where V_i is volume index of product i, ΔX_i is the changes for product i export value and ΔM_i is the changes for product i import value from start time to end time during a period. For the quality category:

$$MQ_i = \frac{(\Delta UX_i - \Delta UM_i)}{2\max\{|\Delta UX_i|, |\Delta UM_i|\}}, -1 \le MQ_i \le 1 \tag{19}$$

where MQ_i is Marginal Quality index of product i, ΔUX_i is the changes for unit export value and ΔUM_i is the changes for unit import value from start time to end time during a period. The associated GTISB are shown in Figure 7 and Figure 8 below.

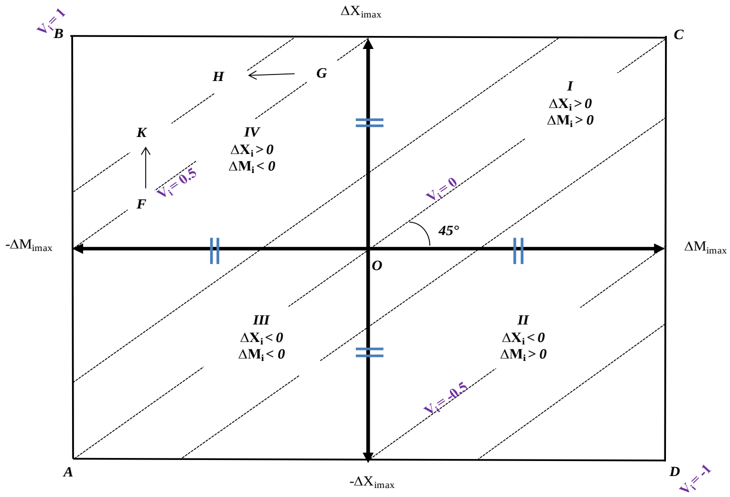

Figure 7: Geometric Volume Intensity Space Box (G*VISB*)
(Adapted: Azhar and Elliott, 2003)

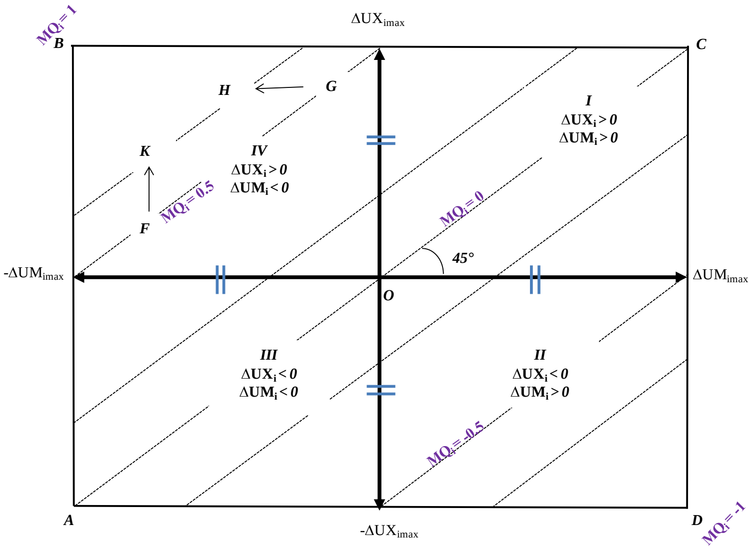

Figure 8: Geometric Quality Intensity Space Box (G*QISB*)
(Adapted: Azhar and Elliott, 2008a)

Additional extension to consider is when both of volume and quality are combined as per below suggestion equation:

$$V_i + MQ_i = VQ_i, \quad -2 \leq VQ_i \leq 2 \tag{20}$$

$$MQ_i = -V_i + VQ_i \quad -2 \leq VQ_i \leq 2 \tag{21}$$

where VQ_i: is the volume quality combination of product i. Geometrically it is illustrated in Figure 9 below.

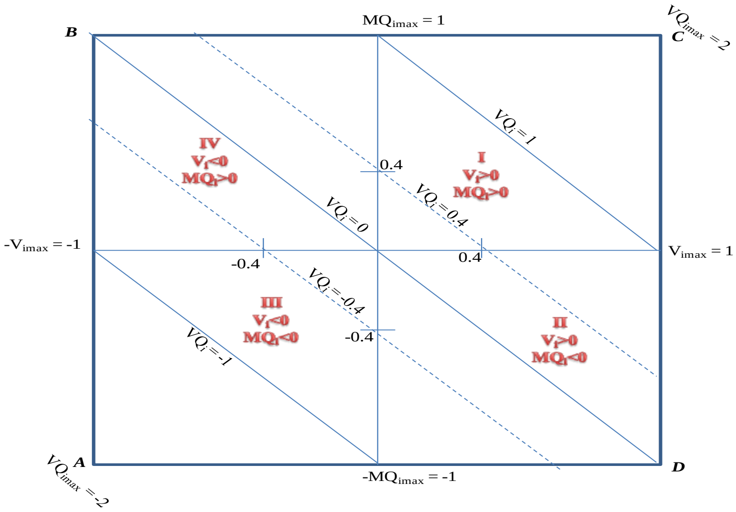

Figure 9: Geometric Volume Quality Intensity Space Box (GV*QISB*)
(Adapted: Azhar and Elliott, 2011)

From equation (21) and Figure 9 above, it can be seen that V_i and MQ_i can be adjusted or trade-off while still maintaining the same respective VQ_i iso-line. It is either to increase V_i and decrease MQ_i or vice versa while the total adjustment or trade-off would still be bound by the same respective VQ_i iso-line. Furthermore, if the adjustment or trade-off of either V_i or MQ_i or both are too strong, it can causes jumping to other VQ_i iso-line. As such this provides marketer a flexi strategy in either to focus either on volume or quality or both while still maintaining the same objective or change to new objective. From an initial value of V_i and MQ_i, marketers can now have projected info and quantified visibility of what will happen by varying value of V_i or MQ_i. Consider movement from a to b, b to c, c to a and a to d as illustrated in Figure 10 and explanation in Table 8 below.

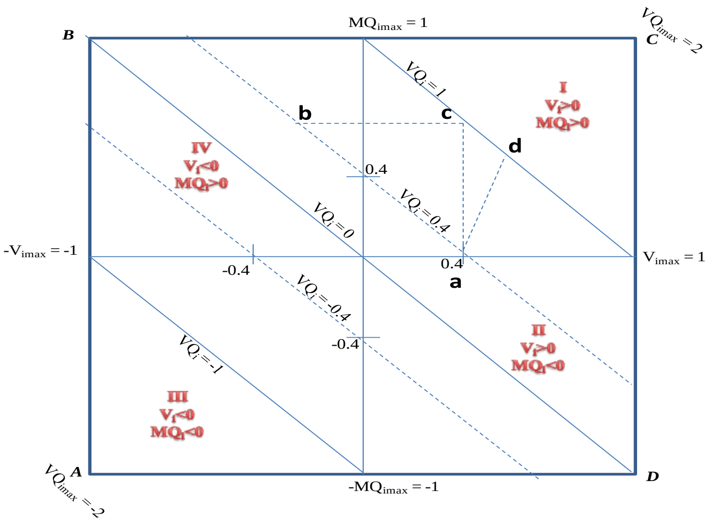

Figure 10: Illustration of Adjusted V and MQ in GVQISB diagram
(Adapted: Azhar and Elliott, 2011)

Table 8 Effect of V_i, MQ_i and VQ_i by projecting their movements

Movement	V_i		MQ_i		VQ_i		Host Market Potential	
	From	To	From	To	From	To	From	To
a to b	$V_i > 0$	$V_i < 0$	$MQ_i = 0$	$MQ_i > 0$	0.4	0.4	F_V	H_V, F_Q
b to c	$V_i < 0$	$V_i > 0$	$MQ_i > 0$	$MQ_i > 0$	0.4	1	H_V, F_Q	F_V, F_Q
c to a	$V_i > 0$	$V_i > 0$	$MQ_i > 0$	$MQ_i = 0$	1	0.4	F_V, F_Q	F_V
a to d	$V_i > 0$	$V_i > 0$	$MQ_i = 0$	$MQ_i > 0$	0.4	1	F_V	F_V, F_Q

Note: H_V and H_Q is host country possessing market potential in volume and quality perspective, F_V and F_Q is foreign country possessing market potential in volume and quality perspective.

From Table 8 above it can be observed that host market potential prediction effect and consequence by varying volume and quality trade-off can be visualised and quantified. This should be a strong tool for marketer planning strategy.

DISCUSSIONS

In this section, the empirical illustration of TI index in measuring trade intensity shall be discussed. The export and import data shall be secondary data obtained from International Trade Centre (ITC) by using Harmonised System (HS) product code of HS 6-digit. Consider Malaysia as host and Singapore as partner country for HS040630 (processed cheese, not grated or powdered) in measuring trade intensity between both countries. The host country TI range, market potential as well as net trade intensity direction can be allocated as Table 9 below. The TI index shall be compared with T index used by World Bank.

Table 9 Host country TI range, market potential and net trade direction proposed grouping categories.

TI range	Trade intensity (Host country point of view)	Net trade intensity direction	Host country market potential (partner country point of view)
$0.6 \leq TI \leq 1.0$	H_{VH}	H_{VH}	H_{VL}
TI = 0.5	H_{IH}	H_{IH}	H_{IL}
$0.1 \leq TI \leq 0.4$	H_H	H_H	H_L
TI = 0	E	E	E
$-0.1 \leq TI \leq -0.4$	H_L	P_H	H_H
TI = -0.5	H_{IL}	P_{IH}	H_{IH}
$-0.6 \leq TI \leq -0.1$	H_{VL}	P_{VH}	H_{VH}

Note: P_{VH} = Partner Very High; P_{IH} = Partner Intermediate High; P_H = Partner High; H_H = Host High; H_{IH} = Host Intermediate High; H_{VH} = Host Very High; H_L = Host Low; H_{IL} = Host Intermediate Low; H_{VL} = Host Very Low; E = Equilibrium

The TI and T calculation matrix is shown in Table 10 while Figure 11 shows the associate GTISB of respective TI. As observed, T index indicates that Malaysia was having intense bilateral trade flow going to Singapore. Malaysia export share was tremendously high relative to world export share going to Singapore. In 2012 the T index was very high and increased in 2013 but then it suffered very significant decrease in the following years of 2014 and 2015 and further dropped in 2016. In 2017 the T index increased back again albeit not that significant compared to previous years. This implies that in 2012 Malaysia was having very intense bilateral trade flow going to Singapore and the intensity increased in 2013 but then it dropped drastically in following years of 2014 until 2016 but rose up again a bit in 2017. Nevertheless, according to the T formula, Malaysia was considered to be having an intense trade relationship with Singapore throughout the years from 2012 to 2017 by having significant export share relative to the world export share to Singapore despite Malaysia was in fact importing more from Singapore.

Whereas looking at TI index, initially it showed that Malaysia was having an intermediate low bilateral trade intensity with Singapore (2013 – 2012) and the TI moved further down towards very low range (2014 – 2013). However TI increased symmetrically to very high range in the following two years (2016 – 2014) but fell down again to intermediate low range (2017 – 2016). This means that for change period (2013 – 2012), (2014 – 2013) and (2017 – 2016), in term of Malaysia bilateral export and import with Singapore, Malaysia's change in import was greater than change in export which implies that Malaysia was indeed importing more from Singapore despite T index indicated that Malaysia was having intense bilateral export share relative to world export share to Singapore. For change period (2015 – 2014) and (2016 – 2015) the TI and T indices matched in indicating that Malaysia was having very intense bilateral export to Singapore. In parallel, as the net trade intensity direction changes, the host country market potential from the point of view of partner/foreign country also changes which could be transformed into market selection information for potential export opportunity.

Table 10 Comparative of TI and T index between Malaysia and Singapore

Host Country										
Partner Country	**Malaysia**									
Partner Country	**Singapore**									
Product (i)	**HS040630**									
Year	**ΔYear**	**X_{ms}**	**X_{mt}**	**X_{ws}**	**X_{wt}**	**M_{ms}**	**ΔX_{ms}**	**ΔM_{ms}**	**ΔX_{ms} - ΔM_{ms}**	**$2max(\|\Delta X_{ms}\|,\|\Delta M_{ms}\|)$**
2012	[redacted]	534	817	54247	2644485000	1646	[redacted]			
2013	2013 – 2012	567	808	56204	3047380000	2288	33	642	-609	1284
2014	2014 – 2013	264	755	57200	3001429000	3373	-303	1085	-1388	2170
2015	2015 – 2014	308	1516	49300	2316305000	3107	44	-266	310	532
2016	2016 – 2015	363	2611	47036	2271647000	2761	55	-346	401	692
2017	2017 - 2016	263	1405	54990	2602137000	3917	-100	1156	-1256	2312

Table 10 Cont.

Host Country	**Malaysia**						
Partner Country	**Singapore**						
Product (i)	**HS040630**						
Year	**TI**	**HTI**	**NTID**	**HMP**	**X_{ms}/X_{mt}**	**X_{ws}/X_{wt}**	**T**
2012	[redacted]				0.65361	2.05E-05	31862.8
2013	-0.5	H_{IL}	P_{IH}	H_{IH}	0.70173	1.84E-05	38047.9
2014	-0.6	H_{VL}	P_{H}	H_{VH}	0.34967	1.91E-05	18348
2015	0.6	H_{VH}	H_{VH}	H_{VL}	0.20317	2.13E-05	9545.5
2016	0.6	H_{VH}	H_{VH}	H_{VL}	0.13903	2.07E-05	6714.4
2017	-0.5	H_{IL}	P_{IH}	H_{IH}	0.18719	2.11E-05	8857.8

Note: Xms = Export Malaysia to Singapore; Xmt = Total Malaysia Export; Xws = World Export to Singapore; Xwt = Total World Export; Mms = Import Malaysia from Singapore; NTID = Net Trade Intensity Direction; HTI = Host Trade Intensity; HMP = Host Market Potential

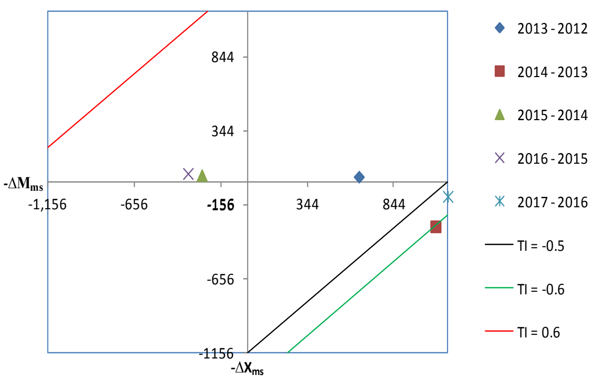

Figure 11: TI between Malaysia and Singapore for HS040630

CONCLUSIONS

The measurement of TI through the simple relationship ratio between ΔX_i and ΔM_i impetus has shown that simple ratio has bias and imbalance characteristics. This leads to disproportionate and asymmetrical result analysis. Nevertheless with the innovative idea produced by equation (16), a proportionate, symmetrical and scale invariant analysis of TI is able to be achieved and applied. The proposed TI index measured within GTISB diagram of a square box has enabled a new way of analysis. In addition, the possible extension of TI index and GTISB into volume and quality base together with doable trade-off mechanism of both is a new frontier of analysis. With that a country market potential in terms of volume and quality perspective are possible to be measured and derived through TI index and GTISB. This proposed measurement does not require the difficulty of choosing suitable base period as the entire time span periods of measurements are encapsulated inside the GTISB. Thus a country market potential across products and tim

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