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Measures of Intra-Industry Trade Reconsidered with Reference to Singapore's Bilateral Trade with Japan and the United States

By

Ramkishen S. Rajan

I. Introduction

To the extent that the differences in overall domestic market sizes and per capita incomes are lower in the case of Singapore and Japan in comparison to Singapore and the United States (Rajan 1995 a: table 16), and given that Singapore and Japan are both East Asian countries with similar confucianist "cultural links" (i.e., following Drysdale and Garnaut 1993, there is relatively less "objective" and "subjective" resistance to their bilateral trade, relative to that between Singapore and the US), drawing on available theoretical literature (see Thorpe 1993: chapter 4 for a review), one would expect a priori that Singapore's bilateral intra-industry trade (IIT) with Japan would exceed that between Singapore and the US. However, computations of Singapore's bilateral IIT with Japan and the United States using the Grubel-Lloyd (G-L) index have shown Singapore-Japan IIT to be consistently and significantly lower than Singapore-US IIT (Chow et al. 1994; Rajan 1995 a: section 6). Nevertheless, these results are not entirely surprising, a number of other studies having also found Japan to be an "outlier" in IIT (see, e.g., Balassa and Noland 1988: chapter 4; Drysdale and Garnaut 1993; Ito 1993: 180; Lincoln 1990; Park and Park 1991; Ravenhill 1993). Indeed, Lincoln (1990: 39) has stated that "(t)he low level of Japan's intra-industry

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trade is a disturbing puzzle." Similarly, Ravenhill (1993: 121) has noted that "the US IIT index ... with other APEC (Asia Pacific Economic Cooperation) countries ... (is) ... substantially higher than that of Japan."

Japan's seemingly low participation in IIT has in turn been used as evidence of its "anti-import bias" (see Takeuchi 1989 for a review). Indeed, insofar as there is the considerable opinion that IIT is inversely correlated with the average level of protection between trading partners (Thorpe 1993: 124–125), there have been suggestions that the above is an indication/outcome of Japan's protectionist policies (Dobson 1993: 21; Lawrence 1987; Lincoln 1990). This has, in turn, provided the impetus for proposals to "pry open" Japan's (supposedly) closed domestic market (Dornbusch 1990; Sazanami 1986). Additionally, insofar as it is commonly believed that IIT (unlike conventional inter-industry trade) has negligible income distributional effects, with "everyone being better off" (Rodrik 1994)[1], this in turn suggests that Japan's seemingly low IIT (as measured by the G-L index) will make liberalization of the Japanese domestic market especially painful, and hence relatively unlikely (Lincoln 1990: 60).

Using latest available data from the Singapore Trade Development Board on Singapore's bilateral trade with Japan and the US, this note argues that much of the above debate regarding Japan's seemingly low IIT is misplaced. This is due mainly to the failure to distinguish between the *level* and *share* of IIT on the one hand, and the "inadequacies" with the G-L index as a measure of even the *share* of IIT on the other.

II. Levels versus Degrees of IIT

While a variety of measures of intra-industry trade (IIT) have been suggested (Greenaway and Milner 1986: chapter 5), the Grubel-Lloyd (G-L) index remains the most commonly used. Following Marvel and Ray (1987: 1281), the G-L index at an "industry" or micro level ($G\text{-}L_i$) can be defined as follows:

$$G\text{-}L_i = [2 \min(X_i, M_i)/(X_i + M_i)] \cdot 100,$$

where: X_i = country's exports of goods in "industry" i
M_i = country's imports of goods in "industry" i.

[1] However, see Rajan (1995b) for a dissenting view.

The G-L index at an aggregate or macro level (G-L) is defined as the weighted average of the G-L indices at the industry level, the weights being based on the share of the industry in overall trade, i.e.:

$$G\text{-}L = \sum \{[(X_i + M_i)/(X + M)] \cdot G\text{-}L_i\},$$

where: $X = \sum X_i$
$M = \sum M_i$.

Though the use of this index is widespread, some authors have argued that, insofar as the G-L index fails to account for aggregate trade imbalances, it consistently biases the actual extent of IIT downwards (see Aquino 1978; Grubel and Lloyd 1975: 22–24; Kol and Mennes 1989; Lincoln 1990: appendix A; Vona 1991). While alternative measures which purport to correct for this bias have been suggested (see Greenaway and Milner 1986: chapters 5 and 6; Kol and Mennes 1989; Vona 1991), none of the measures seem to have gained widespread acceptance in empirical work, the "uncorrected" G-L index generally remaining the "default" measure.

The "inadequacy" of the G-L index in the presence of trade imbalances can be easily illustrated using a highly stylized, yet revealing example (Table 1). We assume a representative one commodity-three country world (countries A, B and C), with the focus being on country A's bilateral trade with the two other countries.

Case 1 is straightforward, in that the level of IIT i.e., 2 min(x, m) is lower in the case of country A's bilateral trade with country B, relative to that between country A and C, as is the turnover $(x + m)$. Accordingly, the original G-L index accurately reflects the level of IIT,

Table 1 – *Country A's Bilateral Trade with Countries B and C*

Country	x	m	$(x+m)$	$(x-m)$	G-L Index
			Case 1		
B	1,000	3,000	4,000	−2,000	50
C	2,500	2,000	4,500	500	89
			Case 2		
B	250	2,000	2,250	−1,750	22
C	1,250	500	1,750	750	57
			Case 3		
B	1,500	3,000	4,500	−1,500	67
C	1,000	750	1,750	250	86

despite the presence of aggregate bilateral trade imbalances. Referring to Case 2, while the turnover of trade between countries A and C is lower than that between A and B, the actual level of IIT is relatively higher in the former. In this instance, the G-L index again provides a suitable measure of the level of IIT despite imbalanced trade at the aggregate level. However in Case 3, while the level of IIT between countries A and B exceeds that between A and C, the G-L index, being biased by the relatively higher trade imbalance in the bilateral trade between the former, shows A and C's IIT to be relatively more intensive. It is in such cases where the G-L index gives a false picture of the level of IIT. In particular, there is a need to distinguish between the *level* and *degree* of IIT, with the G-L index seeming to be equipped to analyze only the latter (albeit in an imperfect manner, as will be discussed in Section III). In similar vein, Greenaway and Milner (1987: 44) have noted that the G-L index "is a measure of the *proportion* of IIT rather than of the *absolute amount* of IIT" (italics added), though the index has been used indiscriminately as a measure of both (see Rajan 1995a: 30).

The importance of the above can be further emphasized by using latest available trade data (first three quarters of 1994) from the Singapore Trade Development Board (TDB). We restrict our focus to Singapore's bilateral manufactured trade (SITC 5–9) with Japan and the United States.[2] Referring to Table A1, it is seen that while the *degree* of aggregate IIT between Singapore and the US (using data at the SITC three-digit category)[3] as measured by the G-L index is 43.6 percent, that between Singapore and Japan is 32.8 percent. However, when actual *levels* of IIT (i.e., $2\sum \min(X_i, M_i)$) are considered (see Table A2), it is found that the aggregate level of IIT in the case of Singapore-US bilateral trade is about $ 13.9 billion and $ 9.0 billion in the case of Singapore and Japan bilateral trade.[4] More interest-

[2] Given that Singapore is a major entrepot center, IIT ought to be calculated for only that part of trade in which there is significant value added. However, unavailability of data on entrepot imports severely hinders the accuracy of such an analysis (see Jaecklin 1992: chapter 3). This, however, is not a major limitation of the present study, since our primary focus here is not on a detailed analysis of bilateral trade linkages (see Rajan 1995a for such a study).

[3] Analysis has been limited to the three-digit SITC level, as timely data for more disaggregated classifications are not available. This apart, Grubel and Lloyd (1975) and Greenaway (1983) have concluded that the three-digit SITC classification is the most appropriate for empirical work. However, see the critique by Rajan (1995b).

[4] Unless otherwise stated, all currency units are in Singapore dollars.

ingly, once trade in SITC 776 (electronic valves), is excluded, the divergence in the levels of IIT drops by almost half.

Further, comparison of the number of product groups in which Singapore's IIT with Japan has exceeded that with the US, shows this to be the case in 83 or about half of the 169 product groups. Following Kol and Mennes (1983: 56), if we consider the number of product groups in which there exists some IIT, i.e., "a 1–0 problem: either it is present (1) or it is not (2)", 162 product groups in the case of Singapore's trade with Japan are involved in IIT, the corresponding figure being 161 in the case of trade with the US.

The above analysis seems to suggest that Japan's participation in IIT at a bilateral level with Singapore is not significantly less than that between Singapore and the US. In other words, Japan is certainly no "anomaly" as far as Singapore's bilateral IIT relations are concerned. This conclusion is at odds with Young (1987: 85), who has noted that "(t)he relatively low degree of intra-industry trade in bilateral trade ... between Japan and Singapore is an interesting fact that remains to be explained." The reason for this divergence in conclusions is that Young's analysis is based solely on IIT as measured by the G-L index, which, as will be further emphasized in the next section, can lead to misleading results.

III. Alternative Measure of the Degree of IIT

Grubel and Lloyd (1975) themselves acknowledged the "downward bias" of their index due to aggregate trade imbalances. This problem is especially acute in the case of Japan, which has enjoyed persistent trade surpluses with major trading partners, including the US and the Asian newly industrializing economies (ANIEs) (see Chou and Shih 1991; Ravenhill 1993: 127).

In the case of Singapore, while the extent of aggregate trade imbalance (i.e., $\{|X - M|/(X + M)\} \cdot 100$) with Japan was 24.0 percent during the period under consideration, that with the US was only 8.9 percent. In fact, part of the reason why Japan's IIT as measured by the G-L index is relatively higher in the first three quarters of 1994 in comparison to the period 1986–1992 (when the index averaged about 23 percent), is due to the fact that the extent of bilateral trade imbalance in recent times has sharply diminished, having averaged 47 percent in the period 1986–1992 (see Rajan 1995a: tables 17 and 18)[5]. This

[5] This apart, there seems to be a definite upward trend in the G-L index value since the early 1980s (Rajan 1995a: table 17; Chow et al. 1994: figure 2). Admittedly, such direct

further illustrates the problem of using the G-L index without any "adjustment" for changes in trade imbalances.

In light of the above, it is imperative that an alternative measure of the *degree* of IIT, which mitigates (if not eradicates) the "trade imbalance problem", be developed. One possibility would be to redefine the index at an industry level (R_i) as follows:

$$R_i = \{[\min(X_i, M_i)/2\,M_i] + [\min(X_i, M_i)/2\,X_i]\} \cdot 100\,.$$

As in the case of the G-L index, the reformulated index at a macro level (R) is:

$$R = \sum\{[(X_i + M_i)/(X + M)] \cdot R_i\}\,.$$

As is obvious, the above reformulated index is the simple average of the level of IIT as a proportion of total exports and imports, as opposed to the G-L index, which, as noted, is computed by taking the level of IIT as a proportion of aggregate trade (i.e., $X + M$). The reformulated index is bounded between 50 and 100, unlike the G-L index which has a range of between 0 and 100. The higher the degree of IIT, the greater the value of the index, and conversely, the lower the degree of IIT, the closer the index is to 50. At the extreme, if trade is completely "matched", i.e., $X_i = M_i$, in this case, both the G-L as well as the reformulated indices $= [\min(X_i, M_i)/X_i] \cdot 100 = [\min(X_i, M_i)/M_i] \cdot 100 = 100$. The one drawback of the index is that when there is no IIT, the index has an infinite value (as one of the divisors equals zero). This problem is however trivial, being easily remedied by manually setting the index equal to zero in such cases. The reformulated index has a very desirable property, in that it ensures that more or less equal weight is given to non-zero IIT regardless of the actual volume of trade. This is done by allowing for a minimum index number of 50 as long as there is non-zero IIT. The reformulated index consequently substantially mitigates the downward bias due to imbalanced trade, a problem that plagues the conventional G-L index. A further advantage of the reformulated index is that unlike the G-L index which is non-linear, it is easily shown that the reformulated index is strictly linear, and consequently more suited for econometric studies (Greenaway and Milner 1986: 63).

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comparisons are, however, not completely appropriate as in Rajan (1995a) I computed IIT for total trade, as opposed to trade in manufactured goods as is the case in this paper.

IV. Singapore-Japan and Singapore-US IIT Recomputed

The reformulated index developed above is used to recompute Singapore's bilateral IIT with Japan and the US for the relevant time period. While the share of Singapore-US IIT is 66.7 percent, that between Singapore and Japan is 61.6 percent. Thus, while the G-L index figures for the Singapore-Japan trade were "artificially" lowered due to "a large excess of exports over imports (rather than the reverse)" (Lincoln 1990: 56), the reformulated index, by mitigating the "trade-imbalance problem," reduces the gap in the shares of IIT quite significantly. The "trade-imbalance" problem is made especially apparent when comparing the results of computations using the G-L index and the reformulated index. In particular, in the case of Singapore-US IIT, the top ten product groups computed using the G-L index remain unchanged even if the reformulated index is used (compare Tables A1 and A3), which in turn is a reflection of the relatively balanced bilateral trade. However, in the case of the Singapore-Japan trade (Tables A1 and A3), it is found that only two product groups overlap, viz. SITC 553 (perfume and cosmetics) and SITC 892 (jewelry). This "lack of correlation" in the results based on the two indices in the case of Singapore's bilateral IIT with Japan in turn reiterates the importance of accounting for the "trade imbalance problem," contrary to the opinions of Greenaway and Milner (1981), Lincoln (1990: appendix A) and Vona (1991).

This apart, comparisons of the top ten product groups with high *levels* of IIT (Table A2) and high *degrees* of IIT as measured by the reformulated index (Table A3), reveal that there is only one product group common to both in the case of Singapore-US trade (viz. SITC 776), and none so in the case of Singapore-Japan trade. This further illustrates the importance of ensuring that any study of participation in IIT consider both the levels as well as shares of IIT.

V. Concluding Observations

This note has emphasized the inadequacy of the conventional G-L index in measuring the degree of IIT due to the "trade imbalance problem" on the one hand, as well as the need to make a distinction between the level and degree of IIT on the other. Using latest data for Singapore's bilateral trade with the US and Japan, it has been argued that conclusions and consequent policy implications based on the G-L index can be grossly incorrect. Specifically, an alternative measure of the degree of IIT has been developed. It has been shown that the newly developed measure equals the G-L index only if trade is exactly balanced. Using the reformulated IIT index which mitigates (though, admittedly, not eliminating) the "problem" of imbalanced bilateral trade between Singapore and Japan, it is found that while the share of IIT in Singapore-Japan bilateral trade still lags behind that between Singapore and the US, the gap is narrower than if the G-L index were used. This, and a consideration of the absolute levels of bilateral IIT, as well as the numbers of industries which experience positive IIT, work in tandem to strongly suggest that Japan's participation in bilateral IIT with Singapore is not significantly different (i.e., lower) than that between Singapore and the US. Insofar as there is clear evidence that Singapore's IIT with Japan has been steadily rising on the one hand, while that with the US has been declining on the other (see Rajan 1995b: section 6; Chow et al. 1994: figure 4), it might be expected that the share (and, quite possibly, even the level) of Singapore-Japan IIT might exceed that between Singapore and the US in the not too distant future. One ought not to be surprised to find broadly similar results in the case of Japan's IIT with the other ANIEs.

This study has further emphasized the need for more careful analyses of Japan's IIT with its trading partners. This is especially so in the case of Japan's trade relations with the US and the European Union (EU), as Japan is often criticized for its low participation in IIT (Lawrence 1993: 24; Lincoln 1990). If Japan's IIT with Singapore is at all a reflection of Japan's IIT with other trading partners, it is hypothesized that once a more "appropriate" and thorough analysis of IIT is undertaken, it might be found that, consistent with the minority viewpoint (see Saxonhouse 1993), Japan is not a nation with a "distinctive" pattern of IIT resulting from its exclusive "belief in one-sided comparative advantage" as suggested by Lincoln (1990: 72), and by implication, Japan's manufactured imports might in reality not be "abnormally low" (Takeuchi 1989: 166). Rather, on the basis of Japan's trade relations with Singapore, Japan's seemingly low IIT as measured by the G-L index (as well as its persistent merchandise trade surpluses) seems attributable to its phenomenal success in penetrating export markets, and is largely a reflection of Japan's "overwhelming comparative advantage in manufacturing" (Saxonhouse 1993: 31).

Appendix

Table A1 – *Product Groups with Ten Highest G-L Index Values between Singapore and Japan and Singapore and the US (percent)*

SITC Code	Index value	Share in total trade	SITC Code	Index value	Share in total trade
	Singapore–Japan			*Singapore–US*	
667	99.9	0.05	655	99.3	0.01
846	99.0	0.03	892	98.8	0.58
892	98.5	0.26	611	97.4	0.02
848	96.8	0.02	971	97.3	0.05
842	94.4	0.02	821	95.1	0.29
911	93.2	0.02	881	93.9	0.21
689	91.9	0.01	894	93.9	0.45
553	90.0	0.20	776	93.8	14.75
752	87.9	8.61	553	93.7	0.40
591	85.1	0.01	662	92.1	0.01
Overall	32.8	100	Overall	43.6	100

Source: Singapore Trade Development Board (1994).

Table A2 – *Product Groups with Ten Highest Levels of IIT between Singapore and Japan and Singapore and US*

SITC Code	Amount ($ million)	Share in total trade %	SITC Code	Amount ($ million)	Share in total trade %
	Singapore–Japan			*Singapore–US*	
752	2,063,504	8.61	776	4,409,260	14.75
776	1,807,440	0.34	752	2,139,988	22.83
764	1,581,526	3.08	759	1,835,108	12.29
759	634,716	7.29	764	621,132	3.64
931	235,368	1.18	931	475,680	2.72
762	233,102	1.12	772	390,844	1.62
771	226,416	1.35	778	337,070	1.87
761	199,674	1.28	741	256,372	0.89
772	174,914	4.37	872	222,778	0.84
885	161,554	0.90	774	211,598	2.06
Overall	8,951,886	100	Overall	13,899,326	100

Source: Same as Table A1.

Table A3 – *Product Groups with Ten Highest Degrees of IIT between Singapore and Japan and Singapore and US (percent)*

SITC Code	Index value	Share in total trade	SITC Code	Index value	Share in total trade
Singapore–Japan			*Singapore–US*		
655	99.3	0.02	655	99.4	0.01
892	98.8	0.26	892	98.8	0.58
611	97.3	0.01	611	97.4	0.02
971	97.2	0.47	971	97.3	0.05
821	95.1	0.24	821	95.4	0.29
894	93.9	0.40	881	94.3	0.21
553	93.7	0.20	894	94.2	0.45
662	92.1	0.04	776	94.2	14.75
741	90.6	0.98	553	94.0	0.40
642	90.0	0.24	662	92.6	0.01
Overall	61.6	100	Overall	66.7	100

Source: Same as Table A1.

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