Has Japan Been ‘Opening-Up’?: Empirical Analytics of Trade Patterns

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Abstract

The US–Japan trade dispute has been widely reported. It continues to threaten the stability of the world trading order because the United States alleges that the Japanese market remains ‘closed’ to its exports. The Clinton administration has made it clear that it will judge the openness of the Japanese market by results. In light of this, this paper examines how the pattern of Japan’s total multilateral trade and trade with the United States has changed between 1981 and 1991. It finds that between 1986 and 1991, more than half of the growth in Japan’s total multilateral trade, and all of the growth in trade with the United States, was a result of intra-industry trade growth. The paper also finds that most of the growth in intra-industry trade is a result of import growth in net export industries. This is the type of trade that the United States has been urging Japan to increase and is consistent with an opening-up of the Japanese market.

Has Japan Been ‘Opening-Up’?: Empirical Analytics of Trade Patterns

Introduction

The recent escalation of the US–Japan trade dispute has been widely reported. The issue under dispute is the ‘closed’ nature of the Japanese market. The Clinton administration has made it clear that it will judge the openness of the Japanese market by results — using quantitative indicators of the success of importers in Japan rather than by Japan’s compliance with international trade rules. With this criterion of ‘openness judged by results’ in mind, previous researchers have examined the extent of Japan’s intra-industry trade as an indicator of ‘openness’ (Balassa 1986; Lawrence 1987, 1991; Lincoln 1990; Lowe 1991; Park and Park 1991; Petri 1991; Ravenhill 1993; Saxonhouse 1986, 1993). The focus on intra-industry trade underlies the recognition that the only way in which Japan can reduce its massive trade surplus with the United States (and some of the other OECD countries) is by increasing its share of intra-industry trade in total trade. This focus also derives from the fact that the US–Japan trade dispute is about the bilateral imbalance in manufactures trade, a category of trade in which intra-industry trade can play an important role. The United States and Japan tend to specialise in, and export, similar manufactured goods. In this context, Japan’s surplus could be reduced
if it reduces its exports (which punitive tariffs and/or yen appreciation might achieve), or
increases its imports (which involves ‘opening’ its markets). In either case, this would be
reflected as an increase in the share of intra-industry trade as measured by the Grubel–Lloyd
index (see Grubel and Lloyd 1975); the modus operandus of all previous studies.

There are a number of problems associated with using the Grubel–Lloyd index as an
indicator of openness. Petri (1991) claims that most of the recent increase in intra-industry trade,
as measured by the Grubel–Lloyd index, is due to declining sectors where segments of their
export activities have been abandoned to foreign producers. Thus the increases in the Grubel–
Lloyd index are misleading in so far as they are used to infer an increase in openness through
increases in imports in net export industries, or increases in intra-industry specialisation. In
other words, an increase in the Grubel–Lloyd index may be due to a decrease in inter-industry
or net trade rather than an increase in intra-industry trade.

Despite the fact that almost all previous studies that have examined intra-industry trade
in Japan have been interested in the contribution of intra-industry trade to the growth in trade,
they have used movements in a share index (the Grubel–Lloyd index) to infer the importance
of intra-industry trade in trade growth. This method can lead to misleading interpretations and,
at best, can give qualitative information only. The Grubel–Lloyd index can record an increase
(decrease) despite intra-industry trade contributing less (more) than net trade to the growth in
trade. This paper develops an analytical framework for decomposing the growth in total trade
into the contributions of growth in intra-industry and net trade. With these contributions
measures, it is possible to provide explicit answers to questions such as: ‘How much of the
growth in trade was a result of growth in intra-industry trade, as opposed to growth in net trade?’.
The contribution measures employed in this study also overcome the problem with the Grubel–
Lloyd index that Petri (1991) refers to because increases in intra-industry trade are distin-
guished from decreases in net trade.

The point that Petri makes highlights a more general problem in inferring underlying trade
patterns from movements in Grubel–Lloyd indexes. To understand the factors that underlie
changes in the roles of intra-industry trade and net trade over time, it is important to come to grips
with the roles played by imports and exports. In the context of Japan’s trade, it would be useful
to separate increases in intra-industry trade that are due to increases in imports from those
caused by increases in exports. To clarify the roles of imports and exports, this study also derives
formulas that measure their contributions to growth in total, intra-industry and net trade. With
these measures, it is possible to provide answers to questions such as: ‘How much of the growth
in intra-industry trade was a result of import growth as opposed to export growth? All the contributions measures in what follows are computed using data at the 3-digit level of the Standard International Trade Classification (SITC) for Japan’s total multilateral trade and trade with the United States for the periods 1981 to 1986 and 1986 to 1991.

The second section of this paper derives the growth contribution measures. The third section discusses data issues; while the fourth section presents the results of the analysis. A final section summarises the major findings.

**Analytical framework**

**Decomposition of total trade growth: contributions of growth in intra-industry and net trade**

Total trade \( TT \) for commodity \( i \) in any year is the sum of intra-industry trade \( IIT \) and net trade \( NT \):

\[
TT_i = IIT_i + NT_i, \quad (1)
\]

where \( TT_i = X_i + M_i \), \( i \)

and \( IIT_i = 2 \cdot \text{minimum}(X_i, M_i) \) \( i \)

\( NT_i = |X_i - M_i| \) \( i \)

\( X_i \) and \( M_i \) are exports and imports of commodity \( i \) valued in base period fob prices.

The percentage growth in total trade of commodity \( i \) \( (tt_i) \) over any period is given by

\[
tt_i = Cnt_i + Cii_i, \quad (5)
\]

where \( Cnt_i = (1 - GL_i) nt_i \), \( i \)

\( Cii_i = GL_i iit_i \), \( i \)

\( GL_i = IIT_i / TT_i \) \( i \)

\( iit_i \) and \( nt_i \) are the percentage changes over the period in \( IIT_i \) and \( NT_i \). Note that

\[
GL_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)}, \quad (9)
\]

which is the Grubel–Lloyd index of intra-industry trade at the beginning of the period. Under the assumption that \( iit_i \) is determined independently of \( nt_i \), \( Cii_i \) is the contribution to growth in total trade of growth in intra-industry trade, while \( Cnt_i \) is the contribution of growth in net trade.
In the introductory section, reference was made to Petri’s (1991) claim that recent increases in the Grubel–Lloyd index may be due to decreases in exports in net export industries — that is, that the increase in the Grubel–Lloyd index may be a result of a decrease in net trade rather than an increase in intra-industry trade. To see how this works, we use equations (3) and (8) to write the Grubel–Lloyd index for net export industry \( i \) as

\[
GL_i = \frac{2M_i}{X_i + M_i},
\]

or

\[
GL_i = \frac{2}{1 + \left(\frac{X_i}{M_i}\right)}.
\]

From (11), we can see that \( GL_i \) will increase whenever

\[
m_i > x_i,
\]

where \( m_i \) and \( x_i \) are growth rates over the period in \( M_i \) and \( X_i \).

The case that Petri highlights occurs in net export industries and only when total trade growth is negative. That is,

If

\[
m_i > x_i
\]

and

\[
m_i > 0,
\]

for

\[
X_i > M_i,
\]

then

\[
\Delta GL_i > 0
\]

despite

\[
\text{ii}_i
\]

Equations (13) to (17) imply that during periods of negative growth in trade, the Grubel–Lloyd index will increase as long as the percentage decrease in net trade is greater than the percentage decrease in intra-industry trade.\(^8\) With this study’s contribution measures, however, reductions in net trade and/or intra-industry trade make (or are measured as) independent negative contributions to the growth in trade.

How reliable are movements in the value of Grubel–Lloyd indexes during periods of positive trade growth? In answering this question, we start from the general rule that the Grubel–Lloyd index for industry \( i \) (\( GL_i \)) will increase over a period whenever \( \text{ii}_i > nt_i \). However, even under this condition, growth in \( \text{ii}_i \) may make a relatively minor contribution to growth in total trade of product \( i \). More formally,

\[
\text{ii}_i > nt_i
\]

implies

\[
\Delta GL_i > 0.
\]

But if

\[
GL_i < nt_i / (nt_i + \text{ii}_i),
\]

and

\[
\text{ii}_i + nt_i > 0,
\]
then $C_{iit} < C_{nt}$. \(^9\) (22a)

Similarly, $nt_i > iit_i$. \(^9\) (18a)

implies $GL_i < 0$. \(^9\) (19a)

But if $GL_i > nt_i / (nt_i + iit_i)$ \(^9\) (20a)

and $iit_i + nt_i > 0$, \(^9\) (21a)

then $C_{nt_i} < C_{iit_i}$. \(^9\) (22a)

These propositions show that movements in the Grubel–Lloyd index might prove misleading when used to infer the importance of growth in intra-industry trade during periods of positive trade growth as well. Our contribution measures ($C_{iit_i}$ and $C_{nt_i}$) overcome these problems by taking into account not only growth rates in intra-industry and net trade but also of their shares in total trade.

**Decomposition of total, net and intra-industry trade: contributions of imports and exports**

In this subsection, growth in total, net and intra-industry trade is decomposed into the contributions of imports and exports. These contribution measures make it possible to identify the changes in imports and exports that underlie the growth in total, net and intra-industry trade.

Starting from equation (2), we find that

$$nt_i = C_{mmt_t} + C_{xtt_t},$$ \(^9\) (23)

where

$$C_{mmt_t} = \left( \frac{M_i}{TT_i} \right) m_i,$$ \(^9\) (24)

$$C_{xtt_t} = \left( \frac{X_i}{TT_i} \right) x_i.$$ \(^9\) (25)

Assuming independent determination of $m_i$ and $x_i$, $C_{mmt_t}$ and $C_{xtt_t}$ are the contributions of import and export growth to growth in total trade in good $i$.

Next we decompose $iit_i$ and $nt_i$ into the contributions of import and export growth. Equations (3) and (4) show that

$$iit_i = C_{miiit} + C_{xiit},$$ \(^9\) (26)

and

$$nt_i = C_{mnt} + C_{xnt},$$ \(^9\) (27)
where the contributions of import and export growth to the growth in \( IIT_i \) and \( NT_i \) are calculated as

\[
C_{miit} = m_p, \quad (28)
\]

\[
C_{xiit} = (1 - \delta_i) x_i, \quad (29)
\]

\[
C_{mnt} = (M_i / (M_i - X_i)) m_p, \quad (30)
\]

and

\[
C_{xnt} = (X_i / (X_i - M_i)) x_i. \quad (31)
\]

\( \delta_i \) is 1 if \( X_i > M_i \) and zero if \( X_i < M_i \). (We assume that \( M_i \) is not precisely equal to \( X_i \).) Equations (26), (28) and (29) reflect the fact that the growth in imports determines growth in intra-industry trade for net export products, while the growth in exports accounts for the growth in intra-industry trade for net import products. Equations (27), (30) and (31) imply that both growth in imports and reductions in exports make positive contributions to net trade for net import products. Similarly, they make negative contributions to net trade for net export products. This information is summarised in Table 1.

### Table 1  Relationship between industry status and import and export contributions to the growth in total, intra-industry and net trade

<table>
<thead>
<tr>
<th></th>
<th>( C_{mtt} )</th>
<th>( C_{xtt} )</th>
<th>( C_{miit} )</th>
<th>( C_{xiit} )</th>
<th>( C_{mnt} )</th>
<th>( C_{xnt} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net import industry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imports</td>
<td>( \uparrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
</tr>
<tr>
<td>Exports</td>
<td>( \uparrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
</tr>
<tr>
<td><strong>Net export industry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imports</td>
<td>( \uparrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
</tr>
<tr>
<td>Exports</td>
<td>( \uparrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
</tr>
</tbody>
</table>

*Note:* The upward pointing arrow (\( \uparrow \)) symbolises an increase, while the downward pointing arrow (\( \downarrow \)) symbolises a decrease. The dash (\( \cdot \)) symbolises 'no effect'.

6
Data

Previous studies on intra-industry trade in Japan have used data disaggregated at the 3-digit level of the SITC or higher. For comparability, and to focus on the effect of our methodology on the measurement of intra-industry trade, this study also uses 3-digit SITC data. Furthermore, as mentioned in the introduction, the interest here is in intra-industry trade as an indicator of openness. With respect to the US–Japan trade dispute in particular, our focus is on the extent of intra-industry trade in controversial industries such as cars and car parts. Disaggregation at the 3-digit level of the SITC has been found to be sufficiently fine to treat cars (SITC 781) and car parts (SITC 874) as separate industries. Other products that have been the subject of trade disputes such as telecommunications equipment (SITC 764), medical equipment (SITC 774) and photographic equipment (SITC 881) are also treated as separate industries at this level of disaggregation.

At the 3-digit level, this study used data from the United Nations’ COMTRADE database covering 133 manufacturing industries for Japan’s total multilateral trade and 132 industries for trade with the United States. The definition of manufacturing employed here covers industries belonging to SITC 5–8 less 67–68 (metals). These data are in current prices and denominated in US dollars. Since the contribution measures in this study are based on share-weighted growth rates, what is needed are data measured in constant prices in order to remove the effects of currency or price changes. Consequently, two transformations were applied to the COMTRADE data. First, the data was converted into yen using the yen–US dollar average annual exchange rate indexes in the IMF’s International Financial Statistics. Then the data were deflated using yen import and export price indexes from the Bank of Japan’s Price Indexes Annual. The data relate to the calendar years 1981, 1986 and 1991.

It was noted in the second section of this paper that our measures of the contributions of growth in intra-industry and net trade to the growth in total trade are valid only if growth rates in intra-industry trade are largely uncorrelated with growth rates in net trade. This is found to be true for the Japanese data used in this study. Similarly, the measures of the contribution of growth in imports and exports to the growth in total, net and intra-industry trade employed in this study are valid only if growth rates in imports are largely uncorrelated with growth rates in exports. Again, this is found to be the case for the Japanese data. The second section of the paper also showed that our decomposition of growth in intra-industry and net trade into the contributions of growth in imports and exports are valid only in the absence of status-switches. Status-switches are very rare with the Japanese data.
Results

Tables 2 and 3 aggregate the results for the 3-digit manufacturing industries into three sectoral classifications: SITC 1-digit groupings, a grouping based on trade status (namely, net import or net export) and total manufacturing. The aggregation formulas are in the notes at the bottom of the tables. Tables 2a and 2b report the contribution measures for total multilateral trade, while Tables 3a and 3b contain similar results for trade with the United States. Tables 2c and 3c report 'scaled' or trade-weighted averages of the contribution measures. With these trade-weighted measures, it is possible to identify the contribution of each sector in determining the results at the total manufacturing or aggregate level. In all cases, two time periods are considered: 1981 to 1986 and 1986 to 1991.

Total multilateral trade

1981 to 1986

First for consideration is total manufacturing. Total trade grew by 42.67 per cent, with intra-industry trade growth contributing 10.25 per cent and net trade growth contributing the remaining 32.42 per cent. Growth in net trade clearly dominates the growth in total trade during this period. Where does this growth in net trade emanate from? Table 2a shows that the 42.92 per cent growth in net trade is a result of strong export growth in net export industries. The growth in intra-industry trade, on the other hand, is due predominantly to import growth in net export industries. In fact, this growth in imports accounts for 85 per cent (37.32 out of 43.72) of the growth in intra-industry trade. How much of the contribution of growth in intra-industry trade to total trade growth of 10.25 per cent is due to export growth as opposed to import growth? Table 2c shows that net import industries account for about 15 per cent (1.48 out of 10.25), while net export industries account for the remaining 85 per cent (8.77 out of 10.25). Since export (import) growth accounts for all the growth in intra-industry trade in net export (net import) industries, it is possible to conclude that only 15 per cent of the contribution of growth in intra-industry trade to total trade growth was a result of export growth, while the remaining 85 per cent was a result of import growth.

At the sectoral level, Table 2a shows that intra-industry trade growth contributes more than net trade growth to the growth in total trade in the chemicals and materials sectors. Table 2c indicates that intra-industry trade growth in the chemicals sector makes the largest contribution (35 per cent) to the growth in intra-industry trade at the aggregate level (that is, total
### Table 2a Total multilateral trade: contributions measures and Grubel–Lloyd indexes, 1981 to 1986

<table>
<thead>
<tr>
<th>Product description</th>
<th>( tt(j) )</th>
<th>( C_{\text{tt}}(j) )</th>
<th>( C_{\text{nt}}(j) )</th>
<th>( GL(j) _81 )</th>
<th>( GL(j) _86 )</th>
<th>( C_{\text{mtt}}(j) )</th>
<th>( C_{\text{xtt}}(j) )</th>
<th>( C_{\text{iit}}(j) )</th>
<th>( C_{\text{mnt}}(j) )</th>
<th>( C_{\text{xnt}}(j) )</th>
<th>( nt(j) )</th>
<th>( C_{\text{mm}}(j) )</th>
<th>( C_{\text{mn}}(j) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITC 5 Chemicals</td>
<td>64.73</td>
<td>43.35</td>
<td>21.39</td>
<td>0.66</td>
<td>0.66</td>
<td>34.59</td>
<td>30.14</td>
<td>75.51</td>
<td>49.90</td>
<td>25.60</td>
<td>60.12</td>
<td>12.23</td>
<td>47.89</td>
</tr>
<tr>
<td>SITC 6 Materials</td>
<td>16.03</td>
<td>14.49</td>
<td>1.54</td>
<td>0.32</td>
<td>0.40</td>
<td>12.42</td>
<td>3.61</td>
<td>46.52</td>
<td>44.33</td>
<td>2.20</td>
<td>2.58</td>
<td>4.42</td>
<td>7.00</td>
</tr>
<tr>
<td>SITC 7 Machinery, transport equip.</td>
<td>41.97</td>
<td>3.39</td>
<td>38.58</td>
<td>0.14</td>
<td>0.13</td>
<td>2.15</td>
<td>39.82</td>
<td>23.56</td>
<td>23.15</td>
<td>0.41</td>
<td>45.06</td>
<td>1.38</td>
<td>46.44</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>60.20</td>
<td>20.66</td>
<td>39.54</td>
<td>0.43</td>
<td>0.40</td>
<td>18.86</td>
<td>41.34</td>
<td>49.82</td>
<td>47.13</td>
<td>2.69</td>
<td>68.90</td>
<td>1.63</td>
<td>70.53</td>
</tr>
<tr>
<td>Net import industries</td>
<td>52.24</td>
<td>18.78</td>
<td>33.46</td>
<td>0.47</td>
<td>0.46</td>
<td>42.85</td>
<td>9.39</td>
<td>39.61</td>
<td>0.00</td>
<td>39.61</td>
<td>63.61</td>
<td>81.46</td>
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<td>Net export industries</td>
<td>42.31</td>
<td>9.55</td>
<td>32.76</td>
<td>0.21</td>
<td>0.21</td>
<td>4.78</td>
<td>37.54</td>
<td>44.51</td>
<td>44.51</td>
<td>0.00</td>
<td>41.71</td>
<td>6.08</td>
<td>47.79</td>
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<tr>
<td>Total manufacturing</td>
<td>42.67</td>
<td>10.25</td>
<td>32.42</td>
<td>0.24</td>
<td>0.24</td>
<td>8.21</td>
<td>34.47</td>
<td>43.72</td>
<td>37.32</td>
<td>6.40</td>
<td>42.92</td>
<td>1.25</td>
<td>44.16</td>
</tr>
</tbody>
</table>

### Table 2b Total multilateral trade: contributions measures and Grubel–Lloyd indexes, 1986 to 1991

<table>
<thead>
<tr>
<th>Product description</th>
<th>( tt(j) )</th>
<th>( C_{\text{tt}}(j) )</th>
<th>( C_{\text{nt}}(j) )</th>
<th>( GL(j) _86 )</th>
<th>( GL(j) _91 )</th>
<th>( C_{\text{mtt}}(j) )</th>
<th>( C_{\text{xtt}}(j) )</th>
<th>( C_{\text{iit}}(j) )</th>
<th>( C_{\text{mnt}}(j) )</th>
<th>( C_{\text{xnt}}(j) )</th>
<th>( nt(j) )</th>
<th>( C_{\text{mm}}(j) )</th>
<th>( C_{\text{mn}}(j) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITC 5 Chemicals</td>
<td>53.23</td>
<td>38.14</td>
<td>15.08</td>
<td>0.66</td>
<td>0.68</td>
<td>26.04</td>
<td>27.19</td>
<td>61.32</td>
<td>34.16</td>
<td>27.17</td>
<td>41.26</td>
<td>15.13</td>
<td>26.13</td>
</tr>
<tr>
<td>SITC 6 Materials</td>
<td>24.64</td>
<td>14.89</td>
<td>9.75</td>
<td>0.40</td>
<td>0.44</td>
<td>17.28</td>
<td>7.36</td>
<td>36.07</td>
<td>33.98</td>
<td>2.09</td>
<td>16.85</td>
<td>5.55</td>
<td>11.30</td>
</tr>
<tr>
<td>SITC 7 Machinery, transport equip.</td>
<td>53.62</td>
<td>26.76</td>
<td>26.85</td>
<td>0.13</td>
<td>0.26</td>
<td>14.00</td>
<td>39.62</td>
<td>213.73</td>
<td>207.86</td>
<td>5.87</td>
<td>30.70</td>
<td>13.75</td>
<td>44.45</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>66.64</td>
<td>23.43</td>
<td>43.21</td>
<td>0.46</td>
<td>0.42</td>
<td>54.92</td>
<td>11.72</td>
<td>51.16</td>
<td>0.00</td>
<td>51.16</td>
<td>79.72</td>
<td>101.34</td>
<td>15.12</td>
</tr>
<tr>
<td>Net import industries</td>
<td>45.22</td>
<td>24.18</td>
<td>21.04</td>
<td>0.21</td>
<td>0.31</td>
<td>12.09</td>
<td>33.13</td>
<td>114.54</td>
<td>114.54</td>
<td>0.00</td>
<td>26.67</td>
<td>15.33</td>
<td>41.99</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>47.04</td>
<td>24.00</td>
<td>23.03</td>
<td>0.24</td>
<td>0.33</td>
<td>16.16</td>
<td>30.87</td>
<td>102.93</td>
<td>93.55</td>
<td>9.38</td>
<td>30.19</td>
<td>7.59</td>
<td>37.77</td>
</tr>
</tbody>
</table>

**Note:** In all the formulas below, the \( s(j) \)’s are sets of products, where \( j \in \{ \text{SITC 5, 6, 7, 8, NM, NX, TM} \} \). (Note that \( NM = \) net import industries, \( NX = \) net export industries, and \( TM = \) total manufacturing). To obtain these sectoral aggregates, we begin by defining the following:

\[
TT(j) = \sum_{i \in s(j)} TT_i \quad \text{(1)}
\]

\[
C_{\text{nt}}(j) = (1 - GL(j)) nt(j) \quad \text{(8)}
\]

\[
NT(j) = \sum_{i \in s(j)} NT_i \quad \text{(2)}
\]

\[
C_{\text{iit}}(j) = GL(j) ii(j) \quad \text{(9)}
\]

\[
IIT(j) = \sum_{i \in s(j)} IIT_i \quad \text{(3)}
\]

\[
C_{\text{mm}}(j) = \sum_{i \in s(j)} C_{\text{mnt}}(iIT(j)) \quad \text{(10)}
\]

\[
GL(j) = \sum_{i \in s(j)} GL_i (TT_i / TT(j)) \quad \text{(4)}
\]

\[
C_{\text{mn}}(j) = \sum_{i \in s(j)} C_{\text{xnt}}(iIT(j)) \quad \text{(11)}
\]

Using equations (1) to (4) above, we obtain:

\[
tt(j) = \sum_{i \in s(j)} tt_i (TT_i / TT(j)) \quad \text{(5)}
\]

\[
xnt(j) = \sum_{i \in s(j)} xnt_i (NT_i / NT(j)) \quad \text{(13)}
\]

\[
iit(j) = \sum_{i \in s(j)} iit_i (iIT(j) / IIT(j)) \quad \text{(7)}
\]

\[
C_{\text{mm}}(j) = \sum_{i \in s(j)} C_{\text{xnt}}(iIT(j)) \quad \text{(15)}
\]
Table 2c  Total multilateral trade: ‘scaled’ contributions, 1981 to 1986 and 1986 to 1991

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tt'(j)</td>
<td>Cnt'(j)</td>
</tr>
<tr>
<td>SITC 5 Chemicals</td>
<td>5.42</td>
<td>3.63</td>
</tr>
<tr>
<td>SITC 6 Material</td>
<td>2.09</td>
<td>1.89</td>
</tr>
<tr>
<td>SITC 7 Machinery</td>
<td>27.96</td>
<td>2.26</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>7.20</td>
<td>2.47</td>
</tr>
<tr>
<td>Net import industries</td>
<td>4.13</td>
<td>1.48</td>
</tr>
<tr>
<td>Net export industries</td>
<td>42.67</td>
<td>10.25</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>46.07</td>
<td>12.72</td>
</tr>
</tbody>
</table>

Note: Using the information in the notes to Tables 2a and 2b, and noting that TT(TM) is total trade in total manufacturing, we define the following:

\[ tt'(j) = \sum_{i \in s(j)} tti \left( TTI / TT(TM) \right) \]  
\[ Cnt'(j) = \sum_{i \in s(j)} C_{nti} \left( TTI / TT(TM) \right) \]  
\[ Cnt'(j) = \sum_{i \in s(j)} C_{nti} \left( TTI / TT(TM) \right) \]

manufacturing). Table 2c also reveals that the dominant contribution of net trade growth to the growth in total trade at the aggregate level is due to trade in the machinery and transport equipment sector. Almost 80 per cent (25.70 out of 32.42) of the contribution of growth in net trade to the growth in total trade of total manufacturing is due to trade in machinery and transport equipment.

1986 to 1991

In the second period (Table 2b), intra-industry trade growth contributes just above half the growth in total trade of total manufacturing. Most of the rapid growth in intra-industry trade during this period was due to import growth in net export industries. This growth in imports in net export industries has the effect of reducing the growth in net trade by reducing Cmnt. As in the previous period, all the growth in net trade is due to export growth in net export industries.17

At the sectoral level, the most significant change in this period is the increase in the importance of intra-industry trade growth in the machinery and transport equipment sector. Growth in intra-industry and net trade now contribute almost equal amounts to the growth in total trade in this sector. Table 2c shows that this sector accounts for almost 75 per cent (17.74 out of 24.00) of the contribution of intra-industry trade growth to the growth in total trade at the aggregate level.
Table 3a  Trade with the United States: contribution measures and Grubel–Lloyd indexes, 1981 to 1986

<table>
<thead>
<tr>
<th>Product description</th>
<th>( tt(j) )</th>
<th>( C_l(j) )</th>
<th>( C_n(j) )</th>
<th>( GL(j)_{(81)} )</th>
<th>( GL(j)_{(86)} )</th>
<th>( C_m(j) )</th>
<th>( C_x(j) )</th>
<th>( n_t(j) )</th>
<th>( C_mnt(j) )</th>
<th>( C_xt(j) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITC 5 Chemicals</td>
<td>119.37</td>
<td>48.97</td>
<td>70.40</td>
<td>0.50</td>
<td>0.45</td>
<td>92.34</td>
<td>27.02</td>
<td>87.74</td>
<td>1.36</td>
<td>86.38</td>
</tr>
<tr>
<td>SITC 6 Materials</td>
<td>60.95</td>
<td>32.83</td>
<td>28.12</td>
<td>0.33</td>
<td>0.41</td>
<td>24.03</td>
<td>36.92</td>
<td>111.71</td>
<td>80.39</td>
<td>31.32</td>
</tr>
<tr>
<td>SITC 7 Machinery, transport equip.</td>
<td>126.80</td>
<td>13.98</td>
<td>112.82</td>
<td>0.20</td>
<td>0.15</td>
<td>8.23</td>
<td>118.57</td>
<td>51.54</td>
<td>49.73</td>
<td>1.82</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>106.10</td>
<td>49.99</td>
<td>56.11</td>
<td>0.48</td>
<td>0.48</td>
<td>29.80</td>
<td>76.30</td>
<td>99.78</td>
<td>57.24</td>
<td>42.54</td>
</tr>
<tr>
<td>Net import industries</td>
<td>102.02</td>
<td>43.30</td>
<td>58.72</td>
<td>0.39</td>
<td>0.42</td>
<td>80.37</td>
<td>21.65</td>
<td>111.04</td>
<td>0.00</td>
<td>111.04</td>
</tr>
<tr>
<td>Net export industries</td>
<td>112.51</td>
<td>13.12</td>
<td>99.39</td>
<td>0.21</td>
<td>0.18</td>
<td>6.56</td>
<td>105.95</td>
<td>62.31</td>
<td>62.31</td>
<td>0.00</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>118.19</td>
<td>22.79</td>
<td>95.40</td>
<td>0.27</td>
<td>0.23</td>
<td>19.20</td>
<td>98.99</td>
<td>74.53</td>
<td>46.86</td>
<td>122.26</td>
</tr>
</tbody>
</table>

Table 3b  Trade with the United States: contribution measures and Grubel–Lloyd indexes, 1986 to 1991

<table>
<thead>
<tr>
<th>Product description</th>
<th>( tt(j) )</th>
<th>( C_l(j) )</th>
<th>( C_n(j) )</th>
<th>( GL(j)_{(86)} )</th>
<th>( GL(j)_{(91)} )</th>
<th>( C_m(j) )</th>
<th>( C_x(j) )</th>
<th>( n_t(j) )</th>
<th>( C_mnt(j) )</th>
<th>( C_xt(j) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITC 5 Chemicals</td>
<td>44.31</td>
<td>18.88</td>
<td>27.43</td>
<td>0.45</td>
<td>0.43</td>
<td>36.37</td>
<td>7.93</td>
<td>40.49</td>
<td>1.58</td>
<td>38.91</td>
</tr>
<tr>
<td>SITC 6 Materials</td>
<td>3.17</td>
<td>13.80</td>
<td>10.63</td>
<td>0.41</td>
<td>0.53</td>
<td>10.61</td>
<td>7.43</td>
<td>39.02</td>
<td>39.87</td>
<td>0.86</td>
</tr>
<tr>
<td>SITC 7 Machinery, transport equip.</td>
<td>27.49</td>
<td>33.14</td>
<td>5.65</td>
<td>0.15</td>
<td>0.38</td>
<td>18.25</td>
<td>9.24</td>
<td>230.43</td>
<td>223.98</td>
<td>6.45</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>3.68</td>
<td>10.30</td>
<td>13.98</td>
<td>0.48</td>
<td>0.60</td>
<td>5.35</td>
<td>9.03</td>
<td>18.56</td>
<td>5.91</td>
<td>12.65</td>
</tr>
<tr>
<td>Net import industries</td>
<td>39.37</td>
<td>18.00</td>
<td>21.37</td>
<td>0.42</td>
<td>0.43</td>
<td>30.37</td>
<td>9.00</td>
<td>43.23</td>
<td>0.00</td>
<td>43.23</td>
</tr>
<tr>
<td>Net export industries</td>
<td>21.06</td>
<td>29.58</td>
<td>8.52</td>
<td>0.18</td>
<td>0.39</td>
<td>14.79</td>
<td>6.27</td>
<td>168.12</td>
<td>168.12</td>
<td>0.00</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>23.90</td>
<td>28.00</td>
<td>4.10</td>
<td>0.23</td>
<td>0.41</td>
<td>17.86</td>
<td>6.04</td>
<td>132.75</td>
<td>120.51</td>
<td>12.24</td>
</tr>
</tbody>
</table>

Note: The aggregation formulas are the same as for total multilateral trade. See notes to Tables 2a and 2b.
### Table 3c  Trade with Japan: ‘scaled’ contributions, 1981 to 1986 and 1986 to 1991

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$t'(j)$</td>
<td>$Clt'(j)$</td>
</tr>
<tr>
<td>SITC 5 Chemicals</td>
<td>10.05</td>
<td>4.12</td>
</tr>
<tr>
<td>SITC 6 Material</td>
<td>5.11</td>
<td>2.75</td>
</tr>
<tr>
<td>SITC 7 Machinery</td>
<td>90.40</td>
<td>9.97</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>12.63</td>
<td>5.95</td>
</tr>
<tr>
<td>Net import industries</td>
<td>14.79</td>
<td>6.28</td>
</tr>
<tr>
<td>Net export industries</td>
<td>103.40</td>
<td>16.51</td>
</tr>
<tr>
<td>Total Manufacturing</td>
<td>118.19</td>
<td>22.79</td>
</tr>
</tbody>
</table>

*Note:* The aggregation formulas are the same as for total multilateral trade. See note to Table 2c.

### Table 4  Relationship between Grubel–Lloyd indexes and contribution measures

<table>
<thead>
<tr>
<th></th>
<th>Total multilateral trade</th>
<th>Trade with United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta GL_i &gt; 0$, $\text{ii}_i \leq 0$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net export industries</td>
<td>21</td>
<td>39</td>
</tr>
<tr>
<td>Net import industries</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>24</td>
<td>45</td>
</tr>
<tr>
<td>$\Delta GL_i &lt; 0$, $\text{Cii}_i &gt; Cnt_i$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITC 5 Chemicals</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>SITC 6 Materials</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SITC 7 Machinery</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>$\Delta GL_i &gt; 0$, $Cnt_i &gt; Cii_i$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITC 5 Chemicals</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>SITC 6 Materials</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>SITC 7 Machinery</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>SITC 8 Miscellaneous</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>CORR ($\Delta GL_i$, $Cii_i$)</td>
<td>0.35</td>
<td>0.49</td>
</tr>
</tbody>
</table>

*Note:* Except for the last row, the figures reported in the table refer to the number of industries. In the last row, the numbers are correlation (CORR) coefficients.
Trade with the United States
1981 to 1986

Total trade in total manufacturing grew very sharply during this period, reaching almost 120 per cent. More than 80 per cent of this growth was a result of growth in net trade. Export growth also contributed to more than 80 per cent of the growth in total trade. The fact that almost all of this growth in exports emanated from net export industries explains the dominant contribution of net trade growth to growth in total trade. Therein lie the roots of the current trade dispute with the United States. At the sectoral level, intra-industry trade growth contributes more than net trade growth to the growth in total trade only in the case of materials. Despite this, however, we find from Table 3c that, on a trade-weighted basis, intra-industry trade growth in materials makes the smallest contribution to the growth in intra-industry trade at the aggregate level. The growth in net trade in the machinery and transport equipment sector accounts for almost 85 per cent of the growth in net trade at the aggregate level.

1986 to 1991

Unlike the first period, total trade growth in total manufacturing in the second period was relatively subdued at 23.90 per cent. All of this growth in total trade was due to growth in intra-industry trade; the contribution of growth in net trade is negative. More than 90 per cent of the rapid growth in intra-industry trade during this period was a result of import growth in net export industries, while the remainder is accounted for by export growth in net import industries. Table 3c shows that more than 90 per cent (25.52 out of 28.00) of the contribution of intra-industry trade growth to total trade growth in total manufacturing is a result of import growth in net export industries. Thus, it would appear that almost all the growth in both intra-industry trade and total trade during this period is of the type that the United States has been urging Japan to engage in. It is also of the type that the United States claims has not been taking place in Japan because of the ‘closed’ nature of Japanese markets. Perhaps total trade growth (driven by import growth in net export industries) is insufficiently rapid at 23.90 per cent, given the very rapid growth in total trade (driven mainly by export growth in net export industries) in the first period. Nevertheless, the total trade growth that has taken place during this period is almost completely of the variety that suggests (slow but certain) opening-up of the Japanese market.
The second section of this paper showed, as a theoretical possibility, that movements in the Grubel–Lloyd index could be misleading when used as an indicator of openness or to infer the intra-industry trade contribution to trade growth. Table 4 shows that this possibility is realised quite often at the empirical level. First we consider Petri’s (1991) claim that recent increases in Japan’s intra-industry trade (as measured by the Grubel–Lloyd index) are due largely to decreases in exports in net export industries. In the second period, this occurs in 39 out of the 97 net export industries for total multilateral trade, and 49 out of the 92 net export industries for trade with the United States. Thus it would appear that Petri is right, and using the Grubel–Lloyd index as an indicator of openness would be misleading. Next we consider the reliability of using movements in the Grubel–Lloyd index to infer the intra-industry trade contribution to trade growth. It is clear from Table 4 that in quite a number of industries, the Grubel–Lloyd index increases despite growth in net trade contributing more to the growth in total trade than intra-industry trade growth. The correlation coefficient between changes in GL, and $C_{it}$, is less than 0.5 in all cases, lending further weight to the proposition that movements in the Grubel–Lloyd index are an unreliable indicator of the growth contribution of intra-industry trade.19

Conclusion

The US–Japan trade dispute continues to threaten the stability of the world trading order because the United States alleges that the Japanese market remains ‘closed’ to its exports. The Clinton administration has made it clear that it will judge the openness of the Japanese market by results — quantitative indicators of importers’ success in Japan — rather than by Japan’s compliance with international trade rules. In assessing the ‘openness’ of the Japanese market, previous researchers have inevitably examined the extent of Japan’s intra-industry trade as one indicator of ‘openness’. The method used, however, has been second-best to say the least, with movements in a share index used to infer the importance of intra-industry trade in trade growth. This method can lead to misleading interpretations and, at best, can give qualitative information only. This paper uses a growth decomposition formula that measures the contributions of growth in intra-industry and net trade to the growth in total trade. The study measures the contributions of growth in imports and exports to the growth in total, net and intra-industry trade. The study finds that between 1986 and 1991, more than half of the growth in Japan’s total
multilateral trade, and all of the growth in trade with the United States, was a result of intra-
industry trade growth. The study also finds that most of the growth in intra-industry trade is a
result of import growth in net export industries. This is the type of trade that the United States
has been urging Japan to increase, and is consistent with an opening-up of the Japanese market.
While this is the right type of trade growth, the continuing dispute with the United States is due
to the fact that the volume is still relatively low. It would appear that an increase in the volume
of this type of trade is still required to appease the United States.
Notes

* I wish to thank Prema-Chandra Athukorala, Peter Dixon, Takatoshi Ito and an anonymous referee for comments. I retain full responsibility for any errors, however. An earlier and shorter version of this paper is forthcoming as Menon (1996b).

Reported in ‘Trade by numbers’, The Economist, 21 May 1994, p. 84. See also Advisory Committee on Trade Negotiations (1993).

2 Balassa (1986) and Lowe (1991) find that the degree of intra-industry trade is strongly positively correlated with measures of openness in a cross-country setting.

3 The apparent low levels of intra-industry trade in many export industries in which Japan has been most successful intensifies the costs of adjustment for its trading partners, and renders Japan vulnerable to accusations that it engages in ‘adversarial trade’, meaning that it sets out to systematically destroy the industries of its competitors (Drucker 1987). These apparent low levels of intra-industry trade may also deprive Japan of potential allies in foreign markets who might otherwise oppose protectionist measures against Japanese exports (Ravenhill, 1993). The relatively muted response of the world trading community to various threats by the United States, such as Super 301 or the more recent warning to slap a 100 per cent tariff on Japanese luxury cars unless Japan increases its imports of US cars, might be examples of the ‘cold-shoulder’ treatment that Japan is receiving from its other trading partners.

4 In 1994, for instance, the volume of Japan’s manufactured exports was three times greater than Japan imported from the United States, with a manufactures trade surplus of US$77 billion. In terms of total merchandise trade, the ratio of its exports to imports was much lower at 1.875, or a total trade surplus of US$55 billion. The difference between its manufactures and total trade surplus is due predominantly to a trade deficit in agricultural goods of about US$20 billion.

5 For a discussion of how the yen appreciation has affected Japanese exporters, see, for instance, Petri (1991), Ravenhill (1993) and Athukorala and Menon (1994).

6 Using this method, Saxonhouse (1993, p. 25), for instance, claims that ‘[t]he role of intra-industry trade in Japan’s overall trade is growing more rapidly than the role of such trade in any of the other advanced industrialised countries’. This conclusion is based on the observation that ‘[n]ot only is the gap [in the Grubel–Lloyd index] between Japan and these other [industrialised] economies narrower than is generally believed, the gap in manufacturing trade is closing at a rapid pace’. If a growth index rather than movements in a share index had been used for this purpose, then the somewhat ambiguous references to ‘gaps’ and the pace at which they are closing could be avoided and replaced with a precise measure of the role of intra-industry trade in total trade growth. Furthermore, as shown in the next section of this paper, comparison of movements in the value of the Grubel–Lloyd index can lead to error.
An alternative and widely-used measure of ‘openness’ which meets the Clinton administration’s ‘results criterion’ is the import-to-GDP ratio. This measure, like the Grubel–Lloyd index, is a share measure and thus is inappropriate for inter-temporal comparisons. Furthermore, it does not allow us to identify the source of the changes in imports; that is, whether they emanate from net export or net import industries.

From equation (17), we can see that this includes the case where there is no change in intra-industry trade (that is, $iit_i = 0$).

Equations (20) and (21) imply that

$$GL_i nt_i + GL_i iit_i < nt_i,$$

that is, $-(1 - GL_i)nt_i + GL_i iit_i < 0$,

that is, $Ciiit_i < Cnt_i$.

The decomposition of $iit_i$ and $nt_i$ into the contributions of growth in imports and exports is only valid in the absence of status-switches. A status-switch takes place for good $i$ if it changes from being a net import at the beginning of the period of study to a net export at the end of the period or vice versa. When this occurs, we find that

$$iit_i = ((M_i / X_i) - 1) + (M_i / X_i) m_i, \text{ for } M_i > X_i \text{ initially},$$

or

$$iit_i = ((X_i / M_i) - 1) + (X_i / M_i) x_i, \text{ for } X_i > M_i \text{ initially},$$

and

$$nt_i = -2 + (M_i / (X_i - M_i)) m_i + (X_i / (M_i - X_i)) x_i.$$

We can see from the equations above that our decomposition would be invalid in the presence of status-switches because the effect of import (export) growth on intra-industry or net trade depends on the extent of export (import) growth (Menon and Dixon 1996).

The definition of ‘industry’ employed in compiling the data base is potentially important to the measurement of our contribution measures. Sceptics such as Lipsey (1976), Rayment (1976), Finger (1975) and Pomfret (1985) have argued that almost all measured intra-industry trade is a statistical artefact brought about ‘categorical aggregation’, where trade data is grouped in heterogeneous categories. In a sense they are right. At an extremely fine level of disaggregation, there will be no intra-industry trade. (See Menon [1996a, Appendix B] for details on how categorical aggregation affects the measurement of our contribution measures.) The problem, however, is that this level of disaggregation may exceed the bounds placed on any reasonable notion of an industry. The issue boils down to the motivation behind analysing intra-industry trade. While the concerns raised by these sceptics might be important when the motivation is to test theories explaining trade patterns, it is not particularly relevant in the context of intra-industry trade as an indicator of openness.
In the absence of price deflators at the 3-digit level of the SITC, we use price indexes defined at the 2-digit level to deflate each of the 3-digit items. The multilateral price indexes are used to deflate the data for both total multilateral and bilateral trade. There are problems associated with using multilateral price indexes to deflate bilateral trade data, particularly if there is substantial pricing to market by either trading partner. These problems are unlikely to be very severe in this case because Japan and the United States are each other’s most significant trading partner.

Where $i$ ranges over 133 Japanese manufactured products traded multilaterally, the correlation coefficient between $i t_i$ and $nt_i$ is -0.06 for the period 1981 to 1986 and -0.09 for the period 1986 to 1991. For the 132 products traded with the United States, the correlation coefficient is -0.11 for the period 1981 to 1986 and -0.13 for 1986 to 1991. This finding is consistent with theory, since the factors that determine intra-industry trade are different from those that drive net trade (see, for instance, Helpman and Krugman [1985]).

The assumption of independent determination of $m_i$ and $x_i$ is supported by the fact that the correlation coefficient for Japan’s total multilateral trade is -0.03 for the period 1981 to 1986 and -0.04 for 1986 to 1991. For Japan–US trade, the correlation coefficients for the two periods are -0.05 and -0.14, respectively.

For Japan’s total multilateral trade, we found that 5 out of the 133 industries switched from net export to net import industries between 1981 and 1986, while 4 industries switched from net export to net import industries and one other in the opposite direction between 1986 and 1991. For Japan–US trade, 7 out of the 132 industries switched from net import to net export industries, while 3 more switched in the opposite direction between 1981 and 1986. Between 1986 and 1991, 2 industries switched from net importers to net exporters, while 11 switched in the opposite direction. These switching industries were excluded when computing the contributions of growth in imports and exports to the growth in intra-industry and net trade.

The detailed results for the 133 industries for total multilateral trade and the 132 industries for trade with the United States are available on request.

For a discussion of ‘scaling’ of intra-industry trade indexes, see Milner (1988).

As mentioned in the third section of this study, status-switching industries were not included in our computations of the contributions of import and export growth to the growth in intra-industry and net trade. From Tables 2a and 2b, we find that the effect of excluding these industries is minimal. For instance, in Table 2a, the growth in intra-industry trade should have been 42.71 per cent (that is, 10.25/0.24) instead of 43.72 per cent, while the growth in net trade should have been 42.66 per cent (that is, 32.42/0.76) instead of 42.92 per cent. Similarly, in Table 2b, the exclusion of switching industries results in growth in intra-industry trade of 102.93 per cent, when it should have been 100 per cent (namely, 24.00/0.24), while the growth in net trade is 30.19 per cent when
it should have been 30.30 per cent (namely, 23.03/0.76). The size of these errors for total multilateral trade is very similar to those for Japan–US trade. Given the small size of these errors, it is unlikely that the relative contributions of import and export growth to the growth in either intra-industry or net trade would have been significantly altered by the exclusion of switching industries.

Caution should be exercised in interpreting the quantitative significance of these correlation coefficients because, while $\Delta GL_i$, is constrained to the interval [-100, 100], $Ciit_i$ is not. We report these coefficients because previous researchers have used $\Delta GL_i$ as an indicator of $Ciit_i$. In a sense, the fact that $\Delta GL_i$ is constrained to this interval is a demonstration of our proposition that it is an inefficient indicator of the growth contribution of intra-industry trade.
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