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# HOW IMPORTANT IS INTRA-INDUSTRY TRADE IN AUSTRALIA'S RAPID TRADE GROWTH?

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**ABSTRACT**

Empirical work on intra-industry trade (IIT) is almost 30 years old. Initial research sought to identify if IIT was a significant share of total trade (TT). The Grubel-Lloyd (GL) index was widely used for this purpose, since it provides a relatively reliable measure of the importance of IIT at any point in time. Interest has since shifted to the changing importance of IIT *over* time, particularly with the emergence of regional trading blocks. Previous researchers have used movements in the GL index to infer the importance of IIT over time. This is not only vague, but can be misleading. In this paper, we show how to measure the contributions of net trade (NT) and IIT to the growth in TT. To understand changes in IIT over time, we also derive the contributions of imports and exports to the growth in TT, NT and IIT. All our formulas are illustrated with data for 205 Australian manufacturing industries defined at the 3- and 4-digit level of the SITC for the periods 1981 to 1986 and 1986 to 1991. The results show that while almost all the growth in TT was driven by NT between 1981 and 1986, IIT contributes almost half the sharp growth in TT between 1986 and 1991. The dominant contribution of NT between 1981 and 1986 was mainly a result of import growth, while the increase in the contribution of IIT between 1986 and 1991 was almost solely due to export growth.

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## CONTENTS


| | | |
|---|---|---|
| | **Abstract** | i |
| **1.0** | **Introduction** | 1 |
| **2.0** | **Analytical Framework** | 2 |
| | 2.1 Decomposition of TT: Contributions of NT and IIT | 2 |
| | 2.2 Decomposition of TT, NT and IIT: Contributions of Imports and Exports | 4 |
| **3.0** | **Data Issues** | 8 |
| **4.0** | **Results** | 9 |
| | 4.1 1981 to 1986 | 9 |
| | 4.2 1986 to 1991 | 11 |
| | 4.3 GL Indexes and Contributions | 12 |
| **5.0** | **Concluding Remarks** | 12 |
| | **References** | 14 |


### Tables


| | | |
|---|---|---|
| 1. | Contributions measures: 1981 to 1986 | 10 |
| 2. | Contributions measures: 1986 to 1991 | 10 |


### Figures


| | | |
|---|---|---|
| 1. | $M_i > X_i$ | 7 |
| 2. | $X_i > M_i$ | 7 |

# *HOW IMPORTANT IS INTRA-INDUSTRY TRADE IN AUSTRALIA'S RAPID TRADE GROWTH?*

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## 1.0 Introduction

International trade has grown faster than income in the postwar period. Nominal exports plus imports as a share of nominal GNP for an average OECD country grew by more than 1 percent per annum over the past three decades. Much of this growth is often attributed to an increase in the importance of intra-industry trade (IIT) in trade growth. This point is of relevance in addressing the issue of trade adjustment in the context of trade liberalization or regional trading agreements. If most of the growth in trade is attributable to IIT, then the resource re-allocation costs in the short to medium term are likely to be lower (see Greenaway, 1982; Harris, 1984). This is because IIT does not require inter-industry factor movements. Whereas trade expansion through net trade (NT) requires factor transfer from import-competing industries to export-oriented industries, trade expansion through IIT requires only specialization within industries. Furthermore, as Krugman (1981) has shown, it is possible for all factors to gain from trade in an IIT setting, thus alleviating adjustment pressures. In this context, Caves (1981) suggests that protectionist pressures are unlikely to grow in proportion to the degree of import competition, thus making it more likely for governments to press ahead with the process of trade liberalization. The integrity of regional trading agreements are more likely to be maintained if governments are not faced with pressures to intervene to protect employment in less competitive industries.

There have been numerous studies measuring changes in shares of IIT in total trade (TT) for both developed and developing countries[1]. The method employed in these studies has been to compute the Grubel and Lloyd (GL, 1975) index (sometimes with a correction for the aggregate trade imbalance) at different points in time, and to infer some pattern of the changing importance of IIT.

However, this method cannot tell us how much of the growth in trade is *attributable* to IIT. The GL index can also record an increase (decrease) despite IIT contributing less (more) than NT to the growth in trade. Furthermore, an increase (decrease) in the GL index over time is compatible with a decrease (increase) in IIT. In other words, the GL index can be misleading when used to infer growth in IIT.

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(1) See, for instance, Greenaway and Milner (1986), Greenaway and Tharakan (1986), Messerlin and Becuwe (1986), and Park and Park (1991).

In this paper, we propose a formula for decomposing the growth in TT into the contributions of NT and IIT. We show that the *modus operandi* of previous studies, the Grubel-Lloyd index, plays the role in this formula of a share in a weighting scheme. In interpreting changes in the IIT share of TT over time, previous researchers[2] have often alluded to underlying changes in import-export performance. To clarify the roles of imports and exports, we derive formulas that measure their contributions to growth in total, net and intra-industry trade.

All our formulas are illustrated with data for 205 Australian manufacturing industries defined at the 3- and 4-digit level of the Standard International Trade Classification (SITC) for the periods 1981 to 1986 and 1986 to 1991. We chose the Australian experience over these periods for several reasons: (i) manufacturing trade as a share of GDP rose sharply, from 21 percent in 1981 to 32 percent in 1991, (ii) protection levels in the manufacturing sector rose between 1981 and 1986, but then fell off markedly between 1986 and 1991, and (iii) the Closer Economic Relations (CER) trading agreement with New Zealand, one of the most comprehensive agreements in the world, was signed in 1983 and further expanded in 1988.

The paper is in five parts. Section 2 contains the derivations of the decomposition formulas. Data issues are discussed in Section 3. Results of our Australian study are presented in Section 4. A final section summarises the main points.

## 2.0 Analytical Framework

### 2.1 Decomposition of TT: Contributions of NT and IIT

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

$$\boldsymbol{Tt_i} \;=\; \boldsymbol{Nt_i} \;+\; \boldsymbol{IIT_i}\,, \tag{1}$$

where $\boldsymbol{TT_i} \;=\; \boldsymbol{X_i} \;+\; \boldsymbol{M_i}\,,$ (2)

$$\boldsymbol{NT_i} \;=\; |\boldsymbol{X_i} \;-\; \boldsymbol{M_i}| \tag{3}$$

and $\boldsymbol{IIT_i} \;=\; (\boldsymbol{X_i} + \boldsymbol{M_i}) \;-\; |\boldsymbol{X_i} - \boldsymbol{M_i}|\,.$ (4)

$\boldsymbol{X_i}$ and $\boldsymbol{M_i}$ are exports and imports of commodity *i* valued in base period f.o.b. prices.

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(2) See, for instance, Petri (1991, 65), Park and Park (1991).

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

$$tt_i = Cnt_i + Ciit_i , \quad (5)$$

where $Cnt_i = (1 - GL_i)\, nt_i$ , (6)

$$Ciit_i = GL_i\, iit_i , \quad (7)$$

$$GL_i = ITT_i / TT_i \quad (8)$$

and $nt_i$ and $iit_i$ are the percentage changes over the period in $NT_i$ and $IIT_i$. Note that

$$GL_i = 1 - \{|X_i - M_i| / (X_i + M_i)\} ,$$

which is the Grubel-Lloyd index of intra-industry trade at the beginning of the period.

In our study of Australian trade reported in Section 4, we find that growth rates in net trade are largely uncorrelated with growth rates in intra-industry trade[3]. Under the assumption that $nt_i$ is determined independently of $iit_i$, $Cnt_i$ is the contribution to growth in total trade of growth in net trade, while $Ciit_i$ is the contribution of growth in intra-industry trade.

A common practice is to use movements over a period in GL indices as indicators of the importance of growth in IIT.[4] $GL_i$ will increase over a period whenever $iit_i > nt_i$. However, even under this condition, growth in $iit_i$ may make a relatively minor contribution to growth in total trade of product *i*. Consequently, in this study we prefer to use our contribution measures ($Cnt_i$ and $Ciit_i$). These take account not only of growth rates in intra-industry and net trade, but also of their shares in total trade. More formally:

$iit_i > nt_i$ implies $GL_i$ is increasing,

but if $GL_i < nt_i / (nt_i + iit_i)$ , (9)

and $nt_i + iit_i > 0$ , (10)

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(3) The correlation coefficient between $nt_i$ and $iit_i$ is 0.017 for the period 1981 to 1986, and -0.062 for the period 1986 to 1991. This finding is consistent with theory, since the factors that determine NT are different from those that drive IIT (see, for instance, Helpman and Krugman, 1985).

(4) Examples of this include Messerlin and Becuwe (1986), Petri (1991), and Park and Park (1991).

then $Ciit_i < Cnt_i$ .[5]

Similarly, $nt_i > iit_i$ implies that $GL_i$ is decreasing,

but if $GL_i > nt_i / (nt_i + iit_i)$ (9a)

and $nt_i + iit_i > 0$ , (10a)

then $Cnt_i < Ciit_i$ .

These propositions show that movements in the GL index might prove misleading when used to infer the importance of growth in IIT.

### 2.2 Decomposition of TT, NT and IIT: Contributions of Imports and Exports

In this subsection, we decompose growth in TT, NT and IIT into the contributions of imports and exports. Starting from equation (2), we find that

$$tt_i = Cmtt_i + Cxtt_i , \tag{11}$$

where $$Cmtt_i = (M_i / TT_i)\, mi , \tag{12}$$

$$Cxtt_i = (X_i / TT_i)\, x_i \tag{13}$$

and $m_i$ and $x_i$ are growth rates over the period in $M_i$ and $X_i$. Assuming independent determination of $m_i$ and $x_i$, $Cmtt_i$ and $Cxtt_i$ are the contributions of import and export growth to growth in total trade in good $i$.[6]

In decomposing $NT_i$ and $IIT_i$ into the contributions of import and export growth, we must consider the problem 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

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(5) Equations (9) and (10) imply that:

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

i.e. $-(1 - GL_i)nt_i + GL_i\, iit_i < 0,$

i.e. $Ciit_i < Cnt_i.$

(6) The assumption of independent determination of $m_i$ and $x_i$ is supported by the fact that the correlation coefficient is 0.065 for the period 1981 to 1986, and 0.119 for 1986 to 1991.

the period or *vice versa*. First we consider cases where there is no status switch. For these cases, we find from equations (3) and (4) that

$$\boldsymbol{nt_i} = \boldsymbol{Cmnt_i} + \boldsymbol{Cxnt_i} \tag{14}$$

and

$$\boldsymbol{iit_i} = \boldsymbol{Cmiit_i} + \boldsymbol{Cxiit_i}\,, \tag{15}$$

where the contributions of import and export growth to the growth in $\boldsymbol{NT_i}$ and $\boldsymbol{IIT_i}$ are calculated as

$$\boldsymbol{Cmnt_i} = (\boldsymbol{M_i} / (\boldsymbol{M_i} - \boldsymbol{X_i}))\, \boldsymbol{m_i}\,, \tag{16}$$

$$\boldsymbol{Cxnt_i} = (\boldsymbol{X_i} / (\boldsymbol{X_i} - \boldsymbol{M_i}))\, \boldsymbol{x_i}\,, \tag{17}$$

$$\boldsymbol{Cmiit_i} = \delta_i\, \boldsymbol{m_i} \tag{18}$$

and

$$\boldsymbol{Cxiit_i} = (1 - \delta_i)\, \boldsymbol{x_i}\,. \tag{19}$$

$\delta_i$ is 1 if $\boldsymbol{X_i} > \boldsymbol{M_i}$ and zero if $\boldsymbol{X_i} < \boldsymbol{M_i}$. (We assume that $\boldsymbol{M_i}$ is not precisely equal to $\boldsymbol{X_i}$). Equations (14), (16) and (17) imply, for no-switch cases, 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. Equations (15), (18) and (19) reflect the fact that, in no-switch cases, growth in imports determine the growth in IIT for net export products, while the growth in exports accounts for the growth in IIT for net import products.

Now we consider cases in which there are status switches. These take place for net import products ($\boldsymbol{M_i} > \boldsymbol{X_i}$) if and only if:

$$\boldsymbol{m_i} < ((\boldsymbol{X_i} / \boldsymbol{M_i}) - 1) + (\boldsymbol{X_i} / \boldsymbol{M_i})\ \boldsymbol{x_i}\,. \tag{20}$$

The shaded area above the line AB in Figure 1 shows the combinations of growth rates in $\boldsymbol{M_i}$ and $\boldsymbol{X_i}$ for which there is no status switch, while the unshaded area below the line shows combinations for which there is a status switch. Similarly, if we assume that $\boldsymbol{X_i}$ is initially

greater than $M_i$, then the shaded area above the line AB in Figure 2 shows no-switch combinations, while the unshaded area below the line shows switch combinations.

Almost all products in our empirical analysis of Australia's manufacturing trade in Section 4 were net imports at both the beginning and end of the period studied (i.e. they lie in the shaded area of Figure 1). There were a few products that were net exports at both ends of the period (shaded area in Figure 2). Thus, the overwhelming majority of cases fell in the shaded areas, so that $Cmnt_i$, $Cxnt_i$, $Cmiit_i$ and $Cxiit_i$ calculated via equations (16) through (19) are legitimate contribution measures. Notice that the shaded areas contain the (0,0) combination. Thus, for no-switch cases, contributions calculated via equations (16) through (19) give the effects on growth in $NT_i$ and $IIT_i$ of reducing either $m_i$ or $x_i$ to zero.

In the case where the status of a product switches from a net import to a net export or *vice versa*, we find that:

$$nt_i = -2 + (M_i / (X_i - M_i))\, m_i + (X_i / (M_i - X_i))\, x_i \qquad (21)$$

and

$$iit_i = ((M_i / X_i) - 1) + (M_i / X_i)\, m_i \text{ , for } M_i > X_i \text{ initially,} \qquad (22)$$

or

$$iit_i = ((X_i / M_i) - 1) + (X_i / M_i)\, x_i \text{ , for } X_i > M_i \text{ initially.} \qquad (23)$$

On the basis of these formulas, it is tempting to consider $(M_i/(X_i - M_i))\ m_i$ as the contribution of import growth to growth in $NT_i$; $(X_i/(M_i - X_i)\ x_i$ as the contribution of export growth to $NT_i$; etc. However, $(M_i/(X_i - M_i))\ m_i$, for instance, will not normally be the effect on growth of $NT_i$ of reducing $m_i$ to zero. In terms of our figures, we are dealing with $x_i$-$m_i$ combinations below the AB lines. Moving $m_i$ from its observed level to zero will, very often[7], involve crossing the AB line. Once we cross this line, equations (21) through (23) are no longer valid.

With status switches, there is no solution to the problem of computing import and export contributions to growth in $NT_i$ and $IIT_i$. For variations in $x_i$-$m_i$ combinations over our range of interest (including the (0,0) combination), the effect of import growth on $NT_i$ or $IIT_i$ depends on the extent of export growth. Similarly, the effect of export growth on $NT_i$ and $IIT_i$ depends on the extent of import growth. As explained in the next section, we avoided this problem in our study for Australia by carrying out our computations at a level of disaggregation at which status switches did not occur.

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(7) In Figure 1, we will cross the AB line if $x_i > \alpha$. In Figure 2, we will cross the AB line if $x_i > \beta$.

**Figure 1: $M_i > X_i$**

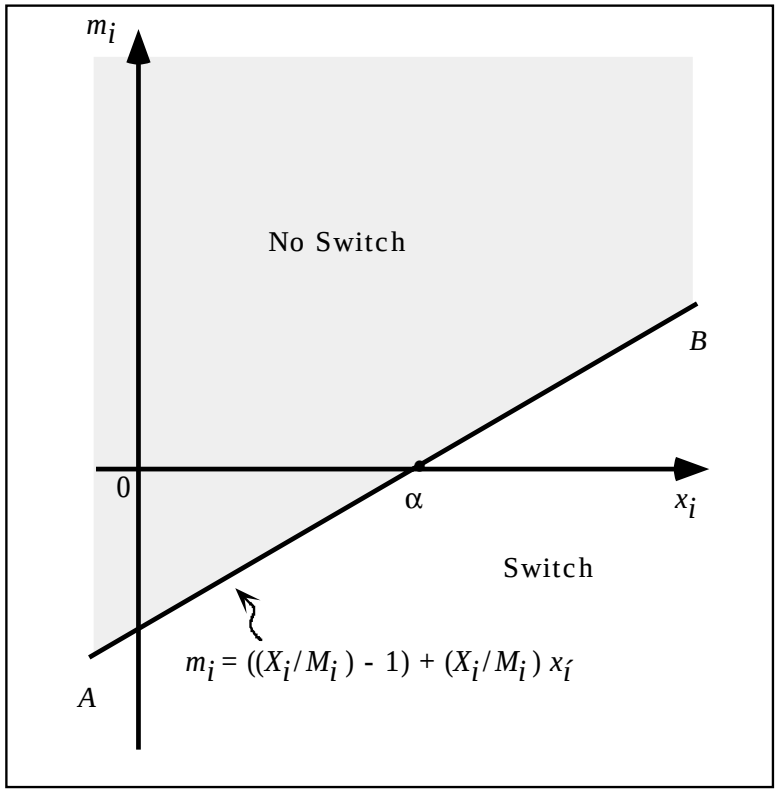
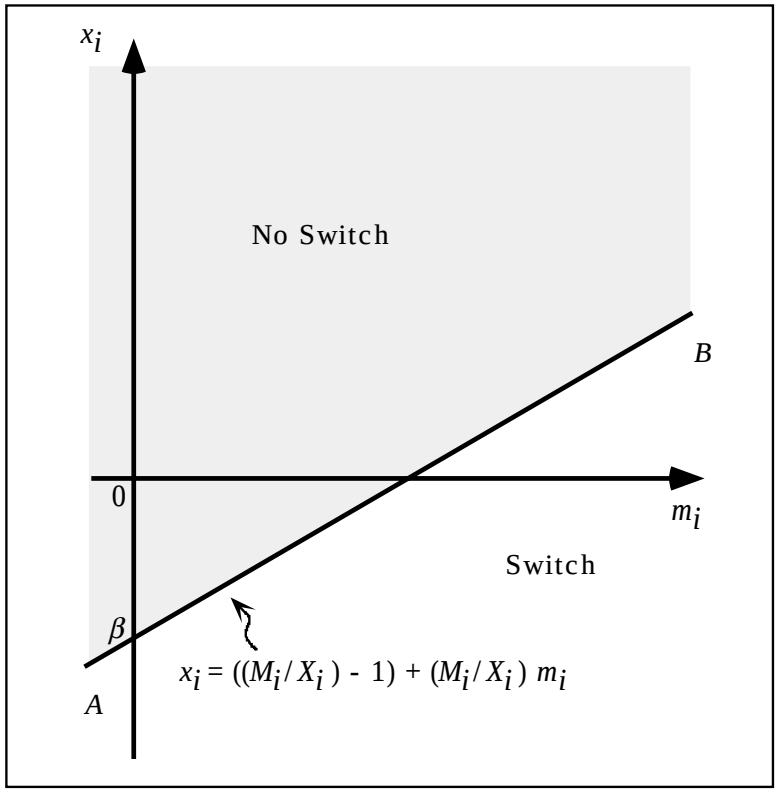



**Figure 2: $X_i > M_i$**



## 3.0 Data Issues

The definition of "industry" employed in compiling the data base is potentially important to the measurement of the contributions of NT and IIT to the growth in TT. Sceptics such as Finger (1975), Lipsey (1976) and Rayment (1976) have argued that almost all measured IIT is purely a statistical artefact brought about by trade data having been grouped in heterogeneous categories. In a sense they are right. At an extremely fine level of disaggregation, there will be no IIT.

However, as explained in Section 1, our interest in the measurement of the contributions of IIT and NT to TT reflects our concern with adjustment problems associated with trade growth and liberalization. For looking at adjustment problems, we need industry categories within which a high degree of factor mobility is possible. To meet this criterion, we judged that disaggregation at the 3-digit SITC level is sufficient. At this level, we have industries such as inorganic acids (SITC 523), paints (SITC 533), paper and paperboard (SITC 641), glass (SITC 664), glassware (SITC 665), tractors (SITC 722), television receivers (SITC 761), and furniture (SITC 821). It is reasonable to assume that the cost of reallocating factors within such industries is low. Consequently, we worked initially with data at this level covering 133 manufacturing industries belonging to SITC 5-8 less 67-68 (Revision 2).
Using data for Australia from the United Nations' COMTRADE data base, we found that one of the 133 industries switched from a net import to a net export, while another switched in the opposite direction between 1981 and 1986. Between 1986 and 1991, five industries switched from net import to net export industries, while one industry switched in the opposite direction. For these eight industries, we moved to 4-digit data, giving us 205 industries in all. For this set of 205 three- and four-digit industries, there were no status switches. Thus, we could compute contributions of imports and exports to growth in NT and IIT for all the industries in our study.

In all the 8 three-digit industries in which we found switches, we also found opposite-signed imbalances at the 4-digit level. We did not find opposite-signed imbalances for the other 3-digit industries. A 3-digit industry has opposite-signed imbalances at the 4-digit level if it has at least one 4-digit component with imports exceeding exports and at least one 4-digit component with exports exceeding imports.

Opposite-signed imbalances may be evidence of significant heterogeneity within the 3-digit industry (see Greenaway and Milner, 1983), casting doubt on the assumption that intra-industry resource movements are relatively costless. Thus, by moving to the 4-digit level for the 8 switching industries, we not only facilitated the computation of import-export contributions, but we may also have improved our industry classification from the point of view of our resource-movement criterion.

## 4.0 Results

In Tables 1 and 2 we have aggregated our results for the 205 manufacturing industries[8] into two sectoral classifications: SITC 1-digit and a factor-intensity-based classification.[9] The aggregation formulas are in the notes at the end of the tables. We consider two periods: 1981 to 1986 (Table 1) and 1986 to 1991 (Table 2). In interpreting all results, it is useful to bear in mind that most Australian manufacturing industries are net-importers.

### 4.1 1981 to 1986

We begin by considering the contributions of imports and exports to the growth in trade. The period 1981 to 1986 is characterised by strong growth in imports, and negative growth in exports. The growth in trade of total manufacturing would have been 11.67 percent (the contribution of imports) instead of 10.11 if not for the negative contribution of exports of 1.56. This outcome is reflected at the sectoral level, with the following two exceptions: (i) SITC 8 (miscellaneous manufactures), where the contribution of exports is positive, and (ii) unskilled-labour-intensive products, where the contribution of imports is negative.

With respect to the contributions of NT and IIT to the growth in TT, we find that the 10.11 percent growth in total manufacturing trade is more than accounted for by NT; the contribution of IIT is negative. This pattern is reflected at the sectoral level, with negative contributions from IIT in all sectors except SITC 8 - the only sector to record positive export growth.

Since most Australian manufacturing industries are net-importers, the strong growth in imports during this period contributes strongly to the growth in NT. With respect to total manufacturing, imports contribute 15.35 out of the 16.80 percent growth in NT, with the remaining 1.46 percent coming from exports. Imports is the dominant contributor in all cases except in the unskilled-labour intensive sector. The contribution of imports is negative in this sector because the net-import industries within this sector record negative import growth. The contribution of exports to the growth in NT is negative in only two sectors. The negative contribution to the growth in NT for SITC 8 is not surprising given that it is the only sector to record positive export growth. The other exception is the natural-resource-intensive sector, where exports make a negative contribution because it is the only sector which is dominated by net-export industries.

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(8) The detailed results for the 205 industries are available on request.

(9) The factor intensity groupings are those derived by Krause (1984), revised to concord with Revision 2 of the SITC by Park and Park (1991).

**Table 1: Contributions measures, 1981 to 1986**[1]

| Product Description | *tt*(*j*) | C*nt*(*j*) | C*iit*(*j*) | ***GL***(*j*)$_{(81)}$ | ***GL***(*j*)$_{(86)}$ | C*mtt*(*j*) | C*xtt*(*j*) | *nt*(*j*) | C*mnt*(*j*) | C*xnt*(*j*) | *iit*(*j*) | C*miit*(*j*) | C*xiit*(*j*) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SITC 5 Chemicals | 5.81 | 9.02 | -3.21 | 0.33 | 0.28 | 8.17 | -2.36 | 13.43 | 11.34 | 2.08 | -9.78 | 0.00 | -9.78 |
| SITC 6 Materials | 1.69 | 4.46 | -2.76 | 0.29 | 0.26 | 3.45 | -1.76 | 6.25 | 5.77 | 0.48 | -9.24 | -1.96 | -7.28 |
| SITC 7 Machinery,transport equip. | 6.98 | 10.74 | -3.75 | 0.20 | 0.15 | 8.87 | -1.89 | 13.21 | 11.00 | 2.21 | -18.19 | 0.00 | -18.19 |
| SITC 8 Miscellaneous | 33.40 | 32.77 | 0.63 | 0.23 | 0.18 | 33.09 | 0.32 | 42.79 | 43.20 | -0.41 | 2.71 | 0.00 | 2.71 |
| Unskilled labour intensive | -4.78 | -1.80 | -2.98 | 0.21 | 0.19 | -3.29 | -1.49 | -2.27 | -4.16 | 1.88 | -14.30 | 0.00 | -14.30 |
| Human capital intensive | 2.70 | 7.19 | -4.49 | 0.22 | 0.17 | 5.25 | -2.55 | 8.92 | 6.36 | 2.56 | -18.83 | 1.02 | -19.85 |
| Natural resource intensive | 6.77 | 8.15 | -1.39 | 0.52 | 0.47 | 7.33 | -0.56 | 16.86 | 29.61 | -12.75 | -1.11 | -11.90 | 10.79 |
| Technology intensive | 19.49 | 21.36 | -1.88 | 0.24 | 0.18 | 20.60 | -1.11 | 28.09 | 26.92 | 1.17 | -7.83 | 0.00 | -7.83 |
| Total manufacturing | 10.11 | 12.89 | -2.78 | 0.24 | 0.19 | 11.67 | -1.56 | 16.80 | 15.35 | 1.46 | -11.29 | -0.18 | -11.11 |

**Table 2**: **Contributions measures, 1986 to 1991**[1]

| Product Description | *tt*(*j*) | C*nt*(*j*) | C*iit*(*j*) | ***GL***(*j*)$_{(86)}$ | ***GL***(*j*)$_{(91)}$ | C*mtt*(*j*) | C*xtt*(*j*) | *nt*(*j*) | C*mnt*(*j*) | C*xnt*(*j*) | *iit*(*j*) | C*miit*(*j*) | C*xiit*(*j*) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SITC 5 Chemicals | 74.87 | 35.21 | 39.65 | 0.28 | 0.39 | 51.77 | 23.10 | 49.36 | 71.56 | -22.20 | 134.68 | 0.00 | 134.68 |
| SITC 6 Materials | 58.97 | 35.48 | 23.49 | 0.26 | 0.31 | 39.69 | 19.28 | 46.75 | 47.57 | -0.81 | 93.69 | 17.57 | 76.12 |
| SITC 7 Machinery,transport equip. | 75.49 | 40.94 | 34.55 | 0.15 | 0.28 | 58.21 | 17.29 | 48.21 | 68.50 | -20.28 | 231.10 | 0.00 | 231.10 |
| SITC 8 Miscellaneous | 52.60 | 29.53 | 23.07 | 0.18 | 0.27 | 41.06 | 11.53 | 36.02 | 50.09 | -14.07 | 128.00 | 0.00 | 128.00 |
| Unskilled labour intensive | 66.73 | 41.46 | 25.27 | 0.19 | 0.26 | 54.09 | 12.63 | 51.05 | 66.60 | -15.55 | 134.55 | 0.00 | 134.55 |
| Human capital intensive | 72.22 | 40.22 | 32.00 | 0.17 | 0.29 | 53.22 | 19.00 | 48.96 | 63.59 | -14.63 | 174.10 | 1.41 | 172.69 |
| Natural resource intensive | 100.07 | 49.53 | 50.54 | 0.47 | 0.49 | 46.45 | 53.62 | 86.32 | 40.99 | 45.33 | 154.86 | 87.43 | 67.43 |
| Technology intensive | 64.81 | 33.77 | 31.03 | 0.18 | 0.30 | 48.94 | 15.87 | 41.37 | 60.02 | -18.65 | 171.84 | 0.00 | 171.84 |
| Total manufacturing | 67.96 | 37.06 | 30.90 | 0.19 | 0.30 | 50.78 | 17.18 | 45.64 | 61.68 | -16.04 | 165.50 | 3.94 | 161.55 |

*Notes:*

(1) In all the formulas below, the *s*(*j*)'s are sets of products. For example, in the first row of each table, *j* = SITC 5, Chemicals. In the fifth row of results, *j* = unskilled labour. i.e. *s*(*j*) is the set of products identified by Krause (1984) to be intensive in the use of unskilled labour in their production. To obtain these sectoral aggregates, we begin by defining the following:

$$\boldsymbol{TT(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{TT_i} \quad (1)$$

$$\boldsymbol{NT(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{NT_i} \quad (2)$$

$$\boldsymbol{IIT(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{IIT_i} \quad (3)$$

$$\boldsymbol{GL(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{GL_i\,(TT_i / (TT(j))} \quad (4)$$

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

$$\boldsymbol{tt(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{tt_i\,(TT_i / TT(j))} \quad (5)$$

$$\boldsymbol{nt(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{nt_i\,(NT_i / (NT(j))}$$

$$\boldsymbol{iit(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{iit_i\,(IIT_i / (IIT(j))}$$

$$\boldsymbol{Cnt(j)} = \boldsymbol{(1 - GL(j))\ nt(j)}$$

$$\boldsymbol{Ciit(j)} = \boldsymbol{GL(j)\ iit(j)}$$

$$\boldsymbol{Cmtt(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{Cmtt_i\,(TT_i / TT(j))}$$

$$\boldsymbol{Cxtt(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{Cxtt_i\,(TT_i / TT(j))}$$

$$\boldsymbol{Cmnt(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{Cmnt_i\ (NT_i / (NT(j))}$$

$$\boldsymbol{Cxnt(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{Cxnt_i\ (NT_i / (NT(j))}$$

$$\boldsymbol{Cmiit(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{Cxiit_i\,(IIT_i / (IIT(j))}$$

$$\boldsymbol{Cxiit(j)} = \Sigma_{i \in s(j)}\ \boldsymbol{Cxiit_i\,(IIT_i / (IIT(j))}$$

Finally, we consider the contributions of imports and exports to the growth in IIT, starting with total manufacturing. Both make negative contributions, with the bulk (11.11 out of 11.29) coming from exports. There are 5 sectors where the contribution of imports is zero. This reflects the fact that all industries within these sectors are net-importers. For SITC 6 (materials) the contribution of imports is positive but small. In this sector, 3 out of the 16 industries are net-exporters, and all 3 increased their imports. In the remaining two sectors, imports make a negative contribution to the growth in IIT because they contain net-export industries that record negative growth in imports. The contribution of exports is negative in all but two sectors. For SITC 8, the positive contribution of exports comes from the positive growth in exports for a sector comprised only of net-import industries. For the natural-resource-intensive sector, the positive contribution of exports is a result of the net import industries within this sector increasing their exports.

**4.2 1986 to 1991**

Again we begin by considering the contribution of imports and export to the growth in trade. Unlike the previous period, both make positive contributions, with exports now contributing about a quarter of the growth in TT. The 67.96 percent growth in TT for total manufacturing is made up of a 50.78 percent contribution from imports and a 17.18 percent contribution from exports. At the sectoral level, the contribution of exports is greater than imports in the natural-resource-intensive sector, a reflection of its export orientation.

The contributions of NT and IIT to the growth in TT are quite different in this period. While NT is still the dominant contributor, IIT now contributes 30.90 out of 67.96 percent growth in TT for total manufacturing. ITT contributes about half the sharp growth in trade for all sectors except unskilled-labour, where the contribution is just above one-third. The low contribution of IIT in this sector may be due to the fact that it contains light manufactured goods which are typically less differentiated. For SITC 5 (chemicals) and the natural-resource-intensive sectors, the contributions of IIT exceeds those of NT.

Next we turn to the contributions of imports and exports to the growth in NT. For total manufacturing, the contribution of exports is to reduce the growth in NT from 61.68 percent (which is the contribution of imports) to 45.64 percent. The contribution of exports is negative in all sectors expect natural-resource-intensive, again reflecting its export orientation.

Finally, we consider the contribution of imports and exports to the growth in IIT. Here we witness the impact of the strong growth in exports during this period. Almost all of the growth in IIT for total manufacturing is due to exports (161.55 out of 165.50). The

contribution of imports is zero for 5 out of the 8 sectors. The positive contribution of imports in the other 3 sectors is due to net-export industries within these sectors increasing their imports. Since net-export industries dominate the natural-resource-intensive sector, the contribution of imports to the growth in IIT exceeds the contribution of exports.

### 4.3 GL Indexes and Contributions

Tables 1 and 2 also include GL indexes for 1981, 1986 and 1991. Earlier we showed, as a theoretical possibility, that the GL index could be misleading when used to infer the contribution of IIT growth to the growth in TT. We find that in the Australian case this possibility is realised at all levels: aggregate, sectoral and industry. This is illustrated particularly for the second period. At the aggregate level, the GL index rises from 19 in 1986 to 30 percent in 1991 despite NT contributing more than IIT to the growth in TT. At the sectoral level, the contribution of NT is greater than the contribution of IIT between 86 and 91 in all but two sectors, despite the GL index increasing in all sectors. The two exceptions are natural-resource-intensive and chemicals. The natural-resource-intensive sector registers the smallest increase in the GL index, in both absolute and percentage terms, while the Chemicals sector ranks fourth in terms of percentage increase, and fifth in terms of absolute increase in the GL index.

At the industry level, we find that the GL index increases between 1986 and 1991 despite NT contributing more than IIT to the growth in TT for 91 out of the 205 industries.[10] The GL index is so often misleading because IIT is growing (sharply) off a low base, but NT is not. The problem in reverse of the GL index falling over this period despite IIT contributing more than NT to the growth in TT occurs for only 2 industries. It could occur much more frequently for most other OECD countries that have an initially high share of IIT.

## 5.0 Concluding Remarks

Empirical work on IIT is almost 30 years old. Initial research in this area sought to identify if IIT was a significant share of TT. Despite concerns relating to the effects of the aggregate trade imbalance, the GL index provides a relatively reliable measure of the importance of IIT at any point in time. Interest has since shifted to the changing importance of IIT *over* time, particularly with the emergence of regional trading blocks. An important consideration for countries contemplating joining or forming a regional trading block is the adjustment costs

(10) The correlation coefficient between $\mathbf{C}iit_i$ and $\Delta GL_i$ is 0.74 and 0.58 for the periods 1981 to 1986 and 1986 to 1991, respectively. If we exclude the industries where $GL_i$ increases (decreases) despite IIT contributing less (more) than NT to the growth in TT, then the correlation coefficients for the two periods are 0.84 and 0.64, respectively.

associated with the expansion in trade when barriers come down. These costs depend on the extent to which the expansion in trade takes the form of net versus intra-industry trade. In this paper, we show how to measure the contributions of NT and IIT to the growth in TT. Our contributions measures overcome the problems associated with using movements in the GL index to infer the importance of IIT over time. To understand changes in IIT over time, we also derive the contributions of exports and imports to the growth in TT, NT and IIT.

All our formulas were illustrated with data for 205 Australian manufacturing industries defined at the 3- and 4-digit level of the SITC for the periods 1981 to 1986 and 1986 to 1991. The results show that while almost all the growth in TT was driven by NT between 1981 and 1986, IIT contributes almost half the sharp growth in TT between 1986 and 1991. The dominant contribution of NT between 1981 and 1986 was mainly a result of import growth, while the increase in the contribution of IIT between 1986 and 1991 was almost solely due to export growth. Our concerns with using movements in the GL index to infer the contribution of IIT to the growth in TT were vindicated. As a contribution indicator, the GL index was often misleading.

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