ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC



Trade Statistics in Policymaking

- A HANDBOOK OF COMMONLY USED TRADE INDICES AND INDICATORS -



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Prepared by

Mia Mikic and John Gilbert

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Acronyms and abbreviations

ADB	Asian Development Bank
AFTA	ASEAN Free Trade Area
AMAD	Agricultural Market Access Database
ANZCERTA	Australia-New Zealand Closer Economic Relations Trade Agreement
APEC	Asia-Pacific Economic Cooperation
APTA	Asia-Pacific Trade Agreement
APTIAD	Asia-Pacific Preferential Trade and Investment Agreements Database
ARCA	additive revealed comparative advantage
ARIC	Asian Regional Integration and Cooperation
ARTNeT	Asia-Pacific Research and Training Network on Trade
ASEAN	Association of Southeast Asian Nations
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BTAs	bilateral trade agreements
CAMAD	Common Analytical Market Access Database
CGE	computable general equilibrium
COMTRADE	United Nations Commodity Trade Statistics Database
CTS	Consolidated Tariff Schedule
DDA	Doha development agenda
DOTS	Direction of Trade Statistics (IMF)
ESCAP	Economic and Social Commission for Asia and the Pacific
EV	equivalent variation
FDI	foreign direct investment
FTAs	free trade agreements
GATT	General Agreements on Tariffs and Trade
GDP	gross domestic product

GE	general equilibrium
GTAP	Global Trade Analysis Project
HHI	Hirschmann-Herfindahl index
HS1996	Harmonised System 1996
IDB	Integrated Data Base
IIT	intra-industry trade
IMF	International Monetary Fund
INDLKBTA	India-Sri Lanka Bilateral Trade Agreement
ITC	International Trade Centre
LDCs	least developed countries
MacMaps	Market Access Maps
MDG	millennium development goal
MFN	most favoured nation
MPM	marginal propensity to import
NAFTA	North American Free Trade Agreement
NTMs	non-tariff measures
OECD	Organisation for Economic Co-operation and Economic Development
OLS	ordinary least squares
PAFTA	Pan-Asian Free Trade Area
PE	partial equilibrium
PTAs	preferential trade agreements
QRs	quantitative restrictions
RCA	revealed comparative advantage
RO	regional orientation
ROW	the rest of the world

TRAINS	Trade Analysis and Information System
RTAs	regional trade agreements
SITC	Standard International Trade Classification
TDI	trade dependence index
TID	Trade and Investment Division (ESCAP)
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNSD	United Nations Statistics Division
US	United States
WB	World Bank
WDI	World Development Indicators
WITS	World Integrated Trade Solution
WTD	World Trade Database
WTO	World Trade Organization

Symbols

∞	Infinity (can be – and +)
$\sum$	Summation
$\sqrt{}$	Square root
$\lvert n \rvert$	Absolute value of n
Δ	Change (discrete)

Acknowledgments

This reference material is a compilation of work associated with tracking and analyzing regional trade flows and regionalism processes. This work has been pursued by the Trade Policy Section of the Trade and Investment Division within the mandate given by the ESCAP members. It provides comprehensive explanations of most of the indicators featured in the Asia-Pacific Trade and Investment Agreements Database (APTIAD).

The publication was prepared by Ms. Mia Mikic, ESCAP and Mr. John Gilbert, Utah State University, United States, under the overall supervision of Mr. Xuan Zengpei, Director, Trade and Investment Division, and Ms. Tiziana Bonapace, Chief, Trade Policy Section of ESCAP.

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I. Introduction

1. BACKGROUND ON TRADE MONITORING WORK IN ESCAP[1]

In March 2005, the Asia-Pacific Research and Training Network on Trade (ARTNeT) held its First Capacity Building Workshop on Trade Research. The main objective of the workshop was to provide a menu of easy-to-use analytical methods and tools for trade research which deliver findings of use to the policymakers in the Asia-Pacific region. The Trade and Investment Division (TID) of ESCAP serves as a secretariat for ARTNeT and was tasked with organizing the workshop. Decisions on the workshop topics had to take into account the characteristics of the target group of countries in which the analysis was going to be most used: developing countries and the least developed countries (LDCs) of the ESCAP region. Several constraints are linked to this target: limited availability of trade and other economic time series data and their imperfect reliability; lack of technical and/or human resources for appropriate analyses in some of the countries, and under-established practice by policymakers to use the findings of complex empirical research in their policymaking. Given these constraints, as well the duration of the workshop itself, there was little option to include more sophisticated methods of empirical research such as the gravity model and computable general equilibrium (CGE) models even though they are typical methods of choice in the analysis of trade flows and trade policy impacts. The choice therefore fell on statistical analysis based on a set of **trade indices and indicators** to assess trade patterns and characteristics and changes in trade patterns of individual economies and their various groupings in this region. While initially this choice was perceived as a "second-best" (as compared with the "first-best" modeling tools), further developments in the network activities and the ESCAP-TID work had linked to and built on this approach. Moreover, more recent criticisms on shortcomings of some modeling approaches and interpretations of their results allowed for these more straightforward and less pretentious methods to be unwrapped.

[1] An earlier version under the title 'Commonly Used Trade Indicators: A Note' was first presented as part of training material for the First ARTNeT Capacity Building Workshop on Trade Research, Bangkok, March 2005. The authors would like to thank participants at that workshop for useful comments. Assistance was provided by Zaw Win Aung in preparing a demonstration database in Access format with the calculation of several indicators for a CD-ROM. Yaomin Wen, Dandan Jian, Christopher Kuonqui and Xingxing Yao all contributed in different ways during their internships with TID/ESCAP.

Meantime, work on mapping, tracking and monitoring of the preferential trade agreements in the ESCAP region for the Asia-Pacific Trade and Investment Agreements Database (APTIAD) progressed to a level where tools for tracking and monitoring had to be chosen. Again, given technical and other constraints, a natural choice fell on trade performance indicators. A concept paper was developed to explain which indicators should be focused on in this particular work and to outline the progression from this approach to more challenging methods based on modeling.[2]

The early harvest of findings on mapping and monitoring of the preferential trade agreements (PTAs) in the region is already available online on APTIAD (http://www.unescap.org/tid/aptiad). At present APTIAD covers over 130 preferential trade agreements linking at least one ESCAP economy with the rest of the world. Approximately 2/3 of those have been implemented while the number of agreements under negotiation or preparation increases daily. APTIAD tracks trade dependence, trade balance and trade shares indices over 2001-2005 for all the agreements in the database. It also has an interactive platform for calculation of another set of trade performance indicators for various membership configurations.

In parallel with the development of APTIAD, other international organizations and research institutions also gave more attention to using trade performance indicators in assessment of regional trade integration in the Asia-Pacific. For example, the Asian Development Bank (ADB) developed a sub-site Asian Regional Integration and Cooperation (ARIC) which includes information on preferential agreements in trade and investment and trade indicators.

2. WHAT ARE TRADE INDICATORS AND WHAT INFORMATION THEY PROVIDE?

Economists use statistical data and indicators in all branches of economics. Sometimes indicators are used as leading indicators (when they have predictive power), sometimes to describe what has happened in the past (lagging indicators). Often one distinguishes between business and macroeconomic indicators. Simple and composite indices are established as recognized approaches in monitoring progress in achieving various policy goals or in benchmarking various policy options.

[2] John Gilbert (2006) 'A Framework for Assessing the Role of PTAs in Trade and Development in Asia and the Pacific,' ESCAP, TID, mimeograph.

With better computing power and the development of exciting econometric and general equilibrium models, the use of indicators went into a somewhat quieter phase in the 1990s. Nevertheless we have many examples of contemporary use of economic indicators for important areas of national, regional and global policymaking, as illustrated below:

a) Indicators to monitor market access indicators for the Millennium Development Goal 8 (http://www.mdg-trade.org)
b) Indicators to track progress towards achieving the European Union internal market (http://ec.europa.eu/internal_market/score/docs/score15/score15_en.pdf)
c) OECD's International Trade Indicators database provides cross-disciplinary information for globalization analysis purposes with particular emphasis on trade aspects (http://stats.oecd.org/wbos/default.aspx?DatasetCode=TRADEINDMACRO)
d) The World Bank combines a number of indicators to provide data on population, environment, economy, states, markets and similar (http://www.worldbank.org)
e) The Statistics Division of ESCAP offers an online database with core annual indicators including economic, demographic, social and composite indices (http://www.unescap.org/stat/data/main/goalindicatorarea.aspx) and another one on short-term indicators by individual country (http://www.unescap.org/stat/data/statind/areaSectorIndicators.aspx)
f) Freedom House and the Heritage Foundation use composite indices to rank countries in terms of economic freedom and status of corruption and bribery (http://www.freedomhouse.org)
g) "Doing Business" at the World Bank benchmarks business regulation and enforcement by tracking selected indicators (http://www.doingbusiness.org/)
h) The World Economic Forum and World Competitiveness Center are behind now widely recognized national competitiveness indices (http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm and http://www.imd.ch/research/centers/wcc/index.cfm).
i) UNCTAD offers the trade and development index "to capture the complex interaction between trade and development and, in the process, to monitor the trade and development performance of countries." Rankings of countries are available online (http://www.unctad.org/Templates/Page.asp?intItemID=3582&lang=1).

A broad definition of a trade indicator is that it is an index or a ratio that can be used to *describe and assess the state of trade flows and trade patterns of a particular economy or economies and can be used to monitor these flows and patterns over time or across economies/regions*. Indicators are the result of using statistical data and as such are the most available, or often the only available, input for so-called *evidence-based policymaking* (Scott, 2005).

Evidence-based policymaking consists of using statistical and other techniques in obtaining sound and transparent data to be used in the consultative process between government and other stakeholders in any area of public policymaking, including trade policy. From the examples given above it appears that evidence-based policymaking in practice has focused on tracking, monitoring and evaluation of the results of policies that have been put in place. However, there is significant scope to use data and empirical research in the process of making decisions in the public area (including on issues recognition, policy choice and sequencing, or forecasting future developments). This approach to policymaking increases transparency and makes policymakers more accountable. Moreover, evidence-based policymaking also builds the platform for democratization of policymaking, particularly in area like trade policy where impacts always cause some income-distributional effects. As recently reported, stakeholders in policymaking agree that "lack of reliable information leads to the dissemination of ideology instead of knowledge, making people misperceive actions of the governments and undermining a democratic decision process" (CESifo, 2007, p.22).

Trade indicators are used in the analysis of international or foreign trade, at the national, regional or global level. By using these indicators one can provide insights into the following type of questions (this list is only illustrative and the ordering is random):

- How much is a country dependent on a regional trade?
- Which are the most dynamic products (sectors) in world (or regional) markets?
- How much of the increase in intra-regional trade could be attributed to a few countries (one country) in a region?
- How intense is trade with (regional) trading partners?

- Are (regional) trading partners' exports becoming more similar (more competitive) or more complementary?
- Is there a geographic "re-orientation" of exports after some external shock (such as financial crisis) or enforcement of a trade agreement?

Asking these questions is a first step towards starting policy oriented research in trade. This is so because each of the above can be followed by "why?" To answer "why" types of questions, one has to engage in further research to identify the most relevant factors that are driving the changes. More often than not, this will require using some econometric testing and should be thus the more technically challenging stage of research.

This handbook does not provide a comprehensive analysis of use of indicators. In particular, it does not contribute to a further development of trade indices from the perspective of statistical theory. It mostly uses indices that have already being constructed in the literature, groups them with respect to the type of information they best provide, and demonstrates their calculation and interpretation in a way that is applicable to any of the ESCAP economies. The handbook, however, contributes to the existing body of empirical literature as it systematizes the available trade indices in terms of the information content they best provide, it clarifies their interpretations from the perspective of a single economy or more economies linked by a preferential trade agreement, it provides precise formulae for calculation, and it offers some policy applications.

3. DATA: AVAILABILITY AND RELIABILITY

Often data for an individual country is available from national statistics, but for comparative purposes it is better to use data sets available from international organizations, such as (in alphabetical order): the International Monetary Fund (IMF), the International Trade Centre (ITC), the United Nations Statistical Division (UNSD), the United Nations Conference on Trade and Development (UNCTAD), the World Bank (WB) and the World Trade Organization (WTO). The United Nations Commodity Trade (COMTRADE) statistical database (http://unstats.un.org/unsd/comtrade/) is used most often. The same commodity trade data is used in the WITS (World Integrated Trade Solution) by the World Bank and to an extent in the

UNCTAD Handbook of Statistics which is available on CDs and at http://www.unctad.org/statistics/handbook. There is a downloadable (but not free) dataset World Trade Database (WTD) maintained by Statistics Canada at http://www.statcan.ca. There are also separate databases on tariffs (and some non-tariff barriers). They are mostly sourced from the published Trade policy reviews (WTO) and countries' notifications on tariff schedules and are accessible through WITS or Trade Analysis Information System (TRAINS) or Integrated Data Base (IDB).[3]

Although trade data is widely available, often it is not complete and it is definitely not fully reliable. In each of the sources of trade data listed above, there are numerous remarks and notes on the weaknesses of data sets.[4] ITC recently published notes on the reliability of trade statistics and reasons for discrepancies in the trade data between trading partners (details available on the ITC website and http://www.trademap.org/reliability_data.php). Users of trade data must be aware of potential problems arising from aggregation of data, currency conversion, incomplete reporting of data and other potential problems when constructing their own trade series.

Without doubt trade in goods is very limited area of economic activity even for a developing country. An increasing share of trade, employment, and income is sourced from tradable services. However, national statistical systems, particularly in developing countries, still have difficulty in providing reliable and timely data on services integrating available information on exports and imports, income, employment and investment. Several agencies (UNSD, European Commission, IMF, OECD, UNCTAD and WTO) are collectively working on devising a better system of collection of services statistics and currently the Manual on Statistics in International Trade in Services, 2002 (http://unstats.un.org/unsd/tradeserv/Papers/m86_english.pdf) and Balance of Payments Manual, 5th edition (http://www.imf.org/external/np/sta/bop/BOPman.pdf) offers best the practical advice. Having a good and comprehensive database including not only trade information but also flows of capital, exchange

[3] There are also other useful datasets such as Consolidated Tariff Schedule (CTS), Common Analytical Market Access Database (CAMAD), or AMAD (Agricultural Market Access Database). See more at http://www.unescap.org/tid/projects/artnetbk05.asp.

[4] The international workshop on Country practices in compilation of international merchanidise trade statistics held at ESCAP in December 2006 revealed a number of problems – more details at http://unstats.un.org/unsd/trade/WS%20Bangkok06/Bangkok_workshop_imts_trade.htm.

rates and data on domestic production and prices, is an important pre-requisite for informed analysis and policymaking. The international community works on standards for the exchange of statistical information from different sources to improve the usability of such data for all users (details on http://www.sdmx.org).

4. READY-TO-USE INDICATORS

It is not always necessary to calculate indicators. There are various online databases which provide a number of trade performance indicators of value for use by policymakers. Below is a short-list of these "over-the-counter" trade indicators for illustrative purposes only.

- ITC – http://www.intracen.org/menus/countries.htm. Country-level statistics provides trade and market profiles and benchmarks for national trade performance and indicators on export supply and import demand. More detailed and specialized datasets are available from the ITC on a subscription basis (www.trademap.org and www.macmap.org).
- WORLD BANK – http://www.worldbank.org/globaloutlook
- UNCTAD – Handbook of Statistics – Part VIII on Special studies http://stats.unctad.org/handbook/ReportFolders/ReportFolders.aspx includes some relevant indices on trade performance and competitiveness.
- OECD - http://stats.oecd.org/wbos/default.aspx?DatasetCode=TRADEINDMACRO
- APTIAD – http://www.unescap.org/tid/aptiad
- ARIC - http://aric.adb.org/indicator.php

Moreover, there is now a long list of empirical literature that provides a good source for various trade performance indicator results. For economies in Asia and the Pacific of special interest is the literature available on the World Bank website: http://lnweb18.worldbank.org/eap/eap.nsf/Sectors/PREM/7E6DC202606E30C485256DFF0062B362?OpenDocument. This site includes trade data on East Asia.

Alternatively, and hopefully, one can calculate desired indicators by using formulae from this handbook and available datasets. Furthermore (and probably more rewarding!) one can work on constructing new indices and composite indicators to answer some of the questions one might be interested in. In constructing an index or an indicator, one needs to observe certain criteria. Most importantly, indicators must be **simple**, **measurable**, **consistent** and **comparable**. Their coverage, of course, may vary as they can be constructed to capture flows of trade at one or more of different levels: sectoral, country, regional, or global. Furthermore, a database should meet these criteria: (1) present a simplified but reliable view of the country, region or whatever the subject of the database would be; (2) contribute to shared knowledge among users, and (3) be useful in making policymaking more transparent and policymakers more accountable.

5. PLAN OF THE HANDBOOK

The objective of this handbook is to be used as a reference in preparation of analysis of already available merchandise trade statistical information for assessment of various trade issues, discussion on negotiating positions and ultimately for conducting consultations. Indicators are grouped in the following categories[5]:

- Trade and economy (trade dependence index, marginal propensity to import, import penetration, export propensity, trade per capita).
- Trade performance (growth rate of trade (exports/imports), normalized trade balance, export/import coverage).
- Direction of trade (trade intensity, intra-regional trade shares, trade entropy).

[5] Some of the indicators could be used to reflect on more than one of the changes in trade patterns so it is possible that other classifications would group indicators somewhat diferently. Most of the indicators listed can be computed for total levels of trade (exports plus imports), or separately for exports and imports for a given economy or a group of economies.

- Sectoral structure of trade (major export category, index of export diversification, revealed comparative advantage, intra-industry trade, trade overlap, complementarity index, export similarity index, competitiveness index).
- Protection (average applied/bound tariffs, weighted average tariffs, dispersion of tariffs).

The handbook consists of seven chapters. Chapter II covers some basic data and notation issues that are common to the following chapters. Chapters III to VI cover definitions, formulae and some calculations for illustrative purposes for selected ESCAP economies of the trade indicators. While it cannot be claimed that all existing indices and indicators are covered in this handbook, considerable effort was put into making sure that most commonly used indicators related to the real side of economy are covered. In each case, the indicators are presented in a simple two page format. The first page has a basic definition, notes on usage, the range of values, interpretation and limitations, and a simple application to give an idea of how the indicator might be used. The second page contains more technical information, including a formal mathematical definition, potential data sources, and a numerical example of the calculation. This material is intended to be helpful when it is necessary not just to understand the indices, but to apply them to a new problem. Chapter VII discusses measures of openness (or protection) at national, regional or global level and offers some indicators commonly used in this area. Chapter VIII concludes with a forward-looking discussion of tools which allow further analysis, enabling more solid answers to "why?" type questions.

II. Notation

Throughout the following chapters we have tried to adopt a common notation so that the trade flow indices are clearly and consistently defined. Understanding the notation requires a small investment in learning about the structure of trade data, the elements of sets, and summation notation. In this chapter we set out the basic ideas.

First consider the basic data element in trade analysis. In any given year, country A sells a given volume of product B to country C. By the same token and from country C's perspective, country C buys this volume of product B from country A in the same year. In trade terminology, country A exports product B to country C, and country C imports product B from country A. The value of this transaction is our basic data element – the product trade flow, in value terms. (Strictly, while the volume should be the same for each country, barring loss and/or measurement error, the value of the transactions will differ slightly because of transportation/insurance. In practice, because the export and import data is often from different sources, it can differ substantially.) We denote this particular data element x_{BAC}, which means simply "exports of product B from A to C." More generally, the basic data element in the text that follows will be x_{isd} where i is the good that is being traded, s is the country that is selling (source of exports) and d is the country that is buying (destination for imports) – and the labels chosen are entirely arbitrary. Because we are referring to single flow, it follows that $x_{isd} = m_{isd}$, where m denotes imports.

There are different ways in which the two parties to the transaction are referred to in the various data sources. In COMTRADE, for example, the data is classified by who supplied it. Thus, if the data is exports, COMTRADE would refer to the exporting country (A) as the "reporter" and the importing country (B) as the "partner." On the other hand, in import data from COMTRADE, the "reporter" is the importing country and the "partner" is the exporting country. This can be a little confusing. The Global Trade Analysis Project (GTAP), on the other hand, adopts a convention that always identifies the direction of the flow. In this terminology the exporting country is the "source" and the importing country the "destination." Any given trade flow is an export from the perspective of the source and an import from the perspective of the destination. We adopt this convention here.

The label i can be thought of as representing a single product category in a larger product set. We can let **I** be the set of all product groups in the data. The size of the set and its exact composition will depend on the data being used (e.g., HS1996 or

SITC, at various digit levels). So for example, it might contain three elements: **I**={Agriculture, Textiles, Manufactures}.

Similarly, the labels *s* and *d* can be thought of as representing a single element of a larger set of countries, and we can let **S** and **D**, respectively, represent those sets. It may be that each set contains only a single country, or multiple countries, or all countries, depending on the context. So, for example, we might have **S**={Australia}, and **D**={Japan, the Republic of Korea, China}. Often the destination might be the entire world.

Once we have defined our sets, we can define summations (adding up) over those sets. The summation notation is a very convenient way of expressing the various trade flow totals that we will be interested in. Its usage can be made clear with a few examples. Suppose we want to know the total trade between two countries. Then we are interested in the following sum:

$$\sum_{\forall i \in I} x_{isd}$$

This is the total over all products of exports from country *s* to country *d*. The sigma (∑) is the summation operator, and the expression underneath tells us what we are adding up over. It is read "for all *i* that are a member of the set **I**." In words, the expression says to add up all the individual product trade flows from country *s* to country *d*. We can of course add up over more than one index, so for example the expression:

$$\sum_{\forall i \in I} \sum_{\forall d \in D} x_{isd}$$

is the total exports of all products from country *s* to all destinations in the set **D**. If **D** is the set of all possible destinations, then the expression is the total exports of country *s*. Since addition is commutative (i.e., A+B is equal to B+A), the order of the addition does not matter, and we may write the same expression in a more compact form:

$$\sum_{\forall i \in I, \forall d \in D} x_{isd}$$

However, even this is a bit cumbersome. At the risk of upsetting the mathematical purists, we adopt a further simplification and drop the sets from the summation expression, instead letting the index itself indicate which set we need, which is always clear from context. Hence, we can write the above expression as follows:

$$\sum_{id} x_{isd}$$

This means that we want to add up the export flows of country *s* over all products and destinations.

Because of the frequency with which total trade statistics are used, we adopt a further simplification for total trade flows. That is, we use an upper case *X* to denote the total trade flow of all products from one country to another. So X_{AB} is the total value of exports from A to B. More generally:

$$X_{sd} = \sum_{i} x_{isd}$$

This avoids repeatedly summing over the *i* index when it is clear from context that this is required.

We finish with some numerical examples that should make the link between notation and data clear. The data we use here and throughout many of the examples in the handbook has been drawn from the GTAP project (Dimaranan, 2006). It is presented in a highly aggregated form that is not really suitable for real world calculations, but is more than adequate to illustrate the computations involved.

The trade data can be arranged in many ways, and different organizations will suit different purposes. A common method is to use a matrix, such as the following for world trade in wheat in 2002:

	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW[6]	Total
Australia	0	4	3	168	441	777	1393
New Zealand	0	0	0	0	7	0	7
China	0	0	0	54	18	2	74
Rep. of Korea	0	0	0	0	1	0	1
ASEAN	0	0	0	0	6	3	9
ROW	5	3	150	339	960	12836	14293
Total	5	7	153	561	1433	13618	15777

Trade Matrix for Wheat (2002) – Units US$ millions

In this representation the exporting countries/regions are in the rows, while the importing countries are in the columns. Hence, for example, in 2002 Australia exported $US168 million in wheat to the Republic of Korea (highlighted in blue). On the other hand, China imported $150 million in wheat from the rest of the world in 2002 (measured net of insurance and freight, highlighted in red).

Note that the diagonal elements for single economies are zero. This is because, by definition, a country does not trade with itself. If the matrix contains aggregate regions (e.g., ASEAN), however, there will be non-zero elements on the diagonal. These represent the intra-regional exports of the group. Note also that for convenience, it is common to put the row and

[6] We use the term ROW (rest of world) in this and in all subsequent tables in the handbook as shorthand for the sum over all countries/regions that do not appear in the table expressly.

column sums in the table. Row sums are total exports of the product by the country/region in the row heading, while column sums are total imports of the product by the country/region in the column heading.

For example, total exports of wheat by Australia in 2002 were worth $1393 million (highlighted in green). In terms of our mathematical notation this would be:

$$\sum_d x_{isd}$$

Where *i*={wheat}, *s*={Australia} and *d*={Australia, New Zealand, China, Republic of Korea, ASEAN, rest of world}. Similarly, total imports of wheat by the ASEAN economies in 2002 were $1433 million (highlighted in purple). In terms of our notation this would be:

$$\sum_s m_{isd}$$

Where *i*={wheat}, *s*={Australia, New Zealand, China, Republic of Korea, ASEAN, rest of world}, and *d*={ASEAN}.

We can form a total trade matrix by adding across all industries first, such as in the example below. This is read in exactly the same way as the product matrix, the rows are the exporters (sources) and the columns the importers (destinations). Again, it is common to supply the row and column totals, since these are used so frequently. They represent the total exports of the countries/regions in the row headings and the total imports of the countries/regions in the column headings, respectively.

For example, total exports from New Zealand to ASEAN in 2002 were $1187 million (highlighted in blue). On the other hand, total exports by ASEAN to all countries in 2002 were $385344 (highlighted in red). Mathematically this is:

$$\sum_d X_{sd}$$

Where s={ASEAN}, and d={Australia, New Zealand, China, Republic of Korea, ASEAN, rest of world}.

	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	3348	4878	5213	7070	41062	61571
New Zealand	2564	0	777	659	1187	9633	14820
China	6058	867	0	16243	23301	398969	445438
Rep. of Korea	2516	301	24232	0	17521	115477	160047
ASEAN	9850	1130	24832	15950	80320	253262	385344
ROW	43045	7169	156819	103738	174227	4341696	4762074
Total	64033	12815	211538	141803	303626	5160099	5893914

Total Trade Matrix (2002) – Units US$ millions

As a final note, tables are generally limited to two dimensions, and this limits the amount of useful data that we can present in them. The trade data has three dimensions (i.e., product, source and destination, and four if we include time). Depending on context, it will be useful to present only the column/row sums for various products or countries or years. Hence, for example, if our interest is in the total trade by country of all commodities, we would drop the destinations from the table and present only the sum over all destinations. This would free up a dimension in the table to use for sectors. Nonetheless, we continue to keep the underlying summation in our presentation of index calculations, for preciseness, to avoid any potential ambiguity, and because when working with original data carrying out the summations may be required.

III. Trade and Economy

This chapter includes information on the following indicators, which provide information on the significance of international trade relative to the overall economy:

- Trade dependence index (openness)
- Import penetration index
- Export propensity index
- Marginal propensity to import

The first indicator, the *trade dependence index*, is one of the most widely used trade statistics. Also termed the *openness* index, it measures the ratio of international trade to the total value of net output (gross domestic product or GDP). A high index value is often interpreted as indicating a more open economy (hence the second terminology) although the index is biased by other factors, including economic size.

The next two indicators are variations on trade dependence indicators that may be more useful in understanding an economy's vulnerability to certain types of external shocks (e.g., exchange rate movements). The *import penetration index* measures the proportion of domestic demand that is satisfied by imports. It is also termed an *import dependency index* and an aggregate *self-sufficiency index*. The second is the *export propensity index*, which measures the share of exports in GDP.

Finally, the *marginal propensity to import* index is an approximation to a commonly used macroeconomic variable. It tells us how much we expect imports to rise for a given rise in the value of income (GDP). Again, this may be useful in evaluating the possible response of an economy to external or internal (policy) shocks.

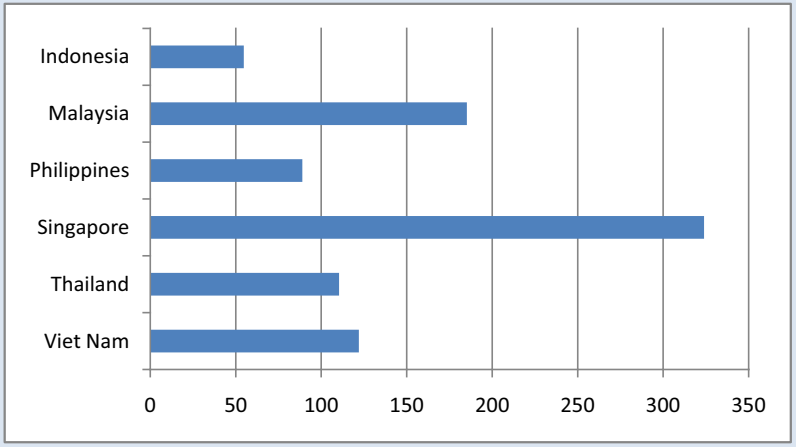
Trade Dependence Index

What does it tell us? The trade dependence index (also often called the openness index) is a measure of the importance of international trade in the overall economy. It can give an indication of the degree to which an economy is open to trade (subject to some serious limitations).

Definition: The value of total trade (imports plus exports) as a percentage of GDP.

Range of values: Takes values between 0 and +∞.

Limitations: Openness of an economy is determined by a large number of factors, most importantly by trade restrictions like tariffs, non-tariff barriers, foreign exchange regimes, non-trade policies and the structure of national economies. The share of trade transactions in a country's value added is a result of all these factors. It is possible that an open and liberalized economy has a relatively small TDI, if a large proportion of its GDP is created by non-traded activities supported by the domestic market. Low trade dependence may indicate high trade restrictions either in that country or towards that country in overseas markets, or both.



Trade Dependence Index for ASEAN-6 Economies (2005)

Example: The above graph presents the trade dependence index for the ASEAN-6 economies in 2005, calculated with trade data from COMTRADE and GDP data from World Development Indicators (both expressed in current US$). There is considerable variation in the degree of openness within these economies, with Malaysia and Singapore much more dependent on trade than the other economies. Note that it is possible for the value of trade to exceed the value of production, hence the index values of over 100 per cent for several economies.

Trade Dependence – Technical Notes

Mathematical definition:

$$\frac{\sum_s X_{ds} + \sum_s M_{sd}}{GDP_d} \times 100$$

Where **d** is the country under study, **s** is the set of all other countries, **X** is total bilateral exports, **M** is total bilateral imports and **GDP** is gross domestic product (of country **d**). In words, the numerator is total exports from **d** plus total imports to **d**, and the denominator is the GDP of **d**.

Data sources: Trade data can be obtained from the United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University. GDP data can be obtained from the World Development Indicators, the Penn World Tables, and national sources.

	GDP	Exports	Imports	TDI
2001	160446	55884	28845	53
2002	195660	56857	30664	45
2003	234773	60777	52518	48
2004	256835	64241	61809	49
2005	286961	85660	71368	55

Trade and Production Data for Indonesia (2001-2005)

Sample calculation: The table above presents GDP and trade data for Indonesia for the period 2001-2005. The GDP data is from the World Development Indicators (WDI), while the trade data is from COMTRADE. All of the data is in compatible units (millions of current US dollars). To calculate the trade dependence index (TDI) we add the total exports to total imports to obtain total trade. In 2005 exports were $85660 (in red) while imports were $71368 (in green). Hence total trade was $158028. Dividing this number by the GDP of $286961 (in blue) and multiplying by 100 to convert to a percentage, we obtain 55 per cent (in purple). This is the measure of trade dependence or openness for Indonesia in 2005. As we can see from the table, the indicator has remained fairly constant over the five year period.

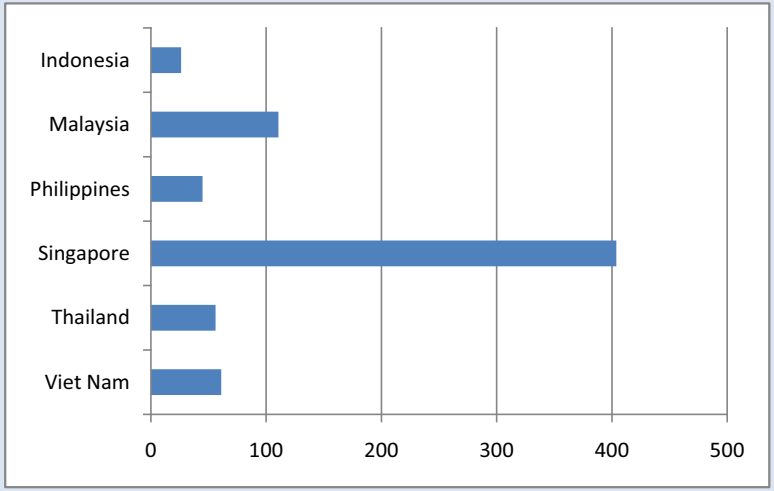
Import Penetration

What does it tell us? The import penetration rate shows to what degree domestic demand (the difference between GDP and net exports) is satisfied by imports. Calculated at the sectoral level it is termed the self-sufficiency ratio. The index may be used as the basis of specific policy objectives targeting self-sufficiency. It may provide an indication of the degree of vulnerability to certain types of external shocks.

Definition: The ratio of total imports to domestic demand, as a percentage.

Range of values: Ranges from 0 (with no imports) to 100 per cent when all domestic demand is satisfied by imports only (no domestic production and no exports).[7]

Limitations: The import penetration index is biased upward by the re-exports (can be corrected for in principle). Will tend to be negatively correlated with economic size. A low import penetration ratio (complete self-sufficiency) may be an inappropriate policy target from an efficiency perspective.



Import Penetration Index for ASEAN-6 Economies (2005)

Example: The above figure presents the import penetration index for the ASEAN-6 economies in 2005. Note the very high figures for Singapore and Malaysia – this does not represent true import penetration, but rather the presence of re-exports in the raw data.

[7] In practice the index can exceed 100 per cent if re-exports are not accounted for, see example.

Import Penetration – Technical Notes

Mathematical definition:

$$\frac{\sum_s M_{sd}}{GDP_d - \sum_s X_{ds} + \sum_s M_{sd}} \times 100$$

Where **d** is the country under study, **s** is the set of all other countries, **X** is total bilateral exports, **M** is total bilateral imports and **GDP** is gross domestic product (of country **d**). In words, the numerator is total imports to **d**, the denominator is the GDP of **d** less total exports and plus total imports (i.e., total domestic demand).

Data sources: Trade data can be obtained from the United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University. GDP data can be obtained from the World Development Indicators, the Penn World Tables, and national sources.

	GDP	Exports	Imports	Domestic Demand	Import Penetration
2001	71216	32077	35702	74841	48
2002	76814	35116	35157	76855	46
2003	79634	36095	40836	84374	48
2004	86703	39610	45417	92510	49
2005	98366	41198	46310	103478	45

Trade and Production Data for the Philippines (2001-2005)

Sample calculation: The table above presents GDP and trade data for the Philippines for the period 2001-2005. The GDP data is from the World Development Indicators (WDI), while the trade data is from COMTRADE. All of the data is in compatible units (millions of current US dollars). The fourth column in the table is domestic demand, calculated as GDP less exports and plus imports, this is the demominator of the import penetration ratio. We illustrate the required calculation with 2005. The value of GDP was $98366 (in blue). Subtracting exports of $41198 (red) and adding imports of $46310 (green) yields domestic demand of $103478 (purple). Taking the ratio of imports to domestic demand ($46310/$103478) and multiplying by 100 to put the expression in percentage terms yields 45 per cent. In words, imports (in aggregate) satisfied 45 per cent of the aggregate demand in the Philippines in 2005, with the remaining 55 per cent satisfied by domestic production.

Note: It is common to calculate this indicator on a sectoral basis, using sectoral imports and value added. This is usually termed a self-sufficiency ratio.

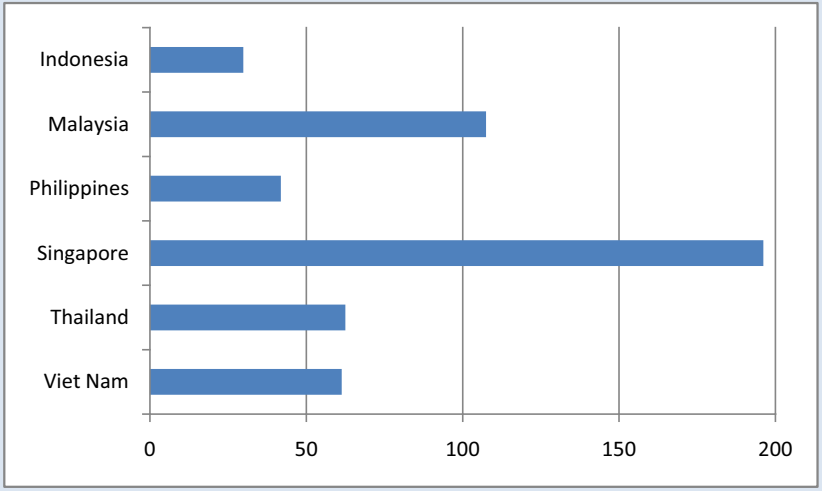
Export Propensity

What does it tell us? The index shows the overall degree of reliance of domestic producers on foreign markets. It is similar to the trade dependence index, but may provide a better indicator of vulnerability to certain types of external shocks (e.g., falls in export prices or changes in exchange rates). It may be a policy target.

Definition: The ratio of exports to GDP, defined as a percentage.

Range of values: The ratio is expressed as a percentage and it ranges from zero (with no exports) to 100 (with all domestic production exported).[8]

Limitations: The export propensity index is biased upward by the re-exports (can be corrected for in principle). Will tend to be negatively correlated with economic size. A high export propensity may be an inappropriate policy target from an efficiency perspective.



Export Propensity Index for ASEAN-6 Economies (2005)

Example: The above figure presents the export propensity index for the ASEAN-6 economies in 2005. Note again the very high figures for Singapore and Malaysia – this in part represents the presence of re-exports in the raw data.

[8] As with the import penetration index, in practice the index can exceed 100 per cent if re-exports are not accounted for. See example.

Export Propensity – Technical Notes

Mathematical definition:

$$\frac{\sum_s X_{ds}}{GDP_d} \times 100$$

Where **d** is the country under study, **s** is the set of all other countries, **X** is total bilateral exports, and **GDP** is gross domestic product (of country **d**). In words, the numerator is total exports from **d**, and the denominator is the GDP of **d**.

Data sources: Trade data can be obtained from the United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University. GDP data can be obtained from the World Development Indicators, the Penn World Tables, and national sources.

	GDP	Exports	Export Propensity
2001	115536	64877	56
2002	126877	67845	53
2003	142640	79892	56
2004	161349	96069	60
2005	176222	110108	62

Trade and Production Data for Thailand (2001-2005)

Sample calculation: The table above presents GDP and trade data for Thailand for the period 2001-2005. The GDP data is from the World Development Indicators (WDI), while the trade data is from COMTRADE. All of the data is in compatible units (millions of current US dollars). The third column of the table presents the export propensity values. For 2005, the value of exports was $110108 (in blue), while the (net) value of production was $176222 (in red). Taking the ratio of exports to GDP and multiplying by 100 to convert to percentage terms we have 62 per cent.

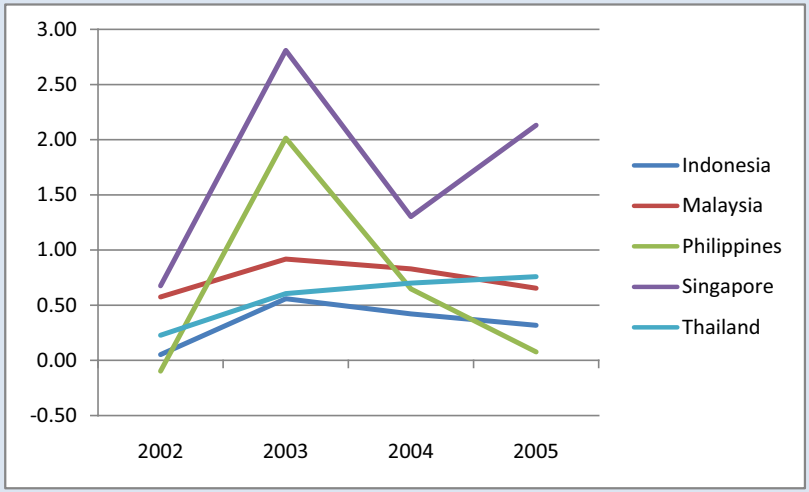
Marginal Propensity to Import

What does it tell us? The marginal propensity to import (MPM) is measure of the extent to which imports are induced by a change in incomes. The relevance for policymakers depends on the cycle of the economy. With higher MPM, in an economic downturn with a fall in GDP, there will also be a significant fall in imports as compared with lower a MPM. More generally, a higher MPM reduces the multiplier effect of an increase in GDP.

Definition: The ratio of the change in total imports to the change in GDP over a defined period (typically one year).

Range of values: In macroeconomic theory ranges between 0 (with no part of extra GDP spent on additional imports) to 1 when the whole extra GDP created is spent on imports.

Limitations: The MPM is not a constant and can vary over time, so care should be taken in using it as an input to policy decisions. Calculations based on annual data only approximate the true value, and may lie outside of the theoretically sensible range (see example).



MPM for Selected ASEAN Economies (2002-2005)

Example: In the figure above we have calculated the MPM over time for selected economies in ASEAN. These are calculated year on year. We observe a substantial increase in the MPM in all the economies in 2003. Note that the calculated values can in fact be negative or exceed unity, in particular in countries with high levels of re-exports.

Marginal Propensity to Import – Technical Notes

Mathematical definition:

$$\frac{\Delta \sum_s M_{sd}}{\Delta GDP_d}$$

Where **d** is the country under study, **s** is the set of all other countries, Δ is the change operator, **M** is total bilateral imports and **GDP** is gross domestic product (of country **d**). In words, the numerator is the change in total imports to **d** over a given period (usually one year), and the denominator is the change in GDP of **d** over the same period.

Data sources: Trade data can be obtained from the United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University. GDP data can be obtained from the World Development Indicators, the Penn World Tables, and national sources.

	GDP	Imports	Δ GDP	Δ Imports	MPM
2001	88001	69344			
2002	95164	73459	7163	4115	0.57
2003	103992	81563	8828	8104	0.92
2004	118461	93559	14469	11996	0.83
2005	130770	101612	12309	8053	0.65

Trade and Production Data for Malaysia (2001-2005)

Sample calculation: The table above presents GDP and trade data for Malaysia for the period 2001-2005. The GDP data is from the World Development Indicators (WDI), while the trade data is from COMTRADE. All of the data is in compatible units (millions of current US dollars). To calculate the marginal propensity to import (MPM) we take the first differences in GDP and imports. In other words, for each year we subtract from the value of GDP the value of the preceding year's GDP, and similarly for imports. These values are in the third and fourth columns of the table. The fifth column is the ratio of the changes. Hence, the MPM for 2005 (relative to 2004) is the change in imports ($8053, in blue) divided by the change in GDP ($12309, in red). This gives us 0.65 (in green). In other words, in Malaysia in 2005, an increase in GDP by $1 might result in roughly a $0.65 increase in imports.

IV. Trade Performance

This chapter includes information on the following indicators, which provide information on the trade performance of an economy or region:

- Growth rate of exports (imports/trade)
- Normalized trade balance
- Export/import coverage

The first indicator, the *compound growth rate*, directly tracks how the value of exports, imports or trade is changing over time. This is one of the most common indicators used when assessing the progress of an economy in any area of economic activity. Often the rate is calculated at level of product groups to identify 'dynamic sectors' or at the regional level to indicate 'dynamic regions.'

The next two indicators are normalized versions of the trade balance, the difference between the value of exports and the value of imports. The *normalized trade balance* index expresses the trade balance as a fraction of total trade. This adjustment allows for meaningful comparisons across countries or time periods by eliminating problems with the units of measurement. Similarly, the *export/import coverage* index expresses the trade balance in terms of a ratio of its components rather than a difference, thereby eliminating the units of measurement and making comparisons across time/regions easier. Although often a variable of considerable interest to policymakers, the trade balance indices should be interpreted carefully. A trade surplus is not necessarily better than a deficit, and the trade balance can reflect many factors outside of the realm of trade policy. This is particularly true for balances calculated at the bilateral level.

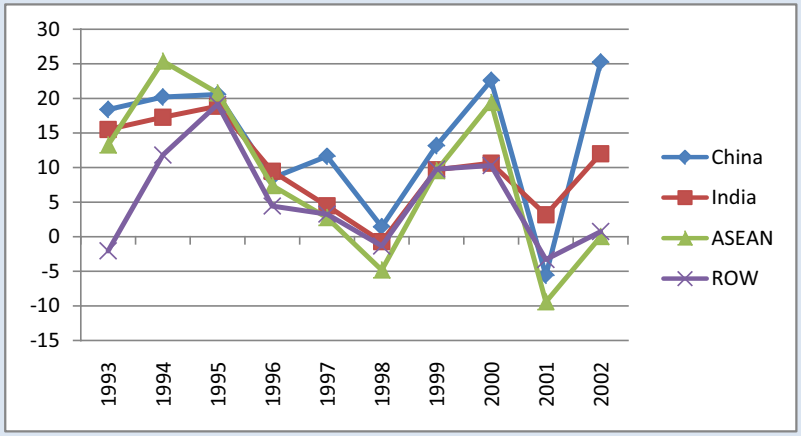
Growth Rate of Exports

What does it tell us? The growth rate is one of the most common indicators used when assessing the progress of an economy in any area of economic activity. Often the rate is calculated at level of product groups to identify 'dynamic sectors.' Comparison of such indicators over many countries might be of interest to producer or exporter associations, investors, policymakers and trade negotiators.

Definition: The annual compound percentage change in the value of exports between two periods.

Range of values: The growth rate is a percentage. It can take a value between -100 per cent (if trade ceases) and +∞. A value of zero indicates that the value of trade has remained constant.

Limitations: Does not explain the source of growth. When evaluating long periods need to be careful of changes in measurement and methods. Growth rates assessed on nominal trade figures may be distorted by exchange rate movements and other factors in the short run.



Selected Export Growth Rates (1993-2002)

Example: Calculating the growth rates for major economies or regional groupings, and ranking them relative to the growth of world exports, can identify 'dynamic' regions in world trade. The above figure depicts the annual growth rate in exports for China, India and ASEAN relative to the rest of world average. The dip in the period 1997-1998, particularly strong for ASEAN, presumably reflects the Asian financial crisis. Overall, however, the region is very dynamic, with average growth rates over the decade of 14 per cent for China, 10 per cent for India, and 8 per cent for ASEAN. This compares to only 5 per cent for the rest of the world.

Growth Rate of Exports – Technical Notes

Mathematical definition:

$$\left(\left(\frac{\sum_{sw} X^{1}_{sw}}{\sum_{sw} X^{0}_{sw}} \right)^{\frac{1}{n}} - 1 \right) \times 100$$

Where **s** is the set of countries in the source, **w** is the set of countries in the world, $\mathbf{X^0}$ is the bilateral total export flow in the start period, $\mathbf{X^1}$ is the bilateral total export flow in the end period, and **n** is the number of periods (not including the start).

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	China	Annual Growth	India	Compound Growth from 1998
2002	445438	25.2	53497	8.8
2001	355696	-5.6	47772	7.8
2000	376706	22.6	46305	10.1
1999	307277	13.2	41859	9.7
1998	271536		38167	

Total Value of Exports for China and India (1998-2002)

Sample calculation: The table above presents the raw export figures for China and India over a five year span (in US$ millions). To calculate the growth of China's exports between 2001 and 2002 (in blue) we take (445438/355696-1)×100=25 per cent. To calculate the compound growth rate of India over the full period we take the ratio of the starting and ending period levels (in red): 53497/38167, and raise to the power of 1/4 (since there are four periods of growth). The result is 1.088. Subtracting one and multiplying by 100 gives us 8.8 per cent.

Notes: The compound growth rate is the annual growth rate required to generate a given level of total growth over a period of length n. If n is equal to 1, this is simply the percentage change in exports. The growth rate may also be calculated for a subset of destinations, or for a subset of products, with appropriate modification. The growth rate can also be calculated for imports and/or trade (imports plus exports).

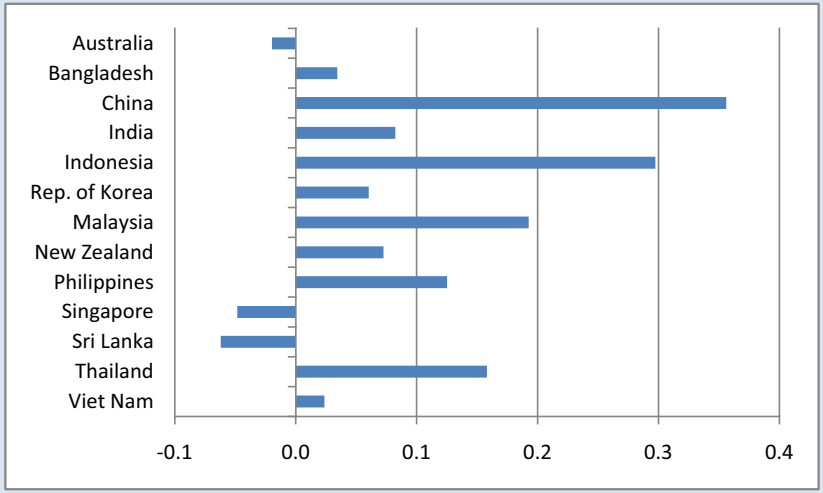
Normalized Trade Balance

What does it tell us? The normalized trade balance represents a record of a country's trade transactions with the rest of the world normalized on its own total trade. In general, economists expect that the trade balance will be zero in the long run, thus imports are financed by exports, but it may vary considerably over shorter periods.

Definition: The trade balance (total exports less total imports) as fraction of total trade (exports plus imports).

Range of values: The index range is between -1 and +1, which allows unbiased comparisons across time, countries and sectors. A value of zero indicates trade balance.

Limitations: The economic reasons for a trade surplus/deficit are complex, and the index cannot directly help shed light on them. Potential for misuse high, especially with respect to bilateral balances.



Normalized Trade Balance for Selected Economies (2002)

Example: The above figure depicts the normalized trade balance for selected economies in 2002. Negative figures indicate a deficit, observed in Australia, Singapore and Sri Lanka. Substantial surpluses are observed in China and Indonesia. However, the balance depicted is calculated on merchandise trade. The balance including services trade may differ.

Normalized Trade Balance – Technical Notes

Mathematical definition:

$$\frac{\sum_{sw} X_{sw} - \sum_{ws} M_{ws}}{\sum_{sw} X_{sw} + \sum_{ws} M_{ws}}$$

Where **s** is the set of countries in the source, **w** is the set of countries in the world, **X** is the bilateral total export flow, and **M** is the bilateral total import flow in the end period. In words, we take total exports from the source region less total imports to the source region, and divide by the total trade of the source region.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Imports	Exports	Normalized Trade Balance
Bangladesh	5919	6340	0.03
China	211538	445438	0.36
India	45356	53497	0.08
Indonesia	36284	67001	0.30
Malaysia	69829	103150	0.19
New Zealand	12815	14820	0.07
Philippines	30554	39294	0.13
Rep. of Korea	141803	160047	0.06
Singapore	104726	95076	-0.05
Sri Lanka	5415	4783	-0.06
Thailand	47609	65488	0.16
Viet Nam	14624	15335	0.02

Total Value of Exports and Imports for Selected Economies (2002)

Sample calculation: The table above presents the raw export and import figures for selected economies in 2002 (in US$ millions). To calculate the normalized trade balance for Bangladesh we would take the difference between total exports (in red) and total imports (blue). This is $421. We divide this by total trade, $12259. The result is +0.03.

Notes: Calculated at the product level, the normalized trade balance corresponds to the **intra-industry trade index**. The normalized trade balance can also be calculated against a sub-region or country, but economic logic does not give us any reason to expect bilateral balance. Hence the results of such an analysis may be informative on the structure of trade, but have little economic significance.

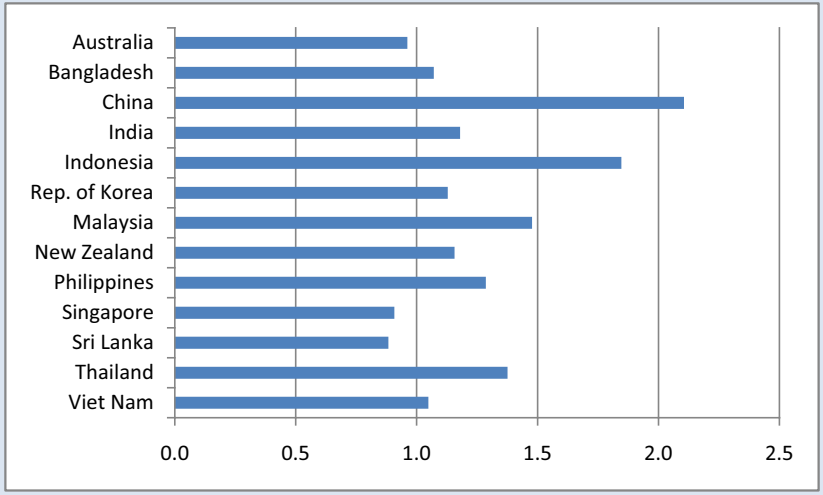
Export/Import Coverage

What does it tell us? This is an alternative to the normalized trade balance. It tells us whether or not a country's imports are fully paid for by exports in a given year. In general, economists expect that the trade balance will be zero in the long run, thus imports are financed by exports, but it may vary considerably over shorter periods.

Definition: The ratio of total exports to total imports.

Range of values: The values for this index range from 0 when there are no exports to $+\infty$ when there are no imports. A ratio of 1 signals full coverage of imports with exports (trade balance).

Limitations: Same as for the normalized trade balance. The economic reasons for a trade surplus/deficit are complex, and the index cannot directly help shed light on them. Potential for misuse high, especially with respect to bilateral balances.



Export/Import Coverage for Selected Economies (2002)

Example: We use the same subset of countries and year as for the normalized trade balance, for comparative purposes. The above figure depicts the export/import coverage for selected economies in 2002. Now figures less than one indicate a deficit, observed in Australia, Singapore and Sri Lanka. Substantial surpluses are observed in China and Indonesia. Again, the balance depicted is calculated on merchandise trade. The balance including services trade may differ.

Export/Import Coverage – Technical Notes

Mathematical definition:

$$\frac{\sum_{sw} X_{sw}}{\sum_{ws} M_{ws}}$$

Where **s** is the set of countries in the source, **w** is the set of countries in the world, **X** is the bilateral total export flow, and **M** is the bilateral total import flow in the end period. In words, we take total exports from the source region, and divide by the total imports of the source region.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Imports	Exports	Export/Import Coverage
Australia	64033	61571	0.96
Bangladesh	5919	6340	1.07
China	211538	445438	2.11
India	45356	53497	1.18
Indonesia	36284	67001	1.85
Malaysia	69829	103150	1.48
New Zealand	12815	14820	1.16
Philippines	30554	39294	1.29
Rep. of Korea	141803	160047	1.13
Singapore	104726	95076	0.91
Sri Lanka	5415	4783	0.88
Thailand	47609	65488	1.38
Viet Nam	14624	15335	1.05

Total Value of Exports and Imports for Selected Economies (2002)

Sample calculation: The table above presents the raw export and import figures for selected economies in 2002 (in US$ millions). To calculate the export/import coverage for Bangladesh we would take total exports (in red) and divide by total imports (blue), i.e., $6340/5919=1.07.

Notes: The export/import coverage can also be calculated against a sub-region or country, but economic logic does not give us any reason to expect bilateral balance. Hence the results of such an analysis may be informative on the structure of trade, but have little economic significance.

V. Direction of Trade

This chapter includes information on the following indicators which can inform policymakers on the level of and changes in the regional pattern or direction of trade flows:

- Export/import/trade shares
- Regional market share
- Trade intensity
- Size adjusted regional export share
- Regional Hirschmann
- Trade entropy

Trade share statistics have many uses. Hence, for example, if we want to know which economies are the most important export destinations for India, we could calculate the shares of India's exports to different economies in India's total exports, and rank them in order of size. If we wish to know whether the introduction of AFTA increased trade among ASEAN economies, we can measure changes over time in the proportion of ASEAN trade is that is with other ASEAN economies. The *regional market share* is a special case that is relevant for assessing regional trading agreements (or trade blocs).

Trade share statistics are also a basic building block for other, more sophisticated, indices of the pattern of trade. The *trade intensity index* can be thought of as a normalized export share. It tells us whether or not the observed share of trade is greater than the world average, or 'intense' relative to what we might expect. The *size adjusted regional export share* statistic is similar, and is a special case designed to look for at whether the intra-regional trade of a given regional trade group is high relative to what might be expected given the size of the membership.

The last two indicators are different measures of the geographical concentration or diversification of a country (or region's) export profile. The *regional Hirschmann* and *trade entropy* indices address the question of whether or not an economy is heavily reliant on a small number of export markets, or sells to a diverse range of economies. They are useful to assess integration into global markets, or the vulnerability of an economy to shifts in economic conditions in particular markets.

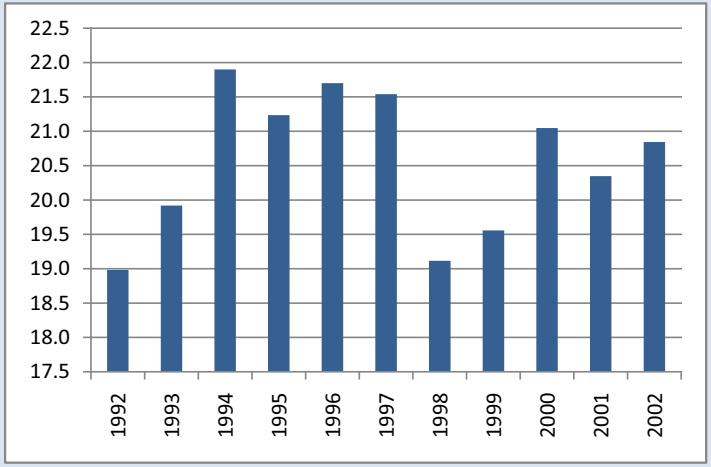
Export Share

What does it tell us? The export share tells us how important a particular export partner is in terms of the overall export profile of an economy. Changes in the export share over time may indicate that the economies in question are becoming more integrated. In the case of intra-regional export shares, increases in the value over time are sometimes interpreted as an indicator of the significance of a regional trading bloc if one exists, or as a measure of potential if one is proposed. The latter assumes that groups with high shares are in some sense 'natural' trading partners.

Definition: The export share is the percentage of exports from the region under study (the source) to the region of interest (the destination) in the total exports of the source region.

Range of values: Takes a value between 0 and 100 per cent, with higher values indicating greater importance of selected trading partner.

Limitations: The intra-regional export share is increasing in the size of the bloc considered by definition, so comparing the shares across different blocs may be misleading. High or low export shares and changes over time may reflect factors other than trade policy.



Intra-Regional Export Shares (per cent) for ASEAN (1992-2002)

Example: Suppose that we wish to find out the proportion of ASEAN's exports that go to other ASEAN members. This particular export share is called the ASEAN **intra-regional export share**. The values are depicted in the figure above. As we can see, the share has increased marginally since the formation of the ASEAN Free Trade Area (AFTA) in 1993.

Export Share – Technical Notes

Mathematical definition: The export share is defined as:

$$\frac{\sum_{sd} X_{sd}}{\sum_{sw} X_{sw}} \times 100$$

Where **s** is the set of countries in the source, **d** is the set of countries in the destination, **w** is the set of countries in the world, and **X** is the bilateral total export flow. The numerator is thus exports from the source to the destination, the denominator total exports from the source.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam	ROW	Total
Indonesia	0	2029	797	5347	1229	389	57210	67001
Malaysia	1550	0	1289	18471	3923	657	77260	103150
Philippines	145	2289	0	2353	516	90	33901	39294
Singapore	4104	14355	2252	0	5370	1443	67552	95076
Thailand	1192	3074	802	4870	0	0	55550	65488
Viet Nam	257	321	272	934	0	0	13551	15335
ROW	29036	47761	25142	72751	36571	12045	5285264	5508570
Total	36284	69829	30554	104726	47609	14624	5590288	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: Exports from the ASEAN-6 economies to other members of ASEAN-6 are highlighted in blue. Total exports from ASEAN-6 economies to all countries are highlighted in red (the row sums). Adding together the numbers in blue we get $80320. This is total intra-ASEAN exports. Adding the numbers in red we get $385344. This is total ASEAN exports to all countries. Taking the ratio and multiplying by 100 we get 20.8 per cent, the intra-regional export share for ASEAN in 2002.

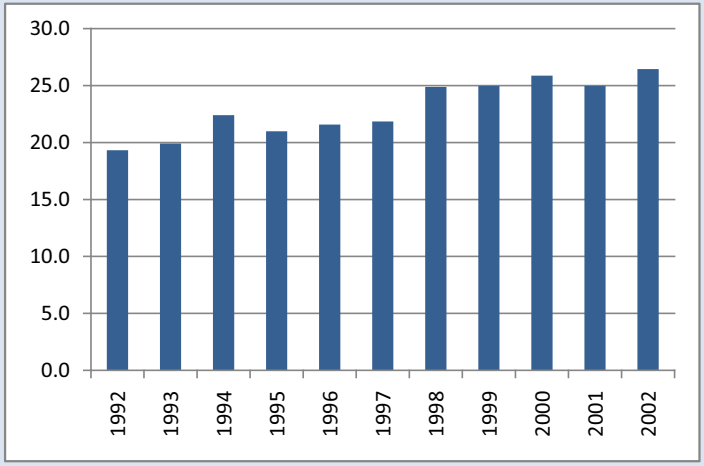
Import Share

What does it tell us? The import share tells us how important a particular trade partner is in terms of the overall import profile of an economy. Changes in the import share over time may indicate that the economies in question are becoming more integrated. In the case of intra-regional import shares, increases in the value over time are sometimes interpreted as an indicator of the significance of a regional trading bloc if one exists, or as a measure of potential if one is proposed.

Definition: The import share is the percentage of imports from the region of interest (the source) to the region under study (the destination) in the total imports of the destination.

Range of values: Takes a value between 0 and 100 per cent, with higher values indicating greater importance of selected trading partner.

Limitations: The intra-regional import share is increasing in the size of the bloc considered by definition, so comparing the shares across different blocs may be misleading. High or low shares and changes over time may reflect numerous factors other than trade policy.



Intra-Regional Import Shares (per cent) for ASEAN (1992-2002)

Example: Staying with the previous example, now suppose that we wish to find out the proportion of ASEAN's imports that come from other ASEAN members. This particular import share is called the ASEAN **intra-regional import share**. The values are depicted in the figure above. As we can see, the share has increased more substantially than the export share since the formation of the ASEAN Free Trade Area (AFTA) in 1993.

Import Share – Technical Notes

Mathematical definition:

$$\frac{\sum_{sd} M_{sd}}{\sum_{wd} M_{wd}} \times 100$$

Where **s** is the set of countries in the source, **d** is the set of countries in the destination, **w** is the set of countries in the world, and **M** is the bilateral import flow. The numerator is thus imports from the source to the destination, the denominator total imports to the destination.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam	ROW	Total
Indonesia	0	2029	797	5347	1229	389	57210	67001
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Thailand	1192	3074	802	4870	0	0	55550	65488
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ROW	29036	47761	25142	72751	36571	12045	5285264	5508570
Total	36284	69829	30554	104726	47609	14624	5590288	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: Exports from the ASEAN-6 economies to other members of ASEAN-6 are also imports of ASEAN-6 economies from other ASEAN-6 economies. These are again highlighted in blue. Total imports by ASEAN-6 economies from all countries are highlighted in green (the column sums). Adding the numbers in blue we get $80320. This is total intra-ASEAN imports. Adding the numbers in green we get $303626. This is total ASEAN imports. Taking the ratio and multiplying by 100 we get 26.5 per cent, the intra-regional import share for ASEAN in 2002.

Note: The intra-regional import share may differ from the intra-regional export share when total trade is not balanced (i.e., the value of exports does not equal the value of imports). Import and export shares differ in general because the economies from which an economy buys goods are not necessarily the same as those to which it sells goods.

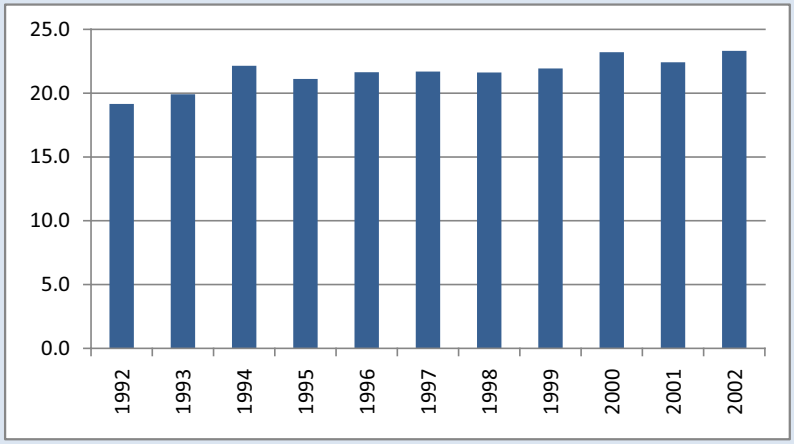
Trade Share

What does it tell us? The trade share tells us how important a particular trade partner is in terms of the overall trade profile of an economy. Changes in the trade share over time may indicate that the economies in question are becoming more integrated. In the case of intra-regional shares, increases in the value over time are sometimes interpreted as an indicator of the significance of a regional trading bloc if one exists, or as a measure of potential if one is proposed.

Definition: The trade share is the percentage of the region under study's trade (imports plus exports) with another region of interest, in the total trade of the region under study.

Range of values: Takes a value between 0 and 100 per cent, with higher values indicating greater importance of selected trading partner.

Limitations: The intra-regional trade share is increasing in the size of the bloc considered by definition, so comparing the shares across different blocs may be misleading. High or low shares and changes over time may reflect numerous factors other than trade policy.



Intra-Regional Trade Shares (per cent) for ASEAN (1992-2002)

Example: The figure above presents the ASEAN **intra-regional trade shares** for the years 1992-2002. Given the two preceding examples, it is not surprising that we again observe an increase in the relative importance of intra-ASEAN trade over time, from around 20 per cent in 1993 to 23 per cent in 2002. In fact, the intra-regional trade share is a weighted average of the intra-regional export and import shares, and so must lie between the two (see technical notes).

Trade Share – Technical Notes

Mathematical definition:

$$\frac{\sum_{sd} X_{sd} + \sum_{ds} M_{ds}}{\sum_{sw} X_{sw} + \sum_{ws} M_{ws}} \times 100$$

Where **s** is the set of countries in the source, **d** is the destination, **w** is the set of countries in the world, **X** is the bilateral flow of exports from the source and **M** is the bilateral import flow to the source. Note the reversal of the usual notation on the import side – we want imports to and exports from the same region when we calculate total trade.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam	ROW	Total
Indonesia	0	2029	797	5347	1229	389	57210	67001
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ROW	29036	47761	25142	72751	36571	12045	5285264	5508570
Total	36284	69829	30554	104726	47609	14624	5590288	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: Exports from the ASEAN-6 economies to other members of ASEAN-6 are highlighted in blue. Total imports by ASEAN-6 economies from all countries are highlighted in green. Total exports of ASEAN-6 economies to all countries are highlighted in red. Adding the numbers in blue we get $80320. This represents both intra-ASEAN imports and exports, so we need to multiply by two. Adding the numbers in green we get $303626. This is total ASEAN imports. Adding the numbers in red we get $385344. This is total ASEAN exports. Hence the intra-regional import share for ASEAN in 2002 is $160640/($303626+$385344)×100, or 23.3 per cent.

Note: The trade share is a weighted average of the import and export shares, with the weights being the share of total imports in total trade and the share of total exports in total trade. It must therefore lie between the values for the export and import shares.

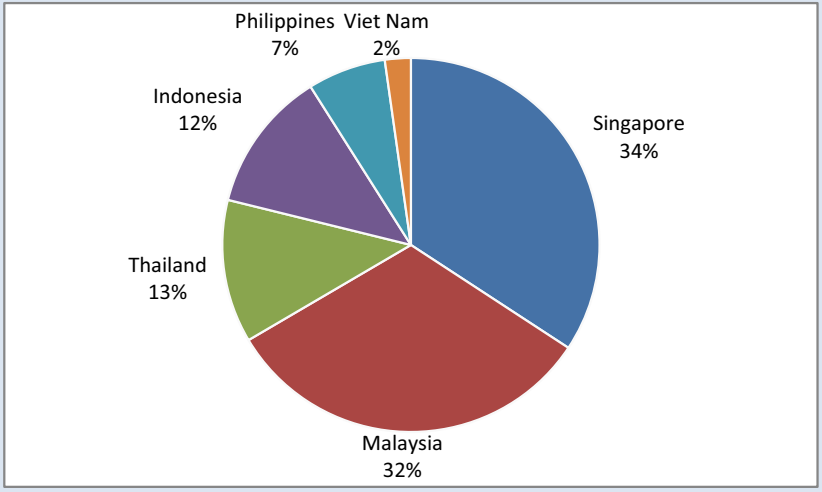
Regional Market Share

What does it tell us? The regional market share statistic tells us the relative importance of the members of a trade bloc in the intra-regional trade of the bloc. It is a variation on the export share. The larger the value, the more the economy in question dominates the exports of the bloc in question.

Definition: The regional market share is defined as the proportion of total exports of a given member(s) of a trading bloc to other members of the bloc, in the total intra-regional exports of the bloc.

Range of values: Takes a value between 0 and 100 per cent, with higher values indicating greater importance of the economy within the regional trading bloc.

Limitations: The usual limitations of shares apply. A high (or low) regional market share may simply reflect the size of the economy in world trade – i.e., the statistic is not normalized.



Regional Market Shares for ASEAN (2002)

Example: The above graph describes the regional markets shares for the ASEAN-6 economies in 2002. As we can see, intra-ASEAN exports are very heavily dominated by Singapore and Malaysia, which together account for over 65 per cent of intra-ASEAN trade.

Regional Market Share – Technical Notes

Mathematical definition:

$$\frac{\sum_{sb} X_{sb}}{\sum_{db} X_{db}} \times 100$$

Where **s** is the set of source countries under study, **b** and **d** are the set of members of the trade bloc under study (the destinations), and **X** is the bilateral flow of exports from the source to the destination. The elements of **s** are a subset of **b**. In words, we have the share of exports from region **s** to trade bloc **b** in total intra-regional exports of trade bloc **b**.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam	ROW	Total
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Viet Nam	257	321	272	934	0	0	13551	15335
ROW	29036	47761	25142	72751	36571	12045	5285264	5508570
Total	36284	69829	30554	104726	47609	14624	5590288	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: Indonesia's exports to other members of ASEAN are highlighted in purple. Total intra-ASEAN exports are highlighted in blue and purple (since Indonesia is part of ASEAN). Total intra-ASEAN exports are the sum of the shaded numbers, or $80320. Total Indonesian exports to ASEAN are the sum of the numbers shaded in purple, or $9801. Hence, Indonesia's regional market share of ASEAN is $9801/$80320×100=12.2 per cent.

Note: This is a variation of the basic **export share** index. A regional market variation of the **import share** index and **trade share** index can be constructed similarly.

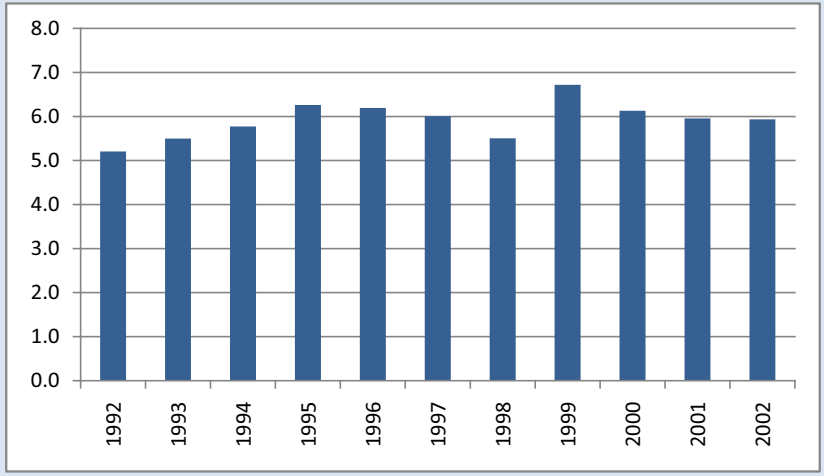
Trade Intensity

What does it tell us? We can think of the trade intensity index as a uniform export share. In other words, the statistic tells us whether or not a region exports more (as a percentage) to a given destination than the world does on average. It is interpreted in much the same way as an export share. It does not suffer from any 'size' bias, so we can compare the statistic across regions, and over time when exports are growing rapidly.

Definition: The trade intensity statistic is the ratio of two export shares. The numerator is the share of the destination of interest in the exports of the region under study. The denominator is the share of the destination of interest in the exports of the world as a whole.

Range of values: Takes a value between 0 and $+\infty$. Values greater than 1 indicate an 'intense' trade relationship.

Limitations: As with trade shares, high or low intensity indices and changes over time may reflect numerous factors other than trade policy.



Trade Intensity Index for ANZCERTA (1992-2002)

Example: Suppose that we wish to assess the 'intensity' of trade among the economies of ANZCERTA. The results are in the figure above. Because the index in greater than one, trade within ANZCERTA would be regarded as highly intense. Is this is consequence of the agreement? It is true that the intensity seems to have increased since the agreement was signed in 1993. On the other hand, the index was very high even before then. This probably reflects geographic proximity, and relative isolation from other markets.

Trade Intensity – Technical Notes

Mathematical definition:

$$\frac{\sum_{sd} X_{sd} / \sum_{sw} X_{sw}}{\sum_{wd} X_{wd} / \sum_{wy} X_{wy}}$$

Where **s** is the set of countries in the source, **d** is the destination, **w** and **y** represent the countries in the world, and **X** is the bilateral flow of total exports. In words, the numerator is the export share of the source region to the destination, the denominator is export share of the world to the destination.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	New Zealand	China	Rep. of Korea	ASEAN	BIMSTEC	ROW	Total
Australia	0	3348	4878	5213	7070	1723	39339	61571
New Zealand	2564	0	777	659	1187	171	9462	14820
China	6058	867	0	16243	23301	4317	394652	445438
Rep. of Korea	2516	301	24232	0	17521	2297	113180	160047
ASEAN	9850	1130	24832	15950	80320	7617	245645	385344
BIMSTEC	590	88	2150	981	4181	2115	54515	64620
ROW	42455	7081	154669	102757	170046	38450	4246616	4762074
Total	64033	12815	211538	141803	303626	56690	5103409	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: Intra-ANZCERTA exports are highlighted in blue, while total exports from ANZCERTA are highlighted in red. Calculating the export share as before we have \$5912/\$76391×100 or 7.7 per cent. World exports to ANZCERTA are highlighted green, while total world exports are highlighted in purple. So the world export share to ANZCERTA is \$76848/\$5893914 or 1.3 per cent. Taking the ratio we have 5.9, this is the trade-intensity index for ANZCERTA in 2002.

Note: In some cases the trade intensity index is adjusted by removing the intra-regional exports from the world total in the denominator. In the example, the denominator in the world export share would be \$5893914-\$5912. Unless the region under study is very large, this adjustment does not make a large difference. Trade intensity can also be calculated using **trade shares** instead of export shares.

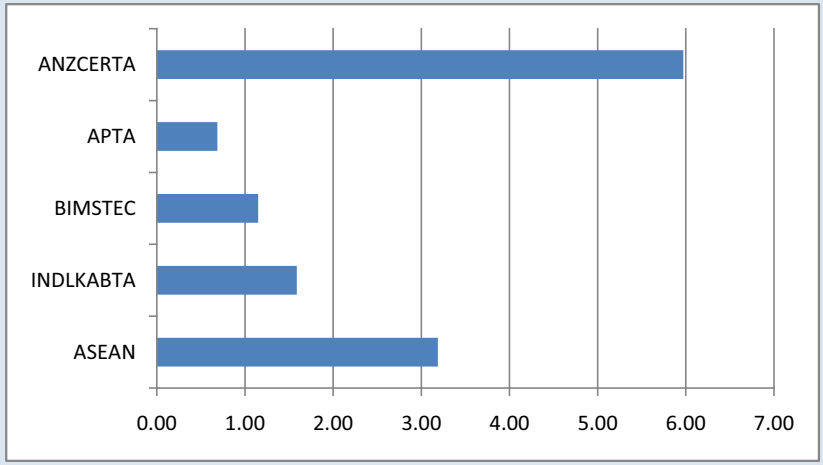
Size Adjusted Regional Export Share

What does it tell us? The size adjusted regional export share is a variation of the trade intensity index. Its purpose is to normalize the intra-regional export share of a regional trading bloc for group size in world trade. This measure is useful when comparing the intra-regional trade of different trading blocs which vary significantly in terms of the number or level of development of the members. The rationale for the adjustment is that we expect larger groups to have a larger share of world and intra-regional exports.

Definition: The ratio of the intra-regional export share for a given trade bloc, to the share of the bloc's exports in world trade.

Range of values: Takes a value between 0 and +∞.

Limitations: As with trade shares, high or low values and changes over time may reflect numerous factors other than trade policy.



Size Adjusted Regional Export Share (per cent) for Selected Trading Agreements (2002)

Example: The above figure depicts the size adjusted regional export share for selected regional trading agreements as at 2002. As we can see, there is considerable variation across different agreements. The ANZCERTA has a high index, but this likely reflects geographical proximity of the economies to each other and geographical isolation from other trading partners. By contrast, the bias for APTA is very low, suggesting that the agreement has not yet fostered cohesive trading relations as compared to other groups.

Size Adjusted Regional Export Share – Technical Notes

Mathematical definition:

$$\frac{\sum_{sd} X_{sd} / \sum_{sw} X_{sw}}{\sum_{sw} X_{sw} / \sum_{wy} X_{wy}}$$

Where **s** is the set of countries in the source, **d** is the destination, **w** and **y** the set of countries in the world, and **X** is the bilateral flow of exports from the source. The numerator is the intra-regional export share of group **s**. The denominator is the share of group **s** in world exports.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	New Zealand	China	Rep. of Korea	ASEAN	BIMSTEC	ROW	Total
Australia	0	3348	4878	5213	7070	1723	39339	61571
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ROW	42455	7081	154669	102757	170046	38450	4246616	4762074
Total	64033	12815	211538	141803	303626	56690	5103409	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: Intra-ANZCERTA exports are highlighted in blue, while total exports from ANZCERTA are highlighted in red. Total world exports are highlighted in purple. First we form the intra-regional export share. This is intra-ANZCERTA exports $(2564+3348) divided by total ANZCERTA exports $(61571+14820), or 0.077 (7.7 per cent). Next we obtain ANZCERTA exports as a fraction of world exports, which is $(61571+14820)/5893914=0.013. Dividing the former share by the latter we obtain 5.9. This is the measure size adjusted export share for ANZCERTA.

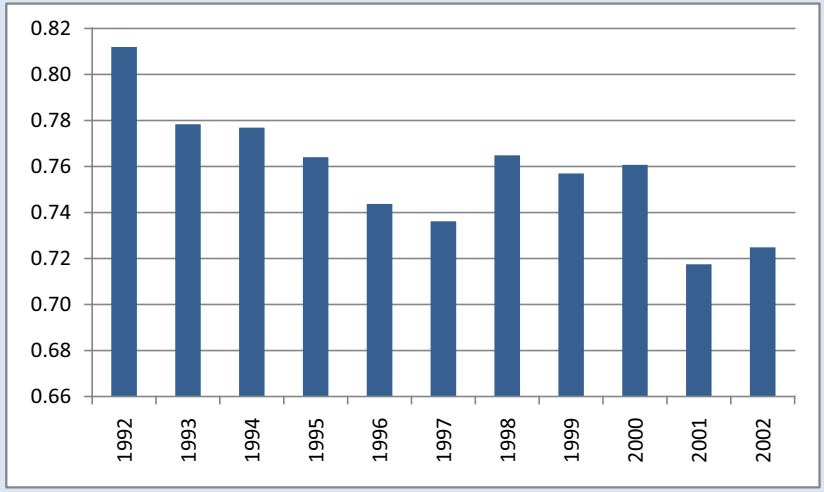
Regional Hirschmann

What does it tell us? The Hirschmann index is a measure of the geographical concentration of exports. It tells us the degree to which a region or country's exports are dispersed across different destinations. High concentration levels are sometimes interpreted as an indication of vulnerability to economic changes in a small number of export markets. An alternative measure is the trade entropy index.

Definition: The regional Hirschmann index is defined as the square root of the sum across destinations of the squared export shares for the region under study to all destinations.

Range of values: Takes a value between 0 and 1.[9] Higher values indicate that exports are concentrated on fewer markets.

Limitations: The Hirschmann index is subject to an aggregation bias – the more disaggregated the data from which it is calculated the better.



Regional Hirschmann Index for Republic of Korea (1992-2002)

Example: Suppose we wish to know about the degree of geographical dispersion of the exports of the Republic of Korea. The Hirschmann index is appropriate. The results are shown above, we note that the index has declined over time, suggesting that the Republic of Korea has diversified its export markets over the period considered.

[9] Strictly, the lower bound is 1/n where n is the number of countries to which the economy under study exports. This will be close to zero in most applications.

Regional Hirschmann – Technical Notes

Mathematical definition:

$$\sqrt{\sum_{d}\left(\frac{\sum_{s} X_{sd}}{\sum_{sw} X_{sw}}\right)^{2}}$$

Where **s** is the set of source countries under study, **d** is the set of destinations, **w** is the set of countries in the world, and **X** is the bilateral flow of exports from the source to the destination. We want to sum over all destinations, so the sets **d** and **w** contain the same elements.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database.

	Australia	New Zealand	China	Rep. of Korea	ASEAN	BIMSTEC	ROW	Total
Australia	0	3348	4878	5213	7070	1723	39339	61571
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ROW	42455	7081	154669	102757	170046	38450	4246616	4762074
Total	64033	12815	211538	141803	303626	56690	5103409	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: The Republic of Korea's bilateral exports are highlighted in blue, the total exports in red. We can calculate export shares as a fraction in the usual manner. This gives us the following values: 0.016, 0.002, 0.151, 0, 0.109, 0.014, 0.707. Squaring each value and totalling gives us 0.54. The square root of this value is 0.73 – this is the regional Hirschmann index for the Republic of Korea in 2002.

Notes: This calculation illustrates the problem with aggregation bias. In this simplified trade matrix the rest of world is a single share. This type of aggregation will push the calculated Hirschmann index up. A Hirschmann index can also be calculated using **import** or **trade shares**. The Hirschmann index is sometimes called the Hirschmann-Herfindahl index (HHI), and is used in other contexts (see the sectoral version later in this volume). It is also calculated in several variants. It may be seen without the final square root operation, or using percentages instead of fractions. It may also be normalized using the number of destinations. The latter adjustment turns the index into a measure of 'evenness' in the export share pattern.

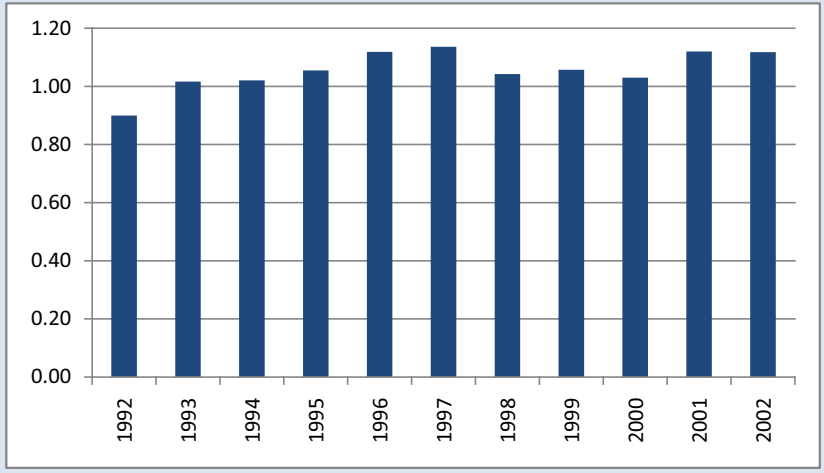
Trade Entropy

What does it tell us? The trade entropy index is another measure of the geographical concentration or dispersion of exports. High values indicate that exports are geographically diversified. This can be interpreted as a measure of the degree to which the country under study is integrated with the world economy, or vulnerable to shocks in a limited number of partners.

Definition: The trade entropy index is calculated by summing the export shares multiplied by the natural log of the reciprocal of the export shares (a weight that decreases with the size of the share) of the country under study across all destinations.

Range of values: Takes a value between 0 and +∞. Higher values indicate greater uniformity in the geographical dispersion of exports. The value of the index is maximized when the export share to every market is the same.

Limitations: The trade entropy index is subject to an aggregation bias.



Trade Entropy Index for Republic of Korea (1992-2002)

Example: We compare the trade entropy index with the regional Hirschmann index by using the same example. Each export share for the Republic of Korea is weighted by the 'importance factor' calculated by the natural log of the reciprocal of the trade share. The results are shown above, again we can see that the Republic of Korea has diversified its export markets over the period considered, this time because the value of the index increases over time.

Trade Entropy – Technical Notes

Mathematical definition:

$$\sum_d \left(\frac{\sum_s X_{sd}}{\sum_{sw} X_{sw}} \right) \ln \left(\frac{1}{\sum_s X_{sd} / \sum_{sw} X_{sw}} \right)$$

Where **s** is the set of source countries under study, **d** is the set of destinations, **w** is the set of countries in the world, and **X** is the bilateral flow of exports from the source to the destination. We want to sum over all destinations, so the sets **d** and **w** contain the same elements. An entropy index can also be calculated using import or trade shares.

Data sources: The United Nations Commodity Trade database (COMTRADE), the International Monetary Fund (IMF) Direction of Trade statistics, the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	New Zealand	China	Rep. of Korea	ASEAN	BIMSTEC	ROW	Total
Australia	0	3348	4878	5213	7070	1723	39339	61571
New Zealand	2564	0	777	659	1187	171	9462	14820
China	6058	867	0	16243	23301	4317	394652	445438
Rep. of Korea	2516	301	24232	0	17521	2297	113180	160047
ASEAN	9850	1130	24832	15950	80320	7617	245645	385344
BIMSTEC	590	88	2150	981	4181	2115	54515	64620
ROW	42455	7081	154669	102757	170046	38450	4246616	4762074
Total	64033	12815	211538	141803	303626	56690	5103409	5893914

Simplified Total Trade Matrix (2002)

Sample calculation: The Republic of Korea's bilateral exports are highlighted in blue, the total exports in red. We can calculate export shares in the usual manner (except for the expression in percentage terms). This gives us the following values: 0.016, 0.002, 0.151, 0, 0.109, 0.014, 0.707. Next we calculate the weights by taking the natural logs of the reciprocal of the export shares: 4.13, and so on. Multiplying each share by the weight and summing over the destinations gives us 0.91 – this is the entropy index for the Republic of Korea in 2002.

Note: Again, note the potential for bias when we use aggregate statistics. Also, the definition of the index requires that the export shares lie in the range 0 to 1. Zero shares are not allowed because division by zero is undefined, so these must be excluded from the calculation.

VI. Sectoral Structure of Trade

This chapter includes indicators which reveal changes in the commodity structure of trade and thus are most useful for the preparation of negotiating positions in trade negotiations. They also are very relevant for formulation of development strategies, as they reflect directly or indirectly the competitive ability of a country's or region's economic sectors or activities. The indices covered in this chapter are:

- Competitiveness
- Major export category (sectoral export share)
- Sectoral Hirschmann
- Export diversification
- Revealed comparative advantage
- Additive revealed comparative advantage
- Michelaye index
- Regional orientation
- Complementarity
- Export similarity
- Sectoral/aggregate intra-industry trade
- Sectoral/aggregate marginal intra-industry trade
- Trade overlap

The first two measures are based on *sectoral export shares*. The first, *competitiveness*, measures the share of an economy in the world market for a particular good. It is a basic measure of world market power. The second, *major export category*, addresses the trade profile of an economy, by measuring the proportion of total exports of the economy that are accounted for

by particular product categories. This is a useful starting point for evaluating the sectoral structure of an economy's export profile (e.g., is the export profile dominated by a few products, which ones?)

The sectoral export share is also a basic building block of some of the more complex indices. The *sectoral Hirschmann* index and the *export diversification* index both use sector export shares to provide an overall measure of an economy's export diversification. This may be important in assessing the vulnerability of an economy to external trade shocks.

The next group of statistics is designed to look at the sectoral pattern of trade in great detail. International trade theory describes how inter-industry trade (trade in different products) is driven by comparative advantage, or lower opportunity cost. *Revealed comparative advantage indices* attempt to use the trade data to tell us the products in which economies have a comparative advantage. We present three alternative measures, the *revealed comparative advantage* index, the *additive revealed comparative advantage* index, and the *Michelaye* index. These measures are sometime used with the regional orientation index, which highlights regional bias in the sectoral export pattern, to identify possible cases of trade diversion with a regional trading agreement (where there is strong regional bias in the absence of comparative advantage).

The final group of indices might be collectively termed 'overlap' indices, as they share a common mathematical foundation. Their purpose is to measure the degree to which categories match, or overlap. The first, *complementarity*, can be thought of as an overall measures of the degree to which what one country has to sell matches what another wants to buy. It is often used as an indicator of the potential for trade expansion following the formation of a regional trading bloc. *Export similarity*, by contrast, provides an overall measure of the degree to which what two countries export matches, and thus is an indicator of the degree to which countries are rivals on international markets.

The *intra-industry trade indices* measure overlap in the import/export profile of a single economy. They provide us with a measure of the importance of scale economies and variety in the trade of an economy. This may be important in assessing

issues of trade fragmentation, or the potential size of adjustment costs under a proposed regional trade agreement, for example. The *trade overlap* index is an alternative to the *aggregate intra-industry trade* measure, with both providing a single economy-wide measure of the importance of intra- vs. inter-industry trade.

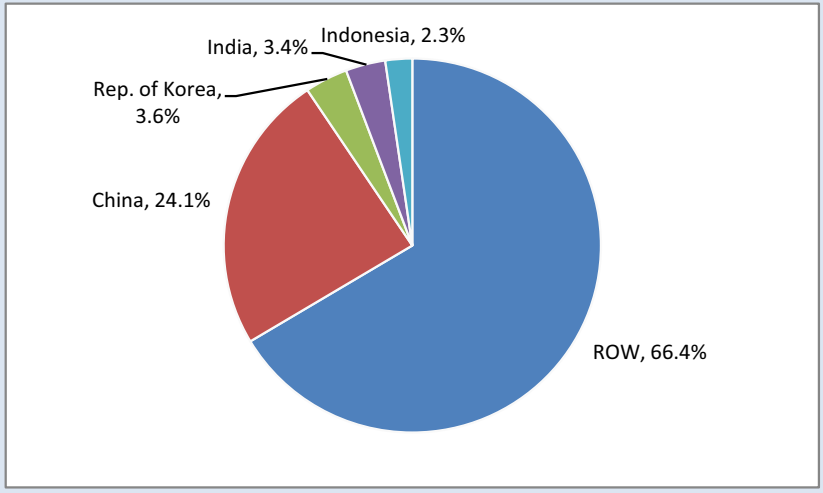
Competitiveness

What does it tell us? Competitiveness in trade is broadly defined as the capacity of an industry to increase its share in international markets at the expense of its rivals. The competitiveness index is an indirect measure of international market power, evaluated through a country's share of world markets in selected export categories.

Definition: The index is the share of total exports of a given product from the region under study in total world exports of the same product.

Range of values: Takes a value between 0 and 100 per cent, with higher values indicating greater market power of the country in question.

Limitations: The index will vary with the level of data aggregation. Somewhat limited measure of market power, which may depend critically on market structure.



Top World Exporters of Texiles/Apparel (2002)

Example: Suppose we want to determine the most important economies in the world trade in textiles/apparel. We can calculate the share of each economy in the world trade in textiles/apparel, and rank them. The results are shown above. The most important economy is China, followed by the Republic of Korea and India.

Competitiveness – Technical Notes

Mathematical definition:

$$\frac{\sum_{d} x_{isd}}{\sum_{wd} x_{iwd}} \times 100$$

Where **s** is the country of interest, **d** and **w** are the set of all countries in the world, **i** is the sector of interest, and **x** is the commodity export flow. In words, it is the share of country **s**'s exports of good **i** in the total world exports of good **i**.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	China	Rep. of Korea	India	Sri Lanka	ROW	Total
Primary Products	25474	12544	670	4569	936	593865	638058
Food Products	9422	9977	2055	4554	116	289570	315694
Textiles and Apparel	844	107040	16284	15103	2661	300870	442802
Other Manufactures	25831	315877	141038	29271	1070	3984273	4497360
Total	61571	445438	160047	53497	4783	5168578	5893914

Total Exports by Category for Various Countries (2002)

Sample calculation: The table above presents the export flow data in a slightly different form. We have totaled exports across destinations first, and presented total exports by category for the selected regions. Suppose we want to calculate China's share of the textiles and apparel (including leather) market. The total Chinese exports of textiles and apparel are highlighted in blue. Total world exports of textiles and apparel are highlighted in red. The competitiveness index for China in textiles/apparel is therefore \$107040/\$442802×100=24.2 per cent.

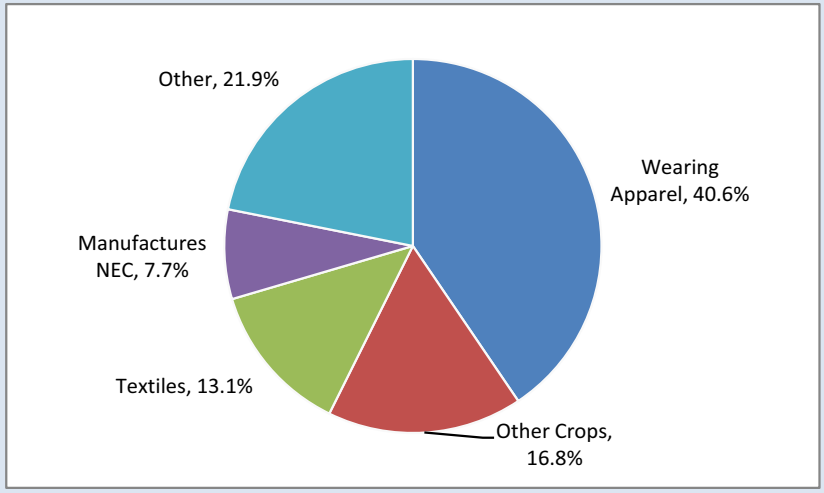
Major Export Category

What does it tell us? Major export category is a simple measure of the extent diversification of exports across sectoral categories. If no single category accounts for 50 per cent or more of total exports, the economy is classified as diversified. Identification of dominating products in country's trade is valuable for both trade policy and adjustment management.

Definition: The index is the value of the largest sectoral export share in total exports of a given economy.

Range of values: Takes a value between 0 and 100 per cent, with higher values indicating greater importance of the product in the export profile of the economy in question.

Limitations: The index will vary with the level of data aggregation. As an indicator of diversification it is limited, one of the others listed below is preferable.



Top Export Categories for Sri Lanka (2002)

Example: Suppose we wish to identify the major export sectors of Sri Lanka. We take the value of exports of each commodity and express them as a percentage of total Sri Lankan exports. We then rank the shares in order of magnitude. The chart above depicts the results. We find that Sri Lanka is very heavily dependent on exports of wearing apparel.

Major Export Category – Technical Notes

Mathematical definition:

$$\frac{\sum_d x_{isd}}{\sum_d X_{sd}} \times 100$$

Where **s** is the country of interest, **d** is the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow and **X** is the total export flow. In words, it is the share of good **i** in the total exports of country **s**.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	China	Rep. of Korea	India	Sri Lanka	ROW	Total
Primary Products	25474	12544	670	4569	936	593865	638058
Food Products	9422	9977	2055	4554	116	289570	315694
Textiles and Apparel	844	107040	16284	15103	2661	300870	442802
Other Manufactures	25831	315877	141038	29271	1070	3984273	4497360
Total	61571	445438	160047	53497	4783	5168578	5893914

Total Exports by Category for Various Countries (2002)

Sample calculation: Suppose we want to calculate the share of textiles and apparel (including leather) in the total exports of Sri Lanka. The total Sri Lankan exports of textiles and apparel are highlighted in blue. Total Sri Lankan exports are highlighted in red. The sectoral export share is therefore \$2661/\$4783×100=55.6 per cent.

Notes: Sectoral export shares of this type form the basic building block of many of the other indices in this group. It is also possible to form **sectoral import** and **sectoral trade shares**.

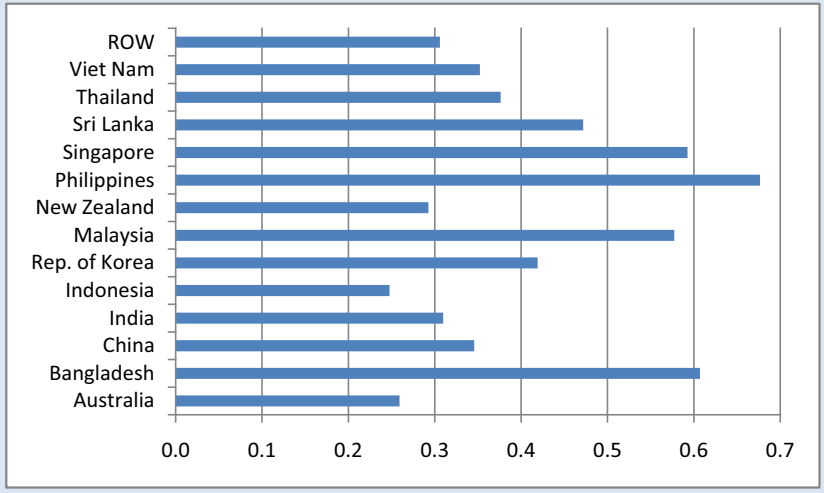
Sectoral Hirschmann

What does it tell us? The sectoral Hirschmann index is a measure of the sectoral concentration of a region's exports. It tells us the degree to which a region or country's exports are dispersed across different economic activities. High concentration levels are sometimes interpreted as an indication of vulnerability to economic changes in a small number of product markets. Over time, decreases in the index may be used to indicate broadening of the export base. An alternative measure is the export diversification index.

Definition: The sectoral Hirschmann index is defined as the square root of the sum of the squared shares of exports of each industry in total exports for the region under study.

Range of values: Takes a value between 0 and 1.[10] Higher values indicate that exports are concentrated in fewer sectors.

Limitations: The Hirschmann index is subject to an aggregation bias.



Sectoral Hirschmann Index for Various Countries (2002)

Example: Suppose we wish to compare the degree of export diversification across of group of economies at some point in time. The Hirschmann index results are presented above. In this sample, Australia, New Zealand, Indonesia, India and China are relatively diversified. By contrast, the Philippines, Singapore, Malaysia and Bangladesh are not.

[10] Strictly, the lower bound is 1/n where n is the number of countries to which the economy under study exports. This will be close to zero in most applications.

Sectoral Hirschmann – Technical Notes

Mathematical definition:

$$\sqrt{\sum_i \left(\frac{\sum_d x_{isd}}{\sum_d X_{sd}} \right)^2}$$

Where **s** is the country of interest, **d** is the set of all countries in the world, **i** is the sectors of interest, **x** is the commodity export flow and **X** is the total export flow. Each of the bracketed terms is the share of good **i** in the exports of country **s** (see **major export category**).

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	China	Rep. of Korea	India	Sri Lanka	ROW	Total
Primary Products	25474	12544	670	4569	936	593865	638058
Food Products	9422	9977	2055	4554	116	289570	315694
Textiles and Apparel	844	107040	16284	15103	2661	300870	442802
Other Manufactures	25831	315877	141038	29271	1070	3984273	4497360
Total	61571	445438	160047	53497	4783	5168578	5893914

Total Exports by Category for Various Countries (2002)

Sample calculation: The sectoral exports of Australia are in 2002 are highlighted in blue. Total exports are highlighted in red. Calculating the export shares (as a fraction) we have: 0.41, 0.15, 0.01, and 0.42 (in row order). Squaring each term and summing yields 0.37. Taking the square root we have 0.6. This is the sectoral Hirschmann for Australia in 2002. Note the overstatement of the index when calculated on aggregate data relative to the more dissaggregated data used in the calculations underlying the figure on the previous page.

Notes: A Hirschmann index can also be calculated using **import** or **trade shares,** if one is interested in import or overall trade dependence issues. The Hirschmann index is sometimes called the Hirschmann-Herfindahl index (HHI), and is used in many other contexts (see the regional version earlier in this volume). It is also calculated in several variants. It may be seen without the final square root operation, or using percentages instead of fractions. It may also be normalized using the number of destinations. The latter adjustment turns the index into a measure of the 'evenness' in the sectoral export share pattern.

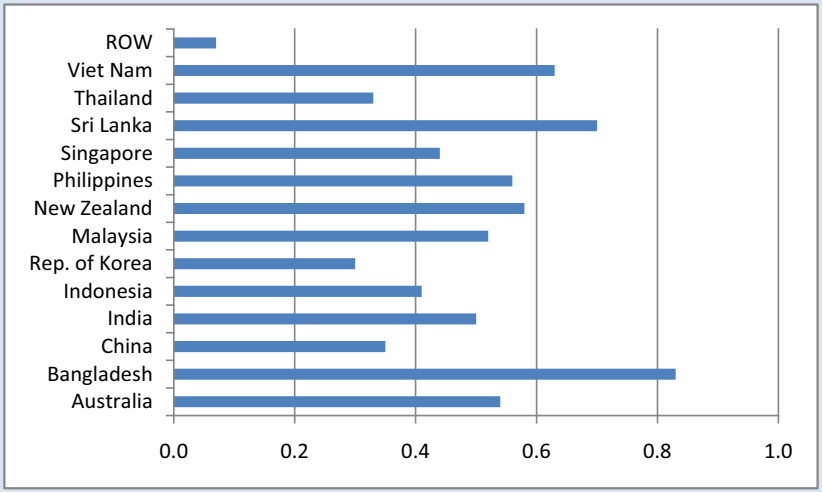
Export Diversification

What does it tell us? The export diversification index is another measure of the sectoral concentration of a region's exports. It tells us the degree to which a region or country's exports are dispersed across different economic activities. Unlike the Hirschmann index, it normalizes the export diversification pattern by comparing it to the world average.

Definition: The sum of the absolute value of the difference between the export category shares of the country under study and the world as a whole, divided by two.

Range of values: Values range from 0 to 1. A value of zero indicates that the export pattern exactly matches the world average. Higher values indicate greater dependence on a small number of products.

Limitations: This measure is subject to an aggregation bias and should be calculated on disaggregated data. An aggregate measure cannot tell us which commodities dominate the export profile, for that we need to go back to the individual shares.



Export Diversification Index for Various Countries (2002)

Example: We calculate the index for the same group of countries as for the sectoral Hirschmann. The results are somewhat different to the sectoral Hirschmann (e.g., by this measure Australia and New Zealand appear less diversified). The reason is that this index adjusts for what is 'normal' for the world as a whole.

Export Diversification – Technical Notes

Mathematical definition:

$$\left(\sum_i \left| \frac{\sum_d x_{isd}}{\sum_d X_{sd}} - \frac{\sum_{wd} x_{iwd}}{\sum_{wd} X_{wd}} \right| \right) \div 2$$

Where **s** is the country of interest, **d** and **w** are the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow and **X** is the total export flow.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Australia	China	Rep. of Korea	India	Sri Lanka	ROW	Total
Primary Products	25474	12544	670	4569	936	593865	638058
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Other Manufactures	25831	315877	141038	29271	1070	3984273	4497360
Total	61571	445438	160047	53497	4783	5168578	5893914

Total Exports by Category for Various Countries (2002)

Sample calculation: We use the same example as before for comparison purposes. The sectoral exports of Australia are in 2002 are highlighted in blue. Total exports are highlighted in red. Calculating the export shares (as a fraction) we have: 0.41, 0.15, 0.01, and 0.42 (in row order). World total exports by sector are highlighted in green, and world total exports in purple. The shares are (in order): 0.11, 0.05, 0.08, and 0.76. We take the absolute value of the difference between each pair. So, for primary products we have 0.41-0.11=0.3. Summing all the terms and dividing by two we have 0.4. This is the export diversification index for Australia in 2002. Again, note the bias in the statistic when calculated on aggregate data relative to the more dissaggregated data used in the calculations underlying the figure on the previous page.

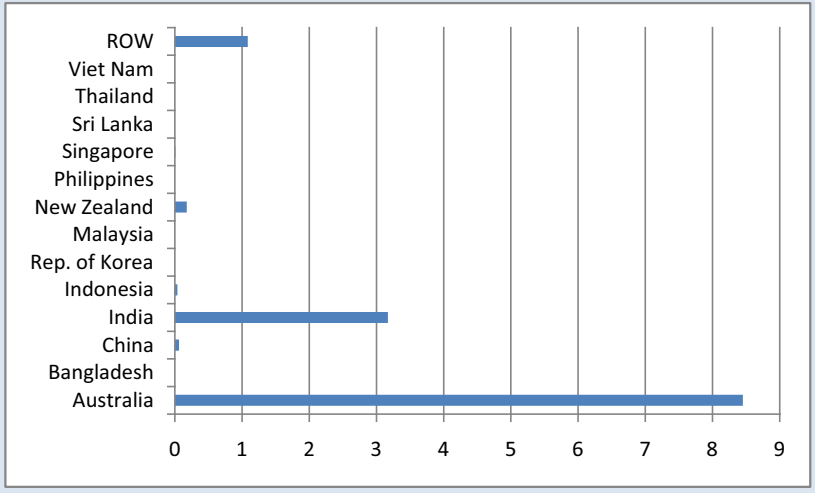
Revealed Comparative Advantage (RCA)

What does it tell us? Comparative advantage underlies economists' explanations for the observed pattern of inter-industry trade. In theoretical models, comparative advantage is expressed in terms of relative prices evaluated in the absence of trade. Since these are not observed, in practice we measure comparative advantage indirectly. Revealed comparative advantage indices (RCA) use the trade pattern to identify the sectors in which an economy has a comparative advantage, by comparing the country of interests' trade profile with the world average.

Definition: The RCA index is defined as the ratio of two shares. The numerator is the share of a country's total exports of the commodity of interest in its total exports. The denominator is share of world exports of the same commodity in total world exports.

Range of values: Takes a value between 0 and $+\infty$. A country is said to have a revealed comparative advantage if the value exceeds unity.

Limitations: The index is affected by anything that distorts the trade pattern, e.g., trade barriers.



RCA Index for Wheat (2002)

Example: Suppose we are interested in the wheat market, and need to determine which economies have a comparative advantage in wheat. The RCA calculation results are presented above for 2002. We are looking for values exceeding unity. In this sample, Australia, India and the rest of world are revealed to have a comparative advantage in wheat.

RCA – Technical Notes

Mathematical definition:

$$\frac{\sum_d x_{isd} / \sum_d X_{sd}}{\sum_{wd} x_{iwd} / \sum_{wd} X_{wd}}$$

Where **s** is the country of interest, **d** and **w** are the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow and **X** is the total export flow. The numerator is the share of good **i** in the exports of country **s**, while the denominator is the share of good **i** in the exports of the world.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database.

Wheat	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	4	3	168	441	777	1393
New Zealand	0	0	0	0	7	0	7
China	0	0	0	54	18	2	74
Rep. of Korea	0	0	0	0	1	0	1
ASEAN	0	0	0	0	6	3	9
ROW	5	3	150	339	960	12836	14293
Total	5	7	153	561	1433	13618	15777

Total	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	3348	4878	5213	7070	41062	61571
New Zealand	2564	0	777	659	1187	9633	14820
China	6058	867	0	16243	23301	398969	445438
Rep. of Korea	2516	301	24232	0	17521	115477	160047
ASEAN	9850	1130	24832	15950	80320	253262	385344
ROW	43045	7169	156819	103738	174227	4341696	4762074
Total	64033	12815	211538	141803	303626	5160099	5893914

Sample calculation: Above we have two simplified trade matrices, representing trade flows for wheat and total trade flows, respectively. Total exports of wheat from Australia are highlighted in blue. Total exports from Australia are highlighted in red. Calculating the share of Australia's wheat exports to its total trade we have: \$1393/\$61571. World trade in wheat is highlighted in green, and total world trade in purple. The proportion of wheat in world trade is: \$15777/\$5893914. Taking the ratio of these two shares we have 8.45. This is the RCA index for Australia in wheat in 2002.

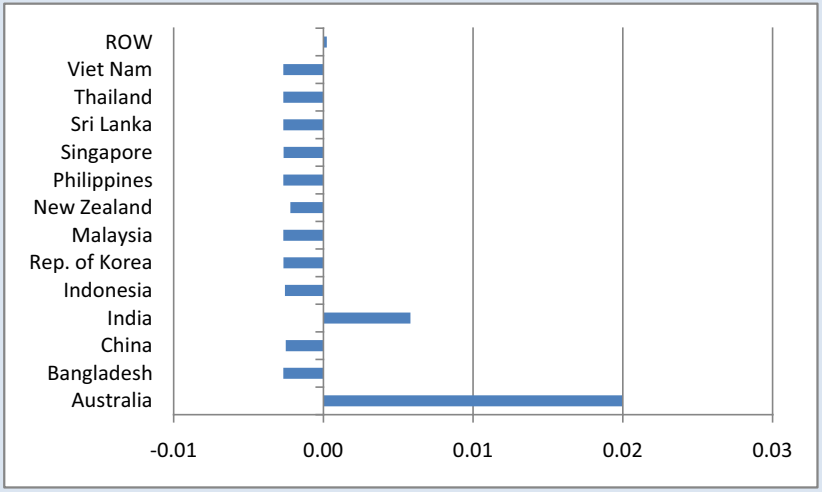
Additive RCA

What does it tell us? The additive RCA (ARCA) index is an alternative to the RCA index. Again, it is used to identify the sectors in which an economy has a comparative advantage, and to track changes over time. Unlike the RCA index, it is symmetric (around zero).

Definition: The ARCA index is defined as the difference of two shares: The share of a country's total exports of the commodity of interest in its total exports and the share of world exports of the same commodity in total world exports.

Range of values: Takes a value between −1 and +1. A country is said to have a revealed comparative advantage if the value exceeds zero.

Limitations: As with RCA, the index is affected by anything that distorts the trade pattern, e.g., trade barriers. It does not identify the source of comparative advantage.



Additive RCA Index for Wheat (2002)

Example: We use the same example as above for comparison purposes. The results of the ARCA calculations for wheat are presented above. Now we are looking for values exceeding zero. Again, in this sample, Australia, India and the rest of world are revealed to have a comparative advantage in wheat.

Additive RCA – Technical Notes

Mathematical definition:

$$\frac{\sum_d x_{isd}}{\sum_d X_{sd}} - \frac{\sum_{wd} x_{iwd}}{\sum_{wd} X_{wd}}$$

Where **s** is the country of interest, **d** and **w** are the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow and **X** is the total export flow. The first term is the share of good **i** in the exports of country **s**, while the second term is the share of good **i** in the exports of the world.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database.

Wheat	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	4	3	168	441	777	1393
New Zealand	0	0	0	0	7	0	7
China	0	0	0	54	18	2	74
Rep. of Korea	0	0	0	0	1	0	1
ASEAN	0	0	0	0	6	3	9
ROW	5	3	150	339	960	12836	14293
Total	5	7	153	561	1433	13618	15777

Total	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	3348	4878	5213	7070	41062	61571
New Zealand	2564	0	777	659	1187	9633	14820
China	6058	867	0	16243	23301	398969	445438
Rep. of Korea	2516	301	24232	0	17521	115477	160047
ASEAN	9850	1130	24832	15950	80320	253262	385344
ROW	43045	7169	156819	103738	174227	4341696	4762074
Total	64033	12815	211538	141803	303626	5160099	5893914

Sample calculation: Above we have the same two simplified trade matrices. Total exports of wheat from Australia are highlighted in blue. Total exports from Australia are highlighted in red. Calculating the share of Australia's wheat exports to its total trade we have: \$1393/\$61571. World trade in wheat is highlighted in green, and total world trade in purple. The proportion of wheat in world trade is: \$15777/\$5893914. Taking the difference between these two shares we have 0.019. This is the ARCA index for Australia in wheat in 2002.

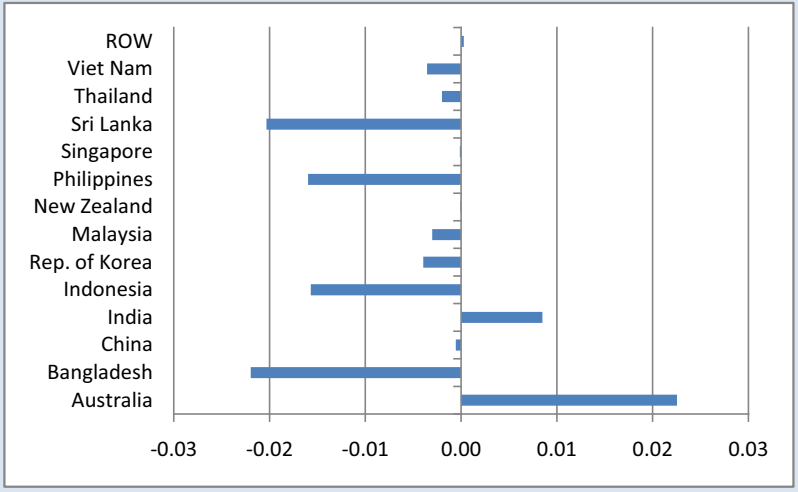
Michelaye

What does it tell us? The Michelaye index is a second alternative to the RCA index. Again, it is used to identify the sectors in which an economy has a comparative advantage. Like ARCA, it is symmetric around zero. The difference between Michelaye and ARCA is that the former compares the export pattern of the country under study to that export pattern of the world, while the latter compares the export pattern of the country under study to its own import pattern.

Definition: The Michelaye index is defined as the difference of two shares: The share of a country's total exports of the commodity of interest in its total exports and the share of the same country's imports of the same commodity in its total imports.

Range of values: Takes a value between −1 and +1. A country is said to have a revealed comparative advantage if the value exceeds zero.

Limitations: As with RCA and ARCA, the index is affected by anything that distorts the trade pattern, e.g., trade barriers. It does not identify the source of comparative advantage.



Michelaye Index for Wheat (2002)

Example: Again we use the same example for comparison purposes. The results are presented above. As with ARCA we are looking for values exceeding zero. Again, i this sample, Australia, India and the ROW are revealed to have a comparative advantage in wheat.

Michelaye – Technical Notes

Mathematical definition:

$$\frac{\sum_w x_{isw}}{\sum_w X_{sw}} - \frac{\sum_w m_{iws}}{\sum_w M_{ws}}$$

Where **s** is the country of interest, **w** is the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow, **X** is the total export flow, **m** the commodity import flow, and **M** the total import flow. The first term is the share of good **i** in the exports of country **s**, while the second term is the share of good **i** in the imports of country **s**.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University

Wheat	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	4	3	168	441	777	1393
New Zealand	0	0	0	0	7	0	7
China	0	0	0	54	18	2	74
Rep. of Korea	0	0	0	0	1	0	1
ASEAN	0	0	0	0	6	3	9
ROW	5	3	150	339	960	12836	14293
Total	5	7	153	561	1433	13618	15777

Total	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	3348	4878	5213	7070	41062	61571
New Zealand	2564	0	777	659	1187	9633	14820
China	6058	867	0	16243	23301	398969	445438
Rep. of Korea	2516	301	24232	0	17521	115477	160047
ASEAN	9850	1130	24832	15950	80320	253262	385344
ROW	43045	7169	156819	103738	174227	4341696	4762074
Total	64033	12815	211538	141803	303626	5160099	5893914

Sample calculation: Above we have the same two simplified trade matrices. Total exports of wheat from Australia are highlighted in blue. Total exports from Australia are highlighted in red. Calculating the share of Australia's wheat exports to its total trade we have: \$1393/\$61571. Total imports of wheat to Australia are highlighted in green, and total imports to Australia in purple. The proportion of Australia's wheat imports to its total imports is: \$5/\$64033. Taking the difference between these two shares we have 0.022. This is the Michelaye index for Australia in wheat in 2002.

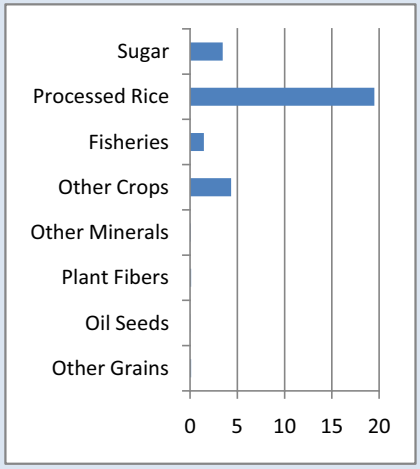
Regional Orientation

What does it tell us? The regional orientation index tells us whether exports of a particular product from the region under study to a given destination are greater than exports of the same product to other destinations. In other words, it measures the importance of intra-regional exports relative to extra-regional exports.

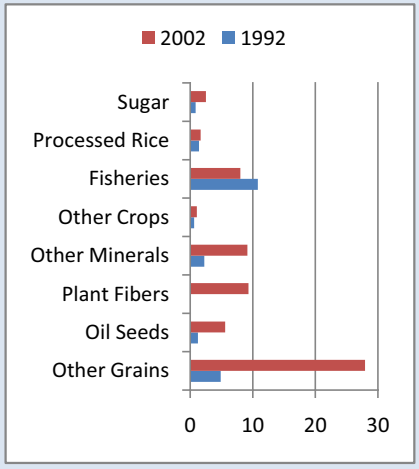
Definition: The index is the ratio of two shares. The numerator is the share of a country's exports of a given product to the region of interest in total exports to the region. The denominator is the share of exports of the product to other countries in total exports to other countries.

Range of values: Takes a value between 0 and +∞. A value greater than unity implies a regional bias in exports.

Limitations: The index may be affected by many factors, including geographical ones. Because it is based on relative shares, a strong regional orientation may be of little economic significance.



RCA Index for Thailand (2002)



RO Index for Thailand/ASEAN

Example: One application of the regional orientation index is the identification of possible cases of trade diversion. In the figure on the right we have calculated the regional orientation of selected Thailand exports to ASEAN in 1992 (prior to AFTA) and in 2002. We see a strong and increasing bias in several categories, notably other grains and plant fibers. On the left, we have the RCA index. In processed rice, fisheries and sugar, Thailand has a comparative advantage. On the other hand it has no advantage in other grains or plant fibers. This pattern is suggestive of trade diversion in those categories.

Regional Orientation – Technical Notes

Mathematical definition:

$$\frac{\sum_d x_{isd} / \sum_d X_{sd}}{\sum_w x_{isw} / \sum_w X_{sw}}$$

Where **s** is the country of interest, **d** is the set of countries in the regional bloc, **w** is the set of all countries not in the bloc, **i** is the sector of interest, **x** is the commodity export flow, and **X** is the total export flow, The numerator is the share of good **i** in the exports of country **s** to region **d**, while the denominator is the share of good **i** in the exports of country **s** to non-members of **d**.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

Wheat	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	4	3	168	441	777	1393
New Zealand	0	0	0	0	7	0	7
China	0	0	0	54	18	2	74
Rep. of Korea	0	0	0	0	1	0	1
ASEAN	0	0	0	0	6	3	9
ROW	5	3	150	339	960	12836	14293
Total	5	7	153	561	1433	13618	15777

Total	Australia	New Zealand	China	Rep. of Korea	ASEAN	ROW	Total
Australia	0	3348	4878	5213	7070	41062	61571
New Zealand	2564	0	777	659	1187	9633	14820
China	6058	867	0	16243	23301	398969	445438
Rep. of Korea	2516	301	24232	0	17521	115477	160047
ASEAN	9850	1130	24832	15950	80320	253262	385344
ROW	43045	7169	156819	103738	174227	4341696	4762074
Total	64033	12815	211538	141803	303626	5160099	5893914

Sample calculation: Australia's exports of wheat to New Zealand, these are highlighted in blue. Australia's total exports to New Zealand are highlighted in green. The ratio is \$4/\$3348. The total exports of wheat from Australia are highlighted in red, and the total exports in purple. So, exports of wheat to non-ANZCERTA members are \$(1393-4)=\$1389, and for total exports we have \$(61571-3348)=\$58223. The RO index is then \$(4/3348)/(1389/58223)=0.05, indicating no strong regional orientation in Australia's exports of wheat to ANZCERTA.

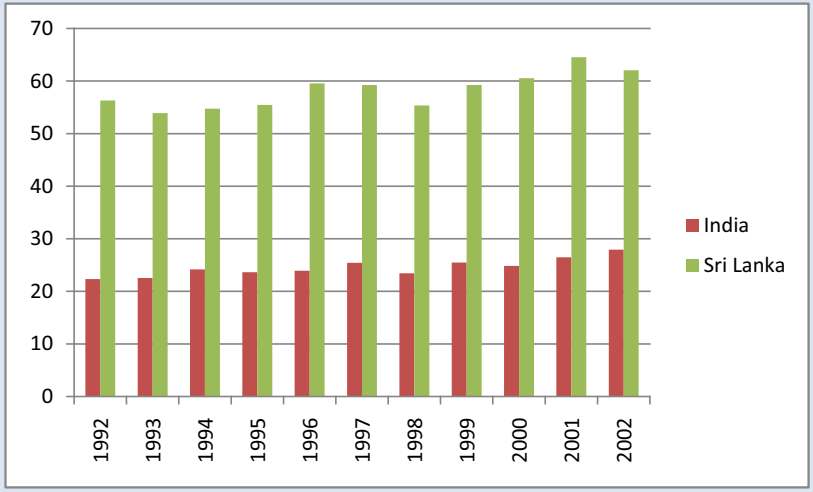
Complementarity

What does it tell us? The complementarity index is a type of overlap index. It measures the degree to which the export pattern of one country matches the import pattern of another. A high degree of complementarity is assumed to indicate more favorable prospects for a successful trade arrangement. Changes over time may tell us whether the trade profiles are becoming more or less compatible.

Definition: The sum of the absolute value of the difference between the import category shares and the export shares of the countries under study, divided by two. The index is converted to percentage form.

Range of values: Takes a value between 0 and 100, with zero indicating no overlap and 100 indicating a perfect match in the import/export pattern.

Limitations: High complementarity indices may be misleading if the countries are geographically distant, or if the size difference in the economies is large (i.e., a match in percentage terms does not imply a match in levels). Aggregation bias.



Complementarity Indices between India/Sri Lanka (1992-2002)

Example: Suppose we want to know whether or not the exports of India and Sri Lanka have grown more complementary over time. We can construct the complementarity index over several time periods and look for changes. The above figure presents the results. The exports of India are quite complementary with the imports of Sri Lanka, but the converse is not true, although the degree has been rising over time.

Complementarity – Technical Notes

Mathematical definition:

$$\left(1-\left(\sum_i\left|\frac{\sum_w m_{iwd}}{\sum_w M_{wd}}-\frac{\sum_w x_{isw}}{\sum_w X_{sw}}\right|\right)\div 2\right)\times 100$$

Where **d** is the importing country of interest, **s** is the exporting country of interest, **w** is the set of all countries in the world, **i** is the set of industries, **x** is the commodity export flow, **X** is the total export flow, **m** the commodity import flow, and **M** the total import flow. In words, we take the sum of the absolute value of the difference between the sectoral import shares of one country and the sectoral export shares of the other. Dividing by 2 coverts this to a number between 0 and 1, with zero indicating all shares matched and 1 indicating none did. Subtracting from one reverses the sign, and multiplying by 100 puts the measure in percentage terms.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	India	Sri Lanka	ROW	Total
Primary Products	4569	936	632553	638058
Food Products	4554	116	311024	315694
Textiles and Apparel	15103	2661	425038	442802
Other Manufactures	29271	1070	4467019	4497360
Total	53497	4783	5835634	5893914

Exports by Category for Selected Economies (2002)

	India	Sri Lanka	ROW	Total
Primary Products	6057	729	631272	638058
Food Products	2203	513	312978	315694
Textiles and Apparel	1282	1178	440342	442802
Other Manufactures	35814	2995	4458551	4497360
Total	45356	5415	5843143	5893914

Imports by Category for Selected Economies (2002)

Sample calculation: Start with the share of primary products in Sri Lanka's imports. This is \$729/5415=0.134. India's export share in this category is \$4569/53497=0.085. Taking the absolute value of the difference we have 0.049. Repeating this for the other categories and summing the results we have 0.13. Halving and subtracting from one we have 0.935, or 93.5 per cent. This is India's complementarity with Sri Lanka in 2002. Note the aggregation bias.

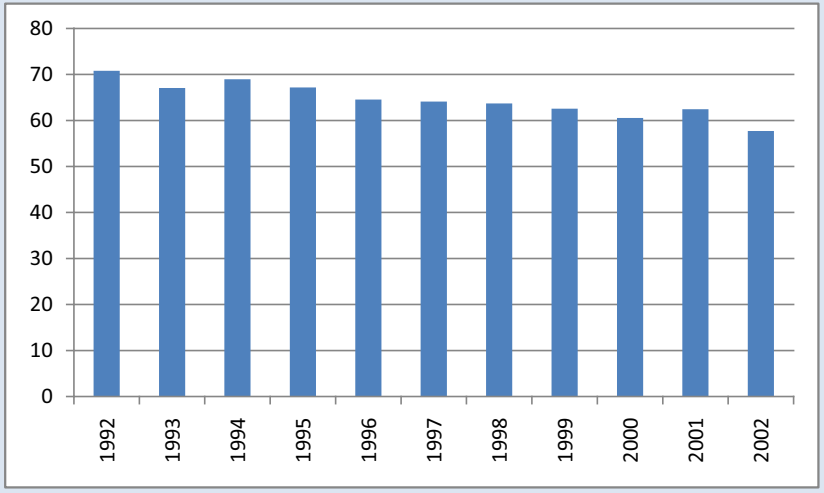
Export Similarity

What does it tell us? The export similarity index is another overlap index. It is designed to measure the degree of similarity between the export profiles of two economies. The more similar the export profiles are, the more likely that economies are competitors in global markets. High similarity indices may also indicate limited potential for inter-industry trade with a regional trading arrangement.

Definition: The export similarity index is the sum over export categories of the smaller of the sectoral export share (as a percentage) of each country under study.

Range of values: Takes a value between 0 and 100 per cent. A value of zero indicates no overlap in the export profiles (the countries are not competitors), a value of 100 indicates perfect overlap.

Limitations: Does not consider the level of exports, only the structure, so may be misleading when the size of the economies considered is very different. Subject to aggregation bias.



Export Similarity Indices between India/China (1992-2002)

Example: China and India are two major developing economies. To what extent are they competitors on the world market? We construct the export similarity index for these two economies. The results are shown above. The export profiles of these two economies remain quite similar, but have been diverging over time. In large part this reflects major shift by China into the electronics and machinery categories, a move not matched by India.

Export Similarity – Technical Notes

Mathematical definition:

$$\sum_i \min\left(\frac{\sum_w x_{isw}}{\sum_w X_{sw}}, \frac{\sum_w x_{idw}}{\sum_w X_{dw}}\right) \times 100$$

Where **d** and **s** are the countries of interest, **w** is the set of all countries in the world, **i** is the set of industries, **x** is the commodity export flow, and **X** is the total export flow. In words, we take the smaller of the sectoral export share (as a percentage) in each product category, and add them together.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	China	Rep. of Korea	India	Sri Lanka	ROW	Total
Primary Products	12544	670	4569	936	619339	638058
Food Products	9977	2055	4554	116	298992	315694
Textiles and Apparel	107040	16284	15103	2661	301714	442802
Other Manufactures	315877	141038	29271	1070	4010104	4497360
Total	445438	160047	53497	4783	5230149	5893914

Exports by Category for Selected Economies (2002)

Sample calculation: Exports by sector from China are highlighted in blue, while total exports are in red. Exports by sector for China are highlighed in green, with the total in purple. We start by calculating the export share for each category. In primary products we have \$12544/445438=0.028. For India we have \$4569/53497=0.085. The former is smaller, so we retain that value (multiplied by 100) and move to the next category. Summing across all categories we obtain: 83.8, the export similarity index between China and India.

Notes: The index is biased upward as the commodity data is aggregated (note the values in the figure on the previous page, which were calculated from dissaggregated data). The export similarity index may also be calculated using an alternative formula similar to the **complementarity** index.

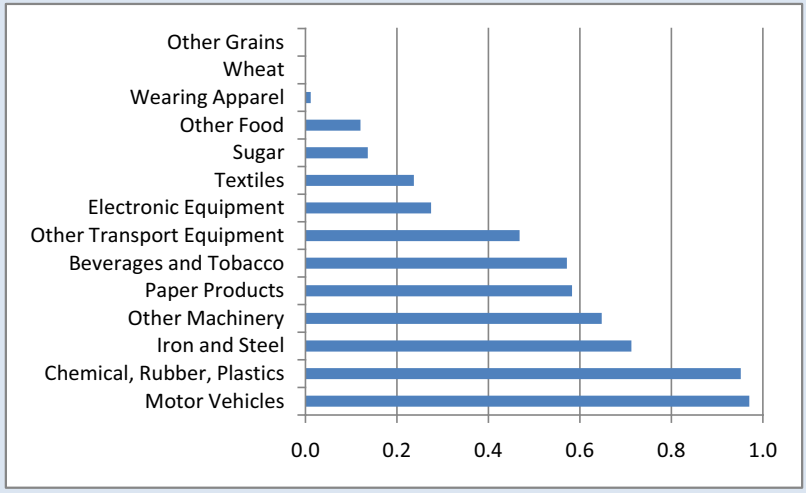
Sectoral IIT

What does it tell us? The sectoral intra-industry trade (IIT) is a measure of the degree to which trade in a particular sector represents intra-industry trade (based on scale economies and/or market structure). By engaging in IIT, a country can reduce the number of similar goods it produces, and benefit from scale economies. Higher IIT ratios suggest that these sources of gains are being exploited. May also indicate that adjustment costs would be lower with trade expansion.

Definition: One minus the ratio of the absolute value of exports in a given product category less imports in the same category to the sum of exports and imports in the category.

Range of values: The index ranges from 0 to 1, with zero indicating pure inter-industry trade, and one indicating pure intra-industry trade.

Limitations: The index is subject to aggregation bias (toward unity), both in terms of sectors and regions. It is not appropriate for measuring changes in intra-industry trade (for that the marginal IIT index should be used).



IIT Index for Selected Sectors in India (2002)

Example: The above figure depicts the sectoral intra-industry trade index for selected product categories in India. In general, IIT index levels are higher in manufactured products than in primary products, reflecting the greater role of economies of scale in the production of those products.

Sectoral IIT – Technical Notes

Mathematical definition:

$$1 - \frac{\left|\sum_d x_{isd} - \sum_d m_{ids}\right|}{\sum_d x_{isd} + \sum_d m_{ids}}$$

Where **s** is the country of interest, **d** is the set of all other countries in the world, **i** is the sector of interest, **x** is the commodity export flow, and **m** the commodity import flow. In the ratio, the numerator is the absolute value of the difference between total exports and total imports in sector **i**, the denominator is the sum of the total exports and imports in sector **i**.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	India	Sri Lanka	ROW	Total
Primary Products	4569	936	632553	638058
Food Products	4554	116	311024	315694
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Exports by Category for Selected Economies (2002)

	India	Sri Lanka	ROW	Total
Primary Products	6057	729	631272	638058
Food Products	2203	513	312978	315694
Textiles and Apparel	1282	1178	440342	442802
Other Manufactures	35814	2995	4458551	4497360
Total	45356	5415	5843143	5893914

Imports by Category for Selected Economies (2002)

Sample calculation: In the textiles and apparel category, India's exports and $15103, and its imports are $1282. Hence the numerator is the absolute value of $15103-1282=$13821.The sum of imports and exports in this category is $15103+1282=$16385. Taking the ratio we have $13821/16385=0.84. The result should lie between 0 and 1. Substracting from 1 yields the IIT index: 1-0.84=0.16. IIT is relatively low in this sector. Note again the potential for aggregation bias.

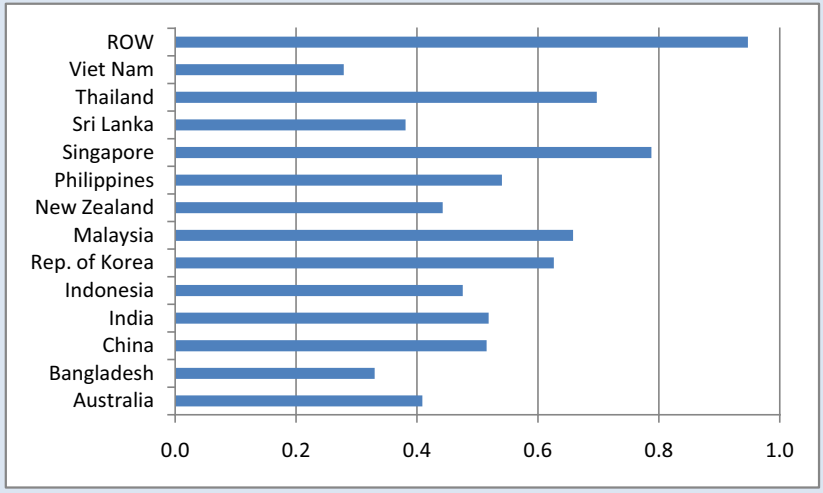
Aggregate IIT

What does it tell us? The aggregate intra-industry trade index provides us with an overall measure of the relative importance of intra-industry trade in an economy's trade profile. As with sectoral IIT, higher ratios suggest that the economies of scale and variety sources of gains are being exploited. Alternatives are the **trade overlap index**, and the **complementarity index** (when applied to a single country).

Definition: The trade weighted average of the sectoral IIT indices.

Range of values: The index ranges from 0 to 1, with zero indicating pure inter-industry trade, and one indicating pure intra-industry trade.

Limitations: As for sectoral IIT, the index is subject to aggregation bias (toward unity), both in terms of sectors and regions. It is not appropriate for measuring changes in intra-industry trade (the marginal IIT index should be used).



Aggregate IIT Index for Selected Economies (2002)

Example: The above figure compares the aggregate IIT indices in selected economies in 2002. While the 'new' trade theory that was first used to motivate trade flows between developed economies, IIT levels are high in many developing economies also, notably Malaysia and Thailand. On the other hand, IIT is relatively low in developed economies like New Zealand and Australia, which have a comparative advantage in primary products. Note the high index for the rest of world category, a product of aggregation bias.

Aggregate IIT – Technical Notes

Mathematical definition:

$$\sum_i \left(\left(1 - \frac{\left| \sum_d x_{isd} - \sum_d m_{ids} \right|}{\sum_d x_{isd} + \sum_d m_{ids}} \right) \frac{\sum_d x_{isd} + \sum_d m_{ids}}{\sum_d X_{sd} + \sum_d M_{ds}} \right)$$

Where **s** is the country of interest, **d** is the set of all other countries in the world, **i** is the sector of interest, **x** is the commodity export flow, **m** the commodity import flow, **X** the total export flow, and **M** the total import flow. The expression is less complicated than it looks. In words, we take each sectoral IIT index and multiply it by the share of that sector in the total trade of country **s**. We then sum the weighted IIT indices across all commodities.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	India	Sri Lanka	ROW	Total
Primary Products	4569	936	632553	638058
Food Products	4554	116	311024	315694
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Total	53497	4783	5835634	5893914

Exports by Category for Selected Economies (2002)

	India	Sri Lanka	ROW	Total
Primary Products	6057	729	631272	638058
Food Products	2203	513	312978	315694
Textiles and Apparel	1282	1178	440342	442802
Other Manufactures	35814	2995	4458551	4497360
Total	45356	5415	5843143	5893914

Imports by Category for Selected Economies (2002)

Sample calculation: We calculated the IIT index for India in textiles and apparel in the previous example: 0.16. In the remaining categories (in order) we have: 0.86, 0.65 and 0.90. Again note the severe agregation bias in this simplified example, primary products appears to have high IIT, but this is not really the case. Next we calculate the trade weights. For primary products we have ($4569+6057)/($53497+45356)=0.11. For the remaining categories we have: 0.07, 0.17, 0.66. Multiplying each sectoral IIT index by the corresponding weight and summing, we have the aggregate IIT index for India in 2002, which equals 0.76.

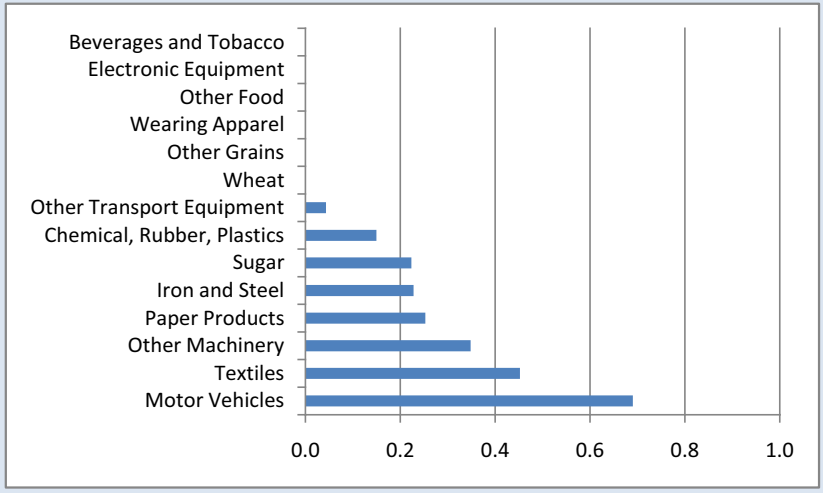
Marginal IIT

What does it tell us? Evaluating changes in IIT over time needs to be done carefully, because the IIT index can remain constant even as the volume of intra-industry trade expands. The marginal IIT index tells us how much of the change in the volume of trade between two periods is intra-industry trade.

Definition: One minus the ratio of the absolute value of the change in exports in a given product category less the change imports in the same category to the sum of the absolute values of the changes in exports and imports in the category.

Range of values: The index ranges from 0 to 1, with zero indicating pure inter-industry trade, and one indicating pure intra-industry trade.

Limitations: As with the other IIT indices, the index is subject to aggregation bias (toward unity), both in terms of sectors and regions.



Marginal IIT Index for Selected Sectors in India (2001-2002)

Example: In the sectoral IIT index example we considered how much of India's trade in various sectors can be classified as intra-industry. Suppose we want to know how the pattern of IIT is changing. We calculate the marginal IIT index for the same set of sectors between 2001 and 2002. This tells us how much of the new trade in that period was intra-industry. The figure above shows the results. While some 70 per cent of the new trade between 2001 and 2002 in motor vehicles was intra-industry, none of the trade in electronic equipment was.

Marginal IIT – Technical Notes

Mathematical definition:

$$1 - \frac{\left|\sum_d \Delta x_{isd} - \sum_d \Delta m_{ids}\right|}{\left|\sum_d \Delta x_{isd}\right| + \left|\sum_d \Delta m_{ids}\right|}$$

Where **s** is the country of interest, **w** is the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow, and **m** the commodity import flow, and Δ is the change. In words, the numerator of the ratio is the absolute value of the change in exports in category **i** less the change in imports in the same. The denominator is the sum of the absolute values of the changes in export and imports. The ratio lies between 0 and 1. Subtracting from one gives us a more natural interpretation, with increasing values indicating more intra-industry trade.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Exports		Imports	
	2001	2002	2001	2002
Primary Products	4280	4569	5945	6057
Food Products	3666	4554	1982	2203
Textiles and Apparel	14491	15103	1172	1282
Other Manufactures	25335	29271	29922	35814
Total	47772	53497	39021	45356

International Trade by Category for India in 2001, 2002

Sample calculation: The table above presents imports and exports by aggregate sector for India in the consecutive years 2001 and 2002. Total trade in textiles and apparel expanded by $722 (million) over the period ($612 in exports, in blue, and $110 in imports, in red). Hence the ratio component of the marginal IIT index for this sector is ($612-$110)/($612+110)=0.7. Subtracting from one we have 0.3. In other words most of the trade expansion was inter-industry rather than intra-industry.

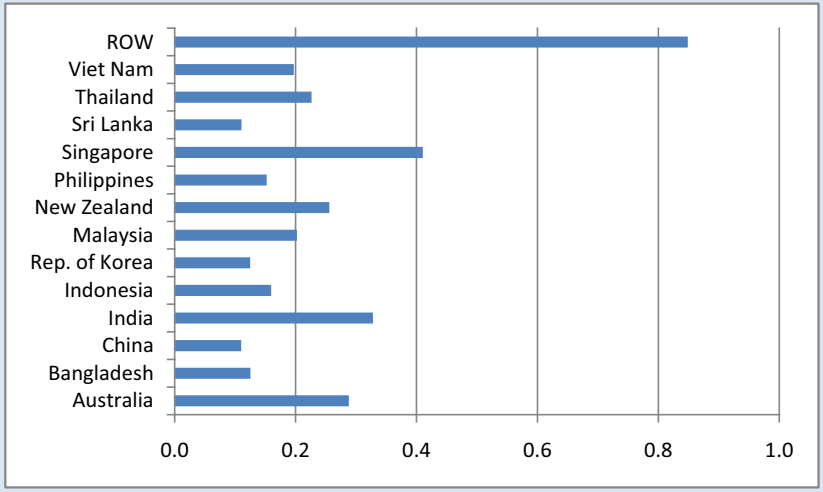
Aggregate Marginal IIT

What does it tell us? The aggregate marginal intra-industry trade index is the marginal equivalent of the aggregate IIT index. Gives us an overall measure of how much of the trade expansion between two periods was intra-industry, and how much was intra-industry.

Definition: The marginal trade share weighted average of the marginal IIT indices for each sector of the economy.

Range of values: The index ranges from 0 to 1, with zero indicating pure marginal inter-industry trade, and one indicating pure marginal intra-industry trade.

Limitations: As with the other IIT indices, the index is subject to aggregation bias (toward unity), both in terms of sectors and regions.



Aggregate Marginal IIT Index for Selected Economies (2001-2002)

Example: The above figure depicts the overall significance of intra-industry trade in the new trade between 2001 and 2002 for various economies. Read in conjunction with the aggregate IIT indices, the results suggest that IIT is of growing importance in the trade of several countries, including India and Australia. Nonetheless, most of the new trade over the period was inter-industry in the selected economies.

Aggregate Marginal IIT – Technical Notes

Mathematical definition:

$$\sum_i \left(\left(1 - \frac{\left| \sum_d \Delta x_{isd} - \sum_d \Delta m_{ids} \right|}{\left| \sum_d \Delta x_{isd} \right| + \left| \sum_d \Delta m_{ids} \right|} \right) \frac{\left| \sum_d \Delta x_{isd} \right| + \left| \sum_d \Delta m_{ids} \right|}{\left| \sum_d \Delta X_{isd} \right| + \left| \sum_d \Delta X_{ids} \right|} \right)$$

Where **s** is the country of interest, **d** is the set of all other countries in the world, **i** is the sector of interest, **x** is the commodity export flow, **m** the commodity import flow, **X** the total export flow, **M** the total import flow, and Δ the change operator. Again, the expression is less complicated than it appears. In words, we take the marginal IIT index for each sector and multiply it by the share of that sector in the marginal trade of country **s** (i.e., the total new trade between the periods considered). We then sum the weighted IIT indices across all commodities.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	Exports		Imports	
	2001	2002	2001	2002
Primary Products	4280	4569	5945	6057
Food Products	3666	4554	1982	2203
Textiles and Apparel	14491	15103	1172	1282
Other Manufactures	25335	29271	29922	35814
Total	47772	53497	39021	45356

International Trade by Category for India in 2001, 2002

Sample calculation: In the previous example we calculated the marginal IIT index for textiles and apparel to be 0.30. The other indices (in order) are 0.56, 0.40 and 0.80. Next we need to calculate the weights. The absolute values of the changes in trade by category (in order) are: $401, $1109, $722 and $9828, which total to $12060. The weights are therefore: 0.03, 0.09, 0.06 and 0.81. Multiplying each marginal IIT index by the appropriate weight we obtain the aggregate marginal IIT index for India of 0.73. Note again the bias caused by the high level of aggregation used in the simplified example.

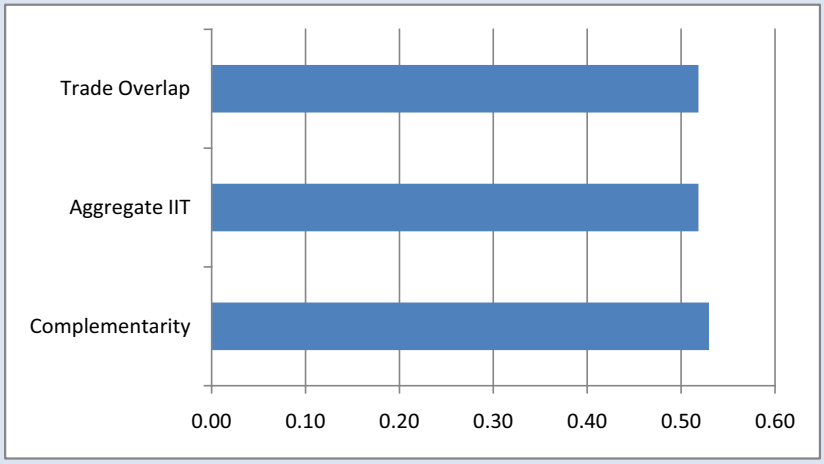
Trade Overlap

What does it tell us? The trade overlap index is an alternative to the aggregate IIT index. Again, it can tell us about the overall significance of intra-industry trade relative to inter-industry trade in the trade profile of an economy at a point in time. It is marginally easier to calculate than the aggregate IIT index.

Definition: For a given country, the sum over all sectors of the smaller of exports and imports in that sector (the overlap) multiplied by two, as a fraction of the total trade of that country.

Range of values: The index ranges from 0 to 1, with zero indicating pure inter-industry trade, and one indicating pure intra-industry trade.

Limitations: Same as for aggregate IIT, the index is subject to aggregation bias (toward unity), both in terms of sectors and regions. It is not appropriate for measuring changes in intra-industry trade (where the marginal IIT index should be used).



Comparison of Aggregate Measures of IIT for India (2002)

Example: To see how the various available measures of aggregate intra-industry trade compare, we have calculated the trade overlap index, the aggregate intra-industry trade index, and the complementarity index (as a fraction rather than a percentage) with India as both the exporting and importing country. The figures all attempt to capture the importance of intra-industry to India as at 2002. As we can see, there is very little difference between these alternatives.

Trade Overlap – Technical Notes

Mathematical definition:

$$\frac{2\times\sum_i \min\left(\sum_d x_{isd}, \sum_d m_{ids}\right)}{\sum_d X_{sd} + \sum_d M_{ds}}$$

Where **s** is the country of interest, **w** is the set of all countries in the world, **i** is the sector of interest, **x** is the commodity export flow, **X** is the total export flow, **m** the commodity import flow, and **M** the total import flow. The first term is the share of good **i** in the exports of country **s**, while the second term is the share of good **i** in the imports of the world. In words, the numerator measures the overlap of imports and exports, the denominator expresses the overlap as a fraction of total trade.

Data sources: The United Nations Commodity Trade database (COMTRADE), the World Trade Database (WTD) maintained by Statistics Canada, and the GTAP database from Purdue University.

	India	Sri Lanka	ROW	Total
Primary Products	4569	936	632553	638058
Food Products	4554	116	311024	315694
Textiles and Apparel	15103	2661	425038	442802
Other Manufactures	29271	1070	4467019	4497360
Total	53497	4783	5835634	5893914

Exports by Category for Selected Economies (2002)

	India	Sri Lanka	ROW	Total
Primary Products	6057	729	631272	638058
Food Products	2203	513	312978	315694
Textiles and Apparel	1282	1178	440342	442802
Other Manufactures	35814	2995	4458551	4497360
Total	45356	5415	5843143	5893914

Imports by Category for Selected Economies (2002)

Sample calculation: We use the same case as used in the aggregate IIT index above (i.e., India's trade in 2002). First we take the smaller of exports/imports for each category (comparing the elements in blue with the corresponding elements in green). These are: $4569, $2203, $1282 and $29271 (in order). The sum is $37325, which we multiply by two to get $74650. This is the numerator. The denominator is total trade, the sum of the red and purple cells: $53497+$45356=$98853. Hence the trade overlap index is $74650/$98853=0.75. This is almost identical to the aggregate IIT index calculated above.

VII. Protection

Numerous measures of the degree of openness of a country to trade have been utilized in the literature. David (2004) is an extensive review, covering some 70 different measures, and discussing much of the debate that has surrounded their use. Measures of the trade policy stance of regions within the economy, flawed as they may be, clearly have a place in interpreting the implications of PTAs, not least because theory indicates a critical role for both pre- and post-PTA tariff levels.

There are two broad categories of openness measure, those based on incidence (direct measures of policy instruments), and those based on outcomes (indirect measures of the degree of distortion using prices or quantities traded). Rose (2004) further breaks the measures down into seven categories:

1. *Openness:* This outcome based measure is what most trade economists have in mind when referencing 'openness'. It is defined as the ratio of total trade (imports plus exports) to GDP (real or nominal). This measure, discussed in Chapter III (as the trade dependence index), is readily available and widely understood, but may be limited as a measure of protection. For example, large economies tend to have low index values, but this can simply reflect the broader industrial structure supported by such economies rather than actual protection.
2. *Adjusted trade flows:* These measures, also outcome based, use deviations of actual trade pattern from predicted norms, most frequently the estimated via the gravity model (see Chapter VIII). These indices therefore capture implicit protection effects well to the extent that the gravity equation is well-specified, but only at an aggregate level.
3. *Price outcome measures:* The classic outcome based index measure is based on unit price differentials, which compare domestic sales prices with landed goods prices. This measure, while theoretically sound, is very data-intensive. As a consequence it is available for relatively few economies. Other measures based on black market currency premia are more readily available, but may reflect macroeconomic structure as much as trade distortion.
4. *Tariffs:* Tariff data is widely available, and incidence indices may be formed as simple averages (which will tend to be biased upward) and weighted average tariffs (which tend to be biased downward). Sectoral tariff data is also available, and useful in the case of PTA analysis, where identifying heavily protected sectors is critical. This chapter focuses on measures that can be derived from tariff information. An obvious limitation is that not all sectors are protected by tariff barriers.

5. *NTBs:* Incidence based measures of non-tariff barriers (NTBs) are usually based on frequency data. The presence of NTBs may also be imputed indirectly through the use of adjusted trade flow or price outcome measures.
6. *Informal/qualitative measures:* These are based on qualitative assessments (e.g., the outward orientation index from the World Bank, and the Index of Economic Freedom from the Heritage Foundation). These are inherently subjective.
7. *Composite indices:* Composite indices take other indices from the above categories, and combine them into a single index. This approach, common in the development context, can be used when various sub-components represent different mechanisms through which policymakers can affect the degree of openness. They can be constructed in various ways. The Sachs and Warner (1995) index is a dummy variable that takes a value of 1 when any one of several different conditions is met. More generally an index can be formed from a weighted average of underlying indices (appropriately normalized). The weights can be decided on the basis of some prior on relative importance, or using a method such as principal components (which in essence lets the variance in the data select the weights optimally).

In this chapter we focus our attention rather narrowly on the tariff data, and the basic indices that are constructed from the raw data. Before turning to the indices, however, we need to set the stage in the same way as we did with the trade flow indices, by very briefly setting out the sources of tariff data, the terminology used in the datasets, and the notation that we will use to describe the basic indices.

Like trade flow data, tariff data is available from a variety of sources. By far the most widely used source is the UNCTAD TRAINS database, which is available through WITS. This database has time series on tariff schedules at the HS 6 digit level specified at the bilateral level, although there are numerous gaps. Many other databases (e.g., GTAP and MacMaps) are based in part on the TRAINS data. The WTO also maintains a database of protection, but at a more aggregate level.

The TRAINS database contains both *bound* and *applied* tariffs. Bound tariffs are the maximum level of tariff that a country has agreed to apply. Applied tariffs are the actual tariffs used, which must be less than or equal to the bound tariff. The applied tariff is distinguished by the MFN tariff, applied to all WTO members, and the effective applied tariff, which includes

preferential rates (e.g., available through an RTA, where these are recorded). The effective applied rate should be less than or equal to the MFN applied rate. The distinction between the classifications is important as it directly impacts on the type of questions for which the tariff data can provide useful information. For example, tariff reductions are almost always negotiated under the WTO in terms of the bound rates, not the applied rates. Hence, in cases where the bound rate substantially exceeds the applied rate (a situation called *binding overhang*) tariff cuts to the bound tariff may have little effect on the actual applied tariff. On the other hand, if one is interested in tracking what has happened to actual protection levels applied within a free trade agreement like AFTA, then it is the effective applied tariff that is of interest. The bound tariffs need not have changed at all.

The basic data element in the tariff schedule is very similar to the data element in the trade flow data. Consider again the flow of exports of product *i* from country *s* to country *d*. We label this data element, x_{isd}. From the importing country perspective, once transportation and insurance have been factored in, this is the value of imports, m_{isd}. A tariff is simply a tax on the import flow, which we can label t_{isd}. In words, t_{isd} is the percentage (ad valorem) tariff rate applied by country *d* on imports of product *i* from country *s*. With this notation in hand, we can use summation notation in the same way as before, and construct aggregate indices of tariff protection. We concentrate on three simple measures:

- (Simple) average tariff
- Weighted average tariff
- Tariff dispersion

The *(simple) average tariff* is a measure of the overall degree of protection in the tariff schedule. It is a useful overall measure, but it can disguise very high protection levels in some sectors. The *weighted average tariff* takes into account the importance of each product in the import profile of the economy in question. It tends to understate the degree of protection because highly protected sectors tend to be given a low weight. The *tariff dispersion* index is a simple measure of how much variation there is in the tariff schedule. All of these measures are automatically calculated in TRAINS, so our calculations are illustrative.

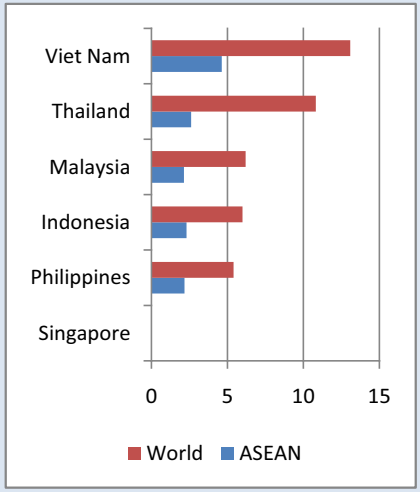
Average Tariff

What does it tell us? The (simple) average tariff tells us how much protection is applied by an economy or region, on average. Higher values indicate a more protected economy, lower values a less protected economy. In general, lower protection levels indicate a greater degree of integration with the global economy. Can be calculated for a subset of regions or products.

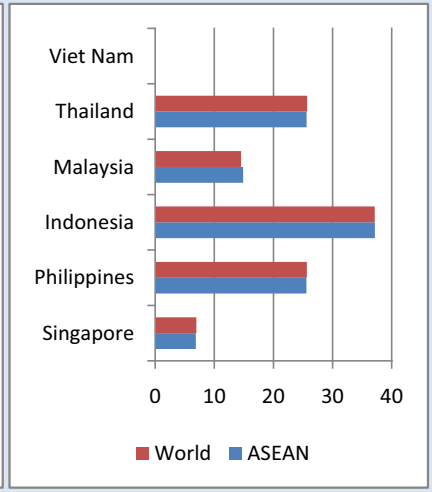
Definition: The mean (average) value of tariffs in a country or region's full tariff schedule, or a part of the schedule.

Range of values: The tariff is defined as a percentage, so the average can range from 0 to +∞ (import ban).

Limitations: The simple average tariff does not adjust for the significance of different products in the trade profile, so a high tariff on an insignificant product may overstate the degree of protection. Does not provide information on tariff peaks.



Effective Applied Tariffs in ASEAN



Bound Tariffs in ASEAN (2006)

Example: The above figures describe the simple average tariff for the ASEAN-6 economies in 2006 (from TRAINS). In the figures we show the difference between the effective applied rates and the bound rates. We have calculated the average across all trading partners, and the average across the other ASEAN-6 members. Note how Singapore has a zero average applied tariff, but still maintains a positive bound tariff. Viet Nam, having only acceded to the WTO in 2007, had no bound tariffs in 2006. The difference between the effective applied tariffs to the world and to ASEAN reflect tariff preferences under AFTA.

Average Tariff – Technical Notes

Mathematical definition:

$$\frac{\sum_{is} t_{isd}}{n \times p}$$

Where **d** is the importing country, **s** is the set of source countries, **i** is the set of products of interest, **t** is the tariff of interest (e.g., bound or applied) defined as a percentage, **n** is the number of products in the product set, and **p** is the number of countries in the source. In words, we take the sum of all the tariffs in the lines of interest, and divide it by the number of elements in those lines.[11]

Data sources: The UNCTAD Trade Analysis and Information System (TRAINS), the ITC Market Access Maps (MacMaps), the WTO Integrated Database (IDB) (applied rates), the WTO Consolidated Tariff Schedule (CTS) (bound rates), and the GTAP database from Purdue University (applied rates).

790111	Containing by weight 99.99 % or more of zinc	5.50
790112	Containing by weight less than 99.99 % of zinc	5.50
790120	Zinc alloys	5.50
790200	Zinc waste and scrap.	1.00
790310	Zinc dust	1.00
790390	Other	1.00
790400	Zinc bars, rods, profiles and wire.	5.00
790500	Zinc plates, sheets, strip and foil.	5.00
790600	Zinc tubes, pipes and tube or pipe fittings	5.00
790700	(1996-) Other articles of zinc.	20.00
	Total	54.50
	Number of Lines	10.00
	Simple Average	5.45

Thailand MFN Tariff Schedule (2006) – HS2002 Category 79

Sample calculation: In the table above we present a subset of the MFN tariff schedule of Thailand in 2006 (applied rates), drawn from TRAINS. The information is on the HS2002 category 79 (zinc and articles thereof). To obtain the simple average we sum the tariffs (all expressed as percentages) in the lines of interest, this gives us 54.5. We then divide by the number of lines, in this case 10. The average level of protection is 5.45 per cent, relatively low.

[11] The elements of the summation and division must be adjusted accordingly if the group of interest is not the full bilateral tariff schedule. If, for example, we are interested only in the average MFN tariff, then we sum the MFN tariffs only over product categories for a given economy, and divide by the number of product categories.

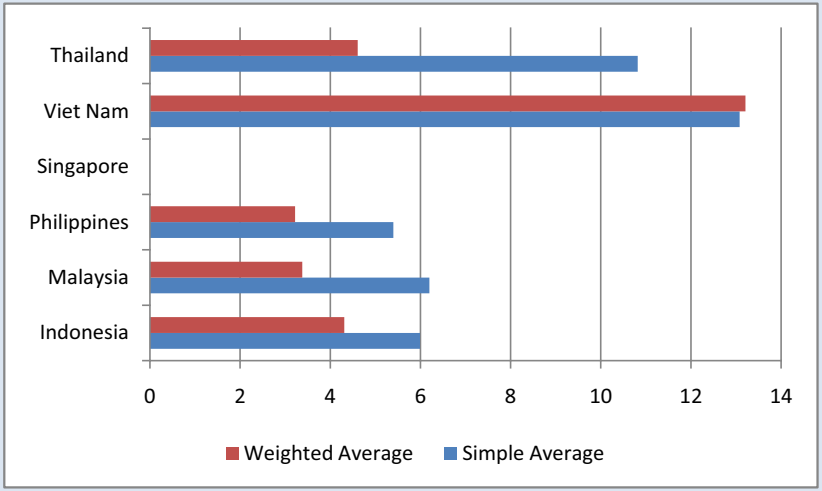
Weighted Average Tariff

What does it tell us? Like the (simple) average, the weight average tariff tells us how much protection is applied by an economy or region, on average. Higher values indicate a more protected economy, lower values a less protected economy. The difference is that the weighted average tariff takes into account the volume of imports in each product category.

Definition: The sum of the tariffs in a country or region's tariff schedule (or part of the schedule) multiplied by a weighting factor representing the product's importance in the country or region's trade.

Range of values: The tariff is defined as a percentage, so the weighted average can range from 0 to +∞ (import ban).

Limitations: As with the simple average, this index may mask tariff peaks. It has a tendency to understate the level of protection because very heavily protected products are imported less (because of the high tariff), and therefore receive a small weight.



Weighted Average Tariff as per cent for ASEAN in 2006

Example: We continue using the tariff schedule for the ASEAN-6 in 2006 as our example. The figure above (again from TRAINS), compares the simple average applied tariff with the weighted average tariff. The trade weights are from 2005. These are the effective applied tariffs, averaged over the world. Note that the weighted averages can be quite different from the simple averages, in general smaller.

Weighted Average Tariff – Technical Notes

Mathematical definition:

$$\sum_{is} \frac{m_{isd}}{\sum_{k} M_{kd}} t_{isd}$$

Where **d** is the importing country, **s** (**k**) is the set of source countries, **i** is the set of products of interest, **t** is the tariff of interest (e.g., bound or applied) defined as a percentage, **m** is the product level imports, and **M** is total imports by category. In words, we take each bilateral tariff and multiply it by the share of the corresponding bilateral import flow in total imports. We then sum the weighted tariffs across all sources/product categories.[12]

Data sources: The UNCTAD Trade Analysis and Information System (TRAINS), the ITC Market Access Maps (MacMaps), the WTO Integrated Database (IDB) (applied rates), the WTO Consolidated Tariff Schedule (CTS).

	Tariff	Imports	Weights	Weighted Tariffs
790111	5.50	67730	0.539	2.96
790112	5.50	2508	0.020	0.11
790120	5.50	32642	0.260	1.43
790200	1.00	374	0.003	0.00
790310	1.00	7436	0.059	0.06
790390	1.00	686	0.005	0.01
790400	5.00	3167	0.025	0.13
790500	5.00	541	0.004	0.02
790600	5.00	146	0.001	0.01
790700	20.00	10533	0.084	1.68
	54.50	125762	1.000	6.40
	10.00			

Thailand MFN Tariff Schedule (2006) – HS2002 Category 79

Sample calculation: We use the same example as above for the simple average. The value of imports (in thousands of US$) is presented in the second column. In the third column we have calculated the **import shares** in this category (as a fraction). Multiplying the elements of the first column by those of the third gives us the fourth column, the weighted tariffs. Summing the weighted tariffs yields the weighted average, 6.40 per cent. The simple average is the same as the weighted average if the import shares are all equal (to 1/n where n is the number of lines under consideration).

[12] As with the simple average, the elements of the summation and division must be adjusted accordingly if the group of interest is not the full bilateral tariff schedule.

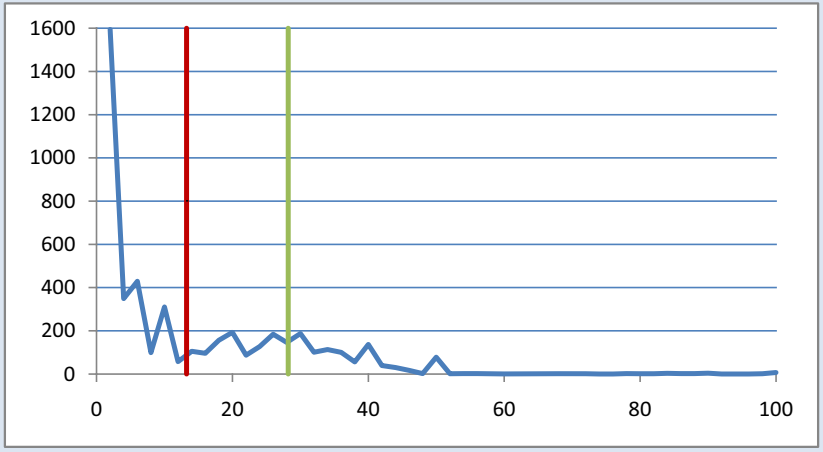
Tariff Dispersion

What does it tell us? The tariff dispersion index is a single number that measures how widely spread out are the tariffs in a schedule or part thereof. In other words, a high tariff dispersion index indicates that there is a lot of variation in the tariff schedule. Economists generally believe that a uniform tariff (with low dispersion) is more economically efficient. An alternative measure is to consider the difference between the maximum tariff and the minimum tariff.

Definition: The tariff dispersion index is the standard deviation of the selected tariff line items.

Range of values: The tariff is defined as a percentage, so dispersion index is measured in the same units. It can range from 0 (if there is a uniform tariff) to $+\infty$.

Limitations: The measure should be used in conjunction with the average tariff. It can be distorted by a small number of exceptional tariffs.



Frequency of Viet Nam Tariffs (2006)

Example: The above graphic represents the frequency of Viet Nam's MFN applied tariff in 2006. The horizontal axis is the tariff value (in per cent), the vertical axis the frequency with which that value appears in the schedule (in this case of roughly 5000 tariff lines). The vast majority of products have zero tariffs applied, but a few reach up 100 per cent. The red line marks the simple average – around 13 per cent. The green line marks one standard deviation from the average. The wider the range of tariff values, the greater the distance between the red and green lines will be.

Tariff Dispersion – Technical Notes

Mathematical definition:

$$\sqrt{\frac{\sum_{is}(t_{isd}-\bar{t}_{isd})^2}{n\times p}}$$

Where **d** is the importing country, **s** is the set of source countries, **i** is the set of products of interest, **t** is the tariff of interest (e.g., bound or applied) defined as a percentage, **n** is the number of products in the product set, and **p** is the number of countries in the source. In words, we take the sum of all the tariffs in the lines of interest, and divide it by the number of elements in those lines.[13]

Data sources: The UNCTAD Trade Analysis and Information System (TRAINS), the ITC Market Access Maps (MacMaps), the WTO Integrated Database (IDB) (applied rates), the WTO Consolidated Tariff Schedule (CTS) (bound rates), and the GTAP database from Purdue University (applied rates).

		Tariff	Squared Deviation
790111	Containing by weight 99.99 % or more of zinc	5.50	0.002
790112	Containing by weight less than 99.99 % of zinc	5.50	0.002
790120	Zinc alloys	5.50	0.002
790200	Zinc waste and scrap.	1.00	19.803
790310	Zinc dust	1.00	19.803
790390	Other	1.00	19.803
790400	Zinc bars, rods, profiles and wire.	5.00	0.203
790500	Zinc plates, sheets, strip and foil.	5.00	0.203
790600	Zinc tubes, pipes and tube or pipe fittings	5.00	0.203
790700	(1996-) Other articles of zinc.	20.00	211.703
	Total	54.50	271.725
	Number of Lines	10.00	
	Simple Average	5.45	

Thailand MFN Tariff Schedule (2006) – HS2002 Category 79

Sample calculation: Again consider the Thai tariff schedule in category 79. We have already calculated the **simple average tariff** to be 5.45 per cent. In the second column in the table we have calculated the difference between each tariff and the simple average, and squared the value (the squared deviations). The sum of the squared deviations is 271.725. We divide this by the number of lines to get 27.17. Taking the square root of this number yields the tariff dispersion index, 5.21 per cent.

[13] Again, the elements of the summation and division must be adjusted accordingly if the group of interest is not the full bilateral tariff schedule.

VIII. Beyond Indices

While direct examination of trade flows and summary trade indices derived from the underlying flows can yield numerous insights on the effects of trade policy changes, such as regional trade liberalization, other more advanced methods are also of interest and warrant careful consideration. Two approaches have proved particularly useful in the international trade policy literature: the estimation of the gravity equation and simulation of policy changes using partial or general equilibrium models. These methods are advanced, and a full description is far beyond the scope of this handbook. Nonetheless, it is very likely that policymakers will encounter the results of studies using these methods, and will need to accurately and critically assess them in order to make effective use of the results in policymaking. Hence, in this chapter we briefly consider the role that gravity models and computable general equilibrium simulation methods can play in informing trade policy debates, with a focus on assisting policymakers in becoming informed "consumers" of the results.

1. COMPUTABLE GENERAL EQUILIBRIUM MODELS

Evaluating the potential impact of trade policy changes *ex ante* (i.e., before they are actually put in place) is usually accomplished using numerical simulation techniques. In essence, this just means that a (symbolic) model from economic theory is built (usually on as a computer program) using specific and numerically defined functional forms instead of abstract ones, and the model then perturbed in a way that represents the policy in question. The results of the model are numeric as opposed symbolic. The two most commonly utilized simulation techniques for numerically evaluating trade liberalization proposals are partial equilibrium (PE) and general equilibrium (GE) modeling. PE refers to an incomplete system where various *ceteris paribus* assumptions are in place, generally an analysis of a single sector. PE models cannot account for the interaction between the sector or sectors under consideration and the rest of the economy. Balanced against this limitation is simplicity, and the fact that reduced-form specification sometimes makes econometric estimation feasible. PE models are well-suited to shocks to a single sector that is sufficiently small for any interaction with the rest of the economy to be ignored.

Computable general equilibrium (CGE) models are numerical models based on general equilibrium theory. Their objective to turn abstract models of general equilibrium theory into a practical tool for policy analysis. A number of features distinguish

GE models. They are multi-sectoral, and in many cases multi-regional, and the behavior of economic agents is modeled explicitly through utility and profit maximizing assumptions. In addition, economy-wide constraints are rigorously enforced. In other words, the markets in a CGE model are all linked together. Distortions in an economic system will often have repercussions far beyond the sector in which they occur. By linking markets, CGE techniques are effective at capturing the relevant feedback and flow-through effects.

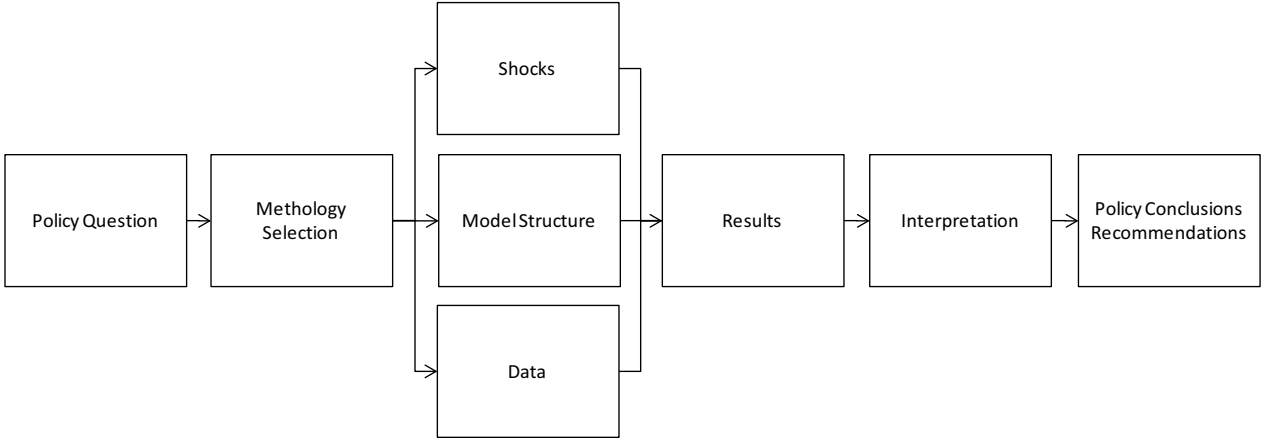
CGE models have been widely adopted in the trade policy literature. Recent surveys of their application (including numerous examples using GTAP) see Scollay and Gilbert (2000), Gilbert and Wahl (2002), Robinson and Thierfelder (2002), Lloyd and MacLaren (2004) and Hertel and Winters (2005). Part of their popularity can be explained by the significant advantages that the CGE approach has over other methods. The most important of these are:

- Theoretical consistency.
- The ability to highlight the importance of linkages between sectors.
- The ability to incorporate unique features of an economic system.
- The ability to predict values for many economic variables in the system.

Balanced against these advantages, however, are some important limitations. In particular:

- The data requirements of CGE models are substantial.
- The human capital investment required in building/using these models is very high.
- There is often uncertainty over parameters, specification, and experimental design.
- By covering all sectors in an economy, a CGE model may miss key features of critical sectors.
- It can be difficult to know what is driving the results (the “blackbox” critique).

Of course, many of these limitations can be alleviated by appropriate modeling and study design. CGE is a highly specialized area of research, and it is not possible to provide a guide to undertaking the method. Rather, our purpose here is to provide notes helpful for consumers of CGE studies as opposed to producers. We begin by considering the design of a CGE study, and outlining key question that a policymaker should ask a provider of CGE modeling services. The figure below outlines the general process, which begins with a policy question.



Process of Undertaking a CGE Analysis

Sample policy questions might be, how would growth in country x affect trade patterns in country y? What would happen in country x if they lowered tariffs in sector z? Would a regional trading agreement between countries x and y be a good idea, and in what sense? And so on. In most cases the policy question is external to the modeling process, it comes from various scenarios under consideration by policymakers.

The next step is selection of an appropriate methodology. This depends critically on the nature of the policy question being asked. As a broad guide, computable general equilibrium will be an appropriate choice if the following conditions are met:

- Appropriate data/human capital is available for the exercise. This is an obvious precondition for doing any CGE work.
- The policy question involves large changes that are well outside of historical experiences. This suggests the need to use simulation techniques of some kind.
- The policy question involves multiple countries and/or multiple sectors. For example, the DDA involves many countries simultaneously liberalizing many different sectors. This suggests that we need general equilibrium rather than partial equilibrium techniques.
- Or, the policy question involves only one sector directly, but that sector is large enough to have an impact on the overall economy. For example, for many LDCs the textile industry is so large relative to the overall economy that general equilibrium may be justified even if the policy scenario involves only that sector.
- Answering the policy question requires detailed information on the economic system and not broad economic aggregates. For example, if trade flows are the only variable of interest, extrapolation from a gravity model may be preferred. If, however, information on how sectoral employment patterns will change when a policy is implemented is needed, CGE may be preferred.

Now, suppose that it has been determined that CGE techniques are an appropriate methodological choice for the policy question at hand. What does an exercise in CGE actually look like? A CGE analysis will consist of three components: data, the model (structure), and shocks. These three elements combine together to produce the simulation results. We consider each in turn.

The data used in a CGE model consists of two types of information. The first is structural information on the economic system under study. This takes the form of 'flows' – the values of economic transactions among the various players in the economy, and 'distortions' – the policy instruments and other factors that impact the economy in its current state. The data requirements are actually fairly substantial. Flow data will typically include information on the flows of primary factors (labor, capital and so on) into productive activities, the flows of production into consumption activities by households, the government, other firms and investment, and of course international trade flows. Distortion data will often include production/consumption taxes and subsidies, and taxes and subsidies on international trade (i.e., tariffs).

The second type of information is 'parametric' – it describes the behavior of the players in the economic system. Exactly what parametric data is required will depend on the model structure, but typically it includes elasticities of substitution in production, demand elasticities, and so on. Key questions that should be asked about the data underlying a CGE simulation exercise include:

- *What is the base year?* The base year is the point in time represented by the flow/distortion data. One of the most common sources of data is the GTAP database. The current version of this database (version 6) has a base year of 2001. The next version (to be released in 2008) will have a base year of 2004. It is important to note that because of the immense data requirements of CGE models, it is very common for the base year data to be several years (or more) old. Moreover, in many cases the underlying data is actually older, and has been adjusted to the new base year (especially in the case of input-output tables, which may be produced only every ten years or so). This matters if significant changes in the economy have occurred since the base year.

- *What adjustments (if any) were made to the base data?* In some cases researchers may be able to compensate for older data by updating some key elements, for example the tariff rates, or by projecting the model forward to a new base year.
- *What are the data gaps?* All data is incomplete in some regard, and it is important to know what the gaps are in order to make sense of the results. For example, the GTAP dataset currently has relatively poor information on services trade and protection. It is important to know this before contemplating using the data for a study of services (unless the researcher is willing and able to make appropriate adjustments). Similarly, the input-output data for some countries is not available, and is instead constructed based on other regions. This should affect how seriously output results for such regions are taken.

The second component of an exercise in CGE is the model structure, the theory of the model. This is the set of assumptions about how the economic system in question actually works. Because CGE models are essentially theoretical models, there is considerable scope for variation in model structure. Certain key elements will be critical for all CGE models, however. Critical questions include:

- *What is the model closure?* Closure is the selection of which variables in the model are to be exogenous (given). There are both micro and macroeconomic elements to the choice. Microeconomic elements relate to the function of markets: factor specificity, price fixing, rationing, unemployment, etc. Macroeconomic closure relates to the balances identity (the relationship between savings, investment and the current account), and the choice of which of the components of this identity are exogenous, or determined by some functional rule. Closures rule issues been discussed at length in Dewatripont and Michel (1987). The key point is that selecting different closures reflects different economic realities, and can therefore have a significant impact on the model results. There is no 'right' closure, different choices must be made to match the economic reality on the ground as closely as possible. The key is to question whether the closure makes sense in context, and how the particular closure chosen impacts the model results.

- *What are the assumptions regarding market structure?* Some models do not maintain the assumption of perfect competition in all markets. A variety of specifications have been adopted to introduce imperfect competition into CGE models (see Harris, 1984). This can have a significant effect on model results. Again, there is no right choice, a model that incorporates imperfect competition may be better suited to some types of questions, but may involve trade-offs that are not worth the benefits in other circumstances (e.g., in a study of primary agricultural markets, the benefit of introducing imperfect competition to the automobile sector in a model may not be worth the extra time and uncertainty over specification involved, time which might be better devoted to getting the protection mechanisms in agriculture modeled correctly).
- *What are the assumptions on the treatment of time?* Simulation in most CGE models involves comparative statics. That is, most models consider the role that changes in exogenous parameters ('shocks') have on the allocation of goods amongst consumers and of resources amongst productive activities, and the consequences for economic efficiency. These models have no explicit time dimension, instead representing different time frames by altering microeconomic elements of the closure (e.g., allowing capital to move across activities or not). Some CGE models run static simulations from a projected future equilibrium. A time element can also be introduced by solving the model sequentially, updating the capital stock to simulate investment and depreciation, the labor stock to simulate population growth, and productivity parameters to simulate advances in technology. Such models are known as recursive dynamic. They generate a base growth path to which the experimental growth path can be compared. In these models, however, the inter-temporal allocation of goods and resources will not be optimal in general. Truly dynamic models attempt to overcome this deficiency by explicitly modeling inter-temporal behavior (Manne, 1985, describes the approaches as 'myopic' and 'clairvoyant'). This substantially increases the computational complexity. Once again, the best approach will depend on the nature of the questions being asked and the trade-offs involved, a recursive dynamic model may not be better than a comparative static model at addressing issues of resource allocation, and may introduce more sources of uncertainty in the growth path, for example. An inter-temporal model may give up substantial sectoral detail in order to get the consumption/investment behavior time-consistent.

The third and final element of a CGE simulation is the choice of 'shocks.' A shock is a change is any exogenous value in the model. Most often, shocks take the form of removing or adding distortions to the economic system (e.g., removing a tariff) or establishing a growth path through changes in the stocks of productive factors and the level of technology. Other possibilities include changes in preferences or the terms-of-trade (depending on the model). In general, the shocks are chosen to represent as fully as possible a proposed policy change underlying the policy question under study. There is really only one key questions to ask:

- *What exactly do the assumed shocks cover and how were they determined?* For example, in simulating a preferential agreement, do the shocks cover all trade or only merchandise trade? Is the simulation covering export subsidies and domestic support, or tariffs only? Does the study assume that other taxes remain in place or do they adjust to make up revenue? (Strictly, this is an element of closure). Are tariffs reduced to zero, or do reductions follow a known schedule? Are sensitive products included? And so on. Basically, the objective is to ascertain whether or not the shocks chosen are a good representation of the likely policy scenario. Again, we should note that not including some features (e.g., services) may reflect data or theoretical limitations, and does not necessarily make the results useless, but it does affect how we interpret them.

These three elements, data, model and shocks, combine to produce the results of a CGE analysis. We emphasize a few critical points again. CGE is not an appropriate choice for all types of policy questions, and the question should ultimately determine the methodology used. If CGE methods are chosen, the details of the three elements outlined above should also be carefully planned to address the policy question, subject to the constraints imposed by data, theory and time. A modeler should be able to articulate clearly to policymakers exactly what choices were made, why the choices were made, and what the consequences of those choices are. A modeler should also be able to clearly articulate to policymakers the limitations of the approach taken. At the same time, it needs to be recognized that *all* models are inherently limited by their very nature, and different models will have different limitations. An honest assessment of the limitations of any framework simply helps us to evaluate the results of a CGE study more objectively.

Once the results are obtained, they have to be interpreted. The meaning of the results and the way they are interpreted depends critically on how the simulation was designed. In a comparative static framework, the results represent the way the economic system would look (or how much it would change) once all of the adjustments allowed under the chosen closure have taken place. Changes in economic variables (e.g., output or trade of a particular sector, employment or GDP) will be presented either in levels (i.e., monetary units) or in percentage changes from the base. Comparative static results are sometimes called a "one-off change", but the terminology is a bit misleading. A comparative static model is representing the economic system at rest, so the results are better interpreted as a "once and for all" change. On the other hand, the results of a dynamic model will usually be presented either as the path of a particular economic variable of the economic system over time, or the difference between the value of an economic variable at a particular point in time (e.g., at the end of the simulation period) relative to a business as usual scenario or baseline.

Since CGE models track large numbers of economic variables (often in the tens or even hundreds of thousands), in principle a large number of different results can be presented. Some of the more common are:

- *Economic welfare.* This is an aggregate measure of the benefit of a policy change to the economy. By far the most commonly used welfare measure is the equivalent variation (EV). This is the monetary value of the increment in income that would have to be given to (or taken away from) a household at today's prices to make them as well off today as they would be under the proposed policy change.
- *Output changes.* These may be at the aggregate level (e.g., nominal or real GDP) or at the sectoral level.
- *Trade changes.* Again, these may be at the aggregate level or at the sectoral level.

Other measures may also be available, depending on the closure and model structure. For example, many recent exercises feature disaggregated households, and can provide insights into the effect of reform on poverty. The results presented should be chosen with the policy goals in mind, but beware of placing undue emphasis on the numbers. Key questions to ask:

- *Are the results reliable?* It is important to understand whether or not a particular result is robust. This is based on the idea that the underlying parameters of the model are not known with certainty, and therefore the results are not known with certainty either. Using sensitivity analysis it is usually possible to measure which results are robust to changes in the parameters and which are not. For example, a model might predict a large welfare gain from a particular policy reform. However, a moderate change in the underlying parameters (keeping them within a reasonable range) might generate a predicted welfare loss. Such a result is not robust, and would be a poor basis for policy decisions.
- *Are the results economically significant?* A result may be robust but of little economic significance. This can be evaluated by comparing the magnitude of predicted changes to the initial levels. For example, a welfare gain of $100 million may seem large in the context of the economy of Bangladesh, but is miniscule relative to the economy of Japan. Similarly, a model may predict a 200 per cent rise in imports in a particular sector, but this may be of no interest if the imports were negligible to begin with. Context is always important when evaluating CGE results.
- *Why does this result happen?* In some cases a CGE simulation may generate unexpected results. In a sense this is a good thing, one of the main purposes of modeling using CGE methods is to bring interactions that might not have been considered to the forefront of policy discussions. Nonetheless, unusual or important results need to be fully explained. Because a CGE model is a theoretical model it is possible to track down the reasons why certain results occur, and this is a critical part of the analysis. For example, a simulation exercise generates a welfare loss in a scenario where a welfare gain was anticipated. Is this because of adverse terms-of-trade movements? Or is it because of a distortion elsewhere in the system, and if so where? If a good explanation is found, that is useful policy information. If an important result comes down to a dubious piece of data or shock assumption, that is cause for concern.
- *How might the results change under different structural assumptions?* It is reasonable to question a modeler on how the results of their exercise might differ had constraints allowed a different approach. This is part of putting the results in context and assessing the limitations. Some differences are well-known from surveys of the CGE literature, for

- example, CGE models incorporating imperfect competition and/or dynamics tend to predict larger welfare gains, because they capture more potential sources of gains than static/competitive models.[14]
- *How do the results of this study compare to others?* This is perhaps the single most useful question that can be asked, if other studies exist. If other studies by independent researchers using different models generate similar results, the confidence in policy recommendations is enhanced. Moreover, if the assumptions of other studies vary, then comparison can provide useful information on the importance of those assumptions.

Once the results are analyzed it is possible to draw policy conclusions. Is the proposed policy a good one? In what sense? What issues will we need to be aware of as we implement the policy? Are there any potential problems? How can these be overcome? How does the proposed policy compare with other possible choices? Properly designed and implemented, and judiciously interpreted, CGE models can be excellent tools in framing the policy debate.

[14] Beware of pushing this too far, however, to push a desired outcome, since the analysis is speculative, if you truly believe that imperfect competition is going to change the results dramatically in a way that favors a particular outcome, then imperfect competition should be a part of the modeling framework to begin with (assuming it can be justified in context). Policymakers need to be vigilant about chasing a particular result. Any modeling process can be manipulated to generate a desired outcome, but to do so violates the entire premise and purpose of the modeling exercise, which is to inform the policy debate, not justify a pre-determined stance.

2. GRAVITY MODELS

The gravity model is perhaps the most widely used econometric model of international trade patterns. An econometric model uses historical data to try to estimate (and test the robustness of) a hypothesized economic relationship. Once estimated, an econometric model may also be used to try and extrapolate to cases outside of what has been experienced, i.e., as a predictive policy device.

The gravity model is based on the idea that the volume of bilateral trade between any pair of countries is an increasing function of the combined 'mass' of the economies, and a decreasing function of distance between the two. While in the past the approach was viewed as lacking a strong microeconomic foundation, this is no longer the dominant view. The development of the 'new' trade theory helped to provide stronger theoretical foundations for the specification, and it is now recognized that a reduced form gravity equation can be derived from most models of international trade that incorporate transportation costs (see Deardorff, 1998). An extensive review of the gravity model in theory and practice is provided by Anderson and van Wincoop (2004). Again, our objective here is only to provide an overview of the issues faced when considering the gravity approach. Key questions:

- *What are the advantages/disadvantages of a gravity approach?* The main advantage is that it is an easy model to implement (although there is still much refinement at the margin going on in the literature), the data for which is readily available. Properly specified, it has also proved to be a very reliable model for explaining existing trade patterns. The main disadvantages are that it may be less useful for predicting changes outside of the range of historical experience, and that it is only capable of explaining trade flows, not more detailed aspects of an economic system.
- *How is the model specified?* In order to estimate the gravity model a double logarithmic specification is usually used, relating the bilateral trade flows of each country pair (the dependent variable) to the product of their GDPs and the distance between them (the independent variables), plus an error term to capture the random component in the data. In most applications, additional independent variables are also often included in the model to improve the fit. These may

include measures of openness, remoteness, common language or currency, a common border, and of course the presence or absence of a regional trading agreement. The variables may be continuous (e.g., some measures of openness) or qualitative measures represented by dummy variables (e.g., a country pair is assigned a 1 if they share a common language, a 0 otherwise).

- *What data is needed?* This depends on the exact specification. The primary data requirement is one or more cross-sections of trade flow data (i.e., a trade matrix) that includes as many economies as possible, including those of interest. Some studies may use only a single year of data (in effect cross-sectional studies). Others may use multiple years (i.e., a panel). Trade flow data is available from numerous sources as outlined in the preceding chapter (e.g., COMTRADE or DOTS). The other requirements are measures of size (usually GDP but sometimes population, both available through WDI) and distance (available from various sources, including the World Distance Tables), and indicators or dummies for any other independent variables used.
- *How is the model estimated?* As a single equation linear model, the gravity model can be estimated easily using ordinary least squares (OLS), although other methods (e.g., generalized least squares) may be helpful if the data exhibits heteroscedasticity (see Frankel, 1997). If the data from which the model is estimated is a panel (i.e., is composed of both time series and cross-sectional elements) then pooled OLS, fixed effects or random effects models may also be used (see Rose, 2004).
- *How are results interpreted?* We can think of the gravity model as estimating a 'normal' trade flow, from which deviations can be investigated. Hence, the approach accomplishes econometrically what indices such as the trade intensity index attempt to do using simple computation – and in fact we can think of a well-specified gravity model as a kind of 'super' trade intensity index. Results will be presented in a table with numerical estimates of the coefficients, measures of their statistical robustness, and overall measures of how well the model fits the data (perhaps for several alternative specifications and estimation methods). In view of the double logarithmic specification, the coefficients on continuous variables are interpreted as elasticities. In other words, suppose that the estimated coefficient on distance is -0.1. This means that if the distance between two countries increases by 1 per cent, we expect to see bilateral trade

decrease by 0.1 per cent. Coefficients on dummy variables are interpreted differently. Suppose that the estimated coefficient on a common border is 0.3. This means that having a common border increases trade by (exp(0.3) -1) ×100=35 per cent.

- *How can the results be used?* The approach also allows us to draw on the theory of statistical inference. Hence, statistically significant coefficients on a PTA dummy variable may be used to infer the presence of net trade diversion/or creation (assuming an appropriate panel is available), in much the same way as changes in the trade intensity index are used. A gravity model can also be used to predict changes in trade flows following a change in some independent variable. For example, given the characteristics of a particular group and the fitted gravity equation, it is possible to calculate the predicted trade flows. One can then change the characteristics in a way that represents the policy proposal (e.g., decrease protection) and see how much the predicted trade flows change.

As with CGE models, properly designed and implemented, and judiciously interpreted, gravity models can be excellent tools in framing trade policy debates, both by rigorously analyzing current trade patterns and helping to evaluate possible changes.

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