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GLOBAL VALUE CHAINS AND Development

INVESTMENT AND VALUE ADDED TRADE IN THE GLOBAL ECONOMY

A preliminary analysis

UNITED NATIONS

Editorial Note

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Executive Summary

UNCTAD's Division on Investment and Enterprise builds on efforts in the international community to map the distribution of value added in global trade, launching a GVC dataset that expands coverage to include almost all countries, including developing economies, and a broad range of industries and activities of relevance to them. The UNCTAD-Eora GVC Database – part of UNCTAD's FDI-TNCs-GVC Information System – provides new perspectives on trade links between economies, on the distribution of value added, income and employment resulting from trade, on the investment-trade nexus and on how transnational corporations (TNCs), through equity and contractual modes, shape patterns of value added trade.

Highlights of the findings presented in this report:

- *Global investment and trade are inextricably intertwined through the international production networks of firms* investing in productive assets worldwide and trading inputs and outputs in cross-border value chains of various degrees of complexity. Such value chains (intra-firm or inter-firm, regional or global in nature, and commonly referred to as Global Value Chains or GVCs) shaped by TNCs account for some 80% of global trade.
- *GVCs are responsible for the growing significance of "double counting" in global trade figures*. The new data shows that some 28% of gross exports consist of value added that is first imported by countries only to be incorporated in products or services that are then exported again. Thus some $5 trillion out of the $19 trillion in global gross exports (in 2010 figures) is actually double counted.
- *GVCs make extensive use of services*. While the share of services in gross exports worldwide is only around 20%, almost half (46%) of value added inputs to exports is contributed by service-sector activities, as most manufacturing exports require services for their production. In fact, a significant part of the international production networks of TNCs are geared towards providing services inputs, as indicated by the fact that more than 60% of global FDI stock is in services activities (26% in manufacturing and 7% in the primary sector). This picture is similar in both developed and developing economies.
- *The majority of developing countries, including the poorest, are increasingly participating in GVCs.* The developing country share in global value added trade increased from 20% in 1990 to 30% in 2000 to over 40% today. Again, the role of TNCs is instrumental, as countries with a higher presence of FDI relative to the size of their economies tend to have a higher level of participation in GVCs and a greater relative share in global value added trade compared to their share in global exports.
- *GVC links in developing countries can play an important role in economic growth*. Domestic value added created from GVC trade can be very significant relative to the size of local economies. In developing countries, for example, value added trade contributes some 28% to countries' GDP on average, as compared with 18% for developed countries. Furthermore, there appears to be a positive correlation between participation in GVCs and GDP per capita growth rates. Economies with the fastest growing GVC participation have GDP per capita growth rates some 2 percentage points above the average.
- *There appear to be a number of distinct GVC development paths for developing countries*, including "engaging" in GVCs, "upgrading" along GVCs, "leapfrogging" and "competing" via GVCs. The best development outcome may result from increasing GVC participation and upgrading along GVCs at the same time. Countries that, over the last 20 years, managed to grow both their participation in GVCs and their domestic value added in exports experienced GDP per capita growth of 3.4% on average, compared to 2.2% for countries that only increased their participation in GVCs without "upgrading" their domestic value addition.

These findings will have some important policy implications. For example, GVCs can be an important avenue for developing countries to build

productive capacity, including through technology dissemination and skill building, opening up opportunities for longer-term industrial upgrading. However, such potential benefits of GVCs are not automatic. Policies matter, including a set of coherent and mutually reinforcing trade and investment policies, as well as the right overall development strategies.

UNCTAD intends to build on the preliminary analyses of the new data presented in this launch report in its forthcoming World Investment Report 2013, which will examine the mechanisms through which GVCs can contribute to development (e.g. market access, employment generation, productive capacity building), as well as the risks involved for developing countries (e.g. social and environmental sustainability impact, the risk of remaining locked into low value adding activities, footlooseness of activities).

The balance of opportunities and risks associated with GVCs makes a well-informed policy debate on their development impact of paramount importance. UNCTAD hopes that its GVC Database will stimulate and contribute to such debate by providing new insights into the evolving nature of globalized production networks.

Acknowledgements

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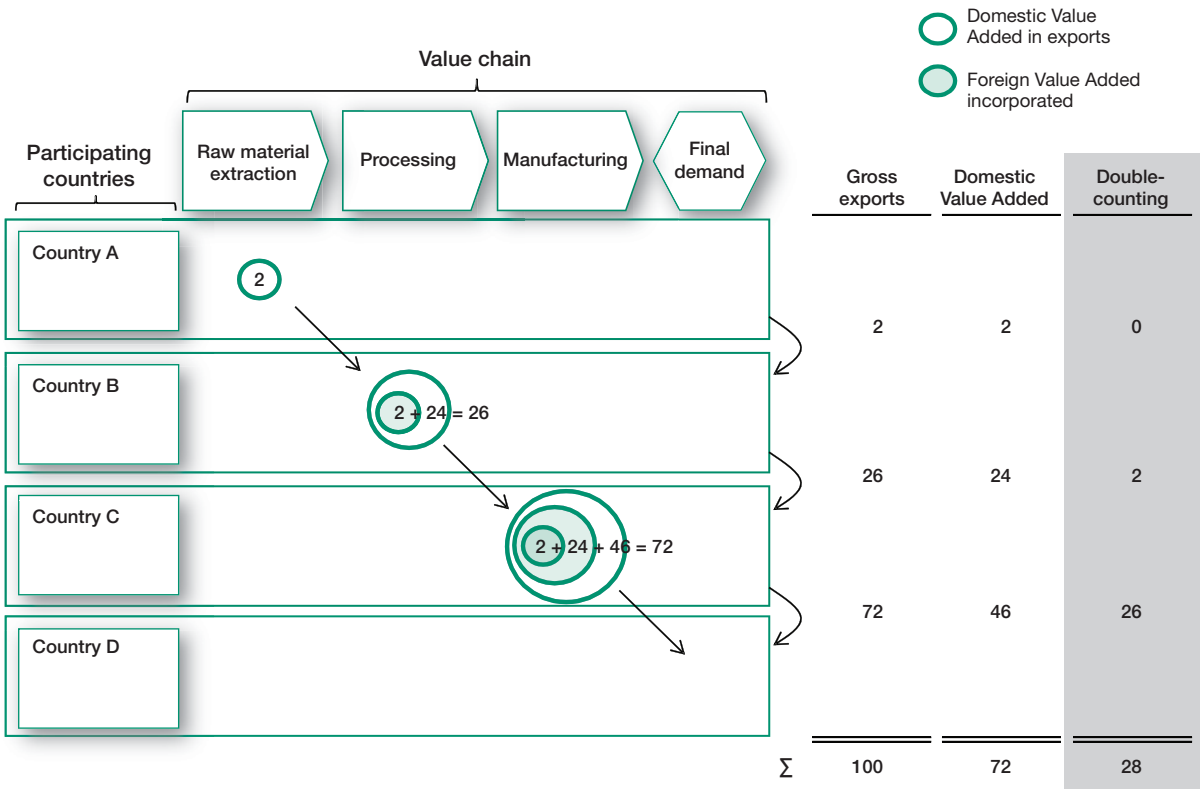
Introduction

Global trade in goods and services, which today amounts to more than $20 trillion, includes a significant amount of *double counting*. Raw material extracted in one country may be exported first to a second country for processing, then exported again to a manufacturing plant in a third country, which may then export it to a fourth for final consumption. The value of the raw material counts only once as a GDP contribution in the original country, but is counted several times in world exports. Value added trade statistics aim to identify the double counting in gross trade figures and show where value is created in global production chains (see figure 1 for a simplified example). Such cross-border production chains, which may comprise only two countries, a region or a global network, are commonly referred to as global value chains (GVCs). A typical GVC producing any end-product for final consumption will involve activities across multiple sectors and industries, from extractive industries or primary sector activities, to manufacturing, to services value added incorporated along the chain.

Value added trade statistics can lead to important policy insights in the area of trade, investment and development. UNCTAD, in line with its role as a research, policy analysis and consensus building institution working for development (and in response to the mandate received at its latest UNCTAD XIII ministerial meeting, as well as requests made by the G20) aims to provide insights into the relevance, impact and patterns of value added trade and GVCs across the global economy, and in particular in developing countries. In a collaborative effort with the Eora project,[1] its Division on Investment and Enterprise has built a value added trade dataset that covers developed and developing countries and a broad range of

Figure 1. Value added trade: how it works



Source: UNCTAD.

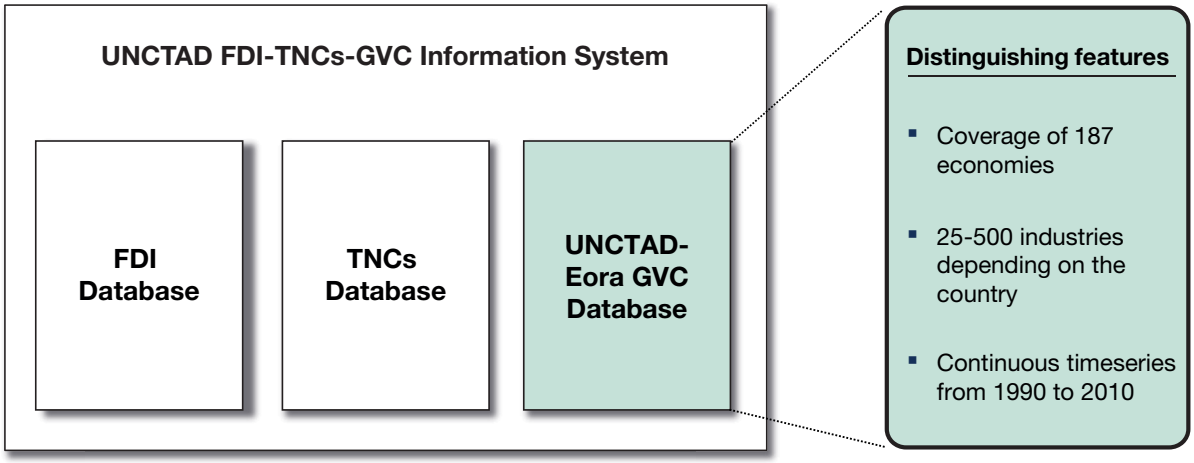
industries relevant to them: the UNCTAD-Eora GVC Database (box 1). With this database UNCTAD has added an important element to its FDI and TNCs Information System (figure 2). The new database will be used as a basis for the *World Investment Report 2013 (WIR13)*, which will assess the patterns, drivers and determinants, development impact and policy implications of value added trade and investment.

As a preview to the theme part of *WIR13*, and to accompany the launch of the UNCTAD-Eora GVC Database, this short report presents a few preliminary findings based on the new data. It essentially aims to answer a number of basic questions that are top of mind for policymakers and the development community:

- *How much value added does trade actually generate?*
- *Which countries incorporate the most foreign value added in their exports?*
- *Which industries have the most segmented value chains?*
- *How much value added do countries get out of their exports?*
- *How significant is value added trade to countries' GDP?*
- *Which countries participate most in GVCs?*
- *How much value are developing countries capturing from trade?*
- *To what extent are developing country exports integrated in GVCs?*
- *What is the role of TNCs in global trade?*
- *How do international production networks of TNCs shape value added trade?*
- *How does the presence of TNCs affect countries' GVC participation?*
- *What is the impact of value added trade and GVCs on economic growth?*
- *Is there a trade-off between GVC participation and domestic value added?*
- *Are there different GVC development paths?*

UNCTAD intends to deepen the analysis on these and other questions, to look at how TNCs shape global and regional value chains and patterns of value added trade, to identify the drivers and determinants of investment in GVCs, and to assess the impact of GVCs, including by analyzing where and how employment and income is generated throughout GVCs. *WIR13* will also examine the mechanisms through which GVCs can contribute to development (e.g. market access, employment generation, productive capacity building), as well as the risks involved for developing countries (e.g. social and environmental sustainability impact, the risk of remaining locked into low value adding activities, footlooseness of activities or vulnerability of production due to cyclical factors). And it will assess the implications for national and international trade and investment policies.

Figure 2. UNCTAD's data on FDI, TNCs and GVCs



Source: UNCTAD.

Box 1. International efforts to map GVCs and the UNCTAD-Eora GVC Database

The growing importance of GVCs has led to the realization that the way international trade has traditionally been accounted for may no longer be sufficient. A growing body of work exists aimed at netting out the "double-counting" effect of GVCs on global trade, determining value added in trade, and mapping how value added moves between countries along GVCs before final consumption of end-products. Value added in trade can be estimated based on international input-output (I-O) tables which illustrate the economic interactions between countries (see the Technical Annex). To date, and using different methodologies, several initiatives have sought to compile inter-country I-O tables. A selection of the main initiatives is listed in the table below.

Project	Institution	Data sources	Countries	Industries	Years	Comments
UNCTAD-Eora GVC Database	UNCTAD/Eora	National supply-use and I-O tables, and I-O tables from Eurostat, IDE-JETRO and OECD	187	25-500 depending on the country	1990-2010	"Meta" database drawing together many data sources and interpolating missing points to provide broad and consistent coverage, even of data-poor countries
Inter-Country-Input-Output model (ICIO)	OECD/WTO	National I-O tables	40	18	2005, 2008, 2009	Based on national input-output tables harmonised by the OECD
Asian International I-O tables	Institute of Developing Economies (IDE-JETRO)	National accounts and firm surveys	10	76	1975,1980, 1985,1990, 1995,2000, 2005	US-Asian tables. Also bilateral tables, including China-Japan.
Global Trade Analysis Project (GTAP)	Purdue University	Contributions from individual researchers and organisations.	129	57	2004, 2007	Non-official dataset. Includes data on areas such as energy volumes, land use, CO2 emissions and international migration.
World Input-Output Database (WIOD)	Consortium of 11 institutions. EU funded.	National supply-use tables	40	35	1995-2009	Based on official national accounts statistics. Uses end-use classification to allocate flows across partner countries

The UNCTAD-Eora GVC Database uses input-output tables to estimate the import-content ratio in exportable products and value added trade. Its value added trade data are derived from the Eora global multi-region input-output (MRIO) table. The Eora MRIO brings together a variety of primary data sources including national input-output tables and main aggregates data from national statistical offices; input-output compendia from Eurostat, IDE (Institute of Developing Economies)–JETRO (Japan External Trade Organization) and OECD; national account data (the UN National Accounts Main Aggregates Database; and the UN National Accounts Official Data); and trade data (the UN Comtrade international trade database and the UN ServiceTrade international trade database). Eora combines these primary data sources into a balanced global MRIO, using interpolation and estimation in some places to provide a contiguous, continuous dataset for the period 1990-2010. The Eora MRIO thus builds on some of the other efforts in the international community. Accompanying every data point in the results provided on the Eora website (www.worldmrio.com) is an estimate of that data point's standard deviation, reflecting the extent to which it was contested, interpolated, or estimated, during the process of assembling the global MRIO from constituent primary data sources. Further details on the EORA database can be found in the Annex: "Technical note on the UNCTAD-Eora GVC Database".

The joint OECD-WTO project (see table), which recently published its first results, is recognized as a comprehensive effort to set a common standard for data on value added in trade. Placing significant emphasis on methodology it necessarily sacrifices some coverage (of countries, industries and time series) for statistical rigor. In contrast, the primary objective of the UNCTAD-Eora GVC Database is extended coverage to provide a developing country perspective. This explains the choice of the MRIO approach, the key innovation of which is the use of algorithms that put together unrelated data and minimize accounting discrepancies irrespective of the type of underlying data, allowing the inclusion of data-poor countries.

Source: UNCTAD.

I. Value added trade patterns in the global economy

How much value added does trade generate?

At the global level, the average foreign value added in exports is approximately 28% (figure 3). That means, roughly, that around $5 trillion of the $19 trillion in 2010 world exports of goods and services has been contributed by foreign countries for further exports and is thus "double counted" in global trade figures.[2] The remaining $14 trillion is the actual value added contribution of trade to the global economy (or around one-fifth of global GDP).

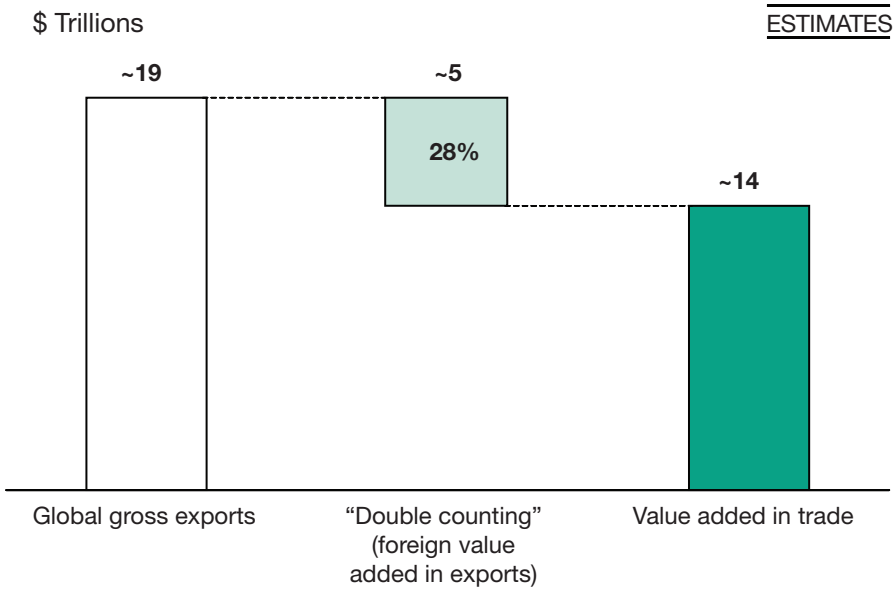
These figures differ significantly by country and by industry, with important policy implications:

- At the *country* level, foreign value added in exports indicates what part of country's gross exports consist of inuts that have been produced by other countries, or the extent to which a country's exports are dependent on imported content. It is also an indication of the level of vertical specialization of economies: the extent to which economic activities in a country focus on particular tasks and activities in global value chains.
- At the *industry* level, the average foreign value added is a proxy for the extent to which industry value chains are segmented or "fine-sliced" into distinct tasks and activities that generate trade, compounding the double counting effect. This is important for policymakers designing, for example, industrial development, trade and investment promotion policies.

Which countries incorporate the most foreign value added in their exports?

Developed countries, as a whole, at 31% have a higher share of foreign value added in exports than the global average (figure 4), i.e. their import dependence of exports appears higher. However, this picture is distorted by the weight in global figures of internal trade within the highly integrated EU economy, which accounts for some 70%

Figure 3. Global value added in trade, 2010



Source: UNCTAD-Eora GVC Database, UNCTAD estimates.

Box 2. Understanding value added trade data and indicators

A country's exports can be divided into domestically produced value added and imported (foreign) value added that is incorporated into exported goods and services. Furthermore, exports can either go to a foreign market for final consumption or as intermediate inputs to be exported again to third countries (or back to the original country). The analysis of GVCs takes into account both foreign value added in exports (the *upstream* perspective) and exported value added incorporated in third-country exports (the *downstream* perspective). The most common indicators, which will also be used in this report, are as follows:

1. **Foreign value added** (foreign value added as a share of exports) indicates what part of a country's gross exports consists of inputs that have been produced in other countries. It is the share of the country's exports that is not adding to its GDP.[3]
2. **Domestic value added** is the part of exports created in-country. It is the share of the country's exports that contributes to GDP (domestic value added trade share). The sum of foreign and domestic value added equates to gross exports. As a share of GDP, domestic value added measures the extent to which trade contributes to the GDP of a country.
3. **GVC participation**[4] indicates the portion of a country's exports that is part of a multi-stage trade process, by adding to the foreign value added used in a country's own exports also the value added supplied to other countries' exports. Although the degree to which exports are used by other countries for further export generation may appear less relevant for policymakers as it does not change the domestic value added contribution of trade, the participation rate is a useful indicator for the extent to which a country's exports are integrated in international production networks and it is thus helpful in exploring the trade-investment nexus.This variable corrects the limitation of the previous indicators in which countries at the beginning of the value chain (e.g. exporters of raw materials) have a low foreign value added content of exports by definition. It gives a more complete picture of the involvement of countries in GVCs, both upstream and downstream.

   A country's GVC participation, measured as a share of exports, effectively assesses the reliance of exports on GVCs. In this sense, it is also an indicator of how much hypothetical "damage" to GVCs (and global GDP) would occur if a country's exports were blocked; alternatively, it represents the vulnerability of the GVC to shocks in the respective country.

GVC indicators can also be used to assess the extent to which **industries** rely on internationally integrated production networks. For example, a number of complex methods have been devised in the literature to measure GVC length.[5] This report will use a simplification device by looking at the degree of double counting in industries which, conceptually, can serve as a rough proxy for the length of GVCs.

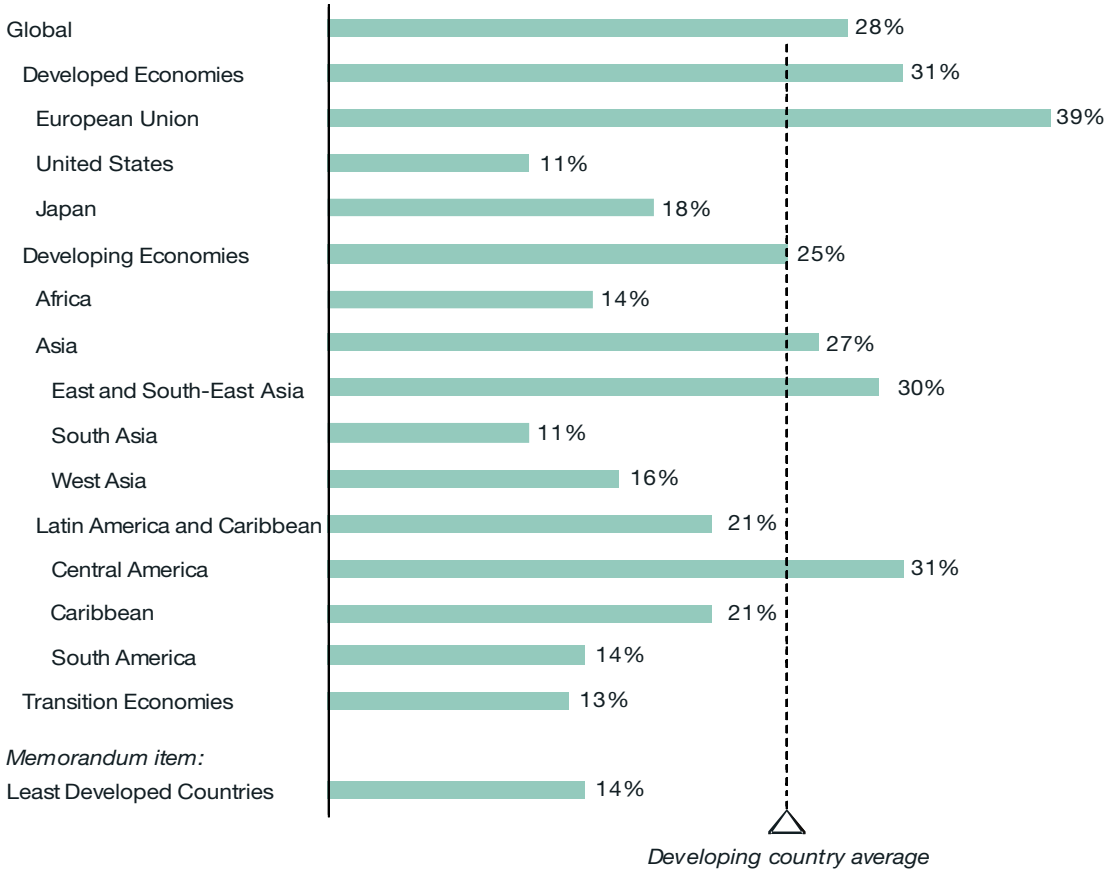
Data on value added trade by industry can provide useful indications on comparative advantages and competitiveness of countries, and hence form a basis for development strategies and policies. However, this short launch report will focus primarily on country-level indicators; WIR13 will explore industry value added trade data and its development implications in greater detail.

Source: UNCTAD; additional references listed in the endnotes.

of EU originated exports. Japan and the United States show significantly lower shares of "double counting".

Thus, while developing countries have a lower share of foreign value added (25%) than the world average (28%) their foreign value added share is significantly higher than in the United States and Japan – or than in the EU, if only external trade is taken into account. Among developing economies, the highest shares of foreign value added in trade are found in East and South-East Asia and in Central America (including Mexico) where processing industries account for a significant part of exports. Foreign value added in exports is much lower in Africa, West Asia, South America and in the transition economies, where natural resources and commodities exports with little foreign inputs tend to play an important role. The lowest share of foreign value added in exports is found in South Asia, mainly due to the weight of services exports, which also use relatively less foreign inputs.

Figure 4. Share of foreign value added in exports, by region, 2010



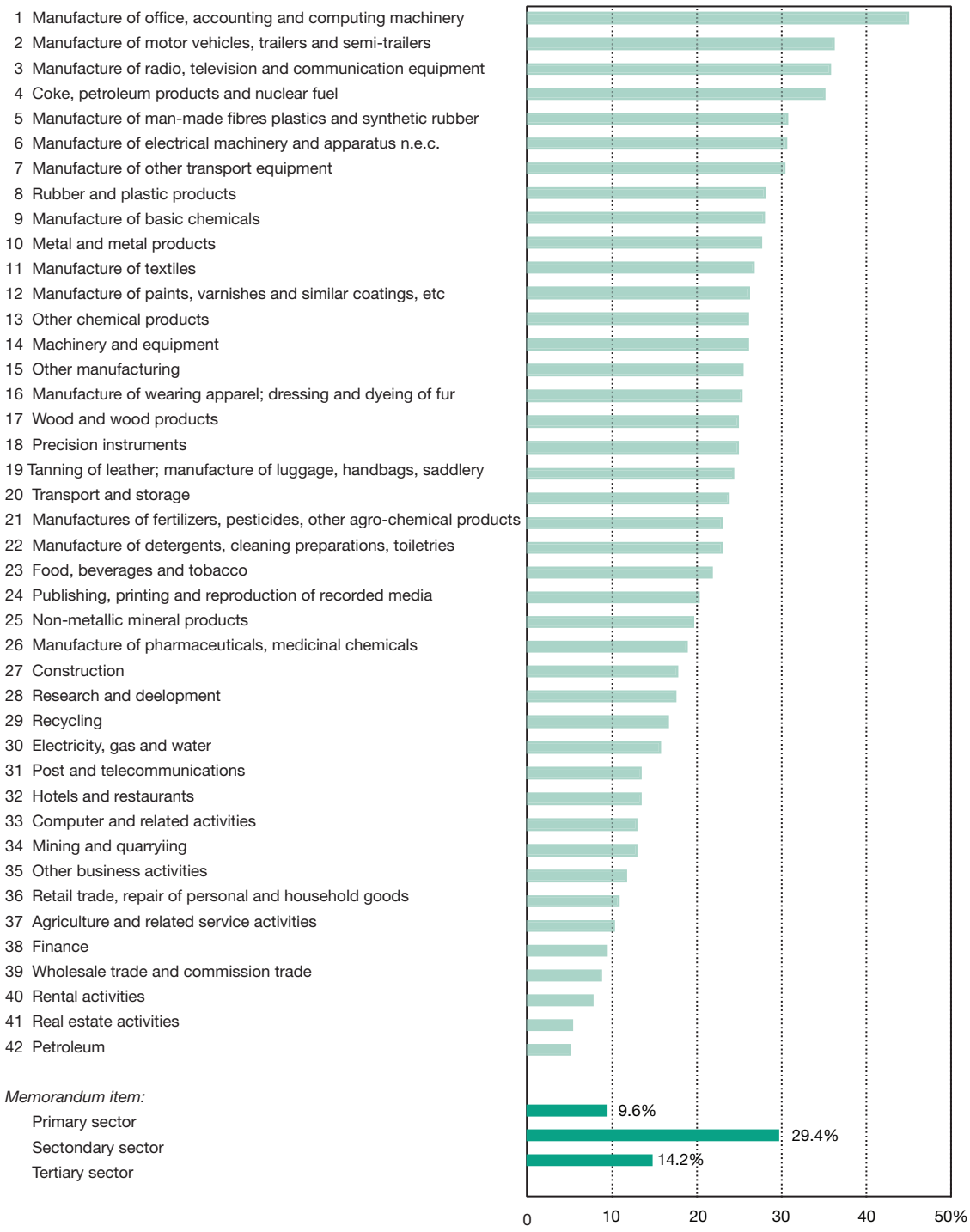
Source: UNCTAD-Eora GVC Database.

Which industries have the most segmented value chains?

The average foreign value added share of exports and the degree of double counting in global exports of an industry provides a rough indication of the extent to which industries rely on internationally integrated production networks, as it proxies the extent to which intermediate goods and services cross borders until final consumption of the industry's output.

Traditionally a select number of manufacturing industries have been at the forefront of value chain segmentation ("fine-slicing" of value chains) and of associated trends such as outsourcing and off-shoring. The electronics and automotive industries, where products can be broken down into discrete components that can be separately produced, easily transported, and assembled in low-cost locations, have led the way in shaping GVCs and consequently rank highest by share of foreign value added in trade (figure 5). A number of industries that incorporate and process outputs from extractive industries and traded commodities (e.g. petroleum products, plastics, basic chemicals) follow closely behind. The extractive industries themselves naturally rank much lower as they require little imported content of exports apart from some services. Foreign value added in exports is thus not a fully-fledged indicator of the GVC complexity of industries; extractive industries are clearly a fundamental "starting point" of many GVCs, not because of their use of foreign value added, but because they constitute value added inputs in many other industries' exports. Similarly, telecommunications, services industries, e.g. business services, finance, utilities, also rank

Figure 5. Share of foreign value added in exports, selected industries, 2010



Source: UNCTAD-Eora GVC Database.

Note: illustrative list of industries selected based on significance in GVCs, at various levels of industry classification.

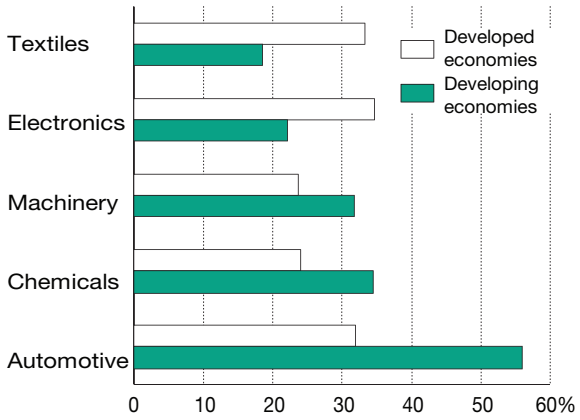
low in terms of imported content of exports as they use fewer intermediate inputs and their involvement in GVCs typically occurs through value added incorporated in exported manufactured goods.

Clearly, GVCs analysis can provide insights on cross-industry production of goods and services. A value chain for a given product may span many different industries and incorporate value added from raw materials to component manufacturing to services. The global average foreign value added shares by industry ignore the fact that each industry may consist of and be part of many different value chains.

Global industry averages also disguise significant differences by country or region (figure 6). Foreign value added shares in the textile industry are much higher in developed than in developing countries, confirming that the latter provide much of the semi-finished inputs used by developed country exporters. Electronics is another industry in which developed countries import a greater share of the value added in their exports. In contrast, in machinery, chemicals and the automotive industry developing countries tend to use more foreign inputs for the production of their exports.

Data on value added trade by industry can shed light on comparative advantages and the competitiveness of countries and regions, and hence can provide a useful metric for formulating development strategies and policies.

Figure 6. Share of foreign value added in exports, developed and developing economies, selected industries, 2010



Source: UNCTAD-Eora GVC Database.

How much value do countries get out of their exports?

Because not all exports constitute domestically value added, the share of value added trade captured by a country can be quite different from its share in global exports.

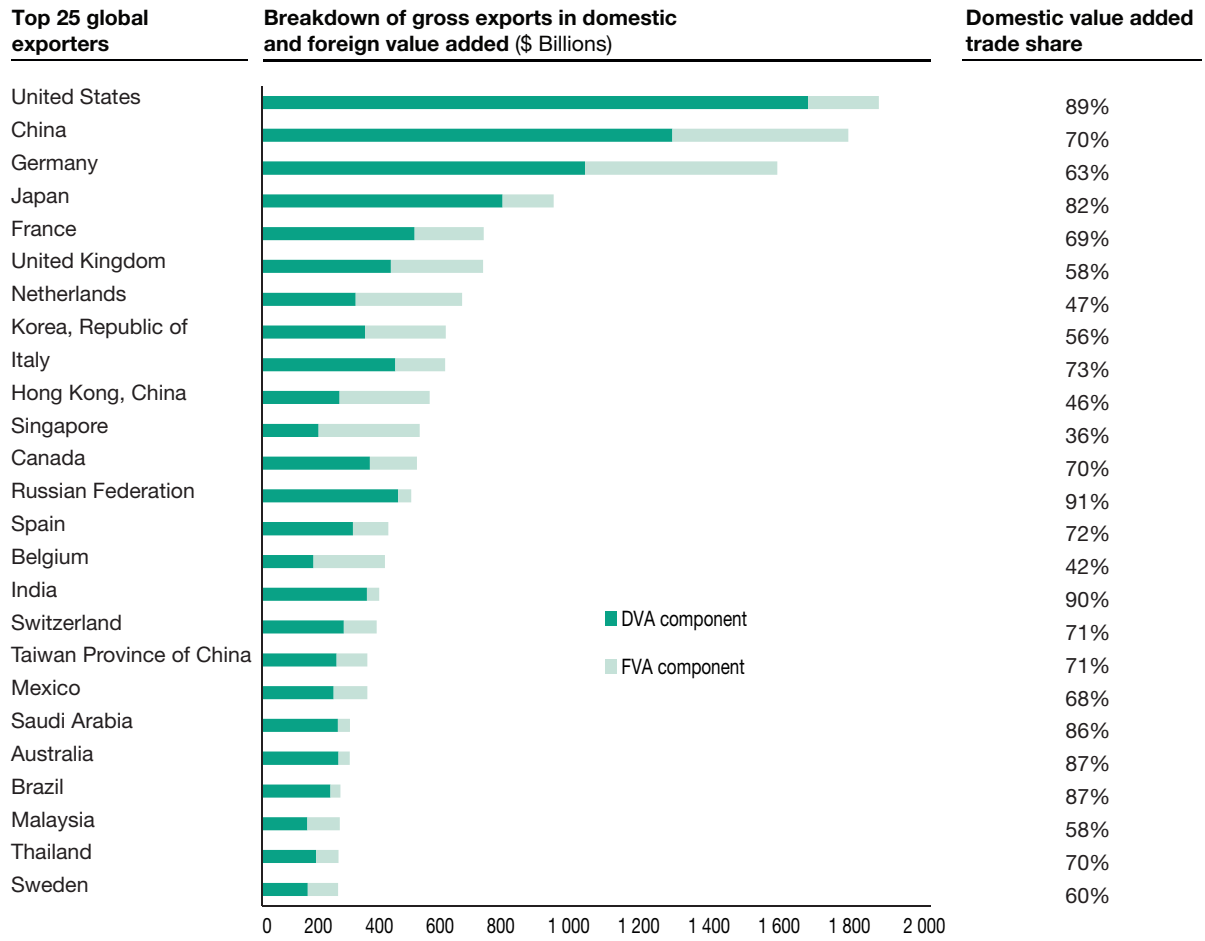
The top 25 global exporters by gross export values show a range of value added trade shares from around 90% for the United States, the Russian Federation, India, Australia and Brazil — countries with relatively high shares of domestic value added — to values well below 60% for the United Kingdom, the Netherlands, the Republic of Korea, Singapore and Malaysia — countries with relatively low shares of domestic value added in their exports.

Factors that influence the share of domestic value added in exports include:

- *Size of the economy*. Large economies, such as the United States or Japan, tend to have significant internal value chains and to rely less on foreign inputs. There are important exceptions, including China, Germany and the United Kingdom.
- *Composition of exports and position in GVCs*. Countries with significant shares of natural resources, oil or other commodities in their exports, such as Russian Federation and Saudi Arabia, tend to have higher relative value added trade shares, as such exports are at the "beginning" of GVCs and require little foreign inputs. Similarly, countries with significant services exports such as India tend to capture relatively more value. In contrast, countries with significant shares of exports in highly segmented industries (see figure 5) may need to import more to generate exports.
- *Economic structure and export model*. Countries with significant shares of entrepôt trade, such as Hong Kong (China), Singapore or the Netherlands, will have higher shares of foreign value added and lower shares of domestic value added in trade. Similarly, countries with important processing trade sectors will capture less domestic value added.

The combination of these three factors explains most countries' domestic value added shares (net of policy factors which will be explored at a later

Figure 7. Domestic value added trade shares of the top 25 exporting economies, 2010



Source: UNCTAD-Eora GVC Database.

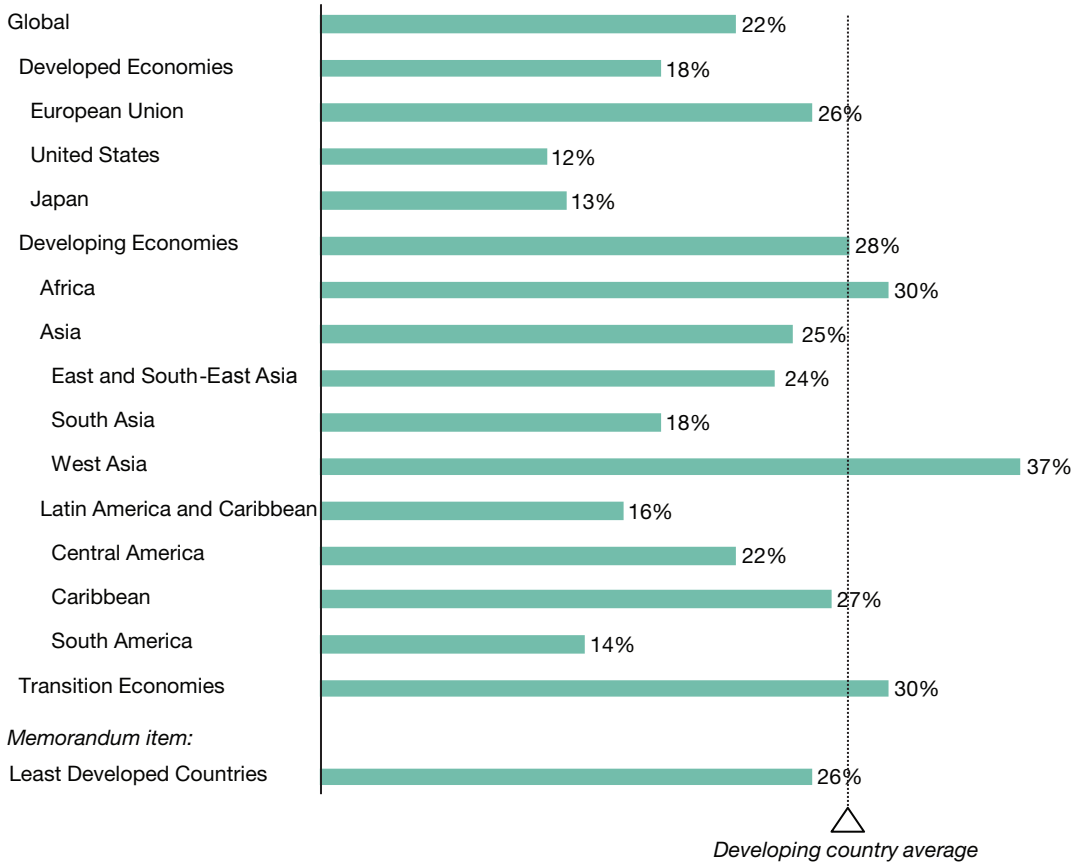
stage). For example, China, on the one hand, is a large economy with an increasingly important internal supply chain. On the other hand, it has a significant share of processing trade and is an important exporter of electronics, the industry with the most complex GVC linkages. Consequently, China's domestic value added trade share (70%) is aligned with the median (71%) domestic value added trade share of the top 25 global exporters (figure 7).

A significant number of countries with relatively low domestic value added shares have high absolute contributions to their GDP from domestic value added in exports. For example, in figure 7, in the group of countries with domestic value added trade shares of less than 75%, the absolute contribution of trade to GDP is about 25%. In the group of countries with more than a 75% share of domestic value added in gross exports it is only around 15%. Thus, while the domestic value added trade shares in small open economies may appear low, the absolute contribution to their GDP can be significant in relation to the size of their economy. This aspect is explored further in the next section.

How significant is value added trade to countries' GDP?

Domestic value added created from trade – the actual contribution of trade to GDP after discounting imported inputs – can be significant relative to the size of local economies. While the contribution of trade to global GDP is over one-fifth, this share

Figure 8. Domestic value added in trade as a share of GDP, by region, 2010



Source: UNCTAD-Eora GVC Database.

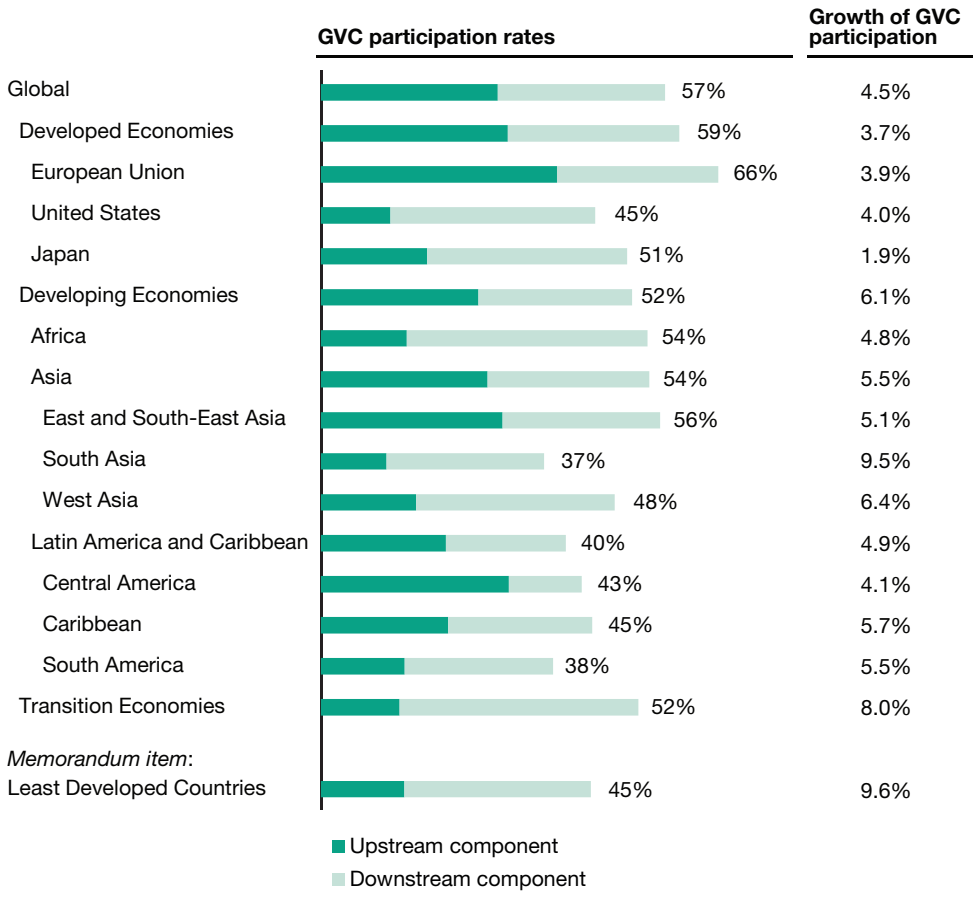
is higher in developing and transition economies (figure 8). It is particularly high in Africa, West Asia and the transition economies due to the relative importance of exports of natural resources there and, in part, due to the relatively small size of the local "non-tradables" economy. The contribution of trade to GDP is high also in East and South East Asia which, on this measure, almost rivals the highly integrated European market. This not only reflects the export competitiveness of these Asian economies but also their higher share of domestic value added in trade compared to Europe.

Which countries participate most in GVCs?

The value and share of developing country exports that depend on GVCs, either because of upstream links (foreign value added in exports) or downstream links (exports that are incorporated in other products and re-exported) is quite significant (figure 9). East and South-East Asia remains the region with the highest level of GVC participation, reflecting its primacy as the most important region for export-oriented manufacturing and processing activities. Central America (including Mexico) also has a high participation rate in the upstream component, where it ranks equal with South-East Asia. However, it has a lower downstream participation rate, reflecting the fact that it exports relatively more to the United States domestic market rather than for onward exports.

A significantly higher GVC participation rate in commodity exporting regions due to high downstream links (despite relatively low upstream

Figure 9. GVC participation, 2010, and GVC participation growth rates, 2005-2010



Source: UNCTAD-Eora GVC Database.

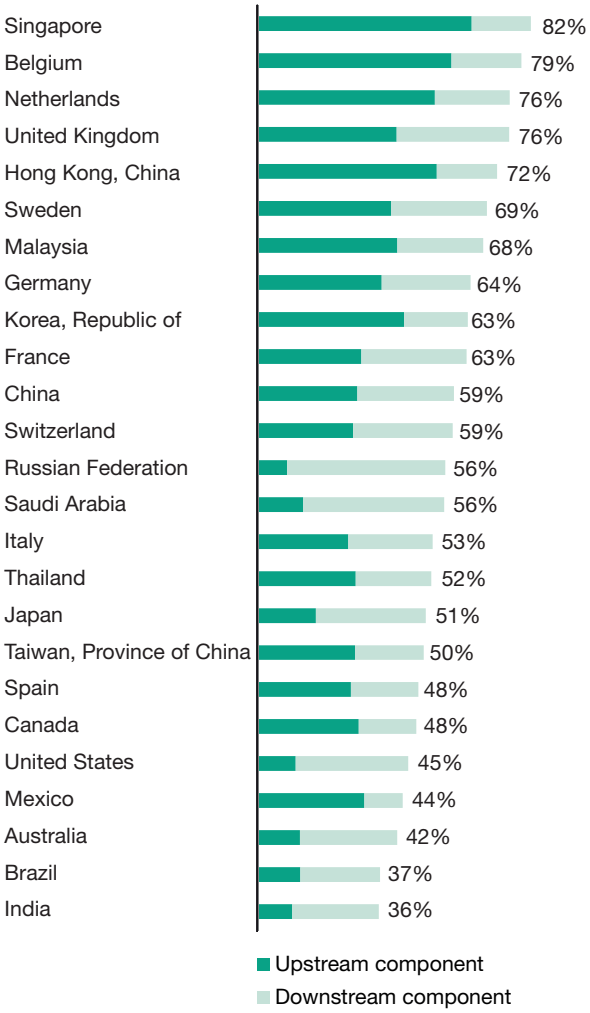
Note: GVC participation indicates the share of a country' exports that is part of a multi-stage trade process; it is the foreign value added used in a country's exports (upstream perspective) plus the value added supplied to other countries' exports (downstream perspective), divided by total exports. GVC participation growth here is the annual growth of the sum of the upstream and downstream component values (CAGR).

links) indicates that much of their exports are processed and incorporated in third-country exports – i.e. they operate at the starting point of GVCs. South Asia remains the lowest ranked region in terms of GVC participation. Much of the services exports from the region satisfies domestic demand in importing countries and is not used to produce further exports.

However, South Asia is the region with the highest GVC participation growth rate, albeit from a low base. Transition economies also show faster than average growth. Nearly all developing regions outpace the developed world in GVC growth. Remarkable is the rapid growth rate of GVCs in the least developed countries partly because of a low base in terms of absolute values.

As noted above, GVC participation – or the role that individual countries play in international production networks – is driven by many different factors, including size of the economy, industrial structure and level of industrialization, composition of exports and positioning in value chains, policy factors, and others. As a result, countries with very different characteristics may be very similar in the ranking of GVC participation (figure 10).

Figure 10. GVC participation rate of the top 25 exporting economies, 2010



Source: UNCTAD-Eora GVC Database.

Note: The GVC participation rate indicates the share of a country's exports that is part of a multi-stage trade process; it is the foreign value added used in a country's exports (upstream perspective) plus the value added supplied to other countries' exports (downstream perspective), divided by total exports.

For example, the United States and Mexico have near identical GVC participation rates, but Mexican exports include a significant amount of processing trade, with high foreign value added inputs, whereas United States exports are used more downstream in value chains, as intermediate inputs in the exports of other countries.

Again, GVC participation is a relative concept. United States firms may dominate many value chains in terms of absolute size, but in relative terms the participation in GVCs of many smaller economies is higher. In other words, United States firms also export many final products that are not used downstream to generate further exports.

The GVC participation rate is a useful metric for examining the trade-investment nexus because it indicates the extent to which countries' exports are integrated into international production networks. The metric can also effectively assess the extent to which a country's exports depend on GVCs. Conversely, the GVC participation rate indicates how much hypothetical "damage" to GVCs would occur if a country's exports were blocked as well as the vulnerability of the GVC to shocks in an individual economy along the value chain.

II. Value added trade patterns in the developing world

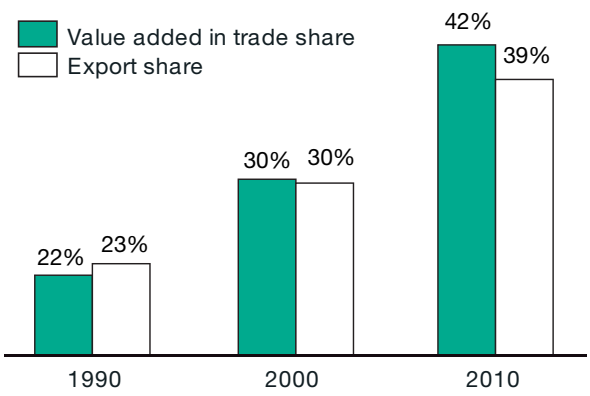
How much value are developing countries capturing from trade?

The share of global value added trade captured by developing economies is increasing rapidly. It grew from around 20% in 1990, to 30% in 2000, to over 40% in 2010. As a group, developing economies are capturing an increasing share of the global value added trade pie (figure 11). As global trade grows, developed economies appear to rely increasingly on imported content for their exports, allowing developing countries to add disproportionately to their domestic value added in exports. This underscores the importance for both developed and developing countries to keep import barriers (tariff and non-tariff) in check in order to maintain export competitiveness.

Looking at the value added trade share for the top 25 developing economy exporters (excluding predominantly oil-exporting countries; figure 12) shows that exporters of natural resources and raw materials that use little foreign value added in exports (such as Chile or Indonesia) obtain a relatively high share of global value added trade, as do services exporters such as India. Relatively open developing economies with strong export performances and highly integrated in GVCs (such as the Republic of Korea, Hong Kong (China), Singapore, Malaysia) get a lower value added contribution from trade. However, the absolute contribution of value added trade to GDP in these countries is high because of the higher relative importance of trade.

Furthermore, comparing the domestic value added contribution to GDP of exports in East and South-East Asian countries with their share in global GDP – another relative measure of value added trade performance – yields positive results; in other words, despite the lower share of domestic value added in exports of these countries, the absolute contribution of value added trade to their economies is very significant.

Figure 11. Share of developing countries in global value added trade and in gross exports, 1990-2010



Source: UNCTAD-Eora GVC Database.

To what extent are developing country exports integrated in GVCs?

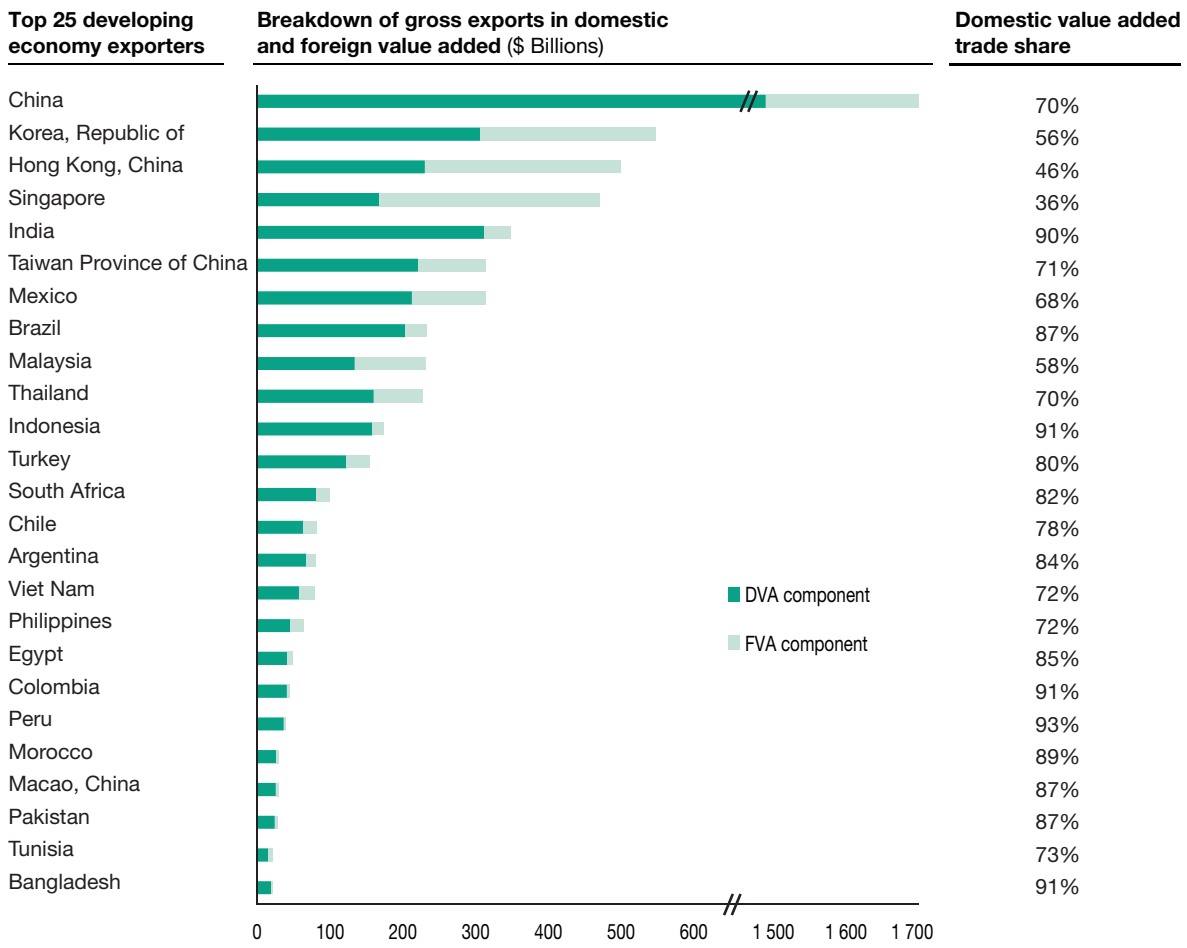
Among the top 25 developing economy exporters there are significant differences in the degree to which their exports are integrated in – or depend on – GVCs (figure 13). The main East and South-East Asian exporters rank highest in GVC participation as they both import a substantial part of their exports (foreign value added) and a significant part of their exports are intermediate goods that are used in third countries' exports. These countries' exports are thus integrated in GVCs both upstream and downstream; in other words, they operate in "the middle" of GVCs. The commodity exporting group of countries also rates relatively high in GVC participation, but largely because of outsized downstream usage of their export products in third countries' exports.

Some of the larger emerging markets such as India, Brazil, Argentina and Turkey, have relatively low GVC participation rates. These countries have lower upstream participation levels, both because of the nature of their exports (natural resources and services exports tend to have less need for imported content or foreign value added) and because larger economies display a greater degree of self-sufficiency in production for exports. They also have lower downstream participation levels

because of a focus on exports of so-called final-demand goods and services, i.e. those not used as intermediates in third-country exports.

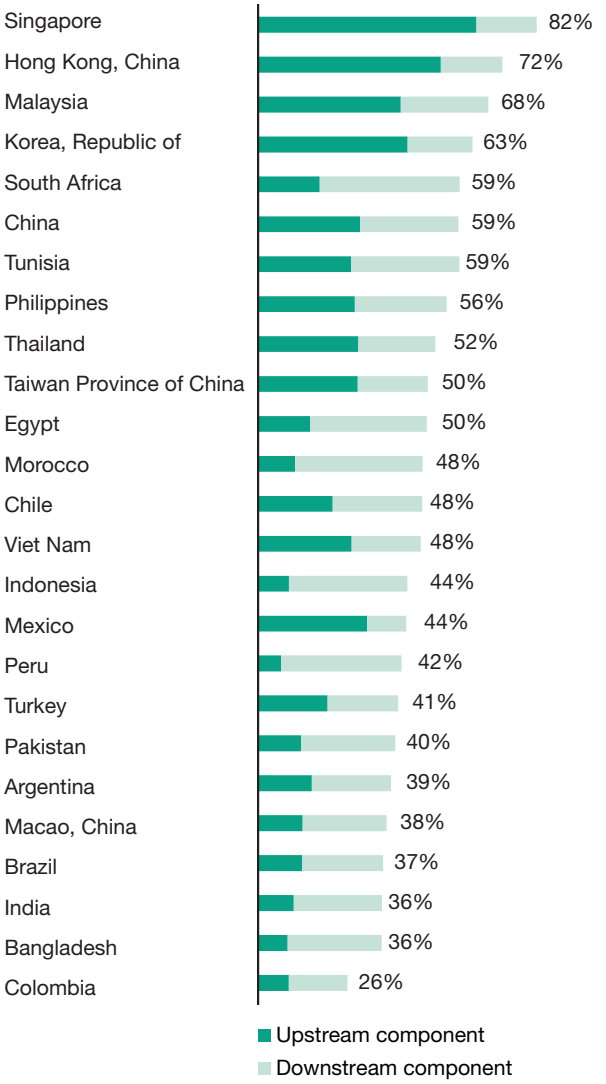
Again, countries may have very similar GVC participation rates for very different reasons. Taiwan Province of China and Egypt have the same overall participation rate (50%), but where the former uses a significant amount of foreign components in its export products, the latter (Egypt) exports more for intermediate use in third-country exports.

Figure 12. Domestic value added trade shares of the top 25 developing economy exporters, 2010



Source: UNCTAD-Eora GVC Database.
Note: Excludes predominantly oil-exporting countries.

Figure 13. GVC participation rate of the top 25 developing economy exporters, 2010



Source: UNCTAD-Eora GVC Database.
Note: Excludes predominantly oil-exporting countries.

III. GVCs: the investment-trade nexus

What is the role of TNCs in global trade?

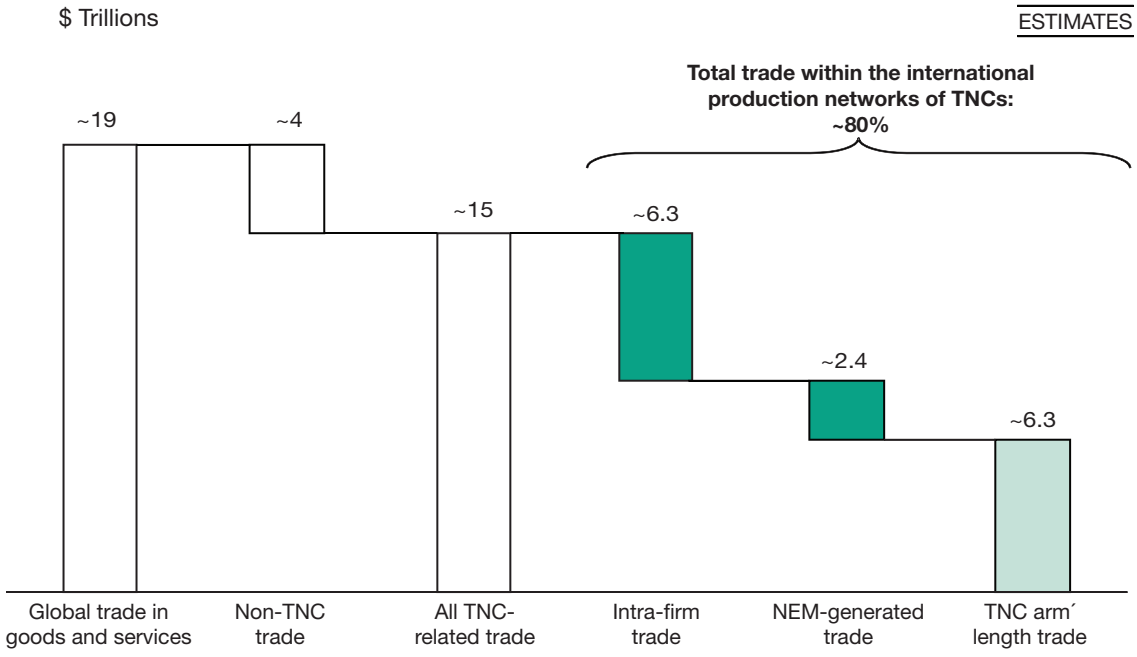
Investment and trade are inextricably intertwined. Much of trade in natural resources is driven by large cross-border investments in extractive industries by globally operating TNCs. Market-seeking foreign direct investment (FDI) by TNCs also generates trade, often shifting arm's length trade to intra-firm trade. Efficiency-seeking FDI, through which firms seek to locate discrete parts of their production process in low-cost locations, is particularly associated with GVCs; it increases the amount of trade taking place within the international production networks of TNCs and contributes to the "double counting" in global trade flows discussed in this report.

The ratio between global FDI stock and trade has almost doubled over the last decade, increasing from around 50% in the mid-1990s to more than 100% in 2010, with growth rates in the FDI to services trade ratio even higher. FDI is an increasingly important driver of trade flows worldwide. UNCTAD estimates that around 80% of global trade (in terms of gross exports) is linked to the international production networks of TNCs, either as intra-firm trade, through non-equity modes of international production (or NEMs, which include, among others, contract manufacturing, licensing, and franchising), or through arm's length transactions involving at least one TNC (figure 14 and box 3).

How do international production networks of TNCs shape value added trade?

The international production networks of TNCs, within which most trade takes place, are heavily geared towards providing those value added inputs required to generate trade. GVCs make extensive use of services. While the share of services in gross exports worldwide is only around 20%, almost half (46%) of value added inputs to exports is contributed by service-sector activities, as most manufacturing exports require services for their

Figure 14. Global trade (exports of goods and services), by type of TNC involvement, 2010



Source: UNCTAD estimates, based on *World Investment Report 2012* (table I.8) and various sources; see also box 3.

Box 3. Estimating trade within the international production networks of TNCs

The estimates for trade taking place with the international production networks of TNCs in figure 15 are based on evidence on investment-trade links of individual countries and regions:[6]

- In the United States, in 2010, affiliates of foreign TNCs accounted for 20% of exports and 28% of imports of goods, while TNCs based in the United States accounted for 45% of exports and 39% of imports. Thus some two-thirds of both exports and imports of goods can be considered as within the international production networks of TNCs.
- In Europe, in 2009, French TNCs accounted for some 31% of goods exports and 24% of imports, while foreign affiliates in France accounted for 34% and 38%, respectively. Thus some 64% of total French exports and 62% of total French imports of goods in 2009 can be considered as within the international production networks of TNCs. Similar scattered evidence exists for other EU countries.
- In Japan, TNCs based there accounted for 85% of exports of goods and services, while foreign affiliates contributed a further 8%. Thus 93% of total Japanese exports of goods and services are linked to TNCs.
- In China, foreign affiliates accounted for some 50% of exports and 48% of imports in 2012. Adding the trade activities of Chinese TNCs, although perhaps not as large as the share of their French or United States counterparts given the lower (but growing) share of Chinese outward FDI, would lead to estimates of trade within international, production networks in excess of the United States share.
- In developing countries as a group it is likely that the share of trade within the production networks of TNCs is higher, for two reasons: (a) the productivity curve of firms is steeper than in developed countries, meaning that trade is likely to be even more concentrated in a small number of large exporters and importers with above-average productivity, i.e. predominantly TNCs and their affiliates; (b) the share of extractive industries in their exports (at around 25%) is significantly higher than the world average (around 17%) and the extraction and trade of natural resources generally involves TNCs.

A significant share of this trade is intra-firm trade, the international flows of goods and services between parent companies and their affiliates or among these affiliates, as opposed to arm's length trade between unrelated parties (inter-firm trade). For example, the share of exports by United States affiliates abroad directed to other affiliated firms, including parent firms, remained high at about 60% over the past decade. Similarly, nearly half of the exports of goods by foreign affiliates located in the United States are shipped to the foreign parent group and as much as 70% of their imports arrive from the foreign parent group. Japanese TNCs export 40% of their goods and services to their own affiliates abroad. Although further evidence on intra-firm trade is patchy, the general consensus is that intra-firm trade accounts on average for around 30% of a country's export, with large variations across countries.

The above explanations for the most part focus on merchandise trade. There is evidence that TNC involvement in services trade, with a growing share of intra-firm trade in services (e.g. corporate functions, financial services, etc.), is even higher. Where not in the form of intra-firm trade, services trade often takes place in NEM relationships (IT/BPO, call centers, etc.). NEMs as a whole (including contract manufacturing activities) are estimated to be worth over $2 trillion (see *World Investment Report 2011*).

Arm's length trade by TNCs (exports to and imports from unrelated parties) is estimated to be worth around $6 trillion, the residual. Non-TNC-related trade includes all transactions between firms that have only domestic operations, anonymous transactions on commodity exchanges, etc.

Source: UNCTAD.

production. The parallel with FDI is clear: more than 60% of global FDI stock is allocated to services activities, a significant part of which is linked to GVCs (figure 15). The share of services FDI is still more than 35% if only non-financial sector FDI is considered (although financial sector FDI is not only a value chain in its own right but also provides crucial services to other GVCs).

This picture is almost the same in both developed and developing countries. Developing country gross exports of primary sector output (commodities) and primary sector value added in trade are only around 4 percentage points higher than the average for all countries, driven by slightly higher primary sector inward FDI stock (8% compared to the 7% average).

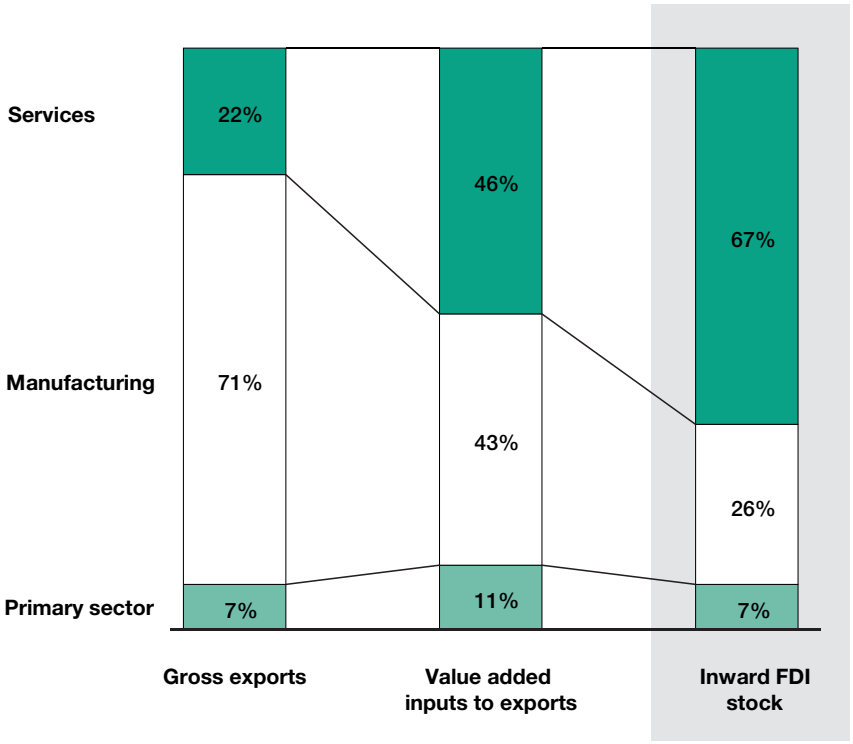
How does the presence of TNCs affect countries' GVC participation?

The involvement of TNCs in generating value added trade is confirmed by the statistical relationship between FDI stock in countries and their GVC participation rates (figure 16). The correlation is strongly positive, and increasingly so over time, especially in the poorest countries, indicating that FDI may be an important avenue for developing countries to gain access to GVCs and grow their participation.

Ranking countries by the ratio of FDI stock over GDP and grouping them in quartiles (figure 17) shows that the group of countries with most FDI relative to the size of their economies tend to have:

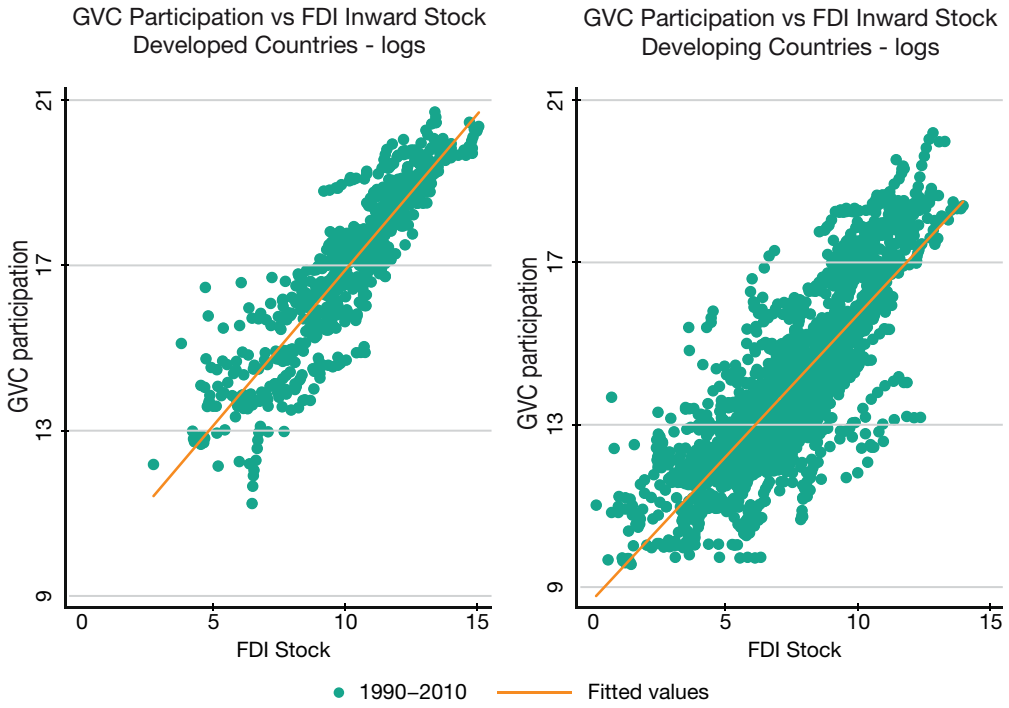
- higher foreign value added in their exports (foreign affiliates of TNCs producing for exports tend to use value added produced by other parts of the TNC production network);
- higher GVC participation (foreign affiliates of TNCs not only use foreign inputs in their production, but also supply to other parts of the TNC network for further exports); and
- a higher contribution of value added trade to their GDP.

Figure 15. Sector composition of global gross exports, value added inputs to exports, and FDI stock, 2010



Source: UNCTAD-Eora GVC Database, UNCTAD FDI Database, UNCTAD FDI Database.
Note: The sectoral breakdown of gross exports is based on ISIC, rather than SITC (normally used for merchandise trade), for consistency with the classification employed for value added trade and FDI. Thus, refined oil/petroleum products and food and beverages are classified under manufacturing.

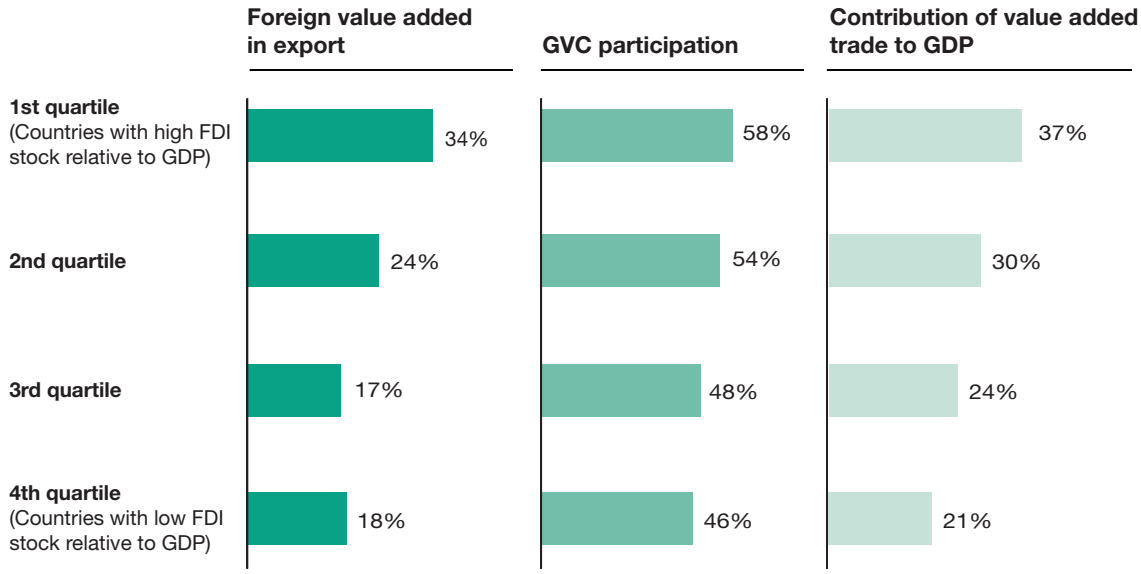
Figure 16. Correlation between levels of inward FDI stock and GVC participation



Source: UNCTAD-Eora GVC Database, UNCTAD FDI Database, UNCTAD analysis.

Note: data for 187 countries over 20 years. The regression between the annual GVC Participation growth and annual FDI Inward (stock) growth, in logs, shows a positive and significant correlation, at the 5% level. This relation also holds, at the 5% level, dividing the sample in developed and developing countries, and in two time periods (1990-2000 and 2001-2010). All regressions use lagged (one year) inward FDI stock growth rates.

Figure 17. Key value added trade indicators, by quartile of inward FDI stock relative to GDP, 2010



Source: UNCTAD-Eora GVC Database, UNCTAD FDI Database, UNCTAD analysis.

Note: data for 180 countries, ranked by inward FDI stock relative to GDP and grouped in quartiles (of 45 each); data reported are median values for each quartile.

IV. The development impact of GVCs

What is the impact of value added trade and GVCs on development?

Participation in GVCs is seen by many developing country policymakers as an important element of their economic development strategy. They recognize that GVCs act as a route to market for export products and services. Production for exports directly generates value added and contributes to GDP, job creation, income generation, tax income and so forth. And, longer term, GVCs can provide opportunities for industrial upgrading along the value chain.

On the other hand, policymakers and the development community recognize that GVCs also entail risks. Not all the potential benefits of GVCs materialize automatically (as shown in this report, local value added contributions and hence employment and income generation may well be limited through the use of foreign value added in exports), and taking advantage of GVC participation (and upgrading opportunities) is dependent on the development of productive capacities, technology and skills. (There are many other potential pitfalls for countries in GVC participation, which will be explored in the policy analysis for *World Investment Report 2013*).

The experience over the last 20 years shows that, as countries increase their participation in GVCs, their GDP growth rates tend to increase as well. A statistical analysis correlating GVC participation and per capita GDP growth rates shows a significant and positive relationship, both for developed and developing economies (figure 18).

However, these results only demonstrate a correlation between the two variables and do not necessarily show causality. In order to establish causality, more research will be required, including the examination of case studies.

Preliminary evidence from the data appears to indicate that increased GVC participation tends to go hand in hand with faster GDP per capita growth (figure 19). The 30 developing economies with the highest GVC participation growth rates in the 20-year period from 1990 to 2010 (first quartile) show a median rate of GDP per capita growth in the same period of 3.3%, compared to 2.1% for the next 30 countries, and 0.7% for the bottom 30 countries.

GDP per capita growth is only a rough and exogenous measure of the effect of GVCs on development. The value added trade data in the UNCTAD-Eora GVC Database provides a detailed breakdown of the components of value added – labour, capital, tax, profits – allowing a more fine-grained assessment of the economic impact of GVC participation, which will be included in *WIR13*.

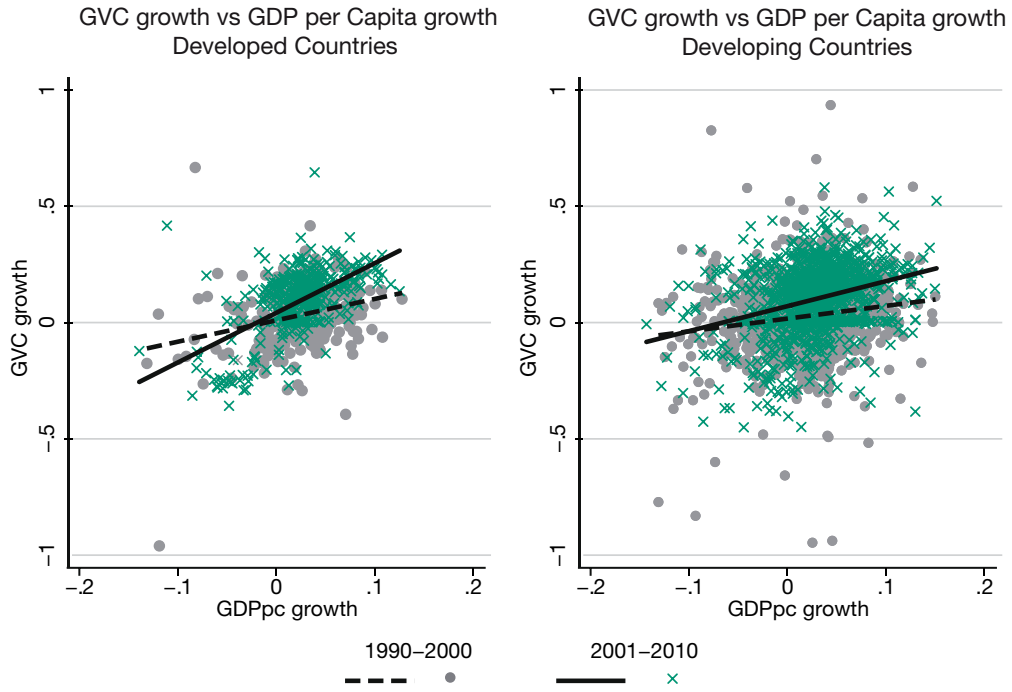
Is there a trade-off between GVC participation and domestic value added?

GVC participation depends on both upstream and downstream links in the value chain. Countries increase their GVC participation both by increasing imported content of exports (foreign value added in exports) and by generating more value added through goods and services for intermediate use in the exports of third countries. Naturally, the latter mechanism yields the positive results for the domestic economy, as it implies growing domestic value added in exports.

In fact, both the right hand quadrants in figure 20 – countries that reduce their reliance on foreign value added in exports – indicate higher GDP per capita growth results than the left hand quadrants. Examples include China, Chile, the Philippines, Thailand and Morocco.

Interestingly, both the top quadrants in the matrix – countries with faster GVC growth rates – have significantly higher growth rates than the bottom quadrants. This suggests that even those countries that rely more on foreign value added in exports, on average, may be better off if it results in higher GVC participation. Countries with high GVC participation growth rates include Indonesia, Malaysia, VietNam, Bangladesh, Mexico and Turkey.

Figure 18. Correlation between growth in GVC participation and GDP per capita



Source: UNCTAD-Eora GVC Database, UNCTAD analysis.

Note: the regression between the annual GDP per capita (in PPS) growth and annual GVC participation index growth, in logs, shows a positive and significant correlation, at the 5% level. This relation also holds, at the 5% level, dividing the sample in developed and developing countries, and in two time periods (1990-2000 and 2001-2010). To avoid picking-up a compositional effect resulting from the correlation between a country' s total value added (used as a component to calculate the GVC participation index) and its per capita GDP, all regressions use lagged (one year) GVC growth rates.

Clearly the optimal policy outcome is depicted in the top right hand quadrant, where countries increase GVC participation through growth in the domestic value added in exports. Examples of countries in the top right quadrant include China, Indonesia, Thailand and Peru. While increasing foreign value added content in exports may be a short-term trade-off for policymakers, longer term the creation of domestic productive capacity yields the better results.

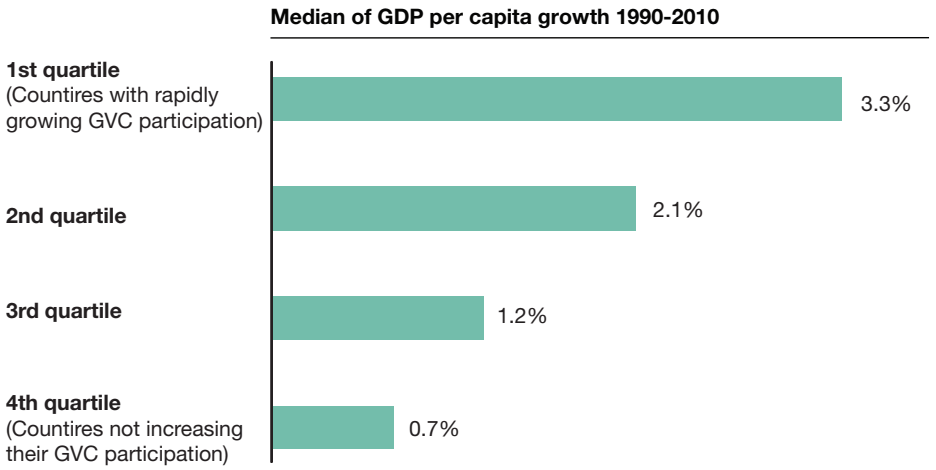
Are there different GVC development paths?

The different outcomes in each of the combinations of GVC integration and domestic value added suggest that there may be a set of distinct "GVC development paths" or evolutionary lines in countries' patterns of participation in GVCs.

Although the matrix is a simplification of reality that cannot capture all the dynamics of development, broadly, a number of GVC development paths can be hypothesized (figure 21), each with a set of prevalent trade and investment patterns:

- *Engaging* in GVCs. Developing countries may see imports of intermediate goods, components and services increase, as well as the importance of processing exports. This pattern often coincides with an influx of processing FDI and the establishment of NEM-relationships (e.g. contract manufacturing) with TNCs.
- *Preparing* for GVCs. Some developing countries may see exports remain predominantly within sectors and industries with domestic productive capacity (with limited need for imported content). FDI inflows help produce intermediate goods and services for

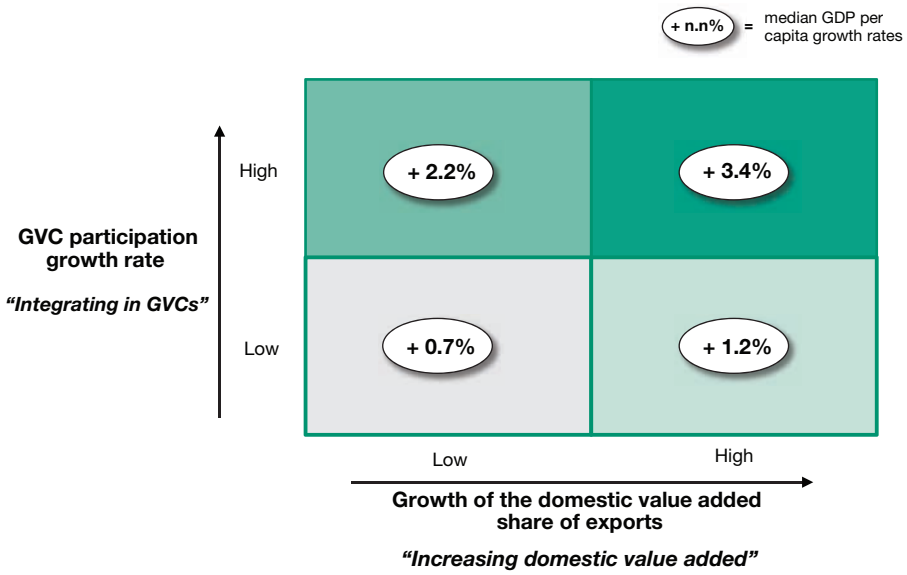
Figure 19. GDP per capita growth rates by quartile of growth in GVC participation, developing economies only, 1990-2010



Source: UNCTAD-Eora GVC Database, UNCTAD analysis.

Note: data for 120 countries, ranked by GVC participation growth and grouped in quartiles (of 30 each); growth rates reported are median values for each quartile.

Figure 20. GDP per capita growth rates for developing countries with high/low growth in GVC participation, and high/low growth in domestic value added share, 1990-2010

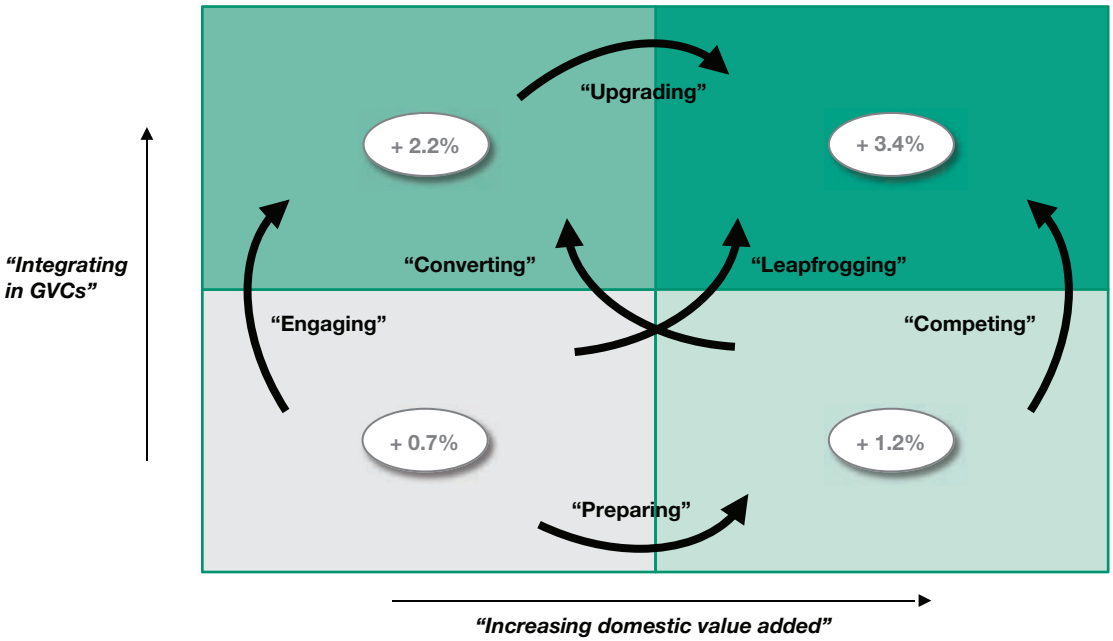


Source: UNCTAD-Eora GVC Database, UNCTAD analysis.

Note: data for 123 developing countries, ranked by growth in GVC participation and domestic value added share; high includes the top two quartiles of both rankings, low includes the bottom two; GDP per capita growth rates reported are median compound annual growth rates for countries in each quadrant.

Figure 21. Possible GVC Development Paths

CONCEPTUAL



Source: UNCTAD.

export products, substituting imports. These patterns of trade and FDI preserve domestic value added in trade, at times at the cost of more rapid integration in GVCs.

- *Upgrading* in GVCs. Some developing countries with an already significant level of integration in GVCs have succeeded in increasing exports of higher value added products and services or in capturing a greater share of value chains (covering more segments). Such export upgrading patterns often combine with an influx of FDI in adjacent value chain segments and higher technology segments.
- *Competing* in GVCs. Some developing countries manage to compete successfully at high value added levels through domestic productive capacity for exports. They may see patterns of FDI aimed at integrating domestic operators in international production networks, often through M&As.
- *Converting* GVCs. Some developing countries have seen the composition of their exports shift towards processing industries requiring higher imported content, or have even seen productive capacity for exports convert to engage in tasks and activities that are part of GVCs. This process can coincide with increased FDI in processing industries, including through M&As, and the establishment of NEM-relationships with TNCs.
- *Leapfrogging* in GVCs. A few countries have experienced very rapid development of domestic productive capacity for exports competing successfully at high value added levels. In these cases, FDI has often acted as a catalyst for trade integration and domestic productive capacity building.

Further research on the effects of integration in GVCs, increased domestic value added trade, and associated patterns of trade and investment, will be needed to explore the policy relevance and implications of different GVC development paths. Nevertheless, the preliminary findings presented in this report provide ample material for a comprehensive policy analysis agenda.

Concluding remarks: a policy analysis agenda

With this report UNCTAD's Division on Investment and Enterprise launches the UNCTAD-Eora GVC Database of value added trade and investment.

The preliminary analysis of the data presented in this report shows how global investment and trade are inextricably intertwined through GVCs. The international production networks of TNCs that shape GVCs through their investments in productive assets worldwide account for some 80% of global trade.

UNCTAD's data show that almost all developing countries, including the poorest, are increasingly participating in GVCs. Evidence on GVC links in developing countries – based on the data presented here and on UNCTAD's wider research on GVCs – suggests that they can have important development benefits:

- GVCs can facilitate access to global markets and integration in the global economy for developing countries, which no longer have to develop an entire industry to generate exports, but can focus on fewer tasks within industry value chains.
- Participation in GVCs generates employment and may result in faster GDP and income growth.
- Moreover, GVCs can be an important avenue for developing countries to build productive capacity, including through technology dissemination and skill building, opening up opportunities for longer-term industrial upgrading.

However, GVCs can also entail risks for developing countries:

- Many of the potential development benefits of GVCs — in particular technology dissemination, skill building and upgrading — are not automatic. Developing countries can remain locked into relatively low value added activities.
- The location of tasks and activities within GVCs is determined by dynamic factors — including relative labour productivity and cost — and as such can shift around the international production networks of multinational firms (they can be footloose).
- The sustainability impact of GVCs can be significant, starting from the environmental impact of moving goods along internationally dispersed value chain segments, to the risk of firms moving activities with greater environmental impact to less regulated locations. Similarly, the social and labour impact of GVCs must be taken into account.

This balance of opportunities and risks makes a well-informed policy debate on the development impact of GVCs of paramount importance. The raison d'être for the UNCTAD-Eora GVC Database on value added trade and investment is to stimulate and contribute to such debate.

UNCTAD will, in the coming months, deepen the analysis of the data, focusing in particular on the development impact and policy implications for developing countries. Questions that UNCTAD will aim to answer include:

- What are the implications of new insights on GVCs for investment and trade theory?
- What are the prospects for further evolution of GVCs and their role in global investment and trade dynamics?
- What are the drivers and determinants of the location or re-location of cross-border productive activity via (equity and non-equity) investment in GVCs?
- Should developing countries adopt specific policies in their development strategy to increase GVC participation? If so, under what circumstances, based on what criteria?
- How can developing country policymakers promote upgrading over time? Is the middle-income trap a real challenge for policymakers?
- Can we measure the "footloose" nature of some of the links in the chain? What kind of shocks and vulnerabilities might threaten the gains from GVC participation? Is trade more volatile within GVCs?

- What policies can maximize the benefits and minimize the negative effects of GVC participation in economic, social and environmental terms?
- What are the implications of the spread of GVCs for transfer pricing?

The data and policy analysis work that UNCTAD will carry out — with the involvement of experts in the field — will contribute to and benefit from on-going debates in UNCTAD's discussion forums and expert meetings, and will culminate in the forthcoming *World Investment Report 2013* on GVCs and Development. Upon publication of *WIR13* the UNCTAD-Eora GVC Database will be made available to the public.

ANNEX. Technical note on the UNCTAD-Eora GVC Database

Calculating value added trade from the Eora data

The Eora dataset provides a multi-region input-output (MRIO) table at the world level used to estimate value added in trade. In particular, the innovation with respect to national input-output tables is that the MRIO tables break down the use of products according to their origin: first, splitting the flows of products between domestically produced or imported; second, distinguishing intermediate and final use; third, indicating the origin of every imported product. Therefore, using a MRIO table can allow us to see the relationship between all producers and consumers in all regions covered.

The construction of the Eora MRIO table follows several steps:[7]

1. The starting points are the national supply and use tables (SUTs). National SUTs are considered better than input-output tables because they provide information on both products and industries. A supply table provides information on products produced by each domestic industry and a use table indicates the use of each product by an industry or final user. However, these tables are only available for a limited number of countries; the remaining countries are hence represented by traditional input-output (I–O) tables, which can be sourced from available data or compiled according to a range of technology assumptions. In order to avoid departures from the original raw data, Eora decided to keep the technology assumption at the industry and product-level made by the respective data provider.

2. National SUTs and I–O tables are linked through international trade statistics using import tables, to obtain a multi-region input-output table.

3. After obtaining a first estimate of a MRIO table, the resulting trade data have been balanced through an industry-level balancing condition: the total output produced by each industry must equal the sum of the inputs used by that industry. This has been achieved via 'constraints data', which are: i) Input-output tables and main aggregates data from national statistical offices; ii) Input-output compendia from Eurostat, IDE-JETRO and OECD; iii) The UN national accounts main aggregates database and official data; iv) The UN Comtrade and UN Service Trade international trade databases. The balancing of the MRIO table is conducted after the initial table is constructed. Disturbances are also allowed in the balancing exercise to allow for unaligned and conflicting information. In general, the reliability of a balanced table increases with the quality and amount of superior data used for balancing, and hence it can be expected that countries with better / more numerous statistical sources will be represented with more confidence in the final MRIO (see the next section for a validation of these data).

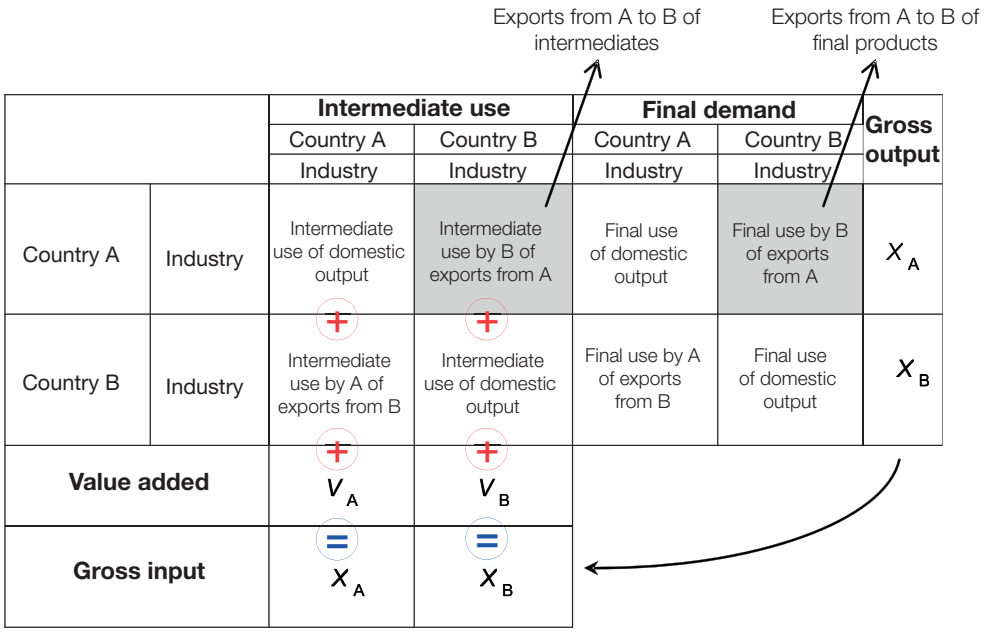
4. The time series is constructed iteratively, by starting with an initial year estimate (year 2000), balancing it with all the starting year constraints, and taking the solution as the initial estimate for the following year, and so on. In each year, all available data for that year (GDP totals, trade data, new I–O tables, interpolated I–O table estimates, and so on) are overlaid onto the initial estimate of that year, and the table is re-balanced.

5. Every single data point in the Eora MRIO is accompanied by an estimate of its standard deviation, reflecting the extent to which it was contested, interpolated, estimated, or adjusted away from its original value in order to assemble a balanced global I–O table.

References for further detail about the Eora database can be found in the end notes.

Figure A.1 below shows a simplified MRIO table, considering only one industry for two countries. The industry (e.g. chemicals) in a country A produces a good x (e.g. plastic) which can be used as an intermediate input in the production of another good or to serve final demand in the same industry. Input-output analysis assumes that the inputs used when producing a product are related to the industry output by a linear and fixed coefficient of production function (at least in the short run). At the

Figure A.1. Structure of a MRIO Table



same time, the output can be used domestically by country A or exported to another country B, where it can also enter as an intermediate or final demand. Analogously, the same good can be imported from country B, and used in A for the production of intermediates or to serve final demand.

The rows in a MRIO table thus indicate the use of gross output from a particular industry in a country. The gross output *X* produced in country A (first row) can be used by country A itself as intermediate or as final consumption, or by the other country B, again as an intermediate input or final product. From here, we can retrieve a measure of gross exports from A to B, summing the intermediate and final output produced in country A and used in country B (the grey blocks in the example above).

The columns of a MRIO table provide instead information on the technology of production, as they indicate the amounts of intermediates needed for the production of the gross output whose use is then decomposed along the row. Hence, each column provides the domestic and foreign share of intermediate in the production of one unit of output. The first column thus shows how much domestic inputs contribute to the production of the gross output of country A (first cell, 'Intermediate use of domestic output'), and how much instead inputs are sourced from abroad through imports (second cell, 'Intermediate use by A of exports from B'). The difference between the gross output produced in each country and the sum of the (domestic and foreign) inputs necessary for its production yields the value added generated in each country (*V*).

Thanks to this information, we can translate the MRIO table for multiple countries and industries into a standard I–O matrix form:[8]

$$\begin{aligned} x &= T + y \\ \Leftrightarrow x &= Ax + y \\ \Leftrightarrow (I - A)x &= y \\ \Leftrightarrow x = (I - A)^{-1}y &= Ly \end{aligned} \qquad (1)$$

where x is gross output, T is the intermediate demand, y is final demand, I is the identity matrix, A is the technological coefficient matrix, and L is the Leontief inverse.[9] From this general equation, we can represent a MRIO table for a n-countries model, still assuming that each country has one representative industry producing a single product.

$$\begin{pmatrix} x^{11} & \cdots & x^{1n} \\ \vdots & \ddots & \vdots \\ x^{n1} & \cdots & x^{nn} \end{pmatrix} = \begin{pmatrix} L^{11} & \cdots & L^{1n} \\ \vdots & \ddots & \vdots \\ L^{n1} & \cdots & L^{nn} \end{pmatrix} \begin{pmatrix} y^{11} & \cdots & y^{1n} \\ \vdots & \ddots & \vdots \\ y^{n1} & \cdots & y^{nn} \end{pmatrix} \qquad (2)$$

This n-countries' framework has been extended in the UNCTAD Eora GVC Database to compute the **"value added trade"** measure, that is the value added embodied in gross trade flows. To calculate the latter, we start from a row vector v with each element representing the share of value added per unit of output by country (that is $v^1 = V^1/X^1$), combined with the Leontief inverse and a vector e summarizing aggregate exports by country as retrieved by the sum of the intermediate inputs exported abroad and exports of final goods[10]

$$\begin{pmatrix} T_v^{11} & \cdots & T_v^{1n} \\ \vdots & \ddots & \vdots \\ T_v^{n1} & \cdots & T_v^{nn} \end{pmatrix} = \begin{pmatrix} v^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & v^n \end{pmatrix} \begin{pmatrix} L^{11} & \cdots & L^{1n} \\ \vdots & \ddots & \vdots \\ L^{n1} & \cdots & L^{nn} \end{pmatrix} \begin{pmatrix} e^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & e^n \end{pmatrix} \quad (3)$$

The first matrix T is the key matrix of our analysis, and for ease of readability it is replicated in the next Figure A.2. The matrix essentially describes how the value added contained in the exports of each country (and industry) is generated (by column) and distributed (by row) across countries. The first column of the matrix describes the value added contained in the export of country 1.[11] This is composed of two parts:

- the term T_v^{11} (in the matrix multiplication we have that $T_v^{11} = v^1 L^{11} e^1$) denotes the *Domestic Value Added* (DVA) content of exports of country 1;
- the generic term T_v^{k1} (in matrix notation $T_v^{k1} = v^k L^{k1} e^1$) denotes the *Foreign Value Added* (FVA) content of exports of country 1 generated by country k (with $k \neq 1$). Recall that the production of output by country 1 (part of which is exported) requires inputs from other countries. In producing these inputs, the other countries also generate value added. Hence, this term represents the share of value added that has been generated in country k (v^k) and that has been imported by country 1 (L^{k1}) in order to produce its exports (e^1).

The (column) sum of Domestic and Foreign Value Added, by construction, will yield the total exports of country 1.

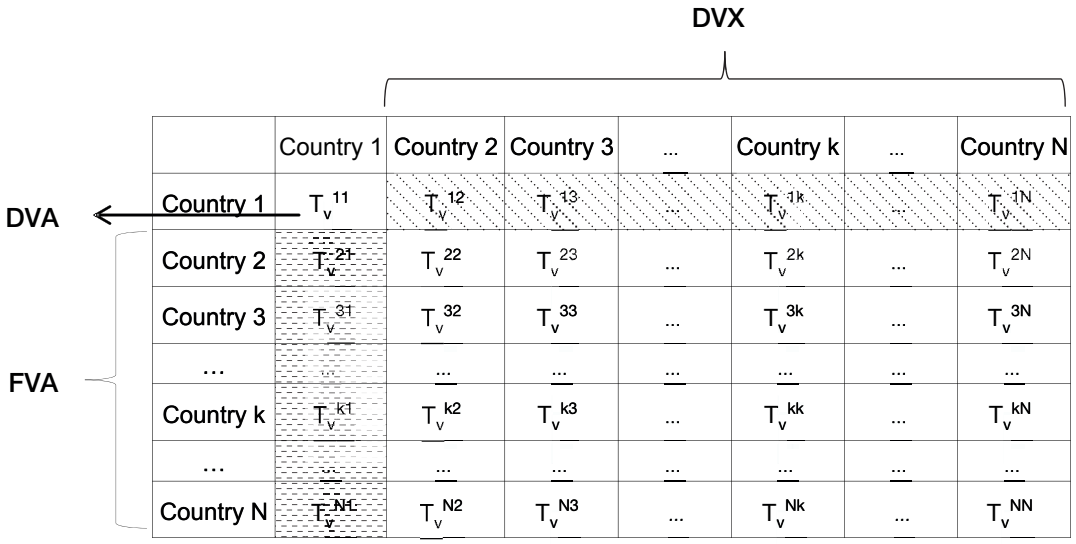
The other columns of the T matrix replicate the exercise for the other countries. So in column 2 of the matrix we will find the term T_v^{22}, which denotes the DVA content of exports of country 2, as well as the generic term T_v^{k2}, which denotes the FVA content of exports of country 2 generated by country k, and so on. Hence, the DVA can be read on the diagonal of the matrix as the generic term T_v^{kk} for any country k in the dataset.

Now, consider country 1 and country 2. As we have seen, country 1 is sourcing some value added from country 2 for its exports (the term T_v^{21} which we have already considered as a component of FVA in the first column), but also country 2 is sourcing some value added from country 1 (the term T_v^{12} in the second column) for its exports. More specifically, in matrix expression we have $T_v^{12} = v^1 L^{12} e^2$: hence this term represents the share of exports of country 2 (e^2) that depends on the value added sourced by country 1 ($v^1 L^{12}$). The same would be true for a country 3, in which the term T_v^{13} in the third column indicates how much country 3 is sourcing in terms of value added from country 1. Hence, by reading the matrix along the row, rather than along the column (and excluding the diagonal term T_v^{kk}), we would have an indication of how much of each country's domestic value added enters as an intermediate input in the value added exported by other countries. The latter terms is what Koopman et al. (2011) call "indirect value added exports" (DVX). Clearly, by construction what each country contributes to all the others in terms of indirect value added exports has to be equal at the world level to what each country sources from all the others in terms of foreign value added, that is at the world level FVA = DVX. The latter gives a rough, though not perfect, proxy of the double counting embedded in the gross (official) trade figures.

More precisely, part of the DVA exported and incorporated in third countries' export can itself return home and thus generate some further double counting, as the original DVA measure would include a share of domestic value added that is returned home after being processed abroad.[12]

However, given the complexity of computing all these terms for a MRIO with 187 countries, and since a perfect decomposition of gross exports in

Figure A.2. The matrix of the value added content of trade



all its components is still under discussion in the literature, we have not carried out this exercise in the UNCTAD Eora GVC data (in short Eora data), limiting ourselves to identify the three terms of DVA, FVA and DVX previously discussed.[13]

In any case, attempts by the literature to calculate such a measure of 're-imported DVA' show that the latter is relatively small at the world level (though it might be slightly more significant for some countries or industries). In particular, Koopman et al. (2011) estimate that the domestic content of foreign exports that finally return home is 4% of gross exports in 2004. The results computed by Stehrer (2012) using the WIOD database indicate at the world level a range from a minimum share of 2.6% in 1995 to a maximum of 3.3% in 2008, with the figure for 2009 being at 2.9%. The OECD–WTO initiative, in turn, estimates that the re-imported DVA equals to just 0.6% of world gross exports in 2009.

In light of this evidence, the foreign value added component (FVA) reported in the Eora data can thus be considered as a lower bound of the actual "double counting" taking place in world trade, remembering in any case that a small (and unaccounted) fraction of double counting remains in our DVA measure.

Validating the UNCTAD Eora GVC data

As recalled in Box 1, a number of world I–O tables nowadays exist providing a measurement of value added trade and thus allowing, in principle, a benchmarking exercise, at least for the common countries and indicators that can be identified within each dataset.

The most simple indicator that can be commonly computed across datasets is the foreign value added content of exports (FVA). Koopman et al. (2012), working with the GTAP database, estimate that the foreign content of exports at the world level is 21.5% in 2004 (Eora data in 2004 is 28.7%).[14] Stehrer (2012) estimates that the world foreign value added of exports (using WIOD) is 23.7% in 2009,[15] while from the OECD–WTO data one can estimate the same figure at roughly 21% of gross exports in 2009. The same figure for the Eora data is at 27.6%.

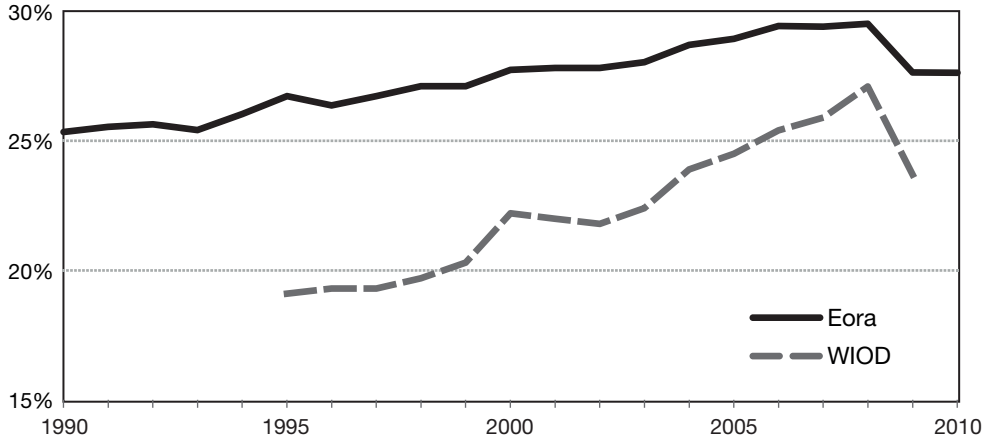
It seems therefore that the UNCTAD Eora GVC data on FVA have a slight upper bias (between 4 and 7%) at the world level with respect to other comparable dataset. This can be expected, considering that the dataset is the only one covering all individual countries in the world. As such it does not include, as others dataset do, an artificial 'Rest of the

World' country whose I–O matrix has been derived through a proportionality assumption based on an 'average' world technology. The latter could yield a downward bias in the computed world FVA, as the world average I–O includes by definition large, relatively close, countries, while most excluded countries in the 'Rest of the World' aggregate tend to be small, relatively more open, economies.

To get a sense of this difference, Figure A3 below reports the extent of the difference in world FVA share between Eora and the WIOD data for various years.[16] As it can be seen, within a common time trend of increasing foreign value added over time (in line with evidence of a deepening globalization process across the world), level differences in the two datasets are not large, and are getting smaller over time.

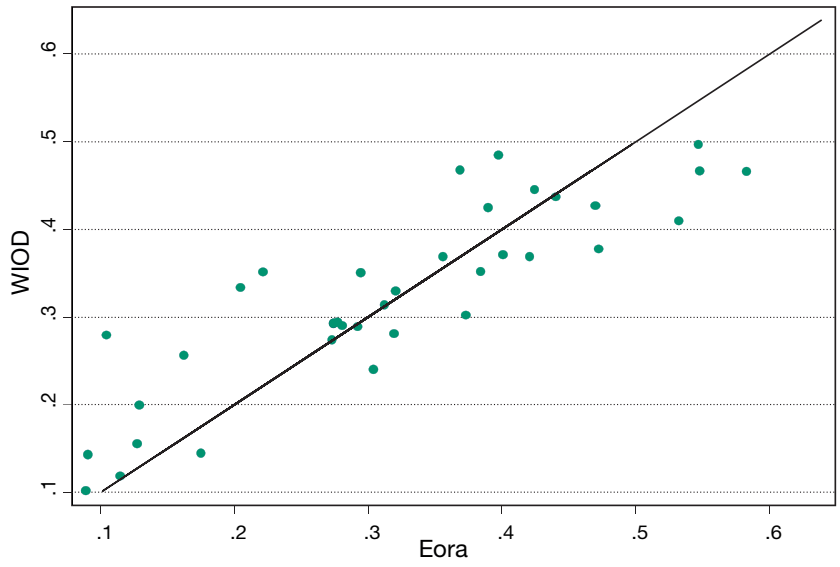
Figure A4 compares instead the FVA share of all the 39 countries included in WIOD (vertical axis) with the same measure retrieved from the Eora data (horizontal axis) for the year 2009 (last available year in WIOD data). As it can be seen, both variables for each country tend to be scattered around the 45° degree line, thus indicating no particular bias in one dataset or the other. Correlation is around .9.[17]

Figure A.3. FVA share in exports, comparison between Eora and WIOD



Source: UNCTAD/Eora, WIOD.

Figure A.4. FVA share in exports by country, WIOD vs. Eora, 2009



Source: UNCTAD/Eora GVC Database; WIOD.

Notes and References

1 The Eora Project, originally funded by the Australian Research Council, based at the University of Sydney and comprising an international team of researchers, developed the so-called "world multi-region input-output database" that is the basis for the generation of the value added trade estimates in the GVC Database discussed in this paper. For further details, see http://www.worldmrio.com/.

2 Equating foreign value added with the double counting in global trade figures is a simplification. Some further double counting takes place within foreign value added as exported value added can re-enter countries to be incorporated in further exports, and so forth. Such circular double counting can be significant in some countries and some industries, but is marginal in most.

3 This variable is related to an active literature on measuring vertical specialization, with the first indicator calculated being the value of imported inputs in the overall (gross) exports of a country. The refinement to this indicator of vertical specialization corrects for the fact that the value of (gross) imports used by country A to produce exports (as retrieved from 'standard' I–O tables) in reality might incorporate the domestic value-added of the same country A that has been used as an input by a foreign country B, from which the same country A then sources. Allowing instead only for the foreign value-added of country B to enter in the calculation of country A's inputs nets out this effect. See: Hummels, D., J. Ishii and K.-M. Yi (2001) "The nature and growth of vertical specialization in world trade", Journal of International Economics 54(1), 75-96; and Johnson, R.C. and G. Noguera (2012) "Accounting for intermediates: Production sharing and trade in value-added", Journal of International Economics 86(2), 224-236.

4 This indicator was first introduced in Koopman, R., W. Powers, Z. Wang and S.-J. Wei (2011) "Give credit to where credit is due: tracing value added in global production chains", NBER Working Papers Series 16426, September 2010, revised September 2011.

5 See Fally, T. (2011). "On the Fragmentation of Production in the US", University of Colorado-Boulder, July.

6 Estimates are based on data from the United States Bureau of Economic Analysis ("U.S. Affiliates of Foreign Companies and U.S. (Ministry of Commerce) Multinational Companies", 2012); China MOFCOM; OECD; IDE-JETRO. Data for Europe from Altomonte, C., F. Di Mauro, G. Ottaviano, A. Rungi and V. Vicard. 2012. "Global Value Chains during the Great Trade Collapse: A Bullwhip Effect?" ECB Working Paper Series No. 1412.

7 Detailed technical information on the construction of Eora can be found in M. Lenzen, K. Kanemoto, A. Geschke, D. Moran (2012) "Mapping the Structure of the World Economy." Environmental Science & Technology 46 (15): 8374–8381.Two more approachable summaries are also due to be published soon: "Tracing Embodied CO2 in Trade Using High-Resolution Input-Output Tables", chapter in Computationally Intelligent Data Analysis for Sustainable Development. ed. T. Yu. and The Eora MRIO, chapter in The Sustainability Practitioner's Guide to MRIO. ed. J. Murray and M. Lenzen.

8 United Nations (1999). "Handbook of input–output table compilation and analysis". Studies in Methods Series F, No 74. Handbook of National Accounting. New York.

9 See Leontief, W. (1970). "Environmental Repercussions and the Economic Structure: An Input-Output Approach". The Review of Economics and Statistics, 52(3), 262–271.

10 Starting with the seminal work of Hummels, Ishii & Yi (ibid.), variations of this methodology have recently been used in a number of recent papers. Johnson & Noguera (ibid.), Timmer, M., B. Los, R. Stehrer, and G. de Vries (2012) "Fragmentation, Incomes and Jobs. An analysis of European competitiveness", WIOD Working Paper 9, Groningen; and Stehrer, R., N. Foster and G. de Vries (2012) "Value Added and Factors in Trade: A Comprehensive Approach", WIIW Working paper 80, Vienna ultimately reapportion worldwide final demand across countries, rather than exports, allowing them to disentangle the value added created in one country due to consumption in other countries ('trade in value added'). The OECD-WTO exercise instead follows an approach entirely similar to the one presented here and originally proposed by Koopman et al. (ibid.): this approach disentangles the domestic and foreign value added embodied in a country's gross exports (referred to in this report as 'value added (in) trade'). Details on the OECD-WTO dataset and method can be found in OECD - WTO (2012), "Trade in Value-Added: Concepts, Methodologies and Challenges", www.oecd.org; and in De Backer and Miroudout (2012). "Mapping Global Value Chains", Paper prepared for the WIOD Conference: Causes and Consequences of Globalization, Groningen, The Netherlands, 24-26 April 2012.

11 As in Stehrer et al. (ibid.).

[12] For a precise decomposition, see Koopman et al. (ibid.).

[13] To get an idea of the complexity of the exercise, each yearly MRIO contains tens of millions of observations, that is around 4GB of data, but together with the superior variables needed to balance the MRIO table at the world level, each dataset to be used by the optimization algorithm grows to 70 GB, and thus requires 2 to 10x as much in RAM capability to run. The Australian NCI supercomputing facilities have been used by the Eora team to retrieve value added trade data.

[14] The GTAP dataset employs a different balancing algorithm with respect to other existing world I–O tables (including Eora), as the balancing algorithm prioritize the correspondance between gross vs. SUT-derived trade flows rather than domestic value added. See Koopman et al. (ibid.).

[15] See Stehrer et al. (ibid.).

[16] The Eora data have been validated against the WIOD data as the latter dataset gives direct access to the original national Supply-use tables. As such, it allows to exactly replicate the underlying methodology in the construction of the indicators to be compared across datasets.

[17] Two outliers have been excluded from the comparison, that is Bulgaria and Luxembourg. In both cases FVA shares in WIOD were some 20% larger than the measure retrieved in Eora. The average (absolute) difference across the remaining countries is instead around 6 percentage points.